Deutsche Physikalische Gesellschaft DPG

Virtual DPG Spring Meeting 2022

with the Divisions

Hadronic and Nuclear Physics, Plasma Physics

and the Working Group

Accelerator Physics

28 March – 1 April 2022

mainz22.dpg-tagungen.de

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Content

Dear conference guests,

On behalf of the German Physical Society and also personally, I would like to welcome you to the virtual DPG-Frühjahrstagung (DPG Spring Meeting) in "Mainz" with the Divisions Hadronic and Nuclear Physics and Plasma Physics as well as the Working Group on Accelerator Physics.

I am very pleased that this Spring Meeting continues to take place despite the pandemic. Maintaining scientific exchange cannot be valued highly enough. Just as important in these times are the DPG conferences once again as outstanding symbols of the importance of scientific thinking in our society: Natural science produces hypotheses that have to be verified experimentally – that is the core of basic research.

I agree with Niels Bohr, who is said to have said: "Forecasts are difficult, especially when they concern the future." Nevertheless, I see physics and the DPG in particular as having a special responsibility to enter into a dialogue with politics on the basis of the findings from basic research in order to meet the major challenges facing society – and thus also to enable future generations to live well on this planet. For this dialogue, the solidarity of the scientific community with the colleagues who dare to go public and steadfastly represent their results is particularly crucial.

I would like to express my sincere thanks to all those involved for the success of this Spring Meeting. First of all, I would like to thank the local conference management, Prof. Dr. Frank Maas, Institute for Nuclear Physics, Johannes Gutenberg University Mainz, for its support as well as the programme committee – consisting of the chairpersons of the divisions and the working group involved – for the outstanding programme of this conference. I would also like to thank the staff of the DPG Head Office for their support and supervision of all meetings.

I would also like to express my sincere thanks to the Wilhelm and Else Heraeus-Stiftung for again providing generous financial support to our young members.

I wish you all an exciting conference and many new insights.

Dr. Lutz Schröter
President of the
Deutsche Physikalische Gesellschaft e.V.

Organisation

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Scientific Organisation

Chairs of the participating Divisions

Hadronic and Nuclear Physics (HK)
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Chair of the participating Working Group

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Symposia

Plasma Induced Accelerators (SYPA)
Organisation: Kurt Aulenbacher, Johannes Gutenberg-Universität Mainz; Silvia Masciocchi, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Plasmas in the Universe (SYPU)
Organisation: Laura Fabbietti, Technische Universität München; Ronny Brandenburg, Leibniz-Institut für Plasmaforschung und Technologie e.V. (INP), Greifswald

Programme

The scientific programme consists of **645** contributions:

3	Plenary Talks
38	Invited Talks
55	Group Reports
445	Talks
104	Posters

Information for Participants

The virtuell conference will be held in the period 28 March – 1 April, 2022.

Conference Location

Web-based Conference – Login information will be provided a few days before the event starts.

Conference Time Zone

All times mentioned on the website and in the programme are in Central European Time (CET), UTC+1.

Conference Website

https://mainz22.dpg-tagungen.de/

Conference Office

The virtual conference office is situated on the conference platform and will be open daily from 08:30 – 16:00 (Friday 08:30 – 12:00) for questions round the conference. You will find it on the conference platform under the „*Welcome*" tab immediately after signed up.

Technical Requirements

The MeetAnyway platform will be used for the conference. In order to participate in the conference, you need a MeetAnyway account with which you can register on the conference platform.

If you do not have a MeetAnyway account yet, please create one on meetanyway.com in good time before the start of the conference – using the email address you used for participant registration. To do this, click on „Create New Account" and follow the instructions on the screen. During registration, you will receive a 6-digit code by email from MeetAnyway to activate your account.

After creating the account, please add a profile picture and your affiliation to your personal profile.

To use all features of the conference platform, you need an up-to-date browser. Chrome is currently the most stable and reliable browser for using the conference platform. Firefox and Safari are browsers that should work but are often less performant. MeetAnyway support staff is highly trained in resolving Chrome issues. If you are using a different browser (e.g. Firefox, Safari or Edge), the support staff cannot provide in-depth troubleshooting support for you.

In case you have not received the activation code for your MeetAnyway account or you have technical difficulties on the meeting platform please contact the MeetAnyway support staff

- by email: support@meetanyway.com
- via the participant helpdesk: https://help.meetanyway.com or
- directly on the conference platform via the (?) symbol at the right top.

All lectures will be held and broadcast via Zoom video conferencing service. For the best experience we recommend that you download or update to the latest version of the Zoom client for meetings before the start of the conference. A Zoom account is not required to use the application. Alternatively, joining the Zoom Meetings is also possible via all common browsers (Chrome, Firefox, Safari and Edge).

A video chat room is linked to each poster, where you can discuss in small groups during the poster sessions. In addition, numerous video chat rooms are offered for exchange and networking.

For video chats, permission to access your microphone and camera is required. Please note that firewalls of company or institute networks can limit the functionality.

How to use the Conference Platform MeetAnyway
For using the platform, you will find detailed step-by-step instructions at *mainz22.dpg-tagungen.de/tagungsplattform*.

Notice Board
All changes regarding the schedule of the conference will be updated currently. The information is identical to the programme updates of the scientific programme and available at the scientific programme in other formats as well (ordered by publication date, filterable by conference part and as an rss-feed). Please use the form at *https://mainz22.dpg-tagungen.de/programm/notice-board-form* to submit amendments, cancellations, etc.

Wilhelm and Else Heraeus Communication Programme
Within this programme, the active participation by young DPG members – from Germany and abroad – at the virtual DPG Meetings is financially supported.
For the virtual DPG-Meetings, the conference fee (exclusively the "early bird rate") is subsidised at 100% (*submission of an application was open until 18 February 2022. Subsequent applications are not possible*). After the conference, your participation in the conference will be checked on the basis of the login data and the funding will be finally confirmed or rejected if no participation took place. Payment will be made – after prior notification by email – by the end of April 2022 at the latest by bank transfer to the account you specified in your application.

The Deutsche Physikalische Gesellschaft thanks the Wilhelm and Else Heraeus-Stiftung for the generous financial support of young academic talents. We hope that young physicists will continue to seize the offered opportunity for active scientific communication at scientific conferences. A total of about 37,800 young academics were supported by this programme so far.

Information for Speakers
All speakers are invited to use our offer for a test session one week before the conference starts. The necessary information for the test session about day, time and login information will be sent out by email to the speakers. We would like to ask you to consider the following points for your presentation:

- Please use the same equipment with which you successfully completed your technical check to avoid technical problems during your presentation.
- Please be in the Zoom session of the virtual room where you will give your presentation at least 10 minutes before the session starts. Access – for session chairs, speakers and participants – to the individual sessions is via the virtual rooms on the conference platform (via the „Join" option). No separate login information will be sent to presenters.
- Please sign in at Zoom with your full name so that the technical support and the conference organisers can identify you as a speaker and give you the rights to share your screen, microphone and camera in Zoom.
- Please make sure that you respect your presentation time!

Information for Poster Presentations
A poster presentation can consist of up to six files – directly visible to the poster visitor – with the following requirements:

- Poster file as PDF without format restriction up to a size of 10 MB
- Image file as PNG, JPG or GIF in 4:3 format (min.1600x1200) up to a size of 10 MB
- animated GIF file in 4:3 format (min.1600x1200) up to a size of 10 MB

The criteria are based on the technical requirements of the conference platform. Therefore, different file formats are not possible.

We recommend creating an image file as a preview image and creating the poster as a PDF file in classic portrait format (DIN A0). If only a poster file is created, this also functions as the preview image.

In addition, up to six further files (in all common formats) of 100 MB each can be attached as downloads to the presentation. Upon receipt of the login data – a few days before the start of the conference – the upload of the created file(s) is possible for the authors.

Once the uploads have been approved by the conference organisers, the posters will be available to all registered conference participants throughout the conference via the password-protected conference platform.

Presenting authors are requested to be available to answer questions and discuss via group video chat during the entire poster session at their poster.

Social Events

Annual Meeting of Young Scientists in High Energy Physics (yHEP) in 2022
On Tuesday, 29 March 2022, 19:00 – 20:00, the annual 2022 meeting of young scientists in high energy physics (yHEP) will take place online. All doctoral candidates, post-docs and scientists on temporary contracts are cordially invited.
We will present our activities from the last year and would like to discuss plans for the coming year with you and hear your ideas and thoughts. Topics are current and future developments in high and low energy physics, i.e. particle, astroparticle, hadron and nuclear physics, as well as accelerator physics, including topics of the situation of early-career researchers, environmental sustainability, networking and shaping the future of our fields.

Please register to our mailing list which can be found from https://yhep.desy.de to receive details on the meeting.

Annual General Meetings of the DPG Divisions and Working Group

Division / Working Group		**Date**	**Time**	**Location**
(HK)	Hadronic and Nuclear Physics	Thursday, 31 March	18:00 – 19:00	HK-MV
(P)	Plasma Physics	Wednesday, 30 March	17:30 – 18:30	P-MV
(AKBP)	Accelerator Physics	Thursday, 31 March	18:00 – 19:00	AKBP-MV

Synopsis of the Daily Programme

Monday, March 28, 2022

			Plenary Talk
09:45	Audimax	PV I	The first wall in fusion experiments – an interface under extreme operational conditions •Rudolf Neu

HK

			Invited Talks
11:00	HK-H1	HK 1.1	A supernova in the lab – Astrophysics with stored, radioactive ions •Jan Glorius
11:30	HK-H1	HK 1.2	Exotic quark-made formations •Mikhail Mikhasenko
12:00	HK-H1	HK 1.3	Nuclear ab-initio theory for neutrino oscillations •Joanna Sobczyk, Sonia Bacca, Bijaya Acharya
			Sessions
11:00	HK-H1	HK 1	Invited Talks I
14:00	HK-H1	HK 2	Heavy-Ion Collisions and QCD Phases I
14:00	HK-H2	HK 3	Heavy-Ion Collisions and QCD Phases II
14:00	HK-H3	HK 4	Instrumentation I
14:00	HK-H4	HK 5	Instrumentation II
14:00	HK-H5	HK 6	Instrumentation III
14:00	HK-H6	HK 7	Structure and Dynamics of Nuclei I
14:00	HK-H7	HK 8	Structure and Dynamics of Nuclei II
14:00	HK-H8	HK 9	Hadron Structure and Spectroscopy I
14:00	HK-H9	HK 10	Hadron Structure and Spectroscopy II
14:00	HK-H10	HK 11	Nuclear Astrophysics I
16:00	HK-H1	HK 12	Heavy-Ion Collisions and QCD Phases III
16:00	HK-H2	HK 13	Heavy-Ion Collisions and QCD Phases IV
16:00	HK-H3	HK 14	Instrumentation IV
16:00	HK-H4	HK 15	Instrumentation V
16:00	HK-H5	HK 16	Instrumentation VI
16:00	HK-H6	HK 17	Structure and Dynamics of Nuclei III
16:00	HK-H7	HK 18	Structure and Dynamics of Nuclei IV
16:00	HK-H8	HK 19	Hadron Structure and Spectroscopy III
16:00	HK-H9	HK 20	Hadron Structure and Spectroscopy IV
16:00	HK-H10	HK 21	Astroparticle Physics I

P

			Invited Talks
11:00	P-H11	P 1.1	Plasma Physics in EUV Lithography •Iris Pilch
11:30	P-H11	P 1.2	Optical emission spectroscopy of spokes in magnetron sputtering discharges •Julian Held, Philipp A Maaß, Volker Schulz-von der Gathen, Achim von Keudell
12:00	P-H11	P 1.3	Functional coatings by atmospheric pressure plasma technology •Kristina Lachmann, Thomas Neubert, Annika Mann, Marvin Omelan, Michael Thomas
			Sessions
11:00	P-H11	P 1	Invited Talks I
14:00	P-H11	P 2	Low Pressure Plasmas I
14:00	P-H12	P 3	Laser Plasmas I
16:00	P-H11	P 4	Low Pressure Plasmas II / Laser Plasmas II
16:00	P-H12	P 5	Helmholtz Graduated School HEPP I

Monday, March 28, 2022

AKBP

Sessions

14:00	AKBP-H13	AKBP 1	New Accelerator Concepts 1
14:00	AKBP-H14	AKBP 2	Radiofrequency Systems 1
16:00	AKBP-H13	AKBP 3	Diagnostics, Control and Instrumentation 1
16:00	AKBP-H14	AKBP 4	Radiation Generation and Applications

Tuesday, March 29, 2022

Plenary Talks

09:00	Audimax	PV II	Advances in laser plasma accelerators and their future prospect •Wim Leemans
09:45	Audimax	PV III	Precision physics with low energy electron scattering: The physics program at MESA •Harald Merkel

HK

Invited Talks

11:00	HK-H1	HK 22.1	Towards background-free measurements of double-beta decay events: a quest to increase the detection sensitivity of the neutrinoless double beta decay mode •Samuel Ayet San Andres
11:30	HK-H1	HK 22.2	Baryon spectroscopy with the Jülich-Bonn dynamical coupled-channel approach •Deborah Rönchen
12:00	HK-H1	HK 22.3	Hadronen und Kerne in der Öffentlichkeit •Christian Klein-Bösing
14:00	HK-H1	HK 23.1	Jets in heavy-ion collisions •Jasmine Brewer
14:30	HK-H1	HK 23.2	The initial state of the quark-gluon plasma at the intersection of hadronic and nuclear physics •Giuliano Giacalone
15:00	HK-H1	HK 23.3	High-precision mass spectrometry with ISOLTRAP at ISOLDE/CERN •Jonas Karthein

Sessions

11:00	HK-H1	HK 22	Invited Talks II
14:00	HK-H1	HK 23	Invited Talks III
16:00	HK-H1	HK 24	Heavy-Ion Collisions and QCD Phases V
16:00	HK-H2	HK 25	Heavy-Ion Collisions and QCD Phases VI
16:00	HK-H3	HK 26	Instrumentation VII
16:00	HK-H4	HK 27	Instrumentation VIII
16:00	HK-H5	HK 28	Computing I
16:00	HK-H6	HK 29	Structure and Dynamics of Nuclei V
16:00	HK-H7	HK 30	Outreach
16:00	HK-H8	HK 31	Hadron Structure and Spectroscopy V
16:00	HK-H9	HK 32	Hadron Structure and Spectroscopy VI
16:00	HK-H10	HK 33	Nuclear Astrophysics II

Tuesday, March 29, 2022

P

			Invited Talks
11:00	P-H11	P 6.1	Laser diagnostics on atmospheric pressure plasmas: From basic to fancy •Volker Schulz-von der Gathen, the CRC 1316 team
11:30	P-H11	P 6.2	Liquid tin interaction with deuterium plasmas •Armin Manhard, Martin Balden, Thomas Schwarz-Selinger, Rudolf Neu
12:00	P-H11	P 6.3	Plasma jets on surfaces •Ana Sobota
			Sessions
11:00	P-H11	P 6	Invited Talks II
14:00	P-H11	P 7	Atmospheric Pressure Plasmas I
14:00	P-H12	P 8	Helmholtz Graduate School HEPP II
16:00	P	P 9	Poster I

AKBP

			Sessions
14:00	AKBP-H13	AKBP 5	Hadron Accelerators – New Devices and Techniques
14:00	AKBP-H14	AKBP 6	Beam Dynamics 1
16:00	AKBP-H13	AKBP 7	Particle Sources
16:00	AKBP-H14	AKBP 8	Radiofrequency Systems 2 – Superconductivity

Wednesday, March 30, 2022

SYPA

			Invited Talks
11:00	Audimax	SYPA 1.1	Laser-driven ion acceleration -20 years of research: applications and prospect •Markus Roth
11:30	Audimax	SYPA 1.2	Laser-plasma ion accelerators for radio-biological research •Karl Zeil
12:00	Audimax	SYPA 1.3	Hybrid plasma accelerators towards higher-quality electron beams •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa
			Session
11:00	Audimax	SYPA 1	Plasma Induced Accelerators

SYPU

			Invited Talks
09:00	Audimax	SYPU 1.1	Recent progress in simulations of dense quantum plasmas and warm dense matter •Michael Bonitz, Paul Hamann, Tobias Dornheim, Zhandos Moldabekov, Alexey Filinov, Jan Vorberger, Pavel Levashov
09:30	Audimax	SYPU 1.2	The quark gluon plasma: from the laboratory to neutron stars •Jan Steinheimer
10:00	Audimax	SYPU 1.3	Characterizing the QCD Plasma •Andrea Dubla

Wednesday, March 30, 2022

SYPU

			Session
09:00	Audimax	SYPU 1	Plasmas in the Universe

HK

			Invited Talks
11:00	HK-H1	HK 34.1	Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions •Sabrina Huth
11:30	HK-H1	HK 34.2	Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis •Andreas Flörs, Luke Shingles, Gabriel Martínez-Pinedo
12:00	HK-H1	HK 34.3	Towards a next-generation LHC heavy-ion Experiment with ALICE •Raphaelle Bailhache
			Sessions
11:00	HK-H1	HK 34	Invited Talks IV
14:00	HK-H1	HK 35	Heavy-Ion Collisions and QCD Phases VII
14:00	HK-H2	HK 36	Heavy-Ion Collisions and QCD Phases VIII
14:00	HK-H3	HK 37	Instrumentation IX
14:00	HK-H4	HK 38	Instrumentation X
14:00	HK-H5	HK 39	Computing II
14:00	HK-H6	HK 40	Structure and Dynamics of Nuclei VI
14:00	HK-H7	HK 41	Structure and Dynamics of Nuclei VII
14:00	HK-H8	HK 42	Hadron Structure and Spectroscopy VII
14:00	HK-H9	HK 43	Hadron Structure and Spectroscopy VIII
14:00	HK-H10	HK 44	Astroparticle Physics II
16:00	HK-H1	HK 45	Heavy-Ion Collisions and QCD Phases IX
16:00	HK-H2	HK 46	Heavy-Ion Collisions and QCD Phases X
16:00	HK-H3	HK 47	Instrumentation XI
16:00	HK-H4	HK 48	Instrumentation XII
16:00	HK-H5	HK 49	Instrumentation XIII
16:00	HK-H6	HK 50	Structure and Dynamics of Nuclei VIII
16:00	HK-H7	HK 51	Structure and Dynamics of Nuclei IX
16:00	HK-H8	HK 52	Hadron Structure and Spectroscopy IX
16:00	HK-H9	HK 53	Hadron Structure and Spectroscopy X
16:00	HK-H10	HK 54	Nuclear Astrophysics III

P

			Invited Talks
11:00	P-H11	P 10.1	AI in fusion: assisting plasma exhaust modelling by machine-learning techniques •Sven Wiesen
11:30	P-H11	P 10.2	COMPACT – A new complex plasma facility for the ISS •Christina A. Knapek
12:00	P-H11	P 10.3	Optical diagnostics of vacuum arc discharges for switching applications •Sergey Gortschakow, Ralf Methling, Steffen Franke, Diego Gonzalez, Dirk Uhrlandt, Sergey Popov, Alexander Batrakov
			Sessions
11:00	P-H11	P 10	Invited Talks III
14:00	P-H11	P 11	Codes and Modelling
14:00	P-H12	P 12	Magnetic Confinement / Plasma Wall Interaction I
16:00	P-H11	P 13	Dusty Plasmas
16:00	P-H12	P 14	Plasma Wall Interaction II / HEPP III
17:30	P-MV	P 15	Annual General Meeting

Wednesday, March 30, 2022

AKBP

Sessions

14:00	AKBP-H13	AKBP 9	Diagnostics, Control, Modeling, Modern IT Applications
14:00	AKBP-H14	AKBP 10	Electron Accelerators and FEL's
16:00	AKBP-H13	AKBP 11	Beam Dynamics 2
16:00	AKBP-H14	AKBP 12	New Accelerator Concepts 2

Thursday, March 31, 2022

HK

Invited Talks

11:00	HK-H1	HK 55.1	Online data processing with GPUs in ALICE during LHC Run 3 •David Rohr
11:30	HK-H1	HK 55.2	From outer space to deep inside: nuclear physics prospects at MAMI and MESA •Michaela Thiel
12:00	HK-H1	HK 55.3	CMOS Monolithic Active Pixel Sensors •Michael Deveaux

Sessions

11:00	HK-H1	HK 55	Invited Talks V
14:00	HK-H1	HK 56	Heavy-Ion Collisions and QCD Phases XI
14:00	HK-H2	HK 57	Heavy-Ion Collisions and QCD Phases XII
14:00	HK-H3	HK 58	Instrumentation XIV
14:00	HK-H4	HK 59	Instrumentation XV
14:00	HK-H5	HK 60	Instrumentation XVI
14:00	HK-H6	HK 61	Structure and Dynamics of Nuclei X
14:00	HK-H7	HK 62	Structure and Dynamics of Nuclei XI
14:00	HK-H8	HK 63	Hadron Structure and Spectroscopy XI
14:00	HK-H9	HK 64	Fundamental Symmetries I
16:00	HK-H1	HK 65	Heavy-Ion Collisions and QCD Phases XIII
16:00	HK-H2	HK 66	Heavy-Ion Collisions and QCD Phases XIV
16:00	HK-H3	HK 67	Instrumentation XVII
16:00	HK-H4	HK 68	Instrumentation XVIII
16:00	HK-H5	HK 69	Instrumentation XIX
16:00	HK-H6	HK 70	Structure and Dynamics of Nuclei XII
16:00	HK-H7	HK 71	Structure and Dynamics of Nuclei XIII
16:00	HK-H8	HK 72	Hadron Structure and Spectroscopy XII
16:00	HK-H9	HK 73	Fundamental Symmetries II
18:00	HK-MV	HK 74	Annual General Meeting

P

Invited Talks

11:00	P-H11	P 16.1	Effect of the green energy revolution on circuit breakers and switches in electrical power distribution systems •Erik D. Taylor
11:30	P-H11	P 16.2	Plasma-beta effects on the island divertor of Wendelstein 7-X •Alexander Knieps, Yasuhiro Suzuki, Joachim Geiger, Andreas Dinklage, Song Zhou, Henning Thomsen, Marcin Jakubowski, Ralf König, Michael Endler, Yu Gao, Yunfeng Liang
12:00	P-H11	P 16.3	Surface modification of inorganic materials by atmospheric-pressure plasmas •Claus-Peter Klages, Vitaly Raev

Plenary Talks

Plenary Talk PV I Mon 9:45 Audimax

The first wall in fusion experiments - an interface under extreme operational conditions — •Rudolf Neu — MPI for Plasma Physics — Technical University Munich

With the largest fusion device, ITER, being built through an international collaboration in the south of France, the test for the viability of nuclear fusion for energy production gets within reach. The hot fusion plasma is confined by a strong magnetic field which conducts the edge plasma into the so-called divertor. It extracts the heat and helium ash produced by the fusion reaction, minimizing plasma contamination through the plasma-facing material. In order to deal with the parallel heat flux from the plasma being in the range of GW/m^2, a large fraction of the power must be dissipated in the edge plasma by radiation. A further reduction of the power density is achieved by inclining the plasma-facing components (PFCs), leading to power loads in the range of 10 MW/m^2. These loads are still larger than those in jet engines by about one order of magnitude and pose huge challenges to the PFCs. For ITER, the adopted solutions are actively cooled PFCs consisting of tungsten armour and heat sinks made of copper alloys. In a future fusion reactor, the demands to the PFCs will be further increased mainly through the considerably larger neutron fluence and lifetime requirements. In order to tackle this, novel metal-metal composites as well as new PFC designs are being developed as risk mitigating alternatives. The presentation introduces the challenges of power exhaust and gives an overview of the state-of-the-art solutions for ITER as well as of novel PFCs for a future fusion power plant.

Plenary Talk PV II Tue 9:00 Audimax

Advances in laser plasma accelerators and their future prospect — •Wim Leemans — DESY Hamburg, Deutschland

Laser-powered, plasma-based accelerators make electrons surf on waves and can reach multi-GeV energy levels in a few 10*s of cm that, if one relies on conventional methods, would require machines multiple football fields long. Although many challenges remain, this new technology is at the brink of offering a profoundly different way in which we may build particle accelerators. An overview of the latest progress and the next steps in the R&D needed to advance this technology will be presented. Applications such as generation of intense radiation, injection into storage rings, future colliders or medical therapy will be discussed.

Plenary Talk PV III Tue 9:45 Audimax

Precision physics with low energy electron scattering: The physics program at MESA — •Harald Merkel for the MAGIX-Collaboration — Johannes Gutenberg University, Mainz, Germany

An increasing number of experimental results with clear tension to the predictions of the Standard Model of particle physics suggests a path to access new physics. While the high energy frontier beyond the Higgs particle does not provide an obvious energy range to look for new phenomena, the precision frontier (also in high energy physics!) has promising candidate experiments for the search for new physics.

In Mainz, the electron accelerator MESA (Mainz Energy-recovering Superconducting Accelerator) is under construction. The key to precision physics at MESA is the operating principle of an energy-recovering linac (ERL). An ERL can provide very high luminosities with nearly massless targets, which increases the possible resolution of low energy electron scattering experiments by orders of magnitude.

In this talk, the physics program of MESA will be presented. Two major experimental setups will be installed: the P2 experiment will focus on the determination of the weak mixing angle as a key parameter of the Standard Model via parity violating electron scattering. The MAGIX setup, a multi-purpose experiment with high-resolution spectrometers, will be able to make a significant contribution, e.g. to astrophysical S-factor measurements of the Oxygen nucleosynthesis, few body physics, proton radius measurements, or the search for messenger particles of the dark matter sector.

Symposium Plasma Induced Accelerators (SYPA)

jointly organised by
the Working Group on Accelerator physics (AKBP) and
the Hadronic and Nuclear Physics Division (HK)

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Research on plasma-driven accelerators is developing dynamically. Beam energy and quality are being improved by new concepts such as the combination of plasma wakefield and laser-wakefield acceleration (hybrid LPWFA). First applications are in reach like for ultra-high dose rates in medical applications.

Overview of Invited Talks and Sessions

(Lecture hall Audimax)

Invited Talks

SYPA 1.1	Wed	11:00–11:30	Audimax	**Laser-driven ion acceleration -20 years of research: applications and prospect-** — •Markus Roth
SYPA 1.2	Wed	11:30–12:00	Audimax	**Laser-plasma ion accelerators for radio-biological research** — •Karl Zeil
SYPA 1.3	Wed	12:00–12:30	Audimax	**Hybrid plasma accelerators towards higher-quality electron beams** — •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa

Sessions

SYPA 1.1–1.3	Wed	11:00–12:30	Audimax	**Plasma Induced Accelerators**

Sessions

– Invited Talks –

SYPA 1: Plasma Induced Accelerators

Time: Wednesday 11:00–12:30 Location: Audimax

Invited Talk SYPA 1.1 Wed 11:00 Audimax

Laser-driven ion acceleration -20 years of research: applications and prospect- — •Markus Roth — Technische Universität Darmstadt, Institut für Kernphysik, Darmstadt, Germany — Focused Energy GmbH, Im Tiefen See 45, Darmstadt, Germany

With the advent of ultra-intense laser beams at the beginning of this century we entered a new regime for ion acceleration. Intensities exceeding 1018 W/cm2 allowed for new acceleration schemes, based on relativistic plasma physics, resulting in intense, directed ion beams of excellent quality. The particle energies of the ion beams currently exceed the range of 100 MeV. Over the last 20 years, research has focused on understanding the underlying physics and optimizing the process. Moreover, new mechanisms have been discovered, sometimes using large-scale computer simulations and tested in the laboratory.

I will present the development of laser-driven ion acceleration over the years and the current state-of-the-art.

Based on the research, applications have been identified to make use of the unique parameters of laser-driven ion beams. They range from medical applications to novel diagnostics capabilities to the production of intense bursts of neutrons for non-destructive testing and to using laser ion beams as an ignitor in fusion energy.

Recently the neutron production and fusion research has gain significant interest, not only from the academia but also from private industry and investors. I will show some of the recent developments and upcoming prospects for non-destructive testing and fusion energy.

Invited Talk SYPA 1.2 Wed 11:30 Audimax

Laser-plasma ion accelerators for radio-biological research — •Karl Zeil — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany

Particle accelerators have always been fundamental engines of discovery and drivers of innovations in industry, basic research, and life sciences. Exploiting the strong electromagnetic fields that can be supported by a plasma, high-power laser-driven compact plasma accelerators can generate short, high-intensity pulses of high energy electrons and ions with special beam properties. By that they may expand the portfolio of conventional machines in many application areas.

For laser-driven ion accelerators, the full application in ultra-high dose rate radiotherapy (RT) research marks one of the most important research objectives and is perfectly timed with the emerging interest on ultra-high dose rate RT. Laser proton accelerators are ideal instruments to investigate ultra-high dose rate effects, yet their ability to provide radiobiological in-vivo data comparable in quality to a clinical reference standard has called for demonstration for a long time.

The talk will introduce the concept of laser-driven ion accelerators and challenges of this technology. For the example of the high power laser source DRACO operated at HZDR, key developments for the production of reliable polychromatic proton beams with maximum energies of around 60 MeV are presented. Most recently, these achievements enabled the first successful small animal pilot study on radiation-induced tumor growth delay in mice using a laser-driven proton source and a clinical reference.

Invited Talk SYPA 1.3 Wed 12:00 Audimax

Hybrid plasma accelerators towards higher-quality electron beams — •S. Karsch[1,2], M. Foerster[1], A. Döpp[1,2], M. Gilljohann[1,3], J. Götzfried[1,2], K. v. Grafenstein[1], F. Haberstroh[1], J. Wenz[1], S. Corde[3], O. Kononenko[3], B. Hidding[3], T. Heinemann[4,6], T. Kurz[5], J. Couperus-Cabadag[5], U. Schramm[5], A. Debus[5], and A. Martinez de la Ossa[6] — [1]Ludwig-Maximilians-Universität München — [2]Max-Planck-Institut für Quantenoptik — [3]Laboratoire d'Optique Appliquee — [4]University of Strathclyde — [5]Helmholtz-Zentrum Dresden-Rossendorf — [6]Deutsches Elektronen-Synchrotron

Laser wakefield acceleration (LWFA) and plasma wakefield acceleration (PWFA), are commonly treated as separate branches of high-gradient plasma-based acceleration. In combination they open a new path for generating ultralow-emittance electron beams from readily available laser sources. While LWFA can generate ultrahigh-current, highly relativistic electron bunches, their emittance is compromised by the strong plasma heating in the oscillating laser fields. By using LWFA-generated electron bunches to drive a wakefield in a secondary plasma, and employing cold injection schemes to provide a suitable witness bunch, we generate ultralow-emittance beams in a small laser lab in a scheme we call Hybrid LPWFA. I will present our experimental findings for the cases of externally and intenally injected witness bunches. They demonstate that LPWFA can yield more stable and higher quality beams than pure LWFA , which makes this approach very interesting for light source applications and as ultra-cold injectors.

Symposium Plasmas in the Universe (SYPU)

jointly organised by
the Hadronic and Nuclear Physics Division (HK) and
the Plasma Physics Division (P)

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Overview of Invited Talks and Sessions

(Lecture hall Audimax)

Invited Talks

SYPU 1.1	Wed	9:00– 9:30	Audimax	**Recent progress in simulations of dense quantum plasmas and warm dense matter** — •Michael Bonitz, Paul Hamann, Tobias Dornheim, Zhandos Moldabekov, Alexey Filinov, Jan Vorberger, Pavel Levashov
SYPU 1.2	Wed	9:30–10:00	Audimax	**The quark gluon plasma: from the laboratory to neutron stars** — •Jan Steinheimer
SYPU 1.3	Wed	10:00–10:30	Audimax	**Characterizing the QCD Plasma** — •Andrea Dubla

Sessions

SYPU 1.1–1.3	Wed	9:00–10:30	Audimax	**Plasmas in the Universe**

Sessions

– Invited Talks –

SYPU 1: Plasmas in the Universe

Time: Wednesday 9:00–10:30 Location: Audimax

Invited Talk SYPU 1.1 Wed 9:00 Audimax

Recent progress in simulations of dense quantum plasmas and warm dense matter — •Michael Bonitz[1], Paul Hamann[1], Tobias Dornheim[2], Zhandos Moldabekov[2], Alexey Filinov[1], Jan Vorberger[3], and Pavel Levashov[4] — [1]Institute for Theoretical Physics and Astrophysics, Kiel University — [2]Center of Advanced Systems Understanding, Görlitz — [3]Helmholtz-Zentrum Dresden Rossendorf — [4]Joint Institute for High Temperatures, Moscow

Presently we are witnessing dramatic progress in experiments with dense quantum plasmas where matter is being compressed to densities exceeding solid density - parameters that occur in many astrophysical plasmas (planet interiors, dwarf stars etc.). At the same time, accurate laser and x-ray based diagnostic tools have emerged that probe the properties of such "warm dense matter". To understand these experiments and predict new ones poses a challenge to theory and simulations [1] and requires a smart combination of different methods including density functional theory, generalized quantum hydrodynamics (QHD), quantum kinetic equations [2], and quantum Monte Carlo [3]. The talk gives an overview on recent developments.

[1] M. Bonitz et al., Phys. Plasmas **27**, 042710 (2020); [2] M. Bonitz, *Quantum Kinetic Theory*, 2nd ed. Springer 2016; [3] T. Dornheim, S. Groth, and M. Bonitz, Phys. Reports **744**, 1-86 (2018)

Work supported by DFG via projects BO1366-13 and BO1366-15 and grant SHP 00026 for supercomputing time at HLRN.

Invited Talk SYPU 1.2 Wed 9:30 Audimax

The quark gluon plasma: from the laboratory to neutron stars — •Jan Steinheimer — FIAS, Frankfurt am Main

The Quark Gluon Plasma (QGP) is a state of matter that existed in the early universe and can only be created in relativistic collisions of heavy nuclei and possibly in the interior of neutron stars and their mergers. The QGP can be considered a color-plasma where the color charges are screened by the strong interaction (QCD) which allows them to move freely. Yet, due to the non-Abelian nature of QCD, and the fact that the force-carriers (Gluons) themselves carry a color charge, the process of the color screening in the QGP is not well understood. Current research on the QGP focusses on its thermodynamic properties as well quantities which may be related to its microscopic features like transport properties. There are still many open questions regarding the properties and especially phase structure of the QGP at large baryon densities in the context of recent astrophysical observations of neutron star mergers, which may probe yet unknown properties of the QGP. In this talk I will briefly review the main properties of the QGP and why it behaves differently than a QED plasma. I will summarize how QGP properties are extracted from high energy nuclear collisions. Finally, I will discuss how these findings can be related to matter found in the inside of neutron stars and especially in the violent mergers of such stars.

Invited Talk SYPU 1.3 Wed 10:00 Audimax

Characterizing the QCD Plasma — •Andrea Dubla — GSI Helmholtz Center for Heavy Ion Research

Under extreme conditions of high temperature and density, QCD predicts the formation of a new state of matter, the so-called quark-gluon plasma (QGP), in which quarks and gluons are the relevant degrees of freedom. Our universe is thought to have been in such a primordial state for the first few millionths of a second after the Big Bang, before quarks and gluons were bound together to form protons and neutrons. Heavy-ion collisions at ultra-relativistic energies at the Large Hadron Collider at CERN produce the unique conditions to form the QGP in the laboratory. Recreating this primordial state of matter and understanding how it evolves will allow us to shed light on questions about how matter is organized and the mechanisms that confine quarks and gluons. This talk gives an overview of the experimental program, based on selected recent results and comparison with model calculation, that allowed after decades to characterize with unprecedented precision this form of strongly interacting matter and its dynamic.

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Overview of Invited Talks and Sessions

(Lecture halls HK-H1 to HK-H10)

Invited Talks

HK 1.1	Mon	11:00–11:30	HK-H1	**A supernova in the lab - Astrophysics with stored, radioactive ions** — •Jan Glorius
HK 1.2	Mon	11:30–12:00	HK-H1	**Exotic quark-made formations** — •Mikhail Mikhasenko
HK 1.3	Mon	12:00–12:30	HK-H1	**Nuclear ab-initio theory for neutrino oscillations** — •Joanna Sobczyk, Sonia Bacca, Bijaya Acharya
HK 22.1	Tue	11:00–11:30	HK-H1	**Towards background-free measurements of double-beta decay events: a quest to increase the detection sensitivity of the neutrinoless double beta decay mode** — •Samuel Ayet San Andres
HK 22.2	Tue	11:30–12:00	HK-H1	**Baryon spectroscopy with the Jülich-Bonn dynamical coupled-channel approach** — •Deborah Rönchen
HK 22.3	Tue	12:00–12:30	HK-H1	**Hadronen und Kerne in der Öffentlichkeit** — •Christian Klein-Bösing
HK 23.1	Tue	14:00–14:30	HK-H1	**Jets in heavy-ion collisions** — •Jasmine Brewer
HK 23.2	Tue	14:30–15:00	HK-H1	**The initial state of the quark-gluon plasma at the intersection of hadronic and nuclear physics** — •Giuliano Giacalone
HK 23.3	Tue	15:00–15:30	HK-H1	**High-precision mass spectrometry with ISOLTRAP at ISOLDE/CERN** — •Jonas Karthein
HK 34.1	Wed	11:00–11:30	HK-H1	**Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions** — •Sabrina Huth
HK 34.2	Wed	11:30–12:00	HK-H1	**Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis** — •Andreas Flörs, Luke Shingles, Gabriel Martínez-Pinedo
HK 34.3	Wed	12:00–12:30	HK-H1	**Towards a next-generation LHC heavy-ion Experiment with ALICE** — •Raphaelle Bailhache
HK 55.1	Thu	11:00–11:30	HK-H1	**Online data processing with GPUs in ALICE during LHC Run 3** — •David Rohr
HK 55.2	Thu	11:30–12:00	HK-H1	**From outer space to deep inside: nuclear physics prospects at MAMI and MESA** — •Michaela Thiel
HK 55.3	Thu	12:00–12:30	HK-H1	**CMOS Monolithic Active Pixel Sensors** — •Michael Deveaux
HK 75.1	Fri	11:00–11:30	HK-H1	**Hyperon Physics with PANDA at FAIR** — •Jennifer Pütz
HK 75.2	Fri	11:30–12:00	HK-H1	**3-hadron problem from lattice QCD** — •Maxim Mai

Invited talks of the joint symposium Plasmas in the Universe (SYPU)

See SYPU for the full program of the symposium.

SYPU 1.1	Wed	9:00– 9:30	Audimax	**Recent progress in simulations of dense quantum plasmas and warm dense matter** — •Michael Bonitz, Paul Hamann, Tobias Dornheim, Zhandos Moldabekov, Alexey Filinov, Jan Vorberger, Pavel Levashov
SYPU 1.2	Wed	9:30–10:00	Audimax	**The quark gluon plasma: from the laboratory to neutron stars** — •Jan Steinheimer
SYPU 1.3	Wed	10:00–10:30	Audimax	**Characterizing the QCD Plasma** — •Andrea Dubla

Invited talks of the joint symposium Plasma Induced Accelerators (SYPA)

See SYPA for the full program of the symposium.

SYPA 1.1	Wed	11:00–11:30	Audimax	**Laser-driven ion acceleration -20 years of research: applications and prospect-** — •Markus Roth
SYPA 1.2	Wed	11:30–12:00	Audimax	**Laser-plasma ion accelerators for radio-biological research** — •Karl Zeil
SYPA 1.3	Wed	12:00–12:30	Audimax	**Hybrid plasma accelerators towards higher-quality electron beams** — •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa

Sessions

HK 1.1–1.3	Mon	11:00–12:30	HK-H1	**Invited Talks I**
HK 2.1–2.5	Mon	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases I**
HK 3.1–3.5	Mon	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases II**
HK 4.1–4.5	Mon	14:00–15:30	HK-H3	**Instrumentation I**
HK 5.1–5.5	Mon	14:00–15:30	HK-H4	**Instrumentation II**
HK 6.1–6.6	Mon	14:00–15:30	HK-H5	**Instrumentation III**
HK 7.1–7.6	Mon	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei I**
HK 8.1–8.6	Mon	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei II**
HK 9.1–9.5	Mon	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy I**
HK 10.1–10.4	Mon	14:00–15:30	HK-H9	**Hadron Structure and Spectroscopy II**
HK 11.1–11.5	Mon	14:00–15:30	HK-H10	**Nuclear Astrophysics I**
HK 12.1–12.5	Mon	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases III**
HK 13.1–13.5	Mon	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases IV**
HK 14.1–14.4	Mon	16:00–17:30	HK-H3	**Instrumentation IV**
HK 15.1–15.5	Mon	16:00–17:30	HK-H4	**Instrumentation V**
HK 16.1–16.6	Mon	16:00–17:30	HK-H5	**Instrumentation VI**
HK 17.1–17.6	Mon	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei III**
HK 18.1–18.6	Mon	16:00–17:45	HK-H7	**Structure and Dynamics of Nuclei IV**
HK 19.1–19.6	Mon	16:00–17:45	HK-H8	**Hadron Structure and Spectroscopy III**
HK 20.1–20.5	Mon	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy IV**
HK 21.1–21.4	Mon	16:00–17:30	HK-H10	**Astroparticle Physics I**
HK 22.1–22.3	Tue	11:00–12:30	HK-H1	**Invited Talks II**
HK 23.1–23.3	Tue	14:00–15:30	HK-H1	**Invited Talks III**
HK 24.1–24.5	Tue	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases V**
HK 25.1–25.5	Tue	16:00–17:30	HK-H2	**Heavy-Ion Collisions and QCD Phases VI**
HK 26.1–26.6	Tue	16:00–17:30	HK-H3	**Instrumentation VII**
HK 27.1–27.5	Tue	16:00–17:30	HK-H4	**Instrumentation VIII**
HK 28.1–28.6	Tue	16:00–17:45	HK-H5	**Computing I**
HK 29.1–29.6	Tue	16:00–17:30	HK-H6	**Structure and Dynamics of Nuclei V**
HK 30.1–30.5	Tue	16:00–17:30	HK-H7	**Outreach**
HK 31.1–31.6	Tue	16:00–17:45	HK-H8	**Hadron Structure and Spectroscopy V**
HK 32.1–32.5	Tue	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy VI**
HK 33.1–33.5	Tue	16:00–17:30	HK-H10	**Nuclear Astrophysics II**
HK 34.1–34.3	Wed	11:00–12:30	HK-H1	**Invited Talks IV**
HK 35.1–35.5	Wed	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases VII**
HK 36.1–36.5	Wed	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases VIII**
HK 37.1–37.5	Wed	14:00–15:30	HK-H3	**Instrumentation IX**
HK 38.1–38.5	Wed	14:00–15:30	HK-H4	**Instrumentation X**

HK 39.1–39.8	Wed	14:00–16:00	HK-H5	**Computing II**
HK 40.1–40.5	Wed	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei VI**
HK 41.1–41.5	Wed	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei VII**
HK 42.1–42.5	Wed	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy VII**
HK 43.1–43.5	Wed	14:00–15:30	HK-H9	**Hadron Structure and Spectroscopy VIII**
HK 44.1–44.4	Wed	14:00–15:30	HK-H10	**Astroparticle Physics II**
HK 45.1–45.4	Wed	16:00–17:15	HK-H1	**Heavy-Ion Collisions and QCD Phases IX**
HK 46.1–46.4	Wed	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases X**
HK 47.1–47.6	Wed	16:00–17:30	HK-H3	**Instrumentation XI**
HK 48.1–48.5	Wed	16:00–17:15	HK-H4	**Instrumentation XII**
HK 49.1–49.4	Wed	16:00–17:00	HK-H5	**Instrumentation XIII**
HK 50.1–50.6	Wed	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei VIII**
HK 51.1–51.5	Wed	16:00–17:30	HK-H7	**Structure and Dynamics of Nuclei IX**
HK 52.1–52.6	Wed	16:00–17:30	HK-H8	**Hadron Structure and Spectroscopy IX**
HK 53.1–53.5	Wed	16:00–17:30	HK-H9	**Hadron Structure and Spectroscopy X**
HK 54.1–54.5	Wed	16:00–17:30	HK-H10	**Nuclear Astrophysics III**
HK 55.1–55.3	Thu	11:00–12:30	HK-H1	**Invited Talks V**
HK 56.1–56.5	Thu	14:00–15:30	HK-H1	**Heavy-Ion Collisions and QCD Phases XI**
HK 57.1–57.6	Thu	14:00–15:30	HK-H2	**Heavy-Ion Collisions and QCD Phases XII**
HK 58.1–58.6	Thu	14:00–15:30	HK-H3	**Instrumentation XIV**
HK 59.1–59.5	Thu	14:00–15:30	HK-H4	**Instrumentation XV**
HK 60.1–60.6	Thu	14:00–15:30	HK-H5	**Instrumentation XVI**
HK 61.1–61.5	Thu	14:00–15:30	HK-H6	**Structure and Dynamics of Nuclei X**
HK 62.1–62.5	Thu	14:00–15:30	HK-H7	**Structure and Dynamics of Nuclei XI**
HK 63.1–63.5	Thu	14:00–15:30	HK-H8	**Hadron Structure and Spectroscopy XI**
HK 64.1–64.5	Thu	14:00–15:30	HK-H9	**Fundamental Symmetries I**
HK 65.1–65.6	Thu	16:00–17:30	HK-H1	**Heavy-Ion Collisions and QCD Phases XIII**
HK 66.1–66.5	Thu	16:00–17:15	HK-H2	**Heavy-Ion Collisions and QCD Phases XIV**
HK 67.1–67.5	Thu	16:00–17:30	HK-H3	**Instrumentation XVII**
HK 68.1–68.4	Thu	16:00–17:15	HK-H4	**Instrumentation XVIII**
HK 69.1–69.6	Thu	16:00–17:30	HK-H5	**Instrumentation XIX**
HK 70.1–70.6	Thu	16:00–17:45	HK-H6	**Structure and Dynamics of Nuclei XII**
HK 71.1–71.5	Thu	16:00–17:30	HK-H7	**Structure and Dynamics of Nuclei XIII**
HK 72.1–72.5	Thu	16:00–17:30	HK-H8	**Hadron Structure and Spectroscopy XII**
HK 73.1–73.5	Thu	16:00–17:45	HK-H9	**Fundamental Symmetries II**
HK 74	Thu	18:00–19:00	HK-MV	**Annual General Meeting**
HK 75.1–75.2	Fri	11:00–12:00	HK-H1	**Invited Talks VI**

Annual General Meeting of the Hadronic and Nuclear Physics Division

Thursday, March 31, 2022 18:00–19:00 HK-MV
The meeting will take place in a virtual format. The zoom link and the agenda will be communicated by email.

Sessions

– Invited Talks, Group Reports, and Contributed Talks –

HK 1: Invited Talks I

Time: Monday 11:00–12:30 Location: HK-H1

Invited Talk HK 1.1 Mon 11:00 HK-H1
A supernova in the lab - Astrophysics with stored, radioactive ions — •Jan Glorius for the E127-Collaboration — GSI Helmholtzzentrum, Darmstadt, Germany
Stars are giant nuclear reactors responsible for the synthesis of every element beyond hydrogen and helium. They generate vast amounts of material through nuclear conversions acting over millions of years or in the blink of an eye, e.g., in quiescent stellar burning or in violent star explosions, respectively. Simulations of the internal stellar processes can reproduce the main features of the solar inventory, however the production of many naturally occurring nuclei is still a mystery. This applies in particular to the so-called p-nuclei arising from stellar explosions, for which the models suffer from large nuclear uncertainties.

This contribution will introduce a novel experimental approach to shed light on such eluding cases by providing data on nuclear key reactions to produce strong constraints for explosive nucleosynthesis. The experimental campaign focuses on proton-capture reactions and is based on the production of radioactive ion beams at GSI, which are subsequently accumulated, cooled and decelerated in the heavy ion storage ring ESR. After years of development with stable beams, the first successful measurement has been conducted recently with a radioactive beam, namely ^{118}Te. The talk will discuss the experimental technique in detail, as well as the status and results of the recent and precursor experiments. Furthermore, the plans for an extension of the campaign to the new CRYRING facility at GSI will be presented.

Invited Talk HK 1.2 Mon 11:30 HK-H1
Exotic quark-made formations — •Mikhail Mikhasenko — ORIGINS Excellence Cluster, Munich, Germany — Ludwig Maximilian University of Munich
Conventional hadrons incorporate three-quark baryons like proton and neutron, and quark-antiquatk mesons, as e.g. pion, kaon, and J/ψ. Recent discoveries in particle-physics experiments around the world change our understanding of the quark-made formations. The tetraquarks of the XYZ family, narrow pentaquarks, and long-lived double-heavy-flavor tetraquarks do exists and heat the scientific debates on their microscopic nature. The talk will review the most amazing findings of hadron spectroscopists that paved the way to the rich world of the exotic states what we know of now. I will focus on the newest observation of the doubly charmed tetraquark T_{cc}^{+} using data collected by the LHCb experiment at the Large Hadron Collider.

Invited Talk HK 1.3 Mon 12:00 HK-H1
Nuclear ab-initio theory for neutrino oscillations — •Joanna Sobczyk[1], Sonia Bacca[1], and Bijaya Acharya[2] — [1]Johannes Gutenberg-Universitat, Mainz, Germany — [2]Oak Ridge National Laboratory, Oak Ridge, USA
We are entering an era of high-precision neutrino oscillation experiments (T2HK, DUNE), which potentially hold answers to some of the most exciting questions in particle physics. Their scientific program requires a precise knowledge of neutrino-nucleus interactions coming from fundamental nuclear studies. Ab initio many-body theory has made great advances in the last years and is able to give relevant predictions for medium-mass nuclei.

In my talk I will give an overview of the recent progress that has been made in describing neutrino-nucleus scattering within the ab-initio coupled-cluster framework, combined with the Lorentz integral transform. These techniques open the door to obtaining nuclear responses (and consequently cross-sections) for medium-mass nuclei starting from first principles. A series of steps has been made in this direction. Firstly, the nuclear 1- and 2-body currents have been rederived and checked for the case of neutrino-deuteron scattering. Afterwards, the Coulomb sum rule of 16O has been calculated, introducing a new technique to remove the center-of-mass contamination. This allowed us to calculate for the first time the longitudinal response of 40Ca. Recently, we obtained spectral functions which enabled us to extend our calculations to the relativistic regime within the impulse approximation.

HK 2: Heavy-Ion Collisions and QCD Phases I

Time: Monday 14:00–15:30 Location: HK-H1

Group Report HK 2.1 Mon 14:00 HK-H1
Measurement of neutral mesons in pp, p–Pb and Pb–Pb collisions with ALICE — •Marvin Hemmer for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt
Multiplicity-dependent measurements of the neutral meson production in pp, p–Pb, and Pb–Pb collisions can be utilised to study different aspects of the hadronisation such as multi-parton interactions and collective effects. Furthermore, a better understanding of the neutral meson production can help to better constrain theoretical models of the production processes and can serve as crucial input for cocktail calculations needed for direct photon and dielectron analyses.

In ALICE, neutral mesons can be measured using different reconstruction methods. For the π^0 and η mesons these methods are based on the detection of decay photons with calorimeters or by reconstructing e^+e^- pairs from conversions in the detector material with the central tracking system. The ω meson is reconstructed using the measured π^0 mesons together with an additional photon ($\omega \rightarrow \pi^0\gamma$) or opposite charged pion tracks ($\omega \rightarrow \pi^+\pi^-\pi^0$).

In this talk, an overview of the π^0, η and ω measurements with ALICE is presented. In particular, we will focus on a multiplicity dependent measurement of π^0 and η in pp collisions at $\sqrt{s} = 13$ TeV.

Supported by BMBF and the Helmholtz Association.

HK 2.2 Mon 14:30 HK-H1
Reconstruction of neutral mesons via photon conversion method in Ag-Ag collisions at 1.58A GeV with HADES* — •Tetiana Povar for the HADES-Collaboration — University of Wuppertal
A main goal of the HADES (High Acceptance DiElectron Spectrometer) experiment is to investigate properties of strongly interacting matter at moderate temperatures and large baryo-chemical potential. One tool is the study of virtual photons and their decays into electron pairs $(e^- + e^+)$ in hadron and heavy-ion collisions. Due to their large mean free path in the final state, electrons and positrons are particularly ideal probes to study the pair production also in the dense nuclear medium. Dalitz-decays of the light neutral mesons π^0, η constitute a major contribution to the observed dielectron spectrum at low invariant masses (below the vector-meson pole mass). A precise determination of their abundance is crucial for proper control of the composition of the whole spectrum.
In HADES, these mesons can be reconstructed via their dominant $\gamma\gamma$ decays (BR ~ 99%) utilizing double photon detection in the electromagnetic calorimeter (ECAL) or via double external pair conversion $\gamma_{\mathrm{material}} \rightarrow e^+ + e^-$ in target or detector material with subsequent electron/positron identification.
We will present preliminary results of π^0 and η production yields in Ag-Ag collisions at 1.58A GeV incident beam energy applying the double photon conversion method (PCM).

* Work supported by BMBF (05P19PXFCA), and GSI.

HK 2.3 Mon 14:45 HK-H1
Production of ω-meson in pp collisions at 13 TeV — •Jens Robert Lühder for the ALICE-Collaboration — Institut für Kernphysik, Wilhelm-Klemm-Str. 9, 48149 Münster
Measurements of neutral mesons in small collision systems can serve as a baseline to understand modifications in heavy-ion collisions, where a QGP is formed. These measurements can also be used to test pQCD predictions and to constrain fragmentation functions as well as parton distribution functions. Furthermore, a good understanding of particle production enables the measurement of direct photons yields, where a large background of decay photons is present and needs to be accounted for.

In this talk the invariant cross section of the ω-meson production in pp collisions at a center of mass energy of $\sqrt{s} = 13$ TeV, as measured by ALICE via its dominant decay channel $\omega \rightarrow \pi^+\pi^-\pi^0$, will be presented. While charged pions can directly be measured by the ALICE central barrel trackers, neutral pions are reconstructed using their decay channel into two photons. This reconstruction is realized with several complementary methods making use of various calorimeters and the ALICE central barrel trackers. The combined result covers an unprecedented p_T range with small statistical and systematic uncertainties.

HK 2.4 Mon 15:00 HK-H1

Measurement of ω mesons in pp and p–Pb collisions at $\sqrt{s_{NN}}$=5.02 TeV with ALICE — •Nicolas Strangmann for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at the LHC investigates the properties of hot and dense nuclear matter in heavy-ion collisions. By comparing the particle production in pp and p–Pb collisions, possible initial state effects can be isolated, which arise from the partons being bound within nuclei. Measurements of the ω meson spectra in pp and p–Pb collisions not only allow for a determination of the nuclear modification factor R_{pA}, but also provide vital input for direct photon cocktail simulations.

In the analysis presented in this talk, ω mesons are reconstructed via their primary decay channel into three pions ($\pi^{+}\pi^{-}\pi^{0}$). While the two charged pions can be identified with the tracking detectors (TPC, ITS), the π^{0} has to be reconstructed from its two decay photons, that are detected in the electromagnetic calorimeter (EMCal).

In this talk, the measurement of the ω meson production in pp and p–Pb collisions at $\sqrt{s_{NN}}$=5.02 TeV will be presented. This includes the signal extraction and various corrections of the ω meson yields as well as the derivation of the R_{pA}.

Supported by BMBF and the Helmholtz Association.

HK 2.5 Mon 15:15 HK-H1

Neutral pion identification from merged clusters with ma- chine learning methods in ALICE — •Jan Honermann for the ALICE-Collaboration — Institut für Kernphysik, Münster, Deutsch- land

The ALICE detector at CERN LHC is designed for the study of hot nuclear matter. Historically, one of the first probes to confirm the presence of such hot nuclear matter in heavy-ion collisions were neutral pions. The production of neutral pions was found to be significantly suppressed in heavy-ion collisions compared to pp or deuteron-gold collisions. Most traditional identification methods for neutral pions in these studies rely on an invariant mass analysis of the decay products. When the energy of the neutral pion becomes too large, these methods stop working though, since hits of decay products can not be resolved individually any longer. In this talk, initial efforts to distinguish between these merged clusters from neutral pions and coincidental hits from background processes with the help of neural networks in 13TeV pp-collisions will be presented.

Supported in the contex of the BMBF ErUM Framework.

HK 3: Heavy-Ion Collisions and QCD Phases II

Time: Monday 14:00–15:30 Location: HK-H2

Group Report HK 3.1 Mon 14:00 HK-H2

Kinetics of the chiral phase transition in a quark-meson σ model — •Hendrik van Hees, Carsten Greiner, and Alex Meistrenko — Institut für Theoretische Physik, Goethe-Universität Frankfurt, Max-von-Laue-Str. 1, D-60438 Frankfurt am Main

A challenging goal in relativistic heavy-ion physics is the investigation of the phase diagram of strongly interacting matter and the determination of its phase structure, governed by the approximate chiral symmetry of the light-quark sector of QCD. In this study [1] we investigate a linear quark-meson σ model in and out of equilibrium employing Schwinger-Keldysh real-time techniques to derive a set of coupled Boltzmann-Uehling-Uhlenbeck (BUU) equations for the σ-mean field (the order parameter of the phase transition) and the quark- and meson phase-space distribution function from a Φ-derivable approximation. We numerically solve the equations to evaluate the grand-canonical baryon-number fluctuations for an expanding fireball. The evolution results in a temporary buildup of higher-order fluctuations of the net-baryon number like the curtosis at low momenta when the system is evolving close to the critical point or the first-order phase-transition line due to slowly evolving σ-mean field. This is partially counterballanced by the further dissipative evolution due to collisions of the quarks, mesons, and the mean field, leading to a considerable weakening of the final fluctuations, depending on the expansion rate of the fireball.

[1] Annals of Physics **431**, 168555 (2021)

HK 3.2 Mon 14:30 HK-H2

Non-hydrodynamic modes from linear response in effective kinetic theory — •Stephan Ochsenfeld, Xiaojian Du, and Sören Schlichting — Bielefeld University, Bielefeld, Germany

Viscous hydrodynamics serves as a successful mesoscopic description of the quark-gluon plasma (QGP) produced in relativistic heavy-ion collisions (HICs). In order to investigate, how such an effective description emerge from the underlying microscopic dynamics we calculate the linear response of energy and flow perturbations in the sound and shear channels from a first-principle calculation in kinetic theory. By using multiple collision integrals we investigate the similarities and differences of the excitations in different microscopic theories and compare them to first and second order hydrodynamics. Surprisingly, we find that even for large gradients the Greens functions in QCD Kinetic theory are well described by one hydrodynamic and one non-hydrodynamic mode. We extract the dispersion relations of hydrodynamic and non-hyrodynamic modes and speculate how these results can be used to improve hydrodynamic descriptions of hot QCD matter.

HK 3.3 Mon 14:45 HK-H2

J/Ψ formation within microscopic Langevin simulations — •Naomi Oei, Nadja Krenz, Juan Torres-Rincon, Hendrik van Hees, and Carsten Greiner — Institute for Theoretical Physics, Frankfurt am Main, Germany

We present a microscopic model to describe dissociation and recombination processes of charmonia in the quark-gluon plasma. For this we simulate the time evolution of a system with several charm-anticharm-quark pairs, in which the heavy quarks are able to interact over a Coulomb like potential. The motion of the heavy quarks and the interaction with the medium are based on a Fokker-Planck equation, which can be realized with Langevin simulations. In this approach we use a momentum-dependent drag force and include random momentum kicks due to collisions with the medium particles. Therefore, through interactions of the heavy quarks with the medium, recombination and dissociation processes are possible. We describe the evolution of the medium as a boost-invariant transversally expanding fireball. We demonstrate that the system reaches the expected thermal distribution in the equilibrium limit and bound-state properties were tested in box simulations. The initial momentum distribution of the pairs is generated using the PYTHIA event-generator and results of the model are studied at RHIC and at LHC energy. We analyze results for different numbers of charm-anticharm-pairs for two initial conditions: The charm- and anticharm-quarks are either placed randomly inside the system or are initially created as a bound state. We show first results of the elliptic flow of charm-quarks and of bound states.

HK 3.4 Mon 15:00 HK-H2

Dynamical broadening of vector-meson spectral functions — •Renan Hirayama[1,2], Jan Staudenmaier[2], and Hannah Elfner[1,2] — [1]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies (FIAS), Frankfurt am Main, Germany

We reconstruct effective spectral functions of the ρ-meson in different scenarios via lifetime analysis using the hadronic transport SMASH. The theoretical interest in the behavior of in-medium spectral functions lies in the expected restoration of chiral symmetry at high energy densities, which may be accessed experimentally by studying dilepton mass spectra in heavy-ion collisions. Within SMASH, a direct assessment of particle lifetimes and the mass distributions is possible. Our reconstruction of the spectral function consists in using the total width – considering both decays and collisions – as input for a Breit-Wigner ansatz. The broadening of the spectral function in a thermal system is shown to be consistent with model calculations, and the dependence of total width on local hadron density is provided. This broadening develops dynamically, since SMASH relies only on vacuum properties of resonances as an input. On the other hand, we present the effective ρ-meson spectral function for the dynamical evolution of heavy-ion collisions, finding a clear correlation of broadening to system size. The results shown in this work are of interest to distinguish dynamical broadening from additional genuine medium-modified spectral functions.

HK 3.5 Mon 15:15 HK-H2

Diffusion coefficients for hot hadron gases in the quark flavor representation — •Jakob Lohr, Jan Fotakis, and Carsten Greiner — University of Frankfurt

Heavy ion collisions play a big role in exploring the properties of hot and dense nuclear matter. In these the baryon number B, the electric charge Q, and the strangeness S of the produced matter are conserved. Their transport could especially be relevant in the description of the evolution of highly compressed baryonic matter, where strong gradients in baryon number are expected.

In general, the diffusion currents generated by gradients in the charge densities are coupled to each other, the coupling of which is characterized by the so-called diffusion coefficient matrix. In most works concerning diffusion coefficients or conductivites, the constituents of matter are usually characterized through the above mentioned conserved charges (BQS). However, in the case of strongly-interacting matter the particles can as well be characterized by their quark content and the corresponding conserved quark flavors.

In this talk, we will give a systematic discussion of the diffusion coefficient matrix of various hadronic systems in the so-called quark flavor representation using linear response theory in relativistic kinetic theory.

HK 4: Instrumentation I

Time: Monday 14:00–15:30 Location: HK-H3

Group Report HK 4.1 Mon 14:00 HK-H3

Der PANDA Luminositätsdetektor — •Florian Feldbauer für die PANDA-Kollaboration — Ruhr-Universtität Bochum

Das PANDA-Experiment, welches im Antiproton-Speicherring HESR an der im Bau befindlichen Beschleunigeranlage FAIR in Darmstadt stehen wird, ist für Fragen der Hadronenphysik optimiert. Mit dieser Anlage wird es möglich sein, neue Zustände zu entdecken und die Linienform dieser wie auch bereits bekannter Zustände sehr präzise zu vermessen. Zur Normierung der dafür verwendeten Energie-Scan-Messungen wird die exakte Kenntnis der Luminosität benötigt. Die Luminosität wird bei PANDA anhand der Winkelverteilung der elastischen Antiproton-Proton-Streuung bestimmt. Um eine absolute Messgenauigkeit von 5% zu erreichen werden die Spuren der gestreuten Antiprotonen gemessen. Dazu werden 4 Detektorebenen mit gedünnten Siliziumsensoren verwendet (HV-MAPS). HV-MAPS sind Pixelsensoren mit integrierter Ausleseelektronik. Die 4 Ebenen, die verfahrbar montiert sind, bestehen aus CVD-Diamanten auf denen die Sensoren aufgeklebt sind. Zur Reduktion der Vielfachstreuung wird der Aufbau im Vakuum betrieben. Das Konzept des Luminositätsdetektors wird vorgestellt und dabei technische Aspekte wie Vakuumsystem, Kühlung und Elektronik diskutiert, sowie Einblicke in die Datenanalyse gegeben.

HK 4.2 Mon 14:30 HK-H3

Silizium-Pixelsensoren für den PANDA-Luminositätsdetektor — •Niels Boelger für die PANDA-Kollaboration — Ruhr-Universität Bochum, AG Physik der Hadronen und Kerne, 44780 Bochum

Das PANDA-Experiment ist eines der Schlüsselexperimente an der zukünftigen Beschleunigeranlage FAIR in Darmstadt. Es dient der Untersuchung des Aufbaus von Hadronen und von Aspekten sowohl der starken und schwachen Wechselwirkung als auch der exotischen Materiezuständen.

Der PANDA-Detektor wird über einen Luminositätsdetektor, 11 Meter strahlabwärts vom Interaktionspunkt verfügen. Dieser aus zwei verfahrbaren Halbdetektoren bestehende Luminositätsdetektor verwendet Silizium-Pixelsensoren, um damit die Verteilung der elastisch gestreuten Antiprotonen in Abhängigkeit vom Streuwinkel zu messen und daraus die Luminosität zu bestimmen. Bei den zur Spurrekonstruktion im Luminositätsdetektor vorgesehenen MuPix-Sensoren handelt es sich um HV-MAPS, was für High-Voltage Monolithic Active Pixel-Sensor steht und gegenüber herkömmlichen Pixelsensoren zwei Vorteile bietet: Zum einen sind der aktiven Sensorteil und die Ausleseelektronik auf dem selben Chip vereint. Zum anderen kann aufgrund der anlegbaren Hochspannung der Ladungsträgertransport schneller erfolgen, als es durch einen Driftprozess möglich wäre. Die Fertigung von aus mehreren Pixelsensoren bestehenden Sensormodulen, sowie die Datenerfassung (DAQ) werden im Vortrag erläutert. This project is supported by the BMBF - Gefördert durch das BMBF

HK 4.3 Mon 14:45 HK-H3

In-beam characterisation of a 65 nm CMOS technology Digital Pixel Test Structure towards a future ALICE Inner Tracking System 3 — •Pascal Becht for the ALICE-Collaboration — Physikalisches Institut, Heidelberg University, Germany

Recently, a new Inner Tracking System (ITS2) based on Monolithic Active Pixel Sensors (MAPS) has been installed in the ALICE detector. For a future upgrade of this tracker, it is intended to replace the three innermost layers of the current ITS2 with a novel vertex detector, the ITS3. The proposed design features wafer-scale, ultra-thin, truly cylindrical MAPS. In oder to benefit from the smaller feature size and the larger available wafers, the new sensors are supposed to be produced in 65 nm CMOS technology.

An extensive R&D programme is established in order to qualify this technology for the application in MAPS. It is supported by the BMBF funded High-D consortium for future particle detector development efforts. As one of the first steps towards the new sensor design, different variants of Digital Pixel Test Structures (DPTS) have been produced and tested in an electron beam at DESY. First results from this testbeam campaign are presented with emphasis on the detection efficiency. It is shown that the measured sensor efficiency exceeds 90%. This outcome is very encouraging for the application of the 65 nm CMOS technology in future MAPS-based detectors.

HK 4.4 Mon 15:00 HK-H3

Towards a wafer-scale, bent silicon prototype for the ALICE ITS3 — •Alperen Yuncu for the ALICE-Collaboration — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Germany

ALICE aims at replacing the three innermost layers of its Inner Tracking System (ITS2) in the LHC Long Shutdown 3. The new vertex detector (ITS3) will be based on wafer-scale, ultra-thin, cylindrical Monolithic Active Pixel Sensors (MAPS). The new sensors will have a thickness of $20-40\,\mu$m and a length of 28 cm. They will be installed around a new beam pipe and the closest layer will be at a radial distance of only 18 mm from the interaction point.

The thickness of the sensors reaches unprecedented values for wafer-scale sensors, which poses a number of R&D challenges. To advance the study of mechanical and electrical properties for large, ultra-thin sensors, before the final silicon for ITS3 will become available, "super-ALPIDE" chips are produced and characterized. These consist of a matrix of 9×2 ALPIDEs (the sensors used for ITS2) diced out from a wafer as a single piece of silicon and have a size of 13.5×6 cm, close to 1/2 the final layer 0. They were produced in three different thicknesses (30, 40, 50 μm) and are now used for mechanical and electromechanical integration tests.

HK 4.5 Mon 15:15 HK-H3

Performances of the MIMOSIS-1 CMOS Monolithic Active Pixel Sensor* — •Hasan Darwish for the CBM-MVD-Collaboration — GSI Darmstadt — Goethe Universität Frankfurt am Main — Université de Strasbourg, CNRS, IPHC UMR 7178, Strasbourg

The CMOS Monolithic Active Pixel Sensor MIMOSIS will be used in the Micro Vertex Detector (MVD) of the CBM experiment at FAIR in Darmstadt. The 50 μm thin sensor will feature 1024×504 pixels with a pitch of $27 \times 30\ \mu m^2$, a peak rate capability of 80 MHz/cm^2 and combine a time resolution of 5 μs with a spatial resolution of ~ 5 μm.

The full size prototype MIMOSIS-1, the second MIMOSIS prototype along its three-prototype development process, was tested with electron and pion beams in several beam tests at DESY and CERN. Sensor performances including detection efficiency, spatial resolution, fake hit rate and pixel cluster multiplicity were measured for a total of 12 combinations of three different kinds of active volumes and four flavours of pixels. Moreover, the tolerance to radiation doses of up to 5 MRad and 3×10^{14} n_{eq}/cm^2 was evaluated.

The technology of the sensor is introduced and first results of the beam tests are shown.

*This work has been supported by BMBF (05P19RFFC1), GSI, CREMLINplus, HFHF, and TANGERINE.

HK 5: Instrumentation II

Time: Monday 14:00–15:30 Location: HK-H4

Group Report HK 5.1 Mon 14:00 HK-H4

The DarkMESA Experiment — •Mirco Christmann for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

At the Institute for Nuclear Physics in Mainz the new electron accelerator MESA will go into operation within the next years. The high-power beam dump of the P2 experiment (150 MeV, 150 μA) is ideally suited for a parasitic dark sector experiment – DarkMESA.

The experiment is designed for the detection of Light Dark Matter (LDM) which in the simplest model couples to a massive vector particle, the dark photon γ'. It can potentially be produced in the beam dump by a process analogous to photon Bremsstrahlung and may then decay into Dark Matter (DM) particle pairs $\chi\bar{\chi}$. A fraction of them scatter off electrons or nuclei in the DarkMESA calorimeter.

For the calorimeter, high-density PbF_2 and lead glass SF5 Cherenkov radiators readout with photomultipliers will be used. Within a `MadGraph` and `Geant4` simulation the accessible parameter space was evaluated. For the prototype stage, a hermetic veto system with two layers of plastic scintillators and 1 cm of lead shielding is currently under development.

DarkMESA DRIFT is currently considered as an addition to the project. A negative ion Time Projection Chamber (TPC) filled with CS_2 at low pressure will serve as DM detector. With the nuclear recoil threshold being in the keV range the accessible parameter space can be extended.

HK 5.2 Mon 14:30 HK-H4

Status of a HPGe-BGO Pair Spectrometer for ELI-NP — •Ilja Homm for the ELI-NP Pair Spectrometer-Collaboration — Technische Universität Darmstadt, Germany

The new European research facility called ELI-NP (The **E**xtreme **L**ight **I**nfrastructure - **N**uclear **P**hysics) is being built in Bucharest-Magurele, Romania. ELI-NP will offer unprecedented opportunities for photonuclear reactions with high intensity, brilliant and fully polarized photon beams at energies up to 19.5 MeV.

The 8 HPGe CLOVER detectors of ELIADE are important instruments for the γ-spectroscopic study of photonuclear reactions. We investigate the possibility to operate an advanced version of an anti-Compton shield (AC shield) as escape γ-rays pair spectrometer for one of the ELIADE CLOVERS. This should improve the performance at high energies where the pair production process dominates. The BGO shield operated as a stand-alone device can also be used as γ-beam intensity monitor and to investigate the cross section for pair production near the threshold. A prototype pair spectrometer, consisting of 64 BGO crystals with SiPM (silicon photomultiplier) readout, has been designed and built. Two test measurements with high energy photons have been performed at the University of Cologne and at the ILL in Grenoble. First results are going to be presented.

This work is supported by the German BMBF (05P15RDENA) and the LOEWE-Forschungsschwerpunkt "Nukleare Photonik".

HK 5.3 Mon 14:45 HK-H4

Characterization system for CsI crystals coupled to APDs — •Han-Bum Rhee, Anna-Lena Hartig, Noel Merkel, Christian Sürder, and Thorsten Kröll for the R3B-Collaboration — Institut für Kernphysik, TU Darmstadt, Germany

CALIFA @ R3B/FAIR is a highly granular detection system based on CsI(Tl) scintillation crystals with readout via avalanche photodiodes (APD). It aims to detect gamma rays and light charged particles. CALIFA consists of 2464 detection units and each detection unit has to be characterized. In order to automatize the characterization two system have been built.

The gain and the noise of the APDs depend on both temperature and bias voltage, hence both have to be controlled. The temperature of the system is controlled via a Peltier unit.

In CALIFA CsI crystals with several distinct trapezoidal shapes are used. This causes inhomogeneities in the crystal light output. These inhomogeneities were investigated by measuring the response of the detector-APD unit to a collimated source, which is placed close to the crystal but at different positions relative to the APD readout. For the placement of the source, a x-y scanning table with stepping motors was employed.

This work is supported by BMBF (05P19RDFN1, 05P21RDFN1) and the GSI-TU Darmstadt cooperation contract.

HK 5.4 Mon 15:00 HK-H4

Recovery study of lead tungstate scintillation crystals for the $\overline{\text{P}}$ANDA-EMC. — •Pavel Orsich[1], Valery Dormenev[1], Markus W. H. Moritz[1], Hans-Georg Zaunick[1], Kai-Thomas Brinkmann[1], and Mikhail Korjik[2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität, Gießen — [2]Institute for Nuclear Problems, Minsk, Belarus

Degradation of the optical transmittance of lead tungstate scintillation crystals in the scintillation spectral range under ionizing radiation leads to the loss of light output, which results in the deterioration of the energy resolution and limits the operation time of calorimeters made from the scintillator. This effect is especially prominent for calorimeters operating at low temperature, such as the Electromagnetic Calorimeter (EMC) of the $\overline{\text{P}}$ANDA experiment, where the calorimeter will be operated at -25 °C to gain an additional factor four in light yield.

We report new results on stimulated recovery of radiation damage in lead tungstate scintillation crystals induced by an external source of infrared photons. This method allows fast and efficient in-situ recovery of the crystals optical transmittance either during beam-off periods or even online in parallel to data acquisition. The application of light for recovery can substantially extend the running period the $\overline{\text{P}}$ANDA-EMC by keeping the radiation damage at a tolerable level.

This work is supported by BMBF, GSI and HFHF.

HK 5.5 Mon 15:15 HK-H4

Serial calibration of the slow-control of the barrel part of the PANDA EMC front-end bus system* — •Christopher Hahn for the PANDA-Collaboration — II. Physikalisches Institut, Gießen, Deutschland

One of the main components of the upcoming PANDA experiment at the future FAIR complex in Darmstadt will be the Electromagnetic Calorimeter (EMC) inside a 2 T solenoid. The EMC's lead-tungstate crystals are read out by Large Area Avalanche Photodiodes (LAAPDs). Due to the required energy resolution, timing and spacial constraints, the individual bias voltage adjustments for the Photodiodes need to be accurate and stable on a level of 100 mV. At the same time, space constraints in the inner detector volume limit options for individual cable routing and connections for the LAAPD bias voltage. These constraints demanded new, innovative and specialized electronics to adjust the individual LAAPD voltage within the inner detector volume. The key elements of the high-voltage adjustment concept will be described. To enable a stable operation of the specialized electronics within a broad temperature window, tests of the slow-control electronics were conducted. First results of these preproduction tests and conclusions leading towards an automated calibration algorithm will be presented in this talk. *gefördert durch das BMBF, GSI und HFHF.

HK 6: Instrumentation III

Time: Monday 14:00–15:30 Location: HK-H5

HK 6.1 Mon 14:00 HK-H5

Gain Calibration of the Upgraded ALICE TPC — •Philip Hauer — Helmholtz-Institut für Strahlen- und Kernphysik – Universität Bonn

For the upcoming Run 3 of the Large Hadron Collider (LHC), the collision rate of lead-lead beams will be increased to 50 kHz. In order to cope with this rate, the TPC was upgraded with a new amplification stage which is now based on Gas Electron Multiplier (GEM) foils. After its re-installation in the experiment, an extensive commissioning and testing program was performed.

One of the main goals of the commissioning program was the calibration of the gain. This comprises a coarse equalisation of the gas gain by fine-tuning the high voltage settings of each GEM foil stack, but also a pad-by-pad gain calibration for each electronic readout channel. In order to achieve this goal, two different types of measurements were conducted. The first one makes use of an X-ray tube which irradiated the active volume of the TPC. The second method is based on the gaseous and meta-stable radioactive isotope Kr-83m which was injected into the TPC.

In this talk, both methods will be explained in more detail. In addition to being indispensible for reaching the desired dE/dx performance of the TPC, the results of the measurements reveal interesting details on stretching issues and edge effects.

Supported by BMBF.

HK 6.2 Mon 14:15 HK-H5

Towards the PUMA pion tracker — •Sabrina Zacarias[1], Emanuel Pollacco[2], Christina Xanthopoulou[1], Alexandre Obertelli[1], and PUMA collaboration[1] — [1]TU-Darmstadt — [2]CEA-IRFU

The PUMA project (antiProton Unstable Matter Annihilation) aims at using low-energy antiprotons to probe the tail of the radial density of short-lived nuclei. With PUMA, the ratio of proton and neutron annihilations after capture will be determined, giving access to a new observable to quantify the ratio of proton to neutron densities at the nuclear periphery. To accomplish it, PUMA aims at transporting one billion low-energy antiprotons (produced at CERN/ELENA) to the CERN/ISOLDE facility where short-lived nuclei are produced. In the poster, the detection system (consisting of a time projection chamber and a trigger barrel) and the readout electronics development will be detailed.

HK 6.3 Mon 14:30 HK-H5

Development of the trigger barrel for PUMA — •Christina Xanthopoulou, Sabrina Zacarias, Dominic Rossi, and Alexandre Obertelli — Technische Universität Darmstadt

The antiProton Unstable Matter Annihilation project aims at the study of the periphery of short-lived nuclei by using low-energy antiprotons. The antiprotons annihilate with the nucleons on the surface of the nucleus which results in pions that pass through the detection system. By identifying the produced pions we are able to determine the ratio of protons to neutrons on the nuclear surface. The detection system consists of one time projection chamber and a trigger barrel. With the time projection chamber we are able to reconstruct the pions trajectories. The trigger barrel is composed of plastic scintillators to which Silicon PhotoMultipleres are attached. It will be used to trigger the trajectory measurements of the pions passing the time projection chamber. Simulations for the characterization of the trigger barrel are performed. Additionally, a trigger barrel test setup is build and used for benchmarking the simulation outcome. In the poster, the current status on the simulations and the test setup for the trigger barrel are presented.

HK 6.4 Mon 14:45 HK-H5

A calibration system for a modular small-format TPC with GEM amplification — •Dmitri Schaab, Reinhard Beck, and Bernhard Ketzer for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik

The performance of a Time Projection Chamber (TPC) relies on a good knowledge of the electric field inside the sensitive volume. This is crucial since deviations from a homogeneous drift field, either due to mechanical imperfections or due to space charge effects at high particle rates, deteriorate the spatial resolution of the detector if they remain uncorrected. One calibration method is to release electrons via the photoelectric effect at well-known positions on the cathode. By the electric field, these electrons are guided across the drift region towards the readout plane and show the integrated spatial distortions. In addition, a drift velocity measurement is provided. This photoelectric calibration concept, first employed at the T2K experiment, was implemented on a small scale involving a test tracking detector and a pulsed UV-laser. The laser light is conditioned using an optical setup and fed into the detector with the help of a multimode fiber bundle. Calculations were made in order to provide a uniform illumination of the detector cathode. The photoelectric calibration system was implemented in a newly built small TPC (sTPC) with GEM amplification. Its fully modular design allows for spatially resolved studies of field distortions using different GEM configurations or readout geometries.

The development of the measurement setup as well as characterizing photoelectric measurements will be presented.

HK 6.5 Mon 15:00 HK-H5

Distortions in the ALICE TPC caused by charge-up effects in the field cage — •Tim Geiger for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

ALICE is the dedicated heavy-ion experiment at the LHC at CERN. The main tracking and particle identification detector of ALICE is a large-volume Time Projection Chamber (TPC). To cope with the increased Pb-Pb interaction rate of 50kHz in Run 3, starting in 2022, the TPC was upgraded from multi-wire proportional chambers to a readout based on Gas Electron Multipliers (GEMs) which allows for a continuous readout of the detector.

In order to achieve its intrinsic track reconstruction resolution, a good understanding of possible space-point distortions is required. To study possible distortions, a dedicated commissioning campaign with x-ray illumination at different intensities was carried out. At the same time, a laser system was used to create ionization tracks in the TPC. The laser light also creates photo electrons at the aluminized high-voltage electrode of the drift field. Distortions in the drift time of the photo electrons are observed, varying with the x-ray intensity. This is caused by charge-up effects near the high-voltage electrode, locally modifying the electric field.

In this poster, we present an analysis of the measured distortions. They are compared to electrostatic calculations of different possible scenarios of modifications in the drift field.

HK 6.6 Mon 15:15 HK-H5

Photon Detection with THGEMs — •Thomas Klemenz[1], Laura Fabbietti[1], Piotr Gasik[2], Roman Gernhäuser[1], Berkin Ulukutlu[1], and Tobias Waldmann[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Traditional devices for photon detection like the Photomultiplier Tube or more recent technologies such as Silicon Photomultipliers are very cost-intensive. Therefore, especially with large area experiments in mind it is exciting to investigate new ways of detecting photons.

In this project we are taking the approach of combining a photosensitive material with a Thick GEM (THGEM) to produce a gaseous photon detector. THGEMs are robust, low-cost devices, which can be easily implemented in large area applications. One side of the THGEM is coated with a photosensitive material and placed within an electrical field. Photons captured by the active surface lead to a release of electrons which drift into the THGEM hole where they undergo avalanche multiplication due to strong electric fields applied. Below the THGEM an anode is reading out the amplified electron signal. Depending on the gain of the THGEM this could enable single photon detection.

We want to study the potential of this approach while trying different photosensitive materials. Ultimately, we aim to measure visible wavelength photons and to provide a low-cost, large area solution for neutrino observation in water and ice environments. In the talk the current status of the project is discussed.

HK 7: Structure and Dynamics of Nuclei I

Time: Monday 14:00–15:30 Location: HK-H6

HK 7.1 Mon 14:00 HK-H6

Investigation of neutron-induced γ-rays from Ge-nuclides in the ROI of GERDA/LEGEND — •Marie Pichotta[1], Hans Hoffmann[1], Konrad Schmidt[2], Steffen Turkat[1], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Dresden — [2]Helmholtz-Zentrum Dresden Rossendorf, Dresden

GERDA has been a pioneering experiment in the search for the still undetected neutrinoless double beta ($0\nu\beta\beta$)-decay of ^{76}Ge and this will also hold for the successor experiment LEGEND. The discovery of this extremely rare process would prove the Majorana character of neutrinos and consequently physics beyond the Standard Model. For an explicit identification of a signal caused by the $0\nu\beta\beta$-decay, which correspond to an energy of 2039 keV for ^{76}Ge, a precise understanding of all background contributions in the region of interest (ROI) is crucial.

Previous experiments indicated γ-lines, produced by neutron activation (n,p) and neutron scattering (n,n') processes on ^{76}Ge and ^{74}Ge but until now, no significant indications of their existence were found. In order to confirm the existence of the γ-lines in this ROI, an enriched Ge-sample was alternately irradiated by neutrons from a DT generator and measured by a HPGe detector. The γ-spectra of more than 40 irradiation cycles show two peaks in the ROI of GERDA/LEGEND. The experimental procedure and the analysis of the peaks will be presented. This project is supported by BMBF (05A17OD1).

HK 7.2 Mon 14:15 HK-H6

Neutrino-induced pion-production off the nucleon in chiral effective field theory — •Niklas Döpper and Norbert Kaiser — Physik-Department T39, Technische Universität München, D-85747 Garching, Germany

The current status of the analysis of neutrino-induced single pion production off the nucleon in the framework of manifestly Lorentz-invariant chiral perturbation theory is presented. The calculation of tree and one-loop diagrams is performed up to and including fourth chiral order with an explicit treatment of the $\Delta(1232)$ resonance. Terms that break the power counting between the loop and small momentum expansion are treated in the extended on-mass-shell scheme. This calculation aims to predict the total cross sections for the reactions of neutrino or antineutrino induced pion production off neutrons and protons at low energies. The present result has implications for the nuclear two-body axial exchange current as generated by one-pion exchange.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 7.3 Mon 14:30 HK-H6

Reaction studies around the Ca isotopic chain in inverse kinematics with the R3B setup — •Christian Sürder for the R3B-Collaboration — Institut für Kernphysik, TU Darmstadt, Germany

In Feb. 2020 an experiment to study isotopes around the Ca isotopic chain, reaching from the proton-rich to the neutron-rich side, was performed with the versatile R3B setup at GSI, Darmstadt, Germany. The isotopes were produced through fragmentation of a primary beam of ^{86}Kr at a beam energy of 580MeV/A on a ^{9}Be target. The secondary cocktail beam included isotopes of Cr, V, Ti, Sc, Ca, K, Ar and Cl. This experiment, part of the R3B Phase 0 program at FAIR, allowed for exclusive studies in inverse kinematics, employing reactions like (p2p), (p2pn), etc. The knocked out particles were detected with CALIFA, a CsI detector with high granularity, situated around the target area. The talk focuses on CALIFA, showing the detector performance and presenting first results of the reaction studies.

This work is supported by BMBF under contract 05P19RDFN1 and 05P21RDFN1 and the Helmholtz Research Academy Hesse - HFHF.

HK 7.4 Mon 14:45 HK-H6

Investigation of 220<A<230 Po-Fr nuclei in the south-east frontier of the A-225 island of octupole deformation — •Nicolas Hubbard[1,2], Marta Polletini[3,4], Helena Albers[2], Giovanna Benzoni[4], Julgen Pellumaj[5,6], and Jose Javier Valiente-Dobon[5] for the DESPEC-S460-Collaboration — [1]Technische Universitaet Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum fuer Schwerionenforschung, Darmstadt, Germany — [3]Universita degli Studi di Milano, Milano, Italy — [4]INFN Senzione di Milano,

Milano, Italy — [5]INFN, Laboratori Nazionali di Legnaro, Legnaro, Italty — [6]Universita di Ferrara, Ferrara, Italy

The Ra-Th (Z=88-90) actinide nuclei around mass number A~225 delimit the region of the nuclear chart where the strongest octupole correlations manifest. In general, there is a dearth of experimental information on the structure of nuclei in this region. An experiment was performed at GSI in April 2021 utilising the FRS+DESPEC setup to directly measure beta-decay half-lives, alpha-branching ratios and lifetimes of excited nuclear states. These results can be used to study the interplay between quadrupole and octupole correlations at the far end of the isle-of-deformation, to obtain beta-decay information beyond N=126 to better model the rapid neutron-capture (r-)process and to study shape isomers in 220,220Po where super-deformed and hyper-deformed structures at low excitation energies are expected. Furthermore, a calibration of the FRS+DESPEC setup using the alpha-emitting Rn and Fr isotopes was employed, providing a high-efficiency ion-decay correlation test as well as refining alpha-decay information.

HK 7.5 Mon 15:00 HK-H6

Branching-ratio of the mixed-symmetry 2^+-state of ^{132}Te* — •R. Mayer[1], T. Stetz[1], T. Beck[1], V. Werner[1], R. Zidarova[1], P. Koseoglou[1], N. Pietralla[1], R.-E. Mihai[2], R. Borcea[2], S. Calinescu[2], C. Costache[2], I. Dinescu[2], A. Ionescu[2], N. Marginean[2], C. Mihai[2], C.-R. Nita[2], S. Pascu[2], L. Stan[2], and S. Toma[2] — [1]IKP, TU Darmstadt — [2]IFIN-HH, Bucharest

^{132}Te is two protons and two neutron holes away from the doubly-magic ^{132}Sn. Its second 2^+ state has been found [1] to be a mixed-symmetry state which mostly decays by a strong M1 transition to the first 2^+ state. The transition to the 0^+ ground state occurs with a small branching ratio of 1.0(5)%. The large relative uncertainty of this ground-state decay branch prevented a precise determination of the $2^+_2 \to 2^+_1$ M1 strength from Coulomb-excitation data [1]. In a recent experiment, populating the 2^+_2 state of ^{132}Te via the two-neutron transfer reaction ^{130}Te(^{18}O,^{16}O)^{132}Te in an experiment at IFIN-HH, we employed the ROSPHERE HPGe array for a Doppler-shift attenuation measurement aimed at the determination of the 2^+_2 lifetime. While that analysis is ongoing, we sought to use the significant background reduction due to the use of the particle detection system SORCERER [2] to obtain a new value for the ground-state decay branch of the 2^+_2 state.

[1] M. Danchev et al., Phys. Rev. C 84, 061306(R) (2011)
[2] T. Beck et al., Nucl. Inst. Meth. Phys. A 951 (2020) 163090
*Supported by the BMBF under the Grants No. 05P19RDFN1 and 05P21RDFN1.

HK 7.6 Mon 15:15 HK-H6

HYDRA: HYpernuclei Decay at R3B Apparatus — •Simone Velardita, Liancheng Ji, Alexandre Obertelli, and Yelei Sun for the R3B-Collaboration — Technische Universität Darmstadt

HYDRA is a physics program within the R^{3}B collaboration at the decay spectroscopy of hypernuclei produced from heavy-ion collisions at GSI/FAIR. The program aims at measuring with high resolution the in-flight pionic decay of light and medium mass hypernuclei. The pion tracker is conceived as a time projection chamber inside the GLAD magnet of the R^{3}B setup.

As a first step, a prototype TPC was built to implement all the technologies proposed for the full TPC. The prototype covers an active area of 256 x 88 mm^2 decomposed into 5632 pads. In the drift region in which the drift length is 300 mm, a homogeneous electric field is held up by a two-layer wire field cage. A compact metal-core Micromegas pad plane is used to amplify and collect drift electrons. The prototype was tested at TU Darmstadt. The first results will be presented in the poster.

The full experimental setup has been simulated within the R3BROOT framework. Simulations were used to optimise the geometry and to define conditions for a forthcoming experiment at GSI/FAIR. Results will be detailed. The first experiment to be proposed with the HYDRA prototype, aiming at the mass radius of hypernuclei such as the hypertriton, expected to be halo, from interaction cross section measurement will be detailed in the poster.

HK 8: Structure and Dynamics of Nuclei II

Time: Monday 14:00–15:30 Location: HK-H7

HK 8.1 Mon 14:00 HK-H7

New evidence for alpha clustering structure in the ground state band of ^{212}Po — •Martin von Tresckow for the IFIN-HH212Po-Collaboration — IKP TU Darmstadt

^{212}Po has two-protons and neutrons outside the doubly-magic nucleus ^{208}Pb and it may be assumed that the nuclear structure can be well described within the shell-model. But various experimental properties, such as the short-lived ground state, are better predicted by an α-clustering model. The B(E2) values of the decays of the low lying yrast-states are an important finger print to describe the structure of ^{212}Po. Especially the missing B(E2; $4^+_1 \to 2^+_1$) value are important in this discussion. We have performed an α-transfer experiment to excited ^{212}Po and determine the lifetimes using the ROSPHERE γ-ray detector array at IFIN-HH in Magurele, Romania. This array consisted of 15 HPGe detectors and 10 LaBr$_3$(Ce) scintillator detectors and was supplemented with the SORCERER particle detector system. The combination of γ-ray and the particle detectors was an important tool to determine the mean lifetimes of all ground state band levels up to the 8^+ state applying the fast-timing method [Ma. von Tresckow et al., PLB 821, 136624 (2021)]. I will present our lifetime analysis and discuss the results within the shell-model and α-clustering model. This work is financially supported by EURONS2, IFA via grant 04FAIR/2020, MCDI via grant PN19060102, UK-STFC via grant ST/P005101/1, Ministry of Science and Higher Education of the Russian Federation under contract No. 075-10-2020-117.

HK 8.2 Mon 14:15 HK-H7

The Systematic Study of Pygmy Dipole States in ^{40,44,48}Ca Induced in the (p,p$'\gamma$) Reaction — •Barbara Wasilewska, Anna Bohn, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The calcium nuclei form a unique isotopic chain. It is the only element with two stable doubly-magic isotopes and the masses spread over a wide range of N/Z ratios. The second feature is especially interesting for studies of the Pygmy Dipole Resonance (PDR). This additional E1 strength in the region of the neutron separation energy (S$_n$) has been shown to increase with the N/Z ratio, but its nature is a subject of discussion [1]. The recent progress in nuclear physics theory enabled *ab-initio* calculations in the medium-mass region [2], making calcium isotopes a perfect probe to examine the states forming the PDR. In a series of experiments at the Institute for Nuclear Physics, University of Cologne, the isotopes ^{40}Ca, ^{44}Ca and ^{48}Ca were studied in the (p,p$'\gamma$) reaction at E$_p$ = 12, 15 MeV. Employment of the SONIC@HORUS set-up allowed a high-precision measurement of the excitations near S$_n$. In the talk, the experimental set-up and the analysis process will be briefly described. The obtained relative excitation cross-sections close to S$_n$ will be shown and compared with other experiments. The attempt to extract spins of observed states will also be discussed.

Supported by the DFG (ZI 510/10-1).

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210.
[2] S.G. Pickstone *et al.*, Nucl. Inst. Meth. A**875** (2017) 104.

HK 8.3 Mon 14:30 HK-H7

Lifetimes of non-yrast states in ^{104}Mo — •Matthias Rudigier[1], Martin von Tresckow[1], Thorsten Kröll[1], Jan Jolie[2], Yung-He Kim[3], Ulli Köster[3], Kosuke Nomura[4], and Jean-Marc Regis[2] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany — [2]Institut für Kernphysik, Universität zu Köln, Köln, Germany — [3]Institute Laue Langevin, Grenoble, France — [4]Physics Department, University of Zagreb, Zagreb, Croatia

The region of neutron-rich nuclei around N=60 is well known for abrupt changes in nuclear structure from N=58 to N=60 for Zr and Sr. The deformation changes quickly and competing minima in the potential energy surface appear which result in shape coexistence. For the heavier isotopes Mo and Ru the evolution is much more smooth. Nuclear structure theory is capable of describing the ground state band of Mo isotopes in this mass region quite well. However, experimental data on non-yrast states is not reproduced similarly well. This is especially true for the first excited 0^+ state in the Mo isotopic chain. We performed an experiment at the Lohengrin mass separator at the ILL, to measure lifetimes of non-yrast states using the fast timing method with the goal to obtain more detailed information on the configurations present in ^{104}Mo. In particular the aim is to determine the lifetime of the first excited 0^+ state. Preliminary results will be discussed in comparison to neighbouring nuclei, as well as in terms of theoretical predictions on level energies and transition strengths.Funding support is acknowledged from the EURONS2 and HFHF.

HK 8.4 Mon 14:45 HK-H7

Spectroscopy of ^{94}Pd — •Aleksandrina Yaneva for the DESPEC-S480-Collaboration — GSI Helmholzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — IKP, Univerity of Cologne, Cologne, Germany

In March 2020 the first formally approved DESPEC experiment (part of the FAIR phase-0 campaign) was performed at GSI Helmholtzzentrium für Schwerionenforschung. This experiment was focused on the measurement of electromagnetic transition rates between yrast excited states in the ^{94}Pd nucleus. The goal was to measure the lifetimes of the I$^{\pi}$=6^+ and 8^+ states in this N=Z+2 isotope, which would provide insight into the evolution of the wave function around the ^{100}Sn region.

The nuclei of interest were produced, identified and transported through the Fragment Separator to be implanted into the AIDA (Advanced Implantation Detector Array) active stopper. AIDA was surrounded by the FATIMA ($LaBr_3$) and GALILEO (HPGe) detector arrays, which provided the fast-timing and precise energy information respectively.

The data obtained from the measurements is currently being analyzed by looking for correlations between ion implantation in AIDA and isomeric decays in FATIMA. In order to measure isomeric lifetimes in FATIMA the prompt response of the detectors has been determined. Similarly precise energy and timing information are being extracted after proper calibration and drift corrections. I will present the current analysis status of the experimental data.

HK 8.5 Mon 15:00 HK-H7

Lifetime measurement in ^{50}Cr with a new compact differential 3-foil Plunger — •Marcel Beckers[1], Christoph Fransen[1], Alfred Dewald[1], Claus Müller-Gatermann[2], Franziskus von Spee[1], Peter Reiter[1], Jan Jolie[1], and Casper Lakenbrink[1] — [1]Institute for Nuclear Physics, University of Cologne — [2]Argonne National Laboratoy

A a new, multi-purpose differential 3-foil plunger has been commissioned. It can be used together with several gamma-ray spectrometers and charged-particle detectors, due to its compact size. As a commissioning experiment, level lifetimes of the 2_1^+ and the 4_1^+ excited states of ^{50}Cr have been measured, using the Differential Decay Curve (DDC) method for 3-foil plungers. This experiment was conducted at the Cologne FN Tandem Accelerator, using the reaction ^{24}Mg(^{32}S,4p2n)^{50}Cr. Results of this measurement with special respect to the performance of the 3-foil plunger device are presented. This project was supported by the BMBF under the contract number 05P18PKFN9.

HK 8.6 Mon 15:15 HK-H7

Erste direkte Lebensdauerbestimmung des 2_1^+-Zustandes von ^{210}Pb — •C. M. Nickel[1], M. Beckers[2], D. Bittner[2], A. Esmaylzadeh[2], B. Falk[2], C. Fransen[2], J. Garbe[2], L. Gerhard[2], K. Geusen[2], A. Goldkuhle[2], K. E. Ide[1], P. R. John[1], J. Jolie[2], V. Karayonchev[2], R. Kern[1], E. Kleis[2], L. Klöckner[2], M. Ley[2], G. Rainovski[3], F. Spee[2], M. Steffan[2], T. Stetz[1] und V. Werner[1] — [1]TU Darmstadt — [2]U Köln — [3]U Sofia

Die Untersuchung des Übergangs vom 2_1^+- in den Grundzustand in Kernen nahe dem doppelt-magischen ^{208}Pb erlaubt die Anpassung von Parametern in Kernmodellen, wie z.B. die effektiven Ladungen im Schalenmodell. Besonders wichtig sind hierbei Kerne mit zwei Valenznukleonen [1], deren elementare Anregungen die niedrigliegenden Kernzustände bilden, wie ^{210}Pb. Am 10 MV FN Tandem-Beschleuniger des Instituts für Kernphysik der Universität zu Köln wurde der 2_1^+-Zustand von ^{210}Pb in einer Zwei-Neutronen-Transferreaktion direkt bevölkert und seine Lebensdauer mithilfe des Kölner Plungers unter Nutzung der Recoil-Distance Doppler-shift-Methode gemessen. Dabei wurden HPGe-Detektoren zur Detektion der Gammastrahlung und Silizium-Detektoren zur Messung der bei der Kernreaktion rückgestreuten Teilchen genutzt. Somit wurde die Lebensdauer des 2_1^+-Zustandes von ^{210}Pb erstmalig direkt bestimmt, verträglich mit, aber deutlich genauer als, der einzige bekannte Literaturwert aus Triton-Streuung [2].

[1] D. Kocheva et al., Eur. Phys. J. A 53, 175 (2017).
[2] C. Ellegaard et al., Nucl. Phys. A 162, 1 (1971).
*Gefördert durch das BMBF unter Projekt-Nr. 05P21RDCI2.

HK 9: Hadron Structure and Spectroscopy I

Time: Monday 14:00–15:30 Location: HK-H8

Group Report HK 9.1 Mon 14:00 HK-H8

Investigation of the Σ^0 production mechanism in p(3.5 GeV)+p collisions at HADES experiment — •Waleed Esmail[1,2] and James Ritman[1,2,3] for the HADES-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Forschungszentrum Jülich, 52428 Jülich, Germany — [3]Ruhr-Universität Bochum, 44801 Bochum, Germany

The production of hyperons serves as a tool to investigate the strong interaction in the non-perturbative energy regime. This talk presents a study of the Σ^0 production mechanism via the exclusive reaction pp $\rightarrow$ p$K^+\Sigma^0$ at a beam kinetic energy 3.5 GeV with the HADES detector. The dynamics of the reaction pp $\rightarrow$ p$K^+\Sigma^0$ was investigated by studying the angular distributions in the CMS, Gottfried-Jackson and helicity frames. The angular distributions in the CMS frame supports the pion exchange mechanism. Furthermore, the helicity angular distributions are highly non-isotropic, which is a clear indication that there is a resonant component of the Σ^0 production. In order to provide a better description of the experimental angular distributions, the Bonn-Gatchina Partial Wave Analysis (Bo-Ga PWA) has been employed. However, due to the insufficient statistics, it was not possible to obtain an unambiguous determination of the relative contribution of each intermediate nucleon resonance to the overall final state. Nevertheless, significant contributions of nucleon resonances N^* (1710) (J^P=1/2$^+$), N^* (1900) (J^P=3/2$^+$) and Δ^* (1900) (J^P=1/2$^-$) are certainly preferred by the PWA fit.

HK 9.2 Mon 14:30 HK-H8

Status of the CALIFA Calorimeter and its performance at FAIR-Phase-0 experiments at R^3B — •Leyla Atar for the R3B-Collaboration — Technische Universität Darmstadt, Germany

CALIFA (the CALorimeter for In Flight detection of γ-rays and light charged pArticles) is one of the key detectors of the R^3B experiment at the GSI/FAIR facility. CALIFA is highly segmented and will consist of 2528 scintillation CsI(Tl) crystals after completion surrounding the reaction target area to facilitate measurement of the emission angle and energy of reaction products. CALIFA covers a huge dynamic range to allow a simultaneous measurement of γ-rays down to 100 keV and scattered light particles up to 300 MeV. A special feature of Califa is the digital Quick Particle Identification (QPID) enabling γ-rays and charged particle identification through Pulse Shape Analysis (PSA) of the scintillation light output.

I will shortly introduce the CALIFA calorimeter and its auxiliary detector systems and give an overview of the performance of CALIFA in the frame of FAIR-Phase-0 experiments performed at the R^3B/FAIR setup. Particularly first results, energy resolution and efficiency as well as QPID will be discussed for specific physics cases. The current development status of CALIFA and further enhancements will be presented.

This work is supported by BMBF contracts (05P19RDFN1) and (05P19RWOFN1).

HK 9.3 Mon 14:45 HK-H8

Feasibility study of the reaction $\bar{p}p \rightarrow e^+e^-\pi^0$ with the PANDA experiment at FAIR — •Alaa Dbeyssi[1], Frank Maas[1,2,3], Luigi Capozza[1], Oliver Noll[1], David Rodriguez Pineiro[1], Christoph Rosner[1], Sahra Wolff[1], Alexander Greiner[1], Julian Moik[1], Samet Katilmis[1], and Dong Liu[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]Prisma Cluster of Excellence, Mainz, Germany

The feasibility of measuring the reaction $\bar{p}p \rightarrow e^+e^-\pi^0$ with the PANDA detector is investigated within the PANDARoot simulation framework. At high center of mass energy and high invariant mass squared of the lepton pair, a collinear factorisation description of the reaction amplitude, based on nucleon-to-meson transition distribution amplitudes, is predicted in the near forward and near backward regimes. At low lepton invariant mass squared, a parametrisation that assumes the exchange of dominant baryon Regge trajectories is suggested. Such a parametrisation will allow us to study the proton electromagnetic form factors in the so called "unphysical region". The collinear factorisation theorem for the nucleon-to-meson transition distribution amplitudes has not yet been proven experimentally. In addition, no data exist so far on the proton electromagnetic form factors in the unphysical region. The capability of PANDA to measure the differential cross sections for the reaction $\bar{p}p \rightarrow e^+e^-\pi^0$ and perform validity tests of the predicted QCD models will be shown in this talk.

HK 9.4 Mon 15:00 HK-H8

Accessing three-body strong interactions of p–p–π^+ and p–p–π^- with ALICE at the LHC — •Marcel Lesch for the ALICE-Collaboration — TUM

In the quest of understanding the nuclear equation of state, which is linked to the modelling of neutron stars, the QCD axion might play a crucial role. The properties of axions are expected to change in systems at finite baryonic densities and in particular they can be related to the in-medium properties of pions. Constraining these properties is thus crucial for the study of the QCD axion and its impact on the description of neutron stars.

The in-medium pion properties can be accessed by the measurement of interactions between pions and many nucleons produced in pp and p-Pb collisions at the LHC. These small systems produce particles at distances of ∼ 1 fm, mimicking a large density environment. This talk will present the first experimental three-body correlations of the p–p–π^+ and p–p–π^- triplets by using the three-body femtoscopy technique. The results have been obtained by analysing high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV measured by ALICE. The three-body effects are probed by employing the Kubo cumulant formalism to subtract the lower order contributions from the measured triplet correlation functions.

HK 9.5 Mon 15:15 HK-H8

LHCspin: towards a polarized gas target for the LHC — •Erhard Steffens[1], Paolo Lenisa[2], Vito Carassiti[2], Giuseppe Ciullo[2], Pasquale Di Nezza[3], Luciano L. Pappalardo[2], and Marco Santimaria[3] — [1]FAU, Erlangen, Germany — [2]U. Ferrara and INFN, Italy — [3]INFN Lab. Nat. di Frascati, Italy

The LHCspin project aims at unpolarized (SMOG2) and polarized fixed-target measurements by means of a gas target upstream of the LHCb detector, close to the vertex detector VELO. The forward geometry of the LHCb spectrometer ($2 < \eta < 5$) allows for the reconstruction of particles produced in fixed-target collisions, with center-of-mass energies ranging from $\sqrt{s_{NN}} = 72$ GeV with Pb beam to $\sqrt{s} = 115$ GeV in pp collisions. The use of H and D targets, polarized transversely to the beam will allow to study the quark TMDs in pp collisions at unique kinematics. In addition, with LHCb being specifically designed for heavy-flavor physics, final states with c- or b-quarks will be efficiently reconstructed as demonstrated in detailed simulations, thus providing access to the so-far unknown gluon TMDs.

The design and status of the study will be presented. An openable storage cell with wake field suppressor and unpolarized gas feed system (SMOG2) is installed and ready to be tested during early 2022. A similar target with transverse B-field plus atomic beam source and diagnostics is being designed. The 7 TeV/1 A beam traversing the target might cause instabilities, which must be suppressed. This is studied in close collaboration with the LHC machine group.

HK 10: Hadron Structure and Spectroscopy II

Time: Monday 14:00–15:30 Location: HK-H9

Group Report HK 10.1 Mon 14:00 HK-H9

Experimental Inputs to the Hadronic Light-by-Light Contribution to the Anomalous Magnetic Moment of the Muon from BESIII — •Christoph Florian Redmer, Achim Denig, Nick Effenberger, and Max Lellmann for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Despite being one of the most precisely studied observables in particle physics, there remains a discrepancy of $4.2\,\sigma$ between the average value of the most recent direct measurements and the prediction within the Standard Model of the anomalous magnetic moment of the muon $a_\mu = \frac{(g-2)_\mu}{2}$. The precision of the prediction is limited by the knowledge of the hadronic contributions, which cannot be determined perturbatively, but depend on input from experiments. One of these contributions is the hadronic Light-by-Light scattering, which depends on the knowledge of transition form factors of light pseudoscalar, scalar, axial, and tensor mesons as well as the coupling of multi-meson systems to two photons, which is accessible in e^+e^- collisions.

The BESIII experiment, operated at the BEPCII accelerator in Beijing, China, has collected the world's largest data sets of e^+e^- collisions in the τ-charm region between 2 GeV and 5 GeV. The data are ideally suited to measure the momentum dependence of transition form factors at space-like momentum transfers of $Q^2 \approx 1\,\mathrm{GeV}^2$, which is of special relevance in the context of a_μ. In this presentation we discuss recent results, ongoing projects, and future prospects of the measurements at the BESIII experiment.

Group Report HK 10.2 Mon 14:30 HK-H9

Study of exclusive reactions in muon-proton scattering at COMPASS — •Johannes Giarra — on behalf of the COMPASS collaboration - Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Johann-Joachim-Becher-Weg 45, 55099 Mainz

In 2016/17 a measurement of exclusive reactions in the muon-proton scattering was performed in order to determine the cross section of the Deeply Virtual Compton Scattering (DVCS) process and exclusive meson production.

The COMPASS spectrometer is located at the M2 beamline of the CERN SPS, which provides a 160 GeV positively and negatively charged muon beam. The muons were scattered off a 2.5m long liquid hydrogen target. To perform an exclusive measurement of the processes the COMPASS spectrometer was supplemented by an additional electromagnetic calorimeter to increase the acceptance for the detection of large angle photons and a proton recoil detector.

The talk will summarize the current status in the analysis for determining the cross section of the DVCS and the exclusive single π^0 production. A focus will be on a detailed description of the methods and analysis steps used to extract the cross sections. A preliminary result on the t-dependence of the DVCS cross section will be presented.

HK 10.3 Mon 15:00 HK-H9

Measurement of the Proton Radius in High-Energy Elastic Muon-Proton Scattering at AMBER — •Christian Dreisbach for the AMBER-Collaboration — Technische Universität München, Physik-Department, Garching, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic scattering and laser spectroscopy measurements of the proton radius have been performed with contradicting results – the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN's Super Proton Synchrotron in the year 2023. A high-precision measurement at low Q^2 realized with a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. The core setup consisting out of silicon tracking detectors up- and downstream of a prototype TPC is studied in a feasibility test measurement in the year 2018 and a pilot run in 2021 under comparable conditions as the proposed measurement. A beam test of a new unified tracking station utilizing scintillating fibers and monolithic pixel-silicon detectors and commissioning of the novel triggerless DAQ system is foreseen in 2022. We present results of the on-going analysis and developments towards a possible setup in 2023.

HK 10.4 Mon 15:15 HK-H9

Radiative corrections to elastic muon-proton scattering — •Norbert Kaiser[1], Yonghui Lin[2], and Ulf-G. Meissner[2] — [1]Physik Department T39, Technische Universität München — [2]HISKP and Bethe Center for Theoretical Physics, Universität Bonn

In support of the upcoming AMBER experiment at CERN to measure the proton charge-radius, the radiative corrections to elastic muon-proton scattering $\mu^\pm p \to \mu^\pm p$ are calculated, keeping the full dependence on the lepton mass. Besides vacuum polarization and the photon-loop form factors $F^\gamma_{1,2}(t)$ of the muon, one has to consider the photon-loop around the proton. The corresponding electric and magnetic form factors $G^\gamma_{E,M}(t)$ consist of infrared-divergent and infrared-finite pieces that are evaluated by including proton structure through electromagnetic form factors (caused by the strong interaction) and the excitation to the $\Delta^+(1232)$-resonance. The same features apply to the computation of the two-photon exchange box-diagrams. It is found that after cancelation of infrared divergences the (soft) photon bremsstrahlung plays a prominent role among the radiative corrections. Therefore, the calculation of bremsstrahlung should be extended beyond the soft photon approximation and adapted to the specific experimental conditions.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 11: Nuclear Astrophysics I

Time: Monday 14:00–15:30 Location: HK-H10

Group Report HK 11.1 Mon 14:00 HK-H10

The explosive nucleosynthesis of proton-rich nuclei mimicked in the laboratory — •Felix Heim, Martin Müller, Svenja Wilden, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics

The universe was born with just hydrogen, helium and small traces of lithium. Most of the heavy nuclei beyond the iron-peak region are created by neutron-capture processes. A group of 30 to 35 proton-rich stable isotopes however, is shielded against these processes. These p nuclei are most likely produced in explosive stellar scenarios by the astrophysical γ process, which is a complex network of thousands of nuclear - mostly photodisintegration - reactions on stable and unstable nuclei. At present, most of the reactions rates involved are taken from theory in the framework of the Hauser-Feshbach model. Therefore, the extension of the experimental database of measured cross sections is one of the tasks of nuclear laboratories. Also, experimental data are required to constrain the nuclear physics parameters entering the theoretical calculations and to test their predictive power. In this contribution, details of the experimental setup and techniques will be presented that are used to measure nuclear reactions relevant for the nucleosynthesis of the p nuclei. In addition, emphasis will be put on studies of the underlying nuclear physics properties.

Supported by the DFG (ZI 510/8-2).

HK 11.2 Mon 14:30 HK-H10

Investigation of ^{170,172}Yb$(\alpha,n)^{173,175}$Hf cross sections in a stacked target experiment — •Martin Müller, Felix Heim, Yanzhao Wang, Svenja Wilden, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

In spite of decades of research, many observed nuclear abundances remain that can not be reproduced by p-process nucleosynthesis calculations [1]. This is mainly due to the lack of constraints for the involved nuclear physics models. Previous studies have shown that key reactions affecting the abundance of the p-nucleus ^{168}Yb are the ^{164,166}Yb(α, γ) reactions and that these are mostly sensitive to the α-optical-model-potential (α-OMP) [2,3]. To study the α-OMP in the Yb chain and its dependence on the proton-to-neutron ratio, a stacked target activation experiment was performed at the University of Cologne's *Cologne Clover Counting* setup investigating the ^{170,172}Yb(α, n)^{173,175}Hf reaction cross sections. The results were validated by simultaneous measurements of the well established ^{55}Mn(α, (2)n)^{57,58}Co and ^{54}Fe(α, n)^{57}Ni reaction cross sections. All measurements were compared to statistical model calculations performed using the TALYS-1.95 code [4].

Supported by the DFG (ZI 510/8-2).

[1] M. Arnould and S. Goriely, Phys. Rep. **384**, 1 (2003)
[2] T. Rauscher *et al.*, Mon. Not. R. Astron. Soc. **463**, 4153 (2016)
[3] T. Rauscher *et al.*, Astrophys. J. Suppl. Ser. **201**, 26 (2012)
[4] A. J. Koning *et al.*, Nucl. Data Sheets **113**, 2841 (2012)

HK 11.3 Mon 14:45 HK-H10

First results of total and partial cross-section measurements of the ^{87}Rb(p, γ)^{88}Sr reaction — •Svenja Wilden, Felix Heim, Martin Müller, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The existence of most of thestable very neutron deficient nuclei - the p nuclei - cannot be explained via neutron-capture reactions. Therefore, at least one other process has to exist in order to describe their origin, the γ process. Since most photodisintegration reactions involved in the process are not directly accessible, reliable statistical model calculations are needed to predict cross sections and reaction rates. To improve the calculations the nuclear input parameters need to be constrained and a large experimental database is needed. Via comparison of experimental data to theoretical predictions different models can be excluded or constrained. In order to study the ^{87}Rb(p, γ)^{88}Sr reaction, for the first time an in-beam experiment at the high-efficiency HPGe γ-ray spectrometer HORUS at the University of Cologne was performed. Proton beams with energies between E_p = 2.0 − 5.0 MeV inside the Gamow window were provided by the 10 MV FN Tandem accelerator.

Supported by the DFG (ZI 510/8-2).

HK 11.4 Mon 15:00 HK-H10

Investigation of the 3He(α,γ)7Be reaction at the Felsenkeller shallow underground facility — •Steffen Turkat[1], Daniel Bemmerer[2], Axel Boeltzig[2], Fabia Dietrich[2], Armin Freimann[2], Thomas Hensel[1], Jonas Koch[2], Till Lossin[2], Felix Ludwig[2], Jannis Michaelis[2], Max Osswald[2], Simon Rümmler[2], Konrad Schmidt[2], Julian Schwengfelder[2], and Kai Zuber[1] — [1]Institut für Kern- und Teilchenphysik, TU Dresden, Dresden, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The ^{3}He(α,γ)^{7}Be reaction plays a significant role in Big Bang nucleosynthesis, as well as in solar fusion processes. It affects the predicted solar ^{7}Be and ^{8}B neutrino fluxes as well as the nucleosynthesis of primordial ^{7}Li.

A measurement of the γ-ray angular distribution is currently underway in order to enable a better comparison between several experimental data sets at E = 0.7 - 1.3 MeV and a unique data set from the LUNA collaboration at E = 0.09 MeV - 0.13 MeV. A setup using 21 HPGe detectors and implanted 3He targets is used at the 5 MV Felsenkeller underground accelerator. In addition to the angular distribution study, the activated samples are counted offline. First results of this ongoing campaign will be summarized. - Supported by DFG (ZU123/21-1)
The use of GAMMAPOOL resources is gratefully acknowledged.

HK 11.5 Mon 15:15 HK-H10

Energy calibration of the 5MV accelerator at the Felsenkeller shallow-underground laboratory — •Simon Rümmler[1], Daniel Bemmerer[1], Axel Boeltzig[1], Fabia Dietrich[1], Armin Freimann[1], Jonas Koch[1], Till Lossin[1], Felix Ludwig[1], Max Osswald[1], Konrad Schmidt[1], Julian Schwengfelder[1], Steffen Turkat[2], and Kai Zuber[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics — [2]TU Dresden, Institute of Nuclear and Particle Physics

Astrophysical radiative capture reactions occur at low energies, resulting in low cross sections and hence low counting rates in the γ-detectors. This calls for accelerator facilities that are located underground, shielded from cosmic rays. The shallow-underground laboratory at Felsenkeller in Dresden provides 45 meters of rock overburden for the installed 5MV Pelletron accelerator. In addition to a low-background setting, an energy calibration of the accelerator is needed to perform precise measurements.

During the commisioning of the accelerator and its two ion sources, as well as during first astrophysically relevant experiments, measurements for different methods of an energy calibration were recorded. The results of the individual methods were obtained independently and provide consistent results, even at different accelerator voltages. The overall result of the completed energy calibration and a comparison of the methods will be presented.

HK 12: Heavy-Ion Collisions and QCD Phases III

Time: Monday 16:00–17:30 Location: HK-H1

Group Report HK 12.1 Mon 16:00 HK-H1

Measurements of Heavy-flavour Baryon Production with ALICE at the LHC — •Jeremy Wilkinson for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

The measurement of charmed baryons in hadronic collision systems at the LHC has recently shown an enhancement of the charmed baryon-to-meson ratios (Λ_c^+/D^0 and Ξ_c/D^0) with respect to previous measurements in e^+e^- and e^-p collisions, challenging previous assumptions about the universality of charm hadronisation processes between different collision systems. This in turn has a significant effect on the measured total charm cross section, where previously the relative contributions of charmed baryons had to be assumed based on results from leptonic collision experiments.

This talk will present the latest measurements performed by the ALICE Collaboration for charmed baryon production at mid-rapidity in pp and p–Pb collisions at the LHC. In particular, we highlight recent developments in analysis techniques using the XGBoost algorithm for machine learning selections, and the KFParticle package, which uses a Kalman filter to re-fit the decay tracks from baryon candidates and provide constraints to improve the mass resolution. These methods provide unprecedented experimental access to the low-p_T region for Λ_c^+ to serve as a constraint on the charm fragmentation fractions. In addition, they can be used to give indirect access to the beauty sector through non-prompt Λ_c^+, as well as previously inaccessible decays such as $\Omega_c^0 \rightarrow \Omega^-\pi^+$ and $\Xi_c^+ \rightarrow \Xi^-\pi^+\pi^+$.

HK 12.2 Mon 16:30 HK-H1

Reconstruction of $\Xi_c^+ \rightarrow \Xi^-\pi^+\pi^+$ in proton-proton collisions at $\sqrt{s}$ = 13 TeV with the ALICE detector — •Carolina Reetz — Physikalisches Institut, Universität Heidelberg — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Recent measurements of charmed-baryon production at midrapidity in pp and p-Pb collisions show a baryon-to-meson ratio significantly higher than the one in e^+e^- collisions, suggesting that the fragmentation of charm quarks into hadrons is not universal across different collision systems.

The reconstruction of the Ξ_c^+ baryon decaying to $\Xi^-\pi^+\pi^+$ with the ALICE detector is the subject of the studies presented in this contribution. The reconstruction of the complex decay topology is performed with the help of the KF Particle Package. It supports the reconstruction of full particle decay chains, exploiting the use of invariant mass and topological constrained fits and including the complete treatment of tracking and vertexing uncertainties. These features are of crucial importance in the selection of reconstructed candidates which is performed by applying machine learning techniques in the form of Boosted Decision Tree (BDT) models using XGBoost.

The application of these advantageous techniques is of utmost importance in the search for rare signals and allows to extract signal even in low p_T-intervals where the signal-to-background ratio is rapidly decreasing. The cross section measurement together with the full treatment of the systematic uncertainties and the comparison to model calculations is reported.

HK 12.3 Mon 16:45 HK-H1

Reconstruction of beauty jets in proton-proton collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Katharina Demmich — Westfälische Wilhelms-Universität Münster, Germany

In this contribution, the performance of a beauty-jet tagging algorithm based on transverse impact-parameter threshold cuts will be discussed for data collected by the ALICE experiment in proton-proton collisions at $\sqrt{s}$ = 13 TeV. Owing to the relatively large lifetimes and the cascade of weak decays of beauty hadrons, the measurement of the impact parameter of tracks within jets can be utilised to select beauty jets. Measuring the beauty-jet production cross section in proton-proton collisions is a fundamental step towards a thorough testing of QCD calculations for the production and fragmentation of heavy flavours in nucleon-nucleon collisions. Thereby, the ALICE experiment offers excellent capabilities to assess theory predictions down to low $p_{T,Jet}$ due to its unique tracking performance. In addition, the investigation of beauty-jet observables in proton-proton collisions is a reference for respective analyses on heavy-ion collisions. As such, it opens the possibility to study the mass dependence of particle interactions with the Quark-Gluon Plasma (QGP).

HK 12.4 Mon 17:00 HK-H1

Measurement of charm production cross-section via electron-muon coincidence — •Victor Feuillard for the ALICE-Collaboration — Physikalische Institut, Heidelberg, Germany

The measurement of the production of heavy-flavor hadrons, meaning hadrons with charm or beauty quarks, in proton-proton collisions provides a test of quantum chromodynamics (QCD), the theory of the strong interaction. Indeed, in hadronic collisions, heavy quarks are almost exclusively produced through initial hard partonic scattering processes because of their large masses.

One available method to investigate heavy-flavor production is the measurement of the contribution of semi-leptonic decays of heavy-flavor hadrons to the dilpeton spectra. In particular, it is possible to measure the production of heavy mesons in the electron-muon spectrum.

In this talk, we will present the measurement of the charm production cross section in pp collisions at $\sqrt{s}$ = 13 TeV in ALICE using electron-muon coincidence.

HK 12.5 Mon 17:15 HK-H1

Hydrodynamic approach to heavy-quark diffusion in the quark-gluon plasma — •Federica Capellino[1,2], Andrea Beraudo[3], Andrea Dubla[2], Stefan Floerchinger[4], Silvia Masciocchi[1,2], Jan M. Pawlowski[4], and Ilya Selyuzhenkov[2] — [1]Physikalisches Institut Heidelberg, Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]INFN Sezione di Torino, Torino, Italy — [4]Institut für Theoretische Physik, Heidelberg, Germany

In this work, a new hydrodynamic approach to the transport of heavy quarks in the quark-gluon plasma (QGP) is presented. We exploit the conservation of the number of heavy quark-antiquark pairs within the evolution of the QGP to construct causal second-order hydrodynamic equations of motion. The hydrodynamic transport coefficients associated with the heavy-quark diffusion current are then compared with the momentum-diffusion coefficients obtained in transport theory (Fokker-Planck equation). By investigating the relation between the two approaches, we provide new insights concerning the level of local thermalization of charm and bottom quarks inside the expanding QGP. Our results show that a fluid dynamic description of diffusion is feasible for charm quarks. In particular, in Bjorken flow the hydrodynamization time of charm quarks is in general short compared to the typical expansion time of the QGP, justifying a fluid description of charm diffusion. This work is funded via the DFG ISOQUANT Collaborative Research Center (SFB 1225).

HK 13: Heavy-Ion Collisions and QCD Phases IV

Time: Monday 16:00–17:15 Location: HK-H2

HK 13.1 Mon 16:00 HK-H2

Coarse Grained Transport Dynamics with FRG spectral function — •Maximilian Wiest[1], Tetyana Galatyuk[1,2,4], Ralf-Arno Tripolt[3], Lorenz von Smekal[3,4], Jochen Wambach[1], and Joachim Stroth[2,4,5] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Justus Liebig University Giessen, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Germany — [5]Goethe University Frankfurt, Germany

The bulk of the detected particles stemming from heavy ion collisions are hadrons. Being strongly interacting, they are heavily influenced by final state interactions. As produced dileptons are not subject to the strong interaction, they do not suffer from this disadvantage and can leave the fireball undisturbed, probing the hot and dense matter before it freezes out. We use the microscopic transport model UrQMD to simulate gold-gold collisions at 1.23 AGeV at different centrality classes. Employing a Coarse Graining approach, we are able to combine the simulated microscopic dynamics with in-medium spectral functions obtained from FRG methods. This allows us to study the thermal dilepton production in heavy-ion collisions at SIS 18 energies. Our aim is to investigate the consistency of our approach. For this purpose, we will compare different methods of extracting the bulk observables as well as determining thermalization and explore the effect of variations in the underlying parameters like grid sizes. Supported by VH-NG-823, DFG CRC-TR 211 and GSI.

HK 13.2 Mon 16:15 HK-H2

Quantum Mechanical Bound State Formation in Time Dependent Potentials — •Jan Rais[1], Hendrik van Hees[2], and Carsten Greiner[3] — [1]Institute for theoretical physics, Goethe Universität Frankfurt — [2]Institute for theoretical physics, Goethe Universität Frankfurt — [3]Institute for theoretical physics, Goethe Universität Frankfurt

We study the formation of quantum mechanical bound states within a 1-dimensional attractive square well potential, by first solving the stationary system and then study a time dependent system. Here we introduce a time dependent potential, which could generally be of every shape. In our case, we introduce Gaussian potentials which are sufficiently small in space, due to the size of the box and differ due to different time lengths. We are interested to study the time scales, in which bound states populate and depopulate. Therefore we also clarify how to treat the question, where to obtain Heisenberg's uncertainty relation in energy and time and how it is fulfilled in our system. Furthermore we study the applicability of first order perturbation theory on the considered quantum system.

HK 13.3 Mon 16:30 HK-H2

Dynamic critical behavior of spectral functions via classical statistical real-time simulations — •Frederic Klette and Sören Schlichting — Bielefeld University, Bielefeld, Germany

Finding the position of the critical point in the QCD phase diagram and determining the behavior in its vicinity has been the subject of active research for several decades. Spectral functions of a system and other real-time observables, can not be reconstructed with an acceptable accuracy from Euclidean time data. Due to QCD being difficult to simulate directly in real time we use universality to investigate the physics near the QCD critical point. Using the fact that models with an O(n) symmetry are in the same, or at least a similar universality class as the chiral model, we study these via classical statistical simulations to learn about their dynamic critical behavior. More precisely, we aim to develop a detailed analysis of the dynamic critical scaling behavior of the spectral function and related observables of an O(4) symmetric model in (3+1) dimensions.

HK 13.4 Mon 16:45 HK-H2

Non-Equilibrium Transport of Conserved Charges in High- Energy Heavy Ion Collisions — •Philip Plaschke and Sören Schlichting — Bielefeld University, Germany

Non-equilibrium Green*s functions provide an efficient way to describe the pre-equilibrium evolution of macroscopic quantities in early stages of heavy-ion collisions. Within the kinetic theory framework we use moments of the distribution functions to calculate time dependent non-equilibrium Green*s functions describing the evolution of initial energy/momentum/charge perturbations [1]. Using kinetic theory in relaxation time approximation we will study the pre-equilibrium evolution of a Bjorken background and compute Green*s functions for the charge current and energy-momentum tensor for initial perturbations around this background. By calculating the Green*s functions, we show that only modes with long wavelength survive up into the hydrodynamic regime. [1] [Kamata, Martinez, PP, Ochsenfeld, Schlichting, Phys. Rev. D (2020)]

HK 13.5 Mon 17:00 HK-H2

Classifying the QCD equation of state in heavy-ion collision experiments with Deep Learning — •Manjunath Omana Kuttan[1,2,3], Kai Zhou[1], Jan Steinheimer[1], Andreas Redelbach[1,4], and Horst Stöcker[1,2,5] — [1]FIAS, Frankfurt am Main, Germany — [2]Institut fur Theoretische Physik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [3]Xidian-FIAS international Joint Research Center, Frankfurt am Main, Germany — [4]Institut fur Informatik, Johann Wolfgang Goethe Universität, Frankfurt am Main, Germany — [5]GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Darmstadt, Germany

We present a novel technique to identify the nature of QCD transitions that happen in a heavy-ion collision experiment, particularly at the CBM experiment [1]. We show that Deep Learning (DL) models based on PointNet can be used as a fast, online method for identifying a first order phase transition from a crossover transition that happens in heavy-ion collision experiments. We use a comprehensive data preparation method to train and evaluate the models in several hypothetical experimental scenarios. A model trained on the reconstructed tracks from CBM detector simulations requires only about 40 events for accurate predictions. This makes the PointNet models an ideal candidate for online analysis of the continuous datastream produced in the CBM experiment. The DL model is shown to have up to 99.8% prediction accuracy and outperforms conventional methods based on mean observables such as the V_2 or $\langle P_t \rangle$.

[1] Omana Kuttan, M., et al. JHEP, 2021(10), 1-25.

HK 14: Instrumentation IV

Time: Monday 16:00–17:30 Location: HK-H3

Group Report HK 14.1 Mon 16:00 HK-H3

Status of the CBM Micro Vertex Detector* — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt am Main

The Compressed Baryonic Matter (cbm) Experiment will be a core experiment of the future fair facility. Its Micro Vertex Detector will be composed from four stations and operate in the target vacuum. Its mission is to reject background in di-electron spectroscopy and to reconstruct weak decays of multi-strange baryons and open charm created in the up to 10 MHz p+p and up to 100 kHz Au+Au collisions of the fixed target experiment. The 0.3 – 0.5% X_0 thin stations will be equipped with 50 μm thin, highly granular Monolithic Active Pixel Sensors named mimosis, which are being designed by the iphc Strasbourg and will combine a spatial and time resolution of 5 μm and 5 μs, respectively, with a peak rate capability of 80 MHz/cm^2.

We discuss first results from tests of the mimosis-1 full size sensor prototype, which was irradiated with doses up to 3×10^{14} n_{eq}/cm^2 and 5 MRad and tested hereafter at desy and the cern-sps. Moreover, the status of the R&D on detector integration will be summarized.

*This work has been supported by bmbf (05P19RFFC1), gsi, cremlinplus, and hfhf.

Group Report HK 14.2 Mon 16:30 HK-H3

The LHCb Upgrade II Plans with focus on the MightyTracker — •Klaas Padeken[1], Sebastian Neubert[1], and LHCb MightyTracker group[2] — [1]Rheinische Friedrich-Wilhelms Universität Bonn — [2]CERN

For the HL-LHC the LHCb Collaboration plans a major Upgrade in the long shutdown 4 (2031) to increase the instantaneous luminosity from $2{\cdot}10^{33}$ cm^{-2}s^{-1} to $1.5 \cdot 10^{34}$ cm^{-2}s^{-1} with streaming, triggerless output. This requires a major redesign of a few subdetectors. This talk will focus on MightyTracker, which will replace the current SciFi Tracker with a hybrid detector, comprised of HV-CMOS pixel sensors surrounding the beampipe and scililating fibers further outside. This will be the largest CMOS detector with a total of 18 m^2 of active area. The current developments and plans will be presented.

HK 14.3 Mon 17:00 HK-H3

Material budget imaging of carbon foam support structures using ALPIDE sensors — •Bogdan Mihail Blidaru for the ALICE-Collaboration — Physikalisches Institut, Heidelberg University, Germany

During the next LHC Long Shutdown, ALICE plans to replace the three innermost layers of the recently upgraded Inner Tracking System (ITS2) with a novel vertex detector based on wafer-scale, ultra-thin, truly cylindrical Monolithic Active Pixel Sensors (MAPS). The new sensors will be thinned down to 20-40 μm, featuring an unprecedented low material budget of less than 0.05% x/X_0 per layer and will be arranged concentrically around the beam pipe, as close as 18 mm from the interaction point.

To reach such ultra low material budget levels, the routing of power and signals will be integrated onto the sensor and the water cooling and mechanical support will be removed. A series of ultra-lightweight half-ring spacers, made of open cell carbon foam will be instead used in the active area. They will be inserted between the sensor layers to define their relative radial position and offer mechanical support.

To study the effects of scattering, carbon foam wedges of different proposed materials are tested in a high-resolution ALPIDE telescope using electron beams in the GeV-range at the DESY Test Beam Facility. The material budget is estimated with good accuracy by measuring the position-resolved scattering angle distribution of the beam particles. The foam structure is properly resolved and good agreement between expectations and data is found.

HK 14.4 Mon 17:15 HK-H3

Sensor tests for the PANDA Micro-Vertex-Detector — •Nils Tröll for the PANDA-Collaboration — II. Physikalisches Institut, Giessen, Germany

Double sided silicon strip detectors are part of the Micro-Vertex-Detector (MVD), which is the innermost detector of PANDA. High resolution track measurements are to be carried out to investigate the strong interaction in particular.

Methods for accuracy measurements on test structures of the silicon-strip-sensors will be presented. These techniques and full-sensor measurements are used for characterization and quality testing of the final MVD sensors. In addition, radiation tolerance characterization on silicon diodes using a neutron source will be shown.

HK 15: Instrumentation V

Time: Monday 16:00–17:30 Location: HK-H4

Group Report HK 15.1 Mon 16:00 HK-H4

A new high level filter system for the AMBER experiment at the CERN SPS — •Benjmain Moritz Veit for the AMBER-Collaboration — Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz

AMBER is a new experiment at the European Organization for Nuclear Research (CERN) dedicated to study fundamental questions related to the emergence of hadron mass from QCD. Therefore a variety of measurements with muon and hadron beams, which will cover a wide range in the squared four-momentum transfer Q2, at the M2 beam line of the Super Proton Synchrotron (SPS) are forseen. One of the first measurements in AMBER phase 1 is the elastic scattering of high-energy muons off protons to precisely determine the proton charge radius. For this experiment, it is planned to transform the current classical DAQ approach to a streaming DAQ scheme, in which detectors deliver continuous time-stamped data streams with data rates of up to 20GB/s to the DAQ. This data streams will be concentrated by a system of FPGA-based multiplexers and a timeslice builder switch before the full data stream is stored by readout computers on a temporary local storage. The local storage allows for extraction and validation of calibration information before the final processing. The newly developed asynchronous running high level filter system (HLT) use this information to partially reconstructed, analyse, and eventually reduced the amount of data. The goal of the filter system is to reduce the data rate below 500MB/s before it is written to permanent storage. An overview of the design of the filter system will be presented.

HK 15.2 Mon 16:30 HK-H4

NuDAQ - A flexible and extendable data acquisition system for above-small size nuclear physics setups — •Michael Weinert, Christoph Fransen, Andreas Harter, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The increasing number of channels in modern day nuclear physics experiments led to a redesign of the digital data acquisition system (DAQ) and the overall approach to setting up experiments at the Institute for Nuclear Physics in Cologne. While a high channel count and low dead times are welcomed features of modern digital acquisition systems, the highest achievable spectral resolution is mandatory for experiments that depend on the analysis of e.g. γ-ray energies well below 1 keV precision or direct lifetime measurements in the ps regime. A new DAQ system was built around the commercially available V1730 and V1782 digitizer modules by CAEN SpA, which are used to process signals from semiconductor detectors as well as photomultiplier-based detectors. A centralized server station, connected to each setup via fibre channel, builds the heart of the DAQ system that does not have to be moved between experiments, is accessible even when beam is on target, and benefits from an independent power supply and a fast uplink. An online-coincidence filter module has been implemented on the CAEN V2495 FPGA module which also allows to process veto signals per detector. This contribution presents the new system and improved workflow and display the high performance available for local experiments. Supported by the BMBF (05P21PKEN9).

HK 15.3 Mon 16:45 HK-H4

A Cost-Effective Modular Data Logger for Detector Laboratories — •Philip Hauer, Mario Engel, Oliver Adam, Thomas Block, Jan Paschek, Tobias Rudolph, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik – Universität Bonn

Many important parameters of a gaseous detector (e.g. the gas gain) depend on environmental parameters such as pressure and temperature. For the operation of gaseous detectors it is therefore crucial to monitor these parameters precisely and reliably. In order to fulfil this task, a modular logger for environmental parameters in laboratories was developed. In addition, the used temperature and pressure sensor is so small that it can be placed inside the gas system such that it can measure the temperature and pressure of the gas directly.

The logger is based on different sensors that are connected to a micro-controller which has a built-in WiFi chip. The micro-controller connects to a local wireless network which is created by a Raspberry Pi. Via the MQTT protocol, the recorded data are sent to the Raspberry Pi which forwards the data to a remotely accessible database for long-term storage.

On this poster, the setup is described in more detail. Some exemplary data

and how they are used to correct gain fluctuations are also shown.
Supported by BMBF.

HK 15.4 Mon 17:00 HK-H4

Developing Feature Extraction Algorithms with Vivado HLS for the CBM-TRD — •David Schledt — Infrastructure and Computer Systems in Data Processing, Frankfurt, Deutschland

Traditionally FPGA firmware was developed solely with Hardware Description Languages (HDL) like Verilog or VHDL. However, with the steady improvements of tools like Vivado HLS (High Level Synthesis) it is now possible to write parts of the firmware with higher level languages like C++. Using HLS allows faster development cycles, easier code reuse and, most importantly, to efficiently write complex algorithms for the FPGA.

The Compressed Baryonic Matter (CBM) experiment at the Facility for Antiproton and Ion Research (FAIR) will investigate the QCD phase diagram at high net-baryon densities. The experiment employs a free streaming data acquisition with self-triggered front-end electronics (FEE). At interactions rates of up to 10 MHz the readout firmware has to process very high data loads. The CBM Transition Radiation Detector (TRD) is equipped with the SPADIC front-end ASIC. The SPADIC allows for an oscilloscope-like sampling of the detector signals. From the sampled signal several different features can be extracted, such as the deposited charge or a time resolution above the pure sampling frequency. In this talk I will present how different feature extraction algorithms were implemented in the FPGA with Vivado HLS.

This work is supported by BMBF-grant 05P21RFFC3.

HK 15.5 Mon 17:15 HK-H4

Firmware improvements for the FPGA-based Sampling-ADC readout of the Crystal Barrel Calorimeter — •Benedikt Otto for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The CBELSA/TAPS experiment investigates the photoproduction of neutral mesons. Since June 2021, the experiment's main calorimeter is equipped with a new Sampling-ADC (SADC) readout, based on 14bit@80MS ADCs and Kintex7 FPGAs. The firmware taking care of feature extraction and UDP/IP communication is currently developed further and improved.

Part of these enhancements is the resource-efficient implementation of a finite-impulse-response (FIR) filter to perform effective noise reduction. Additional improvements to the feature-extraction algorithms themselves are presented as well. To furthermore accommodate multihit-features and a custom waveform compression method, the packet structure had to be adapted.

As integral part of the firmware development, a comprehensive test suite was implemented using python and cocotb which allows convenient and automated testing of firmware components.

HK 16: Instrumentation VI

Time: Monday 16:00–17:30 Location: HK-H5

HK 16.1 Mon 16:00 HK-H5

Beam measurements with the RD51 beam telescope using the VMM3a and SRS — •Karl Jonathan Flöthner[1,2], Lucian Scharenberg[1,2], Daniel Petri Sorvisto[4], Eraldo Oliveri[1], Francisco Fuentes[3], and Bernhard Ketzer[2] — [1]CERN — [2]Univ. of Bonn (DE) — [3]Helsinki Institute of Physics — [4]Univ. of Aalto (FI)

RD51 is an international research and development collaboration at CERN with focus on advanced gas-avalanche detector technologies and associated electronic-readout systems. For testbeam campaigns the RD51 collaboration provides a GEM-based beam telescope for detector studies. It consists of several triple-GEM detectors with an active area of 10x10 cm^2 and additional scintillators to generate a trigger signal for the start of events. During the last year the telescope was equipped with the new VMM3a ASIC coupled to the Scalable Readout System (SRS). In this configuration the system can provide a MHz counting rate-capability, spatial resolutions in the order of 50 μm (COMPASS like triple-GEM detector) and time resolutions in the 10-ns regime (VMM capable of few ns). The new setup was tested in the laboratory and during two testbeam campaigns (July/October 2021). The system contains five GEM-detectors and a total of 42 VMMs (2688 channels). During the last beam campaign, the telescope has been used to investigate different fine-pitch GEM foils to understand the impact on spatial resolution with MIPs. The talk will discuss some challenges of the system and present first results of the last testbeam data, focussing on the performance of the fine-pitch GEM.
Supported by BMBF.

HK 16.2 Mon 16:15 HK-H5

New GEM detectors for AMBER — •Jan Paschek[1], Karl Flöthner[3], Markus Ball[1], Michael Hösgen[1], Michael Lupberger[1,2], and Bernhard Ketzer[1] — [1]Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn, Bonn, Germany — [2]Physikalisches Institut der Universität Bonn, Bonn, Germany — [3]CERN GDD, Meyrin, Schweiz

Phase II of the COmmon Muon Proton Apparatus for Structure and Spectroscopy (COMPASS) is planned to be finished in 2022 by measuring the transverse-momentum dependent PDFs in deep inelastic scattering of muons on a deuterium target.
Using the COMPASS spectrometer a new proposal for a future QCD facility at the M2 beamline of the SPS accelaror, at CERN has been accepted. Running under the name AMBER, the physics program includes a measurement of the proton radius in elastic muon-proton scattering. The GEM stations are mandatory for scattered muon tracking. With a low material budget, high efficiency (> 97%) and a good spatial resolution (around 70μm) the triple GEM detectors are an ideal tracking system. Combined with further detectors and a magnetic field, the momentum of scattered muons can be determined.
However, the existing GEM detectors have to be replaced as they cannot cope with the anticipated beam rates and have suffered from 20 years of operation COMPASS. A new detector layout was developed.
In this contribution, first test results as well as the quality assurance procedure for detector construction will be presented.

HK 16.3 Mon 16:30 HK-H5

Impact of the gas choice and the geometry on the breakdown limit in (TH)GEM-based detectors — •Lukas Lautner[1,2], Piotr Gasik[3], Andreas Mathis[1], Laura Fabbietti[1], Tobias Waldmann[1], Berkin Ulukutlu[1], and Thomas Klemenz[1] — [1]Physik Department, Technische Universität München — [2]CERN — [3]GSI - Helmholtzzentrum fur Schwerionenforschung GmbH

In this study we investigate the intrinsic stability limits of Gas Electron Multiplier (GEM) and Thick GEM detectors upon irradiation with alpha particles. The measurements are performed in Ar- and Ne- based mixtures with different CO_2 content to study the influence of the gas on discharge probability and critical charge limits. The latter are obtained by comparing the experimental data to results obtained within a Geant4 simulation framework. The measurements provide a direct comparison between GEMs and THGEMs and allow us to evaluate the influence of geometrical parameters, such as hole size, pitch and (TH)GEM thickness, on the stability of a structure and the resulting critical charge value. We observe that the breakdown limit is strongly dependent on the gas, and that the amount of quencher in the mixture does not necessarily correlate with higher stability. The outcome of these studies is of particular interest for currently running or planned photon and hadron-blind detectors based on THGEM technology as well as cryogenic applications.

HK 16.4 Mon 16:45 HK-H5

Charge density breakdown limits in Micromegas structures — •Tobias Waldmann[1], Berkin Ulukutlu[1], Piotr Gasik[2], Laura Fabbietti[1], Thomas Klemenz[1], and Lukas Lautner[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum

Micro Mesh Gaseous Structures (Micromegas) are detectors implemented in a wide range of modern particle physics experiments. Among their major advantages are high achievable gains, good energy resolution and intrinsic ion backflow suppression. However, a major limiting factor to the performance is the formation of electrical discharges inside the amplification region, which can eventually blind or permanently damage the involved detector components. Therefore, the limits of safe operation of such detectors need to be studied in detail. In our studies we investigated the discharge stability of Micromegas with respect to different mesh geometries and gas mixtures. As in previous studies with GEMs and THGEMs, the measurements show clear evidence for charge density being a driving factor in the discharge formation process in Micromegas. This is observed through a dependence on the used gas mixture, where Neon-based mixtures with low CO2 content yield the best stability against the development of discharges. The results provide further constraints and limits for the safe operation of Micromegas-based detectors, opening up new possibilities for their optimization.

HK 16.5 Mon 17:00 HK-H5

A Pulsed Drift Tube for 100keV Antiprotons — •Jonas Fischer, Alexandre Obertelli, and Frank Wienholtz — IKP TU Darmstadt, Deutschland

The PUMA collaboration aims at trapping, storing and transporting 10^9 antiprotons in a cryogenic penning trap. To achieve this, antiprotons from ELENA need to be decelerated from 100keV to 4keV in a first step. To minimise losses in the deceleration process, a Pulsed Drift Tube (PDT) was installed at LNE51 at CERN.

A good vacuum of below 10^{-10} mbar is necessary to avoid the annihilation of the antiprotons with residual gas molecules. This, and the high voltage, pose strict restrains on the design and operation of the pulsed drift tube. In this talk I will give an overview over the pulsed drift tube designed for PUMA.

HK 16.6 Mon 17:15 HK-H5

Testing Low's theorem with the Forward Conversion Tracker of ALICE 3 — •Martin Völkl for the ALICE-Collaboration — Universität Heidelberg

Soft theorems play a fundamental role in the development of quantum field theory. In scattering processes the production of soft photons diverges in the infrared in a controlled manner. Low's theorem relates the production cross section of a process with and without additional soft photon emission by a simple formula without dependence on the details of the process. However, this simple and fundamental prediction was found to strongly underestimate measured soft photon production in hadronic processes for previous experiments.

With this contribution we discuss the prospects of measuring and investigating this effect with the future ALICE 3 experiment using the proposed Forward Conversion Tracker (FCT). This detector can measure photons from collisions at LHC energies down to very low photon momenta. The resulting measured photons can then be related to the information about the hadronic event measured with ALICE 3. This allows exploration of the apparent discrepancy between calculations and experiment which would significantly impact our fundamental understanding of quantum field theories.

HK 17: Structure and Dynamics of Nuclei III

Time: Monday 16:00–17:45 Location: HK-H6

Group Report HK 17.1 Mon 16:00 HK-H6

Absolute electromagnetic transition rates in the semi-magic 211At nucleus and their implications for the nuclear structure above 208Pb. — •Jan Jolie[1], Vasil Karayonchev[1], Andrey Blazhev[1], Arwin Esmaylzadeh[1], Christoph Fransen[1], Lukas Knafla[1], Claus Mueller-Gatermann[1], Jean-Marc Regis[1], and Pieter Van Isacker[2] — [1]IKP, Universitaet zu Koeln, Zuelpicher Str. 77, D-50937 Koeln, Germany — [2]GANIL, CEA/DRF-CNRS/IN2P3, Bvd Henri Becquerel, F-14076 Caen, France

Motivated by the abnormal yrast B(E2) values in 210Po[1], lifetimes of excited states in 211At were measured using the electronic gamma - gamma fast timing technique and the Recoil Doppler Shift Method (RDSM) at the Cologne FN Tandem accelerator. For the fast timing experiment the 208Pb(6Li,3n) fusion-evaporation reaction and the HORUS detector array equipped with eight HPGe detectors and nine LaBr3(Ce) scintillators were used[2]. For the RDSM experiment the 209Bi(16O,14C) two-proton transfer reaction was performed and 14C was detected with solar cells mounted in the Cologne plunger setup. Several lifetimes were determined for the first time. The results are compared to shell model calculation using two approaches: analytical calculations using a semiempirical interaction for three particles in a single j = 9/2 shell and untruncated numerical full shell model calculations with the modified Kuo-Herling interaction. Very good agreement is obtained, especially with the analytical single-j calculation.

[1] D. Kocheva, et al., Eur. Phys. J. A 53 (2017) 175;[2] V. Karayonchev, et al., Phys. Rev. C 99 (2019) 024326.

HK 17.2 Mon 16:30 HK-H6

Investigation of collectivity in ^{142}Xe by Coulomb excitation — •Corinna Henrich for the IS548-MINIBALL-Collaboration — TU Darmstadt, Darmstadt, Germany

The isotope ^{142}Xe lies in the neutron-rich area north-east of the doubly-magic ^{132}Sn, in a region through which the astrophysical r-process is expected to pass. This nucleus is of particular interest as it allows to follow the onset of octupole collectivity, which is expected to peak for the nearby ^{144}Ba, and the evolution of quadrupole collectivity.

A perfect tool to investigate the low-lying structure and collectivity of ^{142}Xe is "safe" Coulomb excitation as it gives access to reduced transition strengths as well as spectroscopic quadrupole moments.

The experimental campaign was carried out at HIE-ISOLDE (CERN). After the excitation on a lead target, the deexcitation gamma rays are detected using the MINIBALL spectrometer in coincidence with the corresponding particles. The latter are detected utilizing the silicon detector array C-REX.

Final experimental results are presented and compared to SCCM and LSSM calculations.

This work is supported by the German BMBF under contracts 05P15RDCIA, 05P18RDCIA, and 05P21RDCI2, by the EU within ENSAR2 under grant no. 654002, and by ISOLDE.

HK 17.3 Mon 16:45 HK-H6

Lifetime measurements to investigate γ-softness and shape coexistence in ^{102}Mo — •Arwin Esmaylzadeh[1], Vasil Karayonchev[1], Jan Jolie[1], Kosuke Nomura[2], Marcel Beckers[1], Andrey Blazhev[1], Christoph Fransen[1], and Lukas Knafla[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Department of Physics, University of Zagreb

Lifetimes of low-spin excited states in ^{102}Mo populated in a ^{100}Mo(^{18}O, ^{16}O)^{102}Mo two-neutron transfer reaction were measured using the recoil-distance Doppler-shift technique at the Cologne FN Tandem accelerator. Lifetimes of the 2_1^+, 4_1^+, 6_1^+, 0_2^+, 2_γ^+, 3_γ^+ states and one upper limit for the lifetime of the 4_γ^+ state were obtained. The energy levels and deduced electromagnetic transition probabilities are compared with the ones obtained within the mapped interacting boson model framework with microscopic input from Gogny mean field calculations. With the newly obtained signatures a more detailed insight in the γ-softness and shape coexistence in ^{102}Mo is possible and discussed in the context of the $Z \approx 40$ and $N \approx 60$ region. The nucleus of ^{102}Mo follows the γ-soft trend of the Mo isotopes. The properties of the 0_2^+ state indicate, in contrast to the microscopic predictions, shape coexistence which also occurs in other $N = 60$ isotones [1].

[1] A. Esmaylzadeh et al., Phys. Rev. C (accepted in PRC) (2022)

HK 17.4 Mon 17:00 HK-H6

Configuration Interaction Monte Carlo with Chiral Three-Body Forces — •Pierre Arthuis[1,2,3], Carlo Barbieri[3,4,5], Francesco Pederiva[6,7], and Alessandro Roggero[6,7,8] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI — [3]Department of Physics, University of Surrey — [4]Dipartimento di Fisica, Università degli Studi di Milano — [5]INFN, Sezione di Milano — [6]Physics Department, University of Trento — [7]INFN-TIFPA Trento Institute of Fundamental Physics and Applications — [8]InQubator for Quantum Simulation (IQuS), Department of Physics, University of Washington

Neutron matter from saturation to low densities is a particularly interesting system, its equation of state (EoS) directly affecting the structure of the inner core of neutron stars and the skin of heavy neutron-rich nuclei. High-accuracy methods are thus of remarkable importance.

Configuration Interaction Monte Carlo (CIMC) combines the natural language needed to deal with momentum-dependent interactions to the efficiency of Quantum Monte Carlo techniques while satisfying the variational ansatz. The method demonstrated very efficient for two-body Hamiltonians, but was never extended to tackle three-body interactions.

Here we present the first CIMC results obtained for cold neutron matter at densities below and around nuclear saturation density with a chiral potential including three-body forces. Besides the EoS of neutron matter, we will display also results for the momentum distribution and the static structure factor.

HK 17.5 Mon 17:15 HK-H6

Investigation of the B(E2; $0_{gs}^+ \to 2_1^+$) value of ^{116}Sn — •M. Beuschlein[1], O. Papst[1], J. Kleemann[1], V. Werner[1], N. Pietralla[1], T. Beck[1,3], M. Berger[1], I. Brandherm[1], A. D'Alessio[1], U. Friman-Gayer[1,2], M. Hilcker[1], K. E. Ide[1], J. Isaak[1], R. Kern[1], F. Niederschuh[1], P. C. Ries[1], G. Steinhilber[1], J. Wiederhold[1], and R. Zidarova[1] — [1]IKP, TU Darmstadt — [2]Duke University and TUNL, Durham, NC, USA — [3]FRIB, East Lansing, MI, USA

The tin isotopes, being proton-magic with a long chain of experimentally accessible nuclei, are an important testing ground for nuclear structure models. Present data show systematic deviations between measured electric quadrupole (E2) ground-state excitation strengths depending on the used techniques. Also, various nuclear structure models come to different predictions on the systematics of B(E2) strengths, particulary around ^{116}Sn. We performed a measurement of ^{116}Sn relative to ^{112}Sn using the nuclear resonance fluorescence method at S-DALINAC at TU Darmstadt. A beam of continuous bremsstrahlung up to an endpoint energy of 2.2 MeV was used to populate the first excited 2^+ states of ^{112}Sn and ^{116}Sn. Photons of the subsequent de-excitation were measured by three high-purity germanium detectors. With our relative measurement we aim to provide a test for a predicted dip of E2 strengths around ^{116}Sn [1], and obtain the absolute B(E2) strength from a previous measurement of ^{112}Sn.

Supported by the DFG through the research grant SFB 1245.

[1] T. Togashi *et al.*, Phys. Rev. Lett. **121**, 062501 (2018)

HK 17.6 Mon 17:30 HK-H6

Transition strengths of the intruder band of ^{96}Zr — •T. Stetz[1], T. Beck[1], N. Pietralla[1], V. Werner[1], M. Boromiza[2], I. Gheorge[2], A. Ionescu[2], R. Kern[1], R. Lica[2], N. Mărginean[2], R. Mărginean[2], C. Mihai[2], R.-E. Mihai[2], C.R. Nita[2], O. Pabst[1], S. Pascu[2], C. Sotty[2], L. Stan[2], A. Turturica[2], J. Wiederhold[1], and W. Witt[1] — [1]TU Darmstadt, Germany — [2]IFIN-HH, Romania

The zirconium (Zr) isotopes have recently been discussed in terms of type-II shell evolution [1,2], with ^{98}Zr closest to the critical point of a quantum phase transition from spherical to deformed ground-state shapes [3,4]. Spherical and deformed structures were found to coexist, weakly mixing, already in ^{96}Zr [2], but key data to classify the observed structures is missing [4]. Therefore, ^{96}Zr has been studied in an experiment, populating excited states of the intruder band in the 2n transfer reaction ^{94}Zr(^{18}O,^{16}O)^{96}Zr at 49 MeV at the 9 MV tandem accelerator in IFIN-HH. The HPGe ROSPHERE array in a combination with the SORCERER particle detector was used to obtain the data. With the Doppler shift attenuation method, the lifetime of the first excited 4^+ state was determined. From this, transition strengths to lower lying states have been obtained and compared with theoretical approaches in order to study the shape of the intruder band.

[1] T. Togashi *et al.*, Phys. Rev. Lett. **117** 172502 (2016)
[2] C. Kremer *et al.*, Phys. Rev. Lett. **117** 172503 (2016)
[3] W. Witt *et al.*, Phys. Rev. C **98** 041302 (2018)
[4] W. Witt *et al.*, Eur. Phys. J. A **55** 79 (2019)
*Supported by BMBF 05P18RDCIA-TP1 and 05P21RDCI2-TP1.

HK 18: Structure and Dynamics of Nuclei IV

Time: Monday 16:00–17:45 Location: HK-H7

Group Report HK 18.1 Mon 16:00 HK-H7

The search for the tetraneutron — •Meytal Duer[1] and Thomas Aumann[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]TU Darmstadt — [2]GSI Helmholtzzentrum

Whether multi-neutron systems can exist as weakly bound states or very short-lived unbound resonant states has been a long-standing quest. The discovery of such a system would have far-reaching implications for many aspects of nuclear physics, from the nature of the force itself up to the way it builds nuclei, and also for the modeling of neutron stars.

The experimental search for isolated multi-neutron systems has been going for six decades, with a particular focus on the four-neutron system called tetraneutron, resulting in up to date only few indications for its existence, leaving it an elusive nuclear system.

In this talk I will present our most recent result from an experiment performed at the RIKEN Nishina Center located in Japan. The measurement was conducted at the SAMURAI setup, there using a new experimental approach based on a knockout reaction at large momentum transfer with radioactive high-energy ^{8}He beam we were able to investigate the four-neutron system.

This work is supported by the DFG through grant no. SFB 1245, the GSI-TU Darmstadt cooperation and the BMBF project 05P15RDFN1.

HK 18.2 Mon 16:30 HK-H7

Precise and Accurate Measurement of the Neutron-Neutron Scattering Length — •Marco Knösel[1] and Thomas Aumann[1,2,3] for the NeuLAND-SAMURAI-Collaboration — [1]Technische Universität Darmstadt — [2]GSI Helmholtz-Zentrum für Schwerionenforschung — [3]Helmholtz Forschungsakademie Hessen für FAIR

In this contribution, a new experimental approach is presented to determine the neutron-neutron scattering length using the knockout reactions ^{6}He$(p, p\alpha)2n$ and $t(p, 2p)2n$ as well as the charge-exchange reaction $d(^7\mathrm{Li},^7\mathrm{Be})2n$. In order to coincidently detect the two neutrons in the final states of these reactions with sufficient time and position accuracy, a new high-resolution neutron detector has to be developed. This is done at Technische Universität Darmstadt in cooperation with the SAMURAI collaboration at RIKEN in Japan, where the experiment will take place. The value of the neutron-neutron scattering length can be inferred from the comparison of the experimentally determined $2n$ relative-energy spectrum to halo EFT calculations.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245, the BMBF under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation agreement.

HK 18.3 Mon 16:45 HK-H7

Ground and dipole excited states of the ^{8}He halo nucleus from ab initio coupled-cluster theory — •Francesca Bonaiti[1], Sonia Bacca[1,2], and Gaute Hagen[3,4] — [1]Institut für Kernphysik and PRISMA$^+$ Cluster of Excellence, Johannes Gutenberg-Universität, 55128 Mainz, Germany — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany — [3]Physics Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA — [4]Department of Physics and Astronomy, University of Tennessee, Knoxville, TN 37996, USA

We perform coupled-cluster calculations of ground- and dipole excited-state properties of the ^{8}He halo nucleus with nucleon-nucleon and three-nucleon interactions from chiral effective field theory, both with and without explicit delta degrees of freedom. By increasing the precision in our coupled-cluster calculations from inclusion of leading order three-particle three-hole excitations in the cluster operator, we are able to reproduce (within uncertainties) the available experimental data for the ground-state energy and the charge radius. We also investigate the excited states induced by the electric dipole operator and present a discussion on the Thomas-Reiche-Kuhn and cluster sum rules. Finally, we compute the electric dipole polarizability, providing a theoretical benchmark for future experimental determinations that will study this exotic nucleus.

HK 18.4 Mon 17:00 HK-H7

E1 strength distribution of ^{11}Li in Halo EFT — •Matthias Göbel[1], Daniel R. Phillips[2], and Hans-Werner Hammer[1,3] — [1]Technische Universität Darmstadt, Germany — [2]Ohio University, Athens, Ohio, USA — [3]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum, Darmstadt, Germany

Low-energy enhancements of E1 strength distributions are a characteristic property of halo nuclei. We use Halo EFT with a ^{9}Li core and the two halo neutrons as degrees of freedom to calculate this observable for the two-neutron halo nucleus ^{11}Li.

The E1 strength distribution is significantly influenced by final-state interactions. We investigate their role and test different approximation schemes. The comparison of the leading-order results with experimental data from RIKEN [T. Nakamura et al., Phys. Rev. Lett. 96, 252502 (2006)] shows reasonable agreement.

This work was supported Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245 and by the U.S. Department of Energy (Contract No. DE-FG02-93ER40756).

HK 18.5 Mon 17:15 HK-H7

Three-body resonances in pionless effective field theory — •Sebastian Dietz[1], Hans-Werner Hammer[1,2], Sebastian König[3,1], and Achim Schwenk[1,2,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt — [2]ExtreMe Matter Institute EMMI and Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Darmstadt — [3]Department of Physics, North Carolina State University, Raleigh — [4]Max-Planck-Institut für Kernphysik, Heidelberg

We investigate the appearance of resonances in three-body systems using pionless effective field theory at leading order. The Faddeev equation is analytically continued to the unphysical sheet adjacent to the positive real energy axis using a contour rotation. We consider both the three-boson system and the three-neutron system. For the former, we calculate the trajectory of Borromean three-body Efimov states turning into resonances as they cross the three-body threshold. For the latter, we find no sign of three-body resonances or virtual states at leading order.

* This work was supported in part by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Projektnummer 279384907 - SFB 1245 and by the National Science Foundation under Grant No. PHY-2044632. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under the FRIB Theory Alliance award DE-SC0013617. Computational resources have been provided by the Jülich Supercomputing Center.

HK 18.6 Mon 17:30 HK-H7

Investigating Short-Range Correlations in exotic nuclei at R3B using inverse kinematics — •Enis Lorenz[1], Thomas Aumann[1,2], Anna Corsi[3], Aldric Revel[3], Meytal Duer[1,2], Or Hen[4], and Julian Kahlbow[4,5] for the R3B-Collaboration — [1]TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]CEA-Saclay, France — [4]Massachusetts Institute of Technology, Cambridge, USA — [5]Tel Aviv University, Tel Aviv, Israel

Short-Range Correlations (SRC) are two-body components of the nuclear wave function with high relative momentum and low center-of-mass momentum relative to the Fermi momentum, k_F. These high-momentum nucleons, which are absent in a simple Fermi gas model, are formed as temporary closed-proximity nucleon pairs with high density, several times the nuclear saturation density. Studying the characteristics of SRC-pairs gives an unique opportunity to explore the interaction of cold dense nuclear matter as in neutron stars.

The first kinematically complete measurement of SRC in exotic nuclei will be performed at the R3B setup as part of the FAIR Phase-0 experimental program in Spring 2022 by scattering a ^{16}C beam off a liquid hydrogen target in inverse kinematics at energy of 1.25 GeV/nucleon.

This work is supported by the State of Hesse within the Research Cluster ELEMENTS project 500/10.006 and by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2.

HK 19: Hadron Structure and Spectroscopy III

Time: Monday 16:00–17:45 Location: HK-H8

Group Report HK 19.1 Mon 16:00 HK-H8

Coupled Channel Partial Waves Analysis with PAWIAN — •Meike Küssner[1], Bertram Kopf[1], Malte Albrecht[1], Fritz-Herbert Heinsius[1], Helmut Koch[1], Marc Pelizäus[1], Xiaoshuai Qin[1], Matthias Steinke[1], Ulrich Wiedner[1], and Lianjin Wu[2] — [1]Ruhr-Universität Bochum, Germany — [2]Shandong University, Qingdao, China

The light meson regime still holds open questions that can only be answered using sophisticated analysis strategies to describe the data. Coupled channel partial wave analyses offer unique possibilities to disentangle the different states in the highly populated spectrum of light mesons and to overcome challenges such as interfering and overlapping resonances that decay into multiple channels and occur close to kinematical thresholds.

This also requires the use of performant software that incorporates sophisticated dynamical models taking into account unitarity and analyticity constraints. The software package PAWIAN offers such possibilities and proved its capabilities in recent coupled channel analyses. The talk will discuss recent results of coupled channel analyses performed with data stemming from different production mechanisms like $\bar{p}p$ annihilation, $\pi^- p$ scattering, radiative J/ψ decays and two-photon production as well as $\pi\pi$ scattering and discuss future objectives.

Supported by DFG CRC110 and FOR 2359

HK 19.2 Mon 16:30 HK-H8

Amplitude analysis of the decays $B_S \rightarrow \psi(2S)K^+K^-$ and $B_S \rightarrow \psi(2S)\pi^+\pi^-$ — •Piet Nogga — Rheinische Friedrich-Wilhelms Universität Bonn

We present $\psi(2S)K^+K^-$ and $\psi(2S)\pi^+\pi^-$ final state data originating from B_S mesons recorded during Run I and Run II at the LHCb experiment corresponding to an integrated luminosity of 1,2 and 6 fb^{-1} at $\sqrt{s} = 7, 8$ and 13 TeV, respectively, with the goal of investigating the spectrum of scalar mesons. These are particularly interesting as they may contain possible glueball contributions, a discussion which was recently rekindled by a BESIII analysis regarding radiative charmonium decays.

The unambiguous extraction of resonance parameters requires sophisticated amplitude models and techniques for the simultaneous analysis of both channels.

This talk will present a preliminary selection of these final states and discuss the coupled channel analysis.

HK 19.3 Mon 16:45 HK-H8

A truncated partial wave analysis using bayesian inference — •Jean Noël for the CBELSA/TAPS-Collaboration — HISKP, Rheinische Friedrich-Wilhelms Universität Bonn.

Following the description of the Standard Model of particle physics, more specifically quantum chromodynamics (QCD), so called hadrons are bound states of quarks and gluons. A difficulty in investigating these fundamental particles arises from being unable to observe them in isolation due to confinement.

One approach for investigating the formation of hadrons is the photoproduction of mesons.

The focus will lie on the reaction p + $\gamma \rightarrow$ p + π^0. By employing a truncated partial wave analysis (TPWA) the approach can be kept model independent. A fully bayesian investigation will be employed and the advantages of extracting the partial waves (up to an overall phase) with this method will be discussed.

Preliminary results obtained from this approach will be shown.

HK 19.4 Mon 17:00 HK-H8

Meson Spectrum from Functional Methods beyond Rainbow-Ladder — •Stephan Hagel[1,2] and Christian S. Fischer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI-Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

A novel approach to construct an expression for the quark self-energy from a Bethe-Salpeter kernel is presented. It can be shown that this approach satisfies the axialvector Ward-Takahashi identity. This approach is used to calculate the quark propagator and solve the corresponding Bethe-Salpeter equation. Furthermore, it is investigated, how different tensor structures in the quark-gluon-vertex effect the light meson spectrum.

HK 19.5 Mon 17:15 HK-H8

Multidimensional density estimation using Normalizing Flows — •Ellinor Eckstein — University of Bonn, Bonn, Germany

The investigation of multi-body hadronic decays of beauty and charm hadrons requires detailed estimates of efficiencies and background distributions in multidimensional phase space.

A fairly new approach for model independent density estimation are Normalizing Flows, a Machine Learning technique, which gained popularity in recent years. They provide a method to construct flexible probability density distributions by applying a series of trainable transformations on a simple base distribution. A special feature of these distributions is their invertibility. Consequently, the entire Normalizing Flow is invertible and, thus, a very transparent tool for parametrisations. Due to their straightforward structure NFs are easily expandable into multiple dimensions making them attractive for efficiency or background estimation. This talk gives a brief introduction to Normalizing Flows and demonstrates its performance on LHCb data.

HK 19.6 Mon 17:30 HK-H8

4-quark states from functional methods — •Joshua Hoffer[1,2] and Christian S. Fischer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSIHelmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

Since the discovery of tetraquarks, there has been a lot of excitement around this topic from the theoretical as well as the experimental side. To study the poperties of these 4-quark states we use a functional framework which combines (truncated) Dyson-Schwinger and Bethe-Salpeter equations in Landau gauge. This approach allows us to extract qualitative results for mass spectra, decay widths and wavefunctions of tetraquark candidates. Furthermore, we can investigate the possible internal structure of such states. We report on recent developments and results using this functional framework and give an overview about the current status as well as future developments.

HK 20: Hadron Structure and Spectroscopy IV

Time: Monday 16:00–17:30 Location: HK-H9

Group Report HK 20.1 Mon 16:00 HK-H9

Polarisation observables Σ, T, P, and H in π^0 and η photoproduction off quasifree nucleons — •Nicolas Jermann for the CBELSA/TAPS-Collaboration — University of Basel, Switzerland

The excitation spectrum of the nucleon is an important testing ground for quantum chromodynamics in the regime where it cannot be treated perturbatively. During the last two decades much progress has been made on the theory side, e.g. lattice gauge methods, and in experiments, particularly using energy tagged photon beams at electron accelerators, which has now reached a state where not only differential cross sections but also asymmetries measured with polarised photons and polarised targets allow for detailed partial wave analyses. This provides much more stringent information about the involved reaction multipoles and thus the contributing nucleon resonances.

The present experiment was done at the ELSA accelerator in Bonn with the CBELSA/TAPS detector setup. The incident electron beam of 3.2 GeV impinged on a diamond radiator where it produced coherent bremsstrahlung photons with linear polarisation, which again impinged on a transversely polarised, deuterated butanol target. This allows the simultaneous measurement of the polarisation observables Σ, T, P, and H. Analysed were the final states $N\pi^0$ and $N\eta$ with the almost 4π covering electromagnetic calorimeter CBELSA/TAPS.

One of the main motivations of this experiment was a more detailed investigation of the not yet understood narrow structure in the excitation function of the $\gamma n \rightarrow n\eta$ reaction at approximately 1 GeV. Preliminary results will be discussed.

HK 20.2 Mon 16:30 HK-H9

Helicity dependent cross sections for the photoproduction of $\pi^0\pi^\pm$ pairs from quasi-free nucleons — •Debdeep Ghosal for the CBELSA/TAPS-Collaboration — University of Basel, Basel, CH

Photon induced $\pi^0\pi^\pm$-pairs production from quasi-free nucleons bound in the deuteron has been investigated in view of the helicity dependence of those two reactions. Measurements with a liquid deuterium target were used to extract the unpolarized cross sections for protons and neutrons. A deuterated, longitudinally polarized butanol target together with a circularly polarized photon beam was used to measure the double polarization observable E. Antiparallel and parallel spin configurations of the beam photon and target nucleon correspond to the spin-dependent cross sections $\sigma_{1/2}$ and $\sigma_{3/2}$ respectively, which have been derived from E. The measurements were done at the Mainz MAMI accelerator with tagged photon beams produced via bremsstrahlung from longitudinally polarized electron beams. The reaction products from the two target types were detected with an almost 4π solid-angle covering calorimeter composed of the Crystal Ball, TAPS detectors and particle identification detectors. The results are sensitive to sequential decays of nucleon resonances via intermediate states and also by emission of charged ρ mesons. Furthermore, the results have been compared to the recent available model calculation.

HK 20.3 Mon 16:45 HK-H9

Measuring the 2s-1s transition in Muonic atoms — •Nilesh Deokar — Johannes Gutenberg University of Mainz, Johann Joachim-Becher-Weg 45, 55128 Mainz, Germany

Muonic X-rays are produced when negative muons are stopped inside matter and cascade down the different energy levels of an atom. The 2s-1s muonic X-rays are a potential observable to study the Atomic Parity Violation (APV) in muonic atoms. For a Krypton (2018) and a Zinc (2019) target, Muonic X-ray measurements were carried out at the Paul Scherrer Institute using muon beam from the piE1 beamline facility to detect these 2s-1s X-rays. High Purity Germanium (HPGe) detectors surrounded the targets to detect the outgoing Muonic X-rays. The X-rays of interest in Krypton and Zinc are in the 1-2 MeV energy range. The signal though, is buried under background arising from delayed Michel electrons, nuclear capture background from muons, Bremsstrahlung etc. A scan of various time and energy cuts along with X-ray-Xray coincidences is implemented to reduce this background and optimize the signal to background ratio. A clear observation of the 2s-1s transition opens up to the possibility for an APV experiment with muonic atoms.

HK 20.4 Mon 17:00 HK-H9

Accessing the coupled-channel dynamics with two-particle correlations at ALICE — •Valentina Mantovani Sarti for the ALICE-Collaboration — TUM, Garching, Germany

The strong interaction between hadrons can be characterised by the so-called coupled-channel dynamics, responsible for inelastic processes such as absorption and annihilation. The strength of the coupling to the inelastic channels can lead to the formation of molecular states, such as the $\Lambda(1405)$ in the $\overline{\text{K}}$N–$\Sigma\pi$ system and it also plays a crucial role in the possible existence of new bound states, as it might occurs in baryon-antibaryon interaction.

Measurements of two-particle correlations in the relative momentum space performed in different colliding systems and probing different inter-particle distances opens the possibility to partially isolate the elastic interaction and to provide experimental constraints for the coupling to the inelastic channels. In this talk we will present results on the coupled-channel dynamics of $\overline{\text{K}}$N interaction, and on the annihilation processes in p-$\overline{\text{p}}$, p-$\overline{\Lambda}$ and p-$\overline{\Lambda}$ interactions obtained in pp, p–Pb and Pb–Pb collisions. The effect of inelastic contributions in these systems has been investigated within the C^{3}ATS framework.

HK 20.5 Mon 17:15 HK-H9

New experimental limits on the effective strong interaction between multi-strange hadrons by ALICE — •Georgios Mantzaridis[1] and Otón Vazquez Doce[2] for the ALICE-Collaboration — [1]Technische Universität München, Fakultät für Physik, James-Franck-Str. 1, 85748 Garching — [2]Laboratori Nazionali di Frascati, Via Enrico Fermi 40, 00044 Frascati (Roma)

Understanding from first principles the strong interaction between hadrons with $S < -1$ is one of the key challenges for nuclear physics today. Traditional experimental techniques such as scattering or hypernuclei experiments are not able to access these strangeness sectors because of the small lifetimes of the involved hadrons. On the other hand calculations using lattice QCD are particularly stable in this regime because of the larger quark masses.

In an attempt to close this gap we present the direct measurement of two interactions of the $S = -3$ sector: the p-Ω^- and the Λ-Ξ^- interaction. For both systems the correlation function was measured in high-multiplicity pp collisions at $\sqrt{s} = 13$ TeV with ALICE at the LHC.

We have compared the p-Ω^- interaction to first principle lattice QCD calculations and found that they agree with the measured data if the inelastic channels are neglected. The Λ-Ξ^- correlation function is compared to predictions from leading order chiral effective field theory, meson exchange models as well as lattice QCD calculations. The data supports a shallow Λ-Ξ^- interaction which is more compatible with small scattering parameters.

HK 21: Astroparticle Physics I

Time: Monday 16:00–17:30 Location: HK-H10

Group Report HK 21.1 Mon 16:00 HK-H10

The Search for Neutrinoless Double-Beta Decay with LEGEND — •Michael Willers for the LEGEND-Collaboration — Physik-Department, Technische Universität München, Germany

The **L**arge **E**nriched **G**ermanium **E**xperiment for **N**eutrinoless $\beta\beta$ **D**ecay (LEGEND) is a ton-scale, ^{76}Ge-based, neutrinoless double-beta ($0\nu\beta\beta$) decay experimental program with a discovery potential at half-lifes longer than 10^{28} years.

LEGEND employs a phased approach that enables the collaboration to gradually increase the detector mass and exposure, and at the same time reduce the background in the signal region of interest. The first, 200 kg, phase of the experiment (LEGEND-200) is being actively commissioned at the Gran Sasso underground laboratory (Laboratori Nazionali del Gran Sasso, LNGS) in Italy and data taking will start in 2022. The ton-scale phase of the experiment (LEGEND-1000) is currently in the conceptual design stage and construction is projected to start as early as 2025.

In this contribution, the ongoing commissioning activities at LNGS and the potential of LEGEND-200 will be presented and the prospects for the future ton-scale phase LEGEND-1000 will be discussed.

This work is supported in part by the German Research Foundation via the collaborative research center *SFB1258* and the cluster of excellence *ORIGINS*, the German Federal Ministry for Education and Research, and the Max-Planck Society.

Group Report HK 21.2 Mon 16:30 HK-H10

Detecting CEνNS and beyond with the CONUS reactor neutrino experiment — •Aurelie Bonhomme for the CONUS-Collaboration — Max Planck Institut für Kernphysik (MPIK), Heidelberg

The detection of neutrinos through coherent elastic neutrino-nucleus scattering (CEνNS) process opens a new window to study the fundamental properties of this elusive particle and to probe physics beyond the Standard Model. The CONUS experiment - operational since April 2018 - is located at 17m from the 3.9GW$_{\text{th}}$ core of the nuclear power plant Brokdorf (Germany) and aims to detect CEνNS in the fully coherent regime with four 1 kg-sized HPGe point-contact detectors with a ~300eV$_{\text{ee}}$ energy threshold. The full spectral analysis of the first CONUS dataset allowed to set the current best limit on CEνNS with reactor antineutrinos and to bring competitive limits on physics beyond the standard model, such as non-standard neutrino interactions or neutrino magnetic moment. These new results will be presented in this talk. Furthermore, a special emphasis will be put on the strategy followed by the collaboration to further reduce the uncertainties, in particular via a dedicated measurement of the ionization quenching factor of nuclear recoils in germanium.

HK 21.3 Mon 17:00 HK-H10

New results on the ^{76}Ge double beta decay with neutrinos and exotic decay modes from GERDA Phase II — •Elisabetta Bossio for the GERDA-Collaboration — Physik Department, Technische Universität München, Garching, Germany

Two-neutrino double beta ($2\nu\beta\beta$) decays are amongst the rarest nuclear processes ever observed. Precision studies of the electron sum energies require ultra-low background and an excellent understanding of the experiment's response. Both are key features of the Germanium Detector Array (GERDA) experiment, which searched for neutrino-less double beta ($0\nu\beta\beta$) decay with enriched high purity germanium detectors in Liquid Argon at Laboratori Nazionali del Gran Sasso (LNGS) in Italy. The measurement of the Standard Model $2\nu\beta\beta$ decay half-life of ^{76}Ge was performed with unprecedented precision, profiting from the high signal-to-background ratio and the small systematic uncertainties. It provides essential inputs for nuclear structure calculations, that benefit the interpretation of $0\nu\beta\beta$ decay results. Furthermore, the search for distortions of the $2\nu\beta\beta$ decay spectrum allows exploring new physics, like $0\nu\beta\beta$ decay with Majorons emission, Lorentz invariance, or search for sterile neutrinos. The new results of the ^{76}Ge $2\nu\beta\beta$ decay half-life and improved limits on exotic decay modes will be presented in this talk. This research is supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the Excellence Cluster ORIGINS and the SFB1258.

HK 21.4 Mon 17:15 HK-H10

Constraining the $^{77(m)}$Ge Production with GERDA Data and Implications for LEGEND-1000 — •Moritz Neuberger[1], Luigi Pertoldi[1], Stefan Schönert[1], and Christoph Wiesinger[1,2] for the GERDA-Collaboration — [1]Physik-Department E15, Technische Universität München — [2]Max-Planck-Institut für Physik (Werner-Heisenberg-Institut) Föhringer Ring 6 80805 München

The delayed decay of $^{77(m)}$Ge, produced by neutron capture on ^{76}Ge, is a potential background for the next-generation neutrino-less double-beta decay experiment

LEGEND-1000, especially when considering the alternative LNGS site. Based on Monte Carlo simulations, various mitigation strategies and suppression techniques have been proposed to tackle this background [1,2]. In this talk we will present first results on $^{77(m)}$Ge searches in the full GERDA data. Given the very similar configuration - bare germanium detectors in liquid argon - it serves as a benchmark for our LEGEND-1000 predictions. This research was supported by the BMBF through the Verbundforschung 05A20WO2 and by the DFG through the SFB1258 and Excellence Cluster ORIGINS.

[1] C. Wiesinger et al., Eur. Phys. J. C (2018) 78: 597
[2] LEGEND-1000 pCDR, arXiv 2107.11462

HK 22: Invited Talks II

Time: Tuesday 11:00–12:30 Location: HK-H1

Invited Talk HK 22.1 Tue 11:00 HK-H1
Towards background-free measurements of double-beta decay events: a quest to increase the detection sensitivity of the neutrinoless double beta decay mode — •Samuel Ayet San Andres for the NEXT-Collaboration — Justus-Liebig-University Giessen

Neutrinoless double beta decay, whose discovery would reveal the Majorana nature of neutrinos, is an extremely rare decay mode consisting of two simultaneous beta decays in which two electrons and no neutrinos are emitted. The current experiments in the search of such decay mode are far from a background-free condition, and the level of background achieved plays a crucial role in the limits of the reportable half-life of this decay mode. A method that allows discarding all the events except the ones produced via double beta decay is the correlation of the events with the detection of the daughter nuclei of the decay, leaving only the two-neutrino double beta decay as the only background of the experiment. The different research lines within the NEXT collaboration in the pursuit of a background-free experiment in order to increase the half-life sensitivity for the neutrinoless double beta decay will be presented.

Invited Talk HK 22.2 Tue 11:30 HK-H1
Baryon spectroscopy with the Jülich-Bonn dynamical coupled-channel approach — •Deborah Rönchen — Institute for Advanced Simulation and Jülich Center for Hadron Physics, Forschungszentrum Jülich, 52425 Jülich, Germany

In order to probe the nature of the strong interactions in the medium-energy regime, where a perturbative expansion of QCD is not possible, the spectrum of excited baryons provides important information. Over the time, different approaches have been developed to connect predictions from quark models or lattice calculations to experimental data. Among those, dynamical coupled-channel models are especially suited for a simultaneous analysis of multiple reactions with different initial and final states. Unitarity and analyticity are preserved which allows for an extraction of resonance parameters in a well defined way, i.e. in terms of pole positions and residues.

I will give an introduction into the framework of the so-called Jülich-Bonn dynamical coupled-channel model, and present results of a combined study of pion- and photon-induced hadronic reactions. Recently, the approach was also extended to electroproduction reactions.

Invited Talk HK 22.3 Tue 12:00 HK-H1
Hadronen und Kerne in der Öffentlichkeit — •Christian Klein-Bösing — Institut für Kernphysik, WWU Münster, Germany

Die Hadronen- und Kernphysik befasst sich mit der Suche nach Antworten auf fundamentale Frage wie: Woraus besteht unsere Welt und was hält sie im Innersten zusammen? Fragen, die jede Forscherin und jeder Forscher sicherlich schon im kleineren Kreis diskutiert hat, z.B. im Kontext einer gerade eingereichten Abschlussarbeit.

Diese Kommunikation durch die Forschenden in organisierter Form an die breite Öffentlichkeit zu tragen (Outreach) dient dabei unterschiedlichen Gesamtzielen, beispielsweise: vorhandene Neugier auf Grundlagenforschung zu stillen, Interesse an Grundlagenforschung zu wecken, Wertschätzung für Erkenntnisgewinn durch Grundlagenforschung zu fördern, die Öffentlichkeit über wissenschaftliche Methodik aufzuklären oder auch Nachwuchs zu gewinnen. Durch jede Outreach-Aktivität kommt es aber auch zu einer entscheidenden Rückkopplung der Öffentlichkeit mit der aktuellen Forschung.

In diesem Vortrag werden Outreach-Konzepte für die Hadronen und Kernphysik in Deutschland vorgestellt, die unter anderem von den Forschungsgruppen im bundesweiten Netzwerk Teilchenwelt umgesetzt werden.

HK 23: Invited Talks III

Time: Tuesday 14:00–15:30 Location: HK-H1

Invited Talk HK 23.1 Tue 14:00 HK-H1
Jets in heavy-ion collisions — •Jasmine Brewer — CERN, Espl. des Particules 1, 1211 Meyrin Switzerland

Heavy-ion collisions provide unprecedented experimental access to the high-temperature phase of QCD, the quark-gluon plasma, where quarks and gluons are deconfined. Ongoing experimental and theoretical efforts aim to understand the structure and interactions of this novel material. Energetic particles and jets produced in heavy-ion collisions interact with the quark-gluon plasma and can provide unique insight on the structure of the quark-gluon plasma on different length scales. I will give a brief review of the theory and phenomenology of jet modification in heavy-ion collisions.

Invited Talk HK 23.2 Tue 14:30 HK-H1
The initial state of the quark-gluon plasma at the intersection of hadronic and nuclear physics — •Giuliano Giacalone — ITP Heidelberg

Experiments conducted in the world's largest accelerator machines, the BNL Relativistic Heavy Ion Collider (RHIC) and the CERN Large Hadron Collider (LHC), have established that by smashing heavy nuclei at high energy one produces small lumps of a fluidlike substance, namely, the hot state of strong-interaction matter, dubbed the quark-gluon plasma (QGP). The established hydrodynamic paradigm of the QGP have permitted us over the years not only to perform quantitative extractions of the transport properties of this medium from data, but also to obtain a more and more refined understanding of its initial condition. I review the current status of the initial condition of the QGP, emphasizing the outcome of state-of-the-art models and the overall picture that they yield. I discuss the progress made in the definition of observable quantities that offer a specific sensitivity to the physics of the initial state, allowing us to place stringent constraints on the parameters of initial-state Monte Carlo generators from experimental data. Such advances have established, in particular, the importance of having an accurate implementation of the structure of the colliding ions, and the nucleons therein, in such frameworks. The initial state of heavy-ion collisions provides, hence, fertile ground for new interdisciplinary connections involving different aspects of hadronic and nuclear physics across energy scales.

Invited Talk HK 23.3 Tue 15:00 HK-H1
High-precision mass spectrometry with ISOLTRAP at ISOLDE/CERN — •Jonas Karthein — Massachusetts Institute of Technology, Cambridge MA 02139, USA

This talk summarizes recent results of the ISOLTRAP mass spectrometer located at the radioactive ion beam facility ISOLDE at CERN. First, the latest hardware and software developments regarding the high-precision time-of-flight and Penning trap mass spectrometers will be introduced. Furthermore, recent results probing the edges of existence on the neutron-rich and deficient sides of the nuclear chart around the $Z = 50$ closed nuclear shell will be discussed, highlighting a recent publication in the vicinity of the doubly-magic ^{100}Sn [Nature Physics 17, 1099 (2021)].

HK 24: Heavy-Ion Collisions and QCD Phases V

Time: Tuesday 16:00–17:30 Location: HK-H1

Group Report HK 24.1 Tue 16:00 HK-H1

Measurements of J/ψ production at midrapidity with ALICE at the LHC — •Minjung Kim for the ALICE-Collaboration — Physikalische Institut, Universität Heidelberg, Heidelberg, Germany

The measurement of J/ψ production in heavy-ion collisions has been used as a valuable tool to study the properties of the quark*gluon plasma (QGP) since charm quarks are mainly produced via initial hard scatterings. Especially at LHC energies, the production of low transverse momentum J/ψ, which can be measured precisely with the ALICE (A Large Ion Collider Experiment) detector, is sensitive to the regeneration mechanism. Measurements of J/ψ production in p*Pb collisions provide an opportunity to study cold–nuclear–matter effects as well as possible final state mechanisms, which can modify its production with respect to the one in pp collisions.

Based on the electron identification capability provided by the Time Projection Chamber (TPC) installed at midrapidity, J/ψ production is measured via the dielectron decay channel in ALICE. In addition, it is possible to statistically separate the contribution of J/ψ from a weak decays of beauty hadrons (non-prompt J/ψ) using the long life time of beauty hadrons, relying on excellent track pointing resolution provided by the Inner Tracking System (ITS).

In this presentation, we will show latest measurements of J/ψ production in p-Pb and Pb-Pb collisions at midrapidity by ALICE, in comparison with theoretical calculations.

HK 24.2 Tue 16:30 HK-H1

J/ψ identification in ALICE with XGBoost — •Lasse Bassermann for the ALICE-Collaboration — Physikalisches Institut der Universität Heidelberg

In ALICE (A Large Ion Collider Experiment), J/ψ meson production is analyzed at midrapidity via the decay to an electron-positron-pair. Until now this identification was done by hand using a cut-based-method, which assumes that electrons, if they match certain parameters, originate from the decay of a J/ψ meson. Another method to identify J/ψ mesons could be through machine learning algorithms, such as XGBoost. XGBoost is an open-source software that provides machine learning algorithms using a gradient boosting framework, where an ensemble of weak prediction models is used.

In this poster the first steps of implementing an XGBoost algorithm for identifying J/ψ mesons are presented. This includes the first adaptions of the algorithm to the data used as well as the selection of the data. First comparisons with the cut-based method are discussed.

HK 24.3 Tue 16:45 HK-H1

J/ψ production as a function of charged-particle multiplicity in pp collisions at the LHC — •Ailec de la Caridad Bell Hechavarria for the ALICE-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

The increase of the inclusive J/ψ yields as a function of charged-particle multiplicity was found to be stronger than linear in previous ALICE publications, where both J/ψ and the charged-particle multiplicity were measured at midrapidity. The causes for this behavior have been investigated in previous studies with PYTHIA8 and attributed to possible auto-correlation effects. Insight on this effect could be gained by measuring the charged-particle multiplicity in three azimuth regions relative to the direction of the J/ψ.

Data collected with ALICE at the LHC during Run 2 is used to investigate the relative J/ψ yield, measured at mid-rapidity (|y|<0.9) in its di-electron decay channel and as a function of the charged-particle multiplicity, in various regions of the azimuthal angle with respect to the emission of the J/ψ meson.

In this contribution, new measurements of this correlation performed in pp collisions at $\sqrt{s}$=13 TeV TeV will be shown.

*Supported by DFG under GRK2149

HK 24.4 Tue 17:00 HK-H1

J/ψ production as a function of the event multiplicity in p-Pb collisions at the LHC — •Tabea Eder for the ALICE-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster

Previous ALICE results indicate a stronger than linear increase of the inclusive normalized J/ψ yield with charged-particle multiplicity, both measured at mid-rapidity, in proton-lead collisions at $\sqrt{s_{NN}}$ = 5.02 TeV. The corresponding ALICE results on proton-proton collisions at $\sqrt{s}$ = 13 TeV provide a clearer picture of a stronger than linear increase.

In PYTHIA8, this behavior has been associated with auto-correlation effects in proton-proton collisions. This has been achieved by investigating the multiplicity dependence of J/ψ production in different regions of the azimuthal angle, which is the difference between the J/ψ meson and the charged particle emission angle. For proton-lead collisions, no results on these distributions for the J/ψ meson are available yet.

In this talk first results on the multiplicity dependence of the normalized J/ψ yield for proton-lead collision in regions of the azimuthal angle will be presented, using ALICE data at $\sqrt{s_{NN}}$ = 5.02 TeV recorded during the LHC data taking Run 2 in 2016.

Supported by BMBF within the ErUM Program.

HK 24.5 Tue 17:15 HK-H1

Measurement of J/ψ polarization in proton-proton collisions at $\sqrt{s}$ = 13 TeV with the ALICE muon spectrometer — •Federica Zanone for the ALICE-Collaboration — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Germany

ALICE is the experiment at the CERN LHC devoted to the study of quark-gluon plasma, but it is also well suited to perform other QCD studies, such as the investigation of quarkonium polarization.

Polarization is the measure of the degree to which the spin of a particle is aligned with respect to a chosen axis and reflects the process responsible for its production. At present theoretical models have difficulties in explaining both the quarkonium production cross section and polarization, so precise results from experiments are necessary to better constrain the theory approaches. The polarization of a vector meson, such as J/ψ, can be experimentally determined by measuring the angular distribution of its decay products since such distributions can be expressed in terms of the eigenvalues corresponding to the mother angular momentum eigenstates. This study focuses on the decay channel $J/\psi \rightarrow \mu^+\mu^-$ in the pseudorapidity region $-4.0 < \eta < -2.5$ and addresses the highest J/ψ statistics sample collected so far by ALICE in pp collisions. This analysis provides the measurement of J/ψ polarization parameters as a function of p_T in the helicity and Collins-Soper reference frames and investigates the range $p_T < 15\ GeV/c$, extending, for the first time, the measurement down to $p_T = 0$. Comparisons of the results to previous measurements both in pp and PbPb collisions, as well as to theoretical models, are provided, too.

HK 25: Heavy-Ion Collisions and QCD Phases VI

Time: Tuesday 16:00–17:30 Location: HK-H2

Group Report HK 25.1 Tue 16:00 HK-H2

The Compressed Baryonic Matter (CBM) experiment and its demonstrator mCBM at FAIR — •Adrian Amatus Weber for the CBM-Collaboration — Justus-Liebig Universität Gießen

The key objective of the Compressed Baryonic Matter experiment (CBM) at FAIR is to explore the QCD phase diagram at high net-baryon density and moderate temperatures in nucleus-nucleus collisions. At the FAIR energy regime, a rich phase structure could occur comprising the potential restoration of chiral symmetry and a first order phase transition, resulting in a substantial discovery potential. CBM is designed as a fixed-target experiment and will be equipped with fast and radiation-tolerant detector systems to measure with unprecedented interaction rates of up to 10MHz which will allow to study extremely rare probes with high precision. To achieve the required performance, a triggerless-streaming data acquisition and data transport system is being developed sending data with up to 1 TB/s to a large-scale computer farm for event reconstruction and first-level event selection. The presentation will summarize the preparation status of the CBM experiment including latest results of the mCBM experiment. With mCBM ("mini-CBM") a CBM precursor experiment and demonstrator has been set up within the FAIR phase-0 program, comprising pre-series and prototype modules of all CBM detector systems. During the 2021 beam campaign, high-rate tests for various detector subsystems could be performed as well as first runs with the final DAQ / data transport configuration of CBM were taken.

HK 25.2 Tue 16:30 HK-H2

CBM performance for (multi-)strange hadron measurements using Machine Learning techniques — •Shahid Khan[1], Viktor Klochkov[1], Olha Lavoryk[2], Oleksii Lubynets[3,4], Andrea Dubla[3], and Ilya Selyuzhenkov[3,5] for the CBM-Collaboration — [1]University of Tuebingen — [2]University of Kyiv — [3]GSI, Darmstadt — [4]University of Frankfurt — [5]NRNU MEPhI, Moscow

The Compressed Baryonic Matter (CBM) experiment at FAIR will investigate the QCD phase diagram at high net-baryon density ($\mu_B > 400\ MeV$) in the energy range of $\sqrt{s_{NN}} = 2.9 - 4.9$ GeV. Precise determination of dense baryonic matter properties requires multi-differential measurements of strange hadron yields, both for the most copiously produced kaons and Λ as well as for rare (multi-)strange hyperons and their anti-particles.

This work focuses on the multi-differential reconstruction and yield of strange hadrons (K_s^0, Λ, and Ξ^-) using Machine Learning (ML) algorithms such as XGBoost for different collision energies. The hadrons are reconstructed via their weak decay topology using the Kalman Filter algorithm. The ML algorithms allow efficient, non-linear, and multi-dimensional selection criteria to be implemented and achieve a high signal to background ratio in the region around the invariant mass peak of the candidates. The ML algorithms are deployed and the yield extraction (multi-step fitting procedure) is implemented differentially in centrality, transverse momentum, and rapidity. Estimation of systematic uncertainties and a novel approach to study feed-down contribution to the primary strange hadrons using ML will also be discussed.

HK 25.3 Tue 16:45 HK-H2

Charged Kaon and ϕ Reconstruction in Ag+Ag Collisions at $\sqrt{s_{NN}}$ = 2.5 GeV with HADES — •Marvin Kohls for the HADES-Collaboration — Goethe-Universität Frankfurt am Main

Heavy ion collisions in the few GeV energy regime probe similar temperatures and densities as created in neutron stars, which provides a tool to probe the matter created in those macroscopic collisions in earthly laboratories [1].

In March 2019, the HADES collaboration recorded $13 \cdot 10^9$ Ag(1.58A GeV)+Ag events as part of the FAIR Phase-0 program. Within this talk we present the status of the reconstruction of K^+, K^- and ϕ from this measurement series.

As these strange hadrons are produced below the free nucleon-nucleon production threshold, they are a good probe for in-medium effects with respect to their steep excitation function. In this presentation the relative yields of strange particles with different excitation energies are compared and the consistency with theoretical models is reviewed. Furthermore the system size dependence of strangeness production is tested by comparing central and peripheral collisions.

The work has been supported by BMBF (05P19RFFCA), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006), GSI and HIC for FAIR.

[1] Adamczewski-Musch, J., Arnold, O., Behnke, C. et al. *Probing dense baryon-rich matter with virtual photons*. Nat. Phys. 15, 1040*1045 (2019) doi:10.1038/s41567-019-0583-8

HK 25.4 Tue 17:00 HK-H2

Emission of light nuclei from semi-central events in Au+Au collisions at $s_{NN} = \sqrt{2,42}$ GeV with HADES — •Holger Huck for the HADES-Collaboration — Goethe-Universität, Frankfurt am Main, Deutschland

In the few GeV energy regime light nuclei are emitted abundantly, contributing to the bulk of created matter. We present results on p, d, t and ^3He momentum spectra as yields from central and semi central Au+Au collisions at $s_{NN} = \sqrt{2,42}$ GeV.

After particle identification the transverse mass spectra of the particle candidates are extracted. Subsequently, they are corrected for acceptance and efficiency losses. The centrality dependance of the obtained spectra and yields are then compared and put into context of the world data.

HK 25.5 Tue 17:15 HK-H2

Ambiguities in the hadro-chemical freeze-out of Au+Au collisions at SIS18 energies and how to resolve them — •Anton Motornenko[1], Jan Steinheimer[1], Volodymyr Vovchenko[3], Reinhard Stock[4,1], and Horst Stoecker[1,2,5] — [1]FIAS, Frankfurt — [2]ITP, Goethe Universität — [3]Nuclear Science Division, LBL — [4]IKP, Goethe Universität — [5]GSI, Darmstadt

The thermal fit to preliminary HADES data of Au+Au collisions at $\sqrt{s_{NN}} = 2.4$ GeV shows two degenerate solutions at $T \approx 50$ MeV and $T \approx 70$ MeV. The analysis of the same particle yields in a transport simulation of the UrQMD model yields the same features, i.e. two distinct temperatures for the chemical freeze-out. While both solutions yield the same number of hadrons after resonance decays, the feeddown contribution is very different for both cases. This highlights that two systems with different chemical composition can yield the same multiplicities after resonance decays. The nature of these two minima is further investigated by studying the time-dependent particle yields and extracted thermodynamic properties of the UrQMD model. It is confirmed, that the evolution of the high temperature solution resembles cooling and expansion of a hot and dense fireball. The low temperature solution displays an unphysical evolution: heating and compression of matter with a decrease of entropy. These results imply that the thermal model analysis of systems produced in low energy nuclear collisions is ambiguous but can be interpreted by taking also the time evolution and resonance contributions into account. [1] Phys.Lett.B 822 (2021) 136703, arXiv:2104.06036 [hep-ph]

HK 26: Instrumentation VII

Time: Tuesday 16:00–17:30 Location: HK-H3

HK 26.1 Tue 16:00 HK-H3

Performance and quality testing of frontend electronics for the CBM RICH detector * — •Pavish Subramani for the CBM-Collaboration — University of Wuppertal

The CBM experiment is a high collision rate rate experiment, producing estimated single Cherenkov photon rates of up to ~ 300 kHz per pixel in its Ring Imaging Cherenkov Detector (RICH). Signals of the 8×8 pixel Multianode Photomultiplier Tubes (MAPMT) are digitized using the FPGA-TDC based DIRICH frontend readout chain, providing excellent timing precision. A dedicated lab setup producing realistic detector signals using a pulsed laser light source was set up in order to validate the high rate capability of the DIRICH readout. It is found that individual readout channels can withstand photon rates up to 2.2 MHz/pixel, limited only by maximum data rate capability and buffer size on the frontend board. In addition, also effects of high photon occupancy on the MAPMTs were investigated, which might cause additional signals due to capacitive cross talk within the MAPMT or readout chain. Occupancies of up to 55 % (simultaneous photon hits on more than half of the MAPMT pixels) were investigated, indicating that in the expected occupancy range of 10–15 % the readout works flawlessly with very low crosstalk. The talk will focus on the laboratory test setup and qualification measurements of the readout chain obtained herewith.

* supported by BMBF (05P19PXFCA, 05P21PXFC1) and GSI.

HK 26.2 Tue 16:15 HK-H3

Precursor of the NOVEC-649 based cooling system for the CBM Micro Vertex Detector — •Franz A. Matejcek — Goethe-Universität Frankfurt

The Micro Vertex Detector of the Compressed Baryonic Matter Experiment (CBM) is placed 5 cm behind the target. The pixel detector with low material budget operates in vacuum. It consists of four stations equipped with 288 thin and large area CMOS sensors which produce a total of around 70 W of heat. To ensure their radiation hardness and detecting efficiency they have to be operated below -10 °C. The material budget-optimized cooling concept relies on efficient conductive cooling of the sensors, glued onto TPG carriers, providing very high thermal conductivity in the geomatrical acceptance. Actively cooled heat sinks outside the acceptance transfer the heat to the dedicated high-tech coolant NOVEC-649 (3M), featuring low viscosity in the temperature range of interest and good radiation hardness. This contribution will focus on the steps towards routine operation with NOVEC-649 and the evaluation of the thermal performance of a MVD prototype.

This work has been supported by BMBF (05P19RFFC1), CremlinPLUS, GSI and HIC for FAIR.

HK 26.3 Tue 16:30 HK-H3

Study of the material budget and data rates for the STS detector system of the CBM experiment — •Mehulkumar Shiroya for the CBM-Collaboration — Goethe University Frankfurt, Frankfurt am Main, Germany

The Compressed Baryonic Matter (CBM), a fixed target experiment is under development at the Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt(Germany). The aim of the experiment is to study the QCD phase diagram of strongly interacting matter at high density and moderate temperature employing heavy-ion beams in the energy range between 2 AGeV-11 AGeV.

The experiment is designed to run with beam intensities up to 10^9 Au + Au particles/sec and an interaction rate of up to 10^7 collisions/sec. Therefore, fast and free streaming electronics is needed for read-out and data transfer. The read-out electronics are connected to the silicon micro-strips sensors via polyimide-Al micro-cables and are placed outside the active region of STS to minimize the material budget. Detailed realistic knowledge of the detector geometry, including both active and passive material, is necessary to estimate the material budget of the detector which has a large impact on the absorption of delta electrons created in beam-target interaction, as well as in nuclear interaction of particles created in the heavy-ion collision with the active and passive materials. We present the status of the simulations of the STS detector geometry and its impact on the expected signal rates.

HK 26.4 Tue 16:45 HK-H3

Proof-of-Principle of Collinear Laser Spectroscopy on Neutral Atoms following Photodetachment — •Laura Renth[1], Bernhard Maass[1,4], Dag Hanstorp[3], Phillip Imgram[1], Daniel Koestel[2], Di Lu[3], Wilfried Nörtershäuser[1], and Thomas Walther[2] — [1]IKP, TU Darmstadt — [2]IAP, TU Darmstadt — [3]University of Gothenburg — [4]Argonne National Laboritory, Chicago, USA

At the Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) [1] in Darmstadt a new experimental approach was tested to perform collinear laser spectroscopy on boron atoms produced from a negative ion sputtering source.

An ion sputtering source produced negatively charged boron ions which where then guided into the COALA beamline. From this ion beam an atomic beam was created by photodetachement with a pulsed laser. Then, collinear laser spectroscopy was performed for the $2p\ ^2P_{1/2} \rightarrow 3s\ ^2S_{1/2}$ and for the $2p\ ^2P_{3/2} \rightarrow 3s\ ^2S_{1/2}$ transitions of ^{11}B and on the the $2p\ ^2P_{3/2} \rightarrow^3 s\ ^2S_{1/2}$ transition of ^{10}B. The resonance was only observed after implementing new diagnostic tools at COALA, namely a Wien filter and the generation of short ion pulses to perform time-of-flight (TOF) spectrometry. First results will be presented and the potential of this approach are discussed.

[1] K. König, J. Krämer, C. Geppert, P. Imgram, B. Maaß, T. Ratajczyk, W. Nörtershäuser. A New Collinear Apparatus for Laser Spectroscopy and Applied Science (COALA). Rev. Sci. Instr. 91, 081301 (2020).

HK 26.5 Tue 17:00 HK-H3

Integration of a Resistive Plate Chamber for Precise Measurement of High-Momentum Protons in Short Range Correlations — •Manuel Xarepe[1,2], Thomas Aumann[1,4], Alberto Blanco[3], Daniel Galaviz[2], Luis Lopes[3], Andrea Jedele[1,4], João Saraiva[3], Hans Törnqvist[1,4], Bastian Löher[4], and Håkan Johansson[5] for the R3B-Collaboration — [1]TU-Darmstadt — [2]LIP-Lisbon — [3]LIP-Coimbra — [4]GSI — [5]Chalmers-UT

Within the framework of the FAIR Phase-0 experimental program, that will study for the first time of Short Range Correlations (SRC) in radioactive nuclei at the R3B (Reactions with Relativistic Radioactive Beams) experiment of the FAIR laboratory, by measuring the breakup reaction of 16C on a proton target in inverse kinematics, an innovative approach based on Resistive Plate Chambers (RPC) as a proton Time-of-Flight (ToF) is presented. The excellent time resolution properties of the RPC (about 50 ps) will allow for a precise measurement of the momentum of the forward emitted protons from high-momentum correlated pairs. In this work the RPC detector will be introduced, the characteristics of the integration of the detector in the R3B experiment will be presented, and first results from calibrations using cosmic rays, radioactive sources and a test beam time after installation in the experimental cave will be shown.

HK 26.6 Tue 17:15 HK-H3

Characterization of plastic scintillators with radioactive sources for the DarkMESA experiment — •Matteo Lauss for the MAGIX-Collaboration — Institute for Nuclear Physics, Mainz University, German

At the Institute for Nuclear Physics in Mainz the new electron accelerator MESA will go into operation within the next years. In the extracted beam operation (150 MeV, 150 μA) the P2 experiment will measure the weak mixing angle in electron-proton scattering in 10,000 hours operation time. The beam dump of this experiment is ideally suited for a parasitic dark sector experiment - the DarkMESA experiment. It is designed for the detection of Light Dark Matter (LDM) which in the simplest model couples to a massive vector particle, the dark photon γ'.

A highly efficient veto detector surrounding the calorimeter hermetically is essential to probe the target parameter space of DarkMESA successfully. The veto detector will mainly consist of plastic scintillation counters. A detector prototype is currently under construction using 2 cm thick plastic scintillators of type EJ-200 and a matrix of 5×5 lead fluoride crystal bars for the calorimeter. The measurement of the scintillation light is accomplished by silicon photomultipliers (SiPM) mounted on a specially designed electronic board. Systematic studies with a selection of commonly used radioactive sources were conducted to determine the homogeneity of the light yield across the scintillators. The light yield was determined by extracting the Compton edge for gamma emitters with an appropriate response function.

HK 27: Instrumentation VIII

Time: Tuesday 16:00–17:30 Location: HK-H4

Group Report HK 27.1 Tue 16:00 HK-H4

The TRD in CBM: status and steps towards series production — •Florian Roether — Institut für Kernphysik, Frankfurt, Deutschland

In 2025, the Compressed Baryonic Matter Experiment (CBM) at FAIR is scheduled to start operation. Starting end of 2023, the various detectors will be installed, including the Transition Radiation Detector (TRD). The main task of the TRD is to identify electrons above momenta of 1 GeV/c. In addition, the TRD also contributes to the identification of nuclear fragments. After an intensive and thorough research and development phase, we will start series production of the chambers for the TRD in 2022.

This presentation will summarize the status of the project and the development of the workflows required for series production. We will also present first results and findings from the pre-series production of the detector chambers.

This work is supported by BMBF-grant 05P21RFFC3.

HK 27.2 Tue 16:30 HK-H4

Application of TRD Trigger on the Hypertriton Analysis in p–Pb collisions at ALICE — •Benjamin Brudnyj for the ALICE-Collaboration — Institut für Kernphysik, Goethe Universität, Frankfurt am Main

The production of light (anti-)(hyper-)nuclei has recently become a topic of high interest. One interesting example is the lifetime of the lightest hypernucleus, the hypertriton. Several measurements indicate a significant deviation from the theoretical expectation, in particular in heavy-ion collisions. Therefore, it is important to also measure these rare nuclei in pp and p–Pb collisions.

Due to their short lifetime only their decay products can be measured, e.g. the charged two body decay channel $^3_\Lambda\mathrm{H} \rightarrow {}^3\mathrm{He} + \pi^-$. In order to be able to measure these rare (anti-)fragments also in pp and p–Pb collisions, a trigger on nuclei was implemented on p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV to increase the statistics by using the ability of the ALICE-TRD to perform fast trigger decisions.

In this talk the performance of a trigger on different light nuclei will be presented, as well as the current status of a hypertriton analysis using data on p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV. In order to measure the hypertriton with a sufficient significance and a good signal-to-background ratio, a study to optimize topological cuts is performed. Supported by BMBF and the Helmholtz Association.

HK 27.3 Tue 16:45 HK-H4

CBM-TRD QA algorithm results for mCBM 2021 — •Axel Puntke — Institut für Kernphysik, Münster, Germany

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) will explore the QCD phase diagram in the region of very high net baryon densities. The Transition Radiation Detector (TRD) is an important subdetector of the final CBM experiment and is used to identify electrons at high momenta, contributes to tracking of particles and supports the identification of light nuclei via their energy loss.

For commissioning and performance measurements, the TRD takes part in the mCBM high-rate beam campaigns at the SIS18 accelerator, which are part of the FAIR-Phase 0 program. For this purpose, a set of QA algorithms is developed which can automatically produce QA plots, based on the used configuration parameters of the current setup. This also includes correlations with other subsystems (e.g. TOF) which have recorded data simultaneously.

In this poster, the first results, based on the data recorded during the mCBM 2021 beamtime, will be shown . Besides TRD there were also the subsystems TOF, STS, RICH and PSD involved and can be used for temporal and spatial correlations.

This work is supported by BMBF grant 05P21PMFC1.

HK 27.4 Tue 17:00 HK-H4

n2EDM - coating of ultra-cold neutron storage vessel — •Noah Yazdandoost für die nEDM-Kollaboration — Department of Chemistry, Johannes Gutenberg-University, Mainz

The n2EDM experiment at PSI aims to measure the neutron electric dipole moment (nEDM) with ultra-cold neutrons (UCN). UCN are neutrons with energies in the range of nano electron-volts.

A non-zero nEDM would break time and parity reversal symmetry and could explain observations like the matter-antimatter asymmetry of the universe. To measure the nEDM, polarized UCN are filled into a storage vessel where a constant electric and magnetic field is applied. The Ramsey method of separated oscillatory fields is used to measure the Larmor precession frequency of the UCN in the storage vessel. A measured shift in the Larmor precession frequency between parallel and antiparallel field orientation implies a non-zero nEDM. The maximum energy of the stored UCN is limited by the Fermi pseudo-potential of the material the vessel is made of. Besides having a high Fermi pseudo-potential, the material needs to be non-magnetic and electrically insulating.

This talk gives an overview of the n2EDM experiment and the coating process of the insulating rings of the experiment.

HK 27.5 Tue 17:15 HK-H4

Laser cooling of C3+ ions at the Experimental Storage Ring at GSI — •Ken Ueberholz[1], Volker Hannen[1], Danyal Winters[2], Christian Weinheimer[1], Noah Eizenhöfer[4], Michael Bussmann[3], Max Horst[4], Daniel Kiefer[4], Nils Kiefer[5], Sebastian Klammes[2], Thomas Kühl[2,6], Markus Löser[3], Xinwen Ma[7], Wilfried Nörtershäuser[4], Rodolfo Sanchez[2], Ulrich Schramm[3,8], Mathias Siebold[3], Peter Spiller[2], Markus Steck[2], Thomas Stöhlker[2,6,9], Thomas Walther[4], Hanbing Wang[7], Weiqiang Wen[7], Benedikt Langfeld[4], and Lars Bozyk[2] — [1]WWU

Münster — [2]GSI Darmstadt — [3]HZDR Dresden — [4]TU Darmstadt — [5]Uni Kassel — [6]HI Jena — [7]IMP Lanzhou — [8]TU Dresden — [9]Uni Jena

In May 2021, an improved XUV fluorescence detection system and a new tuneable pulsed UV laser system were employed in a *beam experiment* for laser cooling of bunched relativistic (47% of c) carbon ions stored at the Experimental Storage Ring at GSI Helmholtzzentrum Darmstadt. Successful laser cooling was demonstrated using the powerful (~200 mW), high repetition rate (~10 MHz) and tuneable (wavelength and pulse duration) UV laser system. One of the main points of interest was to study the effects of ion bunch and laser pulse timing on the cooling process and on the fluorescence detection, which was done by varying the delay of the laser pulses. In the talk preliminary results of these measurements will be presented and discussed. This work has been supported by BMBF under contract number 05P19PMFA1.

HK 28: Computing I

Time: Tuesday 16:00–17:45 Location: HK-H5

Group Report HK 28.1 Tue 16:00 HK-H5

Track Finding with PANDA — •Anna Alicke[1], Tobias Stockmanns[1], and James Ritman[2,1,3] for the PANDA-Collaboration — [1]Forschungszentrum Jülich, Institut für Kernphysik — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Ruhr-Universität Bochum, Experimentalphysik, Lehrstuhl I

An overview of the various track finding methods for the barrel part of the PANDA detector will be presented. PANDA's barrel tracking system consists of three detector parts. The innermost tracking detector is the Micro-Vertex-Detector (MVD). Surrounding the MVD is the the Straw Tube Tracker (STT), which consists of over 4200 drift tubes. Additionally, forward boosted tracks are identified by the Gas Electron Multiplier plates (GEM). The STT tubes produce coarse track information given by their tube ID and a drift time information which significantly improves the spatial resolution. The drift time information determines circles (isochrones) to which the tracks must pass tangentially.

Track finding is divided into two parts: track finding for primary particles and for secondary particles. Two algorithms for each part are presented and compared. The two algorithms for primary particles are global tracking algorithms. The first algorithm is the current default track finder in PANDA and is based on adding hits to existing track assumptions. The second one is a track finder based on Hough transformations. For secondary particles a well optimized track finder based on a cellular automaton is compared to a novel approach that uses three chosen hits to find the true particle track.

HK 28.2 Tue 16:30 HK-H5

Machine Learning Approach for Track Finding Using Language Models — •Jakapat Kannika, James Ritman, and Tobias Stockmanns — Forschungszentrum Jülich, Jülich, Germany

In the particle physics experiments, track finding is a pattern recognition task in which input hits are clustered into different groups of output tracks. The hits are signals of the particles traveling through the detectors, and the tracks are groups of trajectories of those particles. This study is focusing on implementing a track finding algorithm using language models for straw tube based tracking systems. The language model is a probability distribution which is used in order to recognize the sequences of data. The model is widely used in the field of natural language processing, where applications such as speech recognition, handwriting recognition, word prediction also use the language models. In the current study, we extract features from the hit data and treat them as discrete values similarly to words, then do a language modeling. The obtained language model is used in the same way as in the word prediction applications, but in this case, it predicts the next hits. The algorithm is now able to track particles in square and hexagonal geometries in conditions where noise or crossing tracks are presented. The current status and an outlook on the overall performance will be presented.

HK 28.3 Tue 16:45 HK-H5

Space-charge distortions in the ALICE TPC I: A data-driven approach to model space-charge distortion fluctuations — •Matthias Kleiner — Institut für Kernphysik, Goethe-Universität Frankfurt

The Time Projection Chamber (TPC) is the main tracking and particle identification detector of the ALICE experiment at the CERN LHC. For Run 3, starting in 2022, interaction rates of 50 kHz in Pb-Pb collisions required a major upgrade of the TPC readout system. The Multi-Wire Proportional Chambers (MWPCs) were replaced by stacks of four Gas Electron Multiplier (GEM) foils, allowing continuous data acquisition. Due to intrinsic properties of the GEMs, a significant amount of ions produced during the electron amplification drifts into the active volume of the TPC, leading to space-charge distortions of the nominal drift field. Various effects cause fluctuations of the space-charge distortions on very short time scales. These fluctuations have to be corrected to preserve the intrinsic tracking precision of the TPC of 100 μm. A dedicated calibration procedure has been developed for the correction of the space-charge distortions. The measured integrated digital currents (IDCs) on the pads, which are used as an estimate for the space-charge density, are processed and taken as an input for a data-driven machine learning approach.

In this talk, procedures for the optimization of the IDCs for the space-charge distortion calibration for the ALICE TPC in Run 3 will be presented.

Supported by BMBF and the Helmholtz Association

HK 28.4 Tue 17:00 HK-H5

Space-charge distortions in the ALICE TPC II: Data-driven machine learning algorithms for the space-charge distortion calibration — •Ernst Hellbär[1], Harald Appelshäuser[2], Marian Ivanov[1], Matthias Kleiner[2], Silvia Masciocchi[1], and Jens Wiechula[2] for the ALICE-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — [2]Institut für Kernphysik, Goethe-Universität Frankfurt, Germany

The Time Projection Chamber (TPC) plays a crucial role in tracking and particle identification for the ALICE experiment at the CERN LHC. The readout of the TPC was upgraded during the long shutdown 2 of the LHC in order to provide the capability to continuously record collision data at 50 kHz of Pb-Pb collisions. The intrinsic properties of the new readout chambers based on Gas Electron Multiplier (GEM) technology lead to a backflow of amplification ions into the drift volume of the TPC which is minimized to below 1%. In combination with the expected particle multiplicities and high interaction rates in Pb-Pb collisions, the ion backflow (IBF) causes significant space-charge distortions and distortion fluctuations. The latter are relevant on time scales of the order of 10 ms and have to be fully corrected accordingly to restore the intrinsic space-point resolution of the TPC of the order of a few 100 μm. The calibration of the distortion fluctuations is performed using data-driven machine learning algorithms which are trained with simulated data. The calibration procedure and first result of the performance will be presented.

This contribution is supported by BMBF.

HK 28.5 Tue 17:15 HK-H5

The mSTS as a pathfinder for the Detector Control System of the STS in the CBM experiment — •Marcel Bajdel for the CBM-Collaboration — Goethe-Universität Frankfurt am Main

The Compressed Baryonic Matter (CBM) experiment dedicated to the study of the properties of the strongly interacting matter is now under construction at the Facility for Anti-proton and Ion Research (FAIR) in Darmstadt.

In order to optimize the performance of experimental subsystems, a small-scale mCBM demonstrator was installed for the test purposes. As the future Silicon Tracking System (STS) is the core detection system of CBM, the mSTS is now a subject of the intensive investigation.

The CBM's Detector Control System (DCS) focuses on monitoring of the detector operation conditions, provides tracking of its vital parameters, data storage, and ensures a safe operation of the mSTS. A novel approach based on the containerization was implemented for these purposes. A Experimental Physics and Industrial Control System (EPICS) based system was configured and deployed in order to control, monitor and store process variables (PV) associated with the hardware.

In this presentation, we will present the results from the beam-test campaigns in 2020-2021, which allowed us to evaluate the performance of its soft- and hardware components.

HK 28.6 Tue 17:30 HK-H5

Comparison of simulation frameworks for the P̄ANDA FAIR phase-0 experiment at MAMI — •Alexander Greiner[1], Alaa Dbeyssi[1], David Rodriguez Pineiro[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Luigi Capozza[1], Oliver Noll[1], Peter-Bernd Otte[1], Sahra Wolff[1], and Samet Katilmis[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]PRISMA Clus- ter of Excellence, Mainz, Germany

A complex detector system is being developed for the P̄ANDA experiment at the FAIR accelerator facility in Darmstadt. The electromagnetic process group (EMP) at the Helmholtz institut in Mainz is developing the backward end-cap (BWEC) of this detector and a preliminary version will be used in the P̄ANDA FAIR Phase-0 project to measure the electromagnetic transition form factor of π^0 at the MAMI-accelerator in Mainz. To verify that the planned setup of the BWEC can withstand the radiation exposure of the experiment without affecting the data acquisition through malfunctions, simulations were performed to estimate the radiation exposure of the whole experiment and of single important components. In the context of these simulations a comparison between the used simulation framework GEANT4 and the prominent FLUKA framework was performed.

HK 29: Structure and Dynamics of Nuclei V

Time: Tuesday 16:00–17:30 Location: HK-H6

HK 29.1 Tue 16:00 HK-H6

Total Reaction Cross-Section Measurements in the S444 Commissioning Experiment for R^3B — •Lukas Ponnath[1], Roman Gernhäuser[1], Tobias Jenegger[1], Philipp Klenze[1], and Thomas Aumann[2] for the R3B-Collaboration — [1]Technische Universität München — [2]Technische Universität Darmstadt

The R^3B (Reactions with Relativistic Radioactive ion Beams) experiment at the research facility FAIR, currently under construction in Darmstadt, enables kinematically complete reaction studies for the most exotic nuclei.

The S444 commissioning experiment for R^3B, performed in the FAIR Phase-0 campaign in 2019, was the first operation of many new R^3B detectors in a common setup. With a stable ^{12}C beam and a set of different beam energies ranging from 400AMeV to 1AGeV we challengend this large installation around the GLAD magnet using the $^{12}C(p,2p)^{11}B$ benchmark reaction.

During this successful commissioning we could measure the energy dependence of total reaction cross-sections of a ^{12}C beam on a ^{12}C target, which is poorly known for energies above 400AMeV. This is an important input for current calculations based on the eikonal reaction theory.

In my Talk I will present the current status and preliminary results of the analysis and discuss the technique and evaluated error budget for the different steps.

(supported by BMBF 05P21WOFN1)

HK 29.2 Tue 16:15 HK-H6

Recent high-precision mass spectrometry of heavy and superheavy nuclides at SHIPTRAP — •Oliver Kaleja for the SHIPTRAP-Collaboration — University of Greifswald, Germany — GSI Darmstadt, Germany

Within the recent FAIR phase-0 program, the Penning-trap mass spectrometer SHIPTRAP at GSI in Darmstadt, Germany, was used to extend direct high-precision mass spectrometry to superheavy nuclides ($Z \geq 104$) in the vicinity of the $N = 152$ shell closure. Besides lowest production rates down to few atoms per hour, an improved efficiency, ion sensitivity and mass-resolving power of up to 11 000 000 allowed resolving metastable states with half-lives >200 ms, i.e, ^{251m,254m}No($Z = 102$), ^{254m,255m}Lr($Z = 103$), ^{257m}Rf($Z = 104$), and ^{258m}Db($Z = 105$) from their respective ground state. For the first time, isomer excitation energies in the range of $\approx$ 30 keV to 1.3 MeV were determined directly. In addition, multiple metastable states in a variety of heavy isotopes, many of which are close to the $Z = 82$, $N = 126$ shell closures, have been measured, e.g., for isotopes of Pb, Bi, Po, At, Rn, Fr ($Z = 82-87$), Th($Z = 90$), and Cf($Z = 98$). This allowed the direct determination of the excitation energies of long-lived isomeric states and therefore to contribute to the understanding of the level and decay schemes of these heavy nuclei, complementing the findings from decay and laser spectroscopy investigations. In this contribution an overview of the experimental challenges and results is given.

HK 29.3 Tue 16:30 HK-H6

Commissioning and status of a gas-jet apparatus for laser spectroscopy of the heaviest elements — •Jeremy Lantis for the GSI Gas Jet-Collaboration — Johannes Gutenberg University Mainz, 55099 Mainz, Germany — Helmholtz Institute Mainz, 55099 Mainz, Germany

Laser spectroscopy measurements can provide information about fundamental properties of both atomic and nuclear structure. These techniques are of particular importance for the heaviest actinides and superheavy elements, where atomic data are sparse. Recent resonance ionization spectroscopy experiments at GSI, Darmstadt have focused on in-gas-cell measurements using the RADRIS technique, with success measuring several nobelium and fermium isotopes. However, the limited resolution of these measurements hampers the precision in determining the nuclear moments and spin. To overcome these limitations, a new gas-jet apparatus has been constructed to perform laser spectroscopy of atoms in a hypersonic jet, providing an almost collision-free and reduced Doppler broadened environment, which improves the achievable resolution by an order of magnitude and provides substantially improved nuclear data of exotic nuclei. The reach and capabilities of the apparatus will be discussed, as well as planned online experiments involving the determination of the nuclear moments of ^{253,255}No and the definitive identification of the nucleonic configuration of the $K^\pi = 8^-$ isomer of ^{254m}No.

HK 29.4 Tue 16:45 HK-H6

Perturbative inclusion of core excitation in a structure model of one-neutron halo nuclei — •Live-Palm Kubushishi and Pierre Capel — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

Halo nuclei are exotic nuclear structures found near the dripline and thus short-lived. In standard reaction models, halo nuclei are described as simple two or three-body systems: an inert core with one or two weakly bound neutrons. However, some breakup data suggest that the structure of the core, and in particular its excitation to its excited states, can play a role in the dynamics of the reaction [1]. In this talk, we propose a simple structure model to account for that effect. Here we consider the example of the one-neutron halo nucleus ^{11}Be. To improve our description of the ^{10}Be core without resorting to a purely microscopic model, we use a collective one: the rigid rotor. We assume the core to be weakly deformed, which we treat at the first order of perturbations to couple it to its 2^+ first excited state, and we add this degree of freedom to the halo effective field theory description of ^{11}Be [2]. Our calculations were performed using the R-matrix method on a Lagrange mesh. In this context, we have been able to reproduce with a good agreement, the coupled-channels results [3] and improve the halo-EFT model [2] with respect to *ab initio* results [4].

[1] R. de Diego, et al., *Phys. Rev. C* 95, 044611 (2017).
[2] P. Capel, et al., *Phys. Rev. C* 98, 034610 (2018).
[3] F.M. Nunes, et al., *Nucl. Phys. A* 596, 171 (1996).
[4] A. Calci, et al., *Phys. Rev. Lett.* 117, 242501 (2016).

HK 29.5 Tue 17:00 HK-H6

Investigation of fission in quasi-free-scattering experiments at R^3B — •Tobias Jenegger, Philipp Klenze, Lukas Ponnath, and Roman Gernhäuser — Technische Universität München, Germany

The advanced R^3B Setup at GSI allows to investigate fission of exotic nuclei in inverse kinematics via the (p,2pf) reaction. Fission via quasi-free-scattering is a new method to directly determine the excitation energy of the fissile nucleus and its fission barrier. This can only be achieved by kinematically complete measurement of all reaction products. Hence the CALIFA calorimeter, covering a polar angular acceptance from 22° up to 89° in the laboratory system around the target, plays a crucial role. It enables the detection of γ-rays with energies from 100 keV up to 30 MeV as well as protons and other light charged particles with energies up to 700 MeV, hence giving the opportunity to detect both the two coincident protons from the quasi-free-scattering process and emitted γ-rays from deexcitation of the fission products.

We present first analysis steps from a pilot experiment performed in the FAIR Phase-0 campaign in March 2021 with a relativistic ^{238}U beam and a LH2 target focussing on the identification of the fission products and the kinematic analysis of the (p,2pf) reaction.

(supported by BMBF 05P21WOFN1)

HK 29.6 Tue 17:15 HK-H6

Electron scattering off ^{10}B under 180° — •Maximilian Spall, Maxim Singer, Jonny Birkhan, Isabelle Brandherm, Martha Liliana Cortés, Florian Gaffron, Katharina E. Ide, Johann Isaak, Igor Jurosevic, Peter von Neumann-Cosel, Florian Niederschuh, Norbert Pietralla, Gerhart Steinhilber, and Tim Stetz — Institut für Kernphysik, Technische Universität Darmstadt

Electron scattering experiments under 180° are an excellent tool to study transversal form factors of magnetic excitations due to the suppression of longitudinal excitations by several order of magnitudes with respect to the transversal excitations and the associated radiative tail background from elastic scattering at this angle. A measurement was performed with the 180° system at the S-DALINAC [1], in order to investigate the M3 transition of the 3^+ ground state to the excited 0^+ state at 1.74 MeV in ^{10}B which is the analogue to the second-forbidden beta-decay of ^{10}Be. The measurement will extend existing data towards lower momentum transfer allowing to improve the precision of the determined transition strength. The combined information from electron scattering and beta-decay will serve as a precision test of the unified description of electroweak observables in ab-initio models. First results of the new ^{10}B(e,e') data will be presented and a novel approach for the scattering angle calibration will be discussed. *Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245.

[1] C. Lüttge et al., Nucl. Instrum. Meth. A 366, 325*331 (1995).

HK 30: Outreach

Time: Tuesday 16:00–17:30 Location: HK-H7

Group Report HK 30.1 Tue 16:00 HK-H7

Übersichtsvortrag Mainzer Outreach Aktivitäten — •Stephan Aulenbacher[1], Achim Denig[1], Wiebke Kött[2] und Heike Enzmann[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]Institut für Kernphysik, Mainz — [2]Institut für Physik, Mainz

Seit Januar 2019 ist Mainz nicht nur lokaler Knotenpunkt des Netzwerk Teilchenwelt, sondern darüber hinaus auch noch thematischer Knotenpunkt für Hadronen und Kerne. Dieser Vortrag soll einen Überblick über die Mainzer Outreach Projekte geben. Im Fokus stehen dabei Veranstaltungen wie die jährliche Mainzer Teilchenphysik Akademie sowie die neu etablierte Detektorschule. Aber auch routinierte Veranstaltung wie das Angebot der Masterclasses, mit besonderem blick auf die neue Streubretter Masterclass, sowie das Schülerpraktikum und die Führung durch die Beschleunigeranlage MAMI werden vorgestellt werden. Darüber hinaus werden Sonderprojekte präsentiert werden.

HK 30.2 Tue 16:30 HK-H7

Präzise geplant - die interaktive Wanderausstellung ”Präzision” — •Renée Dillinger-Reiter und Wiebke Kött — Johannes Gutenberg-Universtität, Mainz

In den letzten zwei Jahren wurde eine mobile Ausstellung zur öffentlichen Präsentation der Forschung unseres Exzellenzclusters ”Precision Physics, Fundamental Interactions and Structure of Matter” geplant und umgesetzt. Im November 2021 wurde sie in Berlin eröffnet und ist aktuell in Mainz zu sehen.

Bei der Konzeption einer solchen Ausstellung ergeben sich vielfältige Herausforderungen: neben der Finanzierung und einem hohen Arbeitsaufwand bei Entwurf und praktischer Umsetzung müssen die Inhalte geschärft werden. Dies betrifft unter anderem die Suche nach dem zentralen Leitthema, die Schwerpunktsetzung, das Herunterbrechen der wissenschaftlichen Details auf eine für Laien verständliche Ebene, die Auswahl einzelner Beispiele und die Ansprache der Zielgruppe durch interaktive Elemente.

HK 30.3 Tue 16:45 HK-H7

Entwicklung einer LHCb-Masterclass auf Grundlage von Hadronenspektroskopie — •Stefan Harst, Sebastian Neubert, Barbara Valeriani-Kaminski, Hannah Schmitz, Mindaugas Sarpis und Klaas Padeken für die Netzwerk Teilchenwelt-Kollaboration — Rheinische Friedrich-Wilhelms-Universität Bonn

Teilchenphysik Masterclasses ermöglichen Schüler:innen einen tieferen Einblick in das Thema der Teilchenphysik. Dabei beinhalten sie einführende Vorträge in die Teilchen- und Detektorphysik und schließen mit einer Analyse von Messdaten ab, welche von den Schüler:innen eigenständig durchführt wird.

Um die Physik der schweren Baryonen Schüler:innen näher zu bringen, wurde eine neue LHCb-Masterclass zum Thema Hadronenspektroskopie entwickelt. In dieser Masterclass analysieren Schüler:innen Messdaten des Zerfalls $\Omega_c^0 \rightarrow \Xi_c^+ K^-$, die der LHCb-Detektor im Zeitraum 2011-2015 aufgenommen hat.

Der Vortrag befasst sich mit der Entwicklung dieser Masterclass im Rahmen einer Bachelorarbeit und gibt weiterhin Eindrücke eines ersten Praxistests wieder.

HK 30.4 Tue 17:00 HK-H7

Escape Radon: Entwicklung eines digitalen Escape Rooms für den Physikunterricht — •Hannes Nitsche — Technische Universität Dresden

Digitale Spiele werden über die letzten Jahre vermehrt zu Lehrzwecken genutzt und sollen Lernkonzepte auf spielerische Art und Weise erweitern. Eine der außergewöhnlicheren Spielformen, die ihren Weg in die Bildung findet, ist die des digitalen Escape Rooms. Grundlage dieses Vortrags ist eine wissenschaftliche Arbeit, in der der didaktische Mehrwert dieses Spielformats für den Physikunterricht untersucht wurde. Dazu wurde eine digitale Escape Story entwickelt, welche sich inhaltlich mit der Radonbelastung in Deutschland auseinandersetzt und dabei kernphysikalische Grundlagen vermittelt. Im Vortrag wird die Escape Story ’Escape Radon’ sowie die Ergebnisse ihrer Erprobung und Evaluation vorgestellt. Des Weiteren wird erörtert, welche Gestaltungselemente von digitalen Escape Rooms das Interesse der Lernenden am Lehrinhalt fördern können und wieweit sich die Methode für Lehrzwecke adaptieren lässt.

HK 30.5 Tue 17:15 HK-H7

Archimedes principle and Galileo’s free fall experiments — •Rainer Schicker for the ALICE-Collaboration — Phys. Inst., Im Neuenheimer Feld 226, 69120 Heidelberg

Archimedes of Syracuse formulated a principle (~ 246 BC) according to which a body immersed in a fluid is subject to a buoyant force. The free fall of objects was studied by Galileo Galilei by dropping unequal masses from the Leaning Tower of Pisa (~ 1590 AD). The synthesis of Archimedes Principle and Galileo’s free fall conclusions is feasible by measuring the fall of differently shaped objects in liquids of different densities. The interpretation of such measurements necessitates the understanding of physics concepts widely used and discussed in nuclear and particle physics, such as gravitational, inertial and in-medium mass.

A setup was designed and built which is capable of recording the falling time at multiple positions over a falling height of 90 cm. These measurements can be made in air as well as in liquids. The technical details of this setup are described, and first results will be presented and discussed.

HK 31: Hadron Structure and Spectroscopy V

Time: Tuesday 16:00–17:45 Location: HK-H8

Group Report HK 31.1 Tue 16:00 HK-H8

Study of resonant states with $c\bar{c}s\bar{s}$ quark content with BaBar and Belle combined data sets — •Elisabetta Prencipe[1], Dmytro Meleshko[1], Jens Soeren Lange[1], Ihor Melnyk[2], James Ritman[3], and Ashish Thampi[3] — [1]JLU-Giessen, Giessen, Germany — [2]TSNU-Kyiv, Kyiv, Ukraine — [3]FZJ, Juelich, Germany

The B factories Belle and BaBar have collected huge data sets at the energy in the center of mass of the $\Upsilon(nS)$, n = 1,2,3,4, Belle even at that of the $\Upsilon(5S)$, integrating roughly 1.5 ab^{-1} data. This offers unique opportunities to perform spectroscopy studies *e.g.* in radiative decays or ISR analyses. Waiting that the new Belle II experiment will collect the whole planned data sets, 50 ab^{-1}, we have now the opportunity to perform the analysis of invariant mass systems with $c\bar{c}s\bar{s}$ quark content.

A study of resonances with double cs quark content has been conducted with combined BaBar and Belle data sets. We present the results obtained by analyzing the invariant mass systems of $J/\psi\phi$ and $D_s^+D_{sJ}^{(*)-}$ in different production mechanisms: B decays, B_s decays (Belle) and in the continuum. Interesting results are obtained, some of them confirming the LHCb observations in the $J/\psi\phi$ invariant mass though B decays. Results obtained in the neutral B channel, B_s and in the continuum are original measurements. This program has been approved by DFG as the first spectroscopy analysis with combined data sets from B factories.

HK 31.2 Tue 16:30 HK-H8

Search for the Strange Charmonium-like State Z_{cs} in the Reaction $e^+e^- \rightarrow \eta_c K^* K$ with BESIII — •Frederik Weidner[1], Nienke Balz[1], Helge Balzen[1], Johannes Bloms[1], Anja Brüggemann[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Lois Kröger[1], Sascha Lennartz[1], Peter Sandmann[1], and Alfons Khoukaz[1] for the BESIII-Collaboration — [1]Westfälische Wilhelms-Universität, Münster, Germany — [2]Indiana University, Bloomington, USA

In recent years the search for exotic hadrons has identified more and more states which seem to be incompatible with the conventional classification of hadrons as a two or three quark state. However, in most cases the classification of these particles is still inconclusive. One of the areas to search for them is the charmonium region where states have been found which carry isospin or strangeness. These states, called $Z_{c(s)}$, are good candidates for four quark states.

With the newly taken datasets between 4.6 and 4.9 GeV BESIII is searching for $Z_{c(s)}$ states. In this report the search for the Z_{cs} in the decay $Z_{cs} \rightarrow \eta_c K^*$ is presented as this decay is predicted to be one of the main decay channels of the Z_{cs}. Since the η_c meson does not have a golden channel for its reconstruction, in total 14 different decays are considered in a combined fit including three recoiling systems ($K^*K = K^{*+}K^-, K^{*-}K^+$ and $K^{*0}K_s$). In the end the product of the production cross section and the branching ratio will be calculated.

This work is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - 269952272, 271236083 and 443159800.

HK 31.3 Tue 16:45 HK-H8

Search for exotic states in η_c decays at BESIII — •Anja Brüggemann[1], Nienke Balz[1], Helge Balzen[1], Johannes Bloms[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Nikolai in der Wiesche[1], Lois Kröger[1], Sascha Lennartz[1], Peter Sandmann[1], Frederik Weidner[1], and Alfons Khoukaz[1] for the BESIII-Collaboration — [1]Westfälische Wilhelms-Universität Münster, Germany — [2]Indiana University Bloomington, USA

The BESIII detector at the e^+e^- collider BEPCII in Beijing, China, provides the world's largest data sample of the charmonium J/ψ with 10 billion events taken from 2009 to 2019.

Resulting from the radiative J/ψ decay to $\gamma\eta_c$ we analyse the reactions $\eta_c \to \eta' h\bar{h}$, where the $h\bar{h}$ system represents the K^+K^-, K_SK_S, $\pi^+\pi^-$, $\pi^0\pi^0$ and $\eta\eta$ systems. Since the majority of these η_c decay modes are still unlisted in the particle data group database we determine the corresponding branching ratios. Furthermore, since these mesonic η_c decays constitute a gluon-rich environment they offer the opportunity to investigate possible exotic content within $h\bar{h}$ intermediate states, that lie in the mass region below 2 GeV/c^2, where the lightest glueball is predicted.

Incorporating the analysed η_c decay modes our study is based on a combined partial wave analysis, which gives access to the partial decay widths of contributing resonances decaying to $h\bar{h}$. These widths are directly comparable to theory predictions.

The current status of the analysis will be presented.

This work is funded by DFG - 269952272, 271236083 and 443159800.

HK 31.4 Tue 17:00 HK-H8

Feasibility study of predicted decay channels of a hybrid charmonium candidate with $\overline{\text{P}}$ANDA — •Áron Kripkó, Markus Moritz, and Kai-Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

The $\overline{\text{P}}$ANDA experiment will be one of the key experiments at FAIR, which is currently under construction in Darmstadt, Germany. It will be a fixed-target experiment using an antiproton beam with beam momenta between 1.5 GeV/c and 15 GeV/c.

One of the main goals of $\overline{\text{P}}$ANDA is the detailed investigation of the spectrum of charmonia and charmonium-like hybrids. Compared to the the light meson spectrum, the charmonium spectrum is well separated, providing a clean environment to search for non-conventional states. States with exotic J^{PC} can be made in associated formation processes: $p\bar{p} \to mh$, where m is a light meson (π, η) and h is a charmonium hybrid.

Lattice QCD calculations predict the ground-state hybrid charmonium to be a spin exotic with quantum numbers of $J^{PC} = 1^{-+}$ at a mass of around 4.3 GeV/c^2. Its width is expected to be around 20 MeV/c^2 due to the dynamical suppression of its decay into open charm.

The talk will present a preliminary feasibility study for a measurement of the most probable decay channels of this hybrid charmonium candidate performed with PANDARoot, the common simulation framework for such studies of the $\overline{\text{P}}$ANDA experiment.

This work is supported by HFHF and BMBF.

HK 31.5 Tue 17:15 HK-H8

Pentaquark search in $\Lambda_b^0 \to \Lambda_c^+\bar{D}^{*0}K^-$ decays with missing neutrals — •Mindaugas Sarpis — University of Bonn, Bonn, Germany

Charmonium-pentaquarks, P_c, were observed by LHCb in 2015 and 2019 as resonances in the $J/\psi p$ final state from $\Lambda_b \to J/\psi pK^-$ decays. The nature of these resonances is not yet fully understood, but their proximity to baryon-meson thresholds, like $\Sigma_c\bar{D}^{*0}$, motivate 'molecular' pentaquark models. Several phenomenological studies predict large branching fractions for the decay of $P_c \to \Lambda_c^+\bar{D}^{*0}$. The ratio of branching fraction of the exclusive $\Lambda_b^0 \to \Lambda_c^+\bar{D}^{*0}K^-$ channel with respect to $\Lambda_b^0 \to \Lambda_c^+D_s$ was measured to be $0.569\pm0.015\pm0.017\pm0.016$, where the first uncertainty is statistical, the second systematic, and the third due to the uncertainty on the D branching fractions. Due to the low reconstruction efficiency of π^0 or γ candidates in the decay $\bar{D}^{*0} \to \bar{D}^0\pi^0/\gamma$, a kinematic over-constraint method, Extended Cone Closure, is employed to reconstruct the four-momentum of the $\bar{D}^{*0}$ and be able to study the Dalitz plot of $\Lambda_c^+\bar{D}^{*0} - \bar{D}^{*0}K^-$. A model independent approach using Legendre moments analysis and the limit setting procedure for the upper limit on P_c yield is presented.

HK 31.6 Tue 17:30 HK-H8

Measuring Generalized Distribution Amplitudes from the $\overline{p}p \to \gamma\gamma$ and $\overline{p}p \to \pi^0\gamma$ channels with $\overline{\text{P}}$ANDA at FAIR — •Faiza Khalid, Stefan Diehl, and Kai-Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen 35392, Germany

The future PANDA experiment at FAIR with the HESR antiproton beam provides unique possibilities to study the 3D nucleon structure with exclusive channels in $\overline{p}p$ annihilation. Among of the channels of interest for the measurement of Generalized Distribution Amplitudes (GDAs) are $\overline{p}p \to \gamma\gamma$ and $\overline{p}p \to \pi^0\gamma$. Several simulations at center-of-mass energies squared of, $s = 2.5\ \mathtt{GeV}^2$, $s = 5\ \mathtt{GeV}^2$, $s = 10\ \mathtt{GeV}^2$ and $s = 15\ \mathtt{GeV}^2$, were done for these two signal channels and for their associated background channel(s) to check the feasibility of the measurement. The talk will present the feasibility study for the measurement of the $\cos(\theta)$ dependence of the differential cross-section for $\overline{p}p \to \pi^0\gamma$ and $\overline{p}p \to \gamma\gamma$ at different integrated luminosities. The cross sections have been estimated based on data, which is available in a limited kinematic range from the E760 experiment at Fermilab. Results of count rate estimates and estimates of the expected statistical uncertainty for different integrated luminosity values as well as the signal to background ratio will be presented. Different event selection cuts have been investigated to optimize the signal to background ratio while keeping a reasonable reconstruction efficiency.

The work is supported by BMBF and HFHF.

HK 32: Hadron Structure and Spectroscopy VI

Time: Tuesday 16:00–17:30 Location: HK-H9

Group Report HK 32.1 Tue 16:00 HK-H9

The ComPWA project: amplitude analysis with symbolic expressions and multiple computational backends — •Remco de Boer[1], Miriam Fritsch[1], Klaus Götzen[3], Wolfgang Gradl[2], Sebastian Jäger[1], Mathias Michel[2], Klaus Peters[3], Stefan Pflüger[1], Peter Weidenkaff[2], and Leonard Wollenberg[1] — [1]Ruhr-Universität Bochum — [2]Johannes Gutenberg Universität Mainz — [3]GSI Helmholtzzentrum Darmstadt

The search for conventional and exotic hadronic states is a challenging endeavour that has seen significant progress in the past decade. One of the most important techniques for identifying and classifying these states is Partial Wave Analysis. PWA is, however, notoriously difficult, as it requires a thorough understanding of several aspects in particle physics, as well as High Performance Computing. The ComPWA project makes PWA easier to understand and implement with a collection of modern Python libraries. One of the highlights of the project is the ability to express amplitude models as symbolic mathematical formulas that can be inspected and adapted to the specific requirements of an analysis. These expressions not only offer a comprehensible experience of analysing a particle reaction, but also serve as templates to computational backends like TensorFlow that can efficiently fit the model to large data samples.

HK 32.2 Tue 16:30 HK-H9

Quenched glueball spectrum from functional equations — •Markus Huber[1], Christian Fischer[1,2], and Helios Sanchis-Alepuz[3] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionen- forschung, Campus Gießen, 35392 Gießen, Germany — [3]Silicon Austria Labs GmbH, Inffeldgasse 33, 8010 Graz, Austria

We give an overview of results for the quenched glueball spectrum from two-body bound state equations based on the 3PI effective action. The setup, which uses self-consistently calculated two- and three-point functions as input, is completely self-contained and does not have any free parameters except for the coupling. The results for $J^{PC} = 0^{\pm+}, 2^{\pm+}, 3^{\pm+}, 4^{\pm+}$ are in good agreement with recent lattice results where available.

HK 32.3 Tue 16:45 HK-H9

Chiral EFT of nucleons and pions in the presence of external gravitational field — •Herzallah Alharazin, Dalibo Djukanovic, Jambul Gegelia, and Maxim Polyakov — Ruhr-University Bochum

Effective chiral Lagrangian of nucleons and pions in external gravitational field and the corresponding energy-momentum tensor will be considered. Gravitational form factors of the nucleon and their relation to internal forces will be discussed.

HK 32.4 Tue 17:00 HK-H9

Electromagnetic form factors of the nucleon in $N_\mathrm{f} = 2+1$ lattice QCD — Dalibor Djukanovic[1,2], Georg von Hippel[3], Harvey B. Meyer[1,2,3], Konstantin Ottnad[3], •Miguel Salg[3], Jonas Wilhelm[3], and Hartmut Wittig[1,2,3] — [1]Helmholtz Institute Mainz, Staudingerweg 18, 55128 Mainz, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [3]PRISMA$^+$ Cluster of Excellence and Institute for Nuclear Physics, Johannes Gutenberg University of Mainz, Johann-Joachim-Becher-Weg 45, 55128 Mainz, Germany

We present results for the electromagnetic form factors of the nucleon computed on the Coordinated Lattice Simulations (CLS) ensembles with $N_\mathrm{f} = 2+1$ flavors of $\mathcal{O}(a)$-improved Wilson fermions and an $\mathcal{O}(a)$-improved conserved vector current. From the Q^2-dependence of the form factors, we determine the electric and magnetic charge radii and the magnetic moment of the proton. In order to estimate the excited-state contamination, we employ several source-sink separations and apply the summation method. The quark-disconnected diagrams entering into the isoscalar quantities are computed explicitly. For this purpose, a stochastic estimation based on the one-end trick is performed, in combination with a frequency-splitting technique and the hopping parameter expansion. By these means, we obtain a clear signal for the form factors including the quark-disconnected contributions, which have a statistically significant effect on our results.

HK 32.5 Tue 17:15 HK-H9

Lower-order contributions in three-particle femtoscopic correlation functions — •Philipp Schulze-Hagen — TUM, Munich, Germany

In recent years, the femtoscopy technique has been used by the ALICE Collaboration in small colliding systems at the LHC to investigate the strong interaction between hadron pairs. The extension of this experimental technique to the three-particle case aims to deliver the first measurements of genuine three-hadron interactions in the next years. To this end, the two-body effects in the three-particle correlation functions have to be properly accounted for. A recently introduced approach, known as the projector method, combined with the cumulant expansion rule, allows the calculations of such lower-order contributions by projecting known two-particle correlation functions on the three-body phase space. In this work, the relativistic generalization of the projector method will be presented and discussed in the specific case of p–p–π^- and p–p–π^+. It will be shown, in particular, that such method provides significantly smaller uncertainties with respect to the standard data-driven approaches in the extraction of the signal due to the genuine three-particle correlations.

HK 33: Nuclear Astrophysics II

Time: Tuesday 16:00–17:30 Location: HK-H10

Group Report HK 33.1 Tue 16:00 HK-H10

Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis — •Andreas Flörs[1], Luke Shingles[1], and Gabriel Martínez-Pinedo[1,2] — [1]GSI, Darmstadt, Germany — [2]TU Darmstadt, Darmstadt, Germany

It has long since been established that observable actinides in the universe originate from the r-process. In 2017, the electromagnetic counterpart to the gravitational wave detection of two merging neutron stars was observed. From the light curve alone it was possible to characterise two ejecta components: one that contains low-Y_e material such as lanthanides and possibly actinides, and a high-Y_e component with low lanthanide abundances. The dividing characteristic between the two components is the opacity of the material: lanthanides have a $\sim$100 times higher opacity than iron-group material. The opacity of actinides is expected to be on a similar level as that of the lanthanides, or, possibly, even higher.

To identify specific elements, spectroscopic information is required. However, so far no clear detection of individual lanthanides or actinides has been made in the only observed neutron star merger. A great challenge for spectroscopic modelling of kilonovae using radiative transfer codes is the almost non-existent atomic data currently available for lanthanides and actinides. I will present converged and, where possible, calibrated atomic structure calculations from Zr to U. I will then use this collection of atomic data to show how we can use radiative transfer simulations to identify signatures or place constraints on the amount of heavy r-process material synthesized in kilonovae.

HK 33.2 Tue 16:30 HK-H10

Long Term Evolution of Neutron Star Merger Ejecta — •Christian Schwebler[2,1], Gabriel Martínez-Pinedo[1,2,3], Andreas Bauswein[1], Oliver Just[1], and Ninoy Rahman[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany — [2]Institut für Kernphysik (Theoriezentrum), Fachbereich Physik, Technische Universität Darmstadt, Schlossgartenstraße 2, 64298 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

Binary neutron star mergers (BNS) are at the moment the most promising events for r-process nucleosynthesis. We simulate the long term properties of the dynamical merger ejecta, which are crucial for the nucleosynthesis, by three dimensional numerical-relativity simulations. Starting with initial data from BNS merger simulations, which typically cover timescales of milliseconds, our goal is to investigate the ejected material up to several days or weeks, the timescale in which the kilonova, the electromagnetic signal of a BNS merger, is detectable. We focus on the dynamical evolution and the impact of r-process heating on the material.

This project is supported and funded by HGS-Hire and the European Research Council (ERC) under the European Union's Horizon research and innovation programme (ERC Advanced Grant KILONOVA No. 885281)(ERC Starting Grant GreatMoves No.759253)

HK 33.3 Tue 16:45 HK-H10

Neural network reconstruction of the dense matter equation of state from neutron star observables — •Shriya Soma[1], Lingxiao Wang[1], Shuzhe Shi[2], Horst Stoecker[1], and Kai Zhou[1] — [1]Frankfurt Institute for Advanced Studies, Frankfurt am Main, Germany — [2]Stony Brook University, Stony Brook, New York, USA

The equation of state (EoS) of strongly interacting cold and ultra-dense matter still remains a major challenge in the field of nuclear physics. With the advancements in measurements of neutron star masses, radii and tidal deformabilities from electromagnetic and gravitational wave observations, neutron stars play an important role in constraining the EoS. In this work, we present a novel method that exploits deep learning techniques to reconstruct the dense matter EoS from mass-radius (M-R) observations of neutron stars. We employ neural networks (NNs) to represent the EoS in a model-independent way, within the range 1-7.4 times the nuclear saturation density. In an unsupervised manner, we implement the Automatic Differentiation (AD) framework to optimize the EoS, so as to yield an M-R curve that best fits the observations. We demonstrate the rebuilding of an EoS on mock data, i.e., M-R pairs derived from a generated set of polytropic EoSs. We show that it is possible to reconstruct the EoS with reasonable accuracy, using just 12 mock M-R pairs, which is nearly equivalent to the current number of observations. We finally deploy the NNs in the AD scheme on real M-R data, including the recent measurements from NICER, to infer the neutron star EoS and present the results hereof.

HK 33.4 Tue 17:00 HK-H10

Core-collapse supernova simulations with reduced nucleosynthesis networks — •Gerard Navo[1], Moritz Reichert[2], Martin Obergaulinger[2], and Almudena Arcones[1,3,4] — [1]Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany — [2]Departament d'Astronomia i Astrofísica, Universitat de València, Burjassot (València), Spain — [3]Helmholtz Forschungsakademie Hessen für FAIR, GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Core-collapse supernovae play a critical role in the chemical history of the universe. In recent years, huge advances have been reported about multidimensional simulations, magnetic fields, neutrino treatment and reactions, high-density equations of state, nucleosynthesis, and long-time evolution connecting to observations. Here we focus on the nucleosynthesis and their treatment within the simulations. Including large nuclear networks in multidimensional simulations is not feasible because of the computational expense. Therefore, often a simple treatment is used for the composition at temperatures where the nuclear statistical equilibrium can no longer be applied. We have now included reduced networks into state-of-the-art supernova simulations (Obergaulinger & Aloy 2017) to account for the composition and energy generation from nuclear reactions. I will present, the impact of several reduced networks based on multidimensional core-collapse supernovae simulations for different progenitors.

HK 33.5 Tue 17:15 HK-H10

Reevaluation of the cosmic antideuteron flux from cosmic-ray interactions and from exotic sources — •Laura Serksnyte[1], S. Königstorfer[1], I. Vorobyev[1], L. Fabbietti[1], D. M. Gomez Coral[2], P. von Doetinchem[2], J. Herms[3], A. Ibarra[1], T. Pöschl[1], A. Shukla[2], and A. Strong[4] — [1]TUM — [2]University of Hawaii at Manoa — [3]MPI für Kernphysik — [4]MPI for Extraterrestial Physics

The studies of antinuclei cosmic rays are of great interest as they represent one of the most promising indirect probes of exotic phenomena in our Galaxy such as dark matter annihilation and primodial black hole evaporation. However, the antinuclei cosmic rays also contain a background contribution from antinuclei produced in cosmic-ray collisions with the interstellar gas. In order to interpret any future measurement of the cosmic ray antinuclei fluxes, it is imperative to have a full understanding of the uncertainties involved from production to propagation. This requires a data driven estimation of the production and annihilation cross sections of antinuclei, as well as a state-of-the-art propagation model. We studied the antideuteron cosmic-ray flux using the GALPROP propagation model and we obtained the fluxes stemming from exotic sources and from cosmic-ray interactions. We used the most up-to-date antideuteron production cross sections and for the first time included a data-driven estimation of the inelastic antideuteron cross sections. In this talk we will present our results including an in depth study of the prevailing uncertainties such as antideuteron production modeling, propagation parameters and others.

HK 34: Invited Talks IV

Time: Wednesday 11:00–12:30 Location: HK-H1

Invited Talk HK 34.1 Wed 11:00 HK-H1
Nuclear equation of state constrained by nuclear physics, microscopic and macroscopic collisions — •Sabrina Huth — Institut für Kernphysik, TU Darmstadt — EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt

Interpreting high-energy, astrophysical phenomena, such as supernova explosions or neutron-star collisions, requires a robust understanding of matter at supranuclear densities. We present new equations of state where the parameter range of the energy-density functional underlying the equation of state is constrained by chiral effective field theory as well as by functional renormalization group computations based on QCD. We implement observational constraints from measurements of heavy neutron stars, the gravitational wave signal of GW170817, and NICER results. Thermal effects are captured by a novel effective mass parametrization. This has been shown to determine the proto-neutron star contraction in supernova simulations.

Additionally, we use Bayesian inference to combine data from astrophysical multi-messenger observations of neutron stars and from heavy-ion collisions with microscopic nuclear theory calculations to improve our understanding of dense matter. Our findings show that constraints from heavy-ion collision experiments show a remarkable consistency with multi-messenger observations and provide complementary information on nuclear matter at intermediate densities.

* This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) * Project-ID 279384907 * SFB 1245.

Invited Talk HK 34.2 Wed 11:30 HK-H1
Electromagnetic Counterparts of Neutron Star Mergers: Signatures of Heavy r-Process Nucleosynthesis — •Andreas Flörs[1], Luke Shingles[1], and Gabriel Martínez-Pinedo[1,2] — [1]GSI, Darmstadt, Germany — [2]TU Darmstadt, Darmstadt, Germany

It has long since been established that observable actinides in the universe originate from the r-process. In 2017, the electromagnetic counterpart to the gravitational wave detection of two merging neutron stars was observed. From the light curve alone it was possible to characterize two ejecta components: one that contains low-Y_e material such as lanthanides and possibly actinides, and a high-Y_e component with low lanthanide abundances. The dividing characteristic between the two components is the opacity of the material: lanthanides have a ~100 times higher opacity than iron-group material. The opacity of actinides is expected to be on a similar level as that of the lanthanides, or, possibly, even higher.

To identify specific elements, spectroscopic information is required. However, so far no clear detection of individual lanthanides or actinides has been made in the only observed neutron star merger. A great challenge for spectroscopic modeling of kilonovae using radiative transfer codes is the almost non-existent atomic data currently available for lanthanides and actinides. I will present converged and, where possible, calibrated atomic structure calculations from Zr to U. I will then use this collection of atomic data to show how we can use radiative transfer simulations to identify signatures or place constraints on the amount of heavy r-process material synthesized in kilonovae.

Invited Talk HK 34.3 Wed 12:00 HK-H1
Towards a next-generation LHC heavy-ion Experiment with ALICE — •Raphaelle Bailhache for the ALICE-Collaboration — Goether-universität Frankfurt am Main, Germany

Ultrarelativistic heavy-ion collisions are used to study the physics of strongly interacting matter under extreme conditions, i.e. high temperature and density, similar to those of the early universe. In such collisions a deconfined state of quarks and gluons, the Quark-Gluon Plasma (QGP), is formed. Nuclear collisions at the LHC provide access to the highest-temperature, longest-lived experimentally accessible QGP. After three years of Long Shutdown and intensive installation of detector and accelerator upgrades, ALICE is about to take data at a peak Pb–Pb collision rate of 50 kHz to further characterize the properties of this unique state of matter. In spite of the ambitious scientific programme for the upcoming Runs 3 and 4, crucial questions will still remain unanswered with the present detector concepts. Therefore, a next-generation LHC heavy-ion experiment ALICE 3 is proposed for the 2030s. Among others, this should give access to next-level measurements of electromagnetic probes down to unprecedented very low momenta and a clean reconstruction of heavy-flavour hadrons including multi charm states and exotic objects inaccessible in LHC Run 3 and 4. Such measurements call for a substantial increase in luminosity in combination with unprecedented detector performance.

In this talk, we will present the physics programme of ALICE and the resulting detector requirements. We will then discuss a detector concept suitable to meet these requirements.

HK 35: Heavy-Ion Collisions and QCD Phases VII

Time: Wednesday 14:00–15:30 Location: HK-H1

Group Report HK 35.1 Wed 14:00 HK-H1
Creation of fragile anti- and hyper- matter at the LHC — •Janik Ditzel for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität, Frankfurt, Germany

At the Large Hadron Collider at CERN, copious production of light (anti-)(hyper-)nuclei has been measured in Pb–Pb collisions by the ALICE collaboration. The production of such (anti-)(hyper-)nuclei has recently become a topic of high interest, connecting for instance to the possible strangeness content in neutron stars. The most prominent example is the (anti-)hypertriton, which is a bound state of a proton, a neutron and a Λ hyperon. These (anti-)(hyper-)nuclei are reconstructed by their decay products, e.g. in the case for the charged two-body decay channel of the hypertriton: ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He} + \pi^{-}$. The excellent performance of the ALICE apparatus provides a clear particle identification of the daughters and a perfect reconstruction of the decay vertex. Together with results on the production of light (anti-)nuclei, we will show the latest measurement of the Λ separation energy and lifetime of the (anti-)hypertriton and a comparison to different production models. Furthermore, we will show first results on the measurement of (anti-)hypernuclei within the A=4 mass region.

Supported by BMBF and the Helmholtz Association.

HK 35.2 Wed 14:30 HK-H1
Hypernuclei studies in heavy-ion collisions at CBM — •Susanne Glässel, Christoph Blume, and Enxhela Vardhami for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created, and even very rare double hypernuclei like ${}^{6}_{\Lambda\Lambda}\mathrm{He}$ are expected. The reconstruction of hypernuclei was implemented into the CBM software PFSimple, which is based on the KFParticleFinder package. The reconstruction algorithm and parameters were optimized for the identification of hypernuclei with respect to important performance indicators. Expected efficiencies and signal-to-background-ratios were calculated for a reliable estimation of the number of reconstructable hypernuclei. Rapidity dependencies of these performance indicators were analyzed to identify the detector areas with an high efficiency for hypernucei measurements. The experimental sensitivity to properties of hypernuclei, such as their lifetime, was evaluated. Results for ${}^{3}_{\Lambda}\mathrm{H}$ will be discussed as an example. DFG-grant BL 982/3-1, DFG-grant BR 4000/7-1.

HK 35.3 Wed 14:45 HK-H1
Studies on hypertriton reconstruction in heavy-ion collisions at CBM — •Enxhela Vardhami, Christoph Blume, and Susanne Glässel for the CBM-Collaboration — IKF, Frankfurt

Under the extreme conditions of relativistic heavy-ion-collisions the creation of exotic matter like hypernuclei is possible. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. At beam energies of around 12A GeV, in combination with high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created. The reconstruction of hypertriton was studied with the CBM software PFSimple. Focus was placed on the most probable 3-body-decay ${}^{3}_{\Lambda}\mathrm{H} \rightarrow d+p+\pi^{-}$ (branching ratio = 40.2 %). Different cuts were evaluated with regards to their performance indicators like efficiency, signal-to-background-ratio and significance. To further improve the reconstruction performance and speed, the correlations between several cuts were analyzed. A systematic study of cut combinations was performed to prepare optimized sets of cuts for various study purposes, eg. high efficiency, high background suppression or for different particle identification approaches.

HK 35.4 Wed 15:00 HK-H1

Extending strong-interaction studies in ALICE to nuclei: measurement of proton-deuteron and Lambda-deuteron correlations — •Bhawani Singh[1] and Michael Jung[2] for the ALICE-Collaboration — [1]Technische Universität München — [2]Goethe-Universität Frankfurt am Main

In the endeavour to explore the strong interaction among hadrons, ALICE has for the first time extended its femtoscopic studies to nuclei. The large data sample of high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV allows us to measure both the proton–deuteron (p–d) and the Lambda–deuteron (Λ–d) momentum correlations.

In this contribution, the measured correlation functions for p–d and Λ–d are presented and compared to theoretical predictions. A large discrepancy between data and theory is observed in the case of p–d correlations, where the data show a depletion at low relative momenta, while the models predict a strong attractive signal. Possible explanations include a late formation of the deuterons and the formation of a bound state. The Λ–d correlation is in agreement with no observed interaction, supporting the findings in p–d, but the current data would also allow for a remaining strong-interaction signal. Future measurements by ALICE in the upcoming LHC Run 3 will help to shed more light on the sector of nuclei in femtoscopy.

HK 35.5 Wed 15:15 HK-H1

Measurement of the Λ separation energy in hypertriton with ALICE using machine learning techniques — •Regina Michel for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwer-ionenforschung — Technische Universität Darmstadt

Hypertritron ${}^{3}_{\Lambda}$H is the lightest hypernucleus, consisting of a Λ hyperon, a proton and a neutron. It is structured as a halo nucleus, where the Λ hyperon is very loosely bound to a "deuteron core". Measurements of the Λ separation energy can be used as a test for QCD, for some models of neutron stars and to constrain the difference of the lifetimes of ${}^{3}_{\Lambda}$H and Λ. The Λ separation energy can be measured via the invariant mass of the hypertriton decay products. The two-body-decay ${}^{3}_{\Lambda}\mathrm{H} \rightarrow {}^{3}\mathrm{He}+\pi$ is considered. Monte Carlo simulations are conducted to simulate the hypertriton interactions and decays while flying through the detector. A data sample from Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV recorded with ALICE at the LHC is analyzed using machine learning techniques.

HK 36: Heavy-Ion Collisions and QCD Phases VIII

Time: Wednesday 14:00–15:30 Location: HK-H2

Group Report HK 36.1 Wed 14:00 HK-H2

Charged pion emission from central heavy-ion collisions measured with HADES — •Marvin Nabroth for the HADES-Collaboration — Goethe-Universität Frankfurt, Frankfurt, Germany

Relativistic heavy-ion collisions provide an experimental tool to generate strongly interacting matter that exhibits extreme densities and high temperatures. With the HADES (High-Acceptance-Dielectron-Spectrometer) experiment the emission of several particle species including di-leptons, originated from a heavy-ion collisions are probed at SIS18 energies at a few GeV. Pions are, due their low mass, the most abundantly emitted mesons. Especially, charged pions can be easily detected by magnet-spectrometry. The resulting high statistics allow to precisely determine their production multiplicities as function of participants, to investigate the condition at the kinematic freeze-out as well as to examine anisotropies in the collective emission behaviour. The fact that the charged pion's spectra are experimentally covered still with high abundance at low transverse momenta makes them a suitable probe for the investigation in regard of the Coulomb effect. Within the scope of this talk, we will discuss the recent published results on charged pions from Au+Au collisions at $\sqrt{s_{NN}} = 2.4\ GeV$ as well as the ongoing analyis regarding charged pions from Ag+Ag collisions at $\sqrt{s_{NN}} = 2.55\ GeV$. Covered are the measured production rates, the results on directed, elliptic and triangular anisotropic flow and the determination of the Coulomb potential. This work has been supported by BMBF (05P19RFFCA), GSI and HIC for FAIR.

HK 36.2 Wed 14:30 HK-H2

Charged-particle production in pp collisions at $\sqrt{s}$ = 900 GeV with LHC Run 3 ALICE data — •Peter Stratmann for the ALICE-Collaboration — Westfälische Wilhelms-Universität Münster, Germany

The ALICE experiment at the Large Hadron Collider (LHC) is designed to investigate properties of the quark-gluon plasma (QGP) created in high-energy heavy-ion collisions. Medium effects can be investigated by comparing to the charged-particle production in pp collisions, where no QGP is expected. In the upcoming LHC Run 3, the ALICE collaboration prepares to collect Pb–Pb data at unprecedented peak-collision rates of about 50 kHz. To accomplish this, the main tracking detectors underwent fundamental upgrades and a brand new reconstruction and analysis framework was developed.

In this talk, we present one of the first measurements performed with these new detectors and software. We investigate the bulk particle production in pp collisions at $\sqrt{s}$ = 900 GeV observed in data taken during a five day pilot beam in the end of October 2021. We discuss the tracking performance and show the correlation of p_{T} spectra with multiplicity for inclusive charged particles obtained with a 2d unfolding procedure that was already used in a comprehensive analysis of Run 1 and Run 2 data. These first results are compared to minimum bias spectra of inclusive charged particles at the same energy, which were among the first measurements when ALICE started taking data.

Supported by BMBF within the ERuM framework and the Helmholtz Association.

HK 36.3 Wed 14:45 HK-H2

Light (anti-)nuclei production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV measured with ALICE — •Malavika Panikkassery Salvan for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — Technische Universität Darmstadt

The production mechanism of light (anti-)nuclei in heavy-ion collisions is not yet fully understood and is under debate in the scientific community. Two prominent phenomenological models typically used to describe the experimental data are: the statistical hadronization model (SHM) which assumes that all hadrons are emitted from a thermal source in local thermal and hadrochemical equilibrium, and the coalescence model where the baryons close to each other in phase space form a nucleus at the kinetic freeze-out.

The ratio of integrated yields of (anti-)deuterons to (anti-)protons in heavy-ion collisions is sensitive to the production mechanism as the two models predict different trends.

In this contribution, the deuteron-to-proton yield ratio measured in central (0-10%) Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE is presented and the results are discussed in the context of the two phenomenological models.

HK 36.4 Wed 15:00 HK-H2

Charged-particle p_{T} spectra as a function of multiplicity in pp, p–A and A–A collisions measured with ALICE — •Youssef El Mard Bouziani for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment focuses on the study of the hot and deconfined QCD medium, the Quark-Gluon Plasma (QGP), by investigating heavy-ion collisions at ultra-relativistic energies. Particle production in different collision systems can be examined by means of the correlation between charged-particle transverse momentum (p_T) spectra and the event multiplicity.

In this talk, a differential analysis of charged-particle p_{T} spectra as a function of charged-particle multiplicity density is presented. The spectra are obtained by means of a 2-dimensional unfolding procedure. The energy and system-size dependence of charged-particle production is inspected studying the correlation of p_{T} and charged multiplicity in different collision systems and center-of-mass energies. In particular, resulting spectra measured in pp, p–Pb, Pb–Pb and Xe–Xe collisions are considered. Comparisons of the measurements to predictions from Monte-Carlo event generators are reported.

Supported by BMBF and the Helmholtz Association.

HK 36.5 Wed 15:15 HK-H2

Study of the production mechanism of light nuclei in small systems at the LHC with ALICE — •Luca Barioglio[1] and Michael Habib[2,3] for the ALICE-Collaboration — [1]Technische Universität München, Garching bei München, Deutschland — [2]GSI, Darmstadt, Deutschland — [3]Technische Universität Darmstadt, Darmstadt, Deutschland

At the LHC, an abundant production of light (anti)nuclei is observed in all collision systems and at all energies. However, their production mechanism is still under debate in the scientific community. The ALICE Collaboration has recently published the measurement of the production of (anti)deuteron and (anti)helion in pp collisions at $\sqrt{s}$ = 5 TeV and at $\sqrt{s}$ = 13 TeV.

In this presentation, the measurement of the coalescence parameter B_A, both as a function of transverse momentum and as a function of multiplicity, and the measurement of the yield-ratios of nuclei and protons as a function of multiplicity will be shown. In particular, B_A as a function of the transverse momentum is, for the first time, compared with theoretical predictions which take into account both the nuclear wave function and the dependence on the size of the emitting source.

HK 37: Instrumentation IX

Time: Wednesday 14:00–15:30 Location: HK-H3

Group Report HK 37.1 Wed 14:00 HK-H3

The new Sampling-ADC readout of CBELSA/TAPS - Feature-Extraction, Pulseshape-Analysis and Pile-Up-Recovery — •Jan Schultes, Benedikt Otto, and Johannes Müllers for the CBELSA/TAPS-Collaboration — HISKP, Uni Bonn

The Crystal Barrel Calorimeter consists of 1320 CsI(Tl) scintillating crystals, which are read out by APDs. The signals are digitized using FPGA-controlled Sampling-ADCs.

Different feature-extraction algorithms are employed on the FPGAs to not only extract energy and timing information, but to perform online pile-up detection as well. In addition to the feature data, the sampled pulseshape can be stored in case of a detected pile-up event, to facilitate the recovery of affected features.

The talk's main focus lies on the subsequent analysis of the data and various custom methods developed to efficiently and accurately recover the features affected by pile-up. Since CsI(Tl) exhibits different scintillation characteristics dependent on the particle species, special care has to be taken in order to address this in the recovery process. Digital filtering as well as custom deconvolution methods are employed.

Finally, the setup's performance during the recent June2021 and November2021 beamtimes and the impact of the recovered data on the reconstruction of physical events is evaluated.

HK 37.2 Wed 14:30 HK-H3

Detector Readout Algorithms and Data Flow Programming on FPGAs with Intel HLS — •Thomas Janson and Udo Kebschull — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, Frankfurt am Main, Germany

We discuss an alternative approach to implementing algorithms for detector readout with FPGAs. The talk is a continuation of past presentations and discusses the implementation of various algorithms that can be implemented on Intel FPGAs using Modern C++. The algorithms are implemented using a data flow C++ template library that we developed specifically for this use case of detector readout. We show how generic template programming can be used to describe algorithms as a data flow graph and compare the results with the conventional HLS C++ programming technique. Metrics such as latency, flow and resource consumption are discussed and compared. The results are then compared and evaluated with the traditional method, which implements algorithms using a hardware description language such as Verilog or VHDL.

HK 37.3 Wed 14:45 HK-H3

Investigations and improvements of the TRB3/DiRICH DAQ system used for the PANDA Barrel DIRC — •Merlin Böhm, Katja Gumbert, Steffen Krauss, Albert Lehmann, and Daniel Miehling for the PANDA-Collaboration — Physikalisches Institut , Universität Erlangen-Nürnberg

To identify charged and fast moving particles two DIRC (detection of internally reflected Cherenkov light) detectors will be built for the PANDA experiment at FAIR. A Barrel DIRC of 16 sectors surrounds the interaction point cylindrically and an endcap disc DIRC made of four identical quadrants covers the forward hemisphere. Since the focal planes of both DIRCs are located in a $\gtrsim$ 1 Tesla B-field, Microchannel-Plate Photomultipliers (MCP-PMTs) are the only viable option to detect the generated Cherenkov photons. For the Barrel DIRC the FPGA based GSI TRB3/DiRICH data acquisition system is foreseen to read out the MCP-PMTs. Several improvements were applied to improve the performance of this DAQ system. E.g., with modifications of the power supply for the FPGAs on the TRB3 boards the timing precision was improved significantly. Furthermore, the TRB/DiRICH boards planned for the final PANDA experiment were operated in magnetic fields up to 3 T to investigate the B-field effects on the thresholds and pulse heights and different input stage modifications were tested. The recent modifications and the obtained measurement results will be shown and discussed in this talk.

- Funded by BMBF and GSI -

HK 37.4 Wed 15:00 HK-H3

The front-end signal path of the P2 experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], Kathrin Imai[1], •Rahima Krini[1], Frank Maas[1,2], David R. Pineiro[2], Tobias Rimke[1], and Malte Wilfert[1] — [1]Institute for Nuclear Physics, Mainz, Germany — [2]Helmholtz Institute Mainz, Germany

The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with an accuracy of 0.15% at a low four-momentum transfer of Q^2=4.5·10^{-3}GeV^2. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz.

The small asymmetries $\mathcal{O}(10^{-8})$ and the high precision require very high statistics and therefore an integrating measurement with the associated integrating data acquisition readout chain. A joint read-out electronics for P2 experiment in Mainz and for Moeller experiment at the Jefferson Laboratory is under development in collaboration with a group of University of Manitoba. The first prototype of a full differential integrating detector signal chain was build and tested at MAMI (Mainzer Mikrotron). The results fulfill the requirements of the P2 parity violation experiment and will be presented in this talk.

HK 37.5 Wed 15:15 HK-H3

Streaming readout for the AMBER GEM detectors — •Michael Lupberger[1], Chiara Alice[2], Lukas Bayer[1], Karl Jonathan Flöthner[1,3], Christian Honisch[1], Marco Mignone[4], Jan Paschek[1], Benjamin Roth[1], Dimitri Schaab[1], Maxim Alexeev[2], and Bernhard Ketzer[1] — [1]Universität Bonn — [2]CERN — [3]Universita e INFN sez. Torino — [4]INFN sez. Torino

The Apparatus for Meson and Baryon Experimental Research (AMBER) will be a fixed-target experiment at CERN's SPS. In the approved phase I of the experiment, running also under the name NA66, a proton radius measurement by elastic muon-proton scattering is foreseen in 2023 and 2024. The recoil proton will be measured in a high-pressure Time Projection Chamber (TPC). The muon kinematics is determined with a spectrometer, which partly uses the existing COMPASS detectors.

Due to the higher beam rate and the need for a continuous readout to match the instantaneous muon track with delayed information of the recoil proton in the TPC, significant detector upgrades and novel developments are necessary. The muon reconstruction will rely on new large-area GEM detectors with self-triggering readout. Tests of prototype detectors with two possible candidate ASICs, the VMM and the TIGER chips, have been performed in order to evaluate their performance.

The contribution will report on the results of the tests of the GEM detectors with the new streaming readout.

HK 38: Instrumentation X

Time: Wednesday 14:00–15:30 Location: HK-H4

Group Report HK 38.1 Wed 14:00 HK-H4

Status of the CBM Time-of-Flight project — •Ingo Deppner and Norbert Herrmann — Physikalisches Institut, Uni. Heidelberg

In order to provide an excellent particle identification (PID) of charged hadrons at the future high-rate Compressed Baryonic Matter (CBM) experiment the CBM-TOF group has developed a concept of a 120 m^2 large Time-of-Flight (ToF) wall (with 93000 channels) equipped with multi-gap resistive plate chambers (MRPC). The MRPC detectors were extensively tested in several beam campaigns at particle fluxes of up to a 30 kHz/cm^2 and reached by now the close to final design. Prior to its destined operation at the Facility for Antiproton and Ion Research (FAIR), a preproduction series of MRPCs is being used for physics research at two scientific pillars of the FAIR Phase-0 program. At STAR, the fixed-target program of the Beam Energy Scan II (BES-II) relies on 108 CBM MRPC detectors for forward PID at interaction rates of up to 2.5 kHz with 3 to 31.2 AGeV Au beams. At mCBM, high-performance benchmark runs of Λ production at top SIS18 energies (1.5/1.9 AGeV for Au/Ni beams) and CBM design interaction rates of 10 MHz became feasible. Apart from the physics perspectives, these FAIR Phase-0 involvements allowed for high rate detector tests and long term stability tests. Observations and conclusions for the upcoming mass production will be discussed. The project is partially funded by BMBF contract 05P21VHFC1.

HK 38.2 Wed 14:30 HK-H4

Inner-TOF, a Trigger Scintillator for HADES — •Dieter Grzonka[1], Pawel Kulessa[2], James Ritman[2,3,1], Thomas Sefzick[1], and Marcin Zielinski[4] — [1]Institut für Kernphysik, Forschungszentrum Jülich, 52428 Jülich, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [3]Ruhr-Universität Bochum, Institut für Experimentalphysik I, 44801 Bochum, Germany — [4]Jagiellonian University, 30-348 Krakow, Poland

In order to reduce the trigger rate originating from background in proton induced reaction studies at the HADES experiment an additional trigger scintillator was built. It consists of large trapezoidal shaped modules (height~730mm, long side~700mm, short side~90mm) containing three separate plastic scintillator plates with a thickness of about 6 mm, which are read out by 6x6 mm^2 SiPMs. Each scintillator is equipped with 12 SiPMs attached to the scintillator edge. A trigger signal is generated by exceeding a certain SiPM signal multiplicity resulting in a close to 100% efficiency for the detection of a minimum ionizing particle which was investigated with cosmic particles and proton beams at COSY. The detector system and its performance will be presented.

HK 38.3 Wed 14:45 HK-H4

Development of a coincidence time resolution (CTR) setup for measuring timing characteristics of scintillation materials utilizing SiPMs — •Marvin Peter, Kai-Thomas Brinkmann, Valera Dormenev, and Hans-Georg Zaunick — II. Physikalisches Institut, Justus-Liebig-Universität Giessen, Germany

Coincidence time resolution (CTR) measurements have been conducted with different SiPM-based scintillation detectors. The results of measurements with a Raspberry Pi time-to-digital converter (TDC) board based on the TDC-GPX2 chip from Sciosense are compared to those obtained by using a high sampling rate oscilloscope. The goal was to find an optimum setup for fast timing measurements which will be used in the evaluation of new scintillation materials regarding their timing characteristics. Measurement setup, methods and results are discussed in this contribution. This work was carried out in the framework of BMBF Project 05K2019 - UFaCal.

HK 38.4 Wed 15:00 HK-H4

Deployment of digital fast-timing method for picosecond precision lifetime measurements using the NuDAQ system at IKP Cologne — •Andreas Harter, Jean-Marc Régis, Michael Weinert, Lukas Knafla, and Jan Jolie — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The comissioning of the NuDAQ digital data acquisition system built at the Institute for Nuclear Physics in Cologne is presented. Special regard is set on the ability of high-precision timing of the incoming detector pulses using a digital timing algorithm. Usually, analogue constant-fraction-discriminators (CFDs) and time-to-amplitude converters (TACs) are used to provide a timing signal with precision of around 1 ps or even better (dependent on the DAQ). However, the complexity of an analogue fast-timing electronics setup increases rapidly with the number of detectors. The digital CFD integrated in the V1730 digitizer modules with a sampling rate of 500 MHz uses a digital algorithm to determine a time stamp of an incoming signal with a precision of 2 ps [1]. Our results using the γ-γ timing technique impressively show that this easy-to-use digitizer using the sophisticated timing algorithm is competitive to the conventional analogue timing technique.

[1] CAEN SpA, https://www.caen.it/products/v1730/

HK 38.5 Wed 15:15 HK-H4

Performance status for the endcap-time-of-flight upgrade of STAR — •Philipp Weidenkaff — Ruprecht-Karls-Universität Heidelberg

As part of the FAIR phase 0 program, CBM-ToF MRPC modules have been installed as endcap-time-of-flight detectors in STAR for the beam-energy-scan II (BES II) program from 2019 to 2021. These detectors provide a major improvement to the particle identification capability of the experiment in the forward region ($1.0 < \eta < 1.5$), which is especially necessary for the fixed target program. In this talk, an evaluation of PID capabilities and physics performance improvements is shown. The results are based on the 2020 fixed target run.

The project is partially founded by BMBF 05P15VHFC1.

HK 39: Computing II

Time: Wednesday 14:00–16:00 Location: HK-H5

HK 39.1 Wed 14:00 HK-H5

Machine Learning Algorithms for Pattern Recognition with the PANDA Barrel DIRC — •Yannic Wolf — GSI Helmholtzzentrum für Schwerionenforschung

Precise and fast hadronic particle identification (PID) is crucial to reach the physics goals of the PANDA detector at FAIR. The Barrel DIRC (Detection of Internally Reflected Cherenkov light) is a key detector for the identification of charged hadrons in PANDA. Several reconstruction algorithms have been developed to extract the PID information from the measured location and arrival time of the Cherenkov photons. In comparison to other Ring Imaging Cherenkov detectors, the hit patterns observed with DIRC counters do not appear as rings on the photosensoer plane but as complex, disjoint 3D-patterns.

Using the recent advances in machine learning (ML) algorithms, especially in the area of image recognition, we plan to develop new ML PID algorithms for the PANDA Barrel DIRC and compare the results to conventional reconstruction methods.

HK 39.2 Wed 14:15 HK-H5

Event Analysis for the FAIR Phase-0 Experiment at MAMI — •Julian Moik[1], Luigi Capozza[1], Alaa Dbeyssi[1], Alexander Greiner[1], Samet Katilmis[1,2,3], Dong Liu[1], Frank Maas[1,2,3], Oliver Noll[1,2], Peter Bernd Otte[1], David Rodriguez Pineiro[1], Christoph Rosner[1], and Sahra Wolff[1] for the PANDA-Collaboration — [1]Helmholtz-Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz,Germany — [3]PRISMA Clus- ter of Excellence, Mainz, Germany

The PANDA experiment at the future FAIR facility requires a complex detector system, whose backward calorimeter is being developed by the EMP group at the Helmholtz Institute in Mainz. A preliminary version of this detector will be used in a PANDA FAIR Phase-0 experiment at the electron accelerator MAMI for a measurement of the electromagnetic transition form factor of the neutral pion.

Primasoft is a Geant4 based Monte Carlo simulation environment designed specifically for this experiment. By working with simulated pion events, analysis methods can be developed while the experiment is still under construction. In this context a neural network was developed to assist in the event reconstruction process. More specifically a feed forward network was implemented to improve the position reconstruction and the energy estimation of measured particles, thereby improving the error of the kinematic variables.

HK 39.3 Wed 14:30 HK-H5

Using Neural Network regression to describe the expected energy loss in the ALICE TPC in Run3 — •Christian Sonnabend for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

The ALICE experiment at CERN uses the largest Time Projection Chamber (TPC) built to date to identify particles that are created in collisions at the LHC. Particle identification is done by simultaneous measurement of the specific energy loss ($\mathrm{d}E/\mathrm{d}x$) and momentum (p) of the traversing particles, and comparison to the expected energy loss described by a Bethe-Bloch function. However, in practice, the expected $\mathrm{d}E/\mathrm{d}x$ cannot be described by a simple one-dimensional function, but several effects have to be taken into account. E.g. the inclination angle of a particle track has an effect on the charge deposited in a given region of the TPC readout, thus changing its $\mathrm{d}E/\mathrm{d}x$ signal (η-correction (pseudorapidity)). In order to correct for such effects, fits to a multidimensional parameter space consisting of e.g. p, η, multiplicity or particle mass are performed to adjust the expected $\mathrm{d}E/\mathrm{d}x$ signals of the tracks.

With the application of Machine Learning in particle physics, new methods can be exploited to extract such functional forms. Thus, a variety of neural network fits to data are conducted to investigate their performance and compare their ability to describe deviations of the expected energy loss from an input Bethe-Bloch parametrisation in a multi-dimensional space.

HK 39.4 Wed 14:45 HK-H5

Reconstruction of Photon Conversions with the ALICE Transition Radiation Detector — •Martin Kroesen for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

So called direct photons give us an undisturbed insight to the Quark Gluon Plasma created in relativistic heavy ion collisions. A huge statistics is needed for this analysis since the background is large and the reconstruction efficiency via the Photon Conversion Method (PCM) relatively low. Therefore the ALICE Transition Radiation Detector (TRD), which is located at a radius of about 3 m, is now employed for photon reconstruction using the PCM. It is shown that it is possible to reconstruct these photons with the TRD information only. This enables an increase of the total photon efficiency in ALICE as well as a cross check additional to the standard reconstruction of photon conversions in the Time Projection Chamber. For that purpose a full stand alone tracking algorithm using a combinatorial search was developed. Based on TensorFlow a high precision photon hypothesis test and parameter fit completes the reconstruction by exploiting topological constraints. The stand alone TRD tracks can also be used for other purposes such as calibration or nuclear interaction analyses. First results from the p-Pb run in 2018 are presented, showing a peak for $\pi^0 \rightarrow \gamma\gamma \rightarrow e^+e^-e^+e^-$.

HK 39.5 Wed 15:00 HK-H5

Analysis status of ETOF at STAR — •Yannick Söhngen — Physikalisches Institut Universität Heidelberg

In 2025/2026 the CBM-Experiment will start operation at the SIS100, currently under construction at FAIR in Darmstadt. To facilitate a smooth start of physics analysis of the experiments at the SIS100 the FAIR Phase 0 program comprises the usage of pre-series equipment in running experiments. As part of the CBM-TOF FAIR Phase 0 program an Endcap-Time-Of-Flight (ETOF) wheel consisting of 108 RPC*s designed for the CBM-TOF wall, was operated at the STAR-Experiment located at RHIC at Brookhaven. This provides on the one hand the opportunity to study the impact of long periods of operation on the system and the detectors and thus helps to streamline the decision-making process for the CBM TOF-Wall. This provides on the one hand the opportunity to explore the physics reach of the installed counters with their superb timing resolution. Of special interest is the performance in the Fixed Target BESII campaign covering the available energy in the CMS range from 3GeV to 13GeV. The status of the data-analysis chain, integrating CBM-analysis elements, and its modeling in the STAR Monte-Carlo framework will be presented and discussed. Preliminary results for the production of the Phi meson and the Lambda baryon will be shown. The project is partially funded by BMF contract 05P21VHFC1.

HK 39.6 Wed 15:15 HK-H5

The PUNCH4NFDI consortium in the NFDI - status, first results, and outlook — •Thomas Schörner for the PUNCH4NFDI-Collaboration — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg

With the "Nationale Forschungsdateninfrastruktur" (NFDI, national research data infrastructure), a massive effort is undertaken in Germany to provide a coherent research data management, to make research data sustainably utilisable and to implement the FAIR data principles. PUNCH4NFDI is the consortium of particle, astro- and astroparticle, as well as hadron and nuclear physics within the NFDI. It aims for a FAIR future of the data management of its community and at harnessing its massive experience not least in "big data" and "open data" for the benefit of "PUNCH" sciences (Particles, Universe, NuClei and Hadrons) as well as for physics in general and the entire NFDI. In this presentation, we will introduce the work programme of PUNCH4NFDI, its connection to everyday work in the physical sciences and beyond, and in particular the idea of digital research products and the PUNCH science data platform.

HK 39.7 Wed 15:30 HK-H5

Simulation Method for Calculating the Summing Effect Correction Factor — •Yanzhao Wang, Jan Mayer, Felix Heim, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

γ-ray spectrometers have been utilized to investigate the radioactive properties of either activation or in-beam experiments since decades. One of the main problems undermining the measurement accuracy is called coincidence summing, which occurs when multiple γ-rays have energy depositions at the same detector almost simultaneously [1]. To offset this effect, correction factors on the initial γ-ray countings are calculated using the Geant4-based Monte Carlo simulation of consecutive emissions from all possible γ-ray cascades in the decay scheme. Compared to traditional analytical methods, the method presented in this talk does not only simplify the calculating procedure in case of complex decay schemes, but also is more accurate with the consideration of the Compton scattering in the detector volume.

Supported by the BMBF (05P21PKFN1).

[1] T.M. Semkow *et al.*, Nucl. Instrum. Methods Phys. Res. A **290** (1990) 437

HK 39.8 Wed 15:45 HK-H5

anan — ein Debugger für Hochleistungsrechner — •Alexander Adler — Goethe-Universität Frankfurt

Das Projekt anan ist ein Werkzeug zur Fehlersuche in verteilten Hochleistungsrechnern. Die Neuheit des Beitrags besteht darin, dass die bekannten Methoden, die bereits erfolgreich zum Debuggen von Soft- und Hardware eingesetzt werden, auf Hochleistungs-Rechnen übertragen worden sind. Im Rahmen der vorliegenden Arbeit wurde ein Werkzeug namens anan implementiert, das bei der Fehlersuche hilft. Außerdem kann es als dynamischeres Monitoring eingesetzt werden. Beide Einsatzzwecke sind getestet worden.

Das Werkzeug besteht aus zwei Teilen:

1. aus einem Teil namens anan, der *interaktiv* vom Nutzer bedient wird
2. und aus einem Teil namens anand, der *automatisiert* die verlangten Messwerte erhebt und nötigenfalls Befehle ausführt.

Der Teil anan führt *Sensoren* aus — kleine mustergesteuerte Algorithmen —, deren Ergebnisse per anan zusammengeführt werden. In erster Näherung lässt anan sich als Monitoring beschreiben, welches (1) schnell umkonfiguriert werden (2) komplexere Werte messen kann, die über Korrelationen einfacher Zeitreihen hinausgehen.

HK 40: Structure and Dynamics of Nuclei VI

Time: Wednesday 14:00–15:30 Location: HK-H6

Group Report HK 40.1 Wed 14:00 HK-H6

The Microscopic Structure of the Low-Energy Electric Dipole Response of ^{120}Sn — •Michael Weinert, Florian Kluwig, Markus Müllenmeister, Miriam Müscher, Barbara Wasilewska, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The low-energy electric dipole response of ^{120}Sn was studied in a ^{119}Sn(d,pγ)^{120}Sn experiment, using the SONIC@HORUS setup at the University of Cologne. Unprecedented access to the single-particle structure of excited $J^\pi=1^-$ states below and around the neutron-separation threshold was obtained by comparing experimental data to a novel theoretical approach that combines detailed nuclear structure input from energy-density functional (EDF) plus quasiparticle-phonon model (QPM) theory with reaction theory. The EDF+QPM approach correctly predicts the energies of the relevant neutron single-particle levels in ^{120}Sn and especially the fragmentation of the observed spectroscopic strength [1]. Furthermore, the EDF+QPM approach predicts the increasing contribution of complex configurations to states at higher excitation energies, which has been recently suggested as a cause for the discrepancy between (γ,γ') and (p,p') experiments [2,3]. This contribution will present the combined efforts and discuss possible connections between the spectral fragmentation observed in ^{119}Sn(d,pγ) and ^{120}Sn(α,α'γ). Supported by the DFG (ZI 510/10-1).

[1] M. Weinert *et al.*, Phys. Rev. Lett. **127**, 242501 (2021)
[2] S. Bassauer *et al.*, Phys. Rev. C **102**, 034327 (2020)
[3] M. Müscher *et al.*, Phys. Rev. C **102**, 014317 (2020)

HK 40.2 Wed 14:30 HK-H6

Electric dipole polarizability in ^{58}Ni from forward angle proton scattering — •Isabelle Brandherm[1], Peter von Neumann-Cosel[1], Hiroaki Matsubara[2], and Atsushi Tamii[2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]RCNP, Osaka, Japan

Inelastic proton scattering at very forward angles is an excellent tool for studying the dipole response in nuclei [1]. A (p,p') experiment on ^{58}Ni was performed at the Research Center for Nuclear Physics (RCNP) in Osaka, using a proton beam with 295 MeV and scattering angles close to 0°. With the present setup the electric dipole response is accessible over a wide excitation energy range. This enables the extraction of photoabsorption cross sections as well as the electric dipole polarizability. The latter is correlated to the neutron skin thickness and thus to the symmetry parameter of the equation of state. In addition the isovector spin-flip M1-response can be observed, which forms an isospin analogon to Gamow-Teller transitions. Electric and magnetic dipole contributions to the total experimental cross section were separated by performing a multipole decomposition analysis based on DWBA calculations.

[1] P. von Neumann-Cosel and A. Tamii, Eur. Phys. J. A 55, 110 (2019).

Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245.

HK 40.3 Wed 14:45 HK-H6

γ-decay of the Pygmy Dipole Resonance of ^{150}Nd — •O. Papst[1], J. Isaak[1], N. Pietralla[1], D. Savran[2], V. Werner[1], G. Battaglia[3], T. Beck[1,4], M. Beuschlein[1], S. W. Finch[5,6], U. Friman-Gayer[1,5,6], E. Hoemann[7], K. E. Ide[1], R. V. F. Janssens[6,8], N. Kelly[9], J. Kleemann[1], FNU Krishichayan[5,6], D. R. Little[6,8], B. Löher[2], M. Müscher[7], E. E. Peters[10], P. C. Ries[1], M. Scheck[9], J. Sinclair[9], M. Spieker[4], W. Tornow[5,6], S. W. Yates[10], R. Zidarova[1], and A. Zilges[7] — [1]IKP, TU Darmstadt — [2]GSI, Darmstadt — [3]U. Strathclyde, Glasgow, UK — [4]MSU, East Lansing, MI, USA — [5]Duke U., Durham, NC, USA — [6]TUNL, Durham, NC, USA — [7]IKP, U. Köln — [8]UNC, Chapel Hill, NC, USA — [9]UWS, Paisley, UK — [10]UKY, Lexington, KY, USA

The sensitivity of the Giant Dipole Resonance to axial nuclear deformation results in a separation into two parts (K-splitting). For heavy nuclei, low-lying E1 strength called Pygmy Dipole Resonance [1], often attributed to a semi-collective oscillation of a neutron skin, is expected to exhibit a similar sensitivity. Mean properties of the dipole strength of ^{150}Nd were studied using a new high-resolution mode of the High Intensity γ-ray Source (HIγS) in photon scattering experiments with polarized γ-ray beams below separation thresholds. For the first time for a heavy deformed nucleus, different mean decay branches to the ground-state band could be resolved individually in the Pygmy-region.

* Supported by the State of Hesse under grant "Nuclear Photonics" within the LOEWE program.

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70**, 210 (2013)

HK 40.4 Wed 15:00 HK-H6

Dipole response in ^{144}Nd — •Florian Kluwig[1], Miriam Müscher[1], Ronald Schwengner[2], Mark Spieker[3], Werner Tornow[4], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]Helmholtz-Zentrum Dresden-Rossendorf — [3]Department of Physics, Florida State University — [4]Department of Physics, Duke University and TUNL

For several years, the so-called Pygmy Dipole Resonance (PDR) has been a research topic of great interest [1,2]. It occurs as a concentration of electric dipole strength around and below the neutron separation energy. Systematic studies are essential to improve the knowledge of this excitation mode. For this purpose, the Nd isotopic chain is well-suited due to its wide range of stable, even-even isotopes. Therefore, two complementary (γ,γ') experiments on the rare-earth nucleus ^{144}Nd have been performed at the γELBE facility at the Helmholtz-Zentrum Dresden-Rossendorf [3] using a continuous bremsstrahlung beam and with quasi-monoenergetic γ rays at HIγS [4]. The results of these experiments will be presented in this contribution.

This work is supported by the BMBF (05P21PKEN9).

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210
[2] A. Bracco *et al.*, Prog. Part. Nucl. Phys. **106** (2019) 360
[3] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211
[4] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 40.5 Wed 15:15 HK-H6

γ-decay Behavior of the Giant Dipole Resonances of ^{154}Sm and ^{140}Ce — •J. Kleemann[1], U. Friman-Gayer[2,3], J. Isaak[1], N. Pietralla[1], V. Werner[1], A. D. Ayangeakaa[2,4], T. Beck[1,5], M. L. Cortés[1], S. W. Finch[2,3], M. Fulghieri[2,4], D. Gribble[2,4], K. E. Ide[1], X. James[2,4], R. V. F. Janssens[2,4], S. R. Johnson[2,4], P. Koseoglou[1], FNU Krishichayan[2,3], O. Papst[1], D. Savran[6], N. Sensharma[2,4], W. Tornow[2,3], and A. Williams[2,4] — [1]IKP, TU Darmstadt — [2]TUNL, Durham, NC, USA — [3]Duke University, Durham, NC, USA — [4]UNC, Chapel Hill, NC, USA — [5]FRIB, MSU, East Lansing, MI, USA — [6]GSI, Darmstadt

The giant dipole resonance (GDR) is one of the most fundamental nuclear excitations and dominates the dipole response of all nuclei. Yet, its γ-decay behavior, despite being a key property, is still mostly unknown. Recently, novel data on the γ-decay of the GDR of the well-deformed nuclide ^{154}Sm and the spherical nuclide ^{140}Ce were obtained through photonuclear experiments at the HIγS facility. Individual regions of the GDR were selectively excited by HIγS' intense, linearly-polarized and quasi-monochromatic γ-ray beam. This enables an excitation-energy resolved determination of the GDR's γ-decay behavior. For ^{154}Sm in particular, the obtained data allow for a first experimental test of the commonly accepted K-quantum-number assignments to the double-humped GDR observed in deformed nuclei.

This work was supported by the State of Hesse under the grant *Nuclear Photonics* within the LOEWE program and within the Research Cluster *ELEMENTS*.

HK 41: Structure and Dynamics of Nuclei VII

Time: Wednesday 14:00–15:30 Location: HK-H7

Group Report HK 41.1 Wed 14:00 HK-H7

Mass measurements of short-lived exotic nuclei at TITAN - update on recent developments — •Tobias Murböck for the TITAN-Collaboration — TRIUMF, Vancouver, British Columbia, Canada — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The mass of a nucleus is determined by the number of its constituents, protons and neutrons, and the binding energy resulting from the interaction between those fundamental building blocks. High-precision mass measurements therefore provide relevant data for studies of the nucleus's structure, nuclear astrophysics and fundamental symmetries. In the pursuit of exotic nuclei with extreme proton-to-neutron ratios and half-lives of just a few ms, fast and sensitive experiments are required. One of those experiments, TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN), is located at TRIUMF, Canada's particle accelerator center, in Vancouver. Complementing a Penning trap mass spectrometer, a Multiple-Reflection Time-Of-Flight Mass-Spectrometer (MR-TOF-MS) has been recently added to TITAN. With its capacity for fast, non-scanning, sensitive and high-resolution mass spectrometry, the MR-TOF-MS has helped to extend TITAN's measurement program to even more exotic nuclei. Here we present recent measurements of neutron-rich $^{63-65}$Cr and $^{67-70}$Fe in the region of the N=40 island of inversion, and data from the neutron-deficient nuclei $^{60-61}$Ga and $^{74-76}$Sr in the path of the rp-process. In addition we give an update on technical developments like the improvements in mass resolution to 6E5 and the increased stability of the system.

HK 41.2 Wed 14:30 HK-H7

Energy-density functionals from local chiral interactions — •Lars Zurek[1,2], Rodrigo Navarro Pérez[3], Scott K. Bogner[4], Richard J. Furnstahl[5], and Achim Schwenk[1,2,6] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Department of Physics, San Diego State University — [4]Facility for Rare Isotope Beams and Department of Physics and Astronomy, Michigan State University — [5]Department of Physics, The Ohio State University — [6]Max-Planck-Institut für Kernphysik, Heidelberg

We construct semi-phenomenological nuclear energy-density functionals starting from conventional Skyrme functionals, here considered to represent short-range physics. Pion exchanges are added explicitly at the Hartree-Fock level by applying a density-matrix expansion to local interactions derived from chiral effective field theory. We determine energy-density functionals obtained in this fashion at different orders in the chiral expansion and investigate several choices in the density-matrix expansion.

* Funded by the BMBF Contract No. 05P21RDFNB.

HK 41.3 Wed 14:45 HK-H7

Precision mass measurements of actinides at SHIPTRAP — •Manuel J. Gutiérrez[1,2], Michael Block[1,2,3], Christoph E. Düllmann[1,2,3], Francesca Giacoppo[1,2], Oliver Kaleja[1,4], Kanika Kanika[1,5], Jacques J. W. van de Laar[2,3], Yury Nechiporenko[6,7], Yuri Novikov[6,7], Wolfgang Quint[1,5], and Dennis Renisch[2,3] — [1]GSI Darmstadt, Germany — [2]HIM Mainz, Germany — [3]JGU Mainz, Germany — [4]University of Greifswald, Germany — [5]University of Heidelberg, Germany — [6]PNPI Gatchina, Russia — [7]Saint Petersburg State University, Russia

The existence of superheavy nuclides is possible due to quantum-mechanical shell effects. A region of enhanced stability, dubbed *island of stability*, was long ago predicted at the next spherical shell closure above the doubly magic ^{208}Pb. Although not yet experimentally found, its location has been pinned down to around Z=114–126 and N=184. More information can be retrieved from the study of the actinides, linked to heavier nuclides by decay chains.

Penning-trap mass spectrometry provides precise measurements of atomic masses, which directly translate into binding energies. Their high-resolution measurement provides a powerful indicator of nuclear structure effects. An offline campaign for direct mass measurements of selected U and Pu isotopes was recently carried out at the SHIPTRAP mass spectrometer at GSI, usually devoted to the investigation of superheavy elements. This campaign complements the more extensive program carried out at the TRIGA-TRAP setup in Mainz. This contribution presents the first results of the SHIPTRAP campaign.

HK 41.4 Wed 15:00 HK-H7

Nuclear charge radii of neutron-deficient scandium isotopes — •Kristian König[1,2], Robert Powel[1,3], Andrew Klose[4], Stephan Fritzsche[5], Jeremy Lantis[1,6], Yuan Liu[1], Kei Minamisono[1,3], Witek Nazarewicz[1,3], Wilfried Nörtershäuser[2], Skyy Pineda[1,6], Paul-Gerhard Reinhard[7], and Dominic Rossi[2] — [1]FRIB, Michigan State University — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]Department of Physics and Astronomy, Michigan State University — [4]Department of Chemistry, Augustana University — [5]Helmholtz-Institute Jena — [6]Department of Chemistry, Michigan State University — [7]Institut für Theoretische Physik II, Universität Erlangen-Nürnberg

Charge radii of neutron deficient ^{40,41}Sc (Z=21) isotopes have been determined at the BEam COoler and LAser spectroscopy facility at FRIB to investigate the N=20 shell closure. Particularly, the typical kink structure in the charge radius evolution at N=20 is very weak in Ar, K and Ca while it is strongly pronounced at N=28. With one additional proton in the $1f_{7/2}$ shell in Sc, additional cross-shell interactions occur and affect the behavior at the shell closure. The results will be presented, which promote a global understanding of the structure around ^{40}Ca, and the weak shell-closure signature at N=20.

This work is supported by NSF grant PHY-15-65546.

HK 41.5 Wed 15:15 HK-H7

Status report on the TRIGA-Trap experiment — •Szilard Nagy[1], Klaus Blaum[1], Michael Block[2,3,4], Stanislav Chenmarev[1,5], Christoph E. Düllmann[2,3,4], Steffen Lohse[2,3], and Jacques J. W. van de Laar[2,3] — [1]Max-Planck-Institut für Kernphysik, Heidelberg, DE — [2]Department Chemie - Standort TRIGA, Johannes Gutenberg-Universität Mainz, DE — [3]Helmholtz-Institut Mainz, DE — [4]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, DE — [5]Petersburg Nuclear Physics Insitute, Gatchina, RU

The TRIGA-Trap setup [1] is a double Penning-trap mass spectrometer at the research reactor TRIGA Mainz. Currently we are performing high-precision mass measurements of long-lived transuranium isotopes. A new cylindrical measurement trap made possible the implementation of the phase-imaging ion cyclotron resonance (PI-ICR) technique [2], originally developed at SHIPTRAP. The current status including results for several long-lived actinide isotopes will be presented. Our results find application in nuclear structure studies and provide reliable atomic mass anchor points in the transuranium region.

1. J. Ketelaer *et al.*, Nucl. Instrum. Meth. A **594**, 162-177 (2008).
2. S. Eliseev *et al.*, Phys. Rev. Lett. **110**, 082501, (2013).

HK 42: Hadron Structure and Spectroscopy VII

Time: Wednesday 14:00–15:30 Location: HK-H8

Group Report HK 42.1 Wed 14:00 HK-H8

Experimental Inputs to the Hadronic Vacuum Polarisation Contribution of the Anomalous Magnetic Moment of the Muon at the BESIII Experiment. — •Riccardo Aliberti for the BESIII-Collaboration — Johannes Gutenberg-Universität

The recent result from the Fermilab Muon $g-2$ Experiment has confirmed the tension between the standard model (SM) prediction of the anomalous magnetic moment of the muon (a_μ) and the experimental measurement at a 4.2 σ level. Currently, the uncertainties on experimental and predicted values are very similar (41×10^{-10} and 43×10^{-10}, respectively) and further improvement in both are to be expected in the next years.

The uncertainty on the SM prediction is dominated by hadronic contributions and particularly by the Hadronic Vacuum Polarisation (HVP) component, which is evaluated with a dispersive formalism from the measurement of hadron production cross sections in electron-positron annihilations.

The BESIII experiment, located at the BEPCII collider in Beijing, collects since 2008 data with center-of-mass energies between 2 and 5 GeV, resulting in the world's largest dataset in e^+e^--annihilations in the τ-charm energy region. In this talk the current status and perspective for the measurement of hadron production cross sections, entering the evaluation of the HVP contribution to a_μ, at BESIII are reviewed.

HK 42.2 Wed 14:30 HK-H8

Small Angle Initial State Radiation Analysis of the Pion Form Factor at BESIII — •Yasemin Schelhaas, Riccardo Aliberti, and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

One of the most precisely measured quantities in modern physics is the anomalous magnetic moment of the muon. However, there is a discrepancy of 4.2 standard deviations between the Standard Model (SM) prediction and the average of the latest direct measurements at BNL and Fermilab. This fact is known as the Muon $(g-2)$-puzzle. For the SM prediction the main uncertainty arises from hadronic contributions and can be improved systematically using measurements of hadronic cross sections at e^+e^- colliders. One of the most important processes is $e^+e^- \to \pi^+\pi^-$. Using a data set of 3.2 fb^{-1} at a center of mass energy of 4.18 GeV, the $\pi^+\pi^-$ cross section is measured at the BESIII experiment located at the BEPCII collider in Beijing, exploiting the initial state radiation technique at small angles. The analysis aims to determine the pion form factor at masses above 0.8 GeV, which is also interesting for hadron spectroscopy. In this talk the current status of the analysis is presented.

Supported by DFG.

HK 42.3 Wed 14:45 HK-H8

A FAIR Phase-0 Project at MAMI — Luigi Capozza[1], Alaa Dbeyssi[1], Alexander Greiner[1], Samet Katilmis[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Oliver Noll[1,2], David Rodriguez Piñeiro[1], Christoph Rosner[1], and •Sahra Wolff[1] — [1]Helmholtz-Institut Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

Within the FAIR phase-0 project, the use of FAIR equipment at other facilities before the completion of the civil construction is envisaged. The PANDA EMC is a good candidate for FAIR Phase-0, due to the advanced state of its development. In particular, the backward endcap (BWEC) of the PANDA EMC, which is developed and built at HIM in Mainz, could be ready by 2022, three years before its foreseen installation. Therefore, an experiment at the MAMI electron beam facility making use of the BWEC is envisaged.

The goal is to measure the π_0 electromagnetic transition form factor in virtual Primakoff-kinematics via the electroproduction of a π_0 in the Coulomb field of a heavy nucleus. To select this channel, the momentum distribution of the π_0 needs to be measured by detecting the decay γ particles and the scattered electron in the EMC.

This talk will address the current status of the FAIR Phase-0 experiment at MAMI.

HK 42.4 Wed 15:00 HK-H8

The new Forward Tracker System for the HADES and PANDA Phase-0 experiment — •Gabriela Perez-Andrade[1], James Ritman[2,1], and Peter Wintz[1] for the HADES-Collaboration — [1]Forschungszentrum Jülich — [2]Helmholtzzentrum für Schwerionenforschung

HADES is a fixed-target experiment where proton, pion, and heavy-ion induced reactions are used to study nuclear matter and the properties of baryonic resonances. HADES is in operation at the SIS18 in GSI, Darmstadt, and is part of the phase-0 program of the future FAIR facility. The new Straw Tracking Stations (STS1/2) installed at HADES were built in collaboration with the PANDA experiment. The STS1/2 enlarge the HADES acceptance for hyperon reconstruction in p+p reactions. Each station has four double layers of gas-filled straws. The straw design is based on the PANDA central and forward straw trackers (STT, FT). Four azimuthal orientations of the double layers are used for 3D track reconstruction, and to resolve ambiguities in multi-track events. From pre-commissioning tests, a spatial resolution of 0.13 mm for MIPs was determined. The system was installed at GSI at the end of 2020, and a dedicated commissioning beamtime in February 2021 with proton beams impinging on an LH2 target showed a stable STS operation. The collected data are used to develop the calibration and track reconstruction methods in the experiment analysis software HYDRA. A description of the STS system and a summary of the results from the beamtime will be presented.

HK 42.5 Wed 15:15 HK-H8

Performance Improvement of Deep Machine Learning for the PANDA Software Trigger — •Peiyong Jiang[1,2], Klaus Goetzen[1], Ralf Kliemt[1], Klaus Peters[1], and Frank Nerling[1] for the PANDA-Collaboration — [1]GSI Helmholtzzentrum fuer Schwerionenforschung GmbH, Darmstadt, Germany — [2]Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou, China

Deep machine learning methods have been studied for the PANDA software trigger with data sets from full Monte Carlo simulation using PandaRoot. Following the first comparison of multiclass and binary classification, the binary classification has been selected because of higher signal efficiencies. In total seven neural network types have been compared and the residual convolutional neural network with 4 residual blocks has been chosen. The results of optimized neural networks and those of the conventional method have been compared, showing an efficiency gain of up to 140% for the deep machine learning method. The flatness quality parameters on Dalitz plots and theta-phi projections have been obtained.

HK 43: Hadron Structure and Spectroscopy VIII

Time: Wednesday 14:00–15:30 Location: HK-H9

Group Report HK 43.1 Wed 14:00 HK-H9

Prospects for Spin-Parity Determination of Ξ Resonances in the $\overline{\Xi}\Lambda K^-$ Final State at $\overline{\text{P}}$ANDA — •Jennifer Pütz for the PANDA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung

In order to deepen our insights into the mechanisms of non-perturbative QCD it is essential to understand the excitation pattern of baryons. Up to now only the nucleon excitation spectrum has been subject to systematic experimental studies while very little is known about the excited states of double or triple strange baryons.

In studies of antiproton-proton collisions the $\overline{\text{P}}$ANDA experiment is well-suited for a comprehensive baryon spectroscopy program in the multi-strange sector. A large fraction of the inelastic $\bar{p}p$ cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, enabling high rate studies of excited states both in the baryon and the antibaryon channel.

In Monte Carlo studies, it has been demonstrated that $\overline{\text{P}}$ANDA will be able to observe the $\overline{\Xi}^+\Lambda K^-$ channel with high statistics, and at the same time kinematic constraints will suppress the background to negligible levels. In this study, the feasibility of $\overline{\text{P}}$ANDA to determine the mass, width, spin and parity of two specific Ξ resonances, Ξ(1690) and Ξ(1820), is investigated by making use of a partial wave analysis employing the PAWIAN framework. This talk will present results demonstrating the capability of the $\overline{\text{P}}$ANDA experiment to determine the spin-parity of these resonances using a data sample that can be collected within three days of data collection.

HK 43.2 Wed 14:30 HK-H9

GPD measurements with PANDA based on antiproton scattering — •Stefan Diehl for the PANDA-Collaboration — II. Physikalisches Institut, JLU Giessen, Germany

Generalized parton distributions (GPDs) are a well-established tool to study the three-dimensional nucleon structure in terms of the transverse position and the longitudinal momentum component of the partons. Classically, GPDs are measured in hard exclusive lepton scattering processes such as deeply virtual Compton scattering and deeply virtual meson production, which are currently extensively studied at Jefferson Laboratory with experiments such as CLAS12. While PANDA at FAIR has been designed to study antiproton annihilation, which yields access to time-like GPDs, also known as generalized distribution amplitudes (GDAs), it can also be used to study hard exclusive antiproton scattering processes such as $\bar{p}p \to \bar{p}pe^+e^-$ and $\bar{p}p \to \bar{p}p\mu^+\mu^-$. Such processes can be theoretically described with a dual handbag approach based on classical GPDs. The talk will present a feasibility study for the measurement of hard exclusive lepton pair production in antiproton scattering with PANDA and discuss its impact on the measurement of GPDs. A special focus will be set on the application of neural networks to optimize the particle ID and background suppression.

*Supported by BMBF within ERUM-FSP T08:PANDA and HFHF.

HK 43.3 Wed 14:45 HK-H9

Testing the Chiral Anomaly from Primakoff Reactions in COMPASS Data — •Nan-Hee Kang and Dominik Ecker for the COMPASS-Collaboration — Institute for Hadronic Structure and Fundamental Symmetries, Technische Universität München

In the years 2009 and 2012, the COMPASS collaboration at CERN has measured pion-photon scattering reactions via the Primakoff effect. In these reactions, high-energetic pions scatter off quasi-real photons stemming from the Coulomb field of a nucleus. The low-energy dynamics of the single-π^0 production ($\pi^-\gamma^{(*)} \to \pi^-\pi^0$) is driven by the chiral anomaly and described by the low-energy theorem for $F_{3\pi}$. Previous extractions of the chiral anomaly date back to the Serpukhov experiment in 1987, are restricted to the kinematic threshold region, and extracted $F_{3\pi}$ to a 10%-level. COMPASS measured the invariant mass spectrum including the $\rho(770)$-resonance which allows for more precise extraction of $F_{3\pi}$. The contribution will present the status of the analysis of the 2009 data set and compare its kinematic distributions to the larger 2012 data set.

HK 43.4 Wed 15:00 HK-H9

Diffrectively produced $f_1(1285)\pi$ system in the reaction $\pi^- + p \to \pi^-\pi^+\pi^-\eta + p$ at 190 GeV/c from COMPASS — •David Spülbeck, Henri Pekeler, Mathias Wagner, Simon Havemann, and Bernhard Ketzer for the COMPASS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik der Universität Bonn, Bonn, Germany

Hybrids are strongly interacting bound states with explicit gluonic degrees of freedom. Models and recent lattice QCD simulations alike predict the lightest hybrid state with spin-exotic quantum numbers 1^{-+} to have a strong branching into $f_1(1285)\pi$. This particular decay can be studied well using the data recorded by the COMPASS collaboration on the scattering of a 190 GeV/c pion beam off a fixed hydrogen target. Selecting diffractive reactions of the kind $\pi^- + p \to \pi^-\pi^+\pi^-\eta + p$ yields the world's largest data sample for a partial wave analysis that includes the $f_1(1285)\pi$ channel of interest. This contribution introduces the fundamental principles of the event selection for the $\pi^-\pi^+\pi^-\eta$ final state using COMPASS data. We discuss the selected data sample in detail and show the contributions of several resonances by identifying decay chains that end up in the four-body final state in question. A comparison to the data sample of the E852 collaboration will be made, which gave evidence for the spin-exotic state to decay into $f_1(1285)\pi$. As the COMPASS data sample is about eight times larger, a PWA in bins of the 4-momentum transfer and the invariant mass will be possible, giving important constraints to disentangle resonant and non-resonant processes. Supported by BMBF.

HK 43.5 Wed 15:15 HK-H9

New experimental frontiers in the study of many-hadron systems with ALICE at the LHC — •Raffaele Del Grande for the ALICE-Collaboration — TUM, Munich, Germany

The femtoscopy technique has recently been extended by the ALICE Collaboration to study the strong interaction among hadrons in three-particle systems. Three-body forces involving both nucleons and hyperons are necessary in the theoretical description of nuclear bound objects and represent an important ingredient in the calculation of the nuclear equation of state of neutron stars. Solid experimental constraints to the interaction models are currently missing and therefore, direct measurements of three-hadron interactions are strongly demanded.

The results presented in this talk are obtained using high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV measured by ALICE at the LHC. The first measurement of p–p–p and p–p–Λ correlations will be shown. The corresponding genuine three-particle correlations are obtained by subtracting the known two-body effects from the measured correlation functions of the triplets. A non-zero three-particle cumulant is observed providing an insight on the three-body dynamics for p–p–p and p–p–Λ. The same approach has been used in the measurement of p–p–K^+ and p–p–K^- correlations. The study of these systems is relevant, in particular, for the search of exotic bound states of antikaons and nucleons, whose possible formation is driven by the attractive nature of the isospin I=0 $\bar{K}$N interaction below the mass threshold.

HK 44: Astroparticle Physics II

Time: Wednesday 14:00–15:30 Location: HK-H10

Group Report HK 44.1 Wed 14:00 HK-H10

Results from the first search for axion like particles in storage rings — •Swathi Karanth for the JEDI-Collaboration — Marian Smoluchowski Institute of Physics, Jagiellonian University, Cracow, Poland

The axion was originally proposed to explain the small size of CP violation in quantum chromodynamics. If sufficiently abundant, it might be a candidate for dark-matter in the universe. Axions or axion-like particles (ALPs), when coupled with gluons, induce an oscillating Electric Dipole Moment (EDM) along the nucleon's spin direction. This can be used in an experiment to search for axions or ALPs using charged particles in a storage ring.

In spring of 2019, at the Cooler Synchrotron (COSY) in Jülich, we performed a first test experiment to search for ALPs using an in-plane polarized deuteron beam with a momentum of 0.97 GeV/c. At resonance between the spin precession frequency of deuterons and the ALP induced EDM oscillation frequency there will be an accumulation of the polarization out of the ring plane. Since the axion frequency is unknown, the momentum of the beam was ramped to search for a vertical polarization jump that would occur when the resonance is crossed. At COSY, four beam bunches with different polarization directions were used to make sure that no resonance was missed because of the unknown relative phase between the polarization precession and the EDM oscillations. A frequency window of about 1-kHz width around the spin precession frequency of 121 kHz was scanned. This talk will describe the experiment and provide an upper limit to oscillating EDM.

Group Report HK 44.2 Wed 14:30 HK-H10

The MONUMENT Experiment; ordinary muon capture as a benchmark for $0\nu\beta\beta$ decay nuclear structure calculations — Elisabetta Bossio[1], •Elizabeth Mondragon[1], Stefan Schönert[1], Mario Schwarz[1], and Christoph Wiesinger[1,2] for the MONUMENT-Collaboration — [1]Lehrstuhl für Experimentalphysik E15, Technische Universität München, Garching — [2]Max-Planck Institut für Physik, München

Extracting particle physics properties from neutrinoless double-beta ($0\nu\beta\beta$) decay requires a detailed understanding of the involved nuclear structures. Still, modern calculations of the corresponding nuclear matrix elements (NMEs) differ by factors 2-3. The high momentum transfer of Ordinary Muon Capture (OMC) provides insight into highly excited states similar to those that contribute virtually to $0\nu\beta\beta$ transitions. The precise study of the γ's following the OMC process makes this a promising tool to validate NME calculations. The MONUMENT collaboration is performing a series of explorative OMC measurements involving typical $\beta\beta$ decay daughter isotopes such as ^{76}Se and ^{136}Ba, as well as other benchmark isotopes. In this talk the experiment carried out at the Paul Scherrer Institute and first results from the beamtime in 2021 will be presented. This research is supported by the DFG Grant 448829699.

HK 44.3 Wed 15:00 HK-H10

Characterisation of the plasma in the tritium source of KATRIN with Krypton-83m — •Matthias Böttcher[1], Caroline Fengler[2], Manuel Klein[2], Moritz Machatschek[2], Magnus Schlösser[2], and Jaroslav Storek[2] for the KATRIN-Collaboration — [1]WWU Münster — [2]KIT, Karlsruhe

The KATRIN experiment has the aim to measure the electron-antineutrino mass with the unprecedented sensitivity of 0.2 eV/c^2 at 90 % C. L., using a direct kinematic measurement of the tritium beta spectrum. This requires precise understanding of systematic effects in the gaseous tritium source. Within this radioactive source, a low-density plasma at around 80 K forms, consisting of secondary electrons and ionised molecules. The plasma, influenced by the properties of the source tube, exhibits an electric potential distribution which smears out the beta spectrum. To characterize this effect, gaseous Kr-83m can be injected into the tritium source. Its well defined conversion electron lines, especially the narrow N_{23} doublet, allow for precise determination of energy broadenings and shifts. A dedicated measurement phase with an ultra high intensity krypton source was performed in 2021. In this talk, we describe the use of Kr-83m to assess the plasma systematics of the KATRIN source.

This work is supported by BMBF under contract number 05A20PMA.

HK 44.4 Wed 15:15 HK-H10

Status of the KATRIN neutrino mass analysis using Monte Carlo propagation and a novel neural network approach — Christian Karl[1,2], Susanne Mertens[1,2], Alessandro Schwemmer[1,2], and •Christoph Wiesinger[1,2] for the KATRIN-Collaboration — [1]Max-Planck-Institut für Physik, München — [2]Physik-Department, Technische Universität München, Garching

The Karlsruhe Tritium Neutrino (KATRIN) experiment probes the effective electron anti-neutrino mass by a precision measurement of the tritium beta-decay spectrum near the endpoint. A world-leading upper limit of 0.8 eV c^{-2} (90 % CL) has been set with the first two measurement campaigns. New operational conditions for an improved signal-to-background ratio, the reduction of systematic uncertainties and a substantial increase in statistics allow to expand this reach. The performance figures of three additional datasets, analysed with the Monte Carlo propagation method, and an outlook on their combination using a novel neural network technique will be presented in this talk.

HK 45: Heavy-Ion Collisions and QCD Phases IX

Time: Wednesday 16:00–17:15 Location: HK-H1

Group Report HK 45.1 Wed 16:00 HK-H1

Vector and Axial-Vector Mesons in Nuclear Matter — •Ralf-Arno Tripolt[1], Tetyana Galatyuk[2,3], Lorenz von Smekal[1,4], Jochen Wambach[2], and Maximilian Wiest[2] — [1]Justus Liebig University Giessen, Germany — [2]TU Darmstadt, Germany — [3]GSI, Darmstadt, Germany — [4]Helmholtz Research Academy Hesse for FAIR (HFHF), Campus Giessen, Germany

We present recent results on the in-medium spectral functions of the rho(770) vector meson and the a1(1260) axial-vector meson in nuclear matter, as well as on the resulting thermal dilepton rate. As an effective description of the thermodynamics and the phase structure of nuclear matter we use a chiral baryon-meson model, taking into account the effects of fluctuations from scalar mesons, nucleons, and vector mesons within the Functional Renormalization Group (FRG) approach [1]. Our results show strong modifications of the spectral functions in particular near the chiral critical endpoint which suggest an enhanced dilepton yield at lower energies. Such an enhancement is also found in GiBUU transport simulations for C+C at 1A GeV when including effects of chiral symmetry restoration in the kinetic equations for baryon propagation [2]. Our results may therefore well be of relevance for electromagnetic rates in heavy-ion collisions or neutrino emissivities in neutron-star merger events and help to identify phase transitions and the critical endpoint.

[1] R.-A. Tripolt, C. Jung, L. von Smekal, J. Wambach, Phys. Rev. D 104, 054005 (2021)

[2] A. B. Larionov, L. von Smekal, arXiv: 2109.03556

HK 45.2 Wed 16:30 HK-H1

Dielectron physics opportunities with ALICE 3 — •Florian Eisenhut for the ALICE-Collaboration — Goethe University Frankfurt am Main

ALICE 3 is a compact, next-generation multipurpose detector at the LHC planed as a follow-up to the present ALICE experiment. It will provide unprecedented tracking, particle identification and vertexing capabilities down to a few tens of MeV/c with a large rapidity coverage $|\eta| < 4$. At very low p_{T} and invariant mass (m_{ee}) the thermal dielectron production rate in heavy-ion (AA) collisions is expected to be particularly sensitive to the electric conductivity of the medium. At higher dielectron invariant masses, the spectral shape of thermal radiation from the hot hadron gas carries information about the chiral-symmetry restoration mechanisms, among those is the chiral mixing between ρ and a_1 mesons. In the mass region $1.1 < m_{\mathrm{ee}} < 2.7$ GeV/c^2 the spectrum of thermal dielectrons is dominated by dieletrons from the QGP which directly provides a mean to estimate the early temperature of the medium. Finally, an elliptic flow measurement as a function of m_{ee} and pair transverse momentum allows a study of the dynamic of the medium as a function of time.

This talk will present performance studies for dielectron analyses with ALICE 3. The procedure to determine expected uncertainties of the thermal e^+e^- spectra will be presented and a so-called prefilter technique to reduce the combinatoric background will be explained. Furthermore, feasibility studies of the early temperature of the medium via exponential fits of the invariant mass spectra will be shown.

HK 45.3 Wed 16:45 HK-H1

Feasibility Studies of Di-Electron Spectroscopy with CBM at FAIR — •Cornelius Feier-Riesen for the CBM-Collaboration — GSI, Darmstadt, Germany — Justus-Liebig-Universität Gießen, Gießen, Germany

The Compressed Baryonic Matter experiment (CBM) at FAIR is designed to explore the QCD phase diagram at high net baryon densities and moderate temperatures by means of heavy ion collisions with energies from 2-11 AGeV beam energy (Au+Au collisions) and interaction rates up to 10 MHz, provided by the SIS100 accelerator.

Leptons as penetrating probes not taking part in the strong interaction leave the fireball without being modified thus carrying information from the dense baryonic matter. However, di-leptons are rare probes therefore calling for high efficiency and high purity identification capabilities. In CBM, electron identification will be performed by a Ring Imaging Cherenkov Detector (RICH) and by a Transition Radiation Detector (TRD).

In this contribution, feasibility studies of di-electron spectroscopy from low mass vector meson decays will be presented. Special emphasis is put on the experimental challenge to reduce the combinatorial background in order to get a high significance of the extracted di-electron signal.

HK 45.4 Wed 17:00 HK-H1

Dielectron production in Pb–Pb collisions with ALICE — •Jerome Jung for the ALICE-Collaboration — IKF, Goethe University, Frankfurt, Germany

The study of dielectron production is an exceptional tool to disect the evolution of heavy-ion collisions. In peripheral collisions, a clear excess of dielectrons is observed which exceeds the hadronic decay background at low pair momenta. These soft dielectrons can be attributed to coherent interactions of photons originating from electromagnetic fields generated by the highly Lorentz-contracted colliding ions. In more central collisions, the energy densities are sufficient to create a hot and dense medium. Thermal radiation of this medium can be observed as an excess over the hadronic decay cocktail beyond the pion region. For invariant masses above 1.1 GeV/c^2, correlated heavy-flavour hadron decays are expected to dominate the dielectron yield. Their contribution is modified in the medium compared to elementary collisions to an unknown extend. Therefore, a topological separation based on the distance-of-closest approach (DCA) to the primary vertex can be applied to disentangle them from thermal dielectrons.

In this talk, ALICE measurements of dielectron production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV, will be presented. In peripheral collisions, final results will be compared to theory and measurements at lower energies. In central collisions, the dielectron spectra will be compared to expectations from the hadronic decay cocktail. Finally, a outlook on a DCA analysis in Pb–Pb is given.

HK 46: Heavy-Ion Collisions and QCD Phases X

Time: Wednesday 16:00–17:15 Location: HK-H2

Group Report HK 46.1 Wed 16:00 HK-H2

Regulator dependence of the chiral phase transition at high densities — Konstantin Otto[1], •Christopher Busch[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF)

Functional methods like the functional renormalization group (FRG) provide a powerful tool for the study of non-perturbative phenomena such as the spontaneous breaking of chiral symmetry in QCD. Recent FRG investigations of the QCD phase diagram at low temperature and high densities show a strange backbending of the chiral phase transition line combined with the appearance of a negative entropy density in the chirally symmetric phase. Among possible physical reasons for these observations technical artifacts caused by common FRG truncation schemes are part of ongoing discussions. In this talk we will focus on this issue and will elucidate the role played by different FRG regulator choices. First results of the regulator effects in this regime of the phase diagram will be given.

HK 46.2 Wed 16:30 HK-H2

Critical endpoint of QCD in a finite volume — •Julian Bernhardt[1,2], Christian S. Fischer[1,2], Philipp Isserstedt[1,2], and Bernd-Jochen Schaefer[1,2] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), GSI Helmholtzzentrum für Schwerionenforschung, Campus Gießen, 35392 Gießen, Germany

We summarize recent results on the volume dependence of the location of the critical endpoint in the QCD phase diagram. To this end, we employ a sophisticated combination of Lattice Yang-Mills theory and a (truncated) version of Dyson-Schwinger equations in Landau gauge for 2 + 1 quark flavors. We study this system at small and intermediate volumes and determine the dependence of the location of the critical endpoint on the boundary conditions and the volume of a three-dimensional cube with edge length L. Additionally, we report on the chiral limit of the light quarks for different strange quark masses at vanishing chemical potential.

HK 46.3 Wed 16:45 HK-H2

Phase structure and thermodynamics of QCD from Dyson–Schwinger equations — •Philipp Isserstedt[1,3], Michael Buballa[2,3], Christian S. Fischer[1,3], Pascal J. Gunkel[1,3], and Thorsten Steinert[1] — [1]Institut für Theoretische Physik, Justus-Liebig-Universität Gießen, 35392 Gießen, Germany — [2]Technische Universität Darmstadt, Department of Physics, Institut für Kernphysik, Theoriezentrum, 64289 Darmstadt, Germany — [3]Helmholtz Forschungsakademie Hessen für FAIR (HFHF), Germany

We summarize our recent results on the phase structure and thermodynamics of QCD obtained within the nonperturbative framework of Dyson–Schwinger equations. Our results are based on solutions to a truncated set of these equations for the quark and gluon propagators of (2+1)-flavor QCD in Landau gauge. First, we present baryon number fluctuations and ratios thereof, ranging from vanishing chemical potential up to the critical endpoint. In comparison with experimental data, our results are compatible with the scenario of a critical endpoint at large chemical potential and a freeze-out line that bends below the endpoint [1]. Second, we discuss a truncation-independent method to obtain thermodynamic quantities like the pressure, entropy density, energy density, and interaction measure across the QCD phase diagram from Dyson–Schwinger equations [2], which has been accomplished so far only within simple truncations of the rainbow-ladder type.

[1] Phys. Rev. D 100, 074011 (2019), arXiv:1906.11644 [hep-ph].
[2] Phys. Rev. D 103, 054012 (2021), arXiv:2012.04991 [hep-ph].

HK 46.4 Wed 17:00 HK-H2

Fluctuations and phases in baryonic matter — •Len Brandes — Technical University of Munich

The phase structure of baryonic matter is investigated with focus on the role of fluctuations beyond the mean-field approximation. The prototype test case studied is the chiral nucleon-meson model, with added comments on the chiral quark-meson model. Applications to nuclear matter include the liquid-gas phase transition. Extensions to high baryon densities are performed for both nuclear and neutron matter. The role of vacuum fluctuations is systematically explored. It is pointed out that such fluctuations tend to stabilize the hadronic phase characterized by spontaneously broken chiral symmetry, shifting the chiral restoration transition to very high densities. This stabilization effect is shown to be further enhanced by additional dynamical fluctuations treated with functional renormalisation group methods.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC as well as the DFG Excellence Cluster ORIGINS.

HK 47: Instrumentation XI

Time: Wednesday 16:00–17:30 Location: HK-H3

HK 47.1 Wed 16:00 HK-H3

Performance of the mSTS detector in O+Ni collisions at 2 AGeV with the mCBM setup at SIS18 — •Dario Alberto Ramirez Zaldivar for the CBM-Collaboration — GSI Helmholtzzentrum f r Schwerionenforschung GmbH, Darmstadt, Germany — Goethe University, Frankfurt, Germany

The Compressed Baryonic Matter (CBM) is one of the experimental pillars at the FAIR facility. CBM focuses on the search for signals of the phase transition between hadronic and quark-gluon matter, the QCD critical endpoint, new forms of strange-matter, in-medium modifications of hadrons, and the onset of chiral symmetry restoration. The Silicon Tracking System is the central detector for momentum measurement and charged-particle identification. It is designed to measure Au+Au collisions at interaction rates up to 10 MHz. It consists have 1.8 million channels, having the most demanding requirements in terms of bandwidth and density of all CBM detectors. In the context of FAIR phase 0, the mini-CBM (mCBM) project is a small-scale precursor of the full CBM detector, consisting of sub-units of all major CBM systems which aim to verify CBM's concepts of free-streaming readout electronics, data transport, and online reconstruction. In the 2021 beam campaign at SIS18 (GSI) O+Ni collisions at 2 AGeV were measured with a beam intensity up to 10^{10} ions per spill. The mini-STS (mSTS) setup used for the 2021 campaign consists of 2 stations with 11 sensors. First results obtained from data taken in the 2021 beam campaign will be presented with a focus on the hit reconstruction and mSTS performance studies.

HK 47.2 Wed 16:15 HK-H3

Mechanics, integration, and assembly of the Silicon Tracking System of CBM — •Maksym Teklishyn[1,2], Patrick Dahm[1], Ulrich Frankenfeld[1], Johann Heuser[1], Piotr Koczoń[1], Anton Lymanets[1], Jens Thaufelder[1], and Oleg Vasyliev[1] for the CBM-Collaboration — [1]GSI, Darmstadt — [2]KINR, Kyiv

The Silicon Tracking System is the main tracking detector of the future CBM experiment. Its design fulfills competing requirements of low material budget, high granularity, and free-streaming operation of the detector modules.

The sensitive volume of the detector is formed by 8 tracking layers comprising 106 vertical ladders — highly integrated light-weight structures with a particular set of modules mounted on top. Each of the 876 detector modules consists of a rectangular double-sided silicon micro-strip sensor interconnected with the front-end electronics outside the physics aperture through a set of 32 ultra-thin analogue read-out micro cables of up to 500 mm length.

The detector is to be be integrated inside a constrained volume of about 3 m^3 in the aperture of 1 Tm dipole magnet together with its multiple services: high- and low-voltage lines, read-out optical fibres, cooling lines for dry gas and NOVEC liquid at -40°C, DCS links and sensors.

A set of dedicated testing routines is foreseen at each step of the system assembly to ensure its adequate performance. The design choices together with the assembly and testing sequences are being validated with various prototypes.

HK 47.3 Wed 16:30 HK-H3

Präzisionsvermessung der Vakuumbox des PANDA-Luminositätsdetektors — •Jannik Petersen für die PANDA-Kollaboration — Institut für Kernphysik, Mainz, Deutschland

Beim PANDA-Experiment an der neuen Beschleunigeranlage FAIR bei Darmstadt sollen anhand von Antiproton-Proton-Reaktionen offene Fragen der Hadronenphysik beantwortet werden. Eine Säule des Forschungsprogramms bei PANDA ist die Charmonium-Spektroskopie. Dabei soll auch die Energy-Scan-Methode eingesetzt werden, die die Linienform neuer als auch bereits entdeckter Resonanzen mit noch nie dagewesener Präzision vermessen soll. Bei dieser Methode ist die Luminosität die entscheidende Kenngröße zur Normierung der unabhängigen Scan-Schritte. Daher befindet sich ca. 11 m hinter dem Wechselwirkungspunkt ein dedizierter Detektor, der die Winkelverteilung der am Target elastisch gestreuten Antiprotonen vermessen soll. Aus dieser kann die Luminosität extrahiert werden. Um eine Genauigkeit der Kenntnis der absoluten Luminosität von < 5% und der relativen Luminosität von < 1% zu erreichen, muss die Position der verfahrbaren Siliziumpixeldetektoren im Luminositäts-Detektor relativ zum Wechselwirkungspunkt auf 0,2 mm bekannt sein. Diese Sensoren befinden sich in einer Vakuumbox, die sich durch den Atmosphärendruck verformt. Deswegen ist eine präzise Vermessung der Box erforderlich, was während des Vortrags erläutert werden wird.

HK 47.4 Wed 16:45 HK-H3

Design of a luminosity monitor for the P2 parity violating experiment at MESA — Sebastian Baunack[1], Boris Gläser[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], •Tobias Rimke[1], David Rodriguez Pineiro[2], and Malte Wilfert[1] for the P2-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität Mainz

The P2 experiment at the future MESA accelerator in Mainz plans to measure the weak mixing angle $\sin^2(\theta_W)$ in parity violating elastic electron-proton scattering. The aim of the experiment is a very precise measurement of the weak mixing angle with a accuracy of 0.15% at a low four-momentum transfer of

$Q^2 = 4.5 \cdot 10^{-3}$ GeV^2. In order to achieve this accuracy, it is necessary to monitor the stability of the electron beam and the liquid hydrogen target. Any helicity correlated fluctuations of the target density lead to false asymmetries.

Therefore, it is planned to install a luminosity monitor in forward direction close to the beam axis. The motivation and challenges for designing an air Cherenkov luminosity monitor will be discussed in this talk.

HK 47.5 Wed 17:00 HK-H3

Design of a Luminosity Monitor for MAGIX — •Theodoros Manoussos for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany

The MAinz Gas Injection target eXperiment (MAGIX) will be operated in the energy-recovery mode of the Mainz Energy-recovery Superconducting Accelerator (MESA), a high-intensity electron accelerator currently under construction at the Institute of Nuclear Physics of the Johannes Gutenberg University in Mainz. The windowless design of the two multi-purpose spectrometers enables high precision measurements of the electromagnetic form factors of several nuclei, including the proton, the study of nuclear reactions of astrophysical relevance, as well as dark photon searches. Thereby, the luminosity is an important parameter, which needs to be accurately measured. In this talk, a design study for a luminosity monitoring system using the bremsstrahlung process will be presented.

HK 47.6 Wed 17:15 HK-H3

The Cooling Concept of the CBM Silicon Tracking System — •Kshitij Agarwal for the CBM-Collaboration — Eberhard Karls Universität Tübingen, Tübingen, Germany

As the core detector of the CBM experiment at the under-construction FAIR facility, the Silicon Tracking System (STS) located in the dipole magnet (1 T.m) provides track reconstruction (> 95%) & momentum determination (< 2%) of charged particles from the beam-target interactions ($sqrt(s_{NN})$ = 2.9 - 4.9 GeV). Due to the expected non-ionising irradiation damage at the end-of-lifetime (10^{14} n_{eq}(1MeV)/cm^2), the innermost silicon microstrip sensors will dissipate up to 6 mW/cm^2 at -10°C. So, it is crucial to always keep the silicon sensors at temperatures close to -10°C to avoid thermal runaway and reverse annealing by introducing minimal material budget in the detector acceptance.

The first part of this contribution will focus on the silicon sensor cooling concept, where cold gas (at -10°C) will be carried via thin carbon-fibre (CF) perforated tubes to directly cool the innermost silicon sensors. This will include the CFD Analysis of the sensor cooling concept with a 'toy model', and manufacturing of the perforated CF-tubes. The second part will touch upon the electronic cooling concept, where mono-phase 3M NOVEC 649 (at -40°C) will be used to keep the electronics temperature at -10°C. This will be substantiated with the CFD & Thermal Analysis. The contribution will be concluded by presenting the status of the thermal demonstrator, which will demonstrate the cooling concept under realistic operating conditions.

HK 48: Instrumentation XII

Time: Wednesday 16:00–17:15 Location: HK-H4

HK 48.1 Wed 16:00 HK-H4

Pellet target development for an EDM measurements at COSY — •Otari Javakhishvili for the JEDI-Collaboration — Forschungszentrum Jüelich GmbH

The JEDI (Jülich Electric Dipole moment Investigation) collaboration in Jülich is conducting a set of experiments at COSY, aiming to develop precise equipment and experimental techniques to measure the EDMs of charged particles. One of the key elements of these experiments is the new modular JEDI polarimeter with a special target system. In the current configuration, horizontal and vertical block targets are used in the polarimeter. Targets are mounted on stepper linear actuators and dedicated hardware and software are used to control target movements. The target control system is EPICS based, it can access accelerator and detector data and use them as feedback for automatic target movement or finding proper target position in the beam. The system is controlled by a user-friendly GUI. Also, it has software and hardware interlock systems. This system was successfully tested in the last beamtime. In addition, we are working on a special target system, which will allow to oscillate pellet through the beam. The frequency and speed of oscillation must be variable to achieve the desired effective target density. The monitoring system must be developed, including precise triggering, track reconstruction, and data synchronization units, this allows us to synchronize data of target with other systems in the detector. In this talk achievements and experimental results will be summarized and ongoing activities towards dedicated ballistic pellet target development presented.

HK 48.2 Wed 16:15 HK-H4

Crossing the Widom line: Cluster formation as sensitive probe of supercritical fluids — •Sophia Vestrick, Clara Fischer, and Alfons Khoukaz — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

In contrast to the well-defined vapor pressure curve for fluids below the critical point, there is no distinct characterization as liquid or gas in the supercritical regime. Hence, the Widom line is proposed as location of a phase transition higher order. Whereas its experimental determination is typically challenging, we found a new and simple method for precisely measuring the phase transition of supercritical hydrogen using the formation of cluster beams. Due to the two distinct cluster formation mechanisms in the liquid and in the gaseous phase, an unambiguous assignment of supercritical fluids to liquid-like and gas-like regions is possible. The novel determination of the Widom line using cluster beams represents a universal method that can be easily applied to a wide range of elements or chemical compounds. This project has received funding from BMBF (05P21PMFP1), GSI FuE (MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 48.3 Wed 16:30 HK-H4

Development of a high luminosity lithium target system — •Philipp Eckert, Patrick Achenbach, Julian Geratz, Pascal Klag, and Josef Pochodzalla — Institut für Kernphysik, Mainz, Germany

In preparation for a precision measurement of the hypertriton mass at MAMI by decay pion spectroscopy, a high luminosity lithium target has been developed. It is designed to be 5 cm long in the beam direction but at the same time narrow to minimize the momentum straggling for sideways exiting particles.

The setup is equipped with a cooling system to prevent the lithium from melting as well as thermal cameras to observe the deposited heat and the beam alignment. Before the data taking, a test beamtime with the target is foreseen for next spring.

This project is supported by the Deutsche Forschungsgemeinschaft, Grant Number PO256/7-1 and the European Union's Horizon 2020 research and innovation programme No. 824093.

HK 48.4 Wed 16:45 HK-H4

Electron scattering in argon at the MAGIX windowless gas jet target — •Maximilian Littich for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

MAGIX is a fixed target electron scattering experiment at the upcoming MESA accelerator. It will be operated in the energy recovery mode of the accelerator which allows to reach beam currents of at least 1 mA. This operation mode requires a thin target for which MAGIX will use an internal, windowless gas jet target. This cryogenic supersonic gas jet target will be able to run with different gases, e.g. hydrogen, deuterium, helium, oxygen, argon or xenon.

The MAGIX target is already existing and can be tested in the laboratory. At the existing A1 multi-spectrometer facility at the electron accelerator MAMI, we were able to operate the target with argon as the target gas and beam energies of 700 MeV and 240 MeV.

This talk will present the experimental setup used in the A1 facility and give a summary of the measurements performed. Finally an overview of the target performance and the current state of the analysis is given.

HK 48.5 Wed 17:00 HK-H4

Cluster size determination using shadowgraphy measurements — •Hanna Eick, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz — Institute for Nuclear Physics, Westfälische Wilhelms-Universität Münster

Cluster-Jet Targets from the WWU Münster are an important component of several experiments at different research facilities.

One of them is the HHU Düsseldorf where the ARCTURUS laser is used to investigate the laser-cluster interaction. In this context measurements are performed in order to study the properties of the clusters themselves. These properties include the size of the clusters and their size distribution as well as the amount of gas in which the measured clusters are embedded.

The method used for this purpose is based on the shadowgraphy principle, in which images were taken during the illumination of the cluster beam by <30 fs ultrashort ARCTURUS laser pulses. The evaluation of cluster diameters has to be automated due to the large number of recorded photos.

The talk provides an overview of the evaluation method and presents the results of these analyses. First results show an average cluster size in the order of a few micrometer, which will also be of high interest for other installations using cluster beams.

This project has received funding from the EU's Horizon 2020 programme (824093).

HK 49: Instrumentation XIII

Time: Wednesday 16:00–17:00 Location: HK-H5

HK 49.1 Wed 16:00 HK-H5

Development of a method for the calibration of the backward end cap of the PANDA calorimiter — •Samet Katilmis[1], Alaa Dbeyssi[1], Alexander Greiner[1], David Rodriguez Pineiro[1], Dong Liu[1], Frank Maas[1,2,3], Julian Moik[1], Luigi Capozza[1], Oliver Noll[1,2], Peter-Bernd Otte[1], Sahra Wolff[1], and Cristoph Rosner[1] for the PANDA-Collaboration — [1]Helmoltz Institut Mainz, Germany — [2]Institute of Nuclear Physics, Johannes Gutenberg University, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

The PANDA-Experiment (Antiproton and Proton Annihilation at Darmstadt) is one of the main experimental pillars at the **F**acility for **A**ntiproton and **I**on **R**esearch at Darmstadt (FAIR), which currently is under construction.

The Backward Endcap Calorimiter (BWEC) is developed and built by the EMP group at the Helmholtz Institute Mainz. The BWEC consists of subunits called submodules. Each submodule houses electronic components, such as high voltage boards, ASICS, photodiodes, and others, whose characteristics must be determined for optimal operating settings. This includes determining the characteristics of avalanche photodiodes, high-voltage scans, and various other tests. This procedure is repeated several times for 48 submodules, so convenient, automatic and reconstructable calibration methods are developed.

HK 49.2 Wed 16:15 HK-H5

Recent developments regarding the final $\overline{\text{P}}$ANDA Barrel EMC — •Aniko Tim Falk, Markus Moritz, Hans-Georg Zaunick, Kai-Thomas Brinkmann, Valera Dormenev, Kim Tabea Giebenhain, Christopher Hahn, Marvin Peter, Matthias Sachs, and René Schubert for the PANDA-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

The future electromagnetic calorimeter of the $\overline{\text{P}}$ANDA experiment will provide an excellent energy resolution over a wide dynamic range from a few dozens of MeV up to 15 GeV. The barrel part will consist of 16 segments. Each segment, with the exception of the two for the target pipe, includes 710 individual detectors. The main parts of each detector are a PWO-II crystal, two individual large area avalanche photo diodes and a preamplifier ASIC named APFEL (ASIC for Panda Front-end Electronics). In order to reveal the full potential of the calorimeter, even beyond the design goals, such aspects as the calibration, the APFEL settings and APD gains of each detector must be optimized to provide the best possible energy resolution.

In this talk the most recent progress concerning the final Barrel EMC design shall be presented.

This project is supported by BMBF, GSI and HFHF.

HK 49.3 Wed 16:30 HK-H5

Development of BaO*2SiO2:Ce (DSB:Ce) glass and glass ceramic scintillation material for future detectors — •Valerii Dormenev[1], Andrey Borisevich[2], Kai-Thomas Brinkmann[1], Mikhail Korzhik[2,3], Dmitry Kozlov[2], Markus Moritz[1], Rainer Novotny[1], Pavel Orsich[1,2], and Hans-Georg Zaunick[1] — [1]2nd Physics Institute, Justus Liebig University, Giessen, Germany — [2]Institute for Nuclear Problems of Belarus State University, Minsk, Belarus — [3]NRC "Kurchatov Institute", Moscow, Russia

Utilization of fast and efficient scintillating materials for radiation detectors has played a crucial role in the discovery of the properties of matter in the last decades. However, the operation in a harsh radiation environment generated at high intensity machines such as the LHC and FAIR demonstrated their limitations and underlined the requirements for materials more tolerable to radiation damage in particular caused by high energy hadrons. Glass and glass ceramics can be considered as alternatives to crystal-based scintillators. Here we report on the performance of a low cost glass (BaO*2SiO2) and the glass ceramics DSB: Ce/Gd and in addition on aspects of industrial mass production. Admixing gadolinium oxide (Gd3+) even provides up to five times larger light yield. This work summarizes the present status of the overall performance of small and large samples.

The work was supported by funding of EU Horizon 2020 under Grant Agreement No 777222 (ATTRACT) and No 654002 (INTELUM), BMBF Project 05K2019 - UFaCal and in the spirit of the Crystal Clear Collaboration.

HK 49.4 Wed 16:45 HK-H5

Construction of the crystal Zero Degree Detector for BESIII — •Frederic Stieler[1], Achim Denig[1], Peter Drexler[1], Leonard Koch[2], Wolfgang Kühn[2], Werner Lauth[1], Jan Muskalla[1], Saskia Plura[1], Christoph Florian Redmer[1], and Yasemin Schelhaas[1] — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland — [2]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Deutschland

The crystal Zero Degree Detector (cZDD) is a proposed addition to the BESIII experiment in China. In order to measure hadronic cross sections with the Initial State Radiation (ISR) method for a more precise calculation of the hadronic vacuum polarization contribution to the anomalous magnetic moment of the muon, ISR photons have to be detected. Since these photons are mostly emitted at small angles in relation to the colliding particles, the cZDD will measure these photons at angles of about 1.5 mrad to 10.4 mrad, that are not covered yet by the already existing detectors at BESIII.

In this presentation the design of the first prototype of the cZDD is discussed and further steps are motivated.

HK 50: Structure and Dynamics of Nuclei VIII

Time: Wednesday 16:00–17:45 Location: HK-H6

Group Report HK 50.1 Wed 16:00 HK-H6

Investigation of the low-lying dipole response in real photon-scattering experiments — •Miriam Müscher[1], Johann Isaak[2], Florian Kluwig[1], Deniz Savran[3], Ronald Schwengner[4], Werner Tornow[5], and Andreas Zilges[1] — [1]University of Cologne, Institute for Nuclear Physics — [2]Institute for Nuclear Physics, TU Darmstadt — [3]GSI, Darmstadt — [4]Helmholtz-Zentrum Dresden-Rossendorf — [5]Duke University and TUNL

The photoabsorption cross section of atomic nuclei has great impact on reaction rates in nucleosynthesis processes. For instance, the occurrence of additional dipole strength below and around the particle separation threshold, often denoted by Pygmy Dipole Resonance [1], can enhance reaction rates in the rapid neutron-capture process [2].

Real photon-scattering experiments are well suited to selectively study dipole excited states [3]. In these experiments, photoabsorption cross sections as well as spin and parity quantum numbers can be extracted in a model-independent way. Recent results of complementary (γ,γ') experiments with bremsstrahlung (at DHIPS [4] and γELBE [5]) and with quasi-monoenergetic photons (at HIγS [6]) will be presented.

This work is supported by the BMBF (05P21PKEN9).

[1] D. Savran *et al.*, Prog. Part. Nucl. Phys. **70** (2013) 210
[2] S. Goriely, Phys. Lett. B **436** (1998) 10
[3] U. Kneissl *et al.*, Prog. Part. Nucl. Phys. **37** (1996) 349
[4] K. Sonnabend *et al.*, Nucl. Instr. and Meth. A **640** (2011) 6
[5] R. Schwengner *et al.*, Nucl. Instr. and Meth. A **555** (2005) 211
[6] H.R. Weller *et al.*, Prog. Part. Nucl. Phys. **62** (2009) 257

HK 50.2 Wed 16:30 HK-H6

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalić[1], Thomas Aumann[1,2], Takashi Ariizumi[3], Patrick van Beek[1], Ioana Gheorghe[4], Heiko Scheit[1], Dmytro Symochko[5], and Hiroaki Utsunomiya[3] — [1]Technische Unitversität Darmstadt, Germany — [2]GSI Helmholtzzentrum, Germany — [3]Department of Physics, Konan University, Japan — [4]"Horia Hulubei" National Institute for R & D in Physics and Nuclear Engineering (IFIN HH), Romania — [5]Physikalisch-Technische Bundesanstalt (PTB), Germany

The photoneutron cross sections of ^{112}Sn, ^{116}Sn, ^{120}Sn and ^{124}Sn were measured in (γ, xn) reactions, where $x \in [1,4]$, using a quasi-monochromatic laser Compton-scattering γ-ray beam at the NewSUBARU facility. The goal of the experiment is to resolve the long-standing discrepancy of the total and partial cross sections measured by the Livermore and the Saclay groups. Measurements were done with γ energies from 8 MeV to 38 MeV. As a neutron counter a detector with a flat efficiency was used to take advantage of the direct neutron-multiplicity sorting technique. The (γ, xn) cross sections $x \in [1,4]$ will be determined as well as the total photo absorption cross sections.

In this report the experiment and the current state of the ongoing analysis will be presented.

Suported by HMWK (LOEWE centre "Nuclear Photonics") and DFG (SFB 1245).

HK 50.3 Wed 16:45 HK-H6

Observational indications for broken axial symmetry in heavy nuclei — •Eckart Grosse[1] and Arnd R. Junghans[2] — [1]IKTP Technische Universität Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf

Following the observation of quadrupole moments in atomic hyperfine structure it became a custom to consider most nuclei as axially symmetric; this assumption is still in wide use, albeit it was falsified in several cases. Giving up axiality the apparent shapes in very many giant dipole resonances agree much better to data [EPJA 53, 225 (2017)] and we started to examine other experimental observations with respect on their sensitivity to axiality. Here we had to acknowledge that the popular I(I+1)-rule for rotational energy is strictly connected to axial symmetry. This changes the interpretation of ground state bands e.g. in actinide nuclei. The widely known R42 values (ratios of low level excitation energies) very surprisingly correlate to gamma-triaxialities derived in HFB-calculations modified by a generator coordinate approximation. And these values together with the backshift between experimental and Thomas-Fermi ground state masses allow satisfactory predictions of neutron resonance spacings in quasi all heavy nuclei. As also average widths of such resonances are predicted quite well we consider our findings a falsification of assuming axiality and point out that recent calculations of MC-shell model type [PRC 97, 014315 (2018)] support this statement.

HK 50.4 Wed 17:00 HK-H6

One-nucleon removal from ^{14}O at 100 MeV/nucleon with a thin hydrogen target — •Thomas Pohl, Yelei Sun, Alexandre Obertelli, and SAMURAI 31 Collaboration — TU Darmstadt

Direct reactions at intermediate energies are an important tool for nuclear structure studies, but some reaction mechanisms are still not understood. One debated phenomenon is the asymmetric parallel momentum distribution (PMD) of the residual nucleus occuring occasional in one nucleon removal reactions[1-3]. Recent theoretical calculation of (*p,pN*) reactions with ^{14}O at 100 MeV/nucleon with the distorted-wave impulse approximation (DWIA) predicted a large asymmetric PMD [4]. The low momentum tail is due to the attractive potential between the residues and the outgoing nucleons and the steep falloff on the high momentum side is due to the energy and momentum conservation. Still, comparison with experimental data is necessary for validation and will be a basis for further spectroscopic factor studies. We have performed ^{14}O(*p,pn*)^{13}O and ^{14}O(*p,2p*)^{13}N reactions at 100 MeV/nucleon with a thin solid hydrogen target at SAMURAI at RIKEN. Momentum of the residues were extracted from the SAMURAI spectrometer. Details of the data analysis and preliminary results of the cross section and PMD will be presented.

[1] A. Gade *et al.*, Phys. Rev. C 71, 051301(R)(2005).
[2] K.L. Yurkewicz *et al.*, Phys. Rev. C 74, 024304 (2006).
[3] F. Flavigny *et al.*, Phys. Rev. Lett. 108, 252501 (2012).
[4] K. Ogata *et al.*, J. Phys. Rev. C 92, 034616 (2015).

HK 50.5 Wed 17:15 HK-H6

Correlation experiments in photofission — •Vincent Wende[1], Marius Peck[1], Joachim Enders[1], Sean W. Finch[2], Alf Göök[3], Calvin R. Howell[2], Maximilian Meier[1], Andreas Oberstedt[4], Stephan Oberstedt[5], Norbert Pietralla[1], Jack A. Silano[6], Anton P. Tonchev[6], and Werner Tornow[2] — [1]Institut für Kernphysik, TU Darmstadt, Darmstadt, Germany, — [2]Triangle Universities Nuclear Laboratory, Duke University, Durham, NC, USA, — [3]KTH Stockholm, Stockholm, Sweden, — [4]ELI-NP, IFIN-HH, Magurele, Romania, — [5]EC-JRC Geel, Belgium — [6]Lawrence Livermore National Laboratory, Livermore, CA, USA

Photon-induced reactions provide precision data on nuclear fission due to their selectivity on excitations of low multipolarity. Quasi-monochromatic polarized photon beams allow one to extract information about the transition states and channels through which the fission proceeds. To this end, the masses, total kinetic energy, and polar as well as azimuthal angular distributions of the fission fragments were measured simultaneously in a position-sensitive twin Frisch-grid ionization chamber [1]. We present first results of a pioneering ^{238}U(γ,f) experiment at the High-Intensity γ-Ray Source (HIγS) at an excitation energy of 11.2 MeV [2].

[1] A. Göök et al., Nucl. Instrum. Methods A 830, 366 (2016); M. Peck et al., EPJ Web of Conferences 239, 05011 (2020).
[2] M. Peck, Dissertation, TU Darmstadt (2020).

Supported by DFG (05P18RDEN9) and HMWK (LOEWE Cluster Nuclear Photonics).

HK 50.6 Wed 17:30 HK-H6

Temperature-dependent relative self absorption measurements in ^{27}Al at DHIPS — •P. Koseoglou, M. L. Cortes, J. Isaak, V. Werner, O. Papst, J. Kleemann, M. Beuschlein, N. Pietralla, U. Ahmed, K. E. Ide, I. Jurosevic, C. Nickel, M. Spall, T. Stetz, and R. Zidarova — Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

Self-absorption measurements probe the photoexcitation process of nuclear resonances and, thus, provide direct sensitivity to ground-state transition widths [1-3]. First temperature-dependent relative self-absorption (T-RSA) in nuclear resonance fluorescence measurements on ^{27}Al were performed at the Darmstadt High Intensity Photon Setup (DHIPS) of S-DALINAC. A technique was tested in which measurements are done at multiple absorber temperatures. The advantage of this technique, over the regular RSA, is the possibility to overcome the need for theory input on the effective temperatures, which can be complicated for compound materials, and the uncertainties that they introduce in the measured level widths [2]. The technique and the preliminary results of the first measurements will be presented.

This work was supported by the State of Hesse under grant "Nuclear Photonics" within the LOEWE program.

[1] N. Pietralla et al., Phys. Rev. C **51** 1021 (1995).
[2] U. Friman-Gayer et al., Phys. Rev. Lett. **126** 102501 (2021).
[3] A. Zilges, D. L. Balabanski, J. Isaak, N. Pietralla, Prog. Part. Nucl. Phys. **122** 103903 (2022).

HK 51: Structure and Dynamics of Nuclei IX

Time: Wednesday 16:00–17:30 Location: HK-H7

Group Report HK 51.1 Wed 16:00 HK-H7

Studying Exotic Nuclei with the FRS Ion Catcher — •Sönke Beck for the FRS Ion Catcher-Collaboration — Justus-Liebig-Universität, Gießen, Germany — GSI, Darmstadt, Germany

At the FRS at GSI, exotic nuclei are produced at relativistic velocities by projectile fragmentation or fission. With the FRS Ion Catcher (FRS-IC) experiment they can be slowed down and thermalized in a cryogenic stopping cell (CSC), which in addition contains a ^{252}Cf spontaneous fission source. Their mass and abundance can be measured using a multiple-reflection time-of-flight mass-spectrometer (MR-TOF-MS). The MR-TOF-MS has single-ion sensitivity and features resolving powers of up to one million, or broadband measurements, like covering more than 20 mass units with mass resolving powers exceeding 250 000 in a measurement time of about 10 ms. Thus, very low yields can be handled and masses of nuclei from different production mechanisms can be measured accurately.

High-accuracy mass measurements at the borders of the known nuclear landscape were performed, including neutron-deficient light lanthanides close to the proton drip line and neutron rich nuclei around the $N = 126$ shell closure. Masses of nuclei close to the $N = Z$ line shed light on nuclear structure, for instance the proton-neutron interaction. From the ^{252}Cf internal source, masses and yields of spontaneous fission products can be obtained. Further upgrades will allow studying multi nucleon transfer reactions, and the masses of the respective neutron-rich products can improve nuclear astrophysics r-process calculations. Recent results will be discussed, concluded by an outlook.

HK 51.2 Wed 16:30 HK-H7

Fission isomer studies with the FRS — •Jianwei Zhao[1], Timo Dickel[1,2], Moritz P. Reiter[3], Peter G. Thirolf[4], Michiharu Wada[5], Nazarena Tortorelli[4,1], and Ziga Brencic[6] for the S530-Collaboration — [1]GSI, Darmstadt, Germany — [2]JLU Gießen, Gießen, Germany — [3]University of Edinburgh, Edinburgh, UK — [4]LMU Munich, Munich, Germany — [5]Wako Nuclear Science Center, Saitama, Japan — [6]University of Ljubljana, Ljubljana, Slovenia

Multi-humped fission barriers as they occur in the actinide region give rise to isomeric fission. Such barrier shapes can be described as the result of superimposing microscopic shell corrections to the macroscopic liquid drop barrier. A whole 'island' of fission isomers has been identified in the actinide region (Z = 92 - 97, N = 141- 151) with presently 35 experimentally observed fission isomers. Half-lives range from 5 ps to 14 ms. We will present the results of fission isomer studies with the FRS at GSI. For the first time, the fragmentation of 1 GeV/u ^{238}U projectiles, instead of so-far used light-particle induced reactions, was employed to study fission isomers. The projectile fragmentation gives access to isotopes hard or impossible to reach by light particle reactions and the in-flight separation with FRS allows studying fission isomers with short half-lives. Most importantly, it provides beam with a high purity and with the event-by-event identification. Two detection methods were used to cover fission isomers with half-lives in the range of about 50 ns to 50 ms: beam implantation in a fast plastic scintillator and in a cryogenic stopping cell at the FRS Ion Catcher.

HK 51.3 Wed 16:45 HK-H7

Towards solving the puzzle of high temperature light (anti)-nuclei production in ultra-relativistic heavy ion collisions — •Tim Neidig[1], Carsten Greiner[1], Kai Gallmeister[2], Volodymyr Vovchenko[3], and Marcus Bleicher[1] — [1]Institut for Theoretical Physics, Frankfurt am Main, Germany — [2]nstitut for Theoretical Physics, Gießen, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley, USA

The creation of loosely bound objects in heavy ion collisions, e.g. light clusters, near the phase transition temperature (T ~ 155 MeV) has been a puzzling observation that seems to be at odds with Big Bang nucleosynthesis suggesting that deuterons and other clusters are formed only below a temperature T ~ 0.1-1 MeV. We showed that the light cluster abundancies in heavy ion reactions stay approximately constant from chemical freeze-out to kinetic freeze-out. To this aim we develop an extensive network of coupled reaction rate equations including stable hadrons and hadronic resonances to describe the temporal evolution of the abundancies of light (anti-)(hyper-)nuclei in the late hadronic environment of an ultrarelativistic heavy ion collision. However, because of the partial chemical equilibrium of the stable hadrons, including the nucleon feeding from resonances, the abundancies of the light nuclei stay nearly constant during the evolution and cooling of the hadronic phase and are in excellent agreement with those measured by ALICE at LHC.

HK 51.4 Wed 17:00 HK-H7

Coalescence in Monte Carlo generators and implications for cosmic ray studies — •Maximilian Horst — Technical University Munich

Coalescence is one of the main models used to describe the formation of light (anti)nuclei. It is based on the hypothesis that two nucleons close in phase space can coalesce and form a nucleus. Coalescence has been successfully tested in hadron collisions at colliders, from small (pp collisions) to large systems (Au-Au collisions). However, in Monte Carlo simulations (anti)nuclear production is not described by event generators. A possible solution is given by the implementation of coalescence afterburners, which can describe nuclear production on an event-by-event basis. This idea would find application in astroparticle studies, allowing for the description of (anti)nuclear fluxes in cosmic rays, which are crucial for indirect Dark Matter searches. In this presentation, the implementation of event-by-event coalescence afterburners will be discussed, focusing on different approaches and on the comparison with the experimental results for different collision systems.

HK 51.5 Wed 17:15 HK-H7

The PUMA Experiment: Investigating Short-lived Nuclei with Antiprotons — •Alexander Schmidt, Alexandre Obertelli, and Frank Wienholtz — Technische Universität Darmstadt

The antiProton Unstable Matter Annihilation (PUMA) experiment is a nuclear physics experiment at CERN which will provide the ratio of protons to neutrons in the tail of the nucleon density distributions to constrain nuclear structure theories. To determine this ratio, the interaction of antiprotons and nuclei at low relative energies is used. Following the captures of the antiproton by the nucleus (formation of antiprotonic atom), the antiproton cascades towards the nucleus and eventually annihilates with a nucleon. This annihilation conserves the total charge, so that the annihilated nucleon can be identified by detecting all charged pions produced in the annihilation. The process takes place at larger radii than usual nuclear reactions (e.g. nucleon removal reactions), making this method unique for nuclei with a high neutron-to-proton asymmetry, i.e. short-lived nuclei close to the driplines, halo nuclei and nuclei with a thick neutron skin. As there is no joint facility for antiprotons and short-lived nuclei available, a transportable experimental setup is needed to bring antiprotons from ELENA/CERN to the nuclei at ISOLDE/CERN.

This talk will give an overview over the fundamental physics, the experimental setup and technique as well as the current status of the experiment.

HK 52: Hadron Structure and Spectroscopy IX

Time: Wednesday 16:00–17:30 Location: HK-H8

HK 52.1 Wed 16:00 HK-H8

Recent polarization observable results in η- and η'-photoproduction off the proton. — •Jakob Krause for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn.

While generally good agreement exists for low lying baryonic resonances, especially for high masses there are much more resonances predicted than actually found. This is also known as the problem of the "missing resonances", indicating the poor understanding of QCD in the non-perturbative region. Studying meson photoproduction off the nucleon promises to give further insight into the nucleon excitation spectrum. The analysis thereof requires partial wave analysis (PWA) to identify contributing resonances. It is essential to measure single and double polarization observables in order to find unambiguous PWA solutions. The CBELSA/TAPS experiment located at the electron stretcher accelerator ELSA in Bonn is dedicated to measuring different polarization observables in meson photoproduction employing a polarized photon beam and a polarized target.

This talk will present preliminary results concerning the polarization observable Σ in the reactions $\gamma p \to p\eta$ and $\gamma p \to p\eta'$ measured at the CBELSA/TAPS experiment, which were obtained using Bayesian inference.

HK 52.2 Wed 16:15 HK-H8

Study of neutral-pion pair production in two-photon scattering at BESIII — •Max Lellmann, Achim Denig, and Christoph Florian Redmer for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

The anomalous magnetic moment of the muon, a_μ, is one of the most precisely measured observables of the Standard Model, yet it shows a discrepancy of 4.2σ between Standard Model prediction and measurement. It is still unclear whether this discrepancy is due to a mistake in the measurement, due to a hint for New Physics, or due to a poor understanding of strong interaction at low energies.

The uncertainty of the standard model prediction of a_μ is currently limited by the calculation of the hadronic contributions. The hadronic Light-by-Light contribution to a_μ yields the largest relative uncertainty of all contributions. It is crucial to obtain a better understanding of the coupling of photons to hadrons, especially at small momentum transfers.

The BESIII experiment, located at the institute of high energy physics in Beijing/China, offers a perfect test bed for the investigation of two-photon processes at small momentum transfers. The process $e^+e^- \to e^+e^-\pi^0\pi^0$ is measured at the BESIII experiment at centre-of-mass energies between 3.77 and 4.6 GeV with a total integrated luminosity of more than 10 fb^{-1}. This presentation will discuss the current status of the analysis.

HK 52.3 Wed 16:30 HK-H8

Study of the diffractively produced $\pi\pi\omega$ Events at COMPASS — •Philipp Haas — Physik-Department E18, Technische Universität München

The COMPASS experiment is a multi-purpose fixed-target experiment at the CERN SPS. One of its major goals is the search for so-called exotic mesons that cannot be described as quark-antiquark states. To this end, COMPASS has acquired large data samples on diffractive production of exited light mesons by a 190 GeV/c π^- beam on a proton target. The $\pi_1(1600)$ meson with spin, parity, and charge-conjugation quantum numbers $J^{PC} = 1^{-+}$, which are forbidden for $q\bar{q}$ states, is a promising candidate for a hybrid meson and agrees with predictions from lattice QCD. Lattice QCD further predicts that the $\pi_1(1600)$ dominantly decays into $b_1(1235)\pi$.

While $\pi_1(1600)$ signals have been found in the COMPASS data on $\rho(770)\pi$, $\eta\pi$, and $\eta'\pi$ decay modes, the $b_1(1235)\pi$ channel has so far not been studied. We will present first results of an analysis of COMPASS data on the diffractive process $\pi^-p \to \pi^-\pi^0\omega(782)p$, which includes the $b_1(1235)\pi$ channel. We performed an event selection resulting in a data sample of 730000 events. These data contain clear signals for $b_1(1235) \to \omega(782)\pi$ and will help us to study the $\pi_1(1600)$, and to verify the $\pi_1(2015)$ signal claimed by the BNL E852 experiment.

HK 52.4 Wed 16:45 HK-H8

The full COMPASS dataset of the diffractively produced $\eta^{(\prime)}\pi^-$ final state — •Henri Pekeler, Simon Havemann, David Spülbeck, Mathias Wagner, and Bernhard Ketzer for the COMPASS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The diffractive production of the $\eta^{(\prime)}\pi^-$ system in the $p + \pi^- \to \eta^{(\prime)}\pi^- + p$ channel is very exciting because the partial wave with orbital angular momentum $L = 1$ between the two pseudoscalars carries spin-exotic quantum numbers $J^{PC} = 1^{-+}$. The observation of a resonance in this wave is considered a smoking gun for a hybrid meson with gluonic degrees of freedom.

Data for diffractive π^- proton scattering was taken by COMPASS in two different years. In the talk, we will present the full data set, which, together with recent improvements for the reconstruction, yields an increase of the data sample around a factor of 2 with respect to the data published previously by COMPASS, and around a factor of 4 compared to earlier data sets collected by the E852 collaboration. This allows us to perform a 2-dim. PWA in bins of the invariant mass and the 4-momentum transfer squared t.

Supported by BMBF.

HK 52.5 Wed 17:00 HK-H8

Analysis of data from a pilot run to measure the proton charge radius at AMBER — •Martin Hoffmann for the AMBER-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The proton charge radius can be determined either by measuring the slope of the electric form factor via elastic lepton-proton scattering at low squared four-momenta Q^2 or by laser spectroscopy of hydrogen. Previous measurements of elastic electron-proton scattering as well as laser-spectroscopy of muonic and ordinary hydrogen yielded contradicting results. The AMBER collaboration plans to conduct a precision measurement of the proton electric form factor using high-energy muon-proton elastic scattering. This complementary approach avoids many of the systematic uncertainties of low-energy electron-proton elastic scattering.

The recoil proton is going to be detected in a high-pressure hydrogen time projection chamber (TPC), measuring the transferred momentum. The muon kinematics will be measured with silicon tracking detectors surrounding the TPC and parts of the upgraded COMPASS spectrometer. In 2021, a pilot run was performed in order to study key parts of the full setup under realistic beam conditions.

This contribution presents preliminary results of the pilot run analysis and on-going Monte Carlo simulations.

Supported by EU.

HK 52.6 Wed 17:15 HK-H8

Unified Tracking Stations for the Proton-Radius Measurement at AMBER
— •Karl Eichhorn for the AMBER-Collaboration — Technische Universität München, Physik-Department, Garching, Germany

The proton radius can be determined by measuring the slope of the electric form factor G_E at small squared four-momentum transfer Q^2. Numerous elastic scattering and laser spectroscopy measurements of the proton radius have been performed with contradicting results – the so-called proton radius puzzle. We propose to measure the proton radius in high-energy elastic muon-proton scattering at the M2 beam line of CERN's Super Proton Synchrotron in the year 2023. A high-precision measurement at low Q^2 realized with a high-pressure hydrogen TPC can contribute to a solution of the puzzle, especially in view of the systematics of this approach compared to electron scattering. A combined measurement of the recoil proton and the muon trajectory will be performed. In addition to the precise information about the recoil proton provided by the TPC, a novel unified tracking station is foreseen for an accurate measurement of the scattered muon. Thin scintillating fibers read out by SiPMs joint with monolithic silicon-pixel detectors are used for the reconstruction of the scattered muon. A first prototype beam test is foreseen in the year 2022. We present on-going studies and developments of this unified tracking station.

HK 53: Hadron Structure and Spectroscopy X

Time: Wednesday 16:00–17:30 Location: HK-H9

Group Report HK 53.1 Wed 16:00 HK-H9

The BGOOD Experiment at ELSA - Exotic Structures in the uds Sector?
— •Johannes Gross for the BGOOD-Collaboration — Physikalisches Institut Bonn

The discoveries of the X-, Y-, Z-states in the hidden charm meson sector by Belle and the P_c baryon states by LHCb shed a new light on our understanding of hadronic structure formation: Multi-quark states beside the conventional $q\bar{q}$ and qqq states now have unambiguously been realised. Such states could manifest themselves as single color-bound objects or, contrary, as molecular-like meson-meson or meson-baryon formations. Intriguingly, similar effects to those in the charm sector may be evidenced in the light uds sector. In order to study this, access to extreme forward angles and low transverse momentum kinematics is mandatory. To realise this, the BGOOD experiment at ELSA combines a central calorimeter for neutral meson identification with a forward spectrometer for charged particle identification. First results of the BGOOD experiment that support the possibility of such exotic structures are presented, e.g. cross section measurements of $\gamma p \rightarrow K^+\Lambda(1405)$, $\gamma p \rightarrow K^+\Sigma^0$ and $\gamma n \rightarrow K^0\Sigma^0$ that show pronounced structures in the proximity of production thresholds.

Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

HK 53.2 Wed 16:30 HK-H9

Search of the exotic nuclear two-photon emission decay in isochronous heavy ion storage rings
— •David Freire[1,2,3,4], F. Çağla Akinci[5], Klaus Blaum[1,2], Wolfram Korten[3], Yuri A. Litvinov[2,4], Shahab Sanjari[4,6], and the E143 Collaboration[4] — [1]Max Planck Institute for Nuclear Physics, D-69117 Heidelberg, Germany — [2]Heidelberg University, D-69117 Heidelberg, Germany — [3]IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France — [4]GSI Helmholtz Center, D-64291 Darmstadt, Germany — [5]Istanbul University, T-34452 Istanbul, Turkey — [6]Aachen University of Applied Sciences, D-52005 Aachen, Germany

The nuclear two-photon (2γ) decay is a rare decay mode in atomic nuclei whereby a nucleus in an excited state emits two gamma rays simultaneously. First order processes usually dominate the decay, however two-photon emission may become significant when first order processes are forbidden or strongly retarded, which can be achieved at the experimental storage ring ESR (GSI/FAIR). Within this work we will present the implemented methodology and the obtained results of two beam times performed in 2021, when for the first time the isochronous mode of ESR alongside non-destructive Schottky detectors were operated for the study of short-lived isomer production yields and lifetimes. We investigated specifically the isotope ^{72}Ge, as it is the most easily accessible nucleus having a first excited 0^+ state below the pair creation threshold paramount for the study of 2γ decay without competition of first order decays. In addition, the nuclei ^{70}Se and ^{72}Br were studied, as their isomeric states play a major role in nuclear astrophysics.

HK 53.3 Wed 16:45 HK-H9

Lifetime Measurement in ^{206}Rn and ^{202}Pb via γ-γ Fast-Timing Spectroscopy
— •Mario Ley, Arwin Esmaylzadeh, Lukas Knafla, Jean-Marc Régis, and Jan Jolie — Institut für Kernphysik, Universität zu Köln

Lifetimes of the first excited 2^+ , 4^+ , 6^+ , 8^+ states in ^{206}Rn and the 2^+ and 4^+ states in ^{202}Pb were measured using the γ-γ fast-timing technique with a detector array consisting of $LaBr_3$(Ce) and HPGe detectors. The experiment was performed at the FN-Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The well established Generalized Centroid Difference (GCD) method [1], which is suitable for the determination of lifetimes in the pico- to nanosecond regime, was used to determine the lifetimes.

The derived reduced transition probabilities are discussed with regard to the onset of collective structures for low-lying excited states in ^{206}Rn and the results are compared with shell-model calculations based on the Nucleon Pair Approximation [2].

[1] J.-M. Régis et al., Nucl. Instrum. Methods Phys. Res. A 726 (2013)
[2] Z. Y. Xu, Y. Lei, Y. Zhao, A. Arima, et al., Phys. Rev. C, 79:054315, (2009)

HK 53.4 Wed 17:00 HK-H9

Preliminary results of Lifetime Measurements in ^{208}Rn via γ-γ Fast-Timing Spectroscopy
— •Jan Garbe, Dennis Bittner, Arwin Esmaylzadeh, Guillaume Häfner, Vasil Karayonchev, Jean-Marc Regis, and Jan Jolie — Institut für Kernphysik, Universität zu Köln

Lifetimes of low-lying excited states in ^{208}Rn were measured using the γ-γ fast-timing technique with a detector array consisting of 12 $LaBr_3$(Ce) and 8 HPGe detectors. The experiment was performed at the 10 MV FN-Tandem accelerator of the Institute for Nuclear Physics at the University of Cologne. The sub-nanosecond lifetimes were determined by means of relative centroid shift measurements.

These results were then compared to shell-model calculations.

HK 53.5 Wed 17:15 HK-H9

Lifetime measurements in the ground-state band in ^{104}Pd
— •Maximilian Droste[1], Andrey Blazhev[1], Peter Reiter[1], Nigel Warr[1], Konrad Arnswald[1], Marcel Beckers[1], Robert Hetzenegger[1], Rouven Hirsch[1], Levent Kaya[1], Lukas Knafla[1], Lars Lewandwoski[1], Claus Müller-Gatermann[1], Pavel Petkov[2,1], Dawid Rosiak[1], Burkhard Siebeck[1], Andreas Vogt[1], and Kai Wolf[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Horia Hulubei National Institute for Physics and Nuclear Engineering, Romania

Direct lifetime measurements in ^{104}Pd were motivated to close a gap along the Pd isotope chain. Excited states were populated via the fusion evaporation reaction ^{96}Zr(^{12}C,4n)^{104}Pd at 55 MeV. Lifetime values and reduced transition probabilities were determined in the ground-state band up to the 12^+ state in ^{104}Pd employing the Recoil Distance Doppler-Shift method. The new B(E2; $2^+ \rightarrow 0^+$) value deviates from the evaluated values, which were determined using Coulomb excitation. The transition strengths of higher lying states were obtained for the first time. Recent investigations in other medium weight even-even Pd isotopes question the vibrational character of these Pd isotopes. The experimental results are compared to Large Scale Shell-Model calculations (LSSM) employing the Sr88MHJM interaction. LSSM along the $^{96-106}$Pd isotope chain were performed allowing detailed comparison of level schemes and reduced transition strength values.

HK 54: Nuclear Astrophysics III

Time: Wednesday 16:00–17:30 Location: HK-H10

Group Report HK 54.1 Wed 16:00 HK-H10

Neutronen-induzierte Reaktionen für die Astrophysik — •Mario Weigand, Ernest Ademi, Marcel Bennedik, Lukas Bott, Benjamin Brückner, Sophia Florence Dellmann, Philipp Erbacher, Madeleine Gail, Nicolai Gimbel, Kathrin Göbel, Alexandra Härth, Tanja Heftrich, Svenja Heil, Benedict Heybeck, Alexander Huhn, Sabina Kasilovskaja, Deniz Kurtulgil, Tabea Kuttner, Rim Mourad, Markus Reich, René Reifarth, Tom Staab, Janina Strahl, Diego Vescovi und Meiko Volknandt — Goethe-Universität, Frankfurt a.M., Germany

Für das Verständnis der Häufigkeiten der meisten Elemente schwerer als Eisen spielen Neutroneneinfangreaktionen eine entscheidende Rolle, da die Synthese dieser Elemente durch sukzessive Neutroneneinfänge und Betazerfälle in Sternen verschiedener Stadien erfolgt. Entsprechende Nukleosynthese-Modelle bedürfen experimenteller Daten zu den beteiligten Reaktionsraten. Die Forschungsgruppe "Experimentelle Astrophysik" an der Goethe-Universität Frankfurt hat daher einen Schwerpunkt auf die Messung von Neutroneneinfangwirkungsquerschnitten im astrophysikalisch relevanten Energiebereich gelegt und nutzt dazu die etablierte Aktivierungsmethode. Dabei werden neue Ansätze verfolgt, um Wirkungsquerschnitte für quasistellare Neutronenspektren von T = 5 bis 90 keV zu bestimmen. In diesem Vortrag werden aktuelle Projekte und die neuesten Ergebnisse der letzten Messkampagnen vorgestellt und ein Ausblick über künftige Vorhaben gegeben. Diese Forschungsarbeiten werden gefördert durch das Helmholtz International Center for FAIR.

HK 54.2 Wed 16:30 HK-H10

Proton capture on stored radioactive ions — •Sophia Florence Dellmann[1], Jan Glorius[2], Yuri Litvinov[2], René Reifarth[1], Thomas Stöhlker[2,3], Laszlo Varga[2], and Mario Weigand[1] for the E127-Collaboration — [1]Goethe University Frankfurt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [3]Helmholtz-Institut Jena, Germany

By combining two unique facilities at GSI (Helmholtz Centre for Heavy Ion Research), the fragment separator FRS and the experimental storage ring ESR, the first direct measurement of a proton capture reaction of a stored radioactive isotope has been accomplished. The cross section of the ^{118}Te(p,γ) reaction was measured at energies of astrophysical interest.

The ions were stored with energies of 6 and 7 MeV/nucleon and interacted with a hydrogen jet target. The produced ^{119}I ions were detected with double-sided silicon strip detectors. The radiative recombination process of the fully stripped ^{118}Te ions and electrons from the hydrogen target was used as a luminosity monitor. The proof-of-principle experiment had been performed in 2016 with the stable isotope ^{124}Xe [1]. An overview of the experimental method and preliminary results from the ongoing analysis will be presented.

[1]J. Glorius et al., Phys. Rev. Lett. 122, 092701 (2019)

HK 54.3 Wed 16:45 HK-H10

Nearly background-free measurement of proton-capture reactions using the Experimental Storage Ring — •Laszlo Varga[1], Sophia Florence Dellmann[2], Jan Glorius[1], Yuri A. Litvinov[1], René Reifahrt[2], and Thomas Stöhlker[1,3] for the E127-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung Darmstadt, Germany — [2]Goethe University Frankfurt, Germany — [3]Helmholtz-Institut Jena, Germany

After the successful campaign for proton-capture measurements on stored stable beams at the Experimental Storage Ring at GSI in 2009 and 2016 [1-2], new experiments have been carried out in 2020 and 2021 using a radioactive ion beam. The complex spatial ion hit distributions on the employed UHV-compatible double sided silicon strip detectors (DSSSD) have been modeled through Monte-Carlo based ion-optical simulations using the MOCADI code [3]. To improve the sensitivity of the experimental method the "Elimination of the Rutherford elAstic ScattEring" (ERASE) technique has been developed. With the application of ERASE the sensitivity for the ions of interest is dramatically increased. The suitability of the method was demonstrated in 2020 and in 2021. In this talk, the measured ion-hit spectra of the DSSSD will be introduced focusing on the effects of the ERASE technique. The newly developed method is a powerful tool to study the proton-capture efficiently on nuclei hardly accessible in large quantities.

[1] - Mei B et al 2015 Phys. Rev. C92 035803
[2] - Glorius J et al 2019 Phys. Rev. Lett. 122 092701
[3] - Iwasa N et al 1997 NIM B 126 284-289

HK 54.4 Wed 17:00 HK-H10

Analysis of the 3α-decay of the 0_2^+ state in ^{12}C — •David Werner[1], Madalina Ravar[1,3], Peter Reiter[1], Konrad Arnswald[1], Maximilian Droste[1], Pavel Golubev[2], Rouven Hirsch[1], Hannah Kleis[1], Nikolas Königstein[1], Dirk Rudolph[2], Alessandro Salice[1], and Luis Sarmiento[2] — [1]University of Cologne, Institute for Nuclear Physics, Cologne — [2]Lund University, Department of Physics, Lund, Sweden — [3]TU Darmstadt, Institute of Nuclear Physics, Darmstadt

The branching ratios of the three-particle decay of the Hoyle state, the 0_2^+ excited state in ^{12}C, are an important probe for the inner structure of ^{12}C and relevant to the topic of stellar nucleosynthesis. A ^{12}C(α,α') reaction at 27 MeV beam energy was utilized to populate the state of interest. Two high-statistics experiments were performed at the 10 MV FN-tandem accelerator of the Institute for Nuclear Physics of the University of Cologne. The Lund-York-Cologne-Calorimeter (LYCCA) was used to study the three-particle decay branches of the Hoyle state. The 18 highly-segmented double-sided silicon strip detectors allowed individual detection of the reaction's four α particles with very high angular precision. Results from particle spectra are compared with Geant4 Monte-Carlo simulations. Preliminary results of the analysis, in particular Dalitz plots, will be presented.

HK 54.5 Wed 17:15 HK-H10

Measurement of the inelastic cross sections of antinuclei with ALICE and the implications for indirect dark matter searches — •Stephan Koenigstorfer for the ALICE-Collaboration — Technische Universität München

Antinuclei in cosmic rays are considered a unique probe for signals from exotic physics, such as WIMP Dark Matter annihilations. Indeed, these channels are characterised by a very low astrophysical background, which comes from antinuclei produced by high energy cosmic ray interaction with ordinary matter. In order to make quantitative predictions for antinuclei fluxes near earth, both the production and annihilation cross sections of antinuclei need to be accurately known down to low energies.

In ultra relativistic pp and Pb-Pb collisions at the CERN LHC, matter and antimatter are abundantly produced in almost equal amounts, allowing us to study the production of antinuclei and measure their absorption in the detector material. The antinuclei absorption cross section is evaluated on the average ALICE material. Using this result, we then predict the transparency of our galaxy to anti-3He from both dark matter annihilations and high energy cosmic ray collisions. In this talk we present the first measurements of the anti-3He and anti-3H absorption cross section with ALICE and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.

HK 55: Invited Talks V

Time: Thursday 11:00–12:30 Location: HK-H1

Invited Talk HK 55.1 Thu 11:00 HK-H1

Online data processing with GPUs in ALICE during LHC Run 3 — •David Rohr for the ALICE-Collaboration — CERN, Geneva, Switzerland

The ALICE experiment has undergone a major upgrade for LHC Run 3 and will record 50 times more heavy ion collisions than before. The new computing scheme for Run 3 replaces the traditionally separate online and offline frameworks by a unified one. Processing will happen in two phases. During data taking, a synchronous processing phase performs data compression, calibration, and quality control on the online computing farm. The output is stored on an on-site disk buffer. When there is no beam in the LHC, the same computing farm is used for the asynchronous reprocessing of the data which yields the final reconstruction output. ALICE will employ neither hardware nor software triggers for Pb-Pb data taking but instead store all collisions in compressed form. This requires full online processing of all recorded data, which is a major change compared to a traditional online systems, which sees only the data selected by a hardware trigger. To cope with the increased data rate and computing requirement, ALICE employs graphics cards (GPUs) as the backbone of the online processing. In order to make full use of the online farm also for asynchronous reconstruction, also a large fraction of the asynchronous phase is being designed to run on GPUs. The talk will detail the ALICE Run 3 computing scheme, and outline the hardware architecture and software design for synchronous and asynchronous processing.

Invited Talk HK 55.2 Thu 11:30 HK-H1

From outer space to deep inside: nuclear physics prospects at MAMI and MESA — •Michaela Thiel — Institut für Kernphysik, JGU Mainz

The Equation of State (EoS) links together fundamental properties of nuclear matter. Heavy nuclei, though orders of magnitude smaller than neutron stars, are governed by the same underlying physics, which is enshrined in the EoS. An accurate and model-independent determination of the neutron-skin thickness of heavy nuclei, using parity-violating electron scattering, will provide significant constraints on the density dependence of the nuclear symmetry energy, a key parameter of the EoS. Within the scope of the P2 experimental setup at MESA, the Mainz Radius EXperiment (MREX) will determine the neutron-skin thickness of ^{208}Pb with ultimate precision. For the interpretation of this and future parity-violation measurements at the precision frontier, theoretical predictions with uncertainties below those of the experiments are required. To that end it is mandatory to go beyond the one-photon exchange approximation and include higher-order corrections. Corresponding measurements of the beam-normal single spin asymmetry A_n, an observable sensitive to two-photon exchange processes, are essential to benchmark such calculations. A comprehensive systematic study of the Q^2 and Z dependence of A_n in the mass regime ^{12}C to ^{90}Zr at MAMI, using the A1 spectrometer setup, has laid an excellent foundation for the near-future parity-violation measurement program at MESA. Status and prospects of the projects will be presented. (Talk will be given on behalf of the A1 and P2 collaborations)

Invited Talk HK 55.3 Thu 12:00 HK-H1
CMOS Monolithic Active Pixel Sensors — •Michael Deveaux — GSI Darmstadt
Being pioneered by the IPHC Strasbourg, CMOS Monolithic Active Pixel Sensors for charged particle tracking feature an attractive combination of highest detection efficiency, spatial precision (~ 5 μm) and low power dissipation. The 50 μm thin sensors may be combined with ultra-light support structures and cooling systems. Thanks to progress in CMOS industry and the joined efforts of the community, their rate capability and radiation tolerance were improved by several orders of magnitude during the past 20 years. The maturity reached nowadays allows to use the sensors in multiple applications requiring highest tracking precision in combination with advanced rate capability and time resolution. This includes state-of-the-art tracking and vertex detectors as known from STAR, ALICE, the future CBM experiment and possibly future charm and Higgs factories.

The contribution summarizes the features, capabilities and remaining limitations of the technology and gives a brief insight into current R&D activities within and beyond the hadron physics community.

HK 56: Heavy-Ion Collisions and QCD Phases XI

Time: Thursday 14:00–15:30 Location: HK-H1

Group Report HK 56.1 Thu 14:00 HK-H1
ALICE 3 – A Next-Generation Heavy-Ion Experiment — •Sebastian Scheid for the ALICE-Collaboration — Goethe University, Frankfurt, Germany
In this contribution we will present ALICE 3, a detector proposed for the next-generation heavy-ion program in LHC Run 5 and 6. The innovative detector concept, will give access to novel measurements of electromagnetic and hadronic probes of the QGP at very low momenta that will remain inaccessible in LHC Run 3 and 4. This includes the multi-differential measurement of thermal dileptons, that provide insight on the early phases of the medium formation. The measurement of multi charm states and exotic objects in the heavy flavour sector, as well as the correlation of heavy-flavour hadrons can be used to gain information on the hadronisation and strong interaction processes.

To achieve these measurements the detector has to provide tracking and particle identification down to lowest transverse momenta with an unprecedented pointing resolution while keeping the material budget to a minimum.

HK 56.2 Thu 14:30 HK-H1
Production of non-prompt Λ_c^+ in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Daniel Battistini for the ALICE-Collaboration — Università degli Studi di Torino, Turin, Italy
In proton-proton (pp) collisions, the production of heavy-flavour (HF) hadrons is typically described as a convolution of the parton distribution functions of the colliding protons, the partonic cross section, and the Fragmentation Functions (FFs). The latter describes the hadronisation of the heavy quarks in the different hadron species, and, since this process is non-perturbative, it is usually parametrised from measurements in e^+e^- collisions. However, recent studies by the ALICE Collaboration show that the ratio between the production of charm baryons with respect to mesons is significantly higher in hadronic collisions compared to e^+e^- interactions, invalidating the assumption that the FFs are independent of the collision system.

This contribution presents an extension of the studies on HF-baryon production in hadronic collisions to the beauty sector, via the measurement of the transverse-momentum-differential production cross section of Λ_c^+-baryon originating from beauty-hadron decays in pp collisions at $\sqrt{s}$ = 13 TeV. The measurement will also be compared to theoretical predictions based on fixed order plus next to the leading logarithm pQCD calculations folded with the beauty-hadron to Λ_c^+ decay kinematics from PYTHIA8 simulations.

HK 56.3 Thu 14:45 HK-H1
CBM performance for the measurement of strange hyperons' anisotropic flow in Au+Au collisions at FAIR SIS-100 energies — •Oleksii Lubynets[1,2] and Ilya Selyuzhenkov[1,3] for the CBM-Collaboration — [1]GSI, Darmstadt, Germany — [2]Goethe Universität Frankfurt, Germany — [3]NRNU MEPhI, Moscow, Russia
The main goal of the CBM experiment is to study highly compressed baryonic matter produced in collisions of heavy ions. The SIS-100 accelerator at FAIR will enable investigation of the QCD matter at temperatures up to about 120 MeV and net baryon densities 5-6 times the normal nuclear density. Hyperons produced during the dense phase of a heavy-ion collision provide information about the equation of state of the QCD matter. The measurement of (multi)strange hyperons' anisotropic flow is important for understanding the dynamics and evolution of the QCD matter created in the collision.
We will present the status of performance studies for strange hyperons anisotropic flow measurement for the CBM experiment at FAIR. Strange hyperons decay within the CBM detector volume and are reconstructed via their decay topology. The Particle-Finder Simple package, which provides an interface to the Kalman Filter Particle mathematics, is used to reconstruct decay kinematics and to optimize criteria for strange hyperons candidates selection. Anisotropic flow of strange hyperons is studied as a function of rapidity, transverse momentum and collision centrality. The effects due to non-uniformity of the CBM detector response in the azimuthal angle, transverse momentum and rapidity are corrected using the QnTools analysis package.

HK 56.4 Thu 15:00 HK-H1
Σ^0 reconstruction in Ag+Ag collisions at $\sqrt{s_{NN}}$ = 2.55 GeV with HADES — •Marten Becker for the HADES-Collaboration — Justus-Liebig-University Giessen
HADES investigates the moderate temperature and high density regime of the QCD phase diagram. Strangeness can give a direct insight into the created dense matter, in particular close to the nucleon nucleon production threshold. In 2019 HADES collected Ag+Ag collisions at 2.55 GeV center of mass energy. A newly installed electromagnetic calorimeter allows for photon detection. Furthermore the RICH detector was upgraded, which strongly improves electron identification and the detection of conversion-pairs. In this contribution preliminary results on the search for the Σ^0 baryon, decaying electromagnetically into $\Lambda + \gamma$ will be presented. Detailed simulations prove the feasibility of this measurement using photon detection in the electromagnetic calorimeter or by employing photon conversion method based on the reconstruction of low momentum electrons in the RICH. Using the photon detected in the electromagnetic calorimeter an estimate of the Λ/Σ^0 ratio will be extracted.

HK 56.5 Thu 15:15 HK-H1
K_S^0 and Λ production in and outside jets in pp collisions at 13 TeV — •Lucia Anna Tarasovičová — Westfälis- che Wilhelms-Universität Münster, Germany
The contribution of jet fragmentation and soft processes to the strange hadron production in small collisions is still not understood well. Thus, angular correlations between particles can be utilised to study soft and hard fragmentation and production processes as well as the role of multiple parton interactions. Moreover, a study of the multiplicity dependence can further differentiate between the connection of bulk-particle and strangeness production in a more dense environment and the potential role of collective effects. In this talk, we present results on the two-particle correlation studies with respect to a primary charged hadron with high-p_T (3-20 GeV/c) in pp collisions at 13 TeV measured with ALICE. The production of associated K_S^0 mesons, Λ hyperons and primary charged hadrons in jets and out of jets is studied as a function of the transverse momentum of the trigger and associated particles for several event-multiplicity classes. The yields will be compared among different associated particles and compared with PYTHIA and EPOS LHC event generators.

HK 57: Heavy-Ion Collisions and QCD Phases XII

Time: Thursday 14:00–15:30 Location: HK-H2

HK 57.1 Thu 14:00 HK-H2

Measurement of direct photons in $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV Pb-Pb collisions with ALICE at the LHC — •Meike Danisch for the ALICE-Collaboration — Physikalisches Institut Heidelberg

Measurements of direct photons can provide valuable information on the properties and dynamics of the quark-gluon plasma (QGP) by comparing them to model calculations that describe the whole evolution of the system created in heavy-ion collisions, from the initial conditions to the pre-equilibrium, QGP, and hadronic phases.

In the ALICE experiment, photons can be reconstructed either by using the calorimeters or via conversions in the detector material. The photon conversion method benefits from an excellent energy resolution and is able to provide direct photon measurements down to $p_{\mathrm{T}} = 0.4$ GeV/c.

In this talk, we present the first measurements of direct photon production in Pb–Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV by ALICE, including direct photon spectra from central to peripheral events.

HK 57.2 Thu 14:15 HK-H2

Virtual Photon Measurements with the HADES at GSI — •Jan-Hendrik Otto for the HADES-Collaboration — Justus-Liebig Universität, Gießen, Germany

The **H**igh **A**cceptance **DiE**lectron **S**pectrometer (HADES) is dedicated to the measurement of electromagnetic probes from heavy ion collisions and to study the in-medium behaviour of dileptons in the moderate temperature and high density regime of the QCD phase diagram. Dileptons as penetrating probes are messengers of this dense medium and can reveal the thermal properties and the lifetime of the medium but also give insight into meson properties at high densities.

In this talk we present preliminary results of HADES on the dielectron analysis of 4.5 billion Ag+Ag collisions (0 – 40% centrality) at a centre-of-mass energy of $\sqrt{s_{NN}} = 2.55\,GeV$. The upgraded RICH detector offers excellent electron identification and suppression of conversion-pairs resulting in a signal-to-background ratio larger than 1 for $M_{e^+e^-} > 500MeV/c^2$. The high statistics data sample in combination with a strongly increased electron detection effciency and background suppression allow for a differential analysis in terms of centrality or electron-pair-momentum with a signal up to the phi meson mass region. For higher pair-momenta a signal of the omega meson is clearly seen while vanishing for lower pair-momenta. The temperature extracted from the intermediate mass region compares well with the HADES measurement in Au+Au collisions at $\sqrt{s_{NN}} = 2.42\,GeV$. The obtained dielectron signal spectrum is compared to simulated hadronic cocktail and nucleon-nucleon reference spectra.

HK 57.3 Thu 14:30 HK-H2

Physics opportunities with photons for the ALICE3 experiment — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3, to further contribute to the characterization of the macroscopic QGP properties with unprecedented precision at the LHC Run 5.

Since direct photons provide information about the initial stage of the collision as well as the space-time evolution of the QCD medium, studying background photons signals from meson decays deserves mention. The possibility of reconstruction photons through their conversion in the detector material, benefiting from the good momentum resolution for charged particles, and the large pseudorapidity coverage of the ALICE 3 detector can be jointly exploited to measure neutral mesons with high precision over a large momentum range.

While measurements of J/ψ, Υ are abundant at the LHC, measurements of χ_c, χ_b and other $L = 1$ states in wide p_T and rapidity ranges are needed, to provide stronger constraints on the spectral properties of bound states in the QGP and allow for a more accurate description of the dynamics of quarkonium interactions with the medium.

In this talk, we present performance studies of η meson measurements using the photon conversion method for ALICE 3. Moreover, the performance of χ_c measured through the radiative decay channel $\chi_c \to J/\psi + \gamma$ is also presented.

HK 57.4 Thu 14:45 HK-H2

Direct photons in high-multiplicity pp collisions with dielectrons in ALICE — •Ivan Vorobyev for the ALICE-Collaboration — Technische Universität München

Low-mass e^+e^- pairs produced in ultra-relativistic heavy-ion collisions at the LHC carry important information about the system space-time evolution unperturbed by strong final-state interactions. The dielectron continuum is very rich in physics sources: on top of Dalitz and resonance decays of pseudo-scalar and vector mesons, thermal black-body radiation contains the information about the temperature of the hot and dense system created in heavy-ion collisions. In proton–proton (pp) collisions, measurement of direct photons serves as a fundamental test for perturbative QCD calculations and as a baseline for the studies in heavy-ion collisions. Recently, pp collisions with high charged-particle multiplicities have been found to exhibit interesting phenomena resembling some observations done in heavy-ion collisions. Low-mass dielectrons could provide additional information regarding the underlying physics processes in such collisions.

We present the latest results from the dielectron analysis of large data sample of pp collisions at $\sqrt{s} = 13$ TeV collected with ALICE during the LHC Run 2. A particular focus of the discussion is put on the production of direct photons in pp collisions collected with a trigger on high charged-particle multiplicities. The relative increase of dielectron production in high-multiplicity events with respect to all inelastic collisions is compared to the expectations from already measured multiplicity-dependent production of light and heavy hadrons.

HK 57.5 Thu 15:00 HK-H2

Physics opportunities with photons for the ALICE3 experiment — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3, to further contribute to the characterization of the macroscopic QGP properties with unprecedented precision at the LHC Run 5.

Since direct photons provide information about the initial stage of the collision as well as the space-time evolution of the QCD medium, studying background photons signals from meson decays deserves mention. The possibility of reconstruction photons through their conversion in the detector material, benefiting from the good momentum resolution for charged particles, and the large pseudorapidity coverage of the ALICE 3 detector can be jointly exploited to measure neutral mesons with high precision over a large momentum range.

While measurements of J/ψ, Υ are abundant at the LHC, measurements of χ_c χ_b and other $L = 1$ states in wide p_T and rapidity ranges are needed, to provide stronger constraints on the spectral properties of bound states in the QGP and allow for a more accurate description of the dynamics of quarkonium interactions with the medium.

In this talk, we present performance studies of η meson measurements using the photon conversion method for ALICE 3. Moreover, the performance of chi_c measured through the radiative decay channel $\chi_c \to J/\psi + \gamma$ is also presented.

HK 57.6 Thu 15:15 HK-H2

Background studies for a soft-photon measurement with the Forward Conversion Tracker in ALICE 3 — •Tim Rogoschinski for the ALICE-Collaboration — IKF Frankfurt

We propose to construct a Forward Conversion Tracker at the LHC to measure photons of a few MeV in transverse momentum, so called ultra-soft photons, which have the potential to resolve the long standing "soft-photon puzzle": Several experiments have observed an excess of ultra-soft photons with respect to the expected yield from Low's theorem, which is very fundamentally relating ultra-soft photon production from inner Bremsstrahlung and the spectrum of charged hadrons. It is proposed to include a Forward Conversion Tracker (FCT) in ALICE 3, the next-generation heavy-ion collision experiment proposed for Run 5 and 6 at the LHC, to measure ultra-soft photons. The dominant background in this measurement, decay photons and external Bremsstrahlung, has been investigated and compared to the signal expectation derived from Low's theorem. pp collisions at 13 TeV are simulated via PYTHIA and the produced particles are propagated through the proposed ALICE 3 geometry implemented in a GEANT4 setup. Aiming at a significant measurement, several background-suppression capabilities have been explored: Major improvements were achieved by the rejection of events with an electron or positron in the η - range of the FCT and by reducing the material budget in optimising the shape of the beam pipe. In this talk the status of the simulation and the background studies for a soft-photon measurement with the FCT is presented.

HK 58: Instrumentation XIV

Time: Thursday 14:00–15:30 Location: HK-H3

HK 58.1 Thu 14:00 HK-H3

First steps towards the development of a spatially resolving detector for ultra-cold neutrons — •Konrad Franz for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University Mainz

One of the challenges in neutron detection is to convert the electrically inert neutron into an electrical signal. In the presented detector design this is achieved by employing a conversion layer stacked with a scintillation layer, in which the neutron induced α-particle generates a light pulse. This scintillation light is then guided onto an array of silicon photomultipliers (SiPM). Spatial resolution can be achieved by reading out every SiPM individually. A main advantage of this setup is its compatibility with high magnetic fields, which allows for in-situ detection of ultra-cold neutrons (UCN) in such environments. Combining spatial resolution with a magnetic field gradient UCN energy determination is possible.

The talk will give an overview of the proposed detector design and its advantages will be outlined. Furthermore, the first steps of the development will be presented and the main challenges moving forward will be discussed.

HK 58.2 Thu 14:15 HK-H3

The powering scheme of the CBM Silicon Tracking System — •Anton Lymanets[1], Oleksandr Kshyvanskyi[2], and Maksym Teklishyn[1,2] for the CBM-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH — [2]Kiev Institute for Nuclear Research, Ukraine

The Silicon Tracking System (STS) is the principal tracking detector of the future CBM experiment at FAIR. It will perform charged-particle track measurement with momentum resolution better than 2% in a 1 Tm dipole-magnetic field. A main challenge for the STS is to maintain high track reconstruction efficiency throughout the projected lifetime of the experiment which means being exposed to an accumulated fluence of up to 10^{14} n_{eq}/cm^2, expected to be reached in beam-target interaction rates of 10 MHz. Therefore, front-end electronics with self-triggering architecture needs to have sufficient signal-to-noise ratio (S/N>10) which requires an ultra-low noise system design.

The STS will consist of eight tracking stations comprising 876 double-sided silicon detector modules with a total of 1.8 million readout channels. Operation of the system requires a detailed understanding of the electrical scheme at different hierarchical levels, including: low and high voltage systems, copper data lines from the front-end electronics to the read-out and data combiner boards, signal path, as well as grounding and shielding concepts. The performance parameter of the system is equivalent noise charge (ENC) value measured by the front-end electronics. The electrical scheme of the system as well as its experimental validation in the laboratory and beam will be presented.

HK 58.3 Thu 14:30 HK-H3

Mechanical and thermal studies of various components of the Silicon Tracking System — •Shaifali Mehta for the CBM-Collaboration — Eberhard Karls Universität Tübingen(UT-PIT)

The Silicon Tracking System (STS) located in the aperture of the dipole magnet is designed to perform the charged particle tracking to achieve a momentum resolution better then 2 micro strip sensors, distributed on 8 tracking stations. The stations are made from mechanical half units onto which 106 ultra-light carbon fibre support structures, referred as ladders, are mounted which hold the modules. During the assembly of modules, different glues are used at various steps of the assembly and it is very important to test for the thermal and mechanical properties of the glue. Once the modules are prepared, they are transferred to the ladder using a standard procedure. A well defined technique has been developed to mount the modules on a ladder to achieve the precision in order of 100 μm. Two full ladders and one half ladder has been assembled so far within the required mounting precision. The results from the thermal cycling of the different glues used in module assembly and the concept of mounting the modules onto the ladder for the STS within the defined mechanical precision will be presented in this talk.

HK 58.4 Thu 14:45 HK-H3

Lifetime and Performance of the very latest Microchannel-Plate Photomultipliers — •Daniel Miehling, Merlin Böhm, Katja Gumbert, Steffen Krauss, and Albert Lehmann for the PANDA-Collaboration — Physikalisches Institut, Universität Erlangen-Nürnberg

Two DIRC detectors will be used for particle identification and in particular pion/kaon separation at the PANDA experiment at FAIR. The focal planes of both DIRCs will reside in a magnetic field of up to 2 Tesla. This and other constraints leave the usage of Microchannel-Plate Photomultipliers (MCP-PMTs) as the only option. A few years ago the most limiting parameter was the lifetime of the MCP-PMTs. During operation feedback ions produced in the residual gas and during electron multiplication at the MCP walls are accelerated towards the photo cathode and may damage it. This leads to a sizable quantum efficiency (QE) drop with increasing integrated anode charge. Coating the MCPs by applying an atomic-layer deposition technique (ALD) increased the lifetime drastically. Another important parameter is the detective quantum efficiency (DQE) which is the product of the QE and the difficult to measure collection efficiency (CE). This should also be as high as possible to detect as many Cherenkov photons as possible. Recently tubes with CE values of close to 100% are available. In this talk the results of these performance parameters will be presented and discussed along with an overview of the general performance of the very latest ALD-coated 2x2 inch^2 MCP-PMTs with 8x8 anode pixels from Photek and PHOTONIS. - Funded by BMBF and GSI -

HK 58.5 Thu 15:00 HK-H3

Low Gain Avalanche Diode based T0 Detector in HADES — •Wilhelm Krüger[1], Tetyana Galatyuk[1,2], Vadym Kedych[1], Sergey Linev[2], Jan Michel[3], Jerzy Pietraszko[2], Adrian Rost[1,4], Michael Träger[2], Michael Traxler[2], and Christian Joachim Schmidt[2] — [1]TU Darmstadt, Germany — [2]GSI GmbH, Darmstadt, Germany — [3]Goethe-Universität Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

HADES at SIS18, GSI (Darmstadt, Germany), is going to use a Low Gain Avalanche Diode (LGAD) based reaction time (T0) detector in the upcoming high rate (10^8 p/s) pp experiment in February 2022. For the HADES physics program a T0 determination better than σ_{T0} < 70 ps is necessary, in order to ensure a precise particle identification using time of flight information. In addition, the T0 detector will be used for beam monitoring, which requires a position resolution better than 5 mm. As the detector will be placed in-beam, a high radiation hardness is also required. The recently emerged LGAD technology is a suitable candidate to fulfill all the above listed requirements.

In this contribution the performance of HADES T0-LGADs in a beam test at COSY in Jülich in November 2021 will be presented. The LGADs were tested w.r.t. their timing precision and efficiency, employing different front end electronics. The preliminary performance of the T0 detector during the beam time in February 2022 will be presented as well.

HK 58.6 Thu 15:15 HK-H3

HADES Driftchambers Electronics Upgrade: Power Supply — •Ole J. Artz for the HADES-Collaboration — Goethe-Universität Frankfurt

The readout electronics of the drift chamber tracking system of HADES will be upgraded in the comming year to allow for handling higher trigger rates in future experiments at SIS18 and SIS100. The upgrade is also aiming at an improved robustness w.r.t. electronic noise and the ability to resolve multiple hits in drift cells.

An important part of this activity is improving the power scheme both w.r.t. load and noise immunity. Due to the sensitivity of the detector, switching voltage regulators can not be installed on the front-end electronics, but need to be placed further away. These regulators will be remotely controllable using an Ethernet-capable microcontroller.

As a side-project, the same controller will be employed for flexible read-out of various sensors for the detectors' gas system.

This work has been supported by BMBF(05P19RFFCA), CremlinPLUS, GSI and HIC for FAIR.

HK 59: Instrumentation XV

Time: Thursday 14:00–15:30 Location: HK-H4

Group Report HK 59.1 Thu 14:00 HK-H4

The Silicon Tracking System of the CBM Experiment — •Osnan Maragoto Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Silicon Tracking System (STS) is the central detector for charged-particle identification and momentum determination in the future CBM experiment. It is designed for tracking up to 1000 charged particles per event in nucleus-nucleus collisions at interaction rates up to 10 MHz. Its futures are a low material budget~2% of radiation length, a single-point resolution of ~30 μm inside 1 Tm magnetic field leading to a momentum resolution better than 2%. The experimental conditions pose demanding requirements in terms of channel density and read-out bandwidth: more than 1.6 million channels will be read out with self-triggering electronics. An online event analysis concept will be applied to provide real-time event building and selection. The test and characterization of detector modules, operated in high-intensity heavy-ion beam from the GSI-SIS18 accelerator, as well as the mechanical design and the cooling concepts are, currently, some of the most important goals of the project. This contribution will bring an overview of the STS detector with emphasis on the current status of the detector modules, their performance with beam-target interactions as part of the FAIR Phase 0 activities, the readout chain and system integration aspects aiming towards the pre-series production phase

HK 59.2 Thu 14:30 HK-H4

Quality control and position mapping of the silicon microstrip sensors for the CBM-STS detector — •Olga Bertini for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The central detector of the CBM experiment at FAIR, the Silicon Tracking System (STS), is designed to reconstruct up to thousand charged particle tracks produced at SIS100 in heavy-ion interactions at rates of up to 10 MHz.

The eight tracking stations of the STS, operating in the aperture of a super conducting dipole magnet with 1 T field, will cover the polar angles between 2.5° and 25°. The stations with a total sensor area of 4.2 m^2 will comprise about 900 detector modules consisting of double-sided silicon microstrip sensors, ultra-thin readout cables and front-end electronics that are mounted onto lightweight carbon fiber support strictures. More than 1000 double-sided sensor were produced and delivered to GSI, where their quality was controlled optically and electrically.

A summary of the tests carried out and the quality achieved will be given. The mapping of the sensors to the positions in the detector matching the quality grades and required radiation tolerance will be shown.

HK 59.3 Thu 14:45 HK-H4

The $\overline{\text{P}}$ANDA Cluster-Jet Target at COSY - recent Results and Developments — •Philipp Brand, Daniel Bonaventura, Hanna Eick, Benjamin Hetz, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The $\overline{\text{P}}$ANDA cluster-jet target will be the Day-1 target for the $\overline{\text{P}}$ANDA experiment within the High Energy Storage Ring (HESR) at FAIR. With this device a target thickness of more than 10^{15} atoms/cm^2 is achieved at the interaction point more than 2 m below the nozzle.

To study the influence of such a target on the properties of an accelerator beam, it is installed at the COoler SYnchrotron (COSY) in Jülich. Here, also a barrier bucket cavity and the stochastic cooling are installed, which will be used later at FAIR in the HESR. Therefore, the studies performed within beam times at COSY will give important input for the PANDA experiment. Within this talk results from recent beam times as well as new developments on the target system are presented.

This project has received funding from BMBF (05P19PMFP1 and 05P21PMFP1), GSI FuE (MSKHOU1720 and MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 59.4 Thu 15:00 HK-H4

A prototype for hydrogen-based droplet targets for nuclear and particle physics experiments — •Christian Mannweiler, Daniel Bonaventura, and Alfons Khoukaz — Westfälische Wilhelms Universität, Münster, Germany

Internal target experiments play an important role in in particle physics research. For example, the PANDA experiment at the future HESR accelerator at FAIR will use both a hydrogen cluster-jet target and a hydrogen pellet target.

Another target technology which is closely related to the pellet target is the droplet target. The operating principle of a hydrogen droplet target is to squeeze cryogenically cooled, fluid hydrogen through a small nozzle of, e.g. 10 microns. A piezo actor induces vibrations on the nozzle, causing the hydrogen beam passing through the nozzle to break up. Depending on the nozzle diameter and the piezo frequency, a droplet beam with a diameter of around 20 microns is created. Currently, there are several challenges concerning this technology, chiefly the issue of nozzle clogging, which occurs routinely and hinders the stable long-term operation of such targets.

To combat this issue and improve the overall performance of droplet targets, a new prototype droplet target was recently constructed and commissioned at the WWU Münster. It will be used to tackle the aforementioned nozzle clogging issue as well as other challenges.

In our contribution we will present the new target prototype and its capabilities as well as first results. This project has received funding from the EU Horizon 2020 programme (824093).

HK 59.5 Thu 15:15 HK-H4

The cryogenic stopping cell for the Super-FRS at FAIR: status and outlook — •Daler Amanbayev[1], Samuel Ayet San Andres[1], Timo Dickel[1,2], Hans Geissel[1,2], Wolfgang Plass[1,2], Christoph Scheidenberger[1,2], the Super-FRS Experiment Collaboration[2], and the FRS Ion Catcher Collaboration[2] — [1]II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The beams of exotic nuclei for the high-precision experiments planned at the Low-Energy Branch (LEB) of the Super-FRS at FAIR are produced at relativistic energies of up to 1.5 GeV/u, and have to be slowed down and thermalized down to a few eV. A gas-filled cryogenic stopping cell (CSC) is a key device in this process.

In order to achieve its challenging design performance parameters of areal densities of up to 40 mg/cm^2 for stopping efficiencies of almost unity, fast ion extraction down to times of 10 ms and a rate capability of 10^7 ions per second, a novel two-stage orthogonal extraction concept has been developed. Detailed simulations of the CSC are verified and projected from the performance of the prototype CSC, which is being successfully used in online experiments as a part of the FRS Ion Catcher at GSI.

In this talk, the major components and processes of the CSC will be highlighted, such as fine-pitched radio-frequency carpet design, simulations of ion trajectories traversed by gas jets, a cryogen-free cooling system and an ultra-clean buffer gas recovery system.

HK 60: Instrumentation XVI

Time: Thursday 14:00–15:30 Location: HK-H5

HK 60.1 Thu 14:00 HK-H5

Monte-Carlo simulations of low-energy X-ray interactions in the ALICE TPC — •Ankur Yadav, Philip Hauer, Philipp Bielefeldt, and Bernhard Ketzer for the ALICE-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The ALICE Time Projection Chamber (TPC) was recently upgraded with a Gas Electron Multiplier (GEM) based readout in order to cope with the high Pb-Pb interaction rate of 50 kHz planned for Run 3 of the LHC. In the scope of an extensive commissioning program, several measurements were already conducted without the beam. This included the injection of the meta-stable radioactive isotope Kr-83m into the gas volume of the TPC as well as the irradiation of the TPC with an X-ray source.

In order to better understand and cross-check the measured data, the MC methods provided by the Geant4 toolkit were used to simulate the interaction of low energy X-rays and associated secondary particles in the TPC. A complete detector simulation chain was developed which includes drift, diffusion, gas amplification as well as the effects of electron attachment.

In this talk, the comparison between the simulations and the measured data will be presented.

Supported by BMBF

HK 60.2 Thu 14:15 HK-H5

Quality Control of the upgraded ALICE TPC — •Stefan Heckel for the ALICE-Collaboration — Technische Universität München

About three years ago, in December 2018, the LHC and concomitant the ALICE experiment went into a long shutdown. ALICE has used this time for major upgrades including new readout chambers for the Time Projection Chamber (TPC). The TPC can now be operated in continuous read-out mode, enabling much higher data-taking rates than before. Going along with the detector upgrades, the entire software framework for data taking, reconstruction and analysis is developed anew. Within this framework, the Quality Control (QC) of the detectors plays a crucial role to guarantee a successful data-taking campaing in the upcomming LHC Run 3.

In this talk, the development of the QC for the upgraded ALICE TPC will be summarised. Given the challenging data-taking conditions, the QC has to be able to assess the quality of the data synchronously during data taking. For this purpose, the data will be analysed online with trendings of important quantities as a function of time and automatic checking procedures raising alarms in case of any outlier behaviour observed. The QC results will be visulized using different tools for the ALICE shift crew in the ALICE control room and for the TPC experts. In October 2021, the upgraded ALICE has taken physics data for the first time during a pilot-beam test of the LHC. First results of these data from the TPC-QC point of view will be shown.

HK 60.3 Thu 14:30 HK-H5

Optimization of the calibration parameters for the font-end electronics of the Silicon Tracking System of the CBM experiment — •Dairon Rodriguez Garces for the CBM-Collaboration — GSI Helmholtzzentrum, Darmstadt, Germany

The CBM is a next-generation experiment to be operated at FAIR facility. Its goal is to investigate the phase diagram of strongly interacting matter in the region of high baryon-net densities. To achieve the high rate capability CBM will be equipped with fast and radiation hard detectors employing free-streaming readout electronics. The Silicon Tracking System (STS) is the main detector for charged particle measurements and momentum determination. It is designed as eight tracking layers built from 876 modules. The custom-designed front-end electronics for reading out the double-sided silicon sensors is the STS-XYTER ASIC: analog front-end for signal processing and digital part with hit generation and readout. The characterization of the chip is an extensive procedure that includes multiple functional tests such as proper amplitude and time calibration. These are necessary steps to correctly interpret the collected data. The design of the analog front-end, with a double processing path for independent time and energy measurements, implies that the calibration should consider not only the ADC linearity aspects but also a homogeneous time response among all channels, and a well-known correlation of the threshold in both measuring paths. This work describes the characterization of the timing discriminator of the ASIC, the optimization of other-related chip parameters, and their effect on the measured data.

HK 60.4 Thu 14:45 HK-H5

Towards pre-series production: Quality control of the Silicon Tracking System module and components — •Adrian Rodríguez Rodríguez for the CBM-Collaboration — GSI Helmholtzzentrum

The Silicon Tracking System (STS) is the main tracking detector of the future CBM experiment. It is designed to reconstruct trajectories of charged particles with high efficiency and to achieve a momentum resolution better than 2% inside a 1 Tm magnetic field. The STS comprises 876 modules arranged in 8 tracking stations, where 1.8 million channels are read out with self-triggering electronics matching the experiment's data streaming and online event analysis concept. Currently, the STS project is entering the pre-series production phase, in which more than 30 modules are expected to be assembled with the final components and procedures. This is an essential task for proving the assembly concept of the final detector and requires a thorough quality control procedure in order to ensure the reliable performance of the modules and high production yield. For this purpose, multiple quality control steps have been implemented before and during the assembly of the components and the necessary hardware and software have been developed. This work will present the results of systematic testing of the STS modules and components, the steps to optimize the quality control concept, and the most significant challenges towards series production.

HK 60.5 Thu 15:00 HK-H5

Measurements of the Timing Characteristics of Silicon Photomultipliers — •Christopher Wenzel — Ruhr-Universität Bochum, Institut für Experimentalphysik I

Silicon Photomultipliers (SiPMs) are solid-state detectors with single-photon sensitivity. Samples of the latest generation combine high gain with low noise and have an improved detection efficiency for blue and near-UV light. Due to short rise times below a few hundred picoseconds SiPMs are well suited for fast timing applications such as Time-of-Flight PET.

Within the UFaCal project, various SiPMs are being tested for possible application in a calorimeter prototype that will provide precise timing information in addition to energy.

To compare the timing performance of different SiPMs, the Single Photon Time Resolution (SPTR) was measured. The intrinsic time resolution of the photodetector can be extracted by deconvolving the measured SPTR value and the different contributions of the measurement setup. A limiting factor of the measurable SPTR is given by the pulse width of the used laser system.

This talk presents a setup for SPTR measurements using a femtosecond laser in combination with an optical trigger. Femtosecond pulses grant the ability to neglect the contribution of the laser pulse width to the measured SPTR value. The timing characteristics of a large selection of commercially available SiPMs will be presented.

Funded by BMBF

HK 60.6 Thu 15:15 HK-H5

Development of an Endcap Disc DIRC for PANDA and SCTF — •Simon Bodenschatz, Lisa Brück, Michael Düren, Jan Niclas Hofmann, Sophie Kegel, Jhonatan Pereira de Lira, Mustafa Schmidt, Marc Strickert, Chis Takatsch, Leonard Welde und Vincent Wettig — 2. Physikalisches Institut Justus Liebig Universität Gießen

The Endcap Disc DIRC has been designed for the PANDA experiment at FAIR. The design is currently being iterated on for the future high luminosity Super Charm Tau Factory (SCTF) in Russia where not only pion/kaon separation, but also muon/pion separation is required in a broad momentum range. The DIRC prototypes are tested in the Gießen Cosmic Station, which provides track information of relativistic atmospheric muons and enables performance measurements of MCP-PMT and SiPMs based designs. Prototypes and teststand are readout by a free running DAQ system using TOFPET ASICs as digitizers.

HK 61: Structure and Dynamics of Nuclei X

Time: Thursday 14:00–15:30 Location: HK-H6

Group Report HK 61.1 Thu 14:00 HK-H6

DSAM lifetime measurements using particle-γ coincidences at SONIC@HORUS — •Sarah Prill, Anna Bohn, Christina Deke, Felix Heim, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

In recent years, the (p,p'γ) Doppler-shift attenuation method (DSAM) has been successfully applied to determine lifetimes of excited low-spin states in the sub-picosecond range [1,2]. The use of particle-γ coincidence data taken at the SONIC@HORUS spectrometer in Cologne [3] gives complete knowledge of the reaction kinematics and enables the direct selection of levels via their excitation energy, thus greatly reducing background and eliminating feeding from levels of higher energies. This contribution will present the DSA method and recent results obtained from experiments on Ru, Sn [2] and Te isotopes will be shown. Additionally, a complementary approach to the conventional DSA technique will be presented which aims to extract lifetimes from weak transitions and excited states with low statistics that cannot be analysed with the established method.

Supported by the DFG (ZI-510/9-1).

[1] A. Hennig *et al.*, Nucl. Instr. and Meth. A **794** (2015) 171.
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[3] S. G. Pickstone *et al.*, Nucl. Instr. and Meth. A **875** (2017) 104.

HK 61.2 Thu 14:30 HK-H6

Lifetime measurement of the 2_1^+ state of ^{170}W — •K.E. Ide[1], V. Werner[1], A. Goasduff[2,3], J. Wiederhold[1], P.R. John[1], D. Bazzacco[3], M. Beckers[4], J. Benito[5], M. Berger[1], D. Brugnara[2,3], M.L. Cortés[1], L.M. Fraile[5], C. Fransen[4], A. Gozzelino[3], E.T. Gregor[3], A. Illana[3], J. Jolie[4], L. Knafla[4], R. Menegazzo[3], D. Mengoni[2,3], C. Müller-Gatermann[4,6], O. Papst[1], G. Pasqualato[7], C.M. Petrache[8], N. Pietralla[1], F. Recchia[2,3], D. Testov[2,7], J.J. Valiente-Dobón[3], and I. Zanon[2,3,9] — [1]IKP, TU Darmstadt — [2]Uni Padova, Italy — [3]INFN, LNL, Italy — [4]IKP, Uni Köln — [5]Uni Madrid, Spain — [6]ANL, USA — [7]INFN, Padova, Italy — [8]Uni Paris-Saclay, France — [9]Uni Ferrara, Italy

Recent measurements of the mean lifetimes of the first 2^+ states in the region of the Hf and W isotopic chains pointed out a change of the previously measured mean lifetimes by enhanced experimental techniques. This results in an increased value of the $E2$ transition probability from $N = 114$ down to $N = 98$ with an unexpected sudden drop in the transition probability at $N = 96$, i.e. ^{170}W. The experiment to remeasure the mean lifetime of the 2_1^+ state of ^{170}W with the RDDS method was carried out at the Laboratori Nazionali di Legnaro (LNL). The GALILEO array, comprised of 24 HPGe detectors placed in 5 rings, was used in conjunction with the LNL plunger device. Experimental results are compared to predictions of the CBS model.

*Supported by the BMBF under Grant Nos. 05P18RDFN9 and 05P21RDFN9.

HK 61.3 Thu 14:45 HK-H6

In-beam gamma-ray spectroscopy of neutron rich scandium isotopes — •Radostina Zidarova[1], Martha Liliana Cortés[1], Volker Werner[1], Pavlos Koseoglou[1], Norbert Pietralla[1], Pieter Doornenbal[2], and Alexandre Obertelli[1] — [1]TU Darmstadt, Germany — [2]RIKEN-RIBF, Japan

Experimental data have shown that far from the valley of stability new magic numbers can emerge and the traditional ones can disappear. In particular, two new magic numbers at N=32 and N=34 have been suggested in the vicinity of Z=20 based on spectroscopy and mass measurements. The N=34 sub-shell closure is observed in Ca and Ar isotopes, but vanishes in the Ti isotopes. To get a complete picture of the shell evolution in this region, it is also necessary to study the neighbouring Sc isotopes with only one valence proton above Z=20 and determine their structural evolution towards the possible harmonic oscillator magic number N=40 . Investigation of exotic nuclei in this region was the goal of the third SEASTAR (Shell Evolution And Search for Two-plus energies At RIBF) campaign at RIKEN-RIBF. Neutron-rich isotopes in the vicinity of ^{53}K were produced by fragmentation of a primary ^{70}Zn beam on a ^{9}Be target. The γ rays of ^{55}Sc isotope were observed and γ rays from ^{57,59}Sc were identified for the first time. Observed γ spectra from ^{55,57,59}Sc will be presented together with preliminary level schemes. They will be discussed in the framework of the tensor force driven shell evolution.

Supported by BMBF under Grant Nos. 05P19RDFN1, 05P21RDFN1.

HK 61.4 Thu 15:00 HK-H6

Lifetime measurement of excited states in ^{120}Te — •Franziskus v. Spee[1], Alfred Dewald[1], Claus Müller-Gatermann[1,2], Marcel Beckers[1], Felix Dunkel[1], Lisa Kornwebel[1], Casper-David Lakenbrink[1], Jan Jolie[1], Nigel Warr[1], and Andrey Blazhev[1] — [1]Institut für Kernphysik, Cologne, Germany — [2]Argonne National Laboratory, Illinois, USA

The nuclear structure of tellurium isotopes at Z=52 and the evolution of collectivity are of special interest due to the close proximity of the closed shell at Z=50 in the even-even neighbor Sn. A recoil distance Doppler-shift (RDDS) experiment was performed to investigate absolute transition probabilities in ^{120}Te. Excited states in ^{120}Te were populated using the ^{110}Pd(^{13}C,3n)^{120}Te reaction at the FN-Tandem accelerator facility located at the IKP of Cologne. The $\gamma-\gamma$ coincidence data were analysed with the differential decay-curve method (DDCM) eliminating problems related to feeding and absolute distances. Lifetimes of excited states in the yrast band up to the 8^+ state were measured and the corresponding B(E2) values were calculated. In this contribution we will present the results and compare these with known data from Coulomb excitation experiments and IBM1-Calculations. This work was supported by the Deutsche Forschungsgemeinschaft (DFG) under contract numbers FR 3276/2-1 and DE 1516/5-1.

HK 61.5 Thu 15:15 HK-H6

Extension of the level scheme of ^{104}Ru and lifetime determination using the Doppler-shift attenuation method — •Anna Bohn, Christina Deke, Felix Heim, Sarah Prill, Michael Weinert, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The (p,p'γ) Doppler-shift attenuation method (DSAM) is a powerful tool to determine nuclear level lifetimes in the sub-picosecond range and was well established at the Institute for Nuclear Physics at the University of Cologne in recent years [1,2]. The combined particle-γ detector array SONIC@HORUS [3] enables the measurement of p-γ and p-γ-γ coincidences. Hence, knowledge of the complete reaction kinematics is provided and feeding contributions from energetically higher lying states can be eliminated.
In this contribution, results from a ^{104}Ru(p,p'γ) DSAM experiment will be presented. More than two dozen nuclear level lifetimes as well as over 50 previously unknown levels and decay transitions could be identified via the analysis of p-γ-γ coincidence data.
Supported by the DFG (ZI-510/9-1).
[1] A. Hennig *et al.*, NIM A **794** (2015) 171
[2] M. Spieker *et al.*, Phys. Rev. C **97** (2018) 054319
[3] S. G. Pickstone *et al.*, NIM A **875** (2017) 104

HK 62: Structure and Dynamics of Nuclei XI

Time: Thursday 14:00–15:30 Location: HK-H7

Group Report HK 62.1 Thu 14:00 HK-H7

Extension and acceleration of the in-medium similarity renormalization group — •Matthias Heinz[1,2,3], Jan Hoppe[1,2], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg

The ab initio solution of the nuclear many-body problem for theoretical predictions of nuclear structure observables is a computationally challenging endeavor. Over the past decade, the in-medium similarity renormalization group (IMSRG) has been established as an important method capable of describing a broad range of nuclei up to mass numbers around 100 and beyond, including open-shell systems via different extensions of the method.

A key (as of yet unrealized) milestone in the IMSRG is the relaxation of the many-body truncation of the method, currently restricted to the normal-ordered two-body level, the IMSRG(2). We discuss studies of the next truncation, the IMSRG(3), in small systems and restricted model spaces. We additionally highlight recent developments to accelerate IMSRG calculations that might make the IMSRG(3) more feasible, including basis optimization via natural orbitals and importance truncation applied to the IMSRG.

* Funded by the ERC Grant Agreement No. 101020842 and by the DFG – Project-ID 279384907 – SFB 1245.

HK 62.2 Thu 14:30 HK-H7

Single-particle strength & nucleon correlations of the Ca isotopic chain. — •Luke Rose[1], Stefanos Paschalis[1], Marina Petri[1], Ryo Taniuchi[1], Thomas Aumann[2], Carlo Barbieri[3], Carlos Bertulani[4], Dolores Cortina-Gil[5], Heather Crawford[6], Roman Gernhäuser[7], Marc Labiche[8], Augusto Macchiavelli[6], Alexandre Obertelli[2], Heiko Scheit[2], Daniel Severin[9], Haik Simon[9], Helmut Weick[9], and Christian Sürder[2] for the R3B-Collaboration — [1]The University of York, York, UK — [2]Technical University of Darmstadt, Darmstadt, Germany — [3]University of Surrey, Guildford, UK — [4]Texas A&M University-Commerce, Commerce, USA — [5]Universidade de Santiago de Compostela, Santiago de Compostela, Spain — [6]Lawrence Berkeley National Lab, Berkeley, USA — [7]Technical University of Munich, Munich,Germany — [8]STFC Daresbury, Daresbury, UK — [9]GSI, Darmstdat, Germany

The unique shell structure of Ca isotopes provides an understanding of the evolution of the shell structure and an in-depth exploration of three-body forces used in microscopic shell-model interactions and ab-initio calculations. By extracting the spectroscopic factors of the ground state configuration along the neutron-rich component of the Ca isotopic chain, one can gain insight into the degree of weakening of the N=28 gap. The experiment was performed in 2020 at R3B as part of the Phase-0 program of FAIR probed proton and neutron configurations using (p,pn) and (p,2p) quasi-free scattering reactions.

HK 62.3 Thu 14:45 HK-H7

Density-dependent in-medium NN-potential from chiral four-nucleon force — •Maurus Geiger and Norbert Kaiser — Physik-Department T39, Technische Universität München, D-85747 Garching, Germany

Density-dependent in-medium NN-potentials are calculated analytically from the five classes of reducible four-nucleon forces (4NF) as derived in chiral effective field theory by Epelbaum (Eur. Phys. J. A34: 197-214 (2007)). An overview is given over the pertinent two-loop diagrams that are obtained by closing two nucleon lines. A fortunate feature of the chiral 4N forces is that due to their spin- and isospin dependence the selfclosing of a nucleon line gives a vanishing spin or isospin trace in nuclear matter. The current status of the evaluation of the remaining 42 diagrams for each class is presented together with results for the double Fermi-sphere integrals. Since the leading order chiral 4NF does not introduce any unkown parameters, this in-medium NN-potential can provide an interesting testing ground for the ability of chiral EFT to describe nuclear many-body systems.

This work has been supported in part by DFG (Project-ID 196253076 - TRR 110) and NSFC.

HK 62.4 Thu 15:00 HK-H7

An alternative scheme for effective range corrections in pionless EFT — •Martin Ebert[1], Hans-Werner Hammer[1,2], and Akaki Rusetsky[3,4] — [1]IKP, TU Darmstadt — [2]EMMI, GSI Darmstadt — [3]HISKP and BCTP, Universität Bonn — [4]Tbilisi State University

We discuss an alternative scheme for including effective range corrections in pionless effective field theory. The standard approach treats range terms as perturbative insertions in the T-matrix. In a finite volume this scheme can lead to singular behavior close to the unperturbed energies. We consider an alternative scheme that resums the effective range but expands the spurious pole of the T-matrix created by this resummation. We test this alternative expansion for several model potentials and observe good convergence.

*This work has been supported by Deutsche Forschungsgemeinschaft (Project ID 279384907, SFB 1245 and Project-ID 196253076, TRR 110), Volkswagenstiftung (grant no. 93562) and the Chinese Academy of Sciences (grant no. 2021VMB0007, PIFI).

HK 62.5 Thu 15:15 HK-H7

Lifetime measurements of excited states in ^{55}Cr — •Hannah Kleis[1], Michael Seidlitz[1], Andrey Blazhev[1], Levent Kaya[1], Peter Reiter[1], Konrad Arnswald[1], Alfred Dewald[1], Maximilian Droste[1], Christoph Fransen[1], Oliver Möller[1,2], Noritaka Shimizu[3], Yusuke Tsunoda[3], Yutaka Utsuno[3,4], Peter von Brentano[1], and Karl-Oskar Zell[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Institut für Kernphysik, Technische Universität Darmstadt — [3]Center for Nuclear Study, The University of Tokyo — [4]Advanced Science Research Center, Japan Atomic Energy Agency

Lifetime measurements in neutron-rich Cr nuclei provide key observables to study the $N = 32$ sub-shell closure. Following an earlier measurement in

^{56}Cr [1], excited states in the neighboring $N = 31$ isotope ^{55}Cr have been populated in a ^{48}Ca(^{11}B, $p3n$) ^{55}Cr fusion-evaporation reaction at a beam energy of 32 MeV at the FN tandem accelerator of the University of Cologne. The recoil-distance Doppler-shift method combined with the differential decay-curve method are utilized for $\gamma\gamma$-coincidence analyses in order to determine precise lifetimes for the first $5/2^-$ and $9/2^-$ states of $\tau = 5.61(28)$ ps and $\tau = 6.33(46)$ ps, respectively [2]. In addition, the experimentally determined transition probabilities were confronted with results from the KB3G, FPD6, GXPF1A and GXPF1Br shell-model interactions. In particular, the $B(E2)$ and $B(M1)$ strengths are discussed with respect to the calculated wave functions configurations.

[1] M. Seidlitz et al., Phys. Rev. C 84, 034318 (2011)
[2] H. Kleis et al., Phys. Rev. C 104, 034310 (2021)

HK 63: Hadron Structure and Spectroscopy XI

Time: Thursday 14:00–15:30 Location: HK-H8

Group Report HK 63.1 Thu 14:00 HK-H8

The search for dibaryons in coherent photoproduction off the deuteron at the BGOOD experiment — •Thomas Jude for the BGOOD-Collaboration — Physikalisches Institut, Universität Bonn

The discovery of the $d^*(2380)$ hexaquark, first identified in the fusion reaction $pn \to d\pi^0\pi^0$ has sparked renewed interest in dibaryon searches in the non-strange sector. Evidence of the $d^*(2380)$, with $IJ^P = 03^+$, has been observed in a multitude of final states and observables. Conversely, recent models benefiting from high precision experimental data and theoretical developments have described the $d^*(2380)$ via triangle singularity mechanisms.

The BGOOD experiment at ELSA provides a unique approach to measure such mechanisms via the coherent reaction, $\gamma d \to \pi^0\pi^0 d$. The presented results are from a full kinematic reconstruction, with final state deuterons identified in the forward spectrometer and π^0 electromagnetic decays in the central BGO Rugby Ball. The strength of the measured differential cross section exceeds what can be described by models of coherent photoproduction and instead is consistent with the three isoscalar dibaryon candidates reported by the ELPH collaboration at 2.38, 2.47 and 2.63 GeV/c^2. A low mass enhancement in the $\pi^0\pi^0$ invariant mass is also observed at the $d^*(2380)$ centre-of-mass energy. At higher centre-of-mass energies, a narrow peak in the $\pi^0 d$ invariant mass at 2114 MeV/c^2 with a width of 20 MeV/c^2 supports a sequential two-dibaryon decay mechanism.

Supported by DFG projects 388979758/405882627 and the European Union*s Horizon 2020 programme, grant 824093.

HK 63.2 Thu 14:30 HK-H8

Study of Diffractively Produced $K^0_S\pi^-$, $K^0_S K^-$, and $\Lambda\bar{p}$ Final States at COMPASS — •Julien Beckers — Physik-Department E18, Technische Universität München

The COMPASS experiment is a multi-purpose two-stage spectrometer at the CERN SPS. One of its main goals is to probe the strong interaction at low energies by studying the excitation spectrum of light mesons. This is done by decomposing the data into partial-wave amplitudes with well-defined quantum numbers and searching for resonances in these amplitudes. However, before we can perform such a partial-wave analysis, we have to select the events that correspond to the processes of interest and separate them from background contributions with high purity.

We will present the analysis of three diffractive reactions: $\pi^- + p \to K^0_S K^- + p$, $K^- + p \to K^0_S\pi^- + p$, and $K^- + p \to \Lambda\bar{p} + p$. They have in common that the produced final states contain long-lived neutral particles, that are identified in the spectrometer via their secondary decay vertices. The $K^0_S K^-$ final state, allows us to study a_J- and π_J-like resonances with spin J and complements the $\pi^-\eta$, $\pi^-\eta'$ and $\pi^-\pi^-\pi^+$ final states that have already been studied at COMPASS. The $K^0_S\pi^-$ and $\Lambda\bar{p}$ final states allow us to study excited strange mesons over a wide mass range. We will present the event selection and discuss kinematic distributions, in which first resonance signals are observed. The high precision of our data will allow us to perform detailed searches for new resonances as well as improve parameters of known states.

HK 63.3 Thu 14:45 HK-H8

Search for the X17 boson at the BESIII experiment — •Saskia Plura, Achim Denig und Christoph Florian Redmer für die BESIII-Kollaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

In 2016, the ATOMKI collaboration proposed the existence of a new neutral boson with a mass of 17 MeV to explain their observation of a significant enhancement in the angular correlations of e^+e^- pairs in nuclear transitions of ^{8}Be and ^{4}He. This new particle, referred to as the X17 boson, sparked interest in the particle physics community.

As the X17 should couple to nucleons, we developed a Monte Carlo generator to evaluate the possibility to search for the X17 boson in $J/\psi \to p\bar{p}e^+e^-$ decays, where the (anti-)proton emits an X17 which subsequently decays to an e^+e^- pair. J/ψ decays provide a clean source of nucleon-antinucleon pairs at e^+e^- colliders. We considered both possibilities of the X17 being either a pseudoscalar or an axial vector particle, as well as the QED background.

In this talk, we discuss the feasibility of searching for the X17 at the BESIII experiment, located at the BEPCII collider in Beijing, China, using the available data sample of 10^{10} J/ψ events.

HK 63.4 Thu 15:00 HK-H8

Investigating the ΛK interaction using the femtoscopic technique with ALICE at LHC — •Rossana Facen for the ALICE-Collaboration — Technische Universität München, München, Germany

Traditionally, the strong interaction among hadrons has been studied through scattering experiments. However, this experimental technique becomes very challenging when unstable particles are taken into account. For this reason, a new experimental method, femtoscopy, has been developed to achieve further understanding in the field of Quantum Chromodynamics (QCD): femtoscopy represents a valid method to investigate the interactions between strong interacting particles.

Recent femtoscopic measurements performed by the ALICE collaboration in Pb-Pb collisions were able to provide the scattering parameters of the interaction between Λ hadrons and charged K mesons, predicting an attractive force between Λ and antikaons and a repulsive potential between Λ and kaons.

In this talk we will present the results on the measured correlation functions of $\Lambda K^+ \oplus \bar{\Lambda} K^-$ and $\Lambda K^- \oplus \bar{\Lambda} K^+$ pairs obtained in high-multiplicity pp collision at $\sqrt{s} = 13$ TeV, recorded by the ALICE Collaboration. The small emitting source size achieved in such collisions, of the order of 1 fm, provides direct access to the underlying strong interaction between these hadrons. The scattering parameters extracted from the experimental data will be discussed in detail, compared to the findings obtained in Pb-Pb collisions as well as to the available theoretical chiral models.

HK 63.5 Thu 15:15 HK-H8

Precision studies of the strongly interacting NΛ–NΣ coupled system at the LHC — •Dimitar Mihaylov — TUM, Physics Department, James-Franck-Straße, 85748 Garching

The study of the strong interaction among stable and unstable hadrons is a fundamental question in nuclear physics and it is a key ingredient for the description of the Equation of State, and the understanding of the structure of dense stellar objects, such as neutron stars. Traditional measurements, including scattering and hypernuclei experiments, are insufficient to provide strong constraints to the theoretical modeling of the interaction between hadrons containing strangeness.

Two particle correlation measurements are a prominent tool to probe the strong interaction with high precision even in the multi-strangeness sector. The ALICE collaboration has demonstrated that high-multiplicity pp collisions are particularly well suited due to the enhanced production of strangeness. Combined with the excellent tracking and particle identification capabilities of the ALICE detector, precision studies of the strong interaction among strange hadrons is possible. The present contribution will discuss the latest ALICE results on the study of the NΛ–NΣ coupled system through measurement of the pΛ correlation function.

HK 64: Fundamental Symmetries I

Time: Thursday 14:00–15:30 Location: HK-H9

Group Report HK 64.1 Thu 14:00 HK-H9

Probing charged lepton flavor violation with the Mu2e experiment — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Germany

The Mu2e experiment, which is currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless conversion of muons to electrons in the field of an aluminum nucleus. This process, which violates charged lepton flavor, is highly suppressed in the Standard Model and therefore undetectable. However, scenarios for physics beyond the Standard Model predict small but observable rates. The Mu2e experiment aims for a sensitivity four orders of magnitude better than previous experiments. This is achieved by a rigorous control of all backgrounds that could mimic the monoenergetic conversion electron.

At the Helmholtz-Zentrum Dresden-Rossendorf, we use a pulsed Bremsstrahlung photon beam at the ELBE radiation facility to study the performance of the detector system that will monitor the rate of stopped muons in the aluminum target. Additionally, Monte Carlo simulations are performed for both the pion production target and the muon stopping target.

In the presentation, the design and status of the Mu2e experiment and its detectors will be presented, and results from ELBE beamtimes and the simulation studies will be given.

HK 64.2 Thu 14:30 HK-H9

Fierz interference term in neutron decay — •Max Lamparth[1], Karina Bernert[1], Hartmut Abele[3], Andreas Doblhammer[3], Erwin Jericha[3], Jens Klenke[2], Annabel Kropf[1], Kathrin Lehmann[2], Heiko Saul[1], Ulrich Schmidt[5], Torsten Soldner[4], and Bastian Märkisch[1] — [1]TUM Physik-Department, Garching, Germany — [2]Forschungsreaktor München, Garching, Germany — [3]Atominstitut Wien, Wien, Austria — [4]Institut Laue-Langevin, Grenoble, France — [5]Physikalisches Institut Heidelberg, Heidelberg, Germany

Neutron beta decay is an excellent system to test the structure of the charged weak interaction. The Fierz interference term b is sensitive to hypothetical scalar and tensor interactions and absent in the Standard Model. The signature of a non-zero Fierz term in neutron beta decay is an extra energy-dependent phase-space contribution. Major systematic effects are hence related to the detector response: calibration, temporal stability, spatial uniformity and non-linearity effects.

The spectrometer PERKEO III was installed at the Institute Laue-Langevin, Grenoble, France, with the aim to determine the Fierz interference term with a precision of $5 * 10^{-3}$ from the beta spectrum. We present the measurement and discuss the status of the analysis.

HK 64.3 Thu 14:45 HK-H9

Electron Spectroscopy with PERC — •Karina Bernert[1], Jens Klenke[2], Max Lamparth[1], Manuel Lebert[2], Kathrin Lehmann[2], and Bastian Märkisch[1] — [1]Technische Universität München, Garching, Germany — [2]Forschungsreaktor München, Garching, Germany

The PERC (Proton Electron Radiation Channel) instrument is a neutron decay facility currently being set up at the research reactor FRM II of the Heinz Maier-Leibnitz Zentrum in Garching. Its main component is a 12-meter long superconducting magnet system, which was recently delivered to the FRM II. We aim to measure several correlation coefficients in neutron beta decay one order of magnitude more precisely than currently possible. From the results, we will derive the nucleon axial coupling and the CKM matrix element V_{ud} and search for scalar and tensor couplings.

The spectrum of electrons from neutron decay will be obtained using two detector systems: the primary detector downstream will be a scintillation or silicon detector. The secondary detector system, used to identify backscattering events, consists of two pixelated scintillation detectors read out by silicon photomultipliers. In this talk, we present the status of the experiment and its main components with a focus on the backscatter detector.

PERC is developed in cooperation with scientists from TU Vienna, Universität Heidelberg, Johannes Gutenberg-Universität Mainz and the ILL.

HK 64.4 Thu 15:00 HK-H9

The backward angle measurement at P2 — Sebastian Baunack[1], Maarten Boonekamp[4], Boris Gläser[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], Tobias Rimke[1], David Rodriguez Pineiro[2], and •Malte Wilfert[1] for the P2-Collaboration — [1]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [2]Helmholtz-Institut Mainz, Johannes Gutenberg-Universität Mainz — [3]PRISMA Cluster of Excellence, Johannes Gutenberg-Universität Mainz — [4]IRFU, CEA, Université Paris-Saclay, Gif-sur-Yvette, France

The weak mixing angle $\sin^2\theta_W$ can be measured in parity violating elastic electron-proton scattering. The aim of the P2 experiment is a very precise measurement of the weak mixing angle with an accuracy of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}\,\mathrm{GeV}^2$. In combination with existing measurements at the Z pole with comparable accuracy, this comprises a test of the standard model with a sensitivity towards new physics up to a mass scale of 50 TeV. The experiment will be built at the future MESA accelerator in Mainz.

In addition to the measurement under forward angle, a measurement under backward angle will be performed. This measurement will reduce the uncertainty on the axial form factor and the strange magnetic form factor and thus reducing the systematic uncertainty on the weak charge of the proton. The motivation and challenges for this measurement will be discussed in this talk.

HK 64.5 Thu 15:15 HK-H9

Search for low Q-value beat decays for neutrino mass determination — •zhuang ge[1,2], Tommi Eronen[2], and IGISOL collaboration[2] — [1]GSI Helmholtzzen-trum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany — [2]Department of Physics, University of Jyväskylä, P.O. Box 35, FI-40014 Jyväskylä, Finland

The scale of neutrino masses is one of the burning open questions in physics. The β decay experiments search the electron neutrino mass by measuring the slight distortion and energy deficit of the end-point of the β spectrum. As small as possible decay energy (Q value), is essential to maximize decay events near the end-point. We map out nuclei that potentially undergo β decay with an ultra-low Q value (< 1 keV) to an excited state in the daughter nucleus. A precise and accurate determination of these ultra-low Q values requires the measurements of the groud-state-to-groud-state (gs-to-gs) Q values to ~ 100-eV level. We have measured gs-to-gs decay Q values of several candidates with the JYFLTRAP Penning trap setup. The high-precision Q-value measurement from our experiment combined with the nuclear energy level data will be used to determine whether the possible low Q-value β-decay candidate for the neutrino mass are energetically allowed and, if positive, how small. In this report, the experimental techniques of TOF-ICR and PI-ICR methods to determine the gs-to-gs Q value to a relative precision of ~ 10^{-9} for the application of neutrino mass determination will be discussed and the preliminary results of some prospective cases will be presented.

HK 65: Heavy-Ion Collisions and QCD Phases XIII

Time: Thursday 16:00–17:30 Location: HK-H1

HK 65.1 Thu 16:00 HK-H1

Temperature and net baryochemical potential dependence of η/s in a hybrid approach — •Niklas Götz[1,2] and Hannah Elfner[3,1,2] — [1]Institute for Theoretical Physics, Goethe University, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Strasse 1, 60438 Frankfurt am Main, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt, Germany

In this work, the qualitative impact of the net baryochemical potential dependence of the shear viscosity to entropy density ratio η/s in hydrodynamical simulations is studied. The effect of a predicted non-constant $\eta/s(\mu_B)$ is largely unexplored in hydrodynamic simulations. Previous studies focus only on a temperature dependence or even only a constant effective shear viscosity. This work addresses this issue by studying qualitatively the effect of a generalized $\eta/s(T,\mu_B)$ in the novel hybrid approach SMASH-vHLLE, composed of the hadronic transport approach SMASH[1] and the (3+1)d viscous hydrodynamic code vHLLE[2]. In order to reduce the bias of the result on the equation of state used in the hydrodynamic part of the model, η/s is parameterized directly in the energy density and baryon number density. This work compares the impact of the density dependence for different system sizes and energies and constrains the behaviour of $\eta/s(T,\mu_B)$ by ruling out regions of the parameter space.

[1] https://github.com/smash-transport/smash

[2] https://github.com/yukarpenko/vhlle

HK 65.2 Thu 16:15 HK-H1

New developments in flow analyses with multiparticle > correlations in ALICE and CBM — •Ante Bilandzic for the CBM-Collaboration — Technical University of Munich, Germany

Anisotropic flow measurements in small collision systems with multi-particle azimuthal correlations are not reliable, since correlation techniques are a precision tool only in an environment characterized by large multiplicities and large flow values. We present the first analytic results for combinatorial background in multi-particle azimuthal correlations, and demonstrate that for small multiplicities this contribution is not negligible. We show that the analytic solutions for the combinatorial background are universal as they can be written generically in terms of multiplicity-dependent combinatorial weights and marginal probability density functions of starting multivariate distribution. We conclude that the observed universality of flow measurements in pp, p–Pb and peripheral Pb–Pb collisions at LHC can be attributed solely to the interplay between nonflow correlations and combinatorial background, which always exhibits universal scaling as a function of multiplicity.

We present the feasibility study of using correlation techniques in flow analyses in the CBM experiment at FAIR. The first results for the flow harmonics estimated with multiparticle cumulants, $v_n\{k\}$, and the multiharmonic flow correlations obtained with symmetric cumulants, SC(m, n), are presented. We test the scaling of both statistical and systematical uncertainties for these observables in a fixed-target environment characterized by small multiplicities.

HK 65.3 Thu 16:30 HK-H1

SMASH as an afterburner: Advances in the non-equilibrium hadronic evolution — •Oscar Garcia-Montero — Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Germany

The hot medium created by colliding two heavy ions is a system which is trying against all odds to thermalize. For this reason, we focus on the non-equilibrium dynamics of the late hadronic stage of the fireball. More specifically, two recent developments on the physics of the afterburner, using the code SMASH. First the role of multi-particle reactions in the late stages of heavy-ion collisions are demonstrated to be significant for the final deuteron [1] and proton [2] abundances at intermediate to high beam energies.

Additionally, we present a consistent photon production calculation from hadronic cross sections, including bremsstrahlung and 2-to-2 reactions [3]. Using the hadronic transport approach SMASH as the afterburner for the hadronic stage at RHIC and LHC energies, we find a significant increase in the calculated momentum anisotropies of these photons due to microscopic non-equilibrium dynamics. Non-equilibrium dynamics enhance the photon v_2 below $p_\perp \approx 1.5$ GeV.

[1] Jan Staudenmaier, D. Oliinychenko, J. M. Torres-Rincon, and H. Elfner, Phys. Rev. C 104, 034908 (2021)

[2] O. Garcia-Montero, Jan Staudenmaier, A. Schäfer, J. M. Torres-Rincon, abd H. Elfner, arXiv:2107.08812

[3] A. Schäfer, O. Garcia-Montero, J-F. Paquet, H. Elfner, and C. Gale. arXiv: 2111.13603

HK 65.4 Thu 16:45 HK-H1

Precision hydrodynamic predictions for particle production in isobar collisions at RHIC — •Andreas Kirchner[2], Federica Capellino[1], Stefan Floerchinger[2], Giuliano Giacalone[2], and Eduardo Grossi[3] — [1]Physikalisches Institut Heidelberg — [2]ITP Heidelberg — [3]IPhT Saclay

The STAR collaboration has recently released high precision measurements of soft particle production in Ru+Ru and Zr+Zr collisions permitting us to perform precision tests of hydrodynamic models of the quark-gluon plasma (QGP). In this contribution, we discuss hydrodynamic results for particle production in isobar collisions where we achieve the same precision reached in the experimental data. Our approach relies on a background-fluctuation splitting of the equations of hydrodynamics. We decompose the QGP as an event-averaged azimuthally-isotropic background plus an event-by-event fluctuation. We show that the leading contribution to the average final-state spectra are obtained from the 1+1D evolution of the isotropic background, which is very fast to run. We use, hence, FluiduM, a new solver for the 1+1D evolution of the QGP, to compute predictions for particle spectra, yields and average transverse momenta of identified hadrons. Looking at ratios of quantities between Ru+Ru and Zr+Zr systems, we find that they are insensitive to viscosities and other medium parameters. They are instead driven by initial-state effects driven mainly by the larger neutron skin of 96Zr.

HK 65.5 Thu 17:00 HK-H1

Elliptic flow of pions, kaons and protons relative to the specator plane measured with ALICE at the LHC — •Michael Rudolf Ciupek[1,2], Lukas Kreis[1,2], and Ilya Selyuzhenkov[2] for the ALICE-Collaboration — [1]Physikalisches Institut, Heidelberg, Deutschland — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Deutschland

In relativistic heavy-ion collisions, the shape of the initial energy density in the overlap region of the colliding nuclei is asymmetric and fluctuates. Due to interactions, these are transferred to the momentum distribution of particles in the final state which is quantified by the flow coefficients v_n. Thermodynamic expansion of the quark-gluon plasma (QGP) results in a specific particle mass dependence of the v_n coefficients as a function of the transverse momentum. The measurements of the v_n relative to the spectator plane is of special interest, since the spectators decouple very early in the collision. Comparison of the v_n measured relative to the participant and that wrt. the spectator planes with the corresponding eccentricities allow constraining the initial state models. The particle type (mass) dependence of these differences is sensitive to the viscous effects in the QGP expansion.

In this talk, the ALICE measurements of the v_2 for pions, kaons, and protons with respect to the spectator plane in Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 2.76 and 5.02 TeV are presented. Results are compared with v_2 extracted from two and four-particle cumulants. The spectator plane is reconstructed using the ALICE Zero Degree Calorimeters. The particle identification is performed using a Bayesian approach.

HK 65.6 Thu 17:15 HK-H1

Application of the Three-fluid Hydrodynamics-based Generator THESEUS to CBM. — •Elena Volkova, Hans Rudolf Schmidt, and Viktor Klochkov for the CBM-Collaboration — Eberhard Karls Universität Tübingen

The Compressed Baryonic Matter experiment (CBM) aims to study the area of the QCD phase diagram at high net baryon densities and moderate temperatures. It is predicted by Three-fluid Hydrodynamics-based Event Simulator (THESEUS) that one of the signatures of phase transition is a change in shape of the mid-rapidity curvature and yield.

In this contribution we will present CBM performance for proton rapidity-transverse mass spectra. The results are obtained for Au+Au collisions at $\sqrt{s_{NN}}$ = 2.7 - 4.9 GeV/c produced by THESEUS model. CBM detector response is simulated with the GEANT3 engine and reconstruction is done using the CbmRoot framework. Protons are identified with Time-of-Flight technique using 2 different approaches. Obtained spectra are corrected for detector biases using the UrQMD event generator. Results are compared with simulated values and sources of systematic biases are discussed.

HK 66: Heavy-Ion Collisions and QCD Phases XIV

Time: Thursday 16:00–17:15 Location: HK-H2

HK 66.1 Thu 16:00 HK-H2

Jet-hadron correlations in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02TeV with ALICE — •Luisa Bergmann for the ALICE-Collaboration — Physikalisches Institut, Universität Heidelberg

In relativistic heavy-ion collisions, a deconfined medium with high energy density is created, the quark-gluon plasma. Amongst other observables, jets – originating from primordial hard scatterings – act as useful probes for the properties of this medium. As the initial partons traverse the quark-gluon plasma, they lose energy by interacting with the constituents of the medium. The study of this so called "jet quenching" yields insight into the properties of the medium.

By analyzing the angular correlations of jets with charged hadrons, one obtains information about the energy loss of jets in the medium. The study of these correlation functions for different orientations of the jet to the event plane allows for a measurement of the energy loss which is sensitive to the in-medium pathlength of the jet. In this talk, first studies of event plane dependent jet-hadron correlations for data collected by the ALICE experiment in PbPb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV are presented.

HK 66.2 Thu 16:15 HK-H2

Deuteron production in and out of jets measured with ALICE at the LHC — •Chiara Pinto for the ALICE-Collaboration — Technische Universität München, Garching bei München, Germany

The production mechanism of (anti)nuclei in ultrarelativistic hadronic collisions is under intense debate in the scientific community. The description of the experimental measurements is currently based on two competing phenomenological models: the statistical hadronisation model and the coalescence approach. For the first time, the deuteron production in pp collisions at $\sqrt{s}$ = 13 TeV is measured both in jets and in the underlying event. Due to the collimated emission of nucleons in a jet, the nuclear production by coalescence is expected to be enhanced. In this contribution, the results for the coalescence parameter B_2 in and out of the jet are presented in comparison with predictions from the coalescence model and a recently developed reaction-based production mechanism implemented in PYTHIA 8.3.

HK 66.3 Thu 16:30 HK-H2

Multi-particle correlation in proton-proton collisions from a toy hydrodynamic model — •Seyed Farid Taghavi — E62, Physics department, Technical university of Munich, Garching, Germany

Over the past years, there have been ongoing debates on the origin of the long-range correlations observed in proton-proton collisions at RHIC and LHC. In this talk, a toy model based on Gubser flow is introduced to shed light on the applicability of hydrodynamics in proton-proton collisions. The model, initial state fluctuation + Gubser solution + Cooper-Frye freeze-out, is validated by comparing its results with MC-Glauber + VISH2+1. A rather model-independent approach for the initial state is followed where the RMS radius and ellipticity event-by-event fluctuations are modeled instead of modeling the initial entropy density of individual events. This approach helps us to find out which initial state fluctuating properties would lead to a correct final multiparticle correlation. The toy model describes the multiplicity and transverse momentum dependence of two-point and four-point correlation functions in an accurate agreement with proton-proton collision experimental measurements. In particular, the sign of the four-point correlation function is the same as the observation. We find that neither AMPT nor T_RENTo with nucleonic substructure initial state models can produce the predicted fluctuation for the RMS radius and ellipticity.
Based on:
S. F. Taghavi, Phys.Rev.C 104 (2021) 5, 054906

HK 66.4 Thu 16:45 HK-H2

Differential studies of multi-harmonic flow correlations in ALICE — •Anton Riedel for the ALICE-Collaboration — TU Muenchen, Garching b. M., Deutschland

Symmetric cumulants are a reliable tool for estimating the multi-harmonic correlations between different flow harmonics and have been used in ALICE to constrain the details of η/s temperature dependence of the matter produced in heavy-ion collisions.

In this poster, we present a further differential study of multi-harmonic correlations obtained with symmetric cumulants, SC(k, l) and SC(k, l, m). We present the first results for symmetric cumulants as functions of pseudorapidity η and transverse momentum p_T utilizing Pb–Pb collision at LHC and show how granular the correlations can be extracted using the available statistics. These differential studies provide new and independent constraints both on initial conditions and on the properties of produced nuclear matter.

HK 66.5 Thu 17:00 HK-H2

Impact of hadronic interactions and conservation laws on cumulants of conserved charges in a dynamical model — •Jan Hammelmann[1] and Hannah Elfner[2,1] — [1]Frankfurt Institute for Advanced Studies (FIAS) — [2]GSI Helmholtzzentrum für Schwerionenforschung

Understanding the phase diagram of QCD by measuring fluctuations of conserved charges in heavy-ion collision is one of the main goals of the beam energy scan program at RHIC. Within this work, we calculate the role of hadronic interactions and momentum cuts on cumulants of conserved charges up to fourth order in a system in equilibrium within a hadronic transport approach (SMASH). In our model the net-baryon, net-charge and net-strangeness is perfectly conserved on an event-by-event basis and the cumulants are calculated as a function of subvolume sizes and compared to analytic expectations. We find a modification of the kurtosis due to charge annihilation processes in systems with simplified degrees of freedom. Furthermore the result of the full SMASH hadron gas for the net-baryon and net-proton number fluctuations is presented for systems with zero and finite values of baryochemical potential. Additionally we find that due to dynamical correlations the cumulants of the net-baryon number cannot be recovered from the net-protons. Finally the influence of deuteron cluster formation on the net-proton and net-baryon fluctuations in simplified system is shown. This analysis is important to better understand the relation between measurements of fluctuations in heavy-ion collisions and theoretical calculation which are often performed in a grand canonical ensemble.

HK 67: Instrumentation XVII

Time: Thursday 16:00–17:30 Location: HK-H3

Group Report HK 67.1 Thu 16:00 HK-H3

New detectors for high precision measurements of thermal neutrons — •Jochen Kaminski[1], Markus Gruber[1], Saime Gürbüz[1], Markus Köhli[2], Michael Lupberger[1], Divya Pal[1], Laura Rodríguez Gómez[1], and Klaus Desch[1] — [1]Physikalisches Institut, Universität Bonn, Bonn, Deutschland — [2]Physikalisches Institut, Universität Heidelberg, Heidelberg, Deutschland

In the light of neutron sources in the construction or the commissioning phase, such as the ESS or the CSNS, the demand for neutron detectors is increasing. Because of the shortage and the subsequent rise in cost of helium-3 the availability of conventional neutron detectors is limited. Therefore, new types of detectors based on layers of solid state converters made of boron or gadolinium are being developed. Our group is developing three different types of detectors for high spatial and time resolution for which very different technologies are employed. One of them uses a boron and gadolinium loaded MCP as a converter and amplification stage with a readout by four Timepix3 ASICs, which is ideal for time resolved imaging applications. The two gaseous detectors are aimed for event-by-event high precision measurements of space and time of the conversion point. The detectors use boron-rich conversion layers and are based on the one hand on the TPC principle with a GridPix readout for high precision or on the other hand on a multi-layer GEM-based detector for high rates. In this presentation the principles and the current development statuses of the three detectors are discussed.

HK 67.2 Thu 16:30 HK-H3

Status of the neutron lifetime experiment τSPECT — •Kim Ulrike Ross for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz

The τSPECT experiment aims to measure the neutron lifetime τ_n using a 3D magnetic storage technique. Due to the neutron's magnetic moment, very low-energetic neutrons (ultracold neutrons, UCN) with a maximum energy of ~ 50 neV can be stored in our magnetic trap after double spin flip loading. UCN which are produced in pulses at the TRIGA research reactor Mainz are trapped for varying storage times and afterwards remaining neutrons are counted. The neutron lifetime can then be extracted from an exponential fit. In contrast to previous lifetime experiments employing material walls, systematic effects are reduced significantly by the magnetic confinement of UCN. The target uncertainty in the measured neutron lifetime is $\Delta\tau_n = 1.0$ s in phase I of the experiment.

This talk will give an overview of the status of the τSPECT experiment including the magnetic field configuration, as well as the filling and measurement procedure.

HK 67.3 Thu 16:45 HK-H3

A normalization detector for the neutron lifetime experiment τSPECT — •Martin Engler for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz

The τSPECT experiment aims to measure the free neutron lifetime, using fully magnetic storage. Neutrons with energies of ≈50 neV are stored in the magnetic field gradient and then counted after varying storage times. The individual measurements have to be normalized, in order to account for statistical and systematical changes in the yield of the neutron source. To monitor the neutron flux during the filling process, an in-situ neutron detector, detecting light from a ^{10}B coated ZnS:Ag scintillator coupled to an array of silicon photomultipliers, has been designed and built.
This talk will cover the detectors design, as well as the results of the first test run.

HK 67.4 Thu 17:00 HK-H3

Development of the compact, high resolution particle detection system HI-TREX for ISOLDE — Christian Berner, Roman Gernhäuser, •Sergei Golenev, and Robert Neagu for the MINIBALL-Collaboration — Technical University of Munich

Transfer reactions are a unique tool to populate and probe the structure of nuclei. Due to its unprecedented capabilities in producing and accelerating exotic nuclei, the HIE-ISOLDE facility at CERN provides an excellent opportunity for transfer experiments using radioactive ion beams. HI-TREX is a particle detection setup, optimized for this nuclei. HI-TREX is based on three technological pillars: very thin, AC-coupled, double-sided silicon strip detector (DSSSD); extremely low-powered, high resolution front-end electronics, based on the SKIROC ASICs; and a newly developed, custom made, FPGA based GEneric Asic Readout board GEAR for the TRB data acquisition system. We will present the concept, layout and a whole series of prototype tests towards this demanding technology.

Supported by BMBF 05P21WOCI1

HK 67.5 Thu 17:15 HK-H3

Determination of a high neutron flux using a DT generator — Marie Pichotta, •Hans Hoffmann, and Kai Zuber — TU Dresden IKTP, Dresden, Deutschland

Reproducing r-process reactions on earth is challenging because a very high neutron flux is needed. A promising way is DT implosion at the NIF (National Ignition Facility). There the cross section of reaction ^{40}Ar(2n,γ)^{42}Ar is going to be measured. The reaction ^{40}Ar(n,2n)^{39}Ar will monitor the neutron field. A measurement of the total cross section is needed because theoretical models for this cross section differ.

An argon gas sample enriched in ^{40}Ar was fed into a 20 mm diameter Al sphere at 20 bar. The argon-filled sphere was irradiated with a high neutron flux using the TU Dresden DT neutron generator. It is located at HZDR (Helmholtz-Zentrum Dresden - Rossendorf) and produces a 14 MeV neutron field with densities up to 10^{12} n/(s cm^2). The Ar-filled sphere was positioned in close geometry in order to gain a high neutron flux. 2 metal foils consisting of Al, Zr and Nb respectively, served as neutron monitors. After the irradiation, the monitors' activity was measured using a germanium detector surrounded by a lead shielding. It was calibrated using point sources of known activity and Monte-Carlo simulations. The irradiation procedure and neutron flux analysis will be presented.

HK 68: Instrumentation XVIII

Time: Thursday 16:00–17:15 Location: HK-H4

Group Report HK 68.1 Thu 16:00 HK-H4

Status of R3B setup for as part of the FAIR Phase-0 program — •Andrea Jedele for the R3B-Collaboration — Technische Universität Darmstadt, Fachbereich Physik, D-64289 Darmstadt — GSI Helmholtzzentrum für Schwerionenforschung, D-64291 Darmstadt — Helmholtz Forschungsakademie Hessen für FAIR, D-64289 Darmstadt

The R3B experimental setup located at GSI will be used for upcoming experiments as part of the FAIR Phase-0 program. The versatile setup with large geometric coverage and particle resolution allows for the study of nuclear reaction and structure at relativistic energies.

The experimental setup will be presented followed by an overview of the various detector subsystems. Preliminary results for each detector will be presented to highlight the performance capabilities of the complete setup for upcoming experiments.

This work is supported by the German Federal Ministry for Education and Research (BMBF) under contract number 05P21RDFN2 and by the GSI-TU Darmstadt cooperation agreement.

HK 68.2 Thu 16:30 HK-H4

The new MINIBALL triple cluster detector — •Jasper Wehlitz, Rainer Abels, Timon Büsken, Jürgen Eberth, Kai Henseler, Herbert Hess, Rouven Hirsch, Darius Luyken, and Peter Reiter — IKP Universität zu Köln, Cologne, Germany

The Miniball MB spectrometer consists of eight triple-cryostats, each housing three n-type six-fold segmented HPGe crystals. Major structural changes were made to the cryostat and its electronics to facilitate usability and to increase longevity. The HPGe crystals are individually encapsulated in reusable thin-walled aluminium housing using a new technique that is based on a temperature resistant full-metal elastic seal. As each crystal provides seven signals from the core and six segments a MB cryostat requires 21 preamplifiers. The cryogenically-cooled part of the preamplifier consists of seven jFET-type field effect transistors with their feedback circuits and a coupling capacitor. These parts were improved and coupled to the AGATA preamplifier [1] board in the warm part of the cryostat providing a high bandwidth needed for pulse-shape analysis. First measurements with the new MB triple cluster detectors show energy resolution values and crosstalk properties well within the specifications. The new MB detectors will be employed for future experiments with radioactive ion beams at HIE-ISOLDE (CERN).

[1] S. Akkoyun, et al., Nucl. Instrum. Methods Phys. Res. A 668 (2012) 26

HK 68.3 Thu 16:45 HK-H4

Double-Gamma Nuclear Decay Experiments using Active Compton Supression — •Martin Baumann[1], Thomas Aumann[1,2], Michael Beckstein[1], Patrick Van Beek[1], Daniel Körper[2], Bastian Löher[2], Heiko Scheit[1], and Dmytro Symochko[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany

The 4π Nai detector array Heidelberg-Darmstadt Crystal Ball has been upgraded with 16 LaBr3 detectors and a specially developed compton suppression system called BACCHUS. This made possible double gamma decay measurements with significantly reduced measuring time in comparison to previous experiments. Also the angular distribution between the two emitted photons can now be probed for a larger set of angles. The $\frac{11}{2}^- \rightarrow \frac{3}{2}^+$ transiton of 137-Ba is used as a benchmark to characterise the setup and evaluate future possible uses.
Supported by DFG (SFB 1245)

HK 68.4 Thu 17:00 HK-H4

Test measurement of the HISPEC plunger device at IKP Cologne — •Lisa Kornwebel[1], Christoph Fransen[1], Marcel Beckers[1], Andrey Blazhev[1], Alfred Dewald[1], Felix Dunkel[1], Jan Jolie[1], Casper Lakenbrink[1], Claus Müller-Gatermann[2], Franziskus von Spee[1], and Stefan Thiel[1] — [1]Institut für Kernphysik, Köln, Deutschland — [2]Physics Division, Argonne National Laboratory, IL, USA

The HISPEC plunger, developed and built by our group, is a core device for the HISPEC-DESPEC program which is part of the NUSTAR collaboration within FAIR. This device will be used for the measurement of level lifetimes in exotic nuclei at FAIR with the recoil distance Doppler-shift method. In order to prove the precision of this device, excited states of ^{181}Ta with well-known lifetimes were re-investigated in a test measurement with stable beam at the FN-Tandem accelerator facility at Cologne to determine absolute distances of the very large target and degrader foils in two perpendicular axes. We will present the results with respect to the foil parallelism and the repeat accuracy of these absolute distances. We will further relate the results to an independent measurement of the foil separations with an optical distance measurement system. This work was supported by the BMBF, grant No. 05P19PKFNA.

HK 69: Instrumentation XIX

Time: Thursday 16:00–17:30 Location: HK-H5

HK 69.1 Thu 16:00 HK-H5

The CALIFA trigger system — Leyla Atar[1], Tobias Jenegger[2], Roman Gernhäuser[2], •Philipp Klenze[2,3], and Lukas Ponnath[2] for the R3B-Collaboration — [1]Technische Universität Darmstadt — [2]Technische Universität München — [3]Gesellschaft für Schwerionenforschung, Darmstadt

With the recent completion of the forward region of the R^{3}B calorimeter, CALIFA now features 1504 channels. While previously each channel of CALIFA was operated in free-running mode, recent beamtimes have shown that this puts a huge load on the downstream processing facilities especially in experiments using high rate uranium beams.

Due to the slow signals of the calorimeter CsI(Tl) crystals special procedures have been established not to compromise efficiency. Using the White Rabbit Time Stamps (WRTS) differences of various detector systems, it is easy to verify that this is actually the case.

Additionally, we will discuss the ability of CALIFA to provide a high level trigger based on proton multiplicities or position to ancilliary detectors with limited readout capability in R^{3}B.

Supported by BMBF contract 05P19WOFN1.

HK 69.2 Thu 16:15 HK-H5

Magnet simulations for HISPEC position tracking detector — •Michael Armstrong and Gereon Hackenberg — University of Cologne

Future in-flight spectroscopy of radioactive heavy ion beams in HISPEC (HIgh resolution in-flight SPECtroscopy) experiments at GSI/FAIR will require highly precise beam tracking and timing [1]. For these experiments a pair of Secondary Electron Detector (SED) using Multi-Channel Plate (MCP) detectors are being designed to fulfil these requirements. In order to achieve the necessary precision the MCP's must be enveloped in a homogenous 100 gauss magnetic field. In this poster the design of a prototype permanent magnet is presented including simulations of the magnetic field it should be capable of providing.

This work was supported by GSI under F&E grant KJOLIE1820.

[1] - "Technical Report for the Design, Construction and Commissioning of the HISPEC/DESPEC Beam Line, Infrastructure and Tracking Detectors". HISPEC/DESPEC Collaboration. FAIR PAC NUSTAR. 11 May 2020.

HK 69.3 Thu 16:30 HK-H5

aTEF: Background reduction at KATRIN via an active transverse energy filter — •Kevin Gauda[1], Volker Hannen[1], Alexey Lokhov[1], Hans-Werner Ortjohann[1], Wolfram Pernice[2], Richard Salomon[1], Sonja Schneidewind[1], Maik Stappers[2], and Christian Weinheimer[1] — [1]Institut für Kernphysik, Universität Münster, Germany — [2]Physikalisches Institut, Universität Münster, Germany

The Karlsruhe Tritium Neutrino Experiment (KATRIN) aims at the direct measurement of the electron antineutrino mass with 0.2 eV/c^2 sensitivity from precision spectroscopy of the tritium beta decay. The analysis of its first two science runs yields a new upper limit of $m_\nu < 0.8$ eV (90 % C.L.).

Even in the shifted-analysis-plane (SAP) mode it is required to further lower the background rate to reach the target sensitivity. The background rate is dominated by electrons originating from ionisation of highly-excited (Rydberg) atoms produced by α-decays in the spectrometer walls. Thus, they cannot be distinguished from the signal electrons by energy but they possess much smaller angles w.r.t. the beam axis and, thus, much smaller cyclotron radii in the magnetic fields of KATRIN. The aTEF idea is to construct a detector by microstructuring that is mainly sensitive to the signal electrons because of their larger cyclotron radii. Investigations of first prototypes based on microstructured silicon PIN detectors are presented in this talk.

The work of the authors for KATRIN is supported by BMBF under contract number 05A20PMA.

HK 69.4 Thu 16:45 HK-H5

Influence of the fluorescence detection region on the determination of nuclear moments — •Patrick Müller[1,2], Phillip Imgram[1], Bernhard Maass[3], and Wilfried Nörtershäuser[1,2] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Helmholtz Forschungsakademie Hessen für FAIR, TU Darmstadt, Germany — [3]Argonne National Laboratory, Chicago, IL, USA

Collinear laser spectroscopy (CLS) is usually used at online facilities such as CERN or NSCL to determine isotope shifts as well as nuclear moments of neutron-deficient or -rich nuclei. At the COALA experiment at the Technische Universität Darmstadt, high-precision CLS is used to provide reference values of atomic transition frequencies and nuclear moments in stable isotopes required for online experiments, but also to test new measurement schemes or technical equipment. By recording fluorescence spectra of electric dipole transitions whose linewidths are of the order of the natural linewidth, small effects which shift or deform the classical Lorentzian profile become visible, such as quantum interference or photon recoils.

We report on measurements with a new lens-based fluorescence detection region (FDR) for COALA using Ca^+. Due to its well-defined positional and easy to adjust angular detection range, the FDR is particularly useful for investigating the influence of such geometric effects on fluorescence spectra and, therefore, on extracted nuclear moments.

This work was supported by BMBF under contract *05P19RDFN1.*

HK 69.5 Thu 17:00 HK-H5

Improvement of Pulse Shape Simulations for Highly Segmented HPGe Detectors — •Rouven Hirsch, Rainer Abels, Jürgen Eberth, Kai Henseler, Herbert Hess, Darius Luyken, and Peter Reiter — Institut für Kernphysik, Universität zu Köln

36-fold segmented high purity germanium detectors are the basis for the Advanced GAmma Tracking Array (AGATA). In contrast to conventional γ-ray spectrometers, AGATA utilizes the γ-ray tracking method which reconstructs the path of the γ rays through the detector array. Essential for the tracking is the determination of the γ-ray interaction positions with a sub-segment position resolution. This is obtained via pulse-shape analysis (PSA) of the 37 preamplifier signals. Simulated signal shapes are compared with the measured signals to match the interaction positions. Therefore, the final position resolution strongly depends on the quality and accuracy of the detector signal simulation. Simulated data bases of position dependent signals were generated for a cylindrical 36-fold segmented single ended coaxial HPGe detector employing the AGATA Detector Library [1] and Solid-StateDetectors.jl [2]. Systematic deviations were identified at the crystal borders and segmentation lines by comparing simulated pulse shapes and measured signals for both approaches. The impact of simulation input variables to the pulse shapes was investigated to improve the overall PSA performance. Supported by BMBF Project 05P18PKFN9 and 05P21PKFN9

[1] B. Bruyneel et al. Eur. Phys. J. A (2016) **52**: 70
[2] I. Abt et al. 2021 JINST **16** P08007

HK 69.6 Thu 17:15 HK-H5

Preparation of the hyperatom studies at $\overline{\text{P}}$ANDA — Patrick Achenbach[1,2], Sebastian Bleser[1], •Michael Bölting[1], Josef Pochodzalla[1,2], Falk Schupp[1], and Marcell Steinen[1] — [1]Helmholtz Institute Mainz, 55099 Mainz — [2]Johannes Gutenberg University, 55099 Mainz

The antiproton beam of the HESR at FAIR will allow to produce various hyperon-antihyperon pairs. The dedicated target system of the $\overline{\text{P}}$ANDA hyperatom setup will allow to bind negatively-charged (anti)hyperons and form heavy hyperatoms. First experiments with a ^{208}Pb target aim at studying X-ray transitions of atomically bound Ξ^-, Σ^- and possibly even $\overline{\Sigma}^-$.

The required target system needs to be integrated in the HESR beam pipe and the $\overline{\text{P}}$ANDA target spectrometer. Consequently, it must not only be vacuum-tolerant but also radiation hard and compatible with the present strong magnetic field within $\overline{\text{P}}$ANDA. Within this environment the required redundancy of the target setup can only be achieved by multiple primary targets exchangeable by a system of piezomotors.

In this contribution we will present the final design of the two-staged target system. First tests of the reliability and the precision of the system will be presented.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 824093.

HK 70: Structure and Dynamics of Nuclei XII

Time: Thursday 16:00–17:45 Location: HK-H6

Group Report HK 70.1 Thu 16:00 HK-H6

Lifetime studies in self-conjugate even-even nuclei in the $0f_{7/2}$ shell — •K. Arnswald[1], A. Blazhev[1], F. Nowacki[2], P. Petkov[3,1], and P. Reiter[1] — [1]Institut für Kernphysik, Universität zu Köln — [2]Université de Strasbourg, CNRS, IPHC UMR 7178, Strasbourg, France — [3]*„Horia Hulubei"* National Institute for Physics and Nuclear Engineering, Bucharest-Măgurele, Romania

Reduced transition strengths are sensitive signatures to describe collective excitations of atomic nuclei and the evolution of shell structures. They allow for stringent tests of present-day shell-model interactions in the $0f1p$ shell. In recent years, data were obtained from lifetime experiments utilizing the recoil-distance Doppler-shift technique as well as the Doppler-shift attenuation method and cover the even-even $N = Z$ nuclei between ^{44}Ti and ^{56}Ni. An enhanced collective behavior has been observed for the 2_1^+ states [1]. In ^{44}Ti this collectivity has been associated with core excitations. Precise values along the negative parity band in this nucleus were obtained. These states arise from a strong interplay between sd- and pf-shell orbitals and provide refined tests of cross-shell contributions [2]. For the doubly-magic nucleus ^{56}Ni only the $B(E2, 2_1^+ \to 0_{\text{g.s.}}^+)$ value was known. Lifetimes of the 4_1^+ and 6_1^+ states were newly obtained and confronted with modern shell-model calculations. A comparison along the chain of $N = 28$ isotones between ^{48}Ca and ^{58}Zn shows maximum $B(E2)$ values for these states [3].

[1] K. Arnswald *et al.* Phys. Lett. B **772**, (2017) 599-606
[2] K. Arnswald *et al.* Phys. Rev. C **102**, 054302 (2020)
[3] K. Arnswald *et al.* Phys. Lett. B **820**, (2021) 136592

HK 70.2 Thu 16:30 HK-H6

Lifetime Measurement of the ^{26}O g.s. at SAMURAI — •S. Storck-Dutine[1,3], T. Aumann[1,2], C. Caesar[2,3], J. Kahlbow[4,3], V. Panin[2,3], and D. Rossi[1,2] for the NeuLAND-SAMURAI-Collaboration — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]RIKEN Nishina Center, Tokyo, Japan — [4]Massachusetts Institute of Technology, Cambridge MA, USA

The ground state of the neutron unbound nucleus ^{26}O is speculated to have a lifetime in the pico-second regime. In order to determine the decay lifetime of the ^{26}O ground state with high sensitivity and precision, a new method has been applied. The experiment was performed in December 2016 at the Superconducting Analyzer for MUlti-particle from RadioIsotope Beams (SAMURAI) at the Radioactive Isotope Beam Factory (RIBF) at RIKEN. A ^{27}F beam was produced in the fragment separator BigRIPS and impinged on a W/Pt target stack where ^{26}O was produced. The ratio of the number of decays happening inside and outside of the target will change according to the lifetime. Thus, the velocity difference between the decay neutrons and the fragment ^{24}O delivers a characteristic spectrum from which the lifetime can be extracted. In the report, the experimental setup and method are introduced and the current analysis status is presented.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907 - SFB 1245, the BMBF under contract number 05P21RDFN2 and the GSI-TU Darmstadt cooperation agreement.

HK 70.3 Thu 16:45 HK-H6

Excited states from eigenvector continuation: the anharmonic oscillator — •Margarida Companys Franzke[1], Alexander Tichai[1,2,3], Kai Hebeler[1,2,3], and Achim Schwenk[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg

Eigenvector continuation (EC) has recently attracted a lot attention in nuclear structure and reactions as a variational resummation tool for many-body expansions. While previous applications focused on ground-state energies, excited states can be accessed on equal footing. This work is dedicated to a detailed understanding of the emergence of excited states from the eigenvector continuation approach. For numerical applications the one-dimensional quartic anharmonic oscillator is investigated, which represents a strongly non-perturbative quantum system where the use of standard perturbation techniques break down. We discuss how different choices for the construction of the EC manifold affect the quality of the EC resummation and investigate in detail the results from EC for excited states compared to results from a full diagonalization as a function of the basis-space size.

* Funded by the DFG – Project-ID 279384907 – SFB 1245 and by the ERC Grant Agreement No. 101020842.

HK 70.4 Thu 17:00 HK-H6

Gamma ray spectroscopy of the neutron-rich ^{94,95,96}Kr* - results from the NuBall and SEASTAR campaigns — Rosa-Belle Gerst, •Andrey Blazhev, and Nigel Warr — Institut für Kerphysik, Universität zu Köln

The isotopic chain of krypton isotopes is home to a variety of nuclear-shape phenomena and has been studied extensively. In recent years, we have studied the neutron-rich isotopes during the SEASTAR campaign at the RIBF at the RIKEN Nishina Center and during the NuBall campaign at the ALTO facility at the IPN Orsay. While the former populated the isotopes of interest via nucleon knockout reactions, the latter used fast-neutron induced fission of ^{238}U. In all three studied nuclei, previously unknown gamma-transitions were observed extending the level schemes [1,2]. A new short-lived isomer was discovered in ^{94}Kr [1]. For ^{95}Kr, the analysis of prompt gamma-radiation with and without coincidence of delayed radiation identified the prompt gamma-rays [2] as either feeding or bypassing the known isomeric state [3]. For ^{96}Kr, the measured new transitions imply the existence of low-lying low-spin non-yrast states [2]. The comparison of the new experimental results with 5DCH and mapped IBM calculations, both using the Gogny D1M interaction, could suggest oblate-prolate shape coexistence in the krypton isotopes already at N=60 [2].

*Supported by the DFG under Grant No. BL 1513/1-1

[1] R.-B Gerst et al., Phys. Rev. C 102, 064323 (2020).
[2] R.-B. Gerst et al., submitted to PRC.
[3] J. Genevey et al., Phys. Rev. C 73, 037308 (2006).

HK 70.5 Thu 17:15 HK-H6

Novel normal ordering framework for heavy nuclei — •Jan Hoppe[1,2], Kai Hebeler[1,2,3], Victoria Durant[4], Johannes Simonis[5], Matthias Heinz[1,2,3], Achim Schwenk[1,2,3], and Alexander Tichai[1,2,3] — [1]Technische Universität Darmstadt, Department of Physics — [2]ExtreMe Matter Institute EMMI, GSI Helmholtzzentrum für Schwerionenforschung GmbH — [3]Max-Plank Institut für Kernphysik, Heidelberg — [4]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [5]Jülich Supercomputing Centre

The inclusion of three-nucleon (3N) interactions plays a central role in the solution of the nuclear many-body problem, e.g., for the structure of finite nuclei or bulk properties of nuclear matter, but still represents a computational frontier. Normal-ordering (NO) has proven to be a powerful tool to systematically include 3N interactions in an efficient way. However, traditional NO frameworks require the representation of 3N interactions in a large single-particle basis, which typically necessitates a truncation on the 3N matrix elements. While these truncations have only a minor impact up to medium-mass nuclei, their effects become sizable for heavier systems and hence limit the scope of ab initio calculations. We present a novel NO framework that allows to circumvent this drawback by performing the NO directly in the Jacobi basis. We systematically study the convergence behavior of results obtained in this framework and present results for ground-state energies of selected nuclei up to ^{132}Sn. *Funded by the DFG - Project-ID 279384907 - SFB 1245 and by the ERC Grant Agreement No. 101020842.

HK 70.6 Thu 17:30 HK-H6

Electron-Gamma Coincidence Experiments at the S-DALINAC — •Gerhart Steinhilber, Jonny Birkhan, Isabelle Brandherm, Martha Liliana Cortes, Florian Gaffron, Johann Isaak, Igor Jurosevic, Peter von Neumann-Cosel, Florian Niederschuh, Norbert Pietralla, Maxim Singer, and Maximilian Spall — IKP, Technische Universität Darmstadt

Inclusive (e,e') electron scattering is an established tool in nuclear physics that provides insights in nuclear structure with high accuracy because of its pure electromagnetic nature. In (e,e'γ) coincidence experiments, the advantage of inclusive electron scattering is preserved and additional information, for example, γ-decay branchings of PDR/GDR and the interference of longitudinal and transversal components of low-lying electric dipole excitations are accessible. The existing (e,e') setup at S-DALINAC was extended by a detector array consisting of 6 $LaBr_3$:Ce detectors and successful (e,e'γ) measurements were conducted for the first time since the pioneering (e,e'γ) experiment nearly 40 years ago [1]. In 2021, a first production run was performed using the new (e,e'γ) setup to study the B(M1,$2^+_{ms} \to 2^+_1$) and B(E2,$2^+_{ms} \to 0^+_1$) transition strength of the 2^+_{ms} branching in ^{96}Ru [2] measuring γ-decay branchings. This talk will present the new setup and preliminary results of the ^{96}Ru measurement.

Work supported by DFG (GRK 2128)

[1] C. N. Papanicolas et al., Phys. Rev. Lett. 54 (1985).
[2] N. Pietralla et al., Phys. Rev. C 64 (2001).

HK 71: Structure and Dynamics of Nuclei XIII

Time: Thursday 16:00–17:30 Location: HK-H7

Group Report HK 71.1 Thu 16:00 HK-H7

Nucleon and nuclear structure from measurements in muonic and normal atoms — •Randolf Pohl — Johannes Gutenberg Universität Mainz

Laser spectroscopy of simple atoms is sensitive to properties of the atomic nucleus, such as its charge and magnetization distribution, or its polarizability. This allows determining the nuclear parameters from atomic spectroscopy, but also limits the attainable precision for the determination of fundamental constants or the test of QED and the Standard Model.

In light muonic atoms and ions, one negative muon replaces all atomic electrons, resulting in a calculable hydrogen-like system. Due to the muon's large mass (200 times the electron mass), the muon orbits the nucleus on a 200 times smaller Bohr radius, increasing the sensitivity of muonic atoms to nuclear properties by 200^3 = 10 million.

This has resulted in a 10fold increase in the precision of the charge radius of the proton, deuteron, and the stable helium nuclei. We're currently measuring the hyperfine structure in muonic hydrogen to obtain information about the magnetization of the proton. In Mainz, we're setting up an experiment to determine the triton charge radius by laser spectroscopy of atomic tritium.

HK 71.2 Thu 16:30 HK-H7

nuclear structure corrections in muonic atoms from chiral effective field theory — •simone salvatore li muli[1,2] and sonia bacca[1,2] — [1]Institut für Kernphysik, Johannes Gutenberg Universität, Mainz, Germany — [2]Helmholtz-Institut Mainz, Johannes Gutenberg Universität Mainz, Germany

Precision spectroscopic measurement in muonic atoms require precision theoretical calculations to be able to extract nuclear charge and magnetic radii. While quantum electrodynamics calculations are very precise, nuclear structure corrections are presently the largest source of uncertainty and consequently the bottle-neck for fully exploiting the experimental precision. Utilizing techniques and methods developed in few-body nuclear physics, we have been able to provide the so far most precise determination of nuclear structure corrections to the Lamb shift. I will present our recent calculations for light muonic atoms, where we use chiral effective field theory potentials and perform a study of the uncertainties induced by the order-by-order chiral expansion.

HK 71.3 Thu 16:45 HK-H7

Nuclear structure investigations on $^{253-255}$Es by laser resonance ionization spectroscopy — •Steven Nothhelfer for the Einsteinium-Collaboration — Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — Helmholtz-Institut Mainz, 55099 Mainz, Germany — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

Experimental data on the hyperfine structure splittings and isotope shifts of spectral lines in transuranium elements reveal valuable information about the structure of their atomic nuclei. In this poster we will present results of laser resonance ionization spectroscopy performed on the rare isotopes $^{253-255}$Es at the RISIKO mass separator in Mainz. With small sample sizes ranging down to fg, the prominent 351.5 nm ground-state transition ($5f^{11}7s^2 \rightarrow 5f^{11}7s7p$) was measured in all three Es isotopes. Furthermore, four additional ground-state transitions were measured in ^{254}Es. Hyperfine structure analysis resulted in spin values of $I(^{254}\mathrm{Es}) = 7$ and $I(^{255}\mathrm{Es}) = 7/2$. Nuclear magnetic dipole moments as well as spectroscopic electric quadrupole moments were derived from the extracted hyperfine coupling constants. The literature value of the nuclear magnetic dipole moment for ^{254}Es obtained from angular anisotropy measurements of ^{254}Es α-radiation [1] deviates from our more precise value of this quantity.

Further measurements are planned on ^{254}Es using a new high-resolution gas-jet apparatus [2]. Most recent results will be presented.

[1] N. Severijns et al., Phys. Rev. C 79 (2009), 064322. [2] S. Raeder et al., Nucl. Instrum. Methods. Phys. Res. B 463 (2020), 272-276.

HK 71.4 Thu 17:00 HK-H7

First results of an all-optical nuclear charge radius determination at COALA — •Phillip Imgram[1], Emily Burbach[1], Bernhard Maass[2], Patrick Müller[1], and Wilfried Nörtershäuser[1] — [1]Institut für Kernphysik, TU Darmstadt, Germany — [2]Argonne National Laboratory, Chicago, IL, USA

The Collinear Apparatus for Laser Spectroscopy and Applied Physics (COALA) at the Institute of Nuclear Physics of TU Darmstadt has been designed to perform high-precision experiments on stable isotopes for high-voltage measurements, atomic physics and nuclear structure research. The recently applied upgrade with an electron-beam ion source allows us to study transitions in multiply-charged ions. Here, the focus is on light ions to determine nuclear charge radii with an all-optical approach, i.e. without referencing to charge radii determined by elastic electron scattering or transitions in muonic atoms. Therefore, the $^3S_1 \rightarrow {}^3P_J$ transitions of He-like ions will be measured to a targeted accuracy of <1 MHz with simultaneous collinear and anticollinear laser spectroscopy. This experimental value can directly be compared with nonrelativistic QED calculations [1] that are currently being performed. This contribution will summarize the current status of the project and present first results of $^{12}C^{4+}$ measurements. This project is supported by DFG (Project-ID 279384907 - SFB 1245) and by BMBF (05P21RDFN1).

[1] V. Patkós, Phys. Rev. A 103, 042809 (2021)

HK 71.5 Thu 17:15 HK-H7

CREMA-Measuring the Ground State Hyperfine splitting of Muonic Hydrogen — •Siddharth Rajamohanan[1], Ahmed Ouf[1], and Randolf Pohl[2] — [1]Johannes gutenberg universität mainz, Mainz, Germany — [2]PRISMA+Cluster of Excellence and Institute of Nuclear Physics, Johannes Gutenberg-Universitat Mainz, 55099 Mainz, Germany

Precision measurements on atoms and ions provide a wealth of information of bound state QED and is a unique test of the Standard Model. Significant work has been done to understand the proton radius puzzle. To this end, the CREMA collaboration is presently pursuing a pulsed laser spectroscopy measurement of ground state HFS in muonic hydrogen upto 1ppm accuracy to understand the Zemach radius, which encodes the magnetic properties of the proton. A unique laser system, the multi-pass cavity and the scintillation detection system are necessary for the experiment. We report our progress on the same.

HK 72: Hadron Structure and Spectroscopy XII

Time: Thursday 16:00–17:30 Location: HK-H8

Group Report HK 72.1 Thu 16:00 HK-H8

Role of a triangular singularity in the $\gamma p \rightarrow p\pi^0\eta$ reaction — •Volker Metag and Mariana Nanova for the CBELSA/TAPS-Collaboration — II. Physikalisches Institut, Universität Giessen, Giessen

Recently structures in invariant mass distributions and excitation energy spectra have been attributed to triangular singularities as discussed in e.g., [1,2] and in the review by Guo et al. [3]. These singularities emerge under specific kinematic conditions when new reaction channels open up. It will be shown that a triangular singularity associated with the opening of the $\gamma p \rightarrow pa_0 \rightarrow p\pi^0\eta$ channel can explain the observation of a structure in the $M_{p\eta}$ invariant mass distribution near 1700 MeV/c^2 in the $\gamma p \rightarrow p\pi^0\eta$ reaction [4].

[1] G. D. Alexeev *et al.*, The COMPASS Collaboration, Phys. Rev. Lett **127**, 082501 (2021).

[2] M. Mikhasenko, B. Ketzer and A. Sarantsev, Phys. Rev. D **91**, 094015 (2015).

[3] F. K. Guo *et al.*, Rev. Mod. Phys. D **90**, 015004 (2018).

[4] V. Metag *et al.*, arXiv:2110.05155.

Supported by DFG through SFB/TR16.

HK 72.2 Thu 16:30 HK-H8

Feasibility Studies of the $f_1(1420)$ Meson Production in Two-Photon Fusion Processes at BESIII — •Nick Effenberger, Christoph Florian Redmer, and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Deutschland

The precision of the Standard Model prediction of the anomalous magnetic moment of the muon, a_μ, is completely limited by the knowledge of the hadronic contributions. These are the hadronic Vacuum Polarization contribution as well as the hadronic Light-by-Light (HLbL) scattering contribution. For the latter, data-driven approaches have recently been developed. Recent estimates from such data-driven approaches demonstrate the importance of axial mesons with masses above 1 GeV for a_μ^{HLbL}.

The BESIII experiment, located at the BEPCII collider in Beijing, China, has collected data with center-of-mass energies residing in the τ-charm region. These can be used to study the production of axial mesons in two-photon fusion processes with quasi-real or virtual photons. In this presentation, we discuss the prospects of studying the $f_1(1420)$ meson via its decay to the $K^+K^-\pi^0$ final state.

HK 72.3 Thu 16:45 HK-H8

Search for the Production of the $f_1(1285)$ Resonance in e^+e^- Collisions using Initial State Radiation at BESIII — •Jan Muskalla, Achim Denig, Christoph Florian Redmer, and Riccardo Aliberti — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Hadronic light-by-light scattering (HLbL) is a limiting process for the precision of the Standard Model prediction for the anomalous magnetic moment of the muon a_μ. The uncertainty of a_μ^{HLbL} can be improved using detailed measurements of transition form factors (TFF) of the two-photon coupling to mesons. One such TFF study of interest is on the $f_1(1285)$ meson which can be produced via two-photon fusion processes in e^+e^- annihilations. The BESIII experiment at the electron-positron collider in Beijing (BEPC-II) has collected the world's largest data sets in the τ-charm energy region. Initial state radiation (ISR) allows for a search of the f_1 resonance at energies below the center of mass energy of the collider. The decay channel $e^+e^- \rightarrow f_1\gamma_{ISR} \rightarrow \pi^0\pi^0\eta\,\gamma_{ISR} \rightarrow 7\gamma$ is searched. If successful, this will shed light on the two-photon coupling to the f_1 resonance ($J^{PC} = 1^{++}$) since the resonance is only accessible in e^+e^- annihilation via a two-photon production process. To perform a blind analysis, Monte Carlo simulations for the signal and background channels are analyzed with the aim of performing the analysis on data sets from BESIII with a combined luminosity of 20 fb^{-1}.

HK 72.4 Thu 17:00 HK-H8

Proton-ϕ interaction studied in pp collisions with ALICE at the LHC — •Emma Chizzali for the ALICE-Collaboration — TUM, Munich, Germany

In order to constrain the equation of state of dense objects like neutron stars (NS) and subsequently solve the puzzle about their content, it is fundamental to understand the interaction between their hypothetical constituents. Hyperons might be contained in the core of NS which makes the hyperon-hyperon interaction relevant with the ϕ vector meson as effective exchange particle. Additionally, it is an interesting particle regarding the partial restoration of chiral symmetry in the nuclear medium. For such investigations it is relevant to constrain the vacuum properties of the interaction between the ϕ meson and nucleons. This can be studied experimentally by measuring the correlation function between proton and ϕ meson employing the femtoscopy technique in small collision systems. The small source size in HM pp collisions at the Large Hadron Collider at $\sqrt{s} = 13$ TeV makes it possible to study short-ranged strong potentials with unprecedented precision. The data used to derive the correlation function is measured by the ALICE experiment and corrected for non-genuine contributions. Finally, it is found to reflect the pattern of an attractive force between proton and ϕ meson and employed to extract the scattering parameters of the interaction.

HK 72.5 Thu 17:15 HK-H8

Messung des Verzweigungsverhältnisses des Zerfalls $J/\psi \rightarrow \bar{p}\Sigma^+K_S^0 + c.c.$ am BESIII-Experiment — •Leonard Wollenberg und Miriam Fritsch für die BESIII-Kollaboration — Ruhr-Universität Bochum

Das BESIII-Experiment am BEPC-2 Electron-Positron-Speicherring in Peking hat im Sommer 2018 die Datenaufname für den weltgrößten J/ψ-Datensatz beendet. Insgesamt wurden 10 Milliarden J/ψ-Ereignisse aufgezeichnet. Mit diesem Datensatz ist es möglich, sehr präzise Messungen der Zerfallseigenschaften des J/ψ durchzuführen. Von besonderen Interesse ist die Messung des Verzweigungsverhältnisse $J/\psi \rightarrow \bar{p}\Sigma^+K_S^0+c.c.$, da diese Reaktion bisher nicht vermessen wurde. Bisher gibt es nur eine Messung des Verzweigungsverhältnisses des Isospin Partners Zerfalls $J/\psi \rightarrow \bar{p}\Sigma^0K^+$. In diesem Vortrag wird die erste Messung des Verzweigungsverhältnis des Zerfall Kanals $J/\psi \rightarrow \bar{p}\Sigma^+K_S^0 + c.c.$ präsentiert.

HK 73: Fundamental Symmetries II

Time: Thursday 16:00–17:45 Location: HK-H9

Group Report HK 73.1 Thu 16:00 HK-H9

Electric dipole moments of charged particles at storage rings — •Vera Shmakova for the JEDI-Collaboration — University of Ferrara, Italy

The Standard Model (SM) of Particle Physics cannot explain the matter-antimatter asymmetry in the Universe. Therefore, the search of physics beyond the SM is required and one way to achieve it is to strive for the highest precision in the search for electric dipole moments (EDMs). Permanent EDMs of particles violate both time reversal and parity invariance and, via the CPT theorem, also the combined CP symmetry. Finding an EDM would be a strong indicator for physics beyond the SM.

Storage rings offer possibility to measure EDMs of charged particles by observing the influence of the EDM on the spin motion in the ring. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, making it an ideal testing ground and starting point for the JEDI collaboration (Jülich Electric Dipole moment Investigations) for such an experimental program. The talk will present the JEDI program for the measurement of proton and deuteron EDMs and discuss recent results of the first direct (precursor) measurements of the deuteron EDM in COSY.

Group Report HK 73.2 Thu 16:30 HK-H9

Muonic X-ray measurements at the Paul Scherrer Institute — •Frederik Wauters — Johannes Gutenberg University Mainz, Germany

When negative muons are stopped in a target material, they are quickly captured and form an exotic atom. During this formation process, muonic X-rays, which can have energies up to several MeV, are emitted until the 1s orbital is reached. The muon wave function in the lower orbits has a large overlap with the nucleus, making this system an excellent laboratory to study short range interactions between the muon and the atomic nucleus such as finite size effects, nuclear capture, and possble parity odd interactions.

The muX project at the Paul Scherrer Institute is performing muonic X-ray measurements on medium and high-Z nuclei, deploying a large high-purity germanium array in combination with muon, electron and neutron detectors. A new technique was developed utilizing transfer reaction in a H2/D2 gas cell to stop a standard muon beam in a few ug of target material.

A wide physics program is focusing on atomic parity violation (APV) by measuring the the charge radius of 226Ra, which will serve as an important input for an upcoming APV experiment with Ra in a Paul trap. We are also pursuing measuring APV directly in muonic atoms in the 2s-1s transition. Furthermore, absolute nuclear charge radii measurements serve as a benchmark for laser spectroscopy, and nuclear muon capture gives access to highly excited nuclear states of interest to determine double beta-decay matrix elements.

HK 73.3 Thu 17:00 HK-H9

Status report of the Fermilab Muon g–2 experiment — •René Reimann for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

In spring 2021 the Muon g–2 collaboration published the most precise measurement of the anomalous magnetic moment of the muon, a_μ, with a 460 ppb uncertainty. The measurement principle is based on a clock comparison between the anomalous spin precession frequency of spin-polarized muons, which is the deviation of the Larmor- from the cyclotron-frequency, and a high-precision measurement of the magnetic field environment using nuclear magnetic resonance (NMR) techniques, expressed in terms of the (free) proton spin-precession frequency. The published results are based on the run 1 data. In the meantime a data set of about 12.5 the size of run 1 has been acquired through runs 2-4 and more high-quality data is currently recorded through run 5. In this talk I summarize the current status and focus on improvements and systematic studies that the Muon g–2 collaboration implemented. In particular, I discuss the magnetic field stability and characterization.

HK 73.4 Thu 17:15 HK-H9

Magnetic field measurement in the Fermilab Muon g − 2 experiment — •Hassan Qureshi for the Muon g–2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The Fermilab Muon g − 2 experiment aims to measure the anomalous magnetic moment of the muon, a_μ, to a precision of 140 ppb. Run 1 results were published in April 2021 with an unprecedented precision of 460 ppb. This increased the new world average deviation between the Standard Model theory prediction and the average experimental measurements to $4.2\,\sigma$. The experiment measures the muon anomalous spin precession frequency w_a and the proton spin precession frequency w_p, the ratio of which is used to calculate a_μ. The w_p value expresses the magnetic field as experienced by the circulating muons in the experiment's storage ring. The magnetic field inside the ring is measured using two nuclear magnetic resonance (NMR) probe arrays. First is an array of 378 fixed NMR probes, spread evenly around the top and bottom walls of the vacuum chambers, which continuously measures the field drift within the muon storage ring. The second array consists of a set of 17 NMR probes, mounted on a trolley, which is periodically driven around the muon storage cavity to measure its spatial distribution of the field. In this talk I will discuss the method for tying together data from the two NMR probe arrays in time, in order to interpolate the magnetic field as experienced by muons during their storage time. Furthermore, I will discuss plans to streamline the tying procedure for Run 2 and 3 while improving the w_p uncertainty compared to Run 1.

HK 73.5 Thu 17:30 HK-H9

Electromagnetic interactions as the source of all known forces. — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

Older physical theoretical models represent the space as filled with a substance (ether) where subatomic particles (SPs) are submerged. Newer models represent the space as empty and forces between SPs are explained with the exchange of fictitious carrier particles. In both type of models, the space is composed of SPs and of a fictitious substance or of fictitious carriers. An approach is presented where the space is filled with Fundamental Particles (FPs) with longitudinal and transversal angular momenta, FPs that move with light or infinite speed. The different types of SPs are formed by different configurations of FPs; fermions are focal-points of rays of FPs with aligned angular momenta, photons are rays of FPs with alternating opposed angular momenta, and neutrinos are pairs of FPs with opposed angular momenta. FPs are the constituents of all subatomic particles. Forces between subatomic particles are the product of the interactions (scalar and vector product) of the angular momenta of their FPs. Neither fictitious substances nor fictitious carriers are required. All forces are due to electromagnetic interactions and are described by QED. An important finding of the approach is that the interaction between two charged SPs tends to zero for the distance between them tending to zero. Atomic nuclei can thus be represented as swarms of electrons and positrons that neither attract nor repel each other. As atomic nuclei are composed of nucleons which are composed of quarks, the quarks can also be seen as swarms of electrons and positrons. More at: www.odomann.com

HK 74: Annual General Meeting

Time: Thursday 18:00–19:00 Location: HK-MV

HK 75: Invited Talks VI

Time: Friday 11:00–12:00 Location: HK-H1

Invited Talk HK 75.1 Fri 11:00 HK-H1

Hyperon Physics with PANDA at FAIR — •Jennifer Pütz for the PANDA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

In order to deepen our insights of color confinement in the mass range governed by non-perturbative QCD, it is essential to understand the excitation pattern of baryons. Up to now only the nucleon excitation spectrum has been subject to systematic experimental studies while very little is known about the excited states of double or triple strange baryons.

Antiproton-proton collisions offered by the PANDA experiment are well-suited for a comprehensive baryon spectroscopy program in the multi-strange sector. A large fraction of the inelastic $\bar{p}p$ cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, enabling studies with high statistics of ground states as well as excited states both in the baryon and the antibaryon channel.

The investigation of hyperons is a flagship component of the PANDA physics program, particularly, in the first phase ofcle the experiment. This talk will provide an overview on the hyperon physics with PANDA and highlights its uniqueness compared to complementary experiments worldwide.

Invited Talk HK 75.2 Fri 11:30 HK-H1

3-hadron problem from lattice QCD — •Maxim Mai — University Bonn, Bonn, Germany

The enigma of the spectrum of the strongly interacting particles (hadrons) includes many puzzles. What is the general form of the spectrum of excited states of hadrons? Why do some resonances resemble simple Breit-Wigner form and others do not? Can we say something about the nature of individual states?

The challenge in answering these questions arises from the very structure of the Quantum Chromodynamics (QCD) – the quantum field theory of strong interaction. In that, lattice gauge theory is the only tool available to us to tackle the non-perturbative dynamics of QCD which already led to many important insights.

Currently the frontier of hadron spectroscopy from first principles is entering a new phase, addressing dynamics of resonant multi-hadron states. This has become possible by many groundbreaking advances of theoretical and computational techniques, which I will describe in my talk. The remaining part of the talk will be devoted to the recent results on states of high relevance, bridging the gap to experimental results.

Plasma Physics Division
Fachverband Plasmaphysik (P)

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Overview of Invited Talks and Sessions

(Lecture halls P-H11 and P-H12; Poster P)

Invited Talks

P 1.1	Mon	11:00–11:30	P-H11	**Plasma Physics in EUV Lithography** — •Iris Pilch
P 1.2	Mon	11:30–12:00	P-H11	**Optical emission spectroscopy of spokes in magnetron sputtering discharges** — •Julian Held, Philipp A Maass, Volker Schulz-von der Gathen, Achim von Keudell
P 1.3	Mon	12:00–12:30	P-H11	**Functional coatings by atmospheric pressure plasma technology** — •Kristina Lachmann, Thomas Neubert, Annika Mann, Marvin Omelan, Michael Thomas
P 6.1	Tue	11:00–11:30	P-H11	**Laser diagnostics on atmospheric pressure plasmas: From basic to fancy** — •Volker Schulz-von der Gathen, the CRC 1316 team
P 6.2	Tue	11:30–12:00	P-H11	**Liquid tin interaction with deuterium plasmas** — •Armin Manhard, Martin Balden, Thomas Schwarz-Selinger, Rudolf Neu
P 6.3	Tue	12:00–12:30	P-H11	**Plasma jets on surfaces** — •Ana Sobota
P 10.1	Wed	11:00–11:30	P-H11	**AI in fusion: assisting plasma exhaust modelling by machine-learning techniques** — •Sven Wiesen
P 10.2	Wed	11:30–12:00	P-H11	**COMPACT - A new complex plasma facility for the ISS** — •Christina A. Knapek
P 10.3	Wed	12:00–12:30	P-H11	**Optical diagnostics of vacuum arc discharges for switching applications** — •Sergey Gortschakow, Ralf Methling, Steffen Franke, Diego Gonzalez, Dirk Uhrlandt, Sergey Popov, Alexander Batrakov
P 16.1	Thu	11:00–11:30	P-H11	**Effect of the green energy revolution on circuit breakers and switches in electrical power distribution systems** — •Erik D. Taylor
P 16.2	Thu	11:30–12:00	P-H11	**Plasma-beta effects on the island divertor of Wendelstein 7-X** — •Alexander Knieps, Yasuhiro Suzuki, Joachim Geiger, Andreas Dinklage, Song Zhou, Henning Thomsen, Marcin Jakubowski, Ralf König, Michael Endler, Yu Gao, Yunfeng Liang
P 16.3	Thu	12:00–12:30	P-H11	**Surface modification of inorganic materials by atmospheric-pressure plasmas** — •Claus-Peter Klages, Vitaly Raev
P 20.1	Fri	11:00–11:30	P-H11	**On the hunt for a reactor-relevant scenario for W7-X** — •Golo Fuchert
P 20.2	Fri	11:30–12:00	P-H11	**Plasma für die Gaskonversion: Power-to-X** — •Andreas Schulz, Katharina Wiegers, Matthias Walker, Günter Tovar
P 20.3	Fri	12:00–12:30	P-H11	**Combined Phase Contrast Imaging and Small-Angle X-Ray Scattering Diagnostic of Relativistic Plasmas at the High Energy Density Instrument at European XFEL** — •Alejandro Laso Garcia, Toma Toncian, Hauke Hoeppner, Alexander Pelka, Carsten Baehtz, Erik Brambrink, Jan-Patrick Schwinkendorf, Motoaki Nakatsutsumi, Johannes Hagemann, Thomas Preston

Invited talks of the joint symposium Plasmas in the Universe (SYPU)

See SYPU for the full program of the symposium.

SYPU 1.1	Wed	9:00– 9:30	Audimax	**Recent progress in simulations of dense quantum plasmas and warm dense matter** — •Michael Bonitz, Paul Hamann, Tobias Dornheim, Zhandos Moldabekov, Alexey Filinov, Jan Vorberger, Pavel Levashov
SYPU 1.2	Wed	9:30–10:00	Audimax	**The quark gluon plasma: from the laboratory to neutron stars** — •Jan Steinheimer
SYPU 1.3	Wed	10:00–10:30	Audimax	**Characterizing the QCD Plasma** — •Andrea Dubla

Sessions

P 1.1–1.3	Mon	11:00–12:30	P-H11	**Invited talks I**
P 2.1–2.5	Mon	14:00–15:15	P-H11	**Low Pressure Plasmas I**
P 3.1–3.6	Mon	14:00–15:30	P-H12	**Laser Plasmas I**
P 4.1–4.4	Mon	16:00–17:00	P-H11	**Low Pressure Plasmas II / Laser Plasmas II**
P 5.1–5.3	Mon	16:00–17:05	P-H12	**Helmholtz Graduated School HEPP I**
P 6.1–6.3	Tue	11:00–12:30	P-H11	**Invited talks II**
P 7.1–7.6	Tue	14:00–15:30	P-H11	**Atmospheric Pressure Plasmas I**
P 8.1–8.3	Tue	14:00–15:15	P-H12	**Helmholtz Graduate School HEPP II**
P 9.1–9.49	Tue	16:00–17:30	P	**Poster I**
P 10.1–10.3	Wed	11:00–12:30	P-H11	**Invited talks III**
P 11.1–11.6	Wed	14:00–15:30	P-H11	**Codes and Modelling**
P 12.1–12.6	Wed	14:00–15:30	P-H12	**Magnetic Confinement / Plasma Wall Interaction I**
P 13.1–13.5	Wed	16:00–17:15	P-H11	**Dusty Plasmas**
P 14.1–14.4	Wed	16:00–17:10	P-H12	**Plasma Wall Interaction II / HEPP III**
P 15	Wed	17:30–18:30	P-MV	**Annual General Meeting**
P 16.1–16.3	Thu	11:00–12:30	P-H11	**Invited talks IV**
P 17.1–17.5	Thu	14:00–15:15	P-H11	**Astrophysical Plasmas**
P 18.1–18.3	Thu	14:00–15:15	P-H12	**Helmholtz Graduate School HEPP IV**
P 19.1–19.48	Thu	16:00–17:30	P	**Poster II**
P 20.1–20.3	Fri	11:00–12:30	P-H11	**Invited talks V**
P 21.1–21.7	Fri	14:00–15:45	P-H11	**Atmospheric Pressure Plasmas II**
P 22.1–22.3	Fri	14:00–15:15	P-H12	**Helmholtz Graduate School HEPP V**

Annual General Meeting of the Plasma Physics Division

Wednesday 17:30–18:30 P-MV

Sessions

– Invited Talks, Contributed Talks, and Posters –

P 1: Invited talks I

Time: Monday 11:00–12:30 Location: P-H11

Invited Talk P 1.1 Mon 11:00 P-H11

Plasma Physics in EUV Lithography — •Iris Pilch — Carl Zeiss SMT GmbH, Oberkochen, Germany

Extreme Ultraviolet (EUV) lithography is a technology for high volume manufacturing of semiconductors. The scanners operate at a wavelength of 13.5 nm. The main parts of a scanner are the EUV light source, the illumination optics, the mask, the projection optics and the wafer stage.

The EUV source of a scanner is a laser-produced plasma (LPP) delivering high power, which is needed to ensure productivity of the maschine. For metrology applications, EUV sources with moderate or even low powers are sufficient, and both technologies LPP and discharge-produced plasmas (DPP) are common.

In this talk, an overview on EUV lithography and its next development will be given, and the different EUV source types as well as the challenges of EUV light generation will be described.

Invited Talk P 1.2 Mon 11:30 P-H11

Optical emission spectroscopy of spokes in magnetron sputtering discharges — •Julian Held, Philipp A Maass, Volker Schulz-von der Gathen, and Achim von Keudell — Experimental Physics II, Ruhr University Bochum, Germany

Spokes are patterns of increased light emission, observed to rotate in front of the cathode of magnetron sputtering discharges. They move through the plasma at velocities of several km/s in or against the ExB direction of the discharge. The often distinctly triangular shape of these features has captivated many scientists. Nevertheless, the reason for this curious shape is still not fully understood. This is because the high velocity of spokes and their initial creation at arbitrary positions render measurements challenging. Thus, more demanding plasma diagnostic techniques that require data acquisition over multiple discharge pulses require synchronization between measurement and spoke movement. In this contribution, we present optical emission spectroscopy of spokes in both high power impulse magnetron sputtering (HiPIMS), as well as direct current magnetron sputtering (DCMS). A gated camera is combined with optical filters, isolating emission lines of metal and working gas neutrals and ions. The camera is then triggered on the spoke movement, allowing us to accumulate light from several acquisitions without averaging out the spoke signal. These measurements reveal the dynamic of electrons drifting through spokes in both DCMS and HiPIMS and explain how the distinct spoke shape is formed.

Invited Talk P 1.3 Mon 12:00 P-H11

Functional coatings by atmospheric pressure plasma technology — •Kristina Lachmann, Thomas Neubert, Annika Mann, Marvin Omelan, and Michael Thomas — Fraunhofer Institute for Surface Engineering and Thin Films IST, Bienroder Weg 54E, 38108 Braunschweig, Germany

Atmospheric pressure plasma technology is well known for surface activation, functionalization and cleaning. It is also a versatile method to deposit thin films in the range of several 10 - 100 nm.

The main objective of such coatings is to achieve a higher functionality. Depending on the application, this ranges from a tailored surface tension to adhesion control or chemically reactive surfaces or antimicrobial properties. In the past, film deposition was focussed on the use of small molecules such as (silicon) organic compounds with high vapour pressures. More recently, more complex organic molecules such as fatty acids or polyphenols have also been investigated to achieve higher process sustainability and further functionalities such as soil repellency. To determine surface characteristics the analysis of these films is essential. Here, (derivatisation methods in combination with) FTIR-ATR spectroscopy, staining, investigations into soiling behaviour and the determination of surface tension by contact angle measurements are suitable methods.

In this work, we will demonstrate various applications for complete and area-selective atmospheric pressure plasma coatings not only on flat samples, but also on three-dimensional shapes.

P 2: Low Pressure Plasmas I

Time: Monday 14:00–15:15 Location: P-H11

P 2.1 Mon 14:00 P-H11

Influence of a remote plasma on the chemical vapour deposition of ZrO2 based layers — •Philipp A. Maass[1], Vitali Bedarev[1], Sebastian M. J. Beer[2], Marina Prenzel[1], Marc Böke[1], Anjana Devi[2], and Achim von Keudell[1] — [1]Experimental Physics II, Ruhr-University, Bochum, Germany — [2]Inorganic Chemistry II, Ruhr-University, Bochum, Germany

Chemical vapour deposition (CVD) is a widely applied technique used for thin film deposition. The combination with a plasma source (PECVD) enables the fine-tuning of parameters, opening new possibilities for the fabrication of functional coatings, such as thin thermal barrier coatings.

A metalorganic precursor is transported into the reaction chamber by a 50 sccm N2-flow at pressures of 100 Pa. A ZrO2 layer is deposited onto a heated substrate in the centre of the chamber with a growth rate of several 100 nm/h. To influence and improve the reaction chemistry, a microwave plasma source is mounted opposite the substrate surface. It interacts with the incoming precursor molecules, with the aim to reduce the reaction temperature and change the deposition properties.

During this process, the growth rate and substrate temperature are monitored by in-situ ellipsometry. The deposited layers are characterised in stoichiometry and crystallinity, using X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD).

Depositions are carried out with and without the use of the plasma source. The different growth characteristics are investigated and compared.

P 2.2 Mon 14:15 P-H11

High-resolution terahertz spectroscopy with quantum-cascade lasers for atomic oxygen density measurements — •Jente Wubs, Uwe Macherius, Klaus-Dieter Weltmann, and Jean-Pierre van Helden — Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

Absorption spectroscopy in the terahertz (THz) spectral region between 0.3 and 6 THz provides access to energies that correspond to molecular and atomic transitions involving rotational mode changes and fine structure splitting, respectively. In addition, THz frequencies lie well above typical values for the plasma frequency, allowing the electron density to be determined from a phase shift of transmitted THz radiation. Knowledge about the electron density as well as atomic and molecular densities in plasmas is highly relevant for technological and scientific applications. A promising diagnostic for measuring these densities is THz time-domain spectroscopy. It is based on the ultrafast generation and detection of broadband THz pulses; however, the spectral resolution is limited to approximately 1 GHz. THz quantum-cascade lasers (QCLs) operating in continuous-wave mode are therefore better suited for the detection of sharp absorption lines. Although these lasers have a relatively small tuning range, their narrow linewidth (below 10 MHz) makes them an excellent THz source for high-resolution spectroscopy. In this contribution, first results are presented on the absolute density of ground state oxygen atoms, measured in a low-pressure RF plasma using a QCL operating at 4.75 THz.

P 2.3 Mon 14:30 P-H11

Operando FTIR monitoring of silicon nanoparticle treatment in a low-pressure plasma — •Oguz Han Asnaz and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

With their unique physical, mechanical, electrical and optical properties, nanoparticles have found a wide range of applications ranging from drug carriers in bio-medicine over catalysts to batteries and solar cells. Control of the particle's bulk and surface properties is required in many of these applications. In this contribution, we present results for Silicon nanoparticles generated in a capacitively coupled low-pressure plasma. The particles are then confined in a secondary discharge for further treatment with monitoring during operation by means of in situ time-resolved FTIR spectroscopy with a multipass cell for 24 passes. Using different reactive gasses, surface passivation by hydrogen or oxygen treatment as well as deposition of thin carbon films is possible. Additionally, using an electrostatic particle extractor system (EPEX) developed in our group, particle samples are extracted at multiple moments during the treatment for further analysis with negligible disturbance of the plasma system.

P 2.4 Mon 14:45 P-H11

Plasma diagnostics combination: Calorimetric Probe and Retarding Field Analyser — •Felix Schlichting and Holger Kersten — Christian-Albrechts-Universität, Kiel, Deutschland

A recently developed plasma diagnostic, which combines a retarding field analyser (RFA) and a passive thermal probe (PTP), has been used for the characterization of different plasma environments. The PTP serves as the collector of the RFA, in front of which three centrally aligned grids are operated as the retarding field system. In this setup the collector does not only measure the incoming ion current depending on the voltage applied to the grids of the RFA, but also the incoming energy flux density of the impinging ions or neutrals, respectively. In this study the combined diagnostic is used in an RF plasma, where the probe is embedded into the grounded electrode, as well as in a DC Magnetron sputtering system, where the probe is located at substrate position. The ion energy distribution (IED) is determined regarding the energy exchange of the neutral background gas with the ions extracted from the plasma source. Furthermore, with suitable voltage applied to the grids of the RFA, the secondary electron emission from the collector can be quantified in regard to the ion energies and the material used for the collector plate.

P 2.5 Mon 15:00 P-H11

Selbstkonsistente Modellierung einer linearen Mikrowellenplasmaquelle in einem Magnetfeld — •Stefan Merli[1], Andreas Schulz[1], Matthias Walker[1], Yannick Kathage[2], Stefan Hanke[2] und Christian Day[2] — [1]IGVP, Universität Stuttgart — [2]Karlsruhe Institute of Technology (KIT), Karlsruhe

In diesem Beitrag wird der Einfluss von magnetischen Feldern auf die Eigenschaften einer linearen Mikrowellenplasmaquelle, der sogenannten Duo-Plasmaline, numerisch und experimentell untersucht. Bei dem FEM-basierten Simulationsmodell werden die Transportgleichungen für die Elektronen und der schweren Teilchen selbstkonsistent mit der elektrischen Feldverteilung der eingestrahlten Mikrowelle gelöst. Das betrachtete Plasmagas ist H_2, welches durch insgesamt 44 Elektronenstoß-, Schwerteilchenstoß- und Wandrekombinationsreaktionen in das Modell implementiert wurde. Das zeitlich konstante und homogene Magnetfeld, welches über die Diffusivitäts- und Mobilitätstensoren in die Transportgleichungen eingeht, wurde in paralleler und senkrechter Orientierung zur Plasmaquelle untersucht. Die magnetische Flussdichte wurde über einen weiten Bereich von 0 T über 87,5 mT (ECR) bis hin zu 1 T variiert. Das Hauptaugenmerk lag auf der Untersuchung des Einflusses des Magnetfeldes auf den Heizmechanismus, der Form des Plasmas, den Änderungen in der Dichte und Temperatur sowie in der Dissoziationsrate für H_2. Die Ergebnisse aus den Simulationen werden mit Untersuchungen aus dem Experiment FLIPS, bei welchem homogene Magnetfelder bis zu 250 mT parallel oder senkrecht zur Plasmaquelle erzeugt werden können, verglichen.

P 3: Laser Plasmas I

Time: Monday 14:00–15:30 Location: P-H12

P 3.1 Mon 14:00 P-H12

Pump-probe XUV platform for ultrafast laser-matter interaction research — •Milenko Vescovi[1], Marvin E.P. Umlandt[1,2], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Interaction of ultrafast relativistic intensity laser pulses with matter has shown to be a promising field for the study of matter at extreme conditions, electromagnetic fields generation/amplification, high energy radiation emission and particle acceleration. For most of the aforementioned applications, advanced proposed schemes require stringent tailoring and monitoring of the target/plasma parameters during the interaction. The short (fs) temporal and small (submicron) spatial scales of the evolution of these parameters make direct measurements a challenging task, even more considering that these plasmas are usually overdense for conventional optical diagnostics.

Currently, a pump-probe set up is being developed at HZDR to gain insight into the internal evolution of overdense laser driven plasmas. The XUV beam generated by one of the arms of the Draco laser, through Relativistic Oscillating Mirror High Harmonic Generation, will be used to probe a plasma driven by a second arm of the laser system. The initial set up for these experiments will be shown and probing options of the platform will be discussed.

P 3.2 Mon 14:15 P-H12

Study of x-ray emission from proton acceleration targets at Draco PW laser facility — •Radka Štefaníková[1,2], Niklas Meckel[1,2], Xiayun Pan[1,2], Michal Šmíd[1], Hans-Peter Schlenvoigt[1], Irene Prencipe[1], Michaela Kozlová[1,3], Lennart Gaus[1,2], Marvin E. P. Umlandt[1,2], Milenko Vescovi[1,2], Marvin Reimold[1,2], Tim Ziegler[1,2], Florian Kroll[1], Stephan Kraft[1], Ulrich Schramm[1,2], Karl Zeil[1], Josefine Metzkes-Ng[1], and Katerina Falk[1,2,3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Institute of Physics of the ASCR, Prague, Czech Republic

Laser plasma-based ion accelerators are very promising candidates for many applications. In order to ensure the reliability of such accelerators a comprehensive set of diagnostics is required. X-ray emission spectroscopy allows us to directly measure the plasma conditions of the laser-plasma interaction and also provides information about the hot electron population through the cold K-α emission production.

Here, we present preliminary results from two new x-ray spectrometers used to study interaction regimes relevant for laser-driven ion acceleration at ultrashort pulse PW-class laser facility. We acquired the emission spectra from flat Ti targets for a range of target thicknesses and laser energies. Additionally, artificial laser pre-pulses were added to alter the laser absorption efficiency.

P 3.3 Mon 14:30 P-H12

Investigation of laser reflectivity and transmissivity of laser-plasma interaction with thin foil targets — •Marvin E. P. Umlandt[1,2], Tim Ziegler[1,2], Constantin Bernert[1,2], Marco Garten[1,2], Lennart Gaus[1,2], Ilja Göthel[1,2], Thomas Kluge[1], Stephan Kraft[1], Florian Kroll[1], Josefine Metzkes-Ng[1], Irene Prencipe[1], Martin Rehwald[1,2], Marvin Reimold[1,2], Hans-Peter Schlenvoigt[1], Milenko Vescovi[1,2], Karl Zeil[1], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany

Ion acceleration by compact laser-plasma sources promises a variety of applications ranging from medical relevance to fusion experiments. Reaching the required beam quality parameters for those applications demands a very high level of understanding and control over the laser-plasma interaction process. Central components in this context are the absorption of the electromagnetic laser field by the plasma and the quality of the resulting acceleration field structure.

Measuring and analyzing unabsorbed light - as transmitted and/or specularly reflected parts - thus allows insight into properties of the underlying laser-plasma interaction. We experimentally investigate these interactions for high and low-contrast laser pulses with thin solid density foil targets at the Draco PW laser system (HZDR). The results of spectral, spatial, and energy analysis of transmitted and reflected light indicate changes in the plasma interaction and will be presented.

P 3.4 Mon 14:45 P-H12

Optimized laser ion acceleration at the relativistic critical density surface — •Thomas Kluge[1], Ilja Göthel[1,2], Constantin Bernert[1,2], Michael Bussmann[3], Marco Garten[1,2], Thomas Miethlinger[1,2], Martin Rehwald[1,2], Karl Zeil[1], Tim Ziegler[1,2], Thomas E. Cowan[1,2], and Ulrich Schramm[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden — [3]Center for Advanced Systems Understanding (CASUS)

In the effort of achieving high-energetic ion beams from the interaction of ultrashort laser pulses with a plasma, volumetric acceleration mechanisms beyond Target Normal Sheath Acceleration have gained attention. A relativisticly intense laser can turn a near critical density plasma slowly transparent, facilitating a synchronized acceleration of ions at the moving relativistic critical density front. While simulations promise extremely high ion energies in in this regime, the challenge resides in the realization of a synchronized movement of the ultrarelativistic laser pulse (a0 >* 30) driven reflective relativistic electron front and the fastest ions, which imposes a narrow parameter range on the laser and plasma parameters. We present an analytic model for the relevant processes, confirmed by a broad parameter simulation study in 1D- and 3D-geometry. By tayloring the pulse length plasma density profile at the front side, we can optimize the proton acceleration performance and extend the regions in parameter space of efficient ion acceleration at the relativistic relativistic density surface.

P 3.5 Mon 15:00 P-H12

Simulation of optimized TNSA via temporal pulse shaping under realistic laser contrast conditions — •Marco Garten[1,2], Jakob Wetzel[1,2], Tim Ziegler[1,2], Marvin E. P. Umlandt[1,2], Ilja Goethel[1,2], Thomas Pueschel[1], Stefan Bock[1], Karl Zeil[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany

Controlling the spatio-temporal coupling of laser energy into plasma electrons is crucial for achieving predictable beam parameters of ions accelerated from ultra-high intensity (UHI) laser-driven solid density plasmas. Especially for highest maximum energies, promising targets are foils of a few ten to hundred nanometers thickness. When working with targets of such small scales, meticulous control and precise metrology of the driving UHI laser pulses are paramount to avoiding premature plasma expansion that would lead to losses in absorption efficiency as well as lower accelerating fields. Recently, significant proton beam quality enhancement was reported from the Draco PW facility at HZDR via spectral phase control of the driving laser pulse. In support of these experiments, we present a particle-in-cell simulation study taking into account realistic temporal intensity contrast features. In particular, we focus on the influence of laser spectral phase term manipulations on the acceleration of ions. We furthermore show how the transient femtosecond plasma dynamics and state of the target are encoded into the spectral content of reflected and transmitted light, giving more insight into the previously obtained experimental results.

P 3.6 Mon 15:15 P-H12

Isochoric Heating in Multilayer Targets upon Ultra High Intensity Laser Irradiation by Density Oscillation — •Franziska Paschke-Bruehl[1,2], Lisa Randolph[3], Mohammadreza Banjafar[2,4], Motoaki Nakatsutsumi[4], Lingen Huang[1], Christian Gutt[3], Ulrich Schramm[1], Thomas E. Cowan[1,2], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]Technische Universität Dresden, Dresden, Germany — [3]Universität Siegen, Siegen, Germany — [4]European XFEL, Schenefeld, Germany

Reaching higher ion and electron temperatures in laser-solid plasma interaction can be done by either increasing laser intensity or changing target design. We will show how a multilayer target behaves under ultra high intensity laser irradiation, based on a PIC simulation study. There we observe density oscillation, a dynamic, that has not been mentioned in plasma physics yet. It describes how neighboring layers repeatedly compress each other, causing the ion and electron density of each layer to oscillate over time. During this process, the particles gain kinetic energy and temerpature, thus heat differently compared to a non layered target. Based on that, we will show how the density oscillation affects the isochoric heating of the target. In addition to that we present a method of confirming these computational results in an experiment by applying a GISAXS (grazing- incidence small-angle scattering) technique.

P 4: Low Pressure Plasmas II / Laser Plasmas II

Time: Monday 16:00–17:00 Location: P-H11

P 4.1 Mon 16:00 P-H11

Secondary electron induced effects in the ion energy distribution of a symmetrical capacitively coupled plasma — •Christian Schulze[1], Zoltán Donkó[2], and Jan Benedikt[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Germany — [2]Institute for Solid State Physics and Optics, Wigner Research Centre for Physics, Hungary

The Particle in Cell/Monte Carlo Collisions (PIC/MCC) approach is established as a widespread simulation tool in low pressure plasma science since it offers access to a variety of plasma parameters and - in conjunction with experiments - can provide information about surface properties that are not directly measurable in experiments. However, PIC/MCC simulations are based on simplifications. For example, secondary electron emission (SEE) is usually described by an effective yield for ion (γ_{eff}) and electron (r_{eff}) impact that include other effects leading to SEE like photoemission or kinetic SEE by fast atoms. In order to describe experimental conditions correctly experimental validations are necessary to estimate realistic input parameters. Here, ion flux-energy distributions are measured with an energy-selective mass spectrometer in a geometrically symmetric capacitively coupled plasma and compared with data obtained from 1d3v PIC/MCC simulations. Surface induced effects are studied with Al_2O_3 coated electrodes in comparison to uncoated stainless steel electrodes. The observed changes can be explained by altered plasma properties due to an increase in SEE in the case of an oxidized surface. With this comparative approach, the effective SEE coefficients γ_{eff} and r_{eff} are estimated.

P 4.2 Mon 16:15 P-H11

Toroidal electron beam source for electron-induced processes at atmospheric pressure — •Lars Dincklage[1], Burkhard Zimmermann[1], Gösta Mattausch[1], and Ronny Brandenburg[2,3] — [1]Fraunhofer Institute for Org. Electr., EB and Plasma Technol. FEP, Dresden, Germany — [2]Leibniz-Institute for Plasma Science and Technology, Greifswald, Germany — [3]University of Rostock, Germany

Accelerated electrons can be utilized to induce chemical reactions in gases. A toroidal electron beam (EB) source has been developed for optimum treatment of fluids in tubes as well as to generate EB-sustained atmospheric plasmas for plasma-chemical conversion processes. Electrons are created at a cooled metal cathode by the impact of ions from a low pressure wire anode (WA) plasma, accelerated in the electric field of the cathode and then emitted through an electron exit window (EEW) into the reaction space at the center of the torus. The energy of the electrons (typically 120 keV) and the EB current density at the EEW (about 100 $\mu A/cm^2$) are controlled by the cathode potential and the electric properties of the WA discharge. In order to identify stable operation parameter windows, the WA discharge characteristics as well as its effect on the EB properties were investigated for helium and hydrogen. In case of operation at low pressure and with insufficient plasma current, limiting factors such as the contraction of the plasma and a high ignition voltage were determined. Whereas the first issue was handled by pulsing the plasma, the second was met by applying an external magnetic field. Furthermore, the current efficiency of the source was determined for different states of the metal cathode.

P 4.3 Mon 16:30 P-H11

Start to End simulations with 20 J Laser in relativistically induced transparency regime — •Ilja Göthel[1,2], Tim Ziegler[1,2], Marco Garten[1,2], Constantin Bernert[1], Karl Zeil[1], Marvin E.P. Umlandt[1,2], Thomas Miethlinger[1,2], Sergei Bastrakov[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden — [2]Technische Universität Dresden, 01069 Dresden

TNSA has proven the experimentally most robust mechanism for accelerating ions with ultraintense laser pulses. In experiments at the Draco-PW laser we achieved the promising RIT regime, known for enhancing the performance beyond normal TNSA (several shots of 100MeV protons). Also, advanced pulse and beam characterization techniques enable us to deepen our understanding by simulations.

We present here a start-to-end simulation campaign with a hybrid code approach - hydrodynamic preexpansion in the time 100ps-1ps before the peak, and a 3d PIC mainpulse interaction with input from the hydro code. The scan reproduces the experimentally found behaviour of reflected and transmitted beam diagnostics with thickness.

The enhancement in the RIT regime is known from literature. For a predictive simulation, however, the hybrid code approach is necessary due to the decisive effect of preexpansion by the intrinsic contrast of the laser. Reaching these high energies reproducibly without pulse contrast cleaning devices opens the way to high repetition rate usage; deeper understanding the dynamics by predictive simulations may prove crucial for further progress.

P 4.4 Mon 16:45 P-H11

Characterization of fast electrons accelerated into matter by laser-solid interaction — •Nico Potzkai, Bastian Hagmeister, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Intense laser pulses create plasma on solid surfaces and accelerate electrons into the vacuum as well as into the target. We investigated the latter electrons concerning numbers and energy. Sub 10-fs-laser pulses on different bilayer targets did induce the plasma. The characteristic x-ray line emissions of the two materials were used to quantify the electron population traveling though the material. Our experimental results have been compared with PIC simulations and yield information of details of the laser-surface interaction.

P 5: Helmholtz Graduated School HEPP I

Time: Monday 16:00–17:05 Location: P-H12

P 5.1 Mon 16:00 P-H12

From Idea to Virtual Design: Systems Studies of Stellarator Fusion Power Plants — •Jorrit Lion, Felix Warmer, and Robert C. Wolf — Max Planck Institute for Plasma Physics, D-17491, Greifswald, Germany

Stellarators are attractive candidates for fusion power plants: They operate inherently in steady-state, lack current driven instabilities and do not rely on current drive and or poloidal field coils. To design and model such a power plant, so called systems codes can be applied, which aspire to model all relevant features and constraints of the power plant within a single framework by imposing simplified 0D or 1D models. We report on a new version of the fusion reactor power plant systems code PROCESS, applicable to general stellarator configurations, based on its coil set and the 3D plasma shape [1]. This is achieved by introducing a pre-calculation step to determine effective parameters, which are then being passed to new stellarator specific models in PROCESS. This way, 3D coil-forces, 2D thermal wall loads or stellarator specific operational boundaries can now be modelled within PROCESS. Using these modifications, PROCESS now allows for a combined technological, physical and economical assessment of a very general class of stellarator power plants within a systems code framework. This opens up a new paths to speed up the design cycle and potentially accelerate the deployment of fusion.

[1] J. Lion, et al., "A general stellarator version of the systems code PROCESS", Nucl. Fus. 61 (2021)

P 5.2 Mon 16:25 P-H12

Analysis of multiple MMC submodules operation for future ASDEX Upgrade power supply system integration — •Antonio Magnanimo[1], Markus Teschke[1], Gerd Griepentrog[2], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]Technische Universität Darmstadt, 64283 Darmstadt, Germany

The modular multilevel converter (MMC) has become one of the most attractive converters for high-power applications such as High Voltage DC (HVDC) Power transmission, but also fusion devices power supplies. This converter, thanks to the discrete-leveled output voltage and its identical submodules (SMs) by which it is composed, represents a promising alternative to replace the flywheel generator (FG) that actually provides electrical power to ASDEX Upgrade (AUG) device toroidal field (TF) coils. Due to the pulsed DC operation of these coils and their high power needs (up to 150 MW) for each experiment, a small-scale adapted version of the MMC is under development with some differences compared to conventional ones being used in HVDC systems: SM capacitors have been replaced with supercapacitors (SC) modules to increase the amount of available stored energy while SMs belonging to different arms are interconnected to simplify their control and increase the reliability of the converter. This work shows the operation of four SMs connected in series, parallel and combined series/parallel to demonstrate the scalability of the project, highlighting its advantages, challenges and limits.

P 5.3 Mon 16:50 P-H12

Non-Resonant Divertor Design for Compact Toroidal Hybrid (CTH) — •Kelly Garcia[1], Aaron Bader[1], Heinke Frerichs[1], Gregory Hartwell[2], John Schmitt[2], and Oliver Schmitz[1] — [1]University of Wisconsin-Madison, Madison, WI USA — [2]Auburn University, Auburn, AL USA

Non-resonant divertors separate the confined plasma from surrounding structures with the resulting boundary region comprised of cantori and/or stochastic regions, but without the presence of large islands. Compact Toroidal Hybrid (CTH) can serve as a test-bed for non-resonant divertor solutions. The background field coils and the ohmic current drive system of CTH are used to alter the rotational transform between $0.3 < \iota < 0.75$. Utilizing the FLARE field-line following code, we show the presence of a chaotic edge fieldline structure which evolves with current. These chaotic structures are related to topologically relevant transport mechanisms which we aim to explore. We calculate strike point locations for the exiting plasma for multiple ohmic current values. The calculated strike point locations enable us to design and numerically test an instrumented divertor plate with FLARE which can then be used to experimentally measure non-resonant divertor resiliencies with respect to equilibrium changes. The test plate configuration is designed to intercept most of the divertor flux over a wide range of currents. A physical plate is planned to be placed in CTH where we expect to calculate expected heat flux on this plate. We attempt to calculate optimal plate position locations within CTH.

P 6: Invited talks II

Time: Tuesday 11:00–12:30 Location: P-H11

Invited Talk P 6.1 Tue 11:00 P-H11

Laser diagnostics on atmospheric pressure plasmas: From basic to fancy — •Volker Schulz-von der Gathen and the CRC 1316 team — Ruhr-University Bochum, Bochum, Germany

Atmospheric pressure plasmas are one of the main research topics of the CRC 1316 'Transient atmospheric pressure plasmas: From plasmas to liquids to solids'. An overlaying goals is to understand the interaction of plasmas and species either in gas or liquid form to improve e.g. plasma catalysis or in plasma medical applications. Due to the atmospheric pressure condition most of the investigated plasmas are in the mm or even sub-mm dimensions or show strongly transient behaviour. This covers micro discharges in cavities of only 100 μm dimension to pulsed ns devices in pure noble gases or with more complex molecular admixtures. This poses challenges for many diagnostics. Here we describe a set of laser diagnostics applied allowing for enough spatial and temporal resolution to yield information on the dynamics of species, fields or population densities in some exemplary jet devices. By this we cover schemes from nowadays standard techniques to examples of only recently introduced ones. We will exemplarily discuss some of the advantages and drawbacks for the various schemes involved in particular at atmospheric pressure.

Invited Talk P 6.2 Tue 11:30 P-H11

Liquid tin interaction with deuterium plasmas — •Armin Manhard, Martin Balden, Thomas Schwarz-Selinger, and Rudolf Neu — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany

Plasma-facing components based on low-melting liquid metals such as tin are currently being investigated. They potentially alleviate some issues arising with conventional designs using solid metals (e.g., tungsten), such as embrittlement or permanent damage due to transient thermal overloading. This presentation will first briefly review the current status of the conceptual design for liquid metal divertor components (e.g., [1, 2]). It will then focus on the interaction with hydrogen isotope plasmas, which has recently been investigated by several groups of researchers (e.g., [3, 4]). In contrast to hydrogen gas, against which tin is practically inert, atoms and ions from the plasma show a considerable reactivity both with solid and liquid tin. The effects depend strongly on temperature and range from strong chemical erosion at low temperatures to growth of sponge-like structures just below the melting point. In liquid tin, the formation of gas bubbles can lead to the ejection of tin droplets as well as to the formation of large gas pockets [3, 4, 5]. Some of these adverse effects could be mitigated by containing the liquid tin in capillary porous systems (e.g., [5]).

[1] P. Rindt et al, Fusion Eng. Des. 173 (2021) 112812 [2] S. Roccella et al, J. Fusion Energy 39 (2020) 462-468 [3] A. Manhard et al, Nucl. Fusion 60 (2020) 106007 [4] W. Ou et al, Nucl. Fusion 60 (2020) 026008 [5] W. Ou et al, Nucl. Fusion 61 (2021) 066030

Invited Talk P 6.3 Tue 12:00 P-H11

Plasma jets on surfaces — •Ana Sobota — Technische Universiteit Eindhoven, Postbus 513, 5600MB Eindhoven, The Netherlands

Non-thermal atmospheric pressure plasma jets are an outstanding model in studies of the interaction of non-thermal plasmas and substrates. With their underlying physics based on streamer discharges, but featuring reproducibility in time and space, we are able to experimentally study their behaviour resolved in space and time and measure properties like electric fields and electron densities. Special interest is given in their interaction with targets of varying electrical properties, moving away from metals and into dielectrics and liquid. The talk is going to present recent studies on this topic.

P 7: Atmospheric Pressure Plasmas I

Time: Tuesday 14:00–15:30 Location: P-H11

P 7.1 Tue 14:00 P-H11

Towards *in situ* plasma surface interaction studies utilizing a microplasma in a TEM — •Luka Hansen[1], Niklas Kohlmann[2], Ulrich Schürmann[2], Lorenz Kienle[2], and Holger Kersten[1] — [1]Institute of Experimental and Applied Physics, Kiel Univeristy, Kiel, Germany — [2]Institute for Material Science, Kiel University, Kiel, Germany

The idea of *in situ* investigating a microplasma in a transmission electron microscope (TEM) was first successfully demonstrated in 2013 [1]. Since then no attempts have been taken to observe the plasma surface interaction in real time. Various technical challenges, e.g. size limitations, gas sealing and handling of high voltages, have to be overcome to enable the *in situ* imaging.

A stable atmospheric pressure microplasma discharge was developed and studied *ex situ* in advance to gain insight in the plasma surface interaction by several diagnostics [2]. Prototypes of the vacuum-proof microplasma cell have been build and preparations for the *in situ* studies are ongoing right now.

In the contribution the microplasma and its vacuum-proof encapsulation is addressed and a report on the current state of the *in situ* experiments will be given.

[1] K. Tai *et al.*, 2013 *Scientific Reports* **3** 1325

[2] L. Hansen *et al.*, *PSST* (Submitted)

P 7.2 Tue 14:15 P-H11

Breakdown and quasi-DC phase of a nanosecond discharge — •Nikita Lepikhin[1], Jan Kuhfeld[1], Zoltán Donkó[1,2], Dirk Luggenhölscher[1], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary

A nanosecond Atmospheric Pressure Plasma Jet (ns-APPJ) is studied by picosecond Electric-Field Induced Second Harmonic generation (E-FISH) and spatially/temporally resolved Optical Emission Spectroscopy (OES). Two distinct phases of the discharge are identified: fast breakdown at high electric field is followed by a quasi-DC phase at lower permanent electric field and high electron density. The spatial structure of the discharge after the breakdown is found to be similar to that of a DC-glow discharge. It is demonstrated that the bulk electric field in the quasi-DC phase is independent of the amplitude of the voltage applied to the discharge and, consequently, the electric field strength during breakdown. It is also shown that the voltage and current waveforms and the discharge morphology weakly depend on the gas mixture. The experimental results are compared with the results of PIC/MCC simulations and an analytical model. Good agreement is found throughout.

P 7.3 Tue 14:30 P-H11

Investigations on the impact of electrode proximity on streamer breakdown and development of pulsed dielectric barrier discharges — •Hans Höft, Jente R. Wubs, Manfred Kettlitz, Markus M. Becker, and Klaus-Dieter Weltmann — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Germany

The impact of the electrode proximity on the streamer breakdown and development of pulsed-driven dielectric barrier discharges (DBDs) in a single-filament arrangement was investigated in a gas mixture of 0.1 vol% O_2 in N_2 at 0.6 bar and 1.0 bar. To this end, the gap distance was varied from 0.5 mm to 1.5 mm, while the applied voltage was adapted correspondingly to create comparable breakdown conditions in the gap. The development of the DBDs was recorded by an iCCD and a streak camera system, which enabled sub-ns temporal and μm spatial resolution. Simultaneously, fast electrical measurements provided insight into relevant discharge characteristics such as the transferred charge and consumed energy. The results demonstrate that breakdown in a smaller gap is characterised by a slower streamer propagation but a significantly higher acceleration. It can therefore be concluded that the proximity of the cathode has a strong impact on the characteristics of the streamer breakdown. However, after the streamer has crossed the gap, the discharge structure in front of the anode was found to be the same independent of the actual gap distance.

This work was funded by the DFG in the framework of the MultiFil project (project number 408777255).

P 7.4 Tue 14:45 P-H11

CO_2 Konversion und Energieeffizienz eines Mikrowellen-Plasmabrenners — •Katharina Wiegers, Andreas Schulz, Matthias Walker und Günter Tovar — Institut für Grenzflächenverfahrenstechnik und Plasmatechnologie IGVP, Universität Stuttgart, Stuttgart, Deutschland

Die Menschheit ist heutzutage stark vom fortschreitenden Klimawandel betroffen, der hauptsächlich durch den zunehmenden Ausstoß von Kohlendioxid (CO_2), z. B. durch Verkehr, Kohlekraftwerke und die Industrie, verursacht wird. Ein grundlegendes Problem der Energieerzeugung durch erneuerbare Energiequellen wie Photovoltaik und Windkraftanlagen ist die häufig zu beobachtende Diskrepanz zwischen der tatsächlichen Energieproduktion und dem Energiebedarf aufgrund ihrer diskontinuierlichen Verfügbarkeit. Die so genannte überschüssige Energie kann zum Betrieb eines Mikrowellen-Plasmabrenners bei Atmosphärendruck verwendet werden. Das CO_2-Plasma führt zur Bildung von Kohlenmonoxid (CO) und Sauerstoffradikalen (O·). Um die thermodynamisch erzwungene Rekombination beider zu CO_2 beim Abkühlen zu verhindern, ist ein effektives Trennverfahren erforderlich. Keramische Hohlfasern sind ideal dafür geeignet. Das verbleibende CO kann als C_1-Baustein in der chemischen Industrie verwendet werden. Diese Arbeit konzentriert sich auf die Konversion- und Energieeffizienz des CO_2-Plasmas in Abhängigkeit von verschiedenen Prozessparametern wie Mikrowellenleistung, Gasfluss und der Position im Abgaskanal. Die Effizienzen werden mittels FT-IR und Massenspektrometrie bestimmt.

P 7.5 Tue 15:00 P-H11

Electric field strengths within a micro cavity plasma array measured by Stark shifting and splitting of a helium line pair — •Sebastian Dzikowski[1], Judith Golda[2], Marc Böke[1], and Volker Schulz-von der Gathen[1] — [1]Experimentalphysik II, Ruhr-Universität Bochum — [2]Plasma Interfache Physics, Ruhr-Universität Bochum

The electric field is a key parameter in discharge sources. Its knowledge allows to optimize promising applications by controlling plasma processes such as fluxes of charged particles onto surfaces. Especially, for plasma-enhanced catalysis in microplasmas, high electric fields provide intense ionization rates and with this high ion and electron densities. However, due to limited optical access, experimental data of electric fields in micro-structured plasmas are rare. Here, we exploit the Stark shifting and splitting of the allowed 492.19 nm and forbidden 492.06 nm helium lines on a metal-grid array. This layer-structured array consists of a nickel foil that serves as a high voltage supplied electrode and contains four different sized cavity arrangements in the 100 microns range. This nickel foil is separated from an electrically grounded magnet by a 40 microns thick dielectric. By using a combination of a 2 m long plane grating spectrometer and an attached ICCD camera, electric fields up to 70 kV/cm can be measured and controlled by parameters as cavity sizes and excitation features as polarity, voltage and frequency. As an example, smaller cavities yield to higher electric field strengths. For a better understanding a simple Townsend-model is built-up. This research is supported by DFG within SFB1316 (A6).

P 7.6 Tue 15:15 P-H11

CO_2 conversion in barrier discharges with and without packed bed filling at elevated pressures — •Rezvan Hosseini Rad[1], Milko Schiorlin[1], Volker Brüser[1], and Ronny Brandenburg[1,2] — [1]Leibniz-Institute for Plasma Science and Technology — [2]University of Rostock, Institute of Physics

A coaxial dielectric barrier discharge (DBD) reactor operated at elevated pressures up to 2 bar is investigated for the splitting of carbon dioxide. Electrical plasma parameters as well as concentraions of carbon monoxide as the main chemical product is studied without and with a packed bed (partially or fully) filling the reactors volume. A mixture Ar:CO_2 = 4:1 is used as feed gas. Argon is admixed in order to reduce the breakdown voltage, thus, enabling also a stable plasma operation at the higher pressures. Increasing the pressure leads to an increase of the CO_2 conversion and energy efficiency in case of empty as well as packed bed reactor. The energy efficiency is improved up to 31 % if the reactors volume is fully filled with glass beads with a CeO_2 coating compared with the empty reactor. The chemical performance is correlated with the discharge distribution in the DBD reactor, deduced from electrical diagnostics.

P 8: Helmholtz Graduate School HEPP II

Time: Tuesday 14:00–15:15 Location: P-H12

P 8.1 Tue 14:00 P-H12

PIC-Simulations of Perpendicular Collisionless Shocks in Multiple-Ion GRB Plasmas — •Jonas Graw, Martin Weidl, and Frank Jenko — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Deutschland

Ultra-high-energy cosmic rays (UHECRs) are electrically charged particles, which move throughout the universe with energies greater than about 1 EeV. One likely source of UHECRs is a gamma-ray burst (GRB). The latter eject gas parallel to the axis of rotation with high velocities. Shocks are formed in these jets, in which particles are believed to be accelerated to extremely high velocities. Due to such high energies, protons and neutrons fuse to alpha particles. In our research, we simulate an astrophysical plasma consisting of multiple ion species in a mildly relativistic shock.

We simulate perpendicular collisionless shocks with multiple ion species in a mildly relativistic ($\gamma\beta = 2$) 2D3V PIC setup and we analyze in how far these shocks differ compared to single ion shocks. We observe alternating maxima of the two ion species in real space. When analyzing the highest-energetic particles, we observe that they are accelerated by shock-drift acceleration. We conduct research on how multiple-ion shocks affect the electron acceleration efficiency ϵ_e - a quantity that is observable by astronomers due to synchrotron emission and notice that ϵ_e is only slightly influenced by multiple-ion shocks. Furthermore, we analyze how the shock physics changes when using in-plane and out-of plane shock simulations and when using different magnetizations $\sigma = 1, 0.1, 0.01$.

P 8.2 Tue 14:25 P-H12

TALIF on H_2 Plasmas and its Application to Negative Ion Sources — •Frederik Merk, Christian Wimmer, Stefan Briefi, and Ursel Fantz — Max-Planck-Institut für Plasmaphysik, Garching, Germany

Two-photon absorption laser induced fluorescence (TALIF) is a tool to determine both the density and the velocity distribution function of ground state H atoms in H_2 plasmas. This is done by using a pulsed, frequency tripled dye laser (resulting in 205.08 nm radiation) in order to excite the atoms. The subsequent fluorescence radiation is collected for diagnostic purposes.

In H^-/D^- ion sources, the main mechanism of H^- production is the H atom conversion at a (caesiated) low work function surface. This raises the need for a deeper understanding of the H atom dynamics close to that surface. Therefore a TALIF setup is newly installed at the H^-/D^- ion source BATMAN Upgrade (plasma created with 100 kW of RF power) which comes with multiple challenges due to the high voltage environment of the ion source (45 kV) and the complexity of the diagnostic itself. Thus, to gain experience beforehand, TALIF was installed at a planar ICP (600 W, 13.56 MHz). In order to give context to the TALIF measurements, optical emission spectroscopy is performed on the experiment and evaluated with a collisional radiative model for the determination of basic plasma parameters.

Results of TALIF measurements are presented for the planar ICP unsing H_2, a H_2/He mixture and D_2 as working gases as well as results of the applications to BATMAN Upgrade.

P 8.3 Tue 14:50 P-H12

Investigations into the confinement of positrons in a magnetic dipole trap — •Stefan Nissl[1,2], Eve Stenson[1,2,3], Jens von der Linden[1], Adam Deller[1,3], Juliane Horn-Stanja[1], Uwe Hergenhahn[1,7], Thomas Sunn Pedersen[1,4], Haruhiko Saitoh[6], Christoph Hugenschmid[2], Markus Singer[1,2], Matthew Stoneking[1,5], and James Danielson[3] — [1]Max-Planck-Institute for Plasma Physics — [2]Technische Universität München — [3]University of California, San Diego, La Jolla, CA, USA — [4]University of Greifswald — [5]Lawrence University, Appleton, WI, USA — [6]The University of Tokyo — [7]Fritz-Haber-Institut der Max-Planck-Gesellschaft

The APEX (A Positron-Electron Experiment) collaboration aims to create a strongly magnetized, low-temperature, electron-positron plasma in a magnetic trap. This *pair plasma* is predicted to have unique characteristics and excellent stability properties due to the equal masses of the participating species. In order to achieve plasma densities using the available rate of positrons, it is beneficial to confine positrons for as long as possible and to be able to add them to the trap in multiple batches. Previous experiments in a prototype dipole trap already demonstrated a lifetime of >1s. Single-particle simulations helped to identify the main loss mechanisms and guided key improvements to the trap structure and experiment parameters. Upcoming experiments with significantly improved gamma detection capabilities will focus, among other objectives, on the confirmation of longer confinement times as well as the feasibility of accumulating multiple positron pulses in the trap.

P 9: Poster I

Time: Tuesday 16:00–17:30 Location: P

P 9.1 Tue 16:00 P

Wavenumber analysis of the quasi coherent mode in EDA-H-mode discharges — •Joey Kalis[1,2], Gregor Birkenmeier[1,2], Peter Manz[3], Luis Gil[4], Michael Griener[1], and Ulrich Stroth[1,2] — [1]Max-Planck-Institut für Plasmaphysik, Garching — [2]Physik-Department E28, TUM, Garching — [3]Institut für Physik, Universität Greifswald, Greifswald — [4]Instituto de Plasmas e Fusão Nuclear, Universidade de Lisboa, Lisboa, Portugal

For future reactors based on the tokamak concept, it is necessary to establish high confinement modes without type-I ELMs. In the past years, several natural ELM-free operation scenarios, such as the EDA-H-mode, have been achieved in ASDEX Upgrade. The most prominent characteristic of the EDA-H regime is the appearance of the quasi coherent mode (QCM) at the plasma edge, which may be responsible for the stabilization of the ELMs. For the comparison with theory, it is important to determine the properties of the QCM in detail to identify its underlying driving forces. Due to its high spatial and temporal resolution, the He-beam diagnostic is used to measure different QCM properties. By means of spectral methods and due to a 2D-grid of the He-beam diagnostic, the wavenumber of the QCM in radial and poloidal direction is determined and compared with theoretical predictions.

P 9.2 Tue 16:00 P

Non-Axisymmetric Generalization of the Gyrokinetic Turbulence Code GENE-X — •Marion Smedberg[1], Dominik Michels[1], Andreas Stegmeir[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstrasse 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

For both tokamaks and optimized stellarators, plasma turbulence drives a major part of the heat loss. Thus realistic simulations of plasma turbulence, especially in the edge and scrape-off layer (SOL), are a key step towards a fusion power plant. The recent gyrokinetic turbulence code GENE-X uses a flux-coordinate independent (FCI) coordinate system; this approach has the advantage of remaining well-defined (singularity-free) even for the complex magnetic structures which appear in the edge and SOL, such as open field lines, X-points, islands, and stochastic regions. For this reason, GENE-X is well-equipped to simulate edge and SOL turbulence. However, the code can currently only simulate in axisymmetric geometries, such as tokamaks. In this work, progress towards a non-axisymmetric generalization of GENE-X is presented; this includes updating the grid generator, field line tracers, and fast elliptic solvers.

P 9.3 Tue 16:00 P

Extension of the Braginskii fluid model for edge turbulence simulations — •Christoph Pitzal, Andreas Stegmeir, and Frank Jenko — Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany

Fluid models are a useful tool for plasma turbulence simulations. They are computationally less intense than kinetic models, but they have limited predictive capabilities. This arises from the fact, that not all effects are captured, which are necessary to simulate a fusion device sufficiently. The effects which are not contained are primarily kinetic effects, which are lost due to the missing velocity space, e.g. Landau damping. Because of the missing Landau damping, fluid models significantly overestimate the parallel heat conductivity, whenever the collisionality is small. An approach to introduce Landau damping into a fluid model was already shown in [1]. This approach is formulated solely in k-space. A method to translate this approach into configuration space and thus make it applicable for fluid codes, which operate in configuration space, is presented in [2]. In this project a simple one-dimensional toy model has been implemented and tested to reproduce and understand the Landau fluid closure introduced in [2]. Further the Landau fluid closure will be implemented into the plasma turbulence code GRILLIX [3]. [1] G. W. Hammett and F. W. Perkins, Phys. Rev. Lett., vol. 64, pp. 3019-3022, Jun 1990. [2] J. Chen et al., Computer Physics Communications, vol. 236, pp. 128-134, 2019. [3] A. Stegmeir et al., Physics of Plasmas, vol. 26, no. 5, p. 052517, 2019.

P 9.4 Tue 16:00 P

Early stages of He cluster formation in tungsten — •Annemarie Kärcher[1,2], Vassily V. Burwitz[2], Thomas Schwarz-Selinger[1], Wolfgang Jacob[1], Lucian Mathes[2], and Christoph Hugenschmidt[2] — [1]Max-Planck-Institut für

Plasmaphysik, 85748 Garching, Germany — [2]Technische Universität München, 85748 Garching, Germany

In future fusion reactors, tungsten as plasma-facing material will be subjected to intense fluxes of helium (He). While the consequences of high He fluxes on the surface properties of tungsten have already been thoroughly studied, the mechanisms behind the early stages of the He cluster formation are still unclear. To understand the initial steps of the interaction of He with W, especially the impact of pre-existing defects, annealed, polycrystalline W samples were irradiation-damaged to various damage levels. Then, these were exposed to a low-temperature He plasma at low fluxes and fluences using an implantation energy of 100 eV. These He-implanted samples were measured by Doppler-broadening positron annihilation spectroscopy for defect quantification and elastic recoil detection analysis (ERDA) for quantification of He retention. To obtain information about the depth distribution of He, thin layers of the sample surfaces have been removed and ERDA measurements have been repeated subsequently until the signal intensity dropped to the sensitivity limit. In the irradiation-damaged samples, the He penetration into larger depth is significantly reduced compared with the depth penetration in undamaged samples, while their overall He retention is higher.

P 9.5 Tue 16:00 P

Study of LaB6-Cathodes in Neutral Pressure Gauges for Strong Magnetic Fields — •Bartholomäus Jagielski[1,2], Uwe Wenzel[1], Mirko Marquardt[1], Jiawu Zhu[1], and Thomas Sunn Pedersen[1] — [1]Max Planck Institute for Plasma Physics, Greifswald, Germany — [2]Physical Institute of the University Greifswald, Greifswald, Germany

The neutral gas pressure measurement is a key diagnostic for scrape-off-layer physics, that gives a direct indication of the exhaust rate. However, strong magnetic fields and the requirement for the longevity of diagnostics in increasingly longer lasting plasma pulses, is a major challenge. For this reason, we developed and tested new crystal-cathode pressure gauges with different cathode geometries made of lanthanum hexaboride (LaB6), which can permanently withstand the Lorentz-Forces. For the next campaign of Wendelstein7-X, mono- and polycrystalline LaB6-cathodes have been operated in a specially prepared laboratory, equipped with a superconducting magnet, which provides magnetic field strengths of up to 5.9 T, in a wide range of neutral pressure values, as well as several different working gases. NIR-thermionic investigations have been conducted, cross-checked with ANSYS simulations. The Anode potential has been optimized and we compared several different cathode lengths, ranging from 5mm to 8mm, for different electron emittances. A significant decrease of the required heating current of the shorter variants has been observed. Furthermore, we tested a new two-rod-cathode design, heated by three pyrolytic graphite blocks, showing noticeably improved performance.

P 9.6 Tue 16:00 P

Current Filamentation Instabilities of Proton Beams in Proton Driven Wakefield Accelerators — •Erwin Walter[1], Martin Weidl[1], John Farmer[2,3], Patric Muggli[2], and Frank Jenko[1] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Max Planck Institute for Physics, 80805 Munich, Germany — [3]CERN - 1211 Geneva 23 - Switzerland

Plasma wakefield accelerators can generate electric-field gradients magnitudes larger than conventional accelerators. Using this technology, particle-physics experiments could be performed in much more compact devices.

The Advanced Wakefield Experiment (AWAKE) is a proof-of-concept proton-driven wakefield accelerator located at CERN. Seeded self-modulation, a controlled excitation of the longitudinal self-modulation instability, is exploited to modulate the proton bunch into a train of multiple smaller bunches along its axis. For alternative beam parameters, the electromagnetic Weibel-like beam filamentation instability could result in magnetic field amplification, perpendicular scattering and emittance growth. The experimental parameters have been specifically chosen to avoid filamentation.

Our research investigates which beam parameters are required for filamentation to appear and whether this parameter regime is accessible in future experiments. We present results from full-PIC simulations and compare to linear theory.

P 9.7 Tue 16:00 P

Simulations of the penetration of RMP fields into ASDEX Upgrade plasmas — •Verena Mitterauer and Matthias Hölzl — Max Planck Institute for Plasma Physics, Boltzmannstrasse 2, 85748 Garching - Germany

A proposed mechanism for the mitigation of edge localized modes (ELMs) is the application of small non-axisymmetric magnetic fields by external coils, known as resonant magnetic perturbations (RMPs). Various effects are observed in the plasma in response to RMPs, among others, the stochastization of the edge region, the formation of magnetic islands and the reduction of the edge density and toroidal rotation. A combination of these responses is thought to cause either ELM mitigation or suppression. However, exact mechanisms and extrapolation to ITER are still uncertain such that non-linear simulations are needed. In this work, the JOREK-STARWALL code suite is used for the first time to simulate the effects of RMPs on plasmas with parameters relevant to RMP-ELM suppression experiments in ASDEX Upgrade. The use of the STARWALL extension allows to include the full plasma response to the perturbation field up to the boundary.

Simulations with realistic plasma parameters are compared to the experiment for a plasma configuration that is relevant for ELM suppression studies. A similar corrugation is observed in modelling and experiment. Further simulations are on the way to investigate the interaction of ELM instabilities with the perturbation fields. To capture experiments more accurately, a fluid model with kinetic closure will be developed that can describe neoclassical toroidal viscosity (NTV).

P 9.8 Tue 16:00 P

Tackling turbulence in the plasma edge pedestal with a revised version of the GENE code — •L. A. Leppin, T. Görler, F. Jenko, M. Cavedon, M. G. Dunne, and The ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Boltzmannstraße 2, 85748 Garching b. München, Germany

A major challenge for future fusion power plants is the turbulent plasma dynamics on the microscale, which causes detrimental levels of outward transport of energy and particles. Many open questions on the properties of this dynamics remain in particular for the plasma edge pedestal, which is characterized by strong gradients of temperature and density, causing strong electromagentic fluctuations. An important approach to advance the understanding of turbulent plasma dynamics in the edge are high-fidelity simulations based on 5D gyrokinetic theory. Here we present ASDEX-Upgrade pedestal simulations using a new modification of the well-established gyrokinetic, Eulerian, delta-f code GENE (genecode.org), which enables numerically stable global, electromagnetic simulations at experimental beta values. We systematically investigate the present instabilities and resulting heat fluxes via local, linear as well as global, non-linear simulations. By using experimental temperature profiles and magnetic equilibria from four timepoints within an edge localized mode (ELM) of an ASDEX Upgrade discharge we aim to contribute to the understanding of ELM dynamics on the microscale. Furthermore, we demonstrate the applicability of the new GENE modifications to scenarios from other tokamaks.

P 9.9 Tue 16:00 P

Simulation of the neutral gas pressure in the subdivertor region of Wendelstein 7-X with ANSYS — •Victoria Haak[1], Hugo Cu Castillo[2], Dirk Naujoks[1], Uwe Wenzel[1], Georg Schlisio[1], and W7-X Team[1] — [1]Max-Planck Institute for Plasma Physics, Greifswald, Germany — [2]University of Greifswald, Greifswald, Germany

For low neutral gas pressures, the behaviour of the neutral gas in the subdivertor region of Wendelstein 7-X is governed by molecular flow conditions, i.e. collisions between particles can be neglected. After hitting the walls in the subdivertor region, the particle flux is emitted according to Lambert's cosine law. These similarities between particle flow in the molecular regime and radiation transport are used in order to simulate the neutral gas pressure in the subdivertor region with the steady-state thermal analysis module in ANSYS. This module uses the angular coefficient method to calculate the radiation flux on the individual surfaces. Using the analogy between particles and radiation, the heat flux can be converted into neutral gas pressure by a so-called scaling factor. The distribution of the neutral gas pressure on the walls of the subdivertor region as well as the influence of pumps and leaks can be studied. The results are compared to other simulation results, e.g. from EMC3-EIRENE and to experimental results obtained from neutral gas pressure measurements during OP1.2b using neutral gas pressure gauges.

P 9.10 Tue 16:00 P

Coupling of 3D-PIC and ion optics simulations for studies of H^- beam formation and co-extraction of e^- — •Max Lindqvist[1,2], Niek den Harder[1], Adrien Revel[2], Serhiy Mochalskyy[1], Tiberiu Minea[2], and Ursel Fantz[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Université Paris-Saclay, CNRS, LPGP, Orsay, France

The ITER Neutral Beam Injection system requires a beam of negative ions (NI) with low divergence and high current density. The NIs are produced in RF ion sources, and extracted by application of an electric field; co-extracted e^- are dumped onto the extraction grid. The equipotential surface between the plasma and extracted NI beamlet, referred to as the meniscus, determines the beamlet properties to a large extent. 3D PIC modeling is needed for self-consistent simulation of the meniscus formation, NI extraction and co-extraction of e^-. Due to the high computational cost of 3D PIC modeling, extending the simulation beyond the extraction region is unfeasable. To study the beam properties of NIs and co-extraction of e^- in the ELISE ion source, a half-size ITER-like ion source operated in IPP Garching, the 3D PIC-MCC code ONIX is coupled with the beam code IBSimu. This allows coupling of particle properties from the plasma, to the meniscus to the beamlet. It is shown that NIs extracted near the edge of the meniscus and with a large incident angle to the meniscus form a beam halo. The peak power load of e^- dumped onto the grid system depends on their distribution on the meniscus, the distribution calculated using ONIX results in a higher peak load than a uniform distribution.

P 9.11 Tue 16:00 P

Viability of NN-based Predictor-Corrector Schemes for Plasma Simulations — •Robin Greif[1], Frank Jenko[1], and Nils Thuerey[2] — [1]Boltz- mannstr. 2, 85748 Garching, Germany — [2]Boltzmannstr. 3, 85748 Garching, Germany

We investigate the viability of using neural network driven simulation methods based on novel predictor-corrector schemes developed for fluid and smoke simulations for turbulence in plasma. The approach builds on top of successful pioneering work on numerical schemes from Mantaflow and its successor, Phi-Flow, an open-source machine learnign framework aggregator for fluid dynamic simulations. In this project, we extend Phi-Flow to solve the Hasegawa-Wakatani equations as a proof-of-concept of the viability of modern neural-network based numerical simulation techniques for simple plasma models. The use of deep-learning based numerical integration schemes explored here has been shown to provide superior accuracy at coarser grids than classical methods in fluid simulations and is a promising candidate to reduce the computational cost for the next generation of plasma simulations.

P 9.12 Tue 16:00 P

Physics-informed neural network of the ideal-MHD model in Wendelstein 7-X configurations — •Andrea Merlo, Daniel Böckenhoff, Jonathan Schilling, Samuel Aaron Lazerson, Thomas Sunn Pedersen, and the W7-X Team — Max-Planck-Institute for Plasma Physics, 17491 Greifswald, Germany

In magnetic confinement fusion research, the achievement of high plasma pressure is key to reaching the goal of net energy production. The magnetohydrodynamic (MHD) framework is used to self-consistently calculate the effects the plasma pressure induces on the magnetic field used to confine the plasma. In stellarators (e.g., Wendelstein 7-X), the confining field is inherently 3D, making MHD calculations costly to compute ($\mathcal{O}(1)$ CPUh). In this work, we describe a Physics-Informed Neural Network which has been trained not only to reproduce ground-truth magnetic equilibria computed with a traditional solver (e.g., VMEC), but also to satisfy the flux surface averaged pressure balance equation characterizing ideal-MHD. The NN model is benchmarked against VMEC on a set of W7-X magnetic configurations at finite volume averaged beta, and the computation of a set of representative physics quantities of interests (e.g., magnetic well) is used to validate the model use in addressing magnetic equilibrium dependent physics questions.

P 9.13 Tue 16:00 P

Turbulence in stellarators with GENE-3D — •Felix Wilms, Alejandro B. Navarro, and Frank Jenko — Max-Planck-Institut für Plasmaphysik, Boltzmannstraße 2, 85748 Garching b. München, Germany

GENE-3D is a code that is capable of simulating gyrokinetic plasma turbulence in stellarators globally (Maurer et al., Journal of Computational Physics, 2020). It has recently been upgraded to an electromagnetic version, expanding the variety of turbulent features that can be studied with it (Wilms et al., Journal of Plasma Physics, 2021). In this work, we present a first application to realistic scenarios, by performing multiple simulations with different model complexities and comparing them against experimental measurements of an ECRH-discharge.

P 9.14 Tue 16:00 P

Reduced transport models for a Tokamak flight simulator — •Marco Muraca, Emiliano Fable, Clemente Angioni, Hartmut Zohm, and Teobaldo Luda — Max-Planck-Institut für Plasma- physik, 85748, Garching bei München, Germany

A Tokamak flight simulator is a tool to predict the plasma behavior of a scheduled discharge, such that either actuator trajectories or plasma parameters satisfy the experimental goals, and to reduce probability of plasma disruptions and crossing of operational limits. It is based on the interaction between control system, plasma equilibrium and transport. The transport models have to be physics based to be reliable, but also fast to be used as an inter-discharge prediction tool. This compromise can be reached employing analytical models which are derived from first principle theories. An integrated model including every plasma region has been developed. The confined region is modeled in 1D, while the scrape-off-layer has a 0D structure. For the core region, a normalized temperature gradient threshold model has been adopted, while for the edge an average ELM model has been used. In the SOL a 2-point model for exhaust and a particle balance for the separatrix density have been implemented. All the models have been validated against several stationary cases, by fixing some parameters as boundary conditions and matching experimental data, exploiting the modular structure of the integrated model. A first fully integrated simulation has been matched in the flight simulator, including ramp-up and flattop phases. A stronger validation including more discharges and the ramp-down phase is planned for the future.

P 9.15 Tue 16:00 P

multi fidelity monte carlo (MFMC) sampling and application to plasma physics — •Patrick Storch — Max Planck Institut für Plasmaphysik Boltzmannstr. 2, 85748 Garching

In many situations across computational science and engineering, multiple computational models are available that describe a system of interest. These different models have varying evaluation costs and varying fidelities. Typically, a computationally expensive high fidelity model describes the system with the accuracy required by the current application at hand, while lower-fidelity models are less accurate but computationally cheaper than the high-fidelity model. Plasma physics simulations for e.g. turbulences in tokamak reactors rely on sophisticated gyrokinetic models which are very costly in terms of computing power and runtime. Standard Monte Carlo analyses on these models are highly expensive because a large number of particle trajectories need to be integrated over long time scales, and small time steps must be taken to accurately capture the features of the wide variety of trajectories. Therefore they provide an ideal candidate to apply MFMC sampling to a real world scenario. Numerical experiments with linear and nonlinear examples show that speedups by orders of magnitude are obtained compared to Monte Carlo estimation that invokes only a single model.

P 9.16 Tue 16:00 P

Characteristics of Alfvénic modes in ASDEX Upgrade disruptions — •Paul Heinrich, Gergely Papp, Philipp Lauber, Mike Dunne, Valentin Igochine, Oliver Linder, Marc Maraschek, the ASDEX Upgrade team, and the EUROfusion MST1 team — Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, 85748 Garching, Germany

ASDEX Upgrade has developed multiple massive gas injection-induced scenarios to investigate runaway electron (RE) dynamics. During the current quench of these disruptions, Alfvénic activity is observed in the 300–800 kHz range. These modes are investigated as potential runaway electron mitigation candidates. With the help of a mode tracing algorithm, mode behaviour for 180 discharges was classified. The modes are potentially identified as global Alfvén eigenmodes (GAEs). Changes in the Alfvén continuum during the quench can explain the strong frequency sweep of these modes. A systematic statistical analysis revealed no significant effect of the mode characteristics on the dynamics of the subsequent runaway electron beam.

P 9.17 Tue 16:00 P

Modelling Magnetic Measurements of Tearing Modes in ASDEX Upgrade — •Magdalena Bauer, Marc Maraschek, Hartmut Zohm, Anja Gude, Wolfgang Suttrop, Felix Klossek, Louis Giannone, and the ASDEX Upgrade Team — Max Planck Institute for Plasma Physics, Garching

In future fusion devices, disruptions have to be avoided to prevent damage of the vessel. Locked modes, i.e. tearing modes that are at rest with the vessel due to electromagnetic interaction, are precursors of and significantly involved in disruptions. While rotating modes can be observed by Mirnov coils measuring the poloidal magnetic perturbation field tangential to the wall, locked modes require measuring the radial magnetic field, e.g. by saddle coils on the high-field side. The observed perturbation fields are affected differently by mirror currents induced by rotating modes. In order to model all measurements during a locking process, these mirror currents and their frequency dependence have to be described. Owing to the complexity of the real tokamak, neither the full geometry nor the exact conductivity of all structures can be considered. A recently developed three-dimensional finite element tool modelling the perturbation field for all coils is implemented using an effective conductivity of the wall and - for the saddle coils - an effective distance to the vessel. These two simulation parameters are optimized such that they best describe the ratio of measured mode amplitudes in Mirnov and saddle coils for all frequencies and discharge scenarios. Additional radial field coils are implemented to gain information on the poloidal mode structure of locked modes.

P 9.18 Tue 16:00 P

Analysis and modeling of momentum transport based on NBI modulation experiments at ASDEX Upgrade — •Carl Friedrich Benedikt Zimmermann[1,2], Rachael McDermott[1], Emiliano Fable[1], Basil Duval[4], Ralph Dux[1], Antti Salmi[3], Ulrich Stroth[1,2], Tuomas Tala[3], and Giovanni Tardini[1] — [1]Max Planck Institute for Plasma Physics, 85748 Garching, Germany — [2]Physik-Department E28, Technische Universität München, 85747 Garching, Germany — [3]VTT, P.O. Box 1000, FI-02044 VTT, Finland — [4]EPFL, Swiss Plasma Center, CH-1015 Lausanne, Switzerland

Understanding momentum transport is crucial in reliably predicting the plasma rotation profiles of future fusion devices. At ASDEX Upgrade, momentum transport is studied to validate theoretical models and transport codes. The new momentum transport analysis framework uses neutral beam modulation experiments to determine the con tributions of diffusion, convection, and residual stress to momentum transport within the core plasma. The methodology was applied to a database of more than 90 phases from 50 varied discharges. A recent experimental campaign filled gaps in this database enlarging the probed parameter space to study the effect of the turbulence transition from trapped electron to ion-termperature-gradient modes on momentum transport. Such a large data set makes it possible to study the parameter dependencies of the transport coefficients. In ongoing experiments, the parameter space of the database will be further enlarged allowing more detailed validation of the methodology and theoretical predictions.

P 9.19 Tue 16:00 P

Experimental investigation of velocities and diameters of droplets generated by arcing — •Alberto Castillo Castillo[1,2], Martin Balden[1], Volker Rohde[1], and Rudolf Neu[1,2] — [1]Max-Planck Institute for Plasma Physics (IPP), Garching, Germany — [2]Technical University Munich (TUM), Garching, Germany

Droplet generation by arcing is one of the mechanisms that can generate dust in a fusion device. The metal droplets expelled by the arc can potentially introduce impurities in the plasma core and influence the operation of the device. The aim of this work is to study the velocities, diameters and direction of the droplets expelled by arcing from a metal target. Knowing the sizes and velocities distribution of the droplets would allow an estimation of their influence on plasma operation. Different target materials will be used relevant to fusion devices, with a focus on tungsten.

The experimental setup consist of a vacuum chamber in which an arc is ignited on a target. After an arcing event, the droplets expelled within a certain solid angle enter a vertical drift tube. Along the tube, the droplets pass through the line of sight of two detection systems. Each detector measures the light scattered by the droplet from a perpendicular light source. The amplitude of the signal can be converted to droplet diameter through the application of MIE scatter theory, and the signal length and time delay between both sensors allow the calculation of velocity. The orientation of the target is changed in order to measure the distributions of droplets expelled at different angles.

P 9.20 Tue 16:00 P

Uncertainty Quantification for Multiscale Turbulent Trans- port Simulations — •Yehor Yudin, Udo von Toussaint, and David Coster — Max Planck Institute for Plasma Physics, Boltz- mannstrasse2, 85748 Garching, Germany

One of the challenges in understanding the energy and particle transport processes in the core plasma of a magnetic confinement fusion device is to quantify how it is effected by turbulent dynamics. This work considers a multiscale approach of modeling this problem, where the numerical solution is obtained for coupled models describing processes on different spatial and temporal scales. Furthermore, the resulting model is used to investigate both epistemic and aleatoric uncertainties in the profiles of the transported quantities. This work proposes application of a surrogate modelling technique to reduce the computational cost of resolving a quasi-steady state solution on the miscroscale when it is sufficient to capture only statistics of turbulent dynamics. We studied a Multiscale Fusion Workflow that utilizes turbulent energy and particle fluxes computed with a gyrofluid turbulence code GEM in flux tube approximation to calculate the transport coefficients for core transport code ETS. In this work, a data-driven probabilistic surrogate model based on Gaussian Process Regression is used to infer flux values computed by a turbulence code for given core profiles, and to calculate related uncertainties. For that, we use VECMA toolkit to perform uncertainty quantification, as well as to train, test and utilize surrogate models.

P 9.21 Tue 16:00 P

Bayesian Inference based Sensitivity Studies of Helium Atomic Models — •Erik Flom[1], Oliver Schmitz[1], Maciej Krychowiak[2], Ralf König[2], Stuart Loch[3], and Jorge Munoz-Burgos[4] — [1]University of Wisconsin - Madison, Madison, WI, USA — [2]3Max Planck Inst. for Plasma Physics, Greifswald, Germany — [3]Auburn University, Auburn, AL, USA — [4]Astro Fusion Spectre, San Diego, CA, USA

Understanding the basic plasma parameters of temperature and density, as well as their gradients in the scrape-off layer (SOL), is a topic critical for providing information about the performance of a divertor concept. In order to study the performance of the Wendelstein 7-X divertor concept, an active spectroscopy system on an atomic helium beam was developed and installed on the stellarator. A complete Bayesian treatment has been undertaken with the Minerva Bayesian modeling framework in two approaches. First, it has been shown through a sensitivity study that the diagnostic method is robust against random measurement errors and systematic calibration errors on the scales achievable with the current diagnostic setup. From this, it is concluded that the majority of the uncertainty in the reconstructed temperature and density arises from systematic uncertainties in the underlying collisional-radiative model (CRM) rather than from measurement errors. To demonstrate this, in the second approach, the diagnostic model is tested by inferring the plasma density and temperature using synthetic line intensities and applying different CR models (e.g. including high Rydberg states).

P 9.22 Tue 16:00 P

Work Function Measurements of the Cesiated Surface in a Negative Hydrogen Ion Source Using LEDs — •Jacob Maria Berner, Christian Wimmer, and Ursel Fantz — Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany

The work function of a surface can be determined by measuring the nA-photocurrents arising from the irradiation by light of different wavelengths. When the chosen photon energies are close to the work function, this energy threshold can be calculated using the Fowler method. As a novelty for such a measurement, fiber coupled LEDs are used as a light source of sufficient power.

State of the art negative hydrogen ion sources, as used for the ITER neutral beam injectors, rely on the surface conversion process of H and H_x^+ from a low temperature plasma at cesiated surfaces with low work function. In order to reach longer extraction durations at high extraction currents, a stable work function, which is governed by cesium dynamics, impurities, and the interaction with the plasma, is crucial. Taking on the challenges of measuring small nA-photocurrents in a corresponding environment, the method is developed to determine the work function for the first time ever directly inside a high-performance negative ion source, namely BATMAN Upgrade. Monitoring the temporal stability of the work function is essential, as variations can worsen the extraction performance of H_x^- and countermeasures can be taken accordingly. The results from the feasibility study are expected to enable the establishment of this diagnostic tool for in-situ monitoring of the work function.

P 9.23 Tue 16:00 P

Effect of W7-X divertor geometry modifications on PFC heat load distribution — •Amit Kharwandikar, Dirk Naujoks, Thomas Sunn Pedersen, Felix Reimold, and The W7X Team — Max Planck Institute for Plasma Physics, 17491 Greifswald, Germany

Wendelstein 7-X (W7-X) is an advanced stellarator device operated in Greifswald, Germany, to provide the proof of principle that the stellarator concept can meet the requirements of a future fusion reactor. It employs the island divertor concept to handle the heat and particle fluxes. In the recent experimental campaign OP1.2, ten adiabatically loaded test divertor units (TDUs) were installed in the plasma vessel along with baffles, toroidal/poloidal closures, etc. where high heat loads were observed onto the in-vessel components. Particularly, in the high-mirror magnetic configuration, undesired level of heat loads appeared on the baffles that limited the operation of the device. In some previous studies, it has been shown that the relative position of the divertor targets and the baffle affects the heat load distribution. This poster discusses the investigation of such geometry modifications via modelling. The diffusive field line tracing (DFLT) code - modified to also mimic plasma counter-flows - is used to simulate heat transport to the plasma facing components (PFCs). The aim of this activity is to understand the effect of these simple modifications (in terms of the relative position of targets and baffles) and optimize the same for an acceptable heat load distribution.

P 9.24 Tue 16:00 P

Gyrokinetic modelling of anisotropic energeticparticle driven instabilities in tokamak plasmas — •Brando Rettino[1], Thomas Hayward-Schneider[1], Alessandro Biancalani[2,1], Alberto Bottino[1], Philipp Lauber[1], Ilija Chavdarovski[3], Francesco Vannini[1], and Frank Jenko[1] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]Leonard de Vinci Pole Universitaire, Research Center, 92916 Paris la Defense, France — [3]Korea Institute of Fusion Energy, 34133 Daejeon, South Korea

Energetic particles produced by plasma heating are observed to excite energetic-particle-driven geodesic acoustic modes (EGAMs) in tokamaks. We study the effects of velocity space anisotropy of the EP distribution functions on the excitation of such instabilities with ORB5, a gyrokinetic particle-in-cell code. Numerical results are shown for linear electrostatic simulations with ORB5. The growth rate is found to be sensitively dependent on the phase-space shape of the distribution function. The qualitative behavior of the instability is analyzed theoretically through dispersion relations. Realistic neutral beam energetic particle anisotropic distributions are obtained from the Fokker-Planck solver RABBIT and are introduced into ORB5 as input distribution function. Results show a dependence of the growth rate on the beam injection angle. A preliminary qualitative comparison to experimental measurements is presented,the differences are discussed, and further steps for quantitative non-linear analysis are outlined

P 9.25 Tue 16:00 P

Edge core coupling: physical parameters determining the pedestal width — •Lidija Radovanovic[1], Mike Dunne[2], Elisabeth Wolfrum[2], Friedrich Aumayr[1], and ASDEX Upgrade Team[2] — [1]Institute for Applied Physics, TU Wien, Vienna, Austria — [2]Max Planck Institute for Plasma Physics, Garching, Germany

The outer edge of the plasma, also called the pedestal, serves as a strong insulator between the plasma core and the reactor walls. The top of the pedestal serves as a boundary condition for the hot core plasma. Understanding the physical processes governing the pedestal is crucial for reliable prediction and control of the plasma conditions and its stability. Using the EPED framework as a basis, the pedestal can be considered as a combination of two limits: the pedestal width grows at a constant gradient to the ideal peeling ballooning limit. Understanding this width growth is crucial in order to accurately predict the pedestal for future machines. In this work the pedestal width is further investigated in experiments based on two methods. The first considers a recent analysis at the ASDEX Upgrade, which indicates that locally low magnetic shear at the pedestal top could cause ballooning modes, and it therefore limits the pedestal width. The experimental approach here is changing the shape and the magnetic field of the plasma to move the region of low local magnetic shear. The second method assumes that the turbulent motion of the ionized particles in the plasma edge region is suppressed due to the presence of a steep radial electric field. A comparison of these assumptions with the pedestal width will be shown.

P 9.26 Tue 16:00 P

Magnetic signature of ECCD induced crashes in the Wendelstein 7-X stellarator — •K. Rahbarnia, S. Vaz Mendes, C. Brandt, H. Thomsen, J. Schilling, K. Aleynikova, C. Slaby, A. Könies, and W7-X Team — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

Wendelstein 7-X is a stellarator-type fusion experiment. A strong toroidal plasma current is not needed for optimized confinement properties. Nevertheless, during the last operation campaign a number of experiments including an externally driven plasma current were conducted. The so-called electron cyclotron current drive (ECCD) was used to counteract any rising bootstrap current to completely nullify it. Alternatively, in the presence of co-driven ECCD, the increase of a naturally evolving bootstrap current was accelerated so that an equilibrated state could be reached faster. During ECCD experiments crashes in global plasma parameters have been observed, which sometimes even led to a total collapse of the plasma. Previous analysis mainly involving fast changes of the measured electron temperature caused by the crashes revealed a sawtooth-like behaviour similar to tokamaks. In this study the magnetic signature of these crash events measured by poloidal arrangements of in-vessel Mirnov coils is investigated generally supporting the previous results. Various ECCD scenarios are studied showing similar frequency (around 40kHz) and poloidal mode number (m<5) of the observed bursty magnetic fluctuations. The results are compared to theoretical predictions using the magnetic equilibrium code VMEC and the MHD continuum code CONTI.

P 9.27 Tue 16:00 P

Model based optimization of Advanced Tokamak scenarios — •Raphael Schramm[1], Alexander Bock[1], Emiliano Fable[1], Jörg Stober[1], Simon van Mulders[2], Maximilian Reisner[1], Hartmut Zohm[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck Institut für Plasmaphysik, Garching, Germany — [2]École Polytechnique Fédérale de Lausanne, Switzerland

Advanced Tokamak scenarios aim to reduce the reliance on ohmic current of plasma discharges. This is done by increasing the bootstrap current ($j_{bs} \propto q\nabla p$) with manipulation of the safety factor profile q via external actuators. These can be turned on during the plasma ramp-up, which avoids the safety factor dropping below the desired value, compared to the conventional option to wait until the plasma reaches a stationary state. Last year an ASTRA model has been presented that can be used to the develop such a scenario.

The model has been used to analyze a counter-ECCD scenario with a higher current than the validation scenario. Results of this will be shown. An optimizer, working on a simplified model will be used to improve this scenario. It proposes a change, which is then cross-checked in the ASTRA model in an iterative learning approach. Results will be run in the next ASDEX-U campaign.

In this campaign, a system capable of calculating the safety factor profile in real-time will become available. This contribution will discuss, if accuracy and reliability of such scenarios can be improved by using feed-forward control based on q instead of time.

Real-time control of the q-profile based on this tool will be tested.

P 9.28 Tue 16:00 P

Identification of multiple mode contributions in tomography data from soft X-ray diagnostics — •Henning Thomsen, Christian Brandt, Rene Bussiahn, Sara Vaz Mendes, Kian Rahbarnia, Jonathan Schilling, Thomas Wegner, and W7-X Team — MPI f. Plasmaphysics, 17491 Greifswald

External actuators like impurity injection, density or temperature modulation as well as current drive affect the stability properties of the plasma equilibrium in the Wendelstein 7-X stellarator. The dynamics on the soft X-ray radiation distribution in a poloidal plane is studied by the soft-X ray tomography system XMCTS [1], which measures in the energy range 1-12 keV. The radiation in this energy range originates mainly from Bremsstrahlung of the confined plasma and line radiation from impurity species. In different experiments with impurity injection, a dominant m=1 mode with frequencies in the range of 1-2 kHz has been observed. An analysis of dominant modes is possible with a singular value decomposition. While the dynamics associated with sucb low-frequency modes can often be reconstructed in the tomograms, higher frequency components visible in the line-integrated raw data typically do not show up in the tomographically reconstructed time series. In this contribution the possible reasons and different analysis approaches are discussed.

[1] C Brandt et al Plasma Phys. Control. Fusion 62 (2020) 035010

P 9.29 Tue 16:00 P

Linear (non-)ideal MHD stability analysis of pedestals in axisymmetric and magnetically perturbed tokamak equilibria — •Jonas Puchmayr[1], Mike Dunne[1], Erika Strumberger[1], Branka Vanovac[1], Hartmut Zohm[1], and The ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching, Germany — [2]See author list of H. Meyer et al. 2019 Nucl. Fusion 59 112014

In the H-mode, steep gradients of pressure, temperature and density build up at the plasma edge. These gradients can drive a type of instability, called Edge Localized Modes (ELMs). ELMs will lead to severe damage in future fusion devices. While ELMs are typically well-described as a pressure gradient and current density driven instability in the framework of ideal MHD, there are experimentally observed instabilities that can only be described including additional non-ideal effects in the stability calculation. Experimentally, ELMs are observed to be mitigated or suppressed by resonant magnetic perturbation (RMP) fields, which break the axisymmetry of tokamak equilibria.

In this work, the influence of non-ideal effects on linear MHD stability is analyzed using the code CASTOR3D. As a result, the experimentally observed mode frequency is in good agreement with the theoretical prediction only if resistivity, rotation, viscosity and gyro-viscosity are simultaneously taken into account. In addition, we observe a strong influence of resistivity on the MHD stability threshold for several equilibria. Finally, new results on weakly toroidally coupled modes in magnetically perturbed tokamak equilibria are presented.

P 9.30 Tue 16:00 P

Data-driven non-intrusive reduced-order modeling via Operator Inference for the Hasegawa-Wakatani equations — •Constantin Gahr — Max-Planck-Institut für Plasmaphysik, Garching, Deutschland

Turbulence simulations play a crucial role in the plasma physics community as they give insight into the underlying nonlinear dynamics. However, these simulations are computationally expensive. Reduced-order models provide a computationally cheaper alternative to the high-fidelity model exploiting the fact that in most physics and engineering problems, the dominant dynamics live on low-dimensional manifolds.

We focus on the Hasegawa-Wakatani equations, a plasma model describing two-dimensional drift-wave turbulence, and approximate it with a reduced order model learned via Operator Inference. Operator Inference is a data-driven non-intrusive model reduction method that learns low-dimensional reduced models with polynomial nonlinearities from trajectories of high-dimensional high-fidelity simulations. In addition, it can handle arbitrary nonlinearities by employing lifting transformations that map the given states into states with polynomial nonlinearities. In the present work, we perform one of the first systematic reduced-order modeling studies in plasma physics to ascertain whether Operator Inference can provide accurate and predictive reduced models for the Hasagawa-Wakatani system.

P 9.31 Tue 16:00 P

Electric field structure and power coupled to the plasma in lattice vortex fields — •Christian Lütke Stetzkamp, Tsanko Vaskov Tsankov, and Uwe Czarnetzki — Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany

Recently a novel concept for collisionless electron heating and plasma generation at low pressures was theoretically proposed [1]. It is based on a lattice of vortex fields, which produces certain electron resonances in velocity space.

Here, the power coupled into the plasma is theoretically calculated for generalized lattices and coil forms. Also a way to obtain the power coupling from arbitrary electric field configurations is shown and the performance of the field structure used in the theoretical work [1] is compared to simulated and measured fields.

[1] U. Czarnetzki and Kh. Tarnev, Phys. Plasmas 21, 123508 (2014)

P 9.32 Tue 16:00 P

Dynamic structure factor of the correlated one-component plasma — •Hanno Kählert — Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel

The dynamic structure factor (DSF) plays an important role for the analysis of x-ray scattering spectra of dense plasmas. Here, molecular dynamics simulations are used to obtain first-principle data for the DSF of the classical one-component plasma (OCP), in particular for intermediate coupling strengths. In this regime, a theoretical description is challenging due to strong coupling and collisional effects. The results are compared with theoretical models for the DSF and are used to compute the local-field correction, which measures the deviations of the DSF from the Vlasov (mean-field) result.

P 9.33 Tue 16:00 P

The effect of plasma parameters on the surface treatment of air cathode for zinc-air battery — •He Li, Christian Schulze, Sadegh Askari, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

Plasma technology is of vital importance in the research field of nanomaterials which offers a green and efficient process for functionalization and treatment of surfaces. Most of the previous researches focus on the process parameters, but the relationship between plasma properties, such as ion energy or fluxes of reactive species, and materials properties is still unclear. In this work, a new reactor was assembled which is combining ICP plasma with CCP bias to control the plasma density and ion energy separately during the treatment, and transition metal oxides were used as the substrate to compare the electrochemical performance before and after plasma treatment. The plasma parameters during treatment were measured by the energy-resolved ion mass spectrometry which were analyzed with the corresponding catalytic performances to optimize the treatment process and fundamentally understand the reaction processes and mechanisms between plasma and material surfaces, thus providing a theoretical basis for the future application in the material researches.

P 9.34 Tue 16:00 P

ZrO2 based layers investigated by the 3ω method — •Vitali Bedarev, Philipp Alexander Maass, Marina Prenzel, Marc Böke, and Achim von Keudell — Experimental Physics II, Ruhr-University, Bochum, Germany

Aim of the project is to develop a diagnostic technique to measure the thermal conductivity of thin ZrO2 layers which are deposited via PECVD. The 3ω method was selected as a surface-sensitive technique with high accuracy and short equilibration time. This method can be applied to bulk amorphous solids and crystals as well as to amorphous films tens of microns thick. A thin electrically conductive wire is deposited onto the specimen to measure its thermal conductivity. The wire serves both, as a heater and as a temperature sensor. Joule heating at 2ω frequency occurs when an ac current with angular modulation frequency ω is applied to the wire. The generated thermal wave diffuses into the specimen. This causes a modulation of the resistance at 2ω due to the temperature dependence of the resistance. The voltage drop along the wire contains a contribution from a third harmonic that depends on the modulated temperature rise of the heater and could be used to calculate the samples thermal conductivity. We will present the setup, its characterization by using reference samples and first results on ZrO2 layers and the influence of the structure and morphology of these layers on the thermal conductivity.

P 9.35 Tue 16:00 P

Langmuir probe measurements in a dual-frequency capacitively coupled rf discharge — •Jessica Schleitzer, Thomas Trottenberg, Viktor Schneider, and Holger Kersten — Institute for Experimental and Applied Physics, Christian-Albrechts-University Kiel, Leibnizstr. 19, 24108 Kiel, Germany

The standard frequency for common rf plasmas used in technology is 13.56 MHz. A difference in the area of the electrodes result in a self-bias voltage at the powered electrode. The gas pressure in the device and the dc self-bias mainly determine the sheath potential and, thus, the ion current density and the ion energy towards the electrode surface. An independent control of these important properties - especially in industrial applications - is desirable but usually not possible. By adding a second frequency (27.56 MHz), a so-called electrical asymmetry effect (EAE) is created, which enables the control of the bias voltage and, thus, the ion energy almost independent of the ion flux by varying the phase angle between the two harmonics. Since the EAE is a relatively new approach to separately control these two parameters, the number of diagnostics performed in such a discharge amounts to a minimum. By using a specially designed Langmuir probe in this dual-frequency plasma, it can be determined to what extend the important plasma parameters, i.e. electron density and electron temperature, change with a variation of the phase between the two harmonics. This work aims to provide an initial insight into the differences between a single- and dual-frequency plasma based on Langmuir probe measurements and offers a comparison of theory and experiment.

P 9.36 Tue 16:00 P

Analysis of phase separation processes in dusty plasmas using a polarization camera — •Andre Melzer, Daniel Maier, and Stefan Schütt — Institute of Physics, University Greifswald

Binary dust mixtures provide an interesting system to study fundamental processes such as phase separation. There, two dust species of different sizes are trapped in the plasma of an rf discharge under microgravity conditions. These two species demix due to the difference in the forces exerted by the plasma on the differently sized particles, even if the size disparity is very small. So far, in these experiments, one of the two species has been marked by a fluorescent dye to distinguish between the species.

In a recent set of experiments, a camera equipped with a pixel-wise polarization filter is used to check whether the polarization-dependent scattering can be used to identify the two different species. Here, demixing processes under microgravity conditions are analyzed from the polarization camera data and compared with the information from the fluorescence technique.

P 9.37 Tue 16:00 P

Oxygen dependent etch rates of MF-particles in an RF-plasma — •Cassedyn Wirtz, Sören Wohlfahrt, and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Microparticles are the essential component of a complex plasma. The forces affecting these particles, as well as their accumulated charge, depend prominently on their size. Thus, a precise knowledge of the particle size is a key input for quantitative description and modelling. However, in interaction with the plasma, the size can change due to etching and surface processes. The precise knowledge of the etch rate is especially important for measurements ranging from several minutes to hours. Melamin-formaldehyde (MF) particles are widely used in complex plasmas and known for changing their size during plasma exposure. It was shown that the etch rate depends strongly on the presence of oxygen in the discharge. We use an advanced light scattering technique that uses angular- and polarization resolved light scattering (APRLS) [1], which allows to determine the particle size with high temporal resolution. Utilizing this resolution the etch rates of MF-particles dependent of the oxygen content are further investigated, with focus on the regime of low admixtures (< 10%).

[1] S. Wohlfahrt, D. Block, "High-precision in-situ measurements of size and optical properties of single microparticles in an RF-plasma", Physics of Plasmas 28, 123701 (2021)

P 9.38 Tue 16:00 P

Experiments and Simulations of Phase Separation in Binary Dusty Plasmas — •Stefan Schütt and André Melzer — Institute of Physics, University of Greifswald

Three-dimensionally extended dusty plasmas containing mixtures of two particle species of different size have been investigated on parabolic flights. Phase separation was found even when the size disparity was below 5%. Uphill diffusion coefficients have been determined and lie in the expected range for a phase separation process driven by plasma forces. A measure for the strength of the phase separation is presented that allows to quickly characterize measurements. There is a clear correlation between size disparity and phase separation strength. Molecular dynamics simulations of binary dusty plasmas have been performed and their behavior with respect to the phase separation process has been analyzed. Here as well, it was found that even the smallest size disparities lead to phase separation. It was confirmed that the separation is due to the force imbalance on the two species. Additionally, it was found that in the simulations the separation becomes weaker with increasing mean particle size.

P 9.39 Tue 16:00 P

Pulse excitation method for the determination of microparticle properties — •Armin Mengel and Franko Greiner — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

The fact that a microparticle trapped in the sheath of a radiofrequency plasma behaves like a harmonic oscillator is often employed for diagnostics of particle properties, like charge-to-mass ratio or neutral drag coefficient. While traditional resonance methods like the frequency sweep[1] or phase resolved resonance method(PRRM)[2] rely on a sequence of measurements at a set of individual frequencies, possibly resulting in low time resolution, excitation with a pulse signal offers the opportunity to obtain the same parameters from a single time-resolved trajectory of the particle response within a much shorter time. We present a comparative study of PRRM and pulse excitation method (PEM).

[1] A. Melzer et al., Phys. Lett. A, 191 (1994) 301-308, https://doi.org/10.1016/0375-9601(94)90144-9

[2] H. Jung et al., J. Plasma Phys. (2016), 82(3), 615820301, https://doi.org/10.1017/S0022377816000441

P 9.40 Tue 16:00 P

The shallow water accretion disk experiment SWADEX — •Peter Manz — Institute of Physics, University of Greifswald, Germany

Accretion disks are ubiquitous in astrophysics. In laboratory experiments, especially, the two-dimensional geometry, magneto-hydrodynamic (MHD) and gravitational effects are difficult to study. An analogy to shallow water can be used to simulate the gravitational potential by a gravitational funnel. In MHD a magnetic tension force gives rise to a return force which is directly proportional to the displacement, like a spring under tension. The analogy to the spring motivated the approach using polymers to mimic the effect of the magnetic field. Using viscoelastic fluids instead of liquid metals, it is possible to perform cheaper and safer experiments. First results of studies related to the standing accretion shock instability [1] and the magneto-rotational instability [2] will be presented.

[1] S. Sebold et al. Phys. Rev. E 102, 063103 (2020) [2] F. Günzkofer, P. Manz Phys. Rev. Fluids 6, 054401 (2021)

P 9.41 Tue 16:00 P

Untersuchung der Laser-induzierten Plasmaausbildung im Wasser mit Doppelpuls-LIBS bei Drücken von bis zu 60 MPa — •Marion Henkel[1], Michelle Siemens[2], Benjamin Emde[2], Steffen Franke[1], Jörg Hermsdorf[2] und Ralf-Peter Methling[1] — [1]Leibniz-Institut für Plasmaforschung und

Technologie e.V. (INP), Felix-Hausdorff-Straße 2, 17489 Greifswald, Deutschland — [2]Laser Zentrum Hannover e.V. (LZH), Hollerithallee 8, 30419 Hannover, Deutschland

Um Materialproben hinsichtlich ihrer chemischen Zusammensetzung zu analysieren, ist LIBS ein etabliertes Verfahren. Die Möglichkeit LIBS auch unter Wasser einzusetzen, macht es vor allem für die Rohstofferkundung in der Tiefsee interessant.

Die Doppelpulstechnik ist dafür ein vielversprechender Ansatz, bei der ein erster Laserpuls eine Kavität an der zu analysierenden Materialoberfläche erzeugt und der zweite Laserpuls das Plasma in der Kavität ausbildet.

Hohe Drücke in der Tiefsee haben dabei Auswirkungen auf das Plasma und seine Emission. Es wurde daher eine Druckkammer entwickelt, die Versuche sowohl mit Süß- als auch mit Salzwasser bei 60 MPa erlaubt. Ein Doppelpuls-Nd:YAG-Laser mit 2x400 mJ ermöglicht auch bei hohen Drücken eine Plasmaausbildung.

Spektrale und räumliche Diagnostiken mit einer Zeitauflösung von wenigen Mikrosekunden erlauben eine Untersuchung der Größe und Lebensdauer des Plasmas und der zeitlichen Entwicklung der Emission bei hohen Drücken unter Wasser.

P 9.42 Tue 16:00 P

Accelerating positron rings in a two-fold plasma column — •Lars Reichwein[1], Anton Golovanov[2], Igor Kostyukov[2], and Alexander Pukhov[1] — [1]Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany — [2]Institute of Applied Physics RAS, Nizhny Novgorod, Russia

We present a setup consisting of an electron driver and a short laser pulse which create a two-fold plasma column structure [1]. The obtained laser-augmented blowout allows for the stable acceleration of positron rings over long distances even when the driving beam's evolution is considered. The scheme is studied numerically by means of particle-in-cell simulations. Further, we derive expressions for the accelerating and focusing fields analytically and show that the witness bunch is being accelerated along equilibrium lines in the wakefield structure.

[1] L. Reichwein et al., arXiv:2110.05226v2 (2021)

P 9.43 Tue 16:00 P

OES characterization of the microwave plasma torch in different configurations — •Christian Karl Kiefer[1], Ante Hecimovic[1], Arne Meindl[1], David Rauner[2], and Ursel Fantz[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany — [2]University of Augsburg, 86159 Augsburg, Germany

The microwave plasma torch, operated at under-pressure and atmospheric pressure, has already been tested for a wide range of applications from gas conversion over the decomposition of VOC in exhaust gases to plasma spraying. For the application of CO_2 conversion, axial scans of the rotational and vibrational temperature of the plasma were performed for a nozzle configuration (mixing the hot and cold gas as it exits the resonator) and a quencher configuration (allowing to admix additional cold gas into the effluent) via the analysis of the C_2 Swan emission spectrum. To further characterize the microwave plasma torch at atmospheric pressure via optical emission spectroscopy, spectra from a variety of different pure gases and gas mixtures were acquired and specific features were analyzed. Feasibility studies for the determination of different plasma parameters were performed.

P 9.44 Tue 16:00 P

Ignition and propagation of nanosecond pulsed plasmas in water with different polarities — •Katharina Grosse[1], Marina Falke[2], and Achim von Keudell[1] — [1]Experimentalphysik 2, Ruhr-Universität Bochum — [2]CLICCS, Universität Hamburg

Discharges in liquid enable a variety of applications ranging from wastewater treatment to nanoparticle formation. Pulsed plasmas in liquids ignited by voltage pulses with fast rise times and nanosecond pulse lengths yield a high degree of dissociation of the liquid, a high mass transport and efficient reaction rates with surfaces adjacent to the plasma. However, understanding of the ignition and propagation of these plasmas inside the liquid on these short timescales is still a matter of debate. An indirect method to analyze these processes is the comparison of different voltage polarities applied to the electrode. Different possible processes such as gas bubble or nanopore formation, field effects and the presence of a super critical fluid are evaluated and compared with optical emission spectra and ICCD imaging. A 10 ns long voltage pulse with amplitudes of ±20 kV is applied to a 50 μm thin tungsten wire inside distilled water. The emission intensity, electron density and number of H emitters are similar for both polarities except in the first few ns. This indicates different electron generation mechanisms for different polarities at discharge breakdown. Based on these data, we postulate the ignition and propagation processes to result from electron generation from field effects inside a super critical fluid surrounding the electrode tip.

P 9.45 Tue 16:00 P

Hydrogen production in an atmospheric pressure argon methane microwave plasma — •Simon Kreuznacht, Marc Böke, and Achim von Keudell — Experimental Physics II, Ruhr University Bochum, Germany

Hydrogen is an important precursor in the chemical industry and may also serve as energy carrier, for energy storage, or as climate friendly fuel in the future. Today, hydrogen is produced mainly via steam reforming of methane, which emits a lot of CO_2. A promising alternative production method is the pyrolysis of methane in a microwave plasma, as it is an oxygen free technology.
Here, we present the analysis of the product gas stream of such a plasma. The plasma is operated at atmospheric pressure in an argon methane mixture (60 slm total flow rate up to 35 % methane admixture). Microwaves (2.45 GHz up to 6 kW) are used to sustain the plasma. The length of the plasma reaches up to 60 cm with a diameter of about 1.2 cm. In the center of the plasma the gas temperature reaches up to 4200 K. The main products are hydrogen (H_2), ethyne (C_2H_2), ethene (C_2H_4) and solid carbon. The methane conversion increases linearly with the specific energy input per methane molecule (SEI). Increasing the methane admixture at constant SEI leads to an increased methane conversion. Up to 73 % methane conversion and up to 87 % selectivity towards hydrogen are achieved.

P 9.46 Tue 16:00 P

2D spatially resolved atomic oxygen densities in a micro cavity plasma array — •David Steuer, Henrik van Impel, Volker Schulz-von der Gathen, Marc Böke, and Judith Golda — Experimental Physics II: Physics of Reactive Plasmas, Ruhr-University Bochum, D-44801 Bochum, Germany

Micro cavity plasma arrays have numerous applications, such as the treatment of volatile organic compounds (VOCs) or the generation of ozone. The key to these applications is the generation of reactive species such as atomic oxygen within the plasma. Typically, atomic oxygen densities can be measured by laser spectroscopic methods. In the case of the micro plasma array, which consists of thousands of cavities, optical access is limited. For this reason, an optical emission spectroscopy (OES) approach, energy resolved actinometry (ERA), is used. 2D resolved measurements can be performed by using an ICCD camera in combination with a tunable bandpass filter. The discharge is operated in helium with an oxygen admixture of 0.1%. The triangular voltage is varied at a frequency of 15 kHz between an amplitude of 400-800V. As the voltage increases, the number of ignited cavities rises. Furthermore, the atomic oxygen density per cavity increases with the power. This work is supported by the DFG via SFB 1316 (project A6).

P 9.47 Tue 16:00 P

3-dimensional density distributions of NO in the effluent of a micro atmospheric pressure plasma jet operated in He/N2/O2 mixture and the influence of surfaces — •Patrick Preissing[1], Ihor Korolov[2], Julian Schulze[2], Volker Schulz-von der Gathen[1], and Marc Böke[1] — [1]Ruhr-Universität Bochum, Experimentalphysik II — [2]Ruhr-Universität Bochum, Allgemeine Elektro- und Plasmatechnik

Plasma jets are known to generate a huge number of different reactive species. In that context Nitric Oxide (NO) is one of the key players, as it triggers many biological processes. In this study absolute ground state densities of NO are measured in the effluent of an RF-driven micro atmospheric pressure plasma jet (μAPPJ), that is operated in a He/N2/O2 mixture, by means of Laser Induced Fluorescence (LIF), with 3d spatial resolution. The densities are measured in two distinct atmospheres. In the first one, the jet is expanding into open air, whereas in the second configuration the jet is expanding into a controlled He/ synthetic air mixture. From the time resolved LIF signals the quenching coefficients for He, air, N2 and O2 are determined, as well as the intrusion of the ambient air into the He gas flow expanding from the jet. Parameter studies, varying different parameters such as plasma power, gas flow and gas mixture have been performed and the influence on the absolute NO densities as well as its distributions are investigated. Eventually the influence of surfaces in the effluent that interact with the reactive species is measured.

P 9.48 Tue 16:00 P

Atomic oxygen distribution in the interaction zone of a micro atmospheric pressure plasma jet and a surface — •Sascha Chur[1], David Steuer[1], Volker Schulz-von der Gathen[1], Marc Böke[1], and Judith Golda[2] — [1]EP2 chair Physics, Ruhr University Bochum, Germany — [2]Plasma Interface Physics, Ruhr University Bochum, Germany

The efficiency of catalysts is strongly dependent on the characteristics of the used catalytic surface. Key features are the morphology and nanostructure of the surfaces and its chemical composition. The combination of reactive species provided by a micro-scaled atmospheric pressure plasma jet, electric fields and energy input by laser irradiation can lead to very effective functionalisation and structuring of surfaces via complex laser-plasma-surface interactions. Here, we investigate the distribution of atomic oxygen (O) along treated substrates by means of two-dimensional two photon absorption laser induced fluorescence spectroscopy (TALIF) utilizing a red enhanced ICCD camera. The measurements were performed in the emerging gas beam of a micro atmospheric pressure plasma jet operated with a He/O admixture in the interaction zone of a metallic (Cu) surface. The O density (~10^16 m^-3) forms a maximum in front of the surface. Furthermore it could be shown that the size of the observed volume by the detector systems influences results like density or lifetime significantly. Supported by DFG within SFB1316 (TP B2)

P 9.49 Tue 16:00 P

Determination of hydrogen peroxide concentration in water treated by a capillary plasma jet — •Steffen Schüttler[1], Emanuel Jess[1], Marc Böke[2], Volker Schulz-von der Gathen[2], and Judith Golda[1] — [1]Plasma Interface Physics, Ruhr-University Bochum, Germany — [2]Experimental Physics II: Physics of Reactive Plasmas, Ruhr-University Bochum, Germany

A novel and promising approach to activate a biocatalyst is by use of an atmospheric pressure plasma jet that produces hydrogen peroxide [1]. Since the biocatalyst requires a well-defined portion of hydrogen peroxide, a plasma is ideally suited as it can be easily switched on and off. In the plasma-driven biocatalysis process, the biocatalyst is placed in a liquid, mainly water, and the plasma jet is in contact with the liquid via its effluent. In this work, a capillary plasma jet is used, which offers a wide range of control parameters and optimization possibilities. The hydrogen peroxide concentration in water was measured by UV absorption spectroscopy. This technique allows an in-situ measurement while the plasma is in operation and the spatial resolution of the hydrogen peroxide concentration can be obtained. Furthermore, a spectrophotometric approach was used. Ammonium metavanadate was added to the treated water. Its reaction with hydrogen peroxide leads to an absorption spectrum at 450 nm. This enables comparable measurements to the UV absorption measurements. This work is supported by the DPG within SFB1316 (Subproject B11).

[1] A. Yayci, T. Dirks, F. Kogelheide, M. Alcalde, F. Hollmann, P. Awakowicz, J. E. Bandow, ChemCatChem 2020, 12, 5893.

P 10: Invited talks III

Time: Wednesday 11:00–12:30 Location: P-H11

Invited Talk P 10.1 Wed 11:00 P-H11

AI in fusion: assisting plasma exhaust modelling by machine-learning techniques — •Sven Wiesen — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, D-52425 Jülich, Germany

Rapid computational design of future fusion power plants is usually compromised by a delicate balance between the required numerical effort, e.g. for running first-principle plasma simulations, and an increased complexity in the physics model for relevant operational tokamak plasma scenarios. State-of-the-art exhaust plasma design codes like SOLPS-ITER demand long convergence times when predicting next-step fusion devices like ITER or DEMO. Existing exhaust model frameworks suffer from uncertainties in the underlying atomic physics databases and incomplete sub-models for turbulent plasma transport.

This contribution reflects on the recent progress that enable AI-based model techniques for training of fast exhaust surrogate models. A conceptual basis for an enhanced model predictor scheme is developed that integrates calibrated machine-learning (ML) models like neural networks for 2D/3D edge plasma transport. This approach defers in parts the computational cost of first-principle simulations into the training phase of a surrogate edge plasma model. It is demonstrated how non-linear ML methods help to enhance transport models for the critical region between plasma core and edge taking experimental data as ground-truth. AI-based interpolators and generators are exploited for uncertainty quantification and ML regression analysis illustrate model discovery also for plasma-material interaction physics.

Invited Talk P 10.2 Wed 11:30 P-H11

COMPACT - A new complex plasma facility for the ISS — •Christina A. Knapek — Institute of Physics, University Greifswald, Greifswald, Germany

Complex plasma is a state of soft matter where micrometer-sized particles are immersed in a weakly ionized gas. The particles acquire negative charges of the order of several thousand elementary charges in the plasma, and they can form gaseous, liquid and crystalline states. Direct optical observation of individual particles allows to study their dynamics on the kinetic level even in large many-particle systems. Gravity restricts the research on ground to vertically compressed, inhomogeneous clouds, or two-dimensional systems. A microgravity environment, e.g. the International Space Station (ISS), is therefore essential to study large and homogeneous 3D many-particle systems. The complex plasma facility COMPACT to be operated onboard the ISS builds upon previous studies and hardware developments (PlasmaLab, Ekoplasma) and is envisaged as an international multi-purpose and multi-user facility that gives access to the full three-dimensional kinetic properties of the particles. The heart of COMPACT will be a novel plasma chamber: the Zyflex chamber. It includes a variety of innovations that allow to tune, control and manipulate plasma-particle and particle-particle interaction in various ways. We will present the overall design and research goals of COMPACT, with special focus on the characteristics of the new plasma chamber, supported by plasma simulations and results of experiments performed on ground and during parabolic flights.

Invited Talk P 10.3 Wed 12:00 P-H11

Optical diagnostics of vacuum arc discharges for switching applications — •Sergey Gortschakow[1], Ralf Methling[1], Steffen Franke[1], Diego Gonzalez[1], Dirk Uhrlandt[1], Sergey Popov[2], and Alexander Batrakov[2] — [1]Leibniz institute for plasma science and technology, Greifswald, Germany — [2]Institute of high-current electronics, Tomsk, Russia

Optical diagnostics offers numerous methods for characterization of arc plasmas. The contribution presents selected methods used for determination of arc plasma temperature, anode surface temperature and densities of plasma species during the current pulse and after it termination. The vacuum arcs have been investigated under typical switching conditions - ignition by CuCr contact separation during the AC current flow at several kA magnitude. High-speed cinematography is usually used for observation of arc dynamics and characterization of the anode activity. Optical emission spectroscopy can be applied for determination of dynamics of spectral lines from various species during the active phase, as well as for determination of plasma temperature and electron density. For quantitative characterization of the anode surface temperature, NIR spectroscopy and high-speed camera techniques enhanced by narrow-band filters have been used. Broad band absorption spectroscopy is a suitable techniques for determination of the vapour density close to the current zero crossing and in the early post-arc phase. Advantages and drawbacks of each method along with examples of their application will be presented and discussed.

P 11: Codes and Modelling

Time: Wednesday 14:00–15:30 Location: P-H11

P 11.1 Wed 14:00 P-H11

Modelling of streamer inception in pulsed-driven dielectric barrier discharges at atmospheric pressure — •Aleksandar P. Jovanović, Hans Höft, Detlef Loffhagen, and Markus M. Becker — Leibniz Institute for Plasma Science and Technology (INP), Felix-Hausdorff-Str. 2, 17489 Greifswald, Germany

A pulsed-driven dielectric barrier discharge (DBD) in a symmetric single-filament configuration with hemispherical electrodes is the object of interest of the analysis. The Townsend pre-phase and streamer propagation in Ar and N_2 with an admixture of 0.1 vol.% of O_2 have been investigated by a time-dependent, spatially two-dimensional fluid model. It consists of a set of balance equations for the particle number densities, the electron energy density, and the surface charge density, coupled with Poisson's equation for the determination of electric potential and field. The evolution of the spatial profiles of the electron number density and the electric field showed earlier streamer inception in Ar in comparison to the N_2-O_2 mixture, while qualitatively similar behaviour of the discharge during the streamer propagation was observed in both gases. The streamer propagation and consequently the current rise was slower in Ar (reaching a maximum streamer velocity of 0.43 mm/ns) compared to N_2-O_2 (1.23 mm/ns). An analysis of the electron particle and energy budget was performed to find out how the different gain and loss processes in these two gases affect the pre-phase and the streamer propagation.

Funded by the Deutsche Forschungsgemeinschaft (DFG) – project numbers 407462159 and 408777255.

P 11.2 Wed 14:15 P-H11

Implementation and Validation of Guiding Centre Approximation into ERO2.0 — •Sebastian Rode[1], Juri Romazanov[1], Dirk Reiser[1], Sebastijan Brezinsek[1], Christian Linsmeier[1], and Alexander Pukhov[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung -

Plasmaphysik, Partner of the Trilateral Euregio Cluster(TEC), 52425 Jülich, Germany — [2]Institut für Theoretische Physik I, Heinrich-Heine-Universität Düsseldorf, Germany

The Monte-Carlo code ERO2.0 uses full orbit resolution to follow impurity particles throughout the plasma volume to determine the local erosion and deposition fluxes on the plasma-facing components of fusion devices. For this work, the theory of guiding centre approximation (GCA) was implemented into ERO2.0, enabling direct comparisons to other transport codes and accelerating the code. First, the implementation of GCA theory into the code is described in detail. Additionally, a hybrid simulation mode for ERO2.0 was developed, in which the advantages of both full orbit resolution and guiding centre approximation are used. The GCA implementation was tested in an inner-code benchmarking, using a plasma background corresponding to a deuterium limiter plasma used in JET pulse #80319. Analysing a multitude of output metrics of the code and comparing them between pure full orbit simulations and hybrid simulations, the quality of the GCA implementation was confirmed while a significant code speed up was measured in large scale simulations.

P 11.3 Wed 14:30 P-H11

Simulation results of a plasma lens as a capturing device for the ILC positron source — •Manuel Formela[1], Niclas Hamann[1], Gudrid Moortgat-Pick[1], Klaus Floettmann[2], and Gregor Loisch[2] — [1]Universität Hamburg — [2]DESY

The ILC is an ambitious international collaboration with its positron source especially being at the forefront of pushing technological boundaries. Part of this enterprise has to be the optical matching device responsible for capturing positrons exiting a target and transforming them from a highly divergent beam with a small effective cross-section to a wide, parallel beam to be appropriate for the succeeding accelerator section. For many years this problem has been approached by different types of sophisticated coils. Today considerations exist to utilize an electric current-carrying plasma. This so called plasma lens creates a magnetic field, which is potentially especially qualified for the usage as a so called optical matching device due to its pronounced azimuthal component in contrast to the radial component of conventional devices. Simulations of various tapered plasma lens designs have been conducted to find an optimal device for the ILC positron source. Designs with linear and quadratic tapering, but also with tapering growing with the square root have been examined. Furthermore, the parameter space for the optimization included a wide range of values for entrance and exit radius, length and electric current.

P 11.4 Wed 14:45 P-H11

Surrogate Modeling of Ion Acceleration in the Near-Critical Density Regime with Invertible Neural Networks — •Thomas Miethlinger[1,2], Marco Garten[1,2], Ilja Gothel[1,2], Nico Hoffmann[1], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, 01328 Dresden, Deutschland — [2]Technische Universitat Dresden, 01069 Dresden, Germany

The interaction of near-critical plasmas with ultra-intense laser pulses presents a promising approach to enable the development of very compact sources for high-energetic ions. However, current records for maximum proton energies are still below the required values for many applications, and challenges such as stability and spectral control remain unsolved to this day. In particular, significant effort per experiment and a high-dimensional design space renders naive sampling approaches ineffective. Furthermore, due to the strong nonlinearities of the underlying laser-plasma physics, synthetic observations by means of particle-in-cell (PIC) simulations are computationally very costly, and the maximum distance between two sampling points is strongly limited as well. Consequently, in order to build useful surrogate models for future data generation and experimental understanding and control, a combination of highly optimized simulation codes (we employ PIConGPU), powerful data-based methods, such as artificial neural networks, and modern sampling approaches are essential. Specifically, we employ invertible neural networks for bidirectional learning of parameter and observables, and autoencoder to reduce intermediate field data to a lower-dimensional latent representation.

P 11.5 Wed 15:00 P-H11

Application of surrogate models for tokamak edge plasma simulations — •Stefan Dasbach and Sven Wiesen — Forschungszentrum Jülich GmbH, Institut für Energie-und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany

The effect of operational parameters on the exhaust in a tokamak can be adequately simulated by plasma edge codes like SOLPS-ITER. These simulations suffer from two main limitations: a) due to their complexity these transport codes suffer from long convergence times, and b) each simulation yields only a result for a single tokamak scenario with fixed parameters. However for rapid design studies of future fusion power plants systems codes require fast simplified models for the exhaust in many different scenarios (machine size, field, heating, etc.). Promising candidates for such surrogate models are machine learning models trained on simulation data. The development of such surrogate models is however limited by the high computational requirements for creating a sufficient training database. This work discusses several different pathways of how this limitation might be overcome and shows first steps in their implementation. The approaches shown include the generation of a simulation database based on less numerically demanding fluid neutral simulations and first trials on a surrogate model only replacing the numerically more demanding kinetic neutral part of SOLPS-ITER.

P 11.6 Wed 15:15 P-H11

Atomic Physics for Transient Relativistic Plasmas — •Brian Edward Marre[1,2], Sergei Bastrakov[1], Axel Huebl[3], Marco Garten[1,2], Pawel Ordyna[1,2], Rene Widera[1], Michael Bussmann[4], Ulrich Schramm[1], and Thomas Kluge[1] — [1]Helmholtz Zentrum Dresden-Rossendorf — [2]TU Dresden — [3]Lawrence Berkley National Laboratory — [4]Center for Advanced Systems Understanding

Experiments for laser-driven ion acceleration create extreme states of matter, in particular relativistic solid-density plasmas undergoing transient, non-equilibrium physics. Especially the formation of such plasmas is heavily influenced by collisional and radiative effects. However, state-of-the-art simulations do not model transitions to and from excited atomic states self consistently. As these transitions are now becoming experimentally accessible on fs-nm scales, e.g. at HIBEF at the European XFEL, modelling can be improved by including excited states dynamics in simulations.

We are developing such an extension for the Particle-In-Cell(PIC) simulation code PIConGPU, to model atomic state distributions self consistently in transient plasmas. This extension is based on a reduced atomic state model directly coupled to the existing PIC-simulation, for which the atomic rate equation is solved explicitly in time.

Via the prediction of atomic state populations, this will allow us to predict plasma self-emission and XFEL probing, and improve our understanding of isochoric heating processes and plasma expansion.

P 12: Magnetic Confinement / Plasma Wall Interaction I

Time: Wednesday 14:00–15:30 Location: P-H12

P 12.1 Wed 14:00 P-H12

Experimental observation and modelling of heat loads in W7-X and implications for transport — •David Bold, Felix Reimold, Holger Niemann, Yu Gau, Marcin Jakubowski, Carsten Killer, and the W7-X team — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Modelling the scrape-off layer of a stellarator is challenging due to the complex magnetic 3D geometry. The here presented study analyses simulations of the scrape-off layer (SOL) of the stellarator Wendelstein 7-X (W7-X) using the EMC3-EIRENE code. Comparing with experimental observations, the transport model is validated.

Based on the experimentally observed strike line width, the anomalous transport coefficients, used as input to the code are determined to around $0.2\,m^2/s$. This is however in disagreement with upstream measurements, where such small cross-field transport leads to temperatures higher than measured experimentally. Agreement can be improved by using spatially varying transport coefficients.

Even with spatially varying transport coefficients, differences remain, for example the toroidal heat flux distribution or the hollow temperature profile is not reproduced. Some of the differences could be explained by drifts. The future implementation of drifts into the transport model is expected to help overcome the discrepancies, and thus the development of SOL transport models including drifts is a necessary next step to study the SOL transport of the W7-X stellarator.

P 12.2 Wed 14:15 P-H12

Scaling Behavior of the Weakly Coherent Mode in ASDEX Upgrade I-mode Plasmas — •Manuel Herschel[1,2], Tim Happel[1], Joey Kalis[1,3], Gregor Birkenmeier[1,3], Michael Griener[1], Klara Höfler[1,3], and The ASDEX Upgrade Team[1] — [1]MPI für Plasmaphysik, Garching, Germany — [2]Universität Ulm, Germany — [3]Physik Department E28, TUM, Garching, Germany

Improved confinement regimes are fundamental in the operation of current and future fusion devices. Among these regimes, the I-mode combines the beneficial properties of an H-mode like energy confinement with the absence of ELMs. The physical origin of the I-mode is still not fully understood, but the so-called weakly coherent mode (WCM) dominant in the turbulence spectrum at the plasma edge is often considered to be a key player for I-mode.

To investigate the WCM in detail, turbulence measurements from multiple diagnostics (Doppler reflectometry, thermal helium beam emission spectroscopy) on ASDEX Upgrade are combined in order to characterize the mode better. These measurements include the radial localization, frequency and wavenumber of the WCM, along with important local plasma parameters such as the magnetic field strength, density and temperature.

To ensure statistical significance and enable comparisons over multiple discharges, these measurements are collected in a database consisting of various I-mode plasmas. With this database, the scaling of parameters of the WCM depending on typical plasma variables is examined and compared with proposed theories.

P 12.3 Wed 14:30 P-H12

Post mortem ion beam analysis of the 13C tracer experiment at Wendelstein 7-X — •Christoph Kawan[1], Sebastijan Brezinsek[1], Timo Dittmar[1], Sören Möller[1], and W7-X Team[2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Germany — [2]Max-Planck-Institut für Plasmaphysik, D-17491 Greifswald, Germany

Future fusion reactors will operate under extreme thermal conditions. A key challenge for preserving a safe operation and low maintenance is the mitigation of erosion, transport and deposition of wall material and impurities. To analyze the deposition and transport of impurities, two dedicated experiments were carried out at the end of Wendelstein 7-X campaign 1.2b. $1.1*10^{21}$ molecules $^{13}CH_4$ were injected in standard magnetic divertor configuration through a dedicated gas puff head attached to the multi purpose manipulator directly into the plasma island structures. In the second part, $4.2*10^{22}$ molecules of $^{13}CH_4$ have been injected from a divertor gas injection system at a position where the magnetic island intersects with the horizontal target plate. After the experiment, the wall components were changed and parts of the test divertor unit (TDU) target elements cut for post-mortem analysis. In this work, the deposition of ^{13}C in different locations of W7-X via 1 MeV deuteron ion beam analysis is reported.

P 12.4 Wed 14:45 P-H12

Double-pulse laser ablation molecular isotopic spectroscopy with picosecond laser pulses: Swan band analyses for ^{13}C-^{12}C distinction in graphite — •Erik Wüst, Jannis Oelmann, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Germany

Laser-based methods for spatially and depth resolved measurements of material composition are well-established. Laser ablation molecular isotopic spectroscopy or spectrometry (LAMIS) is a technique for the determination of isotope concentrations in material mixtures. A laser-induced plasma on the material's surface is used to derive the material isotope composition by optical emission spectroscopy (OES). In double-pulse LAMIS (DP-LAMIS) a second laser pulse is focussed into the laser-induced plasma to enhance the plasma's emission and thus improve the limit of detection for isotopes with smaller concentrations. Laser pulses from a Nd:YAG-laser with 35 ps pulse duration were used to induce the plasma and a second laser pulse from the same laser was used to enhance the plasma's emission. Both laser pulses arrive at the sample with a relative delay of 50 ns. A Littrow spectrometer (focal length: f=750 mm, spectral resolution at 473 nm: A=6000, étendue: E=62 $\frac{\mu\,m^2}{sr}$) was used to analyse the band structure. The analysed materials were graphite either with only natural amounts of ^{13}C or coated with a ^{13}C rich layer. The isotopic composition was determined with the aid of the C_2 molecule's Swan band with Δv=1 at 473.7 nm.

P 12.5 Wed 15:00 P-H12

Investigation of hydrogen retention in beryllium and beryllium-tungsten alloys — •Meike Flebbe, Timo Dittmar, and Christian Linsmeier — FZJ, Jülich, Germany

ITER will use beryllium (Be) as first wall material and tungsten (W) as divertor material. Alloys can form due to erosion of beryllium and tungsten particles and their redeposition elsewhere. In the course of the plasma-wall interaction, tritium from the plasma can be deposited in the plasma facing material. For safety and for tritium breeding and economy considerations, the understanding of hydrogen retention in Be-W-alloys is of central importance for the fusion research in order to be able to realize a fusion reactor.

Fundamental experiments are required to understand the processes involved in hydrogen retention in Be-W-alloys. These can be executed with the help of in-situ ion beam experiments. A suitable system for this is ARTOSS, a high vacuum device from the FZJ, in which Be-W-alloys can be produced, loaded with deuterium and examined using analysis diagnostics like thermal desorption spectroscopy (TDS) and ion beam analysis (IBA). Recent studies have shown a low temperature desorption peak at around 400 K for beryllium, which shows a splitting into a fine structure from a threshold fluence of $1 \cdot 10^{21}$ m^{-2} with a sufficiently high resolution. The mechanism behind this split is still unknown. To test whether hydrides are the reason for the fine structure, ramp-and-hold TDS experiments are used.

In this contribution, I will show ramp-and-hold experiments with beryllium and will give an outlook on Be-W experiments.

P 12.6 Wed 15:15 P-H12

Application of a spatially resolved emission model to sputtered tungsten atoms at the linear plasma device PSI-2 — •Marc Sackers, Oleksandr Marchuk, Stephan Ertmer, Philippe Mertens, Arkadi Kreter, and Sebastijan Brezinsek — Forschungszentrum Jülich GmbH - Institut für Energie- und Klimaforschung - Plasmaphysik, Partner of the Trilateral Euregio Cluster (TEC), 52425 Jülich, Deutschland

Highly charged atomic species in the core of a fusion plasma are detrimental to the successful operation of the reactor because they lead to significant cooling of the plasma due to radiation losses. For example, at ITER, the divertor will consist of tungsten blocks [1]. The main erosion channel of these blocks is physical sputtering, which needs to be understood at a fundamental level to estimate tungsten concentration in the plasma core for different operating scenarios.

In this work, the PSI-2 plasma-surface interaction test-bed provides divertor-like conditions. Its plasma source is an arc discharge between a hollow ring-shaped cathode and anode. This geometry allows the acquisition of high-resolution emission spectra ($\lambda/\Delta\lambda \approx 7 \cdot 10^5$) for lines of sight parallel and perpendicular to the surface normal of a target exposed to the plasma. A spatially resolved emission model was fitted to spectra of the 498.26 nm neutral tungsten line obtained during sputtering of mono- and polycrystalline tungsten targets. The angular and energy distribution were derived for bombardment with argon ions from 40 eV to 160 eV.

[1] R.A. Pitts *et al.*, J. Nucl. Mater. 2011, **415**, S957-S964

P 13: Dusty Plasmas

Time: Wednesday 16:00–17:15 Location: P-H11

P 13.1 Wed 16:00 P-H11

The sticking machine: measuring electron sticking coefficients using dusty plasmas — •Armin Mengel and Franko Greiner — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

In many plasma-surface interactions, the electron sticking coefficient is, due to lack of better knowledge, assumed to be 1. However, recent quantum-mechanical calculations[1] hint at significantly smaller values for dielectric surfaces. The goal of the presented project is to experimentally determine the particle charge and thus (via a relative measurement scheme) the low-energy electron sticking coefficient. In order to achieve this, a new approach using microparticles of the material of interest confined in the sheath of a radiofrequency plasma is introduced, employing long-distance microscopy and an improved phase resolved resonance method.

[1] F.X.Bronold et al., Plasma Phys. Cont. Fusion **59** (2017) 014011, https://iopscience.iop.org/article/10.1088/0741-3335/59/1/014011

P 13.2 Wed 16:15 P-H11

Studying the feasibility to observe turbulence in fluid complex plasmas — •Prapti Bajaj[1], Alexei Ivlev[2], Christoph Räth[1], and Mierk Schwabe[1] — [1]Institut für Materialphysik im Weltraum, Deutsches Zentrum für Luft- und Raumfahrt (DLR) — [2]Max-Planck-Institut für Extraterrestrische Physik

Turbulence is a phenomenon observed in a dissipative system far away from thermodynamic equilibrium with many degrees of freedom and it has been studied in fields varying from microscopic to macroscopic scales[1]. In this work, we study the feasibility to observe turbulence in fluid complex plasmas, i.e., a system of micrometer-sized particles embedded in a low-temperature plasma. We performed an experiment in the ground-based setup of PK-3 Plus, where microparticles were injected in a capacitively coupled RF-plasma chamber and a laser illuminated a vertical cross-section of the microparticle cloud. Below a critical pressure, we observed self-excited Dust Acoustic Waves, which we then used to study the properties of turbulence in our system. These waves are generated due to the ion-streaming instability, i.e., motion of ions past the microparticles. Using high-speed imaging, we were able to track individual microparticles to perform a robust spatial and temporal analysis. We use novel analytical tools to study the energy spectrum in the space and time domains. Our aim is to study the spectrum of short-scale disturbances generated due to the cascade of different wave modes[1], and their isotropisation, even in the presence of a background friction force, as in the case of complex plasmas.

[1] "Wave Turbulence" by S. Nazarenko, Springer(2011).

P 13.3 Wed 16:30 P-H11

Decoupling of dust cloud and embedding plasma for high electron depletion in nanodusty plasmas — •Andreas Petersen, Oguz Han Asnaz, Benjamin Tadsen, and Franko Greiner — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

Understanding how dust particles can grow in a reactive plasma discharge and change its behavior, is an interesting topic, since nanoparticles (nps) have become key technological products, e.g. as coatings with tunable optical gap in third generation solar cells, as nanocrystals for photonic applications, and as pharmaceutical nanocarriers.

We have been able, to characterize an argon discharge with embedded amorphous hydrocarbon nps of different size and density, using self excited dust density waves (DDW) as a diagnostic tool.

Our results show, that the comparably high dust density (high Havnes parameter) leads to electron depletion and governs the charge of dust grains, while the size of the particles has only a weak influence on their charge. The ion density and electric potential profile are almost independent of both, dust size as well as dust density. This suggests, that the ion generation and the dust cloud coexist and the coupling of both is weak.

P 13.4 Wed 16:45 P-H11

Stereoscopic Investigation of Particle Chains in Dusty Plasmas — •Daniel Maier, Michael Himpel, Stefan Schütt, and André Melzer — Institut für Physik der Universität Greifswald, Greifswald, Deutschland

In dusty plasmas under microgravity conditions stable chains of charged dust particles can be observed. These chains are stabilized by an outward ion stream and appear near the mid-plane and around the particle free zone (void) of the plasma. So far only 2-dimensional investigations of these chains have been done, with difficulties in proofing the authenticity of a chain, observing it at full length or separating chains from each other. The use of our experimental set-up, with four high-speed cameras allows stereoscopic, 3-dimensional observation and investigation of chains and the interaction of the included particles with high temporal resolution. Here first results of these investigations will be shown.

P 13.5 Wed 17:00 P-H11

Artificial voids in nanodusty plasmas — Ulrike Küst and •Franko Greiner — Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel

Artificial voids are an interesting and frequently studied phenomenon in dusty plasmas [E. Thomas POP 2004, M. Klindworth RSE 2007, O. Arp PRE 2011, M. Schwabe NJP 2017]. Voids are created by projectiles shot into the dust cloud or by electrostatic probes. We investigated artificial voids created in nanodusty plasmas at high electron depletion. By variation of the probe voltage, the size of the void can be varied. The voids are not stable at probe potentials near the local plasma potential. Instead, the whole cloud is destabilized and strong dust streaming is observed. We present a simple force balance that explains the linear increase of the void radius for probe bias variation in the dust repelling regime (negative probe voltage in reference to the plasma potential). The ability to use this force model to estimate the plasma potential and the consequences for credible Langmuir probe measurements in nanodusty plasmas are discussed (see video https://youtu.be/Nmz2nR8uTrE or search the internet for "nanodustcloud").

P 14: Plasma Wall Interaction II / HEPP III

Time: Wednesday 16:00–17:10 Location: P-H12

P 14.1 Wed 16:00 P-H12

Surface Segregation of Cr in the WCrY SMART Alloy — •Pawel Bittner[1], Hans Rudolf Koslowski[1], Andrey Litnovsky[1,2], and Christian Linsmeier[1] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung, 52425 Jülich, Germany — [2]Institute of Laser and Plasma Technologies, National Research Nuclear University MEPhI, 115409 Moscow, Russia

Self-passivating Metal Alloys with Reduced Thermo-oxidation (SMART) are promising candidates for the first wall of the DEMOnstration power plant (DEMO). These materials aim at having an increased oxidation resistance during accidental conditions and acceptable plasma performance during regular operation of the power plant. In this work, the effects of surface segregation, diffusion and sputter erosion on the Cr concentration of a tungsten-chromium-yttrium SMART alloy (WCrY) with a composition of 68 at% of W, 31 at% of Cr and 1 at% of Y are studied with low energy ion scattering (LEIS) measurements and numerical calculations.

A three-parameter phenomenological model to describe the time and temperature dependent surface concentration of Cr is proposed. Further, temporally resolved ion scattering measurements during thermal annealing between 800 K and 1100 K were conducted. The parameters of the model were changed in consecutive numerical calculations to fit these measurements best. The calibrated model is applied to conditions in which the samples were sputtered during annealing and the similarities and differences between theoretical prediction and experimental results are discussed.

P 14.2 Wed 16:15 P-H12

Secondary electron emission from metals at low impact energies — •Franz Xaver Bronold and Holger Fehske — Institut für Physik, Universität Greifswald, 17489 Greifswald, Germany

The interaction of electrons with the walls of discharges is an important surface process in low-temperature plasmas. It affects, for instance, the operation modii of barrier discharges, Hall thrusters, and divertor plasmas in fusion devices. Little is known quantitatively about the process because it typically occurs at energies below 50 eV which are hard to access experimentally. There are thus only a few attempts to measure secondary emission yields in this energy range. A few years ago, we presented therefore an approach, based on an embedding principle, for calculating the complement of the emission yield, the absorption probability, from a microscopic model and applied it to dielectric walls at impact energies below the band gap, where backscattering due to electron-electron collisions is absent. We now generalized the approach to account for it. In addition, we developed a scheme to solve numerically the full nonlinear embedding equation (not only its linearized version), and included–depending on the crystallinity of the surface–Bragg gaps due to coherent scattering on the crystal planes parallel to the interface or incoherent scattering on the ion cores of the bulk. Applying this approach to metal surfaces, we find for impact energies up to 20 eV good agreement with measured emission yields. Depending on the metal and surface quality, the yields are around 10-30 %. Hence, even metal surfaces turn out to be not perfect absorber for electrons.

P 14.3 Wed 16:30 P-H12

Surface charge diagnostics by infrared multiple internal reflection spectroscopy — Kristopher Rasek, •Franz Xaver Bronold, and Holger Fehske — Institut für Physik, Universität Greifswald, 17489 Greifswald, Germany

We propose to measure the surface (wall) charge accumulating at a floating plasma-dielectric interface via infrared multiple internal reflection spectroscopy [1]. The negative charge deposited into the plasma-facing dielectric, forming the negative part of an electric double layer (the positive part being the plasma sheath), leads to a change of the reflection coefficient, when the interface is subjected to infrared radiation. Based on the Boltzmann equations for the charge kinetics of the double layer and nonlocal surface response functions to calculate the reflection coefficient in the presence of the charge inhomogeneity at the plasma-solid interface, we show theoretically and numerically that a local, Drude-like expression is in fact sufficient to describe the optical response. It contains only the integrated surface charge, enabling thus a straightforward analysis of measured data. To amplify the charge-induced change in the reflectivity, we suggest an experimental setup utilizing the plasma-solid interface as a multiple internal reflection element. Numerical results indicate that in such a setup the magnitude of the wall charge can directly be determined from the change it causes in the transmitivity of the optical element. [1] K. Rasek, F.X. Bronold, and H. Fehske, Phys. Rev. E 104, 015204 (2021)

P 14.4 Wed 16:45 P-H12

Effects of thin surface oxide films on deuterium uptake and release from ion-damaged tungsten — •Kristof Kremer, Maximilian Brucker, Thomas Schwarz-Selinger, and Wolfgang Jacob — MPI for Plasma Physics, Garching, Germany

In a fusion reactor, the uptake of deuterium (D) and tritium fuel into the plasma-facing tungsten (W) components is a critical issue with respect to fuel loss and radioactive inventory. However, the possible influence of natural surface oxides on the D uptake in W is not fully understood yet.

Therefore, we investigated the D uptake into W through 33 to 55 nm thick oxide films in dependence of D fluence, D ion energy and sample temperature. To trace the D, we created a 2 micron thick layer of self-ion-damaged W underneath the oxide. It acts as a getter layer and traps any D that permeates the oxide film. We measured the depth-resolved concentration of D and oxygen with ion beam analysis and the surface modifications of the oxide film with scanning electron microscopy. To study D release through the oxide we filled the self-damaged layer with D prior to oxidation and measured the D release with thermal desorption spectroscopy.

We observed a strong influence of surface oxide films on D uptake and release. Uptake: The oxide films block D uptake into metallic W. We explain this by the different heat of solution of D in W oxide and metallic W. At high ion energies, however, D partly reduces the oxide film and enters the metallic W. Release: The oxide film delays the D release until it is chemically reduced under formation of heavy water.

P 15: Annual General Meeting

Time: Wednesday 17:30–18:30 Location: P-MV

P 16: Invited talks IV

Time: Thursday 11:00–12:30 Location: P-H11

Invited Talk P 16.1 Thu 11:00 P-H11
Effect of the green energy revolution on circuit breakers and switches in electrical power distribution systems — •Erik D. Taylor — Siemens AG, Berlin, Germany
Green energy and the general energy revolution are widely discussed as key components in reducing the magnitude of climate change. Most discussions focus on converting to electrical power produced from green sources. However, an important piece of this puzzle is the electrical distribution and transmission systems required to enable this transformation. Green energy and the increased use of electrical power creates new demands on the circuit breakers and switches in electrical distribution systems. The first part of this talk will describe why you need circuit breakers and switches on electrical distribution systems, and what they do. The second part will look at what requirements and applications have changed for these circuit breakers. This includes new requirements from increased usage and the replacement of SF6-based circuit breakers, new conditions created by green energy sources, and the switching of DC currents. The final part will look at how these problems are being solved using vacuum interrupters and vacuum switchgear and look at the plasma physics problems involved with their use.

Invited Talk P 16.2 Thu 11:30 P-H11
Plasma-beta effects on the island divertor of Wendelstein 7-X — •Alexander Knieps[1], Yasuhiro Suzuki[2], Joachim Geiger[3], Andreas Dinklage[3], Song Zhou[1,4], Henning Thomsen[3], Marcin Jakubowski[3], Ralf König[3], Michael Endler[3], Yu Gao[3], and Yunfeng Liang[1,4] — [1]Forschungzentrum Jülich, Jülich — [2]Graduate School of Advanced Science and Engineering, Hiroshima University, Higashi-Hiroshima, Japa — [3]Max-Planck-Institut für Plasmaphysik, Greifswald — [4]Huazhong University of Science and Technology, Wuhan, China
The Wendelstein 7-X Stellarator relies on an island divertor to control its heat- and particle-exhaust. In this divertor concept, the scrape-off layer is formed by a magnetic island chain between the divertor plates and the main plasma.

It is important to conserve the divertor topology in the up- coming steady-state experimental campaign. However, the magneto-hydrodynamic plasma response driven in finite-beta plasmas can substantially effect the magnetic topology in the plasma edge. Depending on the configuration, the plasma response have distinctly different effects.

This presentation will showcase finite-beta MHD equilibrium simulations for finite-beta plasmas in different magnetic configurations of W7-X, calculated with the 3D MHD equilibrium code HINT. Based on these simulations, we then extrapolate the heat-loads on plasma-facing components using an anisotropic diffusion model.

Invited Talk P 16.3 Thu 12:00 P-H11
Surface modification of inorganic materials by atmospheric-pressure plasmas — •Claus-Peter Klages and Vitaly Raev — Institute for Surface Technology, Technische Universität Braunschweig, Braunschweig, Germany
As far as applications in surface technology are concerned, atmospheric-pressure plasmas such as dielectric barrier discharges (DBDs) are frequently associated with polymeric surfaces and plasma polymer deposition. In the present contribution it will be demonstrated, however, that DBDs can also be applied to achieve practically useful modifications of inorganic surfaces utilizing processes which are also of scientific interest.

Examples are the reduction of metal compounds like oxides or sulfides as well as the oxidation of metals, hydrolysis of siloxane bonds on silica surfaces, and the pretreatment of silicon surfaces for low-temperature direct wafer bonding. The focus of the lecture is on recent studies on a "dry" silanization process for the preparation of quartz fibers for applications as optical sensors and on low-temperature oxidation of aluminum using DBDs in argon-water and argon-oxygen mixtures, respectively.

P 17: Astrophysical Plasmas

Time: Thursday 14:00–15:15 Location: P-H11

P 17.1 Thu 14:00 P-H11
Electron acceleration at supernova remnants — •Artem Bohdan — Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany
Supernova remnants (SNRs) are believed to produce the most part of the galactic cosmic rays (CRs). SNRs harbor non-relativistic collisionless shocks responsible for acceleration of CRs via diffusive shock acceleration (DSA), in which particles gain their energies in repetitive interactions with the shock front. As the DSA theory involves pre-existing mildly energetic particles, a means of pre-acceleration is required, especially for electrons. Electron injection remains one of the most troublesome and still unresolved issues and our physical understanding of it is essential to fully comprehend the physics of SNRs. To study any electron-scale phenomena responsible for pre-acceleration, we require a method capable of resolving these small kinetic scales and Particle-in-cell (PIC) simulations fulfill this criterion. Here I report about the latest achievements on kinetic simulations of non-relativistic high Mach number shocks. I discuss how the physics of SNR shocks depends on the shock parameters (e.g., the shock obliquity, Mach numbers, the ion-to-electron mass ratio), which processes are responsible for the electron pre-acceleration and how these shocks can be studied using in-situ satellite measurements. Finally, I outline future perspectives of the electron injection problem and other complementary ways to solve it.

P 17.2 Thu 14:15 P-H11
Suppression of the TeV pair-beam plasma instability by a weak intergalactic magnetic field — •Mahmoud Alawashra[1] and Martin Pohl[1,2] — [1]Institute for Physics and Astronomy, University of Potsdam, D-14476 Potsdam, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany
We constrain the intermediate-scale intergalactic magnetic field (IGMF) through its suppression of the electrostatic instability for blazar-induced pair beams. IGMF of femto-Gauss strength are sufficient to significantly deflect the TeV pair beams, which reduces the flux of secondary cascade emission below the observational limits. A similar flux reduction may result from the electrostatic beam-plasma instability, which operates the best at zero IGMF. We study the effect of sub-fG level IGMF on the electrostatic instability of the blazar-induced pair beam. Considering IGMF with correlation lengths smaller than a few kpc, we find that such fields increase the transverse momentum of the pair beam particles, which dramatically reduces the linear growth rate of the electrostatic instability and hence the energy-loss rate of the pair beam. Our results show that the IGMF eliminates the beam-plasma instability as an effective energy-loss agent at a field strength three orders of magnitude below that needed to suppress the secondary cascade emission by magnetic deflection. For intermediate-strength IGMF, we do not know a viable process to explain the observed absence of GeV-scale cascade emission.

P 17.3 Thu 14:30 P-H11
Analysis of Ball Lightning observations aiming at an experimental verification — •Herbert Boerner — Mainz
Ball Lightning (BL) is still an unexplained phenomenon of atmospheric physics. There is no accepted theory explaining it, and there are no experiments that produce such objects in a laboratory. The only evidence available is through reports by accidental observers. In order to make progress in selecting theories that are consistent with the observations and in defining suitable experiments, it is important to select from the thousands of anecdotal reports those that are both reliable and that contain information on the physics involved. With this in mind, the following reports and properties will be considered: properties of BL objects that

have been recorded consistently over many years, single, very well documented events, and individual reports by reliable observers. The first result is that Bl objects cannot be based on matter, they have to be a form of electromagnetic radiation. This conclusion is motivated by the fact that they can pass through dielectric objects like glass panes, and that they can move with velocities higher than the speed of sound. There are indications, that positive cloud-ground lightning (+CG) has a much higher probability to create these objects that negative CG lightning. Together with the fact that BL objects can be produced far away from lightning channels, this allows a rather good definition of the conditions under which such objects can be created. The importance of some properties of negative corona in air, mainly of Trichel pulses, and the role of free electrons is highlighted and an experimental setup is proposed.

P 17.4 Thu 14:45 P-H11

PIC simulations of SNR's shock waves with a turbulent upstream medium — •Karol Fułat[1], Martin Pohl[1,2], Artem Bohdan[2], and Paul Morris[2] — [1]Insitute of Physics and Astronomy, University of Potsdam, 14476 Potsdam, Germany — [2]DESY, 15738 Zeuthen, Germany

Investigation of astrophysical shocks has a major importance in understanding physics of the cosmic rays acceleration. Electrons to be accelerated at shocks must have an injection energy, which implies that they should undergo some preacceleration mechanism. Many numerical studies examined possible injection mechanisms, however most of them considered homogenous upstream medium, which is unreal assumption for astrophysical environments. We will to investigate electron acceleration at high Mach number and low plasma beta shocks using 2D3V particle-in-cell simulations with a turbulent upstream medium. Here we discuss the method of the generation of the compression-dominated turbulence and its quasi-seamless insertion into the upstream medium in the shock simulation. The modelled turbulence is sufficiently long-lived, and its parameters represent the high-Mach-number and low-beta regime.

P 17.5 Thu 15:00 P-H11

Pre-acceleration in the Electron Foreshock: Electron Acoustic Waves — •Paul Morris[1], Artem Bohdan[1], Martin Weidl[3], and Martin Pohl[1,2] — [1]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]Institute of Physics and Astronomy, University of Potsdam, D-14476 Potsdam, Germany — [3]Max-Planck-Institut für Plasmaphysik, Boltzmannstr. 2, DE-85748 Garching, Germany

To undergo diffusive shock acceleration, electrons need to be pre-accelerated to increase their energies by several orders of magnitude, else their gyro-radii are smaller than the finite width of the shock. In oblique shocks, electrons can escape to the shock upstream, creating a region called the electron foreshock. To determine the pre-acceleration in this region, we undertake PIC simulations of oblique shocks while varying the obliquity angle. We show that while the proportion of reflected electrons is negligible for $\theta_{Bn} = 74.3^\circ$, it increases to $R \sim 3\%$ for $\theta_{Bn} = 30^\circ$, and that these electrons power electrostatic waves upstream with a wavelength around $2.5\lambda_{\rm se}$, where $\lambda_{\rm se}$ is the electron skin length. While the initial reflection mechanism is a combination of shock surfing acceleration and magnetic mirroring, once the electrostatic waves have been generated upstream they themselves can increase the momenta of upstream electrons parallel to the magnetic field. In $\lesssim 1\%$ of cases, upstream electrons are turned away from the shock and never injected downstream. In contrast, a similar fraction are re-directed back towards the shock after reflection and cross into the downstream.

P 18: Helmholtz Graduate School HEPP IV

Time: Thursday 14:00–15:15 Location: P-H12

P 18.1 Thu 14:00 P-H12

Microstructure and deformation behaviour of drawn W wires — •Maximilian Fuhr[1,2], Nuttawan Ketkao[1,3], Till Höschen[1], Nico Hempel[2], Martin Balden[1], Wolfgang Pantleon[4], Jürgen Almanstötter[5], David Rafaja[3], Johann Riesch[1], and Rudolf Neu[1,2] — [1]Max-Planck-Insitut für Plasmaphysik, Garching, Deutschland — [2]Technische Universität München, Garching, Deutschland — [3]TU Bergakademie Freiberg, Freiberg, Deutschland — [4]Technical University of Denmark, Lyngby, Dänemark — [5]OSRAM GmbH, Schwabmünchen, Deutschland

Tungsten (W) shows a pronounced transition from ductile deformation behaviour at high temperatures to brittle behaviour at low temperatures (ductile-to-brittle transition). Standard, coarse-grained W exhibits transition temperatures T_{DBT} around $300^\circ\ C$, rendering it unsuitable for structural applications below T_{DBT}. The transition is shifted to lower temperatures by cold-working W in wire drawing, rolling or a severe plastic deformation process. Sufficiently cold-worked W materials deform plastically at room temperature and below. The reasons for the shift of T_{DBT} are connected to the deformation-induced microstructural changes. Thus, we performed the first systematic study focusing on the structure-property relations of a series of sequentially drawn potassium-doped W wires. The combination of careful microstructural investigations (electron backscatter diffraction (EBSD), X-ray diffraction (XRD)) and various mechanical tests performed at room and elevated temperatures allow for new insights into the deformation behaviour of drawn W wires.

P 18.2 Thu 14:25 P-H12

Edge Transport and Fuelling Studies via Gas Puff Modulation in ASDEX Upgrade — •Christian U. Schuster[1,2], Elisabeth Wolfrum[1], Emiliano Fable[1], Rainer Fischer[1], Michael Griener[1], Balazs Tal[1], Clemente Angioni[1], Thomas Eich[1], Peter Manz[3], Ulrich Stroth[1,2], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching — [2]Physikdepartment E28, Technische Universität München, Garching — [3]Institut für Physik Universität Greifswald, Greifswald

In a tokamak the edge profiles of temperature and density are crucial for a multitude of aspects such as the L-H transition, the achievable pedestal top pressure, or the achieved fusion power itself. The processes that determine these profiles are transport on one hand and sources on the other. Especially for the density profile these processes are not sufficiently understood to predict profiles for future devices.

To characterize the edge transport in a quantitative way, we modulate the fuelling gas flow to perturb the plasma. We then use the transport code ASTRA as forward model and several diagnostics in an integrated data approach. This allows us to determine various quantities, depending on the available experimental data and the quality thereof. In particular we find particle transport coefficients, fuelling properties, and correlations of transport to other quantities. The transport coefficients are not constant in time: already slight perturbations of the plasma alter them, especially just inside the separatrix. We present results for various plasma scenarios ranging from L-modes to H-modes with and without large ELMs.

P 18.3 Thu 14:50 P-H12

Studies of propagating ICRF slow waves — •Felix Paulus, Volodymyr Bobkov, Helmut Faugel, Helmut Fünfgelder, Oleksii Girka, Roman Ochoukov, Hartmut Zohm, and ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik Garching

Heating a plasma with ion cyclotron range of frequencies (ICRF) waves is an established technique in tokamaks. While the design of ICRF antennas aims to launch one solution of the plasma's dispersion relation (fast wave), the other is an unwanted by-product (slow wave). The slow wave propagates in low-density plasmas only and is usually confined to a small region in the scrape-off layer (SOL) or in the limiter shadow in present-day tokamaks. ICRF systems for future devices as ITER or DEMO will need to cope with a propagating slow wave in front of the antenna since a relatively large clearance is foreseen. Studying the slow wave is important because it modifies the antenna near-field and poses a mechanism for transporting plasma-wall interactions.

An approach to study the ICRF slow wave propagation in the ASDEX Upgrade (AUG) tokamak SOL is demonstrated. RAPLICASOL simulation indicates that in SOL relevant plasmas the slow wave manifests in so-called resonance cones. Experiments on the test stand IShTAR are presented where resonance cones were launched from an RF antenna and detected by probing the oscillation of the plasma potential. Based on these results, experiments on AUG are prepared. Preliminary results from these experiments with the slow wave launched from plasma-facing components of the antenna periphery are shown and compared to simulations.

P 19: Poster II

Time: Thursday 16:00–17:30 Location: P

P 19.1 Thu 16:00 P

Validation of quasilinear transport models in the ASTRA framework — •Michael Bergmann, Rainer Fischer, Pedro Molina Cabrera, Klara Höfler, Frank Jenko, and The ASDEX Upgrade Team — Max-Planck-Institute für Plasmaphysik, Boltzmannstr. 2, 85748 Garching

By combining multiple heating and transport subroutines ASTRA is capable of simulating realistic temperature and density radial profiles of fusion plasmas. While these profiles match experimental data taken from e.g. the Integrated Data Analysis (IDA) code, the simulated gradients often differ from measured ones and are largely dependent on the turbulence subroutine chosen. The interest in correct plasma gradients is particularly high as these give rise to the turbulence which dominates the transport. Using two quasi-linear turbulence solvers (TGLF and Qualikiz) as well as their much faster neural-network versions we shall explore the validity and uncertainty of the models in different discharge scenarios via input-error propagation, as well as comparing the models to high-fidelity codes such as GENE and experimental measurements. This work feeds back into attempts of using ASTRA simulations as a theoretical prior for IDA, where the prior of the simulated profile is needed.

P 19.2 Thu 16:00 P

The Disruptive H-Mode Density Limit and MARFE Behaviour — •Felix Klossek, Anja Gude, Marc Maraschek, Bernhard Sieglin, Matthias Bernert, Hartmut Zohm, and the ASDEX Upgrade Team — Max-Planck-Institut für Plasmaphysik, Garching, Germany

The high confinement mode (H-mode) is an operational regime in tokamaks with suppressed turbulence near the edge, so that particles and energy are confined better. High densities, which are desirable in terms of fusion power, are prone to a density limit: a degradation of confinement and subsequent disruption.

When approaching a density limit disruption, a Multifaceted Asymmetric Radiation From the Edge (MARFE) forms as toroidal ring. It is strongly radiating and is therefore altering the power balance in the plasma and reducing the temperature in its vicinity. During the MARFE evolution, this effect becomes more pronounced. The MARFE starts near the X point, where it is also called X point radiator (XPR). It will subsequently move up on the high field side near the separatrix and stay some time at the top of the plasma, before approaching the low field side, entering the core and triggering MHD instabilities which finally lead to the disruption.

The MARFE position can be reconstructed using measurements from bolometer pinhole cameras. A robust and fast approach based on angular probability distributions for each camera is presented.

P 19.3 Thu 16:00 P

GPU Offloading of the Gyrokinetic Turbulence Code GENE-X — •Jordy Trilaksono[1], Dominik Michels[1], Andreas Stegmeir[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

Turbulence in magnetic confinement fusion devices is a non-linear phenomenon which involves multi-scale and multi-physics modeling. Simulating turbulence requires a large number of computing resources exploited in parallel which is provided by modern supercomputers. The recently developed gyrokinetic turbulence code `GENE-X` [1] extends the typical coverage of gyrokinetic turbulence simulations from the core to the edge and scrape-off layer of magnetic confinement fusion devices. Currently, `GENE-X` uses a heterogenous parallelization featuring OpenMP for intranode and MPI for internode parallelism respectively. To enable simulations of the edge and scrape-off layer of reactor relevant fusion devices, like ITER, the scalability of `GENE-X` needs to be improved. Therefore, we present progress towards GPU offloading in `GENE-X` in this work. This includes improving the current offloading approach of `GENE-X` by implementing a separate C++ layer to the code using modern Fortran's C interoperability and CUDA.

[1] D. Michels, et. al., Comput. Phys. Commun. 264, 107986 (2021)

P 19.4 Thu 16:00 P

Application of the Gyrokinetic Turbulence Code GENE-X on TCV — •Philipp Ulbl[1], Dominik Michels[1], and Frank Jenko[1,2] — [1]Max Planck Institute for Plasma Physics, Boltzmannstraße 2, 85748 Garching, Germany — [2]University of Texas at Austin, Austin, TX 78712, USA

Turbulence in the edge and scrape-off layer (SOL) of magnetic confinement fusion devices is a complicated phenomenon whose understanding remains a central task on the way to optimized fusion reactors. Recent progress along these lines has been made with the development of the novel gyrokinetic turbulence code `GENE-X` [1]. In this work, we apply `GENE-X` to the validation case "TCV-X21" [2], studying the evolution of plasma profiles such as density, electron- and ion temperature. Further we compare the results to collisional simulations assessing the effect of collisions on edge and SOL turbulence.

[1] D. Michels, et. al., Comput. Phys. Commun. 264, 107986 (2021)
[2] D. S. Oliveira, T. Body, et. al., arXiv:2109.01618 (2021)

P 19.5 Thu 16:00 P

Predictive simulations of Runaway Electron deconfinement by a helical coil — •Nina Schwarz, Javier Artola, Konsta Särkimäki, and Matthias Hölzl — Max Planck Institute for Plasma Physics, Boltzmannstrasse 2, 85748 Garching - Germany

Future tokamak fusion power plants are designed as high plasma current devices which comes with the risk of generating fast electrons during disruptions. Due to an avalanche mechanism a small seed can create so called Runaway Electrons (RE), which can carry more than 50% of the plasma current. The surrounding structures can be damaged seriously when the vertically unstable RE beam comes into contact with the wall. Current avoidance or mitigation concepts are based on active techniques like the injection of deuterium for plasma dilution. A passive mitigation system has been proposed consisting of a passive coil, in which current is induced during a current quench (CQ), that in turn generates a helical perturbation in the plasma. This triggers magnetic islands that grow and overlap and thus create a region of enhanced radial transport. When a large part of the plasma is stochastic, the complete formation of an RE beam can be mitigated or even be fully prevented. We show here a possible coil geometry based on the SPARC concept [1] in the ASDEX Upgrade configuration. The induction efficiency of the coil is investigated for different CQ times and the vacuum perturbation by different geometries are shown. Finally, 3D non-linear simulations of a disruption with the extended MHD code JOREK are presented with a fully self-consistent inclusion of the passive coil. [1] R.A. Tinguely et al 2021 Nucl. Fusion 61 124003

P 19.6 Thu 16:00 P

Analytical investigation of heat conduction of plasmas in a magnetic field with an island — •Gregor Pechstein and Per Helander — Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, 17491 Greifswald

In a hot plasma that is magnetically confined in a fusion device, heat is transported across flux–surfaces towards the plasma vessel. In the W7-X stellarator, the plasma edge consists of a magnetic island chain. The magnetic islands function as Scrape–Off Layer (SOL), directing the plasma to a divertor. Radiative cooling through collisions with impurities such as carbon can play an important role in reducing the heat loads on the plasma-facing components.

We investigate a heat conduction equation with a loss term describing radiation in and around a magnetic island. The full 2D heat conduction problem can be reduced to a 1D description in the limit of large parallel heat conduction. We focus our investigation on understanding heat transport in three regions: the island center (the "O-point"), the seperatrix, and the region far away from the island. Far away from the magnetic island, the heat conduction given by our model reduces to the perpendicular heat conduction across flux surfaces without an island. The effective heat conduction coefficient reaches a maximum at the seperatrix. The influence of this heat conduction coefficient on the position of the radiation front is also discussed.

P 19.7 Thu 16:00 P

Investigation of spontaneous transitions to high core-electron temperatures in W7-X low-iota plasmas — •Juan Fernando Guerrero Arnaiz[1,2], Andreas Dinklage[1,2], Axel Könies[2], Carolin Nührenberg[2], Bernd Pompe[1], Alessandro Zocco[2], Matthias Hirsch[2], Udo Höfel[2], Christian Brandt[2], Joachim Geiger[2], Kian Rahbarnia[2], Jonathan Schilling[2], John Schmitt[3], Henning Thomsen[2], and the W7-X Team[2] — [1]Universität Greifswald, Greifswald Germany — [2]Max-Planck-Institut für Plasmaphysik, Greifswald Germany — [3]Auburn University

Spontaneous transitions to higher core-electron temperatures preserving the electron pressure were detected in the so-called low-iota configuration of W7-X. Data mining employing a large data set at different heating powers and densities was conducted. Permutation Entropy as a fast and robust novelty detection method was used to characterize the conditions for the occurrence of a core-localized spatio-temporal bifurcation. To investigate the transition mechanism in more detail, highly sampled electron cyclotron emission and soft-X ray data reveal low-coherent fluctuations which disappeared when higher electron temperatures were attained. First analysis of the effects due to the evolving bootstrap current indicates a change of the rotational transform (iota) profile temporarily crossing low-order rational values. The same neoclassical analysis indicates that a transition into the stellarator-specific core electron-root confinement regime would be consistent with the observed increase of the central electron temperature. The role of rational iota values is being assessed in MHD stability studies.

P 19.8 Thu 16:00 P

Modeling the beam emission Balmer-α spectrum in neutral beam heated plasmas at Wendelstein 7-X — •Sebastian Bannmann, Oliver Ford, Udo Höfel, and Robert Wolf — Max-Planck-Institut für Plasmaphysik, Greifswald, DE

The optimized stellarator Wendelstein 7-X (W7-X) is equipped with a neutral beam injection (NBI) system. Knowledge about the particle and heat deposition of the beam in NBI shots is essential for further plasma physics analysis. The deposition depends on the beam and plasma parameters and information can be provided by measuring the Balmer-α light emitted by excited beam and halo particles. As the whole spectrum is too complex to be unambiguously fitted, a modular Bayesian inference network called Minerva is used. This requires implementing a detailed forward model with which one can infer beam and plasma parameters from the measured spectra. Existing modeling tools deploy Monte-Carlo techniques which is not feasible to use in combination with a Bayesian inference framework. The presented work describes the implementation of an analytical neutral beam and halo model. The possibility of inferring ion temperature profiles from the halo Balmer-α emission and density profiles from the halo and beam emission is investigated.

P 19.9 Thu 16:00 P

Optimizing quasi-isodynamic stellarators — •Alan Goodman, Rogerio Jorge, Per Helander, and Sophia Henneberg — Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, 17491 Greifswald

Stellarators are a class of plasma confinement devices that, if designed properly, may be viable nuclear fusion reactors. The W7-X stellarator's successes indicate that stellarators designed to be "quasi-isodynamic" (QI) — which, amongst other things, have minimal plasma boostrap currents — may be a viable path forward for future stellarators. QI configurations have contours of constant magnetic field strength wrapping around the device poloidally (the short way around) with a special symmetry.

Experimental measurements from the W7-X and HSX stellarators have shown that optimization methods are powerful tools in finding configurations with desirable properties. W7-X's optimized QI configuration has proven effective in confining particles trapped in magnetic wells (which is essential for a viable fusion reactor), but further improvements are now possible.

Unfortunately, optimized QI configurations tend to have unintended undesirable properties, such as large elongations and high mirror ratios, so care must be taken to limit these values. We present several objective measures which have shown promise in generating optimized QI stellarators and the results thereof.

P 19.10 Thu 16:00 P

ECRH in early plasma formation — •Albert Johansson and Pavel Aleynikov — Max-Planck-Institut für Plasmaphysik, Wendelsteinstraße 1, 17491 Greifswald

Electron Cyclotron Resonant Heating (ECRH) is important for the operation of current and future fusion devices, and is the main plasma heating mechanism in the Wendelstein 7-X (W7-X) stellarator. Although ECRH at high plasma temperatures and densities is routinely used in experiments and understood theoretically, a complete theoretical description of ECRH at the early stages of plasma formation (breakdown) has yet to be derived. Among the critical questions is the possibility of using higher–harmonics during startup in W7-X and effect of the ECRH-assisted startup in ITER.

In current work we seek to determine the minimum microwave beam power necessary to achieve breakdown, i.e., plasma formation, in conditions similar to the W7-X stellarator. We aim to accurately describe the cyclotron–wave interaction in the early stages of plasma formation, including both beam parameters and magnetic field structure.

Here, a fully relativistic integratable Hamiltonian system for an obliquely propagating beam in a much larger homogeneous magnetic field is derived. It is used to find the non–linear particle trajectories, and thus their energy gain, for various beam parameters.

P 19.11 Thu 16:00 P

Model for collisional transport of impurities in tokamaks and the combined impact of rotation and collisionality — •Daniel Fajardo[1], Clemente Angioni[1], Francis Casson[2], Anthony Field[2], Patrick Maget[3], Pierre Manas[3], and JET Contributors[4] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]UKAEA/CCFE, Abingdon, United Kingdom — [3]CEA/IRFM, Saint Paul-lez-Durance, France — [4]See author list of [E. Joffrin et al. 2019 Nucl. Fusion 59 112021]

The collisional transport of impurities in tokamak plasmas can be dominant over the turbulent transport, particularly for heavy impurities like tungsten (W). An analytical model for the Pfirsch-Schlüter (PS) and Banana-Plateau (BP) components of the neoclassical impurity flux has been developed. It is accurate with respect to the drift-kinetic solver NEO across a broad collisional parameter space and reproduces well the profiles of the transport coefficients with experimental ASDEX Upgrade and predicted ITER profiles. The model includes the impact of rotation on the PS transport only. The impact of rotation on the BP transport, relevant at low collisionalities, has received limited consideration so far. The combined effects of rotation, collisionality and trapped particle fraction are analyzed with NEO. It is found that at sufficiently low collisionality and high Mach number an operational window opens where the temperature screening of impurities is enhanced. It is shown that recent experiments at JET have managed to enter this regime. An analytical description of this effect, in particular for the BP flux, is developed for fast integrated modelling applications.

P 19.12 Thu 16:00 P

Analysis of ITER instabilities for a reduced transport model development — •Virgil-Alin Popa, Philipp Lauber, and Thomas Hayward-Schneider — Max Planck Institute for Plasma Physics, Garching, Germany

Previous work has suggested that Alfven Eigenmodes (AEs) such as the Toroidal AEs (TAEs) can be partially unstable in ITER: energetic particles (EPs), such as fusion-born alpha-particles or neutral beam ions are energetic enough to resonantly interact with these weakly damped plasma waves. Due to the sensitivity of the AEs* properties on the background kinetic profiles, an automated analysis method is required to study their stability that does not rely upon prior knowledge of the linear mode spectrum, as is the case for most reduced models for EP transport. In view of this, the first automated time-dependent workflow for energetic particle stability analysis was created. This is used as a main tool for various linear stability analysis. An ITER Deuterium-Tritium scenario given by a transport code (METIS) was investigated. From the analysis, one can determine the dependance of the instabilities on the background profiles and the alpha particle population, as needed for profile optimisation or reduced transport models.

P 19.13 Thu 16:00 P

Experimental impurity transport analysis for tokamak regimes without type-I ELMs — •Tabea Gleiter[1,2], Ralph Dux[1], Marco Cavedon[3], Rachael McDermott[1], Francesco Sciortino[1], Ulrike Plank[1], and the ASDEX Upgrade Team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Physik-Department E28, Technische Universität München, Garching, Germany — [3]Dipartimento di Fisica "G. Occhialini", Università di Milano-Bicocca, Milano, Italy

A profound knowledge of the transport of impurities is inevitable when it comes to designing tokamak reactor scenarios. In particular, it is necessary to integrate sufficient radiative cooling by impurities near the plasma edge with small impurity concentrations in the core.

High confinement regimes with no or little ELM activity (QCE or EDA H-mode) are promising candidates for future reactor operation. Information about their impurity transport mechanisms is therefore of large interest. In the focus is specifically the pedestal region since an edge transport barrier provokes suppressed turbulence and neoclassical inward transport in the inter-ELM phases of the standard H-mode. However, as no impurity accumulation is observed in the QCE and EDA-H modes despite their negligible ELM activity, a modification of the transport in this area is expected.

In this contribution, first results from transport studies in such ELM-free regimes at ASDEX Upgrade are presented. We show the inverse inference of radially and temporally resolved diffusion and convection from charge exchange recombination spectroscopy (CXRS) data.

P 19.14 Thu 16:00 P

Microstructural evolution of a tungsten heavy alloy during extended heat-treatments — •Philipp Sand and Armin Manhard — Max-Planck-Institute for Plasma Physik, 85748 Garching, Germany

Tungsten heavy alloy (97W-2Ni-1Fe, %wt.) is a possible candidate as plasma-facing material in future nuclear fusion devices. It exhibits a similar heat conductance at high temperature and sputter yield as pure tungsten, whilst showing an improved ductility [1] and hydrogen retention behaviour [2]. These improved properties can be attributed to its heterogenous microstructure, in which, as a consequence of the manufacturer's liquid phase sintering process, tungsten grains are embedded in a perturbating matrix of nickel and iron. In fusion devices as well as in materials testing experiments (e.g. permeation experiments) elevated temperatures for extended times might lead to grain growth or formation of intermetallic phases. Since the grain structure and tungsten-matrix interface constitution can affect the hydrogen transport, the permeation and retention behaviour might change during long-term annealing. A systematic heat treatment study has been performed with a conventional tungsten heavy alloy. Additionally, two-dimensional model systems consisting of Fe-Ni layers on W foils with identical composition where investigated to deepen the understanding of the tungsten-matrix interface. Microstructural changes are tracked with scanning electron microscopy and ion beam analysis. [1] R. Neu, et al., Fusion Eng. Des. 124 (2017) 450-454 [2] H. Maier, et al., J. Nucl. Mater 18 (2019) 245-259

P 19.15 Thu 16:00 P

Off-axis confinement and pulse stacking in a multi-cell Penning-Malmberg trap — •Martin Singer[1,4], James R. Danielson[2], Matthew R. Stoneking[3], Lutz Schweikhard[4], and Thomas Sunn Pedersen[1,4] — [1]Max-Planck Institute for Plasma Physics, 17491 Greifswald, Germany — [2]University of California, San Diego, La Jolla, California 92093, USA — [3]Lawrence University, Appleton, Wisconsin 54911, USA — [4]University of Greifswald, 17489 Greifswald, Germany

For the operation of a multi-cell Penning-Malmberg trap (MCT) the transfer to the storage-cells and consistent stacking of pulses is an essential step. This becomes increasingly complex when many pulses needs to be added in each storage-cell to reach large particle numbers and high plasma space charges, and when the small diameter storage-cells are radially displaced with respect to the large diameter master-cell. If the plasma is displaced off-axis and expanded over both cells, its motion is dominated by competing diocotron drifts. Also, the transfer and pulse stacking into the off-axis cell can lead to halo formation and the loss of particles. Since the APEX collaboration aims to create and study the first magnetically confined, low energy pair plasma, the MCT is a crucial tool on the way to accumulate up to 10^{11} positrons with low heating and particle loss. We will present our new MCT and measurements where we already achieved the transfer and confinement in two off-axis cells simultaneously. This MCT will be used to address open questions such as concerning plasma transfer and stacking as well as off-axis ejection.

P 19.16 Thu 16:00 P

Experimental helium exhaust studies in the full-W ASDEX Upgrade — •Antonello Zito[1,2], Athina Kappatou[1], Marco Wischmeier[1], Volker Rohde[1], Edward Hinson[3], Oliver Schmitz[3], Marco Cavedon[4,1], Rachael McDermott[1], Ralph Dux[1], Michael Griener[1], Arne Kallenbach[1], Ulrich Stroth[1,2], and the ASDEX Upgrade team[1] — [1]Max-Planck-Institut für Plasmaphysik, Garching, Germany — [2]Physik-Department E28, Technische Universität München, Garching, Germany — [3]University of Wisconsin-Madison, USA — [4]Dipartimento di Fisica G. Occhialini, Università di Milano-Bicocca, Milano, Italy

An efficient removal of helium ash by active pumping in future fusion devices is mandatory, in order to avoid fuel dilution and not degrade confinement properties. Helium exhaust in reactor-relevant edge and divertor scenarios has been experimentally investigated at the ASDEX Upgrade tokamak. A small amount of helium was injected during otherwise steady-state deuterium plasma discharges, and the time evolution of the resulting helium content was measured in the plasma and in the exhaust gas. The dynamics of the helium decay following the injection was characterized in several different scenarios and interpreted by means of simple analytic models. In attached H-modes plasmas, the helium pumping efficiency was found to greatly improve with increasing divertor neutral pressures. This was shown to be mainly driven by a more efficient divertor retention of helium at higher pressures. On the other hand, an exhaust degradation was qualitatively observed with the divertor entering a detached regime in L-mode.

P 19.17 Thu 16:00 P

Ion mass ratio impact on the collisional closure in the SOLPS-ITER Scrape-off layer simulations — •Sergei Makarov[1], David Coster[1], and Vladimir Rozhansky[2] — [1]Max-Planck-Institut für Plasmaphysik, D-85748 Garching, Germany — [2]Peter the Great St.Petersburg Polytechnic University, 195251, St.Petersburg, Russia

Impurity transport in the Scrape-off layer of a tokamak is an important and challenging problem. For instance, noble gasses are seeded into the tokamak for additional radiation and divertor target protection. When the impurity mass is significantly larger than the mass of the main ions the multispecies extension of the single ion Braginskii approach can be applied. However, usually impurity/main ion mass ratio can not be assumed infinitely large, and the Grad-Zhdanov 21N-moment method should be used for the transport coefficients estimation. This approach takes into account realistic masses of ions are present in the plasma for coefficients calculation. It is the major improvement in comparison to the previous approach applied for the SOLPS-ITER code. New approach is implemented into the SOLPS-ITER code for multiple ion parallel transport description in collisional plasmas. Previously, the sufficient change in the impurity transport is found when the realistic mass ratio between different ion species is taken into account. Here we explore the origin of this impact. The mass ratio between different species is artificially increased in the collisional terms calculation. The improved approach turns into the standard SOLPS-ITER model, for artificially increased mass ratio.

P 19.18 Thu 16:00 P

Analysis of nonlinear dynamics of shear Alfven waves driven by energetic trapped particles — •farah atour — IPP Garching

In controlled fusion devices, shear-Alfven waves can be driven unstable by resonant interactions with energetic alpha particles. This results in many issues regarding the confinement of the particles and therefore can prevent thermalisation of the plasma core or increase the thermal load on the material's wall. The source of these particles is either from the nuclear fusion reaction produced by the background plasma and/or external heating systems. Due to the importance of these issues, there exists extensive literature on this topic. These studies mostly focus on the nonlinear dynamics of passing particles since they have more significant impacts. However, the nonlinear dynamics of shear-Alfven waves driven by energetic trapped particles deserves also depth analysis and will be the focus of this study. The overall goal of this work is to investigate on a deeper level the fundamental physics processes regarding both the linear stability properties and the nonlinear saturation mechanisms for a single and multi modes. For this reason, to keep the context of dynamical study simplified, these phenomena are investigated by HMGC code, which has a simple circular geometry and is based on the hybrid reduced MHD gyrokinetic model.

P 19.19 Thu 16:00 P

Non-local neoclassical PIC simulations for the self-consistent radial electric field in stellarators. — •Michał Kuczyński, Ralf Kleiber, and Håkan Smith — Wendelsteinstraße 1, 17491 Greifswald, Germany

Transport in fusion plasma devices can be classified as either turbulent or neoclassical. Since turbulent transport is predominantly ambipolar, the radial electric field that arises ensures ambipolarity of the neoclassical part of the transport. This fact allows us to perform neoclassical particle-in-cell (PIC) simulations to calculate the electric field self-consistently. We introduce non-linear and non-local terms into the equations of motion in order to investigate ion and electron root transitions.

P 19.20 Thu 16:00 P

Optimal Quasi-isodynamic Stellarator Magnetic Equilibria Using a Direct Construction Approach — •Katia Camacho Mata, Gabriel Plunk, Michael Drevlak, and Per Helander — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

Two important requirements for a viable stellarator reactor are easy-to-build-coils and good confinement. Omnigenous configurations, traditionally found through numerical optimization, fulfil the good confinement properties requirement but tend to need complex coils to be realised. However, it is unknown whether such complexity is fundamentally necessary.

To explore this question, we use a method developed for the direct construction of omnigenous MHD (Magnetohydrodynamic) equilibria [1], numerically, at first order from the magnetic axis. It avoids the computational cost of conventional optimization and allows a thorough survey of the space of omnigenous stellarators at large aspect ratio.

Omnigenous magnetic fields are necessarily non-analytical and can only be physically realised by a smooth approximation. In previous works this condition was met by introducing regions where omnigeneity was abandoned. A different approach, employing a smoother approximation, and higher number of field periods is analysed in this work aiming to identify configurations that can be realised with easy-to-build coils.

[1]Plunk, G. G., et. al. (2019). Direct construction of optimized stellarator shapes. Part 3. Omnigenity near the magnetic axis. Journal of Plasma Physics, 85(6).

P 19.21 Thu 16:00 P

Towards Simulations of Deuterium Shattered Pellet injection into an MHD active ITER plasma — •Fabian Wieschollek[1], Matthias Hoelzl[1], Eric Nardon[2], and The JOREK Team[3] — [1]Max Planck Institute for Plasma Physics, Boltzmannstr. 2, 85748 Garching b. M., Germany — [2]CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France — [3]See the author list of M. Hoelzl et al 2021 NF 61, 065001

The foreseen disruption mitigation strategy for ITER is shattered pellet injection (SPI). In a realistic disruption scenario, the SPI is being triggered, when the plasma has already become MHD active; in particular 2/1 neoclassical tearing modes (NTM) are often present.

Previous theoretical studies on an ASDEX Upgrade equilibrium have shown, that a large pre-existing NTM may influence the thermal quench (TQ) significantly. According to these studies, the injection into the O-point delays TQ, while it occurs considerably earlier with X-point injection. Results indicate that pre-existing islands do not render the mitigation ineffective.

To further verify these findings, the studies are now being extended to an ITER L-mode plasma, into which Deuterium SPI is launched. Scans will be performed of the initial island width, the number of atoms injected, and the relative injection phase with respect to the island O-point and the concentration of background impurities. Also, different shard velocitiy distributions are considered. We are presenting here the detailed research plans, as well as the first preliminary results.

P 19.22 Thu 16:00 P

Validating soft X-ray tomograms via modeling of perturbative events — •Christian Brandt[1], Henning Thomsen[1], Charlotte Büschel[2], Edith V. Hausten[2], Jonathan Schilling[1], René Bussiahn[1], and and the W7-X Team[1] — [1]Max-Planck-Institute for Plasma Physics, Greifswald, Germany — [2]University Greifswald, Germany

The hot core of a fusion plasma is invisible in the visual part of the spectrum but it radiates strongly in the X-ray range. A soft X-ray (SX) tomography system detects the spatiotemporal structure of the core plasma in a poloidal cross-section at the stellarator experiment Wendelstein 7-X. Depending on the presence of localized structures on top of the background X-ray radiation profile, such as injected impurity pellets, injected cryogenic hydrogen pellets or MHD mode structures, the poloidal cross-sectional SX emissivity can be substantially structured. The validity of the tomograms obtained by tomographic inversion with respect to the real topology of the SX emissivity is benchmarked by forward calculations of different modeled perturbation scenarios (e.g. symmetric vs. asymmetric 2-D emissivity, local blobs, mode structures). More parameters sensitively influencing the quality of the tomographic inversion are investigated, i.e. the signal-to-noise ratio and the amplitude calibration.

P 19.23 Thu 16:00 P

Characterization and driving mechanisms of dominant Alfvén eigenmodes at the Wendelstein 7-X Stellarator — •S. Vaz Mendes, K. Rahbarnia, C. Slaby, H. Thomsen, J. Schilling, C. Brandt, M. Borchardt, R. Kleiber, A. Könies, and Wendelstein 7-X Team — Max-Planck-Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

Alfvén waves are often present in different scenarios of the Wendelstein 7-X stellarator plasmas. Magnetic fluctuations were observed during 727 discharges with different magnetic configurations, heating scenarios and variations of further plasma parameters. The measurements were performed using a system of 41 Mirnov coils, located in half-module 11 of W7-X. The correlation of the observed Alfvénic activity with different plasma parameters is investigated. With increasing heating power the fluctuation bands in the frequency spectra (between 100-450kHz) and associated mode spectra become broader with poloidal mode numbers $\|m\| \leq 5$. In addition, the overall amplitudes of the different Alfvénic fluctuations in this range increases with higher plasma energy. To better understand the conditions for enhanced Alfvénic activity at W7-X possible driving mechanisms are discussed. A possible candidate is plasma turbulence. Magnetic fluctuation levels are compared to turbulent activity, observed for e.g. in density fluctuations.

P 19.24 Thu 16:00 P

Assessment of NII line ratio method for analysis of nitrogen enrichment in the W7-X divertor — •F. Henke, M. Krychowiak, R. König, F. Reimold, D. Gradic, and T. Sunn Pedersen — Max Planck Institute for Plasma Physics, Wendelsteinstr. 1, 17491 Greifswald, Germany

Impurities are of great importance in fusion plasmas. At the plasma edge, their radiation provide an advantageous cooling and dissipation, whereas they can negatively impact the energy confinement and dilute the fusion fuel in the plasma core already at small concentrations. Because the divertor of Wendelstein 7-X consists of graphite, the intrinsic impurity carbon is utilized as the main radiator. As tritium retention rules out carbon for the choice of wall material in a future reactor, seeded gases will be crucial for successful divertor operation.

In order to study the impurity screening capabilities of the divertor of Wendelstein 7-X, we analyse nitrogen seeding experiments via a NII line ratio model in the plasma edge and Charge Exchange Recombination Spectroscopy (CXRS) in the plasma core with the goal of estimating an enrichment coefficient of nitrogen in the divertor $c_{N,divertor}/c_{N,core}$.

Due to the complexity of the W7-X divertor plasmas and geometry, the passive NII line ratio model is subject to considerable uncertainties. The assessment of this method as well as possible model and diagnostics upgrades for its application in future experiment campaigns are discussed in this work.

P 19.25 Thu 16:00 P

Determination of 2D Filament Temperatures and Densities at ASDEX Upgrade with the Thermal Helium Beam Diagnostic — •Daniel Wendler[1,2], Michael Griener[1], Gregor Birkenmeier[1,2], Rainer Fischer[1], Ralph Dux[1], Elisabeth Wolfrum[1], Ulrich Stroth[1,2], and the ASDEX Upgrade team[1] — [1]Max-Planck- Institut für Plasmaphysik, Garching, Germany — [2]Physik Department E28, TUM, Garching, Germany

In all plasma scenarios in magnetic confinement fusion, small filamentary structures appear in the scrape-off layer (SOL), called blobs, with a locally strongly enhanced density which propagate convectively outwards. Blobs contribute to reactor relevant phenomena like the density shoulder formation, large first wall particle and power fluxes close to the density limit and the broadening of the divertor heat flux fall-off length. To calculate the effective power flux which is carried by the filaments, temperature and density as well as the frequency and velocity of filaments have to be determined. While the measurements of mean filament velocities are routinely made with various diagnostics, the simultaneous non-invasive measurement of temperatures and densities of single filaments is now possible with the thermal helium beam diagnostic at ASDEX Upgrade. By means of a grid of 2D distributed lines of sight, the temperature, density and velocities as well as the filament shape can be determined in two dimensions. A dedicated numerical approach based on a collisional-radiative model for the determination of blob temperatures and densities is presented and first measurements of temperatures and densities of blobs in two dimensions are presented.

P 19.26 Thu 16:00 P

Simulations of the O-X mode conversion in MAST-U — •Alf Köhn-Seemann[1], Bengt E. Eliasson[2], Simon J. Freethy[3], Lucy A. Holland[4], Roddy G.L. Vann[4], and David Woodward[2] — [1]IGVP, University of Stuttgart, Germany — [2]SUP, Department of Physics, University of Strathclyde, Glasgow, U.K. — [3]Culham Centre for Fusion Energy, Culham, U.K. — [4]York Plasma Institute, York, U.K.

Coupling microwaves to plasmas where the density exceeds the cut-off density can be achieved by electron Bernstein waves (EBWs). These are electrostatic waves that have no high-density cut-off and are very well absorbed at the electron cyclotron resonance and its harmonics. In addition, EBWs can drive very efficiently toroidal net currents, which is of particular importance in spherical tokamaks like MAST-U.

EBWs can be excited via a two step mode conversion process: an injected O-mode couples to an X-mode at the O-mode cut-off which then propagates outwards again and can couple to EBWs in the vicinity of the upper-hybrid resonance. The overall efficiency is strongly dominated by the O-X conversion. In this work, we present simulations of the O-X coupling process in the MAST-U geometry. Different codes have been used and benchmarked against each other. The dependence on plasma scenarios, beam geometry and plasma density fluctuations were investigated in detail. High conversion efficiencies on the order of 90 % were found making this an attractive heating scheme for MAST-U.

P 19.27 Thu 16:00 P

Causality analysis between turbulent phenomena across the separatrix at the TJ-K stellarator. — •Nicolas Dumérat, Bernhard Schmid, and Mirko Ramisch — IGVP, University of Stuttgart

The use of convergent cross-mapping (CCM) as a causality inference technique has proven its capacity for unveiling causal coupling between two variables measured in the same dynamical system. CCM describes a measure of how well the mapping - from a small region within a multidimensional phase space reconstruction in one variable (from time-delay embedding) - compares to the actual representation of the second variable in its reconstructed phase space.

Thus, CCM allows for the identification of causal links and direction of influence between variables and is extended to the study of plasma turbulence. In this frame, the causal relationship between various turbulent phenomena across the confinement region of the stellarator TJ-K is studied. The causal dependencies between blob generation and the zonal-flow - drift-wave system are investigated through Langmuir probe measurements. Using conditional averaging and bandwidth filtering, different spatial and temporal scales can be isolated and studied individually, allowing for fine causality analysis.

P 19.28 Thu 16:00 P

Investigation of synergistic effects of irradiation damage, hydrogen retention and mechanical loading on tungsten — •Alexander Feichtmayer[1,2], Bailey Curzadd[1,2], Sebastian Estermann[1,2], Maximilian Fuhr[1,2], Till Höschen[1], Robert Lürbke[1,3], Johann Riesch[1], Thomas Schwarz-Selinger[1], Dominik Viebke[1,2], and Rudolf Neu[1,2] — [1]Max-Planck-Institut für Plasmaphysik, 85741 Garching, Germany — [2]Technische Universität München, 85741 Garching, Germany — [3]RWTH Aachen University, 52062 Aachen, Germany

One of the major challenges in the realization of a nuclear fusion power plant such as DEMO is the development of suitable materials for the highly loaded plasma-facing components. The main candidate for the armor inside a future fusion reactor is tungsten. It has a high melting point, low erosion rate and low hydrogen retention, but it is brittle below 500-600 K and irradiation causes further embrittlement.

Since there is no sufficient source for 14.1 MeV fusion neutrons for material tests available, it is proposed to simulate the damage by means of ion irradiation. To investigate the synergistic effects, in-situ experiments such as stress relaxation and tensile tests are performed on thin tungsten wires, during irradiation with high-energy ions and simultaneous loading with low-energy hydrogen. An additional sample heater will allow irradiation and testing under fusion-relevant temperatures up to 1800 K. Due to the fine grain structure of the samples, the experiments will provide results that can be transferred to bulk tungsten and serve also for the development of tungsten fiber-reinforced composites.

P 19.29 Thu 16:00 P

Ortsaufgelöste rovibratorische Besetzungstemperatur von Deuterium im Plasmasimulator PSI-2 — •Nikolas Klose, Stephan Ertmer, Arkardi Kreter, Gennady Sergienko, Bernhard Unterberg und Sebastijan Brezinsek — Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, 52425 Jülich, Deutschland

Im linearen Plasmasimulator PSI-2 wurden D_2-Moleküle mittels optischer Spektroskopie anhand der Fulcher-Banden ($3p^3\Pi_u \rightarrow 2s^3\Sigma_g^+$) untersucht. Die Hauptdiagonalenübergänge Δv=0 der ersten 5 Übergänge wurde analysiert und die rovibratorische Besetzungstemperatur als Funktion der Plasmaparameter (n_e: $2 \cdot 10^{-17}$ m^{-3} - $12 \cdot 10^{-17}$ m^{-3}; T_e: 2 eV - 12 eV) bestimmt, welche durch den Gasdurchfluss in PSI-2 (50 sccm - 490 sccm) und Strom der Bogenentladung (80

A - 150 A) variiert wurden. Weiterhin wurden die radialen Profile der rovibratorischen Besetzungstemperatur mit Langmuirsondendaten unter ionisierenden und rekombinierenden Plasmabedingungen verglichen. Die Rotationstemperatur des ersten diagonalen Übergangs ist nah an der Raumtemperatur, aber mit höheren Vibrationsquantenzahlen fällt T_{rot} signifikant ab.

P 19.30 Thu 16:00 P

Parallel expansion of a pellet plasmoid in a finite electric potential well — •Alistair Mark Arnold[1], Pavel Aleynikov[1], and Boris Breizman[2] — [1]Max-Planck-Institut für Plasmaphysik, Greifswald, Deutschland — [2]Institute for Fusion Studies, University of Texas, Austin, USA

We consider the expansion parallel to magnetic field lines of the plasmoid produced by a fuel pellet. In particular, we take into account the finite height of the electric potential well confining the plasmoid electrons. If it is assumed that electron bounce motion occurs much more rapidly than collisions and trapped electron self-collisions occur much more rapidly than other kinds of collisions, a quasi-equilibrium state is reached with a non-Maxwellian electron distribution function. A closed-form expression for the distribution function is obtained for an arbitrary well under the assumption that pitch-angle scattering dominates. Corresponding analytical expressions are found for particle and energy exchange between the passing and trapped electrons. Agreement with literature on mirror machines and even classical thermodynamics is found in appropriate wells. The non-Maxwellian distribution function precludes rigorous modelling of the plasmoid expansion using the Braginskii equations. The trapped distribution function is, however, specified by only two time-dependent quantities – a fluid closure of the system is possible despite the highly non-Maxwellian distribution. We seek to understand the influence of the above effects on the expansion rate and ultimate electron-ion energy balance during fuel pellet injection.

P 19.31 Thu 16:00 P

Global thermal equilibrium of non-neutral plasma in a magnetic quadrupole trap — •Patrick Steinbrunner[1], Matthew Stoneking[2], Thomas O'Neil[3], and Thomas Sunn Pedersen[1] — [1]Max Planck Institute for Plasma Physics, 17489 Greifswald, Germany — [2]Lawrence University, Appleton, Wisconsin 54911, USA — [3]University of California, San Diego, La Jolla, California 92093, USA

Global thermal equilibrium of a non-neutral plasma confined in a cylindrically symmetric trap is obtained by maximizing the entropy for a given number of particles, temperature and rotation frequency around the axis of symmetry [1]. Plasmas in such states are Boltzmann distributed and satisfy Poisson*s equation as it is observed in Penning-Malmberg traps, in which they are in principle confined indefinitely [1]. These traps consists of a homogeneous magnetic field as well as electrostatic potential walls produced by cylindrical electrodes. They can confine one sign of charge, and the amount of confined space charge is limited by the bias on the electrodes. We present an alternative concept using a magnetic quadrupole field, produced by a levitated current-carrying coil surrounded by another coil with opposite current wound around a grounded vacuum chamber. Computational results suggest that global thermal equilibrium states can be confined in this trap without the need of biased electrodes. Turning off the outer coil*s current would yield a dipole trap [2] in which both signs of charge have been confined for a finite time. [1] Dubin, D. H., & O*neil, T. M. (1999). Rev. Mod. Phys., 71(1), 87. [2] Boxer, A. C., et al. Nat. Phys., 6.3 (2010): 207-212.

P 19.32 Thu 16:00 P

Towards implementation of the FAIR prinicples in plasma science — •Markus M. Becker[1], Dirk Uhrlandt[1], Detlef Loffhagen[1], Peter Hill[2], Marina Prenzel[3], and Achim von Keudell[3] — [1]Leibniz Institute for Plasma Science and Technology (INP), Germany — [2]York Plasma Institute, University of York (UoY), UK — [3]Ruhr University Bochum (RUB), Germany

A few years ago, the FAIR data principles were proposed as a guideline for those wishing to enhance the reusability of their data by making them findable (F), accessible (A), interoperable (I) and reusable (R) [Wilkinson *et al.*, *Sci. Data* 3:160018 (2016)]. Since then, various activities aiming at implementation of the FAIR principles in different fields of plasma science have been started. Within the project QPTDat, INP works together with partner institutions on research data management (RDM) solutions for low-temperature plasma physics. This includes a close collaboration with the CRC 1316 at RUB, where the focus lays on the establishment of data stewards to support RDM in daily practise. The international project Fair4Fusion addresses the RDM needs in the field of fusion plasmas, while PlasmaFAIR at UoY strives to improve the quality and sustainability of plasma research software. This contribution presents current activities at INP, RUB and UoY and emphasizes the need for collaborations and community involvement to derive real benefits from the FAIR principles for research in plasma science.

The work was supported by grants 16QK03A (BMBF), EP/V051822/1 (EPSRC), and 327886311 (DFG).

P 19.33 Thu 16:00 P

Ion-induced secondary electron emission of metal surfaces analysed in an ion beam experiment — •Rahel Buschhaus and Achim von Keudell — Experimentalphysik II, Ruhr-Universität Bochum, Deutschland

Electron emission of surfaces upon ion impact is one of the most fundamental plasma-surface-interaction. Many experimental and theoretical approaches address secondary electron emission coefficient determination (SEEC; amount of released electrons per incident ion) in literature. This determination may remain rather indirect though, because the process of ion-induced electron emission occurs often not isolated from all other plasma-surface-interactions. Using beam experiments avoids this complication and allows a precise electron yield determination. Target conditions in plasmas strongly affect electron emission of the target and thus have an impact on the discharge itself. However, data of oxidized and nitrided targets, as they would appear in any reactive plasma discharge, are very sparse and may even contain significant systematic errors, because they were often measured based on global modeling of the complex behavior of plasma discharges. SEECs of different metal foils such as Cu or Ni with various surface conditions are investigated in a beam experiment. Foils are exposed to beams of Ar^+ with E_{ion}=500 eV - 2 keV and electron yields are determined precisely. A model for the electron emission is presented to explain the data.

P 19.34 Thu 16:00 P

Studies on the plasma permeability of porous materials using polymers as marker materials — •Martin Leander Marxen[1], Luka Hansen[1], Armin Reimers[2], Fabian Schütt[2], Lena Marie Saure[2], Erik Greve[2], Rainer Adelung[2], and Holger Kersten[1] — [1]Institute for Experimental and Applied Physics, CAU Kiel — [2]Institute for Material Science, CAU Kiel

Highly porous materials are of large interest due to their broad potential for application, e. g. as sensors or catalysts making use of their extremly high surface areas. The plasma permeability of highly porous framework materials produced from tetrapodal zinc oxide (t-ZnO) in a low pressure capacitively coupled plasma was studied with a new, indirect approach. The t-ZnO materials have a porosity > 90 %. Furthermore, some of the samples have additional nanomaterial surface layers (e. g. graphene) deposited on the t-ZnO arms, resulting in a change of conductivity. A polymer (EPDM) was covered with the material of interest and then exposed to an oxygen plasma. The covering material was removed afterwards and the surface of the EPDM was investigated by water contact angle measurement and XPS. Changes of the surface can be attributed to plasma species that permeated the covering zinc oxide material and reached the surface. This approach offers an easy and affordable opportunity to get insight in how deep plasma can penetrate into highly porous structures with nano- and microscale features.

P 19.35 Thu 16:00 P

Control of Spokes in Magnetron Discharges — •Mathews George, Wolfgang Breilmann, Julian Held, and Achim von Keudell — Experimentalphysik II, Ruhr-University Bochum

Magnetron Sputtering is a Physical Vapour Deposition (PVD) process widely used in industry and scientific communities. Magnetron plasma appears to be homogeneous to the human eye, but shows localized zones of high brightness rotating in the ExB direction when observed with an ICCD camera with exposure times below 1μs. These local ionization zones, also called 'spokes' are assumed to play a role in the transport of particles and energy away from the target. DCMS was chosen for the development of spoke control as an initial test object since the spokes in DC regime are more uniform compared to HiPIMS. Amplified rectangular signals are applied to two pairs of drivers to raise the plasma potential inside a spoke by drawing electron current from the plasma at the highest gradients in the ExB direction. Ion saturation current shows the responses of the spoke frequency and intensity to the applied signal. The metal ion flux from the target surface is measured time and energy resolved with a mass spectrometer. An additional probe is added to study influence of the control signal on the plasma potential inside a spoke.

P 19.36 Thu 16:00 P

Azimuthal particle transport in high power impulse magnetron sputtering plasmas — •Sascha Thiemann-Monjé, Steffen Schüttler, Julian Held, and Achim von Keudell — Experimental Physics II, Ruhr-University Bochum, 44780 Bochum, Germany

In the past years high power impulse magnetron sputtering (HiPIMS) has become a well established method for depositing high quality hard coatings. Nevertheless, knowledge about the processes inside the discharge is still incomplete. This includes the azimuthal rotation of heavy particles which is induced by the electron Hall-current and is believed to be influenced by rotating ionization zones, the so called 'spokes'.

In this work, optical emission spectroscopy (OES) and x-ray photoelectron spectroscopy (XPS) combined with so called marker targets were used to gain further understanding of the above mentioned particle movement. While OES delivers information about the emitting particles inside the plasma, XPS measurements of substrates placed on the side of the plasma show the contribution of particles leaving the discharge. The measurements where done for circular targets with a diameter of 50 mm and 0.5 Pa Argon as working gas.

It could be shown that the maximum rotation velocity is in the range of 0.5 - 1.8 km/s depending on the measured species. This rotation is as well visible as asymmetric deposition distribution on the side of the discharge.

P 19.37 Thu 16:00 P

Analysis of single particle motion confined in the plasma sheath — •Sören Wohlfahrt and Dietmar Block — Institute of Experimental and Applied Physics, Kiel University, Germany

Microparticles are the essential component of a (dusty) complex plasma. Besides particle-plasma interaction and particle-particle interaction, the dynamics of a single particle are worth to be studied. Particles are typically confined in the plasma sheath, where they accumulate a negative charge that causes levitation in the electric field of the sheath. However, even for perfectly spherical particles the charging process is not isotropic. Small differences in the electron- and ion fluxes can create dipole moments on insulating particles. These dipoles should result in a rotation of the particle [1]. In addition, the particles can have an initial angular momentum due to the injection into the plasma. Thus, we investigate motion of single particles in the plasma sheath. We use angular- and polarization resolved light scattering (APRLS)[2] to analyse the precise motion and orientation of the particle relative to the incident laser beam. This allows us to determine even small deviations from the equilibrium position of the particle and track particle rotation with frequencies up to 500 Hz.

[1] I H Hutchonson, New J. Phys. 6, 43 (2004)

[2] S. Wohlfahrt, D. Block, Phys. Plasmas 28, 123701 (2021)

P 19.38 Thu 16:00 P

Molecular dynamics simulations of turbulent complex plasmas — •Eshita Joshi, Prapti Bajaj, Hubertus Thomas, and Mierk Schwabe — Institut für Materialphysik im Weltraum,Deutsches Zentrum für Luft- undRaumfahrt, Weßling, Germany

Turbulence remains one of the oldest unsolved problems in physics. Studying how a flow can transition from laminar to turbulent can deepen our understanding of how and when turbulence emerges. Complex plasmas are ionised gasses with micrometre sized *dust* particles immersed in them, and they are valuable in studying turbulence as the highly charged microparticles are big enough to be imaged directly when their flow becomes turbulent. We investigate the onset of turbulence by studying complex plasmas flowing past a disturbance. We perform molecular dynamics (MD) simulations of the experiment performed using the Plasmakristall-4 (PK-4) laboratory on board the International Space Station at low pressures to study the emergence and decay of turbulence.

P 19.39 Thu 16:00 P

Complex Plasmas in the Einstein Elevator — •Andreas Schmitz[1], Michael Kretschmer[1], Christoph Lotz[2], and Markus Thoma[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität, Gießen, Germany — [2]Instititut für Transport- und Automatisierungstechnik, Gottfried Wilhelm Leibniz Universität Hannover

An experiment with complex plasmas was conducted in a copy of the former International Space Station Plasmakristallexperiment-Nefedov laboratory in the University of Hannover's drop tower, the Einstein Elevator. For the experiment performed, an argon high-frequency plasma was generated in the plasma chamber at low pressures into which melamine-formaldehyde microparticles were injected. When the setup was dropped inside the Einstein elevator, the microparticles underwent an instantaneous transition from 0 g to 1 g and were subsequently lifted from the sheath region into the bulk plasma during the microgravity phase. The first results of the analysis of this experiment are presented here.

P 19.40 Thu 16:00 P

Study of QED effects in collision of near-surface accelerated electrons with high-intensity lasers — •Marko Filipovic, Christoph Baumann, and Alexander Pukhov — Institut für Theoretische Physik I, Heinrich-Heine-Universität, Düsseldorf, Germany

As the development of laser technology progresses, ever higher intensities and better beam qualities in laboratories become available. This advance enables new experimental setups in the study of laser-plasma interaction and quantum electrodynamic (QED) effects like quantum photon emission and pair production in extreme fields and densities.

We present two-dimensional Monte-Carlo particle-in-cell simulations of two high-intensity lasers grazing the surface of a solid-state target. Due to the fields near the target surface electrons are extracted and accelerated. Finally, the extracted electrons collide with the counterpropagating laser, which generates a QED cascade. Here, the processes are studied for various laser intensities, angle of incidence and point of incidence at the surface.

P 19.41 Thu 16:00 P

Ion spectroscopy of ultrashort laser pulse plasmas ignited by pre-pulses — •Lars Schwabe, Jan Riedlinger, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

Illuminating solids with a high-intensity sub-10-fs laser creates a short-lived high-temperature plasma. The detailed processes during plasma generation are still not fully predictable today. We examined the emitted ions in terms of reached ionization states, probability and kinetic energy distribution, using a Thomson parabola spectrometer with an increased dynamic range to map ions with energies in the sub-100-keV range. Experiments were done with systematically varied laser parameters and pre-pulses, with peak intensities up to 10^{18} W/cm^2 at pulse durations down to 7 fs. The results allow conclusions on the plasma formation processes and the subsequent ionization dynamics in this ultrashort sub-120-fs domain.

P 19.42 Thu 16:00 P

Reconstructing the plasma temperature by optical probing method in femtosecond laser hydrogen jet interaction — •Long Yang[1,2], Constantin Bernert[1,2], Lingen Huang[1], Stefan Assenbaum[1,2], Martin Rehwald[1,2], Karl Zeil[1], Ulrich Schramm[1,2], Ilja Goethel[1,2], Thomas Kluge[1], Jan Vorberger[1], and Thomas E. Cowan[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiation Physics — [2]Technische Universitat Dresden

Plasma temperature is a critical parameter in warm dense matter and unable to be measured directly. In this study, we apply a well-designed experiment to generate an adiabatic expanded, thermalized hydrogen plasma in few ps by 30fs 1.63e18W/cm2 short pulse laser and 5um diameter solid hydrogen jet interaction. With the optical laser probing method at different wave length, the plasma density in expansion process is recorded with optical shadow image. Then plasma temperature is reconstructed by finding the best fit between experiment and hydro with ray tracing simulations. The electron temperature is determined to be around 300eV through this method and compared to the PIC simulations. The results show that both PIConGPU and PICLS overestimate the electron temperature several factors. This is the first time that we design an experiment and benchmark to the PIC codes. The result would help us improve the existed laser plasma interaction model in PIC.

P 19.43 Thu 16:00 P

Temporally and energy resolved actinometry in a micro cavity plasma array — •Henrik van Impel, David Steuer, Volker Schulz-von der Gathen, Marc Böke, and Judith Golda — Ruhr University Bochum, Faculty of Physics and Astronomy, Experimental Physics II, Germany

Dielectric barrier discharges (DBDs) have many applications, such as the generation of ozone or the treatment of volatile organic compounds (VOCs). To understand the underlying processes, fundamental knowledge on the generation of reactive species is necessary. Here we investigate atomic oxygen production as a model system in a micro cavity plasma array, a customized surface DBD confined to geometrically arranged cavities of micrometer size. We studied the behavior and the plasma chemical processes with optical emission spectroscopy methods. The discharge is operated in helium with a molecular oxygen admixture of about 0.1% at atmospheric pressure using a 15 kHz and about 600V excitation voltage. High atomic oxygen densities can already be observed with energy resolved actinometry (ERA). Using a multi-photomultiplier setup and ERA, we measured the temporal evolution of the atomic oxygen density and the effective mean electron energy over the first ignitions, which are affected by the memory effect due to residual charges.

Project is funded within project A6 of the SFB 1316.

P 19.44 Thu 16:00 P

Periodic structures (LIPSS) on metallic coatings (Ti, Cu, Cr) induced by nanosecond laser — •Robin Labenski, Patrick Preissing, Sascha Chur, Marc Böke, Volker Schulz-von der Gathen, and Judith Golda — Ruhr University Bochum, Faculty of Physics and Astronomy, Experimental Physics II, Germany

Catalysts show an increased efficiency in dependence of their morphology and chemical composition. In our research we investigate the formation of Laser-induced Periodic Surface Structures (LIPSS) on metallic coatings (Ti, Cu, Cr, 20nm-100nm) on Si-wafer induced by pulsed laser irradiation (ns-Nd:YAG, 532nm/1064nm, 20Hz). We found that LIPSS usually appear right above the melting threshold of the respective surface material. Under normal incidence they develop a periodicity roughly equal to the used wavelength and are being oriented perpendicular to the polarization direction. For an increasing angle of incidence the periodicity changes in a for the applied polarization (s or p) characteristic manner. All results match prognosis of the Efficacy-Factor-Theory by Sipe [1]. In upcoming measurements we test the chemical composition of LIPSS when induced in different atmospheres and/or simultaneously being treated by the COST reference microplasma jet. Supported by DFG within SFB1316.

[1] JE Sipe "Laser-induced periodic surface structure. I.
Theory", Phys. Rev. B 27.4 (1983)

P 19.45 Thu 16:00 P

RF-atmospheric pressure plasma jet as a source of vacuum- UV photons for photoionisation — •Natascha Blosczyk[1], Tristan Winzer[1], Judith Golda[1,2], and Jan Benedikt[1] — [1]Kiel University — [2]current address: Ruhr-Universität Bochum

Vacuum-UV(VUV) radiation has great use, not only as a means of analysing gas mixtures by their emission and absorption spectra, but also as a way to induce chemical reactions in a target gas. Therefore, the aim of this work is to study VUV-radiation of different atmospheric plasma sources and develop a way to efficiently use it for photoionisation at atmospheric pressure. The VUV-radiation of helium and helium/argon plasmas with excimer continua and line-radiation is measured by VUV-spectroscopy in the 60 to 200 nm range as function of the input power.

Acetylene is used as a model precursor to investigate the use of VUV-photons for photoionisation and follow-up chemistry, where the generated primary ions and ions formed in the polymerization reactions are detected by positive ion mass spectrometry. The VUV-generation in the plasma is separated from the diluted acetylene gas via a controlled gas flow. To further study the effects of the photons on the chemistry, the FTIR-spectrometry will be used to study the properties of deposited thin films from the VUV-photon activated gas mixture, as well as SMPS measurements to ensure a dust-free process.

P 19.46 Thu 16:00 P

Cold Atmospheric Plasma Decontamination of FFP3 Face Masks and Long-Term Material Effects — •Alisa Schmidt[1], Chen-Yon Tobias Tschang[1], Joachim Sann[2], and Markus H. Thoma[1] — [1]I. Physical Institute, Justus Liebig University, Giessen, Germany — [2]Institute of Physical Chemistry, Justus Liebig University, Giessen, Germany

Motivated by the shortages of face masks and safety clothing in the beginning of the corona pandemic, we conducted studies on decontamination of FFP3 face masks with cold atmospheric plasma (CAP) and resulting material effects. Therefore, the bactericidal (Escherichia coli) and sporicidal (Bacillus atrophaeus) efficacy of CAP afterglow decontamination of FFP3 mask material was investigated by decontamination experiments in a surface micro discharge (SMD) plasma chamber. In addition, a detailed analysis of changes in long-term plasma treated (15h) mask material and its individual components - ethylene vinyl acetate (EVA) and polypropylene (PP) - was carried out using surface analysis methods such as laser microscopy, contact angle measurements, X-ray photoelectron spectroscopy (XPS) as well as fabric permeability and resistance measurements. The microbiological experiments showed that plasma treatment of FFP3 face masks with CAP afterglow of an SMD device effectively inactivates E. coli and B. atrophaeus on the fabric. Furthermore, long-term material effects indicate that FFP3 masks can be plasma decontaminated and reused multiple times (up to 5h) but only to a limited extent, as otherwise permeability levels no longer meet DIN EN 149 specifications.

P 19.47 Thu 16:00 P

Comparison of mass spectrometry and optical measurements of plasma catalysis conversion of n-butane — •Laura Chauvet, Christoph Stewig, Theresa Urbanietz, Marc Böke, and Achim von Keudell — Ruhr-Universität Bochum Institute of Experimental Physics II Faculty for Physics and Astronomy Universitätsstraße 150 Building NB 5/174 D-44780 Bochum

With the progress in the production of renewable energy, the use of plasmas to convert molecules into value added species present a novel research field of interest. The coupling of plasma with a surface catalyst might exhibit synergetic effects enhancing the conversion or the selectivity of reactions.

In this framework, a plasma chamber has been designed to study the mechanisms involved in the conversion of carbon-based molecules by plasma catalysis. The chamber is fed by a helium flow with small admixtures of n-butane. A capacitively coupled atmospheric pressure RF discharge is used to dissociate n-butane. Different kinds of catalysts can be spray coated on the electrodes and brought into contact with the plasma. In this work, a sampling system has been designed to sample the gas directly from the edge of the discharge to perform in situ measurements by mass spectrometry. The measurements are compared to the ones performed by Fourier Transform Infrared Spectroscopy (FTIR) measurements. As mass spectrometry is not limited by infrared active species, it is a complementary method to benchmark the optical measurements.

P 19.48 Thu 16:00 P

CO2 utilization in 3D-printed barrier discharge reactors — •Dimas Adrianto[1], Milko Schiorlin[1], Volker Brüser[1], Ronny Brandenburg[1,2], and Sven Grundmann[2] — [1]Leibniz Institute for plasma science and technology, Greifswald, Germany — [2]University of Rostock, Rostock, Germany

Plasma technology and rapid prototyping are two emerging technologies, each with its own set of benefits. However, the benefits of these technologies are rarely combined. The discharge chamber of Dielectric Barrier Discharge (DBD) reactors for investigating CO2 utilization were created using a 3D printer in this study. Because of rapid prototyping's high adaptability and modification potential, the results of fluid dynamics simulations can be directly introduced in the plasma reactor manufacturing process. DBD reactors are made of methacrylic acid polymer and have an overall dimension of 120 x 120 mm, with a powered electrode size of 55 x 55 mm in the center. 3D-printed reactors were initially tested with three different feed-gases: synthetic air, nitrogen, and carbon dioxide to ensure that stable plasma could be generated. Based on electrical characterization, in particular voltage-charge plots, operation parameters such as applied voltage, plasma power, and effective capacitance were studied in detail. Three DBD reactors with different gas flow distribution and velocity profiles were then investigated for carbon monoxide formation in pure CO2. In future experiments, the production of value-added chemicals such as CO and methanol will be further studied.

P 20: Invited talks V

Time: Friday 11:00–12:30 Location: P-H11

Invited Talk P 20.1 Fri 11:00 P-H11

On the hunt for a reactor-relevant scenario for W7-X — •Golo Fuchert for the W7-X team-Collaboration — Max-Planck-Institut für Plasmaphysik, Greifswald, Germany

The optimized stellarator Wendelstein 7-X (W7-X) aims to demonstrate a steady-state reactor-relevant scenario. Already the first divertor experiments at W7-X gave initial insights in how such a scenario could potentially look like, which key questions need to be answered in order to improve the performance of W7-X, and if the scenarios that will be developed can also teach us something about a potential reactor. A starting point of scenario development is the understanding of operational limits. Obviously it has to be physically possible to run a particular scenario. Here, mainly limitations arising from the ECR heating physics and the power balance (radiative density limit) have been identified in the first experimental campaigns of W7-X and essentially follow theoretical expectations. Furthermore, a reactor-relevant scenario should combine good energy confinement, steady-state conditions and divertor detachment. All three criteria have been achieved individually. Good confinement seems to depend on reduced turbulent transport in plasmas with steep density gradients. Steady-state plasmas have been achieved at moderate densities and heating powers. And detachment was demonstrated at high densities. But combining all three into an integrated scenario is a challenge that will guide the experimental exploration of W7-X for the foreseeable future. On this path, the flexibility of the magnetic configuration offers unique opportunities, but increases the complexity of the task at hand.

Invited Talk P 20.2 Fri 11:30 P-H11

Plasma für die Gaskonversion: Power-to-X — •Andreas Schulz, Katharina Wiegers, Matthias Walker und Günter Tovar — Universität Stuttgart, IGVP, Pfaffenwaldring 31, 70569 Stuttgart, Germany

Im Koalitionsvertrag 2021 - 2025 zwischen der Sozialdemokratischen Partei Deutschlands (SPD), BÜNDNIS 90 / DIE GRÜNEN und den Freien Demokraten (FDP) „Mehr Fortschritt wagen“ steht als eines der großen Ziele, die Klimaneutralität spätestens 2045 zu erreichen. Das Umweltbundesamt beziffert den deutschen Primärenergiebedarf für 2018 auf 3.942.341 TJ (1,1 EWh); davon liegt alleine der Anteil für die chemische Industrie bei rund 42 %. Für das Erreichen der angestrebten Klimaneutralität müssen Technologien erforscht werden, die Energie aus erneuerbaren Ressourcen für die chemische Industrie nutzbar machen. Eine Möglichkeit ist, elektrische Energie über Plasmaverfahren in die chemische Synthese zu integrieren. Dabei muss sich das Plasma gegenüber etablierten und sehr gut erforschten Verfahren, wie die Elektrolyse oder elektrische Widerstandserwärmung (Power-to-Heat), behaupten. Grundsätzlich wird ein Plasma dazu genutzt, um ein energetisch tief liegendes Molekül durch Energiezufuhr in einen aktivierten Zustand überzuführen. Aktuell sind am IGVP die Moleküle CO_2, N_2, und H_2O im Fokus der Forschung. CO_2 wird durch Dissoziation in CO und O· zerlegt, N_2 mit O_2 zu NO reagiert und aus H_2O wird für die Radikalchemie die beiden Radikale ·OH und H· erzeugt.

Invited Talk P 20.3 Fri 12:00 P-H11

Combined Phase Contrast Imaging and Small-Angle X-Ray Scattering Diagnostic of Relativistic Plasmas at the High Energy Density Instrument at European XFEL — •Alejandro Laso Garcia[1], Toma Toncian[1], Hauke Hoeppner[1], Alexander Pelka[1], Carsten Baehtz[1], Erik Brambrink[2], Jan-Patrick Schwinkendorf[2], Motoaki Nakatsutsumi[2], Johannes Hagemann[3], and Thomas Preston[2] — [1]Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [2]European XFEL GmbH, Schenefeld, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The bright ultra-short X-ray pulses of the EuXFEL provide an invaluable tool to spatially and temporally investigate the laser-plasma interactions at solid density.

At the HED instrument, the high-power laser ReLaX currently delivers pulses of 3 J of energy with 25 fs duration on target, reaching intensities up to 10^{20} W/cm^2.

In April and May 2021, Small Angle X-Ray Scattering and Phase Contrast Imaging were simultaneously demonstrated in pump-probe experiments at HED in a community experiment involving 15 institutions from all over the world. In this talk we will present the preliminary results of this community experiment probing ultrafast phenomena in a wide array of target configurations: hole boring in wires, shockwave generation in CH blocks, buried heating of a wire inside a CH medium, foam ionization and collective effects in heated foils.

P 21: Atmospheric Pressure Plasmas II

Time: Friday 14:00–15:45 Location: P-H11

P 21.1 Fri 14:00 P-H11

Production of crystalline silicon nanoparticles in an atmospheric plasma jet — •Maren Dworschak[1], Filip Matějka[2], Niklas Kohlmann[3], Pavel Galář[2], and Jan Benedikt[1] — [1]Institute of Experimental and Applied Physics, Kiel University, Germany — [2]Institute of Physics, Czech Academy of Sciences, Czech Republic — [3]Faculty of Engineering, Kiel University, Germany

Due to their opto-electrical properties semiconductor nanoparticles can be used in a wide range of applications including photovoltaic cells. Cold atmospheric plasmas are highly reactive systems that can be used for the generation of such nanoparticles. Compared to low pressure systems the production of crystalline particles is more challenging, but also provides economical benefits. We report on an RF-driven capacitively coupled atmospheric plasma jet with a dielectric on the electrodes. The so-called HelixJet [1] can be operated at large powers and elevated gas temperature, where its operation is not compromised by depositions inside the jet. Its original setup has been modified with an additional electrode to work reliable even at high admixtures of reactive gases. Using silane, silicon nanoparticles with precise size control can be generated over a broad range of sizes. Different reactive gas admixtures are used to modify the surface passivation of the generated nanoparticles. Under the right conditions it is possible for the particles to become crystalline. Their crystallinity is observed through measurements of (time-resolved) photoluminescence, Raman spectroscopy and TEM measurements.

[1] J. Schäfer et al., Plasma Process. Polym. 17 (2020)

P 21.2 Fri 14:15 P-H11

Vibrational excitation in a CO_2/N_2 ns-discharge — Yanjun Du[1,2], •Tsanko V. Tsankov[1], Dirk Luggenhölscher[1], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany — [2]North China Electric Power University, Beijing, China

Repetitively pulsed ns-discharges exhibit large departure from equilibrium. This is especially well suited for studying the excitation of molecules due to the separation of the time scales for population and relaxation. Of particular interest in recent years is the study of discharges in CO_2 in relation to efficient molecule dissociation through ladder climbing excitation of the vibrational states [1]. A tunable quantum cascade laser system for absorption measurements has been set up to measure this excitation with ns resolution [1,2].

Here the system is employed to obtain the excitation dynamics of the CO_2 states in a ns pulsed discharge in a near-atmospheric pressure CO_2/N_2 mixture. The mechanisms for CO_2 molecular excitation during the discharge pulse and in the subsequent afterglow are discussed and compared to the ones in discharges in CO_2/He mixtures.

[1] Y. Du, Ts. V. Tsankov, D. Luggenhölscher, U. Czarnetzki, *J. Phys. D: Appl. Phys.* **54** (2021) 365201.

[2] Y. Du, Ts. V. Tsankov, D. Luggenhölscher, U. Czarnetzki, *J. Phys. D: Appl. Phys.* **54** (2021) 34LT02.

P 21.3 Fri 14:30 P-H11

Plasma catalytic synergies of a non-equilibrium atmospheric pressure plasma jet with MnO_2 surface catalyst — •Christoph Stewig, Theresa Urbanietz, Laura Chauvet, Marc Böke, and Achim von Keudell — Ruhr-Universität Bochum Institute of Experimental Physics II Faculty for Physics and Astronomy Universitätsstraße 150 Building NB 5/174 D-44780 Bochum

Plasma catalysis seeks to exploit potential synergies between surface catalytic reactions and plasma reactions. An excess of renewable energies could be used to produce value-added molecules and thus provide the chemical industry with important reactants or allow for alternative methods of energy storage.

Potential synergetic effects are: (i) a reduction or prevention of catalyst poisoning due to a cleaning of the catalyst surface, hence (ii) a lowering of the catalyst activation temperature, and (iii) an increase in the catalyst activity due to the creation of additional reactive sites by the plasma. (iv) finally, specific molecular excitations could promote specific surface reactions.

We investigate these mechanisms in a RF driven temperature-controlled capacity coupled plasma jet at atmospheric pressure. Fourier Transformed Infrared Spectroscopy (FTIR) measurements are conducted in the plasma and yield information on the excitation and density of noble gas diluted molecules like CO_2 or n-butane.

The effect of a MnO_2 surface catalyst for temperatures of 20°C and 200°C on the dissociation of n-butan are presented.

P 21.4 Fri 14:45 P-H11

VUV-photoionization chamber for the selective study of ion-substrate interactions — •Kerstin Sgonina, Alexander Quack, Christian Schulze, and Jan Benedikt — Institute of Experimental and Applied Physics, Kiel University, Germany

The high reactivity of cold atmospheric pressure plasmas, for example with biological substrates, is in addition to the reactive neutral oxygen and nitrogen species, also based on additive or synergistic effects of these reactive species with charged species, photons, and electric fields. In contrast to photons or electric fields, the study of the isolated effect of ions with biological substrates or ion-based deposition of thin films is more challenging as their isolated production under atmospheric pressure conditions is not trivial. To prove the expected enhanced effect of ions due to their charge and internal energy, knowledge about the ion composition and absolute ion fluxes to the substrate is needed.

To study the isolated effect of ions on substrates and ion-based thin film deposition, an experimental setup has been developed in which photoionized ions are directed towards the substrate. The ions are generated in a helium atmosphere with a small admixture of O_2, C_2H_2 or other gaseous species by VUV-radiation of the helium excimer emission (60-100 nm) generated by a helium driven atmospheric pressure plasma. Mass spectra and relative ion fluxes along the substrate position are measured by ion mass spectrometry. Combined with spatial resolved current measurements, the absolute ion flux can be determined. The deposition of thin films with ions generated from C_2H_2 will be discussed.

P 21.5 Fri 15:00 P-H11

Vibrational excitation in a nanosecond discharge — •Jan Kuhfeld[1], Zoltan Donko[2], Nikita Lepikhin[1], Dirk Luggenhölscher[1], and Uwe Czarnetzki[1] — [1]Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary

Vibrational distribution functions of nitrogen are measured in a nanosecond discharge (200-250 ns, conducting electrodes) by coherent anti-Stokes Raman scattering (CARS). It is found, that for vibrational states with $v < 8$ a two temperature distribution function is a very good approximation to the vibrational distribution. The excitation conditions for vibrational states are constant during most of the discharge pulse and agree very well with the excitation rates from the literature for the given electric field, which is measured by E-FISH (electric field induced second harmonic generation). The development of the vibrational states during the afterglow is compared to a state-to-state kinetic model, which is dominated by VV transfer and transport losses. Here too, good agreement was found for rates available in the literature. Additionally, Particle-in-Cell/Monte Carlo Collisions (PIC/MCC) simulations are performed for the same conditions as in the experiments. The results of these simulations are used to derive analytical models for the discharge. The models can explain the value of the reduced electric field in the plasma bulk (about 80% of the discharge volume), which favors vibrational excitation.

P 21.6 Fri 15:15 P-H11

CO2 dissociation by a nanosecond pulsed dielectric barrier discharge — •Sepideh Mousazadeh Borghei, Volker Brüser, and Juergen F. Kolb — Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany

Reduction of CO2 into value-added chemicals and fuels by means of plasma technology has gain significant interest in recent years. In this project, a coaxial dielectric barrier discharge generated with high voltage pulses of 15-20 kV and a pulse duration of 500 ns at ambient temperature and atmospheric pressure was used to investigate the process of CO2 splitting for CO2 and an admixture of Ar in the ratio of 1:2 (CO2:Ar). The influence of gas flow rate and more importantly the effects of positive and negative polarity on the process of dissociation were investigated. The gaseous product after plasma treatment was analyzed by Fourier transform infrared spectroscopy. The results indicated that gas flow rate plays an important role in the process of dissociation, which the highest CO2 conversion of 5.6% detected for the lowest flow. In addition, positive polarity shows an up to 1.3 fold higher CO concentration compared to negative polarity. Indeed, the obtained results from the inception voltage approved that less voltage was required to start the plasma in positive polarity, and therefore, at the same condition, there are more filamentary channels in positive polarity than negative polarity.

P 21.7 Fri 15:30 P-H11

CO2 conversion in a barrier corona discharge at elevated pressures — •Hamed Mahdikia, Volker Brüser, and Ronny Brandenburg — Leibniz Institute for Plasma Science and Technology, 17489, Greifswald, Germany

A barrier corona discharge in CO2 with admixture of Argon is studied. The aim is to investigate the operation at elevated pressures up to 5 bar for industrial scale CO2 conversion. Therefore, the coaxial asymmetric dielectric barrier discharge contains an inner brush electrode to intensify the electric field strength and to minimize the amplitude of the applied high voltage driving the discharge. Charge-voltage plots are used to characterize the discharge. Depending on the conditions (sinusoidal voltage amplitude, gas composition and pressure), full or partial coverage of the electrodes is obtained. This so-called partial discharging is monitored by the variation of the effective dielectric capacitance. Optical emission spectroscopy was done at full coverage condition for each gas composition and pressure. The line intensity ratio of atomic oxygen at 777 nm to Argon excited species at 772 nm increase significantly by increasing the pressure. On the other hand, absolute CO2 conversion decreases by increasing the CO2 content in the gas mixture and pressure at constant specific energy input (SEI=1.5 kJ/L) while effective conversion increases as well as the energy efficiency, and CO production. A correlation of the mean reduced electric field strength (E/N) and the CO2 dissociation is found. The E/N decreased by increasing the pressure and sustaining voltage to ~ 40 Td for 5 bar which leads to a higher dissociation degree.

P 22: Helmholtz Graduate School HEPP V

Time: Friday 14:00–15:15 Location: P-H12

P 22.1 Fri 14:00 P-H12

Experimental validation of gyrokinetic simulation with scale-resolved multi-field turbulence measurements — •Klara Höfler[1,2], Tobias Görler[2], Tim Happel[2], Pascale Hennequin[3], Pedro Molina Cabrera[2,4], Michael Bergmann[2], Rachel Bielajew[4], Carsten Lechte[5], Anne White[4], Ulrich Stroth[2,1], and the ASDEX Upgrade Team[2] — [1]Physik Department E28, TUM, Garching, Germany — [2]MPI für Plasmaphysik, Garching, Germany — [3]LPP, Ecole Polytechnique, Palaiseau, France — [4]MIT PSFC, Cambridge, Massachusets, USA — [5]IGVP, Stuttgart, Germany

Turbulence is the main driver of heat transport which deteriorates the performance of fusion reactors. To design turbulence optimised devices, simulation codes need to be validated by experiments. Validation work has already been done for single or a reduced number of parameters.

The comprehensive set of turbulence data presented in this contribution is measured on ASDEX Upgrade in different plasma scenarios but at the same radius. It includes wavenumber spectra, density and temperature fluctuation amplitudes and radial correlation lengths, the poloidal dependence of the velocity perpendicular to the magnetic field and the cross phase between density and temperature fluctuations.

These quantities are measured for extensive code validation by Doppler reflectometers and a CECE radiometer. They are compared to non-linear simulations of the gyrokinetic code GENE because of its mature capabilities to assess and reproduce core turbulence. In addition synthetic diagnostic modeling accounts for diagnostic effects.

P 22.2 Fri 14:25 P-H12

The importance of the tertiary instability in the collisionless Dimits regime — •Axel Hallenbert and Gabriel Plunk — Max-Planck-Institut für Plasmaphysik, D-17491 Greifswald, Germany

The upshift from the linear instability threshold until turbulent transport commences, caused by self-generated zonal flows, is known as the Dimits shift. Though this phenomenon could facilitate enhanced magnetic confinement device performance, it has proved difficult to understand and quantitatively predict except in simple cases. These have generally been of the simple fluid model kind, so to proceed towards more realistic scenarios, fully gyrokinetic simulations have been used to investigate the Dimits shift in simple geometries. Here the tertiary instabilty, which describes how zonal flows give way to increasing drift waves, was both the main tool and focus. Many features and dynamics previously linked to this instability in fluid models were indeed confirmed to remain in the presence of kinetic effects. Of greatest importance, in the collisionless regime this facilitates an efficient and here accurate Dimits shift prediction, while also hinting at its further validity in more varied geometries.

P 22.3 Fri 14:50 P-H12

Excitation of High Frequency Waves in Full-6D Kinetic Simulations of Magnetically Confined Plasmas — •Mario Raeth, Klaus Hallatschek, and Katharina Kormann — Max Planck Institute für Plasmaphysik, Garching, Deutschland

Although current gyrokinetic computer simulations are in fair agreement with experimental results in core physics, the assumptions in the derivation make them unreliable in regimes of higher fluctuation amplitudes and stronger gradients, such as the tokamak edge. To correctly describe all phenomena in such regimes, more involved simulations might be necessary. We have developed a novel optimised and scalable semi-Lagrangian solver to simulate ion-temperature gradient modes with the full 6D kinetic equations. It has been verified extensively in the regime of gyrokinetics, including the growth of linear modes and the turbulent saturation. Furthermore, the excitation of high-frequency Bernstein waves (IBWs) has been shown in the non-linear saturation phase. To increase the understanding of the relevance of such high-frequency waves in turbulence, we investigated various excitation mechanisms. Investigations range from non-linear transfer of energy up the frequency scale, to the presence of secondary linear instabilities. The latter lead to a model which allows us to predict a threshold, in the amplitude of a primary gyrokinetic mode, for the excitation and the resulting growth rate of the secondary instability. This helps us to predict the presence and amplitude of IBWs in non-linear ITG simulations, which we could confirm by simulations in our full-6D kinetic code.

Working Group on Accelerator Physics
Arbeitskreis Beschleunigerphysik (AKBP)

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Overview of Sessions

(Lecture halls AKBP-H13 and AKBP-H14; Poster P)

Invited talks of the joint symposium Plasma Induced Accelerators (SYPA)

See SYPA for the full program of the symposium.

SYPA 1.1	Wed	11:00–11:30	Audimax	**Laser-driven ion acceleration -20 years of research: applications and prospect-** — •Markus Roth
SYPA 1.2	Wed	11:30–12:00	Audimax	**Laser-plasma ion accelerators for radio-biological research** — •Karl Zeil
SYPA 1.3	Wed	12:00–12:30	Audimax	**Hybrid plasma accelerators towards higher-quality electron beams** — •S. Karsch, M. Foerster, A. Döpp, M. Gilljohann, J. Götzfried, K. v. Grafenstein, F. Haberstroh, J. Wenz, S. Corde, O. Kononenko, B. Hidding, T. Heinemann, T. Kurz, J. Couperus-Cabadag, U. Schramm, A. Debus, A. Martinez de la Ossa

Sessions

AKBP 1.1–1.6	Mon	14:00–15:30	AKBP-H13	**New Accelerator Concepts 1**
AKBP 2.1–2.5	Mon	14:00–15:15	AKBP-H14	**Radiofrequency Systems 1**
AKBP 3.1–3.7	Mon	16:00–17:45	AKBP-H13	**Diagnostics, Control and Instrumentation 1**
AKBP 4.1–4.6	Mon	16:00–17:30	AKBP-H14	**Radiation Generation and Applications**
AKBP 5.1–5.6	Tue	14:00–15:30	AKBP-H13	**Hadron Accelerators – New Devices and Techniques**
AKBP 6.1–6.6	Tue	14:00–15:30	AKBP-H14	**Beam Dynamics 1**
AKBP 7.1–7.6	Tue	16:00–17:30	AKBP-H13	**Particle Sources**
AKBP 8.1–8.6	Tue	16:00–17:30	AKBP-H14	**Radiofrequency Systems 2 – Superconductivity**
AKBP 9.1–9.6	Wed	14:00–15:30	AKBP-H13	**Diagnostics, Control, Modeling, Modern IT Applications**
AKBP 10.1–10.5	Wed	14:00–15:15	AKBP-H14	**Electron Accelerators and FEL's**
AKBP 11.1–11.7	Wed	16:00–17:45	AKBP-H13	**Beam Dynamics 2**
AKBP 12.1–12.6	Wed	16:00–17:30	AKBP-H14	**New Accelerator Concepts 2**
AKBP 13.1–13.7	Thu	14:00–15:45	AKBP-H13	**Diagnostics, Control and Instrumentation 2**
AKBP 14.1–14.7	Thu	16:00–17:30	P	**Posters**
AKBP 15	Thu	18:00–19:00	AKBP-MV	**Members' Assembly**

Members' Assembly of the Working Group on Accelerator Physics

Thursday 18:00–19:00 AKBP-MV

Sessions

– Contributed Talks and Posters –

AKBP 1: New Accelerator Concepts 1

Time: Monday 14:00–15:30 Location: AKBP-H13

AKBP 1.1 Mon 14:00 AKBP-H13

A new transport line for transverse gradient undulator experiments at the JETI laser plasma accelerator in Jena — •Maisui Ning, Samira Fatehi, Axel Bernhard, Robert Rossmanith, and Anke-susanne Müller — KIT,Karlsruhe,Germany

In this contribution, we describe the current status of the ongoing upgrade of an electron beam transport line employed in the successful experimental demonstration of capture and matching of a laser plasma-accelerated beam at the JETI laser facility, University of Jena. This upgrade aims at adapting the beam line to the higher electron energies achievable with the new JETI laser and enabling an experimental proof of the transverse gradient undulator concept to be performed in a collaboration between KIT and the University of Jena. The upgrade comprises the redesign of both the beam transport line magnets and of the beam optics, which will be described and discussed in detail. This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 1.2 Mon 14:15 AKBP-H13

Synthetic shadowgrams of laser-plasma accelerators computed by a PIConGPU in-situ plugin — •Finn-Ole Carstens[1,2], Klaus Steiniger[1], Richard Pausch[1], Yen-Yu Chang[1], Susanne Schöbel[1], Jurjen Couperus[1], Arie Irman[1], Max Lehmann[1,2], Rene Widera[1], Michael Bussmann[1,3], Ulrich Schramm[1,2], Thomas Cowan[1,2], and Alexander Debus[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Technische Universität Dresden — [3]Center for Advanced Systems Understanding Görlitz

Few-cycle shadowgraphy is a valuable diagnostic for laser-plasma accelerators to obtain insight into the μm- and fs-scale relativistic plasma dynamics. To enhance the understanding of experimental shadowgrams we developed a synthetic shadowgram diagnostic within the fully relativistic particle-in-cell code PIConGPU.

In an initial version of the synthetic shadowgraphy diagnostic, the probe laser is propagated through the plasma using PIConGPU, and then extracted and propagated onto a virtual CCD using a post-processing code based on Fourier optics. However, the latter step requires 3D-FFTs, which results in performance and scaling limitations in large-scale simulations. To circumvent this, we develop an in-situ plugin for PIConGPU, in which we extract the probe laser slice-wise to obtain the synthetic shadowgrams during the simulation without post-processing.

In this talk, we present the development of the PIConGPU plugin and show preliminary results of synthetic shadowgrams for laser and plasma wakefield accelerators.

AKBP 1.3 Mon 14:30 AKBP-H13

Simulating hybrid laser-plasma wakefield accelerators using PIConGPU — •R. Pausch[1], J. P. Couperus[1], S. Schöbel[1,2], S. Bastrakov[1], Y.-Y. Chang[1], S. Corde[4], H. Ding[5,6], A. Döpp[5,6], F. M. Foester[5], M. Gilljohann[4,5,6], F. Haberstroh[5], T. Heinemann[7,8], B. Hidding[8], S. Karsch[5,6], A. Koehler[1], O. Kononenko[4], A. Knetsch[4], T. Kurz[1,2], A. Martines de las Ossa[7], A. Nutter[8], G. Raj[4], K. Steiniger[1], U. Schramm[1,2], P. Ufer[1,2], R. Widera[1], A. Irman[1], M. Bussmann[3,1], and A. Debus[1] — [1]HZDR — [2]TU Dresden — [3]CASUS — [4]LOA — [5]LMU — [6]MPQ — [7]DESY — [8]University of Strathclyde

An LPWFA accelerator uses electrons from a laser wakefield accelerator stage to drive a second plasma wakefield accelerator stage. This approach makes it possible to downscale PWFAs from kilometer-sized facilities to tabletop experiments and makes the improved beam quality of PWFAs available to LWFA laboratories. The experimental realization of the hybrid accelerator at HZDR was accompanied by a simulation campaign with the fully GPU accelerated, 3D3V particle-in-cell PIConGPU. Running simulations on modern GPUs allowed reducing simulation time while modeling different experimental settings in a fully three-dimensional setup. The latter enabled studying the influence of tilted shock fronts and few-cycle probes, among others. In this talk, we will not only introduce the general concept but also discuss some of the recent results obtained using particle-in-cell simulations. Moreover, the technical innovations in PIConGPU that have enabled these new types of simulations will also be briefly addressed.

AKBP 1.4 Mon 14:45 AKBP-H13

Investigation of beam quality enhancement with tailored down-ramp profiles in laser wakefield accelerators using particle-in-cell simulations — •Jonas Günzl[1,2], Richard Pausch[1], Sergei Bastrakov[1], Michael Bussmann[3,1], Yen-Yu Chang[1], Jurjen Couperus[1], Arie Irman[1], Susanne Schöbel[1,2], Klaus Steiniger[1], René Widera[1], Ulrich Schramm[1,2], and Alexander Debus[1] — [1]HZDR — [2]TU Dresden — [3]CASUS

Electrons from laser wakefield accelerators (LWFA) can be ultrashort and quasi-monoenergetic. They have the potential to be an ideal source for advanced light sources or beam drivers for hybrid laser-plasma wakefield accelerators (LPWFA). A wide variety of injection methods have already been developed to produce high-quality LWFA electrons. However, such high-quality electron bunches may degrade upon exiting the LWFA stage.

This poster addresses quality-preserving methods for extracting electron beams from laser wakefield accelerators by adjusting the plasma density of the down ramp. By modeling different gas profiles with the fully relativistic particle-in-cell code PIConGPU, not only the final beam quality but also all relevant physical effects can be studied in detail. This allows not only to find an optimal quality-preserving down ramp but also to study the influence of changes in laser focus position on beam properties during extraction.

AKBP 1.5 Mon 15:00 AKBP-H13

Progress toward high overall energy efficiency in a beam-driven plasma-wakefield accelerator stage — •Felipe Peña[1,2], Judita Beinortaite[1,3], Jonas Björklund Svensson[1], Lewis Boulton[1,4,5], Gregory Boyle[1], Jonathan Christopher Wood[1], Brian Foster[6], James Matthew Garland[1], Pau Gonzalez[1,2], Carl A. Lindstrøm[1], Gregor Loisch[1], Sarah Schröder[1], Stephan Wesch[1], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [3]University College London, London, United Kingdom — [4]SUPA, Department of Physics, University of Strathclyde, Glasgow, United Kingdom — [5]The Cockcroft Institute, Daresbury, United Kingdom — [6]John Adams Institute, University of Oxford, UK

Beam-driven plasma-wakefield acceleration has the potential to reduce the building cost of accelerator facilities, with large accelerating fields that are orders of magnitude greater than radio-frequency cavities. Sustaining strong decelerating fields for the driver and strong accelerating fields for the trailing bunch across long plasma stages will be key to demonstrating high energy efficiency in this scheme. We present preliminary experimental results towards high overall energy efficiency performed at the FLASHForward plasma-accelerator facility at DESY.

AKBP 1.6 Mon 15:15 AKBP-H13

Experimental results of Trojan horse injection in a hybrid LPWFA — •Patrick Ufer[1,2], Alastair Nutter[3], Yen-Yu Chang[1], Sébastien Corde[4], Jurjen Couperus Cabadağ[1], Alexander Debus[1], Andreas Döpp[5], Thomas Heinemann[3,6], Bernhard Hidding[3], Max Gilljohann[4,5], Stefan Karsch[5], Alexander Köhler[1], Olena Kononenko[4], Richard Pausch[1], Susanne Schöbel[1,2], Alberto Martinez de la Ossa[6], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany — [3]University of Strathclyde, Glasgow, UK — [4]LOA, ENSTA ParisTech, CNRS, Ecole Polytechnique, Université Paris-Saclay, France — [5]Ludwig-Maximilians-Universität München, Germany — [6]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

A hybrid (LPWFA) plasma accelerator combines the two schemes of plasma acceleration, using a laser (LWFA) and an electron beam (PWFA) to drive the plasma wave, with the goal to combine the advantages of both methods. This concept allows studies of PWFA-physics in compact setups as well as generating high-quality electron beams to fulfill the demands of secondary light sources like FELs. We present experimental results from hybrid plasma accelerators using plasma cathode injection also known as Trojan horse injection. A short-pulsed laser is used as the injector in the second stage of the accelerator propagating perpendicular to the electron beam. When timed such, that injector laser and the first cavity of the wakefield overlap, the creation of low-energy-spread witness beams have been observed.

AKBP 2: Radiofrequency Systems 1

Time: Monday 14:00–15:15 Location: AKBP-H14

AKBP 2.1 Mon 14:00 AKBP-H14

Goubau-Line Set Up for Bench Testing Impedance of IVU32 Components — •Paul Volz — Helmholtz-Zentrum Berlin — Johannes Gutenberg Universität Mainz

The worldwide first in-vacuum elliptical undulator, IVUE32, is being developed at Helmholtz-Zentrum Berlin. The 2.5 m long device with a period length of 3.2 cm and a minimum gap of about 7 mm is to be installed in the BESSY II storage ring. It will deliver radiation in the soft X-ray range to several beamlines. The proximity of the undulator structure to the electron beam makes the device susceptible to wakefield effects which can influence beam stability. A complete understanding of its impedance characteristics is required prior to installation and operation, as unforeseen heating of components could have catastrophic consequences. To understand and measure the IVU's impedance characteristics a Goubau-Line test stand is being designed. A Goubau-line is a single wire transmission line for high frequency surface waves with a transverse electric field resembling that of a charged particle beam out to a certain radial distance. A concept optimized for bench testing IVUE32-components will be discussed, microwave simulations will be presented, and progress towards a test bench prototype will be shown.

AKBP 2.2 Mon 14:15 AKBP-H14

Commissioning of a new B-Mapping System for SRF Cavity Performance Tests — •Jonas C. Wolff[1,2], Wolfgang C. A. Hillert[1,2], Andre Gössel[1], Detlef Reschke[1], Lea Steder[1], and Lennart Trelle[1] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestraße 85, 22607 Hamburg — [2]Universität Hamburg - Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

Magnetic flux trapped in the Niobium bulk material of superconducting radio frequency (SRF) cavities degrades their quality factor and the accelerating gradient. The sensitivity for flux trapping is mainly determined by the treatment and the geometry of the cavity as well as the Niobium grain size and orientation. To potentially improve the flux expulsion characteristics of SRF cavities and hence the efficiency of future accelerator facilities, further studies of the trapping behavior are essential. For this purpose a so-called B-mapping system to monitor the magnetic flux along the outer cavity surface of 1.3 GHz TESLA-Type single-cell SRF cavities has been developed and is currently in the commissioning phase at DESY. Contrary to similar approaches, this system digitizes the sensor signals already inside of the cryostat to extensively reduce the number of required cable feedthroughs. Furthermore, the signal-to-noise ratio and consequently the measuring sensitivity can be enhanced by shorter analog signal lines, less thermal noise and the Mu-metal shielding of the cryostat. In this contribution the design, required signal processing circuitry for the calibration as well as first performance test results of the B-mapping system are presented in detail.

AKBP 2.3 Mon 14:30 AKBP-H14

Upgrading the Booster Synchrotron RF with a Solid State Amplifier — •Michael Switka, Frank Frommberger, Klaus Desch, Philipp Hänisch, and Daniel Elsner — Elektronen-Stretcher-Anlage ELSA, Physikalisches Institut, Universität Bonn

The DESY-type RF resonator of the ELSA facility's 1.6 GeV synchrotron has been powered by a conventional klystron amplifier since its early days in 1967. The setup was modified to serve the ELSA stretcher ring as booster synchrotron in 1987, but the RF infrastructure was barely altered. As repairs of the reliable, but antiquated RF source become foreseeingly impossible due to the lack of spare part availability, the replacement of the klystron amplifier chain in favour of a state-of-the-art solid state amplifier is carried out. We present the current status of the replacement procedure and first results.

AKBP 2.4 Mon 14:45 AKBP-H14

Upgrade of the 25 MW RF Station for the Linear Accelerator LINAC2 at ELSA — •Dennis Proft, Klaus Desch, and Daniel Elsner — Elektronen-Stretcher-Anlage ELSA, Physikalisches Institut, Universität Bonn

At the Electron Stretcher Facility ELSA the first acceleration stage consists of a 3 GHz traveling wave linear accelerator. It was powered by a 25 MW pulsed high power klystron amplifier. After a failure of the focusing solenoid the required output power could not be reached anymore resulting in an inadvertently complete overhaul of the RF station.

The new RF station has successfully been operating since the beginning of 2021. In this contribution I will present the new setup including the new parameter monitoring capabilities as well as the lessons learned in RF engineering as an accelerator physicist.

AKBP 2.5 Mon 15:00 AKBP-H14

Update of the Quadrupole Resonator for SRF R&D at DESY — •Ricardo Monroy-Villa[1,2], Detlef Reschke[1], Andrea Muhs[1], Jan-Hendrik Thie[1], Maike Röhling[1], Martin Lemke[1], Wolfgang Hillert[2], Marc Wenskat[2], Wolfgang Ackermann[3], Sebastian Keckert[4], and Oliver Kugeler[4] — [1]Deutsches Elektronen-Synchrotron, Hamburg, Germany — [2]Universität Hamburg, Institut für Experimentalphysik, Hamburg, Germany — [3]Institut für Teilchenbeschleunigung und Elektromagnetische Felder, Darmstadt, Germany — [4]Helmholtz-Zentrum Berlin, Berlin, Germany

Superconducting radiofrequency (RF) cavities made of Nb have been shown to achieve their theoretical limit, while only minor improvements using standard procedures are expected in operation. Hence, new treatments and materials that tailor the RF surface are mandatory. Since theoretical models of the RF behavior of such surfaces do not fully describe the observations, we lack guidance for future research and identifying important parameters. To provide experimental data to improve these theoretical models and study material properties, and their impact on the RF performance, a dedicated sample test system is needed. The quadrupole resonator (QPR) is such a test cavity and allows for investigating samples of 7.5 cm in diameter under superconducting-cavity-like conditions in a wide parameter space defined by temperature, magnetic field and frequency. In this work we report the status of the QPR being developed as a joint project of Universität Hamburg and DESY.

AKBP 3: Diagnostics, Control and Instrumentation 1

Time: Monday 16:00–17:45 Location: AKBP-H13

AKBP 3.1 Mon 16:00 AKBP-H13

Simulation of the effect of corrugated structures on the longitudinal beam dynamics at KARA — •Sebastian Maier[1], Miriam Brosi[2], Akira Mochihashi[2], Michael J. Nasse[2], Markus Schwarz[2], and Anke-Susanne Müller[1,2] — [1]LAS, KIT, Karlsruhe — [2]IBPT, KIT, Karlsruhe

Two parallel corrugated plates will be installed at the KIT storage ring KARA (KArlsruhe Research Accelerator). This impedance manipulation structure will be used to study and eventually control the beam dynamics and the emitted coherent synchrotron radiation (CSR). In this contribution, we present the influence of the parameters of the structure on its impedance and simulation results obtained with the Vlasov-Fokker-Planck solver Inovesa showing the impedance impact of different corrugated structures on the CSR power. This work is supported by the DFG project 431704792 in the ANR-DFG collaboration project ULTRASYNC. Sebastian Maier acknowledges the support by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology"

AKBP 3.2 Mon 16:15 AKBP-H13

Implementing electro-optical detection methods for far-field THz detection at DELTA — •Vivek Vijayan, Arne Held, Shaukat Khan, Carsten Mai, and Boris Sawadski — Center for Synchrotron Radiation (DELTA), TU Dortmund, Dortmund, Germany

At the DELTA storage ring at TU Dortmund University, ultrashort THz pulses are coherently emitted by the interaction of a single electron bunch with an ultrashort laser pulse. This THz radiation can be used as a diagnostics tool for the laser-electron interaction as well as for studies of general storage ring parameters and electron beam dynamics. Currently, different thermal and photoconductive THz detectors are used at DELTA, which are sensitive to the intensity of the radiation. Detection schemes using the electro-optic effect enable a quantitative detection of the THz pulse shape with sub-picosecond resolution and are sensitive to both amplitude and phase information of the signal. An experimental setup based on electro-optical detection is currently being implemented at DELTA and its progress is discussed.

AKBP 3.3 Mon 16:30 AKBP-H13

Picosecond time-resolved solvated electron evolution triggered within laser-accelerated proton tracks in liquid water — •Alexander Prasselsperger[1], Mark Coughlan[2], Nicole Breslin[2], Mark Yeung[2], Christine Arthur[2], Hannah Donnelly[2], Steven White[2], Masoud Afshari[1], Martin Speicher[1], Rong Yang[1], Balder Villagomez-Bernabe[3], Frederick J. Currell[3], Jörg Schreiber[1], and Brendan Dromey[2] — [1]Fakultät für Physik, Ludwig-Maximilians-Universität München — [2]School of Mathematics and Physics, Queens University Belfast — [3]School of Chemistry, The University of Manchester

The processes initiating ion track formation in matter are fundamental to radiation science. Gauduel et al. (2010) proposed the dissipation time within these tracks to scale with the local energy density. This especially applies to state-of-the-art laser-based accelerators where peak currents of $> 10^6 A$ have been reached. Utilising a laser-ion-accelerator, we were able to demonstrate these delaying mechanisms for the first time (PRL 2021). By picking a synchronized chirped probe from the main driving laser pulse of a TNSA scheme, we implemented a single-shot $1.12ps$ time-resolved transmission imaging setup. Probing the interactions of accelerated proton bunches in H_2O with this setting revealed the temporal evolution of the solvated electron density over $1ns$ covering both, the x-ray and the ion bunch interactions emitted during the TNSA process. The absolute timing reference provided by the x-rays enabled the measurement of a $> 20ps$ delay in solvation time when compared to models presuming lower local energy density.

AKBP 3.4 Mon 16:45 AKBP-H13

Slow control loop to stabilize the RF power of the FLUTE electron gun — •Marvin Noll, Nigel Smale, Andreas Böhm, Igor Kriznar, Marcel Schuh, Robert Ruprecht, John Jelonnek, and Anke-Susanne Müller — Karlsruher Institut für Technologie (KIT), Karlsruhe, Germany

The linear accelerator FLUTE (Far Infrared Linac and Test Experiment) at KIT serves as a test facility for accelerator research and for the generation of ultra-intense coherent THz radiation.

To achieve stable THz photon energy and optimal beam trajectory, the energy of the electrons emitted from the RF photo-injector must be stable. The accelerating voltage of the RF cavity has been shown to be a significant influencing factor. Here, we report on the development of a slow closed-loop feedback system to stabilize the RF power and thus the accelerating voltage in the RF photo-injector cavity. With this closed-loop feedback system the relative standard deviation of the RF power in the cavity can be improved by 8.5 %.

AKBP 3.5 Mon 17:00 AKBP-H13

A streak camera for measuring the temporal correlation of two pulses in the few-fs range — •Marc Osenberg, Michael Stumpf, and Georg Pretzler — Institut für Laser- und Plasmaphysik, Heinrich-Heine-Universität Düsseldorf

For experiments with fs-scale XFEL or electron pulses together with laser pulses, the mutual timing is crucial. In this talk we present a novel all-optical method for obtaining such timing results with fs resolution. We developed a setup based on a Kerr gate which was elongated into a 1D structure along which single-shot temporal resolution is created within a tunable time window in the ps-range like in a streak camera. The setup requires an ultrashort laser pulse as the gate and an arbitrary light pulse as the signal. In the talk, we will present the setup and its characteristics and will discuss different ways to use it for various signal types, like OTR in the case of an electron pulse, for example.

AKBP 3.6 Mon 17:15 AKBP-H13

Laser alignment of internal components of the linear accelerator FLUTE — •Jens Schäfer, Bastian Härer, Matthias Nabinger, Michael J. Nasse, Robert Ruprecht, Nigel J. Smale, and Anke-Susanne Müller — KIT, Karlsruhe, Deutschland

The linac-based test facility FLUTE (Ferninfrarot Linac- Und Test Experiment) at KIT will be used to study novel accelerator technology and provide intense THz pulses. The latest experiments involving a Split Ring Resonator for longitudinal bunch profile measurements pushed the requirements on alignment precision of several hardware components down to the sub-milimeter level. In order to achieve the required precision, the low energy section of FLUTE was opened and an alignment laser was installed to mark mechanical axis of the machine. This presentation addresses details and challenges of this laser-based alignment process. Jens Schäfer acknowledges the support by the Doctoral School KSETA (Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology).

AKBP 3.7 Mon 17:30 AKBP-H13

Development of an electro-optical longitudinal bunch profile monitor at KARA towards a beam diagnostics tool for FCC-ee — •Micha Reissig[1], Erik Bründermann[1], Stefan Funkner[1], Bastian Härer[1], Gudrun Niehues[1], Meghana M. Patil[2], Christina Widmann[2], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

The Karlsruhe Research Accelerator (KARA) at KIT features an electro-optical (EO) near-field diagnostics setup to conduct turn-by-turn longitudinal bunch profile measurements in the storage ring using electro-optical spectral decoding (EOSD). Within the Future Circular Collider Innovation Study (FCCIS) an EO monitor using the same technique is being conceived to measure the longitudinal profile and center-of-charge of the bunches in the future electron-positron collider FCC-ee. This contribution provides an overview of the EO near-field diagnostics at KARA and discusses the development and its challenges towards an effective beam diagnostics concept for the FCC-ee.

M. R. and M. M. P. acknowledge the support by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology". C. W. achnowledges funding by BMBF contract number 05K19VKD.

AKBP 4: Radiation Generation and Applications

Time: Monday 16:00–17:30 Location: AKBP-H14

AKBP 4.1 Mon 16:00 AKBP-H14

Status of Thomson Backscattering Investigation at MESA — •Christoph Lorey[1] and Atoosa Meseck[1,2] — [1]Johannes Gutenberg Universität, Mainz, Germany — [2]Helmholtz Zentrum Berlin, Berlin, Germany

At the Johannes Gutenberg University (JGU) in Mainz, a new accelerator is currently under construction in order to deliver electron beams of up to 155 MeV to two experiments. The Mainz Energy-recovering Superconducting Accelerator (MESA) will offer two modes of operation, one of which is an energy-recovering (ER) mode. As an ERL, MESA, with it's high brightness electron beam, is a promising accelerator for supplying a Thomson back scattering based Gamma source. Furthermore, at MESA, the polarization of the electron beam can be set by the injector. The aim of this work under the GraKo AccelencE is to provide a concept and comprehensive analysis of the merit and practical feasibility of a Thomson backscattering source at MESA under consideration of beam polarization and transversal effects. In this presentation, an overview and first results of our semi analytical approach to calculate various Thomson back scattering light source scenarios at MESA will be given.

AKBP 4.2 Mon 16:15 AKBP-H14

A novel compact x-ray source for microbeam radiation therapy — •Christoph Matejcek[2,4], Johanna Winter[1,2,3], Jan J. Wilkens[2,3], Stefan Bartzsch[1,2], and Kurt Aulenbacher[4,5,6] — [1]Helmholtz Zentrum München GmbH, Neuherberg — [2]TU München, School of Medicine und Klinikum rechts der Isar, München — [3]TU München, Physik-Department, Garching — [4]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz — [5]elmholtz Institut Mainz — [6]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt

Microbeam radiation therapy is a new preclinical concept in radiation oncology. Due to the use of 25 to 100 um wide and a few 100 um separated planar x-ray beams, high peak dose values are crucial. Additionally, low photon energy of a few 100 keV and high dose rates are demanded to suppress blurring of the dose pattern. To produce such x-rays with a preclinical prototype of a compact microbeam x-ray tube, a new electron source with a fast rotating target for x-ray production is under development. The source will deliver electrons with a kinetic energy of 300 keV and a current of 300 mA on a strongly eccentric 0.05 mm x 30 mm focal spot. Transport of these high currents at low energy will be challenging concerning space charge forces. Furthermore, the realization of the focal spot, a good beam quality, and a low emittance are major topics. An additional application of the x-ray source can be phase contrast imaging. The final design of the x-ray source and the results of the electron tracking simulations will be presented.

AKBP 4.3 Mon 16:30 AKBP-H14

Spectro-temporal properties of CHG radiation — •Arjun Radha Krishnan, Benedikt Büsing, Arne Held, Hubertus Kaiser, Shaukat Khan, Carsten Mai, and Vivek Vijayan — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

The short-pulse facility at the 1.5-GeV synchrotron light source DELTA, operated by the TU Dortmund University, currently employs the Coherent Harmonic Generation (CHG) technique to generate ultrashort coherent radiation pulses in the vacuum ultraviolet spectrum. This is achieved via a laser-induced electron energy modulation and a subsequent dispersive section which converts it to a corresponding density modulation. The spectro-temporal properties of the CHG pulses can be manipulated by the chirp of the seed laser pulses and the strength of the dispersive chicane (R56).

CHG spectra for 400 nm, 266 nm and 200 nm were recorded under variation of R56 and laser chirp of the 800 nm seed laser pulses. The measured spectra and results of numerical simulations to reconstruct the spectra will be presented.

AKBP 4.4 Mon 16:45 AKBP-H14

Utilizing the ELSA accelerator for evaluation of the FLASH effect with ultra-high energy electrons — •Alexandra Wald[1], Manuela Denz[2], Klaus Desch[1], Daniel Elsner[1], Stephan Garbe[2], Frank Giordano[2], Carsten Herskind[3], and Dennis Proft[1] — [1]Elektronen-Stretcher-Anlage ELSA, Physikalisches Institut, Universität Bonn — [2]Universitätsklinikum Bonn — [3]Medizinische Fakultät Mannheim, Universität Heidelberg

At the electron accelerator facility ELSA electrons with a final energy from 0.8GeV up to 3.2GeV can be accelerated and stored. These electrons can be extracted to one of the two detectors for hadron physics experiments as well as to a detector testing site, where the primary electron beam is directly provided for internal and external users.

In cooperation with the University Hospital Bonn (UKB), this test beam line will be used to carry out basic experiments on irradiation of biological cells to evaluate the FLASH-effect using ultra-high energy electron (UHEE) beams. This requires short and intense electron pulses in the order of microseconds to be extracted via a newly designed extraction mode from the storage ring. Furthermore, new diagnostics are planned to be set up to verify the reproducibility of overall charge and position of the electron pulses.

The first steps towards systematic irradiation of cells for measuring the relative biological effectiveness will be presented.

*Funded by the TRA Matter and TRA Life and Health (University of Bonn) as part of the Excellence Strategy of the federal and state governments.

AKBP 4.5 Mon 17:00 AKBP-H14

Status of the Laser-Compton backscattering Source at the S-DALINAC* — •Maximilian Meier, Michaela Arnold, Joachim Enders, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Germany

Compton scattering of a Laser beam off an ultra-relativistic electron beam ($E_e \gg m_e c^2$) through a restricted aperture can provide quasi-monochromatic highly polarized X-ray or gamma-ray beams for a variety of applications [1]. Highest energies of the scattered photons are obtained for photon-scattering angles of 180°, i. e., backscattering. A powerful stable and well synchronized laser with a high repetition rate is essential for a high-flux Laser-Compton light source with narrow energy-bandwidth. A project at TU Darmstadt foresees to synchronize a highly repetitive high-power laser with the Superconducting DArmstadt electron LINear ACcelerator (S-DALINAC [2]), capable of running in energy recovery mode [3], to realize a Laser-Compton backscattering (LCB) source with photon beam energies up to 180 keV. An overview over the design concept of the LCB Source at the S-DALINAC will be given, simulations on the layout and the estimated output will be presented.

[1] C. Bemporad et al., Phys. Rev. 138, B1546 (1965)
[2] N. Pietralla, Nucl. Phys. News 28(2), 4 (2018)
[3] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101(2020)

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AKBP 4.6 Mon 17:15 AKBP-H14

Investigation of irradiation damage in Ti6Al4V via high-energy x-ray diffraction — •Tim Lengler[1,4], Dieter Lott[1], Gudrid Moortgat-Pick[2,4], Sabine Riemann[3], Andrey Ushakov[2], Emad Maawad[1], Andreas Stark[1], and Peter Staron[1] — [1]Institute of Material Research, Helmholz-Zentrum Hereon, 21502 Geesthacht, Germany — [2]Deutsches Elektronen-Synchrotron (DESY), 22607 Hamburg, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), 15738 Zeuthen, Germany — [4]Universität Hamburg, 20148 Hamburg, Germany

For the positron source of the International Linear Collider (ILC) the choice of a suitable target material is crucial. The material must resist the high cyclical load, which is induced in the target while creating about 10^{14} positrons per second. One of the most promising targets consists of the titanium alloy Ti6Al4V. For realistic feasibility tests, several thin plates of the alloy were subjected to an intense electron beam at the Mainzer Microtron.

In this work, we report about the investigation of the irradiated material via High Energy X-Ray Diffraction (HEXRD) at the Hereon endstation of the P07 beamline at DESY. Changes in the crystallographic properties and phases due to the treatment were examined since these may compromise the longevity of the material. Additional tests were performed, where the thermal component of the cyclical load was realized in a quenching dilatometer and again examined via HEXRD. The results will be discussed here.

AKBP 5: Hadron Accelerators – New Devices and Techniques

Time: Tuesday 14:00–15:30 Location: AKBP-H13

AKBP 5.1 Tue 14:00 AKBP-H13

Optimization of proton spin coherence time with three families of sextupoles at prototype EDM ring — •Aleksei Melnikov for the JEDI-Collaboration — Institute for Nuclear Research of the Russian Academy of Sciences, Moscow, Russia

The JEDI collaboration aims to perform a direct measurement of the electric dipole moment (EDM) of protons. For this purpose the prototype storage ring (PTR) is designed. It will allow for feasibility studies of many experimental techniques that are needed to perform an ultimate precision storage ring EDM measurement.

A prototype EDM ring is an intermediate step before building the final storage ring to demonstrate sufficient beam lifetime and SCT (Spin Coherence Time) in a pure electrostatic ring as well as in storage ring with combined electric and magnetic bending elements.

The current lattice of such a ring has fourfold symmetry and operates in a frozen spin mode with weak vertical focusing. Two existing sextupole families are used to increase the spin coherence time. In the current design the maximum value of proton SCT is about 100 s. The proposed way to increase SCT is to insert the third family of sextupoles to adjust chromaticities and second order momentum compaction factor to any desired value. All three families should be located at points with different ratios of optical functions and dispersion. A racetrack option of the prototype ring with strong focusing is proposed to fulfill this requirement. The adjustment of the third sextupole family helped to increase proton SCT up to 1000 s.

AKBP 5.2 Tue 14:15 AKBP-H13

Simulations of Beam Dynamics and Beam Lifetime for the Prototype EDM Storage Ring — •Saad Siddique[1,2,3], Jörg Pretz[1,2], and Andreas Lehrach[1,2] for the JEDI-Collaboration — [1]Institute of Nuclear Physics Forschungszentrum Jülich Germany — [2]Institute 3B Physikzentrum RWTH University Aachen Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH Darmstadt Germany

The matter-antimatter asymmetry may be explained through CP-violation by observing a permanent electric dipole moment (EDM) of subatomic particles. An advanced approach to measure the EDM of charged particles is to apply a unique method of "Frozen spin" on a polarized beam in an accelerator. To increase the experimental precision step by step and to study systematic effects, the EDM experiment can be performed within three stages: the magnetic ring COSY, a prototype EDM ring and finally all electric EDM ring. The intermediate ring will be a mock-up of the final ring, which will be used to study a variety of systematic effects and to implement the basic principle of the final ring. The simulations of beam dynamics of prototype EDM ring with different lattices are performed to optimize the beam lifetime and to minimize the systematic effects. The preliminary design of prototype EDM ring helped to estimate the beam losses by using analytical formulas. Further investigations on enhancing EDM measurement precision and reducing systematic effects are in process.

AKBP 5.3 Tue 14:30 AKBP-H13

Spin tune response to vertical orbit correction at COSY — •Artem Saleev for the JEDI-Collaboration — University of Ferrara, Ferrara, Italy

Searches of electric dipole moments (EDM) of charged particles in pure magnetic rings, such as COSY, or electrostatic and hybrid magnetic-electric storage rings, planned in the future, require new methods to disentangle the EDM signal from the large background produced by magnetic dipole moments. In these experiments, the sources of systematic background are in-plane magnetic fields. It is important to distinguish the origins of the in-plane magnetic fields, which could be produced intentionally by vertical orbit correction to keep the beam on a closed path, or unintentionally due to the alignment errors of the magnets. We propose to use the method of spin tune mapping to determine the relative importance of the two origins. Such method was successfully tested at COSY when local vertical orbit correction was applied.

AKBP 5.4 Tue 14:45 AKBP-H13

Modeling of the optical setting for the measurement of the electric dipole moment of protons at cooler synchrotron COSY — •Mariia Manerova[1,2,3], Andreas Lehrach[1,2], and Maximilian Vitz[1,2] for the JEDI-Collaboration — [1]Institute for Nuclear Physics IV, FZ Jülich, Germany — [2]III. Physikalishes Institut B, RWTH Aachen University, Aachen, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

Electric Dipole Moments (EDMs) of elementary particles are considered to be an excellent probe of physics beyond the Standard Model (SM). They violate parity and time reversal, while through the CPT-theorem also breaking the CP-symmetry. This mechanism may explain the matter-antimatter asymmetry in the universe.

The JEDI (Jülich Electric Dipole moment Investigations) collaboration uses storage rings to measure the EDMs of protons and deuterons with high precision. In a preliminary experiment, measurements of the EDM for deuterons were performed at COSY (COoler SYnchrotron) in Jülich. One important prerequisite for these experiments was the modelling of the optical settings and the beam orbit in COSY to analyze the EDM measurement results.

Further steps include measurements of the proton EDM at COSY. The planned experiments on the proton spin coherence time at COSY will therefore be accompanied by simulation calculations with Bmad. The talk focuses on the model calculation of the beam orbit and optical functions of COSY and compares those to the measurement to achieve a significantly better model description of COSY.

AKBP 5.5 Tue 15:00 AKBP-H13

Laser cooling of bunched relativistic ion beams at the FAIR SIS100 — •Danyal Winters[1], Michael Bussmann[2,3], Daniel Kiefer[4], Volker Hannen[5], Thomas Kühl[1,6], Sebastian Klammes[1,4], Benedikt Langfeld[4], Ulrich Schramm[2,7], Mathias Siebold[2], Peter Spiller[1], Thomas Stöhlker[1,6,8], Ken Ueberholz[5], and Thomas Walther[4,9] — [1]GSI Darmstadt — [2]HZDR Dresden — [3]CASUS Görlitz — [4]TU-Darmstadt — [5]Uni Münster — [6]HI-Jena — [7]TU-Dresden — [8]Uni-Jena — [9]HFHF Frankfurt am Main

The heavy-ion synchrotron SIS100 is the core machine of the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. It is capable of accelerating a large range of ions, produced by the injector (the upgraded GSI facility), up to highly relativistic velocities and extracting them for unique experiments, e.g. APPA/SPARC. In order to cool such intense beams of heavy highly charged ions, laser cooling of bunched ion beams was preferred. Therefore, the laser cooling pilot facility at the SIS100, being also the only in-ring experiment, is currently being realized. We will present this project and give an update of its current status. We will also give an overview of the laser and detector systems that will be used.

AKBP 5.6 Tue 15:15 AKBP-H13

Dispersive coupling in low-energy electron cooling at CRYRING@ESR — •Claude Krantz[1], Zoran Andelkovic[1], Christina Dimopoulou[1], Frank Herfurth[1], Regina Hess[1], Michael Lestinsky[1], Esther B. Menz[1], Konstantin Mohr[1,2], Wilfried Nörtershäuser[2], Andreas Reiter[1], Jon Rossbach[1], Rodolfo Sánchez[1], and Gleb Vorobjev[1] — [1]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt — [2]Institut für Kernphysik, TU Darmstadt, 64298 Darmstadt

The heavy-ion storage ring CRYRING has been recommissioned at GSI/FAIR. Downstream of the ESR, the ring can serve as a platform for precision experiments on highly-charged ions produced by the full GSI accelerator chain. In a complementary standalone mode, CRYRING can operate with weakly or singly charged ions provided by a local low-energy injector. Especially singly-charged ions are often limited to storage velocities of the order of 10^{-2} c, not to exceed the maximum rigidity allowed by the bending magnets. Electron cooling of so slow beams is challenged by dispersive coupling effects which lead to entanglement of the horizontal and longitudinal cooling rates. If dispersion in the cooler section is significant, over-optimisation of cooling for one degree of freedom can lead to cancellation or even reversal of the cooling force in the other dimension. At CRYRING@ESR, the effect was found during preparation of a singly-charged beam of Mg^+ for an atomic-physics experiment, where unwanted heating of longitudinal ion motion by the electron cooler was observed. Dedicated machine studies on dispersive electron cooling at CRYRING are planned.

AKBP 6: Beam Dynamics 1

Time: Tuesday 14:00–15:30 Location: AKBP-H14

AKBP 6.1 Tue 14:00 AKBP-H14

Realization of the Multi-Turn Energy Recovery Mode at S-DALINAC* — •Felix Schliessmann, Michaela Arnold, Manuel Dutine, Marco Fischer, Ruben Grewe, Lars Jürgensen, Norbert Pietralla, Manuel Steinhorst, Lennart Stobbe, and Simon Weih — Institut für Kernphysik, Technische Universität Darmstadt, Darmstadt, Germany

The electron accelerator S-DALINAC at TU Darmstadt was successfully operated in the multi-turn energy recovery mode. Here, electrons were accelerated twice in the same LINAC and were decelerated afterwards in the very same LINAC just as often. During the deceleration in the LINAC, the electrons restore energy to the cavities, which can then be used to accelerate subsequent electrons. This principle enables a saving in acceleration power and an increase in the beam current, respectively. Therefore, this mode is a very promising basis for future accelerator facilities.

The multi-turn energy recovery mode is particularly challenging since several beams are superimposed in the same beamlines and the so-called phase slippage has to be taken into account in advance via beam dynamic simulations.

The content of this contribution covers the essential beam dynamics simulations, the setup of the multi-turn energy recovery mode and measured results.

*Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.

AKBP 6.2 Tue 14:15 AKBP-H14

Beam dynamics aspects of RF separated beams at the CERN M2 secondary beam line — •Fabian Metzger[1,2], Johannes Bernhard[1], Markus Brugger[1], Lau Gatignon[3], Alexander Gerbershagen[1], Bernhard Ketzer[2], and Silvia Schuh-Erhard[1] — [1]CERN, Meyrin, Switzerland — [2]Helmholtz-Institut für Strahlen- und Kernphysik, University of Bonn, Bonn, Germany — [3]University of Lancaster, Lancaster, United Kingdom

Radio-frequency (RF) separation is a technique to enrich the content of a certain particle type within a beam consisting of different species at the same momentum. This technique exploits the different velocities of the different particle types due to their mass difference. The successor of the COMPASS experiment, AMBER, is aiming in its phase 2 for high-intensity, high-purity kaon and antiproton beams which cannot be delivered with the currently existing M2 beam line.

This contribution introduces the principle of RF separation and explains its dependence on different parameters of beam optics and hardware. We discuss particle production rates, beamline transmission principles for specific lines studied, as well as limitations for beam intensity and purity imposed by beam line acceptance and radiation protection. Different beam optics settings have been examined, providing either focused or parallel beams inside the RF cavities. We will discuss the separation and transmission capabilities of the different optics settings for given characteristics of the RF cavities and show preliminary results of the potential purity and intensity of the RF separated beam.

AKBP 6.3 Tue 14:30 AKBP-H14

Layout of the interaction region for electron proton collisions in the LHeC collider — •Tiziana von Witzleben[1] and Bernhard Holzer[2] — [1]CERN, RWTH Aachen — [2]CERN

The LHeC (Large Hadron electron Collider) project studies the design of a future electron-proton collider at CERN. Deep inelastic scattering collisions between electrons and protons will run in parallel to the standard HL-LHC (High Luminosity-LHC) operation. The electrons would be accelerated to a kinetic energy of 50 GeV in a tangential energy recovery linear collider and brought into collision with one of the 7 TeV proton beams of the HL-LHC. The design luminosity of the order of $10^{34} cm^{-2} s^{-1}$ requires strong focusing of both beams in a compact interaction region. The e-p collisions would take place simultaneously with the HL-LHC experiments ATLAS, CMS and LHCb, and possibly alternating with the ALICE experiment in a novel design under study. This, therefore, requires a highly precise beam optics for three beams: the two proton beams of the HL-LHC, as well as the additional electron beam. Initial design studies of the optics and orbits of the three beams have been performed to provide estimates for the aperture and gradients of the required magnets. Different strengths of the mini-beta quadrupoles, as well as different magnetic separations schemes have been modelled and the results will be presented.

AKBP 6.4 Tue 14:45 AKBP-H14

Dynamic aperture studies for the Transfer Line from FLUTE to cSTART — •Jens Schäfer, Bastian Härer, Alexander Papash, Robert Ruprecht, Marcel Schuh, and Anke-Susanne Müller — KIT, Karlsruhe, Deutschland

The compact Storage ring for Accelerator Research and Technology cSTART is a test facility for the application of novel acceleration techniques and diagnostics. The goal is to demonstrate storing the beam of a Laser Plasma Accelerator (LPA) for the first time in a compact circular accelerator. Before installing a LPA, the linear accelerator FLUTE will serve as a full energy injector for the compact storage ring, providing stable bunches with a length of a few femtoseconds. The transport of the bunches from FLUTE to the storage ring requires a transfer line which includes horizontal, vertical and coupled deflections which leads to coupling of the dynamics in the two transverse planes. In order to conserve the ultra-short bunch length during the transport, the transfer line relies on special optics which invokes high and negative dispersion. This contribution presents dynamic aperture studies based on six-dimensional tracking through the lattice of the transfer line.

AKBP 6.5 Tue 15:00 AKBP-H14

Optimization Studies of Simulated THz Radiation at FLUTE — •Chenran Xu[1], Erik Bründermann[1], Andrea Santamaria Garcia[2], Jens Schäfer[1], Markus Schwarz[1], and Anke-Susanne Müller[1,2] — [1]IBPT, KIT, Karlsruhe — [2]LAS, KIT, Karlsruhe

The linac-based test facility FLUTE (Ferninfrarot Linac Und Test Experiment) at KIT will be used to study novel accelerator technology and provide intense THz pulses. In this paper, we present start-to-end simulation studies of FLUTE with different bunch charge and photoinjector laser properties. We employ a parallel optimization algorithm for different operation points of FLUTE to find optimized accelerator settings for the electron bunch length and generation of intense THz radiation.

C. Xu and J. Schäfer acknowledge the support by the Doctoral School KSETA "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology".

AKBP 6.6 Tue 15:15 AKBP-H14

Status of the MESA injector — •Simon Friederich — Institut für Kernphysik, JGU Mainz, Deutschland

The MESA injection system will produce the spin-polarized beam for the upcoming accelerator MESA at the JGU Mainz. The photoemission electron source (STEAM) will deliver 150uA of spin-polarized electrons from GaAs-based photocathodes for the P2 experiment. Afterwards the low-energy beam transportation system (MELBA) can rotate the spin using two Wien filters and a solenoid for polarisation measurements and to compensate for the spin precision in MESA. A chopper and buncher system prepares the phase space for the first acceleration in the normal-conducting pre-booster MAMBO. An additional separation line is designed for polarisation measurements and high bunch charge injection. The overview talk will cover the basic principles and the design of the MESA injector. Particle-in-Cell simulation results with the simulation code OPAL and the status of the build-up in the LINAC tunnel at the "Institut für Kernphysik" will be presented.

AKBP 7: Particle Sources

Time: Tuesday 16:00–17:30 Location: AKBP-H13

AKBP 7.1 Tue 16:00 AKBP-H13

photocathodes for SRF photoinjectors: exploring GaN and multi-alkali options — •Chen Wang[1,2], Sonal Mistry[1], Julius Kühn[1], Thorsten Kamps[1,4], Qun Jin[2], Michael Vogel[2], Xin Jiang[2], Jana Schaber[3], Rong Xiang[3], and Andre Arnold[3] — [1]HZB, Berlin, Germany — [2]University of Siegen, Institute for Materials Engineering, Siegen, Germany — [3]HZDR, Dresden, Germany — [4]Humboldt University of Berlin, Berlin, Germany

Gallium nitride and multi-alkali antimonide photocathodes are two candidates for semiconducting photocathode materials for SRF photoinjectors. GaN photocathode has high thermal stability and can provides high QE under UV light, while multi-alkali antimonide provides high QE at visible wavelengths. The crystal quality and doping level of magnetron sputtered Mg doped GaN films are studied at University of Siegen, since they could affect the diffusion length of excited electrons and the electron affinity of the photocathode, which are related to QE of the sample. SEM and XRD methods are used to study the influence of substrates and sputtering conditions on crystal quality and structure. Doping levels are analyzed by hall effect measurement. QE measurements are conducted at HZDR and also in in-situ measurement chamber. Na-K-Sb photocathodes films are deposited on molybdenum substrates in UHV preparation chamber at HZB. The influence of deposition parameters is studied in order to optimize the growth procedure and to achieve better stability at higher temperature, which could benefit operational lifetime. The chemical compositions of films are analyzed by XPS, and then QE measurements are performed.

AKBP 7.2 Tue 16:15 AKBP-H13

Improved Performance of GaAs photo-cathodes activated by Cs, O_2 and Li — •Maximilian Herbert, Joachim Enders, Markus Engart, Yuliya Fritzsche, Julian Schulze, and Vincent Wende — Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstraße 9, 64289 Darmstadt

Photo-cathodes based on GaAs can be characterized mainly by two parameters: quantum efficiency η and lifetime τ. The former describes the photo-emission efficiency, while the latter is an indicator for the decay of the surface layer required to achieve negative electron affinity (NEA) for GaAs. This layer typically consists of Cs in combination with an oxidant. Previous studies have suggested that the addition of Li to this layer can significantly increase cathode performance by boosting both η and τ. At the Institut für Kernphysik of the Technische Universität Darmstadt, a dedicated test stand for Photo-Cathode Activation, Test and Cleaning using atomic-Hydrogen (Photo-CATCH) is available for GaAs photocathode research. This contribution will present recent performance studies at Photo-CATCH of bulk GaAs photo-cathodes activated with Cs, O_2, and Li in comparison to activations using Cs and O_2 only. An increase in τ by a factor of 7 has been observed without significant reduction of η for Li-enhanced activation.

AKBP 7.3 Tue 16:30 AKBP-H13

High bunch charges in the second injection beamline of MESA — •Anatolii Kalamaiko, Kurt Aulenbacher, Monika Dehn, and Simon Friederich — Institut für Kernphysik, Universität Mainz, Germany

MESA (Mainz Energy-recovering Superconducting Accelerator) is an accelerator with two laser-driven electron sources operating at 100 kV which is under construction at the Johannes Gutenberg University in Mainz. One of the sources is the unpolarized electron source MIST (MESA Injector Source Two) producing a bunch charge of up to 7.7 pC. This source and a Mott polarimeter will be arranged on the same height above the MESA injector main beamline. Thus, it is necessary to develop a parallel shifting beamline to transport electron beam from the source MIST to the main MESA beamline. Besides, the designed beamline should allow to transport beam from the electron source STEAM to the Mott polarimeter. This report is dedicated to the design of the separation beamline which transports and compresses highly charged electron bunches from the electron source MIST to the first acceleration section of MESA.

AKBP 7.4 Tue 16:45 AKBP-H13

RF Synchronised Semiconductor Laser System for MESA — •Rakshya Thapa — Institut für Kernphysik, Mainz, Germany

The Institute of Nuclear Physics at Johannes Gutenberg University Mainz is building the Mainz Energy-Recovering Superconducting Accelerator (MESA) facility. It is planned to operate with both polarised and unpolarised high average current electron beams. For both, a semiconductor photocathode is planned to be employed. To generate a polarised and unpolarised electron beam, laser beams with an emission wavelength in different regimes are used. However, to perform diagnostics that meet realistic beam dynamics, high bunch charge ($\approx$1 pC) and low average beam power (1-10 W) is deemed vital. This can be achieved by the reduction of duty cycle. Therefore, a commercial TAIKO laser, which can be RF synchronised, with emission wavelength 400.8 nm was chosen and its temporal structure was investigated at the chopper system of the Mainz Microtron (MAMI) facility. Results concerning the electron bunch shape and its dependence on operating parameters like laser-pulse energy, electron bunch charge and down conversion factor will be reported.

AKBP 7.5 Tue 17:00 AKBP-H13

Preparation for plasma lens prototype as an optical matching device for the ILC — •Niclas Hamann[1], Manuel Formela[1], Gudrid Moortgat-Pick[2], Klaus Flöttman[3], and Gregor Loisch[3] — [1]Uni Hamburg — [2]Uni Hamburg/DESY — [3]DESY

The ILC is an ambitious project. Therefore many challenges have to be overcome. One of these is to optimize the positron yield after the source. In this talk a new concept for capturing is proposed, the plasma lens. The latest simulations will be shown and preparation tests for an upcoming prototype will also be discussed. The preparation tests are done with a plasma cell designed for PITZ.

AKBP 7.6 Tue 17:15 AKBP-H13

Latest developments and performance of the FLUTE laser system — •Matthias Nabinger, Thiemo Schmelzer, Michael Johannes Nasse, Nigel Smale, Jens Schäfer, Carl Sax, and Anke-Susanne Müller — Karlsruher Institut für Technologie, Karlsruhe, Deutschland

At the FLUTE linac-based accelerator short electron bunches are generated via a photo-injector system. The electrons are produced by laser pulses transported over several meters from the laser laboratory towards the photocathode. To ensure a controlled operation, the laser parameters are monitored and adjusted at several positions. In addition to electron generation, the pulses are used to generate THz pulses for a specific diagnostic experiment. Multiple systems are used to stabilize the laser pulses for optimal use. In this contribution, the latest developments of the FLUTE laser's improved performance will be presented.

Matthias Nabinger and Thiemo Schmelzer acknowledge the support by the Doctoral School KSETA 'Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology'.

AKBP 8: Radiofrequency Systems 2 – Superconductivity

Time: Tuesday 16:00–17:30 Location: AKBP-H14

AKBP 8.1 Tue 16:00 AKBP-H14

Implementation of Nb3Sn co-sputtering for copper cavity coating — •Sara Amidi, Nils Schäfer, Márton Major, and Lambert Alff — TU Darmstadt, Darmstadt, Germany

Thin-film coatings play a crucial role in the superconducting industry. One method of depositing them on a substrate is by using the magnetron sputtering method. The aim of this project is to design a system that can deposit a superconductive coating of Nb3Sn with uniform thickness on the interior side of a copper RF cavity system with TESLA geometry. As the first step in the project, Particle in Cell Monte Carlo (PIC-MC) and Direct Simulation Monte Carlo (DSMC) methods along with the simulation of the thin film deposition using NASCAM software will be investigated. Then based on the result, the practicality of the application of the numerical methods to the RF cavity is inspected and process parameters of the experimental method are improved. However, to have a uniform film thickness across the cavity, the deposition rate needs to be adjusted and we are planning to do that with a unique design of the magnetron system. An idea would be to change the design of the magnets i.e., using a hollow cathode magnetron (HCM) or post cathode magnetron instead of a magnetic rod. In addition, the number of the cathodes and their location in the system have significant importance. Our team would like to appreciate BMBF for funding this research project.

AKBP 8.2 Tue 16:15 AKBP-H14

Determination of High-Pressure Rinsing on the Oxide-Layer Thickness and Oxygen-Concentration of Niobium Samples — •Rezvan Ghanbari[1,2], Marc Wenskat[1,2], Wolfgang Hillert[1,2], and Detlef Reschke[2] — [1]Institute of Experimental Physics, University of Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Hamburg, Germany

This study is devoted to investigate the effect of High-Pressure Rinsing (HPR) on annealing procedures of Niobium (Nb) superconducting radio-frequency cavities. Recently, a so-called "mid-T bake" treatment has exhibited very high-quality factors for Nb cavities and developed models assume that the quality factor severely depends on the oxygen concentration in the near-surface of niobium. On the other hand, based on our observation, we realize that HPR may affect the thickness of oxide layers on the surface of niobium cavities, which is the dominant source of the oxygen diffusion during annealing. Thus, we have measured the oxide thicknesses, after various HPR durations, on the surface of Nb samples before and after applying mid-T bake treatment via Vertical Scanning Interferometer (VSI) and used Secondary Ion Mass Spectrometry (SIMS) to obtain the interstitial oxygen concentration after the annealing. In this way, we have investigated the importance of repeating and jetting high pressure water on the surface of niobium cavities to control oxide growth and we will show the results of this study.

AKBP 8.3 Tue 16:30 AKBP-H14

Surface preparation on niobium TESLA cavities for MESA at the HIM* — •Paul Plattner, Florian Hug, and Timo Stengler — Institut für Kernphysik , Johannes Gutenberg-Universität Mainz

The Mainz Energy-Recovering Superconducting Accelerator (MESA) will be a new recirculating accelerator, which can operate in an external beam mode and an energy recovering mode. In the ERL-mode the electrons cross an internal gas-target at MAGIX and give their kinetic energy into the Superconducting Radio Frequency (SRF) system back after experimental use. The MESA cryomodules are based on ELBE-type cryomodules, which contain two 9-cell TESLA/XFEL-type cavities. In the cryomodule the superconducting cavities are cooled down to 1.8 Kelvin with liquid helium. For maintenance of the cryomodules can be used the clean room infrastructure at the Helmholtz Institute Mainz (HIM). Currently a cryomodule from the ALICE ERL at Daresbury, UK is in the process of refurbishment. So, the current progress can be shown. A superconducting 3 GHz six-cell injector cavity for the S-DALINAC was used to demonstrate that the treatment of a high pressure rinse in the clean room infrastructure at HIM was successful. * This work has been supported by DFG through the PRISMA+ cluster of excellence EXC 2118/2019. The authors acknowledge the transfer of one cryomodule to Mainz by STFC Daresbury.

AKBP 8.4 Tue 16:45 AKBP-H14

Nb_3Sn thin film synthesis for SRF application by co-sputtering — •Nils Schäfer[1], Damian Günzing[2], Nail Karabas[1], Alexey Arzumanov[1], Deborah Motta-Meira[3], Katharina Ollefs[2], Márton Major[1], Heiko Wende[2], and Lambert Alff[1] — [1]Institute of Materials Science, Advanced Thin Film Technology, Technische Universität Darmstadt, Alarich-Weiss-Str. 2, 64287 Darmstadt, Germany. — [2]Faculty of Physics and Center for Nanointegration Duisburg-Essen (CENIDE), Universityof Duisburg-Essen, 47048 Duisburg, Germany. — [3]Argonne National Laboratory, 9700 South Cass Avenue, Lemont, IL, 60439 USA.

Thin film Nb_3Sn is a promising candidate to outperform bulk Nb in next generation particle accelerators. Bulk Nb is a well elaborated material for the superconducting radio frequency (SRF) application. However, this technology has reached its physical limits. Thin film Nb_3Sn is able to push the limits or save tremendous amounts of energy during operation. Unfortunately, the possible acceleration gradients of about 90 MV/m are not reached. Local deviations of the local stoichiometry and grain boundary segregations can be a possible explanation for this. To improve the local homogeneity and grain boundary conditions, a co-sputtering process is used. Extended X-ray absorption fine structure (EXAFS), X-ray absorption spectroscopy(XAS) mappings and X-ray diffraction (XRD) are used to show different grain boundary and phase conditions. Resistance versus field and resistance versus temperature measurements demonstrate the role of grain boundary and phase of the present Nb_3Sn thin films.

AKBP 8.5 Tue 17:00 AKBP-H14

Studies on the stability of different joining methods for permanent magnets — •Simon Gaebel, Carsten Kuhn, Stefan Gottschlich, Sebastian Knaack, Laura Brandenberg, Mario Strehlke, Johannes Bahrdt, Atoosa Meseck, Jürgen Bakos, and Stefan Grimmer — Helmholtz-Zentrum-Berlin

At HZB, research is being conducted into how the supply of synchrotron light from BESSY II can be improved to enable new experimental techniques and detectors at the beamlines. There, permanent magnets are playing an increasingly important role in the construction of new multibend achromat-based particle accelerators to deflect charged particles. Another central part of this research is the development of modern permanent magnet undulators. One of the challenging areas with these is the precise assembly and placement of permanent magnets. Due to increased requirements, such as reducing the period length of an undulator, new concepts for mounting the magnets have become necessary. Properties such as fatigue strength, shear strength and in certain contexts, e.g. with in-vacuum undulators, the vacuum resistance of the connection must be investigated. For this purpose, methods have been developed to investigate the load capacity of adhesive and solder joints. The presentation shows how these are applied and what the consequences are for the application.

AKBP 8.6 Tue 17:15 AKBP-H14

HTS undulators: status and test results of prototype coils for compact FELs — •Sebastian C. Richter[1,2], Amalia Ballarino[1], Daniel Schoerling[1], Axel Bernhard[2], and Anke-Susanne Müller[2,3] — [1]CERN - 1211 Geneva 23 - Switzerland — [2]LAS, KIT, Karlsruhe, Germany — [3]IBPT, KIT, Karlsruhe, Germany

Compact free electron lasers (FELs) require short period, high-field undulators in combination with shorter accelerator structures to produce coherent light up-to X-rays. Likewise, for the production of low emittance positron beams for future linear and circular lepton colliders, like CLIC or FCC-ee, high-field damping wigglers are required. Using high-temperature superconductors (HTS) in form of coated REBCO tape conductor allows reaching higher magnetic fields and larger operating margins as compared to low-temperature superconductors, like Nb-Ti or Nb3Sn. This contribution discusses the development work done on two superconducting undulator geometries (vertical racetrack and helical) with a period length of 13 mm, as well as the status of the prototype coils. Measurement results from powering tests in LN2 of multiple vertical racetrack coils are presented, compared and discussed.

This work has been supported by the Wolfgang Gentner Program of the German Federal Ministry of Education and Research (grant no. 05E18CHA) and by the DFG-funded Doctoral School "Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology".

AKBP 9: Diagnostics, Control, Modeling, Modern IT Applications

Time: Wednesday 14:00–15:30 Location: AKBP-H13

AKBP 9.1 Wed 14:00 AKBP-H13

Sensitivity Analysis of Beam-influencing Parameters at the S-DALINAC Using Surrogate Models* — •Dominic Schneider, Michaela Arnold, Jonny Birkhan, Norbert Pietralla, and Felix Schliessmann — Institut für Kernphysik, TU Darmstadt, Germany

Particle accelerates are complex systems that coincide with their ideal design within the tolerances of its large number of technical components, only. Quantitative understanding of the beam dynamics and the analysis of their sensitivity to various components are challenging tasks. Machine learning methods provide a significant potential for the optimized operation of particle accelerators. In this contribution, the first application of so-called surrogate models to the electron accelerator S-DALINAC will be discussed. This machine learning technique gives access to predict future behavior and an extensive set of characteristics that can be extracted by analyzing the trained model. The talk will focus on a series of measurements performed in the injector section of the accelerator to study the behavior of beam-influencing elements. Surrogate models, constructed and based on the acquired data, are being evaluated to reveal the behavior of these elements. Based on the information obtained, optimizations of the alignment of magnets as well as the beam dynamics simulations at the S-DALINAC will be discussed.

*Work supported by DFG (GRK 2128) and the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006).

AKBP 9.2 Wed 14:15 AKBP-H13

Optimization of spin-coherence time in a prototype storage ring for electric dipole moment measurements — •Rahul Shankar[1], Maximillian Vitz[2], and Paolo Lenisa[1] for the JEDI-Collaboration — [1]Università degli studi di Ferrara and INFN, Italy — [2]Institute of Nuclear Physics, Forshungszentrum Jülich, Germany

The JEDI experiment is dedicated to the search for the electric dipole moment (EDM) of charged particles using storage rings, which can be a very sensitive probe of physics beyond the Standard Model. In order to reach the highest possible sensitivity, a fundamental parameter to be optimized is the particles' Spin Coherence Time (SCT), i.e., the time interval within which the particles of the stored beam maintain a net polarization greater than 1/e. To identify the working conditions that maximize SCT, accurate spin-dynamics simulations with the code BMAD have been performed on the lattice of a "prototype" storage ring which uses a combination of electric and magnetic fields for bending. This talk will present the results of these simulations addressing the impact on the SCT of different factors like horizontal tune, and the electric bending field, as well as suggestions on lattice modifications to further improve its value.

AKBP 9.3 Wed 14:30 AKBP-H13

Parasitic Optimization of the Transfer Beamline Efficiency at ELSA — •Sebastian Witt, Klaus Desch, Daniel Elsner, and Dennis Proft — Elektronen-Stretcher-Anlage ELSA, Physikalisches Institut, Universität Bonn

The 3.2 GeV electron accelerator ELSA consists of three acceleration stages each interconnected by tunable transfer beamlines. The steering of the electron beam through the transfer line from linear accelerator to the booster synchrotron is currently adjusted by hand, which limits a systematic optimization of the transfer efficiency.

To improve the situation, an automated optimization using the "simulated annealing" technique has been developed and integrated into the accelerator's control system. It allows for a continuous optimization without interfering with usual beamtime for experiments by utilizing the 6s off-time in between injections into the storage ring. In a simulation using the actual accelerator's settings as starting parameters, transmission rates have been increased significantly, while testing with the accelerator is still ongoing.

AKBP 9.4 Wed 14:45 AKBP-H13

Magnetic Field Characterization with Circular Scan and Multipole Moment Analysis — •Yimin Tong[1], Yuancun Nie[2], Axel Bernhard[1], and Anke-Suanne Müller[1] — [1]KIT, Karlsruhe, Germany — [2]Wuhan China

For the optimisation of an accelerator like FLUTE which aims at producing femtosecond bunches by means of a specially designed compressor chicane, it is important to take into account the detailed properties of the real and magnets in the beam dynamics simulations. A typical approach to do so is to use particle tracking through flux density maps, measured e.g. by a 3D Hall probe on a sufficiently dense 3D grid and interpolated by an appropriate integration procedure. This approach yields accurate results but can be very time consuming both, regarding the measurement and the simulation. For the FLUTE quadrupole and chicane dipole magnets, we have in addition to this method investigated the alternative approach of measuring the radial flux density component on a cylinder surface concentric with the beam axis and representing the field in the beam dynamics simulations by a set of magnet slices with the multipole components deduced from the measurement. In this contribution the calibration and measurement procedure is described and the two measurement and representation approaches are compared to each other.

This work is supported by the BMBF under grant No. 05H18VKRB1

AKBP 9.5 Wed 15:00 AKBP-H13

Injection optimization using machine learning at the Cooler Synchrotron COSY — •Awal Awal for the JEDI-Collaboration — RWTH Aachen University — GSI Helmholtzzentrum für Schwerionenforschung

In accelerators it is usually desired to have a particle beam with high intensity and small emittance. A key factor that limits the beam intensity in storage rings are injection losses. The setup of the Injection Beam Line (IBL) depends on a large number of configurations in a complex, non-linear, and time-dependent way. Machine learning methods exhibit promising algorithms to effectively tackle the challenge of optimize the IBL setup. In this research, Reinforcement Learning (RL) techniques are planned to be utilized to optimize the IBL for the Cooler Synchrotron (COSY) at Forschungszentrum Jülich (FZJ). Both simulation environment and actual data from COSY are to be used in the process of training the RL agent. The goal is to increase the beam intensity inside COSY while decreasing the setup time required. This method has the potential to be applied in future accelerators like the FAIR facility.

AKBP 9.6 Wed 15:15 AKBP-H13

Microbunching Studies for FLASH2020+ Using Efficient Semi-Lagrangian Vlasov-Simulation — •Philipp Amstutz and Mathias Vogt — DESY, Hamburg, Germany

In semi-Lagrangian approaches a solution to the Vlasov-Equation is obtained by back-tracking its characteristics and subsequently evaluating the initial condition. These methods yield a smooth numerical approximation to the phase-space density (PSD), which can put them at an advantage over particle-based methods. For instance, when studying small-scale effects where the inherent stochastic noise of particle-tracking methods becomes burdensome, semi-Lagrangian schemes are a promising alternative.

In free-electron lasers the electron bunches typically exhibit an "exotic" structure in the longitudinal phase-space resembling a fine, wiggling hair-like band. Such PSDs are not efficiently captured by a regular grid, as large parts of the minimum bounding rectangle of the PSD are void and do not contribute to the dynamics of the system. We present studies of the microbunching instability for FLASH2020+ using SelaV – a semi-Lagrangian Vlasov code we developed, which employs tree-based domain decomposition to efficiently handle exotic PSDs.

AKBP 10: Electron Accelerators and FEL's

Time: Wednesday 14:00–15:15 Location: AKBP-H14

AKBP 10.1 Wed 14:00 AKBP-H14

Particle tracking study for the new laser heater at FLASH — •Dmitrii Samoilenko[1], Pardis Niknejadi[2], Christopher Gerth[2], Lucas Schaper[2], and Wolfgang Hillert[1] — [1]Institute for Experimental Physics, University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, 22607 Hamburg (Germany)

The FLASH (Free electron LASer in Hamburg) facility is currently in a scheduled 9-month shutdown during which some of the upgrades planned in the FLASH2020+ project are being implemented. Among these upgrades is a laser heater which will be installed just upstream of the first bunch compressor, allowing an uncorrelated energy spread in the electron beam to be induced. Increasing energy spread makes it possible to reduce the microbunching gain through the machine and thus counteract one of the most detrimental effects for FEL operation. The amount of induced energy spread has to be carefully balanced to suppress microbunching. At the same time the total energy spread at the end of the linac, which is enhanced especially during the bunch compression, should be kept at a reasonable value not to deteriorate FEL operation. In this work, we use particle tracking simulations to (i) evaluate the performance of the laser heater in terms of induced energy spread; (ii) investigate how the energy spread evolves throughout the rest of the linac. The results are expected to be valuable also for the commissioning of the laser heater.

AKBP 10.2 Wed 14:15 AKBP-H14

Simulation Studies on a XUV FEL Oscillator Setup at FLASH — •Margarit Asatrian[1], Wolfgang Hillert[1], Velizar Miltchev[1], and Georgia Paraskaki[2] — [1]University of Hamburg, 22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, 22607 Hamburg, Germany

Externally seeded Free Electron Lasers (FEL) deliver fully coherent radiation at harmonics of the input seed laser wavelength. However, due to the lack of seed laser sources in the EUV/XUV range and at high repetition rates with sufficient peak power, the shortest wavelength and maximum repetition rate of the seeded FEL radiation are limited.

In order to utilize the full potential of superconducting RF technology being exploited in the world leading FEL facilities like FLASH at DESY and enabling bunch repetition rates in the MHz regime for seeding, an oscillator-amplifier approach is considered, where the role of the seed laser is taken by an optical cavity. A cavity tuned to 13.5 nm is used to store the seed pulse and reuse it for the seeding of bunches at MHz rate. The possibility to build up the power in the cavity starting from shot noise allows the seeding at an already short wavelength.

We present design considerations and our first simulation results for the future setup.

AKBP 10.3 Wed 14:30 AKBP-H14

Simulation for THz FEL seeding at PITZ using pre-bunched electron beams — •Georgi Georgiev[1], Prach Boonpornprasert[1], Wolfgang Hillert[2], Mikhail Krasilnikov[1], and Xiangkun Li[1] — [1]Deutsches Elektronen-Synchrotron DESY, 15738 Zeuthen, Germany — [2]University of Hamburg, 22761 Hamburg, Germany

A THz source with high power and tunability is required for pump and probe experiments at the European XFEL. One option is to use a short accelerator to drive a THz FEL, which could produce THz pulses with the same pulse train structure as the XFEL pulses. The Photo Injector Test facility at DESY in Zeuthen (PITZ) serves as the site for these developments and proof-of-principle experiments on short THz FEL are currently under preparation at this facility. To improve the stability of the THz source, FEL seeding is considered. Arrival time jitter and spectrum from pulse to pulse can be improved by FEL seeding with respect to SASE. This is demonstrated in Genesis simulation results performed with pre-bunched electron beams.

AKBP 10.4 Wed 14:45 AKBP-H14

Status of the EEHG Upgrade Project of the Short-Pulse Source at DELTA — •Benedikt Büsing, Arne Held, Hubertus Kaiser, Shaukat Khan, Carsten Mai, Arjun Radha Krishnan, and Vivek Vijayan — Center for Synchrotron Radiation (DELTA),TU Dortmund University, Dortmund, Germany

At the 1.5-GeV electron storage ring DELTA, operated by the TU Dortmund University, a short-pulse source based on the coherent harmonic generation (CHG) scheme provides ultrashort pulses in the vaccum ultraviolet regime. In this scheme a laser-electron interaction leads to microbunching within a short slice of an electron bunch which results in coherent emission of radiation. The emitted wavelength is limited to low harmonics of the laser wavelength, higher harmonics are accessible by the echo-enabled harmonic generation (EEHG) scheme, where another laser-electron interaction is added. To implement this scheme, it is necessary to modify the short-pulse source and thus about a quarter of the storage ring. The status of the upgrade project is presented.

AKBP 10.5 Wed 15:00 AKBP-H14

Recent Developments at S-DALINAC* — •M. Arnold, J. Birkhan, A. Brauch, M. Dutine, J. Enders, M. Fischer, R. Grewe, L. Jürgensen, M. Meier, N. Pietralla, F. Schliessmann, D. Schneider, M. Steinhorst, L. Stobbe, and S. Weih — Institut für Kernphysik, Technische Universität Darmstadt

The superconducting Darmstadt linear accelerator S-DALINAC is a thrice-recirculating accelerator for electrons. Besides the conventional acceleration scheme with corresponding nuclear physics experiments, the accelerator of TU Darmstadt can also be operated as an energy recovery linac (ERL) [1]. Since its establishment in 1991, the S-DALINAC was mainly developed and operated by students. The latest achievement was the successful operation as a superconducting multi-turn ERL in August 2021 [2]. Dedicated diagnostics to measure both beams in the same beamline simultaneously are in preparation or have been used for first measurements. The beam quality was improved significantly by a new capture cavity. Other projects are working on further improvements of the machine. This contribution will give an overview of the status of those projects.

[1] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020).

[2] Pressemitteilung des Informationsdienst Wissenschaft (idw), ”Technologischer Durchbruch bei Energieeffizienten Teilchenbeschleunigern”, MI-NR. 63/2021, acc/feu.

*Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.

AKBP 11: Beam Dynamics 2

Time: Wednesday 16:00–17:45 Location: AKBP-H13

AKBP 11.1 Wed 16:00 AKBP-H13

Investigation of the spin coherence time for measuring the electric dipole moment of protons in the COSY cooler synchrotron — •Daoning Gu[1,2,3], Maximilian Vitz[1,2], and Andreas Lehrach[1,2] for the JEDI-Collaboration — [1]Institute for Nuclear Physics IV , FZ Jülich, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, Germany — [3]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Electric Dipole Moment (EDM) of a subatomic particle is predicted by the Standard Model (SM) and provides simultaneous violation of parity (P) and time reversal (T). Assuming CPT-theorem holds, an EDM is also a source of CP violation, which is needed to explain the matter-antimatter asymmetry. Measuring an EDM at a higher value than the SM prediction would therefore provide additional CP violation and would be a strong indication for physics beyond the SM.

Optimization of the Spin Coherence Time (SCT) plays a central role in storage ring EDM experiments, since a large SCT is required to achieve the statistical sensitivity for an EDM measurement. After a sufficient long SCT was achieved for deuteron beams, the JEDI-Collaboration in Jülich is preparing a similar measurement for the SCT for protons at the storage ring COSY. Many parameters indicate that for proton beams, the optimization procedure to realize long SCT is more difficult than for deuteron beams. Therefore, spin tracking simulations were performed with the software library BMAD to investigate the sextupole contributions. This talk will concentrate on the recent tracking results to optimize the SCT for a proton beam at COSY.

AKBP 11.2 Wed 16:15 AKBP-H13

Beam dynamics studies by long-term observation of coherently emitted THz pulses at DELTA — •Carsten Mai, Benedikt Büsing, Arne Held, and Shaukat Khan — Center for Synchrotron Radiation (DELTA), TU Dortmund University, Dortmund, Germany

At DELTA, a 1.5-GeV electron storage ring operated as a synchrotron light source by the TU Dortmund University, experiments with THz radiation are carried out at a dedicated beamline. An interaction of short laser pulses with electron bunches is used to generate broadband as well as tunable narrowband radiation up to 6 THz. Coherent emission of (sub-)THz pulses is typically observed during several storage ring revolutions after the initial laser-electron interaction. However, a coherent emission is observed at half-integer multiples of the synchrotron oscillation period after the interaction because the density in the longitudinal phase space is similar to the initial situation. Experimental results and simulations of the longitudinal phase space are presented.

AKBP 11.3 Wed 16:30 AKBP-H13

Detailed analysis of transverse emittance of the FLUTE electron bunch — •Thiemo Schmelzer, Erik Bründermann, Igor Kriznar, Matthias Nabinger, Michael Nasse, Robert Ruprecht, Jens Schäfer, Marcel Schuh, Nigel Smale, Pawel Wesolowski, and Anke-Susanne Müller — KIT, Karlsruhe

The new compact and versatile linear accelerator-based test facility FLUTE (Ferninfrarot Linac- Und Test-Experiment) is operated at KIT. Its primary goal is to serve as a platform for a variety of accelerator R&D studies like the generation of strong ultra-short terahertz pulses. The amplitude of the generated coherent THz pulses is proportional to the square number of particles in the bunch. With the transverse emittance, a measure for the transverse particle density can be determined. It is therefore a vital parameter in the optimization of the operation. In a systematic study, the transverse emittance of the electron beam was measured in the FLUTE injector. A detailed analysis considers different influences such as the bunch charge and compares this with particle tracking simulations carried out with ASTRA. In this contribution, the key findings of this analysis are discussed. Thiemo Schmelzer acknowledges the support by the Doctoral School ”Karlsruhe School of Elementary and Astroparticle Physics: Science and Technology”.

AKBP 11.4 Wed 16:45 AKBP-H13

Development of a transfer line for LPA-generated electron bunches to a compact storage ring — •Bastian Härer[1], Erik Bründermann[1], Alexander Papash[1], Robert Ruprecht[1], Jens Schäfer[1], Christina Widmann[1], Anke-Susanne Müller[1], Laurids Jeppe[2], Philipp Messner[2], Andreas R. Maier[2], Jens Osterhoff[2], and Eva Panofski[2] — [1]Karlsruhe Institute of Technology (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY)

The injection of LPA-generated beams into a storage ring is considered to be one of the most prominent applications of laser plasma accelerators (LPAs). In a combined endeavour between Karlsruhe Institute of Technology (KIT) and Deutsches Elektronen-Synchrotron (DESY) the key challenges will be addressed with the aim to successfully demonstrate injection of LPA-generated beams into a compact storage ring with large energy acceptance and dynamic aperture. Such a storage ring and the corresponding transfer line are currently being designed within the cSTART project at KIT and will be ideally suited to accept bunches from a 50 MeV LPA prototype developed at DESY.

This contribution presents the foreseen layout of the transfer line from the LPA to the injection point of the storage ring and discusses the status of beams optics calculations.

AKBP 11.5 Wed 17:00 AKBP-H13

Beam Pulsing at the S-DALINAC: Superposition of the 3 GHz Beam Structure with a 1 MHz Macrostructure* — •Lennart Stobbe, Michaela Arnold, Jonny Birkhan, Uwe Bonnes, Lars Jürgensen, and Norbert Pietralla — Institut für Kernphysik, TU Darmstadt, Germany

The superconducting electron-linear-accelerator S-DALINAC provides a cw-beam with a 3 GHz time structure for different experiments. This mode is fixed and does not allow to deliver a (macro-) pulsed beam to the experimental setups. As time of flight measurements should become feasible at the so-called QCLAM magnetic spectrometer an additional pulsing device has been built and studied. The 3 GHz beam structure was superimposed with a 1 MHz macrostructure. The superposition was archived with a plate capacitor setup in the S-DALINAC's injector-beamline. The plate capacitor deflected the beam across an aperture with a repetition rate of 1 MHz. The current state of the capacitor setup as well as the first test measurement of the macrostructure with a plastic scintillator will be presented.

*Work supported by DFG (GRK 2128) and the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006).

AKBP 11.6 Wed 17:15 AKBP-H13

Proton Irradiation Site for Si-Detectors at the Bonn Isochronous Cyclotron — •Dennis Sauerland[1], Paul-Dieter Eversheim[1], Reinhard Beck[1], Pascal Wolf[2], and Jochen Dingfelder[2] — [1]Helmholtz-Institut für Strahlen und Kernphysik, Universität Bonn — [2]SiLab, Physikalisches Institut, Universität Bonn

With the Bonn Isochronous Cyclotron either protons, deuterons or ions up to $^{12}C^{4+}$ are accelerated to a kinetic energy ranging from 7 to 14 MeV per nucleon. The extracted beam is guided to one of five experimental sites.

At a new proton irradiation site, a 1 μA proton beam with a diameter of $\leq$ 6 mm is utilized to irradiate a target in air, e.g. cooled Si semiconductor detectors for radiation hardness tests. For homogeneous irradiation, the targets are scanned through the beam in a row-wise pattern with constant velocity and a row spacing much smaller than the beam diameter. During the irradiation procedure, the beam current and position is continuously measured non-destructively using a calibrated, secondary electron emission-based beam monitor, positioned at the exit window of the beamline. An on-the-fly beam monitor calibration can be obtained using a movable Faraday Cup. The diagnostics and the irradiation procedure ensure a homogeneous irradiation of the target with a fluence error of $\leq$ 2 %.

In this talk, an overview of the accelerator facility will be given, the irradiation site with its beam diagnostics will be presented in detail, along with an outlook on planned future developments at the facility.

AKBP 11.7 Wed 17:30 AKBP-H13

Progress of the SSMB Proof-of-Principle experiment at the Metrology Light Source — •Arnold Kruschinski[1], Arne Hoehl[2], Roman Klein[2], Ji Li[1], Jana Puls[2], Markus Ries[1], and Jörg Feikes[1] — [1]Helmholtz-Zentrum Berlin, Berlin, Germany — [2]Physikalisch-Technische Bundesanstalt, Berlin, Germany

The method of Steady-State Microbunching (SSMB) as proposed by Alex Chao and Daniel Ratner in 2010 is envisioned to generate intense coherent synchrotron radiation at a storage ring. The scheme would allow synchrotron light with brilliance similar to an FEL while enabling high repetition rates typical for a storage ring.

A proof-of-principle (PoP) experiment is conducted at the MLS storage ring in Berlin and has successfully demonstrated the viability of the general mechanism behind SSMB by showing stability of a microbunch structure over one turn in the storage ring. This talk will briefly introduce the idea behind SSMB and give an overview of the PoP experiment, its current status and outlook.

AKBP 12: New Accelerator Concepts 2

Time: Wednesday 16:00–17:30 Location: AKBP-H14

AKBP 12.1 Wed 16:00 AKBP-H14

Excitation of beam driven plasma waves in a hybrid LPWFA — •Susanne Schöbel[1,2], Richard Pausch[1], Finn-Ole Carstens[1,2], Yen-Yu Chang[1], Sébastien Corde[3], Jurjen Couperus Cabadağ[1], Alexander Debus[1], Hao Ding[4], Andreas Döpp[4], Thomas Heinemann[5,6], Bernhard Hidding[6], Max Gilljohann[3,4], Stefan Karsch[4], Alexander Köhler[1], Olena Kononenko[3], Alastair Nutter[6], Patrick Ufer[1,2], Alberto Martinez de la Ossa[5], Ulrich Schramm[1,2], and Arie Irman[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technische Universität Dresden, Germany — [3]LOA, ENSTA ParisTech, CNRS, Ecole Polytechnique, Université Paris-Saclay, France — [4]Ludwig-Maximilians-Universität München, Germany — [5]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [6]University of Strathclyde, Glasgow, UK

Here we present imaging of plasma wakefields driven by both, high intensity laser pulses or high peak current electron beams. In particular, a scheme of high-current electron beams from a LWFA as drivers of a beam-driven plasma wakefield accelerator (PWFA) is being extensively studied, aiming to fulfill the demanding quality requirements for applications such as FELs. Observing plasma wakefields in this regime demonstrates the capability of the LWFA beam to create the plasma as well as drive plasma wakefields. Additionally we observed a correlation between the drive beam charge and the shape of the plasma wave. This enables us to find an optimum parameter set towards the experimental demonstration of the hybrid LPWFA.

AKBP 12.2 Wed 16:15 AKBP-H14

Traveling-wave electron accelerators – Getting PIConGPU simulations ready for exascale — •Alexander Debus[1], Sunita Chandrasekaran[2,3], Klaus Steiniger[1], René Widera[1], Sergei Bastrakov[1], Felix Meyer[1], Richard Pausch[1], Marco Garten[1], Thomas Kluge[1], Jeffrey Kelling[1], Benjamin Hernandez[6], Matthew Leinhauser[2,3], Jeff Young[2,5], Franz Pöschel[1], Axel Hübl[4], David Rogers[6], Guido Juckeland[1], and Michael Bussmann[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]CASUS, Center for Advanced Systems Understanding, Görlitz, Germany — [3]University of Delaware, Newark, Delaware, USA — [4]Lawrence Berkeley National Laboratories, Berkeley, CA, USA — [5]Georgia Institute of Technology, Atlanta, GA, USA — [6]Oak Ridge National Laboratory, Knoxville, TN, USA

Traveling-wave electron acceleration (TWEAC) is an advanced laser-plasma accelerators scheme, which is neither limited by dephasing, nor by pump depletion or diffraction. Such accelerators are scalable to energies beyond 10 GeV without the need for staging and are candidates for future compact electron-positron colliders.

TWEAC simulations to high energies require exascale compute resources. Within the early-access program (CAAR) for the upcoming exascale Frontier cluster at ORNL, we prepare PIConGPU, a 3D3V particle-in-cell code, for large-scale TWEAC simulations, including tuning and refining PIConGPU to run on the latest AMD GPUs. In this talk we present progress in TWEAC simulations and the technical advances in PIConGPU that enable running on Frontier.

AKBP 12.3 Wed 16:30 AKBP-H14

Operational Experience and Characterization of a Superconducting Transverse Gradient Undulator for Compact Laser Wakefield Accelerator-Driven FEL — •Kantaphon Damminsek, Axel Bernhard, Sebastian Richter, Robert Rossmanith, Anke-Susanne Müller, Yimin Tong, and Andreas Grau — Karlsruhe Institute of Technology, Karlsruhe, Germany

A 40-period superconducting transverse gradient undulator (TGU) has been designed and fabricated at Karlsruhe Institute of Technology (KIT). Combining a TGU with a Laser Wakefield Accelerator (LWFA) is a potential key for realizing an extremely compact Free Electron Lasers (FEL) radiation source, as the TGU scheme is a viable option to compensate the challenging properties of the LWFA electron beam in terms of beam divergence and energy spread. The superconducting TGU has been commissioned off-line, step by step reaching its final operational parameters. A specially designed set-up for mapping of the magnetic field in the TGU's extremely narrow gap has been installed, commissioned and employed for the magnetic characterization. In this contribution, we report on the operational experience of the TGU and on the magnetic characterization measurement.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 12.4 Wed 16:45 AKBP-H14

Studies for a Laser Wakefield Driven Injector at ELSA — •Kilian Kranz, Klaus Desch, Daniel Elsner, and Michael Switka — Elektronen-Stretcher-Anlage, Physikalisches Institut, Universität Bonn

At the University of Bonn the storage ring ELSA extracts electrons with energies up to 3.2 GeV to hadron physics and novel detector testing experiments. We study the feasibility of replacing the current 26 MeV LINAC injector with a laser wakefield accelerator (LWA). For this, contemporary parameters from current LWA setups at other laboratories are assumed and matched to the acceptance of the booster synchrotron. Moreover, a conceptional draft of a potential LWA setup is created. This takes into consideration the influence of building conditions such as available floor space and building vibrations to estimate a setup and laser beam stability of a plasma generating high power laser system and beamline to the plasma cell. The methods and intermediate results of this study will be presented.

AKBP 12.5 Wed 17:00 AKBP-H14

Signal subtraction of consecutive electron bunches from a high-repetition-rate plasma-wakefield accelerator — •Judita Beinortaite[1,2], James Chappell[2], Gregor Loisch[1], Carl A. Lindstrøm[1], Sarah Schröder[1], Stephan Wesch[1], Matthew Wing[1,2], Jens Osterhoff[1], and Richard D'Arcy[1] — [1]DESY, Hamburg, Germany — [2]University College London, London, UK

Plasma-wakefield acceleration (PWFA) is one of the main candidates for future compact-accelerator technologies with applications in high energy physics and photon science. For PWFA, which currently operates at Hz level, to meet the luminosity and brilliance demands of current users, at least thousands of bunches must be delivered per second. As recently explored at FLASHForward, DESY, the fundamental limitation for the highest repetition rate is the long-term motion of ions that follows the dissipation of the driven wakefield (D'Arcy, R. et al. Recovery time of a plasma-wakefield accelerator. Nature (accepted) (2021)). The recovery of the plasma to an undisturbed state after the driving of a wakefield was observed in the images of consecutive electron bunches, separated by tens of nanoseconds, while the imaging screens have scintillation lifetimes of the order milliseconds. As such, an image processing technique capable of resolving individual bunches within that lifetime is needed. This technique - termed the 'subtraction method' - uses many shots of a preceding bunch to accurately identify and remove its signal from the overlapping signal of a subsequent bunch. As a result, high-repetition-rate processes can be studied to advance PWFA for meaningful application to facilities of the future.

AKBP 12.6 Wed 17:15 AKBP-H14

Radiative particle-in-cell simulations of the beam hosing instability – an analysis by components — •Anton Lebedev[1], Richard Pausch[1], Rene Widera[1], Sergei Bastrakov[1], Michael Bussmann[1,2], Ulrich Schramm[1,3], and Alexander Debus[1] — [1]Abteilung Laser-Teilchenbeschleunigung, Helmholtz Zentrum Dresden-Rossendorf, Dresden — [2]Center for Advanced Systems Understanding, Görlitz — [3]Institut für Strahlenphysik, Technische Universität Dresden, Dresden

We present first results and analyses of radiation spectra expected to be produced by ultrarelativistic particle beams propagating through a plasma medium experiencing the hosing instability. We determine these spectra in particle-in-cell simulations by in-situ computation of radiation based on Liénard-Wiechert potentials, emitted by all simulated particles (>10^9) of the beam and plasma for over 160 distinct detectors distributed across half a solid angle.

In the simulation campaign, conducted at the JUWELS Booster cluster at JSC, we considered linear and non-linear regimes of the instability for ultrarelativistic electron beams of varying emittance impacting a homogeneous electron plasma. We further show a preliminary analysis of the data relating observed characteristics of the spectra to the characteristics of the instability.

Our goal is to open up new experimental avenues for better understanding the beam instability evolution by identifying its radiation signatures that can be measured in experiments.

AKBP 13: Diagnostics, Control and Instrumentation 2

Time: Thursday 14:00–15:45 Location: AKBP-H13

AKBP 13.1 Thu 14:00 AKBP-H13

Concept of a Beam Diagnostics System for the Multi-Turn ERL Operation at the S-DALINAC* — •Manuel Dutine, Michaela Arnold, Ruben Grewe, Lars Jürgensen, Norbert Pietralla, Felix Schliessmann, and Manuel Steinhorst — Institut für Kernphysik, TU Darmstadt

The S-DALINAC is a thrice-recirculating electron accelerator operating in cw-mode at a frequency of 3 GHz. Due to the implementation of a path-length adjustment system capable of a 360° phase shift, it is possible to operate the accelerator as an Energy-Recovery LINAC [1]. The multi-turn ERL operation has been demonstrated in 2021 [2]. While operating the accelerator in this mode, there are two sets of bunches, the still-to-be accelerated and the already decelerated beam, with largely different absolute longitudinal coordinates in the same beamline. For this mode, a non-destructive, sensitive beam diagnostics system is necessary in order to measure the position of both beams simultaneously. The status of a 6 GHz resonant cavity beam position monitor (BPM) will be given together with the results of a wire scanner measurement of the multi-turn ERL beam.

[1] M. Arnold et al., Phys. Rev. Accel. Beams 23, 020101 (2020)

[2] Pressemitteilung des Informationsdienst Wissenschaft (idw), "Technoligischer Durchbruch bei Energieeffizienten Teilchenbeschleunigern", MI-NR. 63/2021, acc/feu.

*Work supported by DFG (GRK 2128), BMBF (05H21RDRB1), the State of Hesse within the Research Cluster ELEMENTS (Project ID 500/10.006) and the LOEWE Research Group Nuclear Photonics.

AKBP 13.2 Thu 14:15 AKBP-H13

Detection of single monoenergetic ion bunches using ionoacoustics — •Sonja Gerlach[1], Felix Balling[1], Anna-Katharina Schmidt[1], Florian-Emanuel Brack[2], Leon Kirsch[1,3], Florian Kroll[2], Marvin Reimold[2], Walter Assmann[1], Ulrich Schramm[2], Christina Trautmann[3], Karl Zeil[2], Katia Parodi[1], and Jörg Schreiber[1] — [1]Ludwig-Maximilians-Universität München, München, Deutschland — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Deutschland — [3]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

Ionoacoustics is an innovative method that employs the acoustic wave emitted by pulsed ion beams slowing down in water. We present the newly developed I-BEAT detector that determines ion bunch properties on a single bunch basis: the I-BEAT detector (Ion-Bunch Energy Acoustic Tracing). Relativistic ions are stopped in a water phantom surrounded by up to four ultrasound transducers for three-dimensional reconstruction of the dose deposited by the ion bunch. As the detector is radiation hard and electromagnetic pulse resistant, it is especially suited to fill the lack of reliable online detection methods for laser-accelerated ions. Additionally, we recently demonstrated that ionoacoustic beam monitoring is also possible in transmission mode. We discuss our results obtained with laser- and conventionally accelerated ion bunches being especially interesting for ion bunch position and intensity monitoring. This work was supported by the German Research Foundation (DFG) within the Research Training Group GRK 2274 and the BMBF under project 05P21WMFA1.

AKBP 13.3 Thu 14:30 AKBP-H13

Observation of BIF at the electron-cooler test-bench at HIM — •Thomas Beiser — Helmholtz-Institut Mainz, Mainz, Deutschland

Wavelength-resolved studies of beam-induced fluorescence have been made at the electron cooler teststand at HIM. As a new feature a low-noise, cooled sCMOS-camera was utilized. Beam-current dependence of the fluorescence has been recorded. Data evaluation is imminent and options for further experiments will be discussed.

AKBP 13.4 Thu 14:45 AKBP-H13

Longitudinal phase space (LPS) characterization of high brightness electron beams at PITZ — •Namra Aftab[1], Zakaria Aboulbanine[1], Gowri Adhikari[1], Prach Boonpornprasert[1], Maria-Elena Castro-Carballo[1], Georgi Georgiev[1], James Good[1], Matthias Gross[1], Andreas Hoffmann[1], Christian Koschitzki[1], Mikhail Krasilnikov[1], Xiangkun Li[1], Osip Lishilin[1], Anusorn Lueangaramwong[1], David Melkumyan[1], Raffael Niemczyk[1], Anne Oppelt[1], Houjun Qian[1], Frank Stephan[1], Grygorri Vashchenko[1], Tobias Weilbach[1], and Wolfgang Hillert[2] — [1]DESY, Zeuthen, Germany — [2]University of Hamburg, Germany

Methodological studies to improve the LPS tomography of space-charge dominated electron beams were carried out at the Photo Injector Test facility at DESY in Zeuthen (PITZ). In the experimental procedure, initially, a 200 μm-wide horizontal slit was introduced before the booster to cut the beam to strongly reduce space charge effects. Next, the signal resolution of this truncated beam was improved by careful beta function control at the reference screen of momentum measurements. A combination of both steps enabled accurate measurement of minimum energy spread and better control of beam phase advance during booster phase scan, i.e. control of booster amplitude and phase scan range. After optimization of the experimental conditions, the momentum projections were fed to a tomographic reconstruction algorithm to obtain the reconstructed LPS. Finally, the noisy artifacts in LPS were addressed to further improve the results.

AKBP 13.5 Thu 15:00 AKBP-H13

Low Gain Avalanche Detector for beam monitoring — •Vadym Kedych[1], Wilhelm Krueger[1], Adrian Rost[1,4], Jerzy Pietraszko[2], Tetyana Galatyuk[1,2], Sergey Linev[2], Jan Michel[3], Michael Traxler[2], Michael Traeger[2], and Christian Joachim Schmidt[2] — [1]Technische Universität Darmstadt, Darmstadt, Germany — [2]GSI GmbH, Darmstadt, Germany — [3]Goethe-Universität, Frankfurt, Germany — [4]FAIR GmbH, Darmstadt, Germany

Linacs suffer from high power consumption for particle acceleration when high energies are desired. Because of this there is a huge interest to accelerators with idea of energy recovery. ERL allow to recirculate beam to the main linac second time with a phase shift of 180° which cause to deceleration of the beam and returning energy to RF cavities. The S-DALINAC at TU Darmstadt allows the possibility to operate it in an ERL mode. Optimization of the acceleration and deceleration processes are extremely important for efficiency operation S-DALINAC in ERL mode. For these purposes setup based on LGAD are being developed. LGAD is a silicon detector optimized for 4D-tracking with timing precision below 50ps thanks to internal low gain which makes it an ideal candidate for precise timing monitoring at S-DALINAC.

In this contribution we present the results from the first (October 2021) LGAD test at S-DALINAC (TU Darmstadt).

**This work has been supported by DFG under GRK 2128.*

AKBP 13.6 Thu 15:15 AKBP-H13

Intensity monitoring of pulsed ion beams: Absolute calibration of the I-BEAT detector — •Ina Hofrichter, Sonja Gerlach, Felix Balling, Jonathan Bortfeldt, Leonard Doyle, Lotta Flaig, Jens Hartmann, Veronika Kratzer, Alexander Prasselsperger, Thomas Rösch, Anna Schmidt, Katia Parodi, and Jörg Schreiber — LMU München, München, Deutschland

The unique properties of laser-accelerated ion bunches - like their high particle flux accompanied by a strong electromagnetic pulse (EMP) - make beam monitoring challenging for well-established diagnostic systems with immediate feedback. The I-BEAT (Ion-Bunch Energy Acoustic Tracing) detector (cf. DOI: s41598-019-42920-5, DOI: 12.2592415) overcomes these difficulties by making use of the ionoacoustic principle: The energy deposited by ions stopping in water generates an acoustic wave from which the ion bunch properties can be reconstructed. The experimental setup consists of a water reservoir surrounded by ultrasonic transducers. Ions enter the detector through a Kapton entrance window. To enable quantitative assessment of the particle number and accordingly the absorbed dose, proper calibration of the detector is required. For that, we propose to use the signal generated in the entrance window, exploiting that its amplitude increases with growing ion number. We have set up a theoretical model to describe this signal and performed first experimental tests to validate our approach with an ionization chamber. This work was supported by the German Research Foundation (DFG) within the Research Training Group GRK 2274 and the BMBF under project 05P21WMFA1.

AKBP 13.7 Thu 15:30 AKBP-H13

Bunch Length Measurement Systems at S-DALINAC — •A. Brauch, M. Arnold, J. Enders, L. Jürgensen, N. Pietralla, and S. Weih — Technische Universität Darmstadt, Darmstadt, Deutschland

Precision experiments at the superconducting Darmstadt electron linear accelerator S-DALINAC require a high-quality beam. Next to other important beam parameters, an optimization of the bunch length to typical values of 0.7 to 2 ps is performed. This is accomplished by inducing a linear momentum spread on the bunch in one of the accelerating cavities. The bunch length can be measured with a target in a dispersive section downstream. This method is time consuming and can provide only an upper limit of the bunch length. Therefore, two new setups for bunch length measurements are introduced. They will improve the optimization process significantly. A new diagnostic beam line is set up in the low energy beam area. It includes a deflecting copper cavity used for measuring the bunch length by rotating the bunch and projecting its length on a target. A streak camera placed at different positions downstream the injector and the main accelerator will be used to measure the bunch length in the future. The device will analyse optical transition radiation from an aluminium coated kapton target. The pulse length of the emitted light is equal to the length of the bunch creating it. This contribution will present the layout of both systems, their current status and design considerations.

AKBP 14: Posters

Time: Thursday 16:00–17:30 Location: P

AKBP 14.1 Thu 16:00 P

A miniature transport-line design for laser plasma accelerator-driven FELs using HTS magnets — •Samira Fatehi, Axel Bernhard, and Anke-Susanne Müller — Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Laser-plasma acceleration is an outstanding candidate to drive the next-generation compact light sources and FELs. Due to extremely high accelerating gradients in LPAs, electron bunches can gain sufficient energies to generate synchrotron radiation in the X-ray regime in only a few millimetres to centimeters of acceleration length. To efficiently capture and transport the LPA-generated bunches in a compact transport line, beam line designs employing combined-function high-strength magnets based on high temperature superconductor technology have been studied. In this contribution we present the beam dynamics calculations as well as the magnet designs for a compact transport line matching the LPA-generated beam to a transverse-gradient undulator.

This work is supported by the BMBF project 05K19VKA PlasmaFEL (Federal Ministry of Education and Research).

AKBP 14.2 Thu 16:00 P

Future Neutron Beam Line at the Bonn Isochronous Cyclotron — •Maximilian Loepke and Reinhard Beck — Helmholtz-Institut für Strahlen- und Kernphysik Bonn

The Bonn Isochronous Cyclotron provides a beam of protons, deuterons or ions up to $^{12}C^{4+}$ with a kinetic energy ranging from 7 to 14 MeV per nucleon. Since 2019 the proton beam is utilized for irradiation of e.g. silicon pixel detectors for radiation hardness tests.

Currently, it is planned to extend the facility's irradiation and experimentation capabilities by providing a neutron beam. The neutrons are produced by converting deuterons into protons and neutrons in a thick carbon or berylium target. Protons are stopped by the target whereas the neutrons, are subsequently collimated and can be used for irradiation of a secondary target.

The angular distribution of neutrons from this stripping reaction is peaked forward and the energy of neutrons emerging at 0 degree is around 0.4 times the deuteron energy for deuterons in this energy range. The neutron flux at the secondary target after collimation has been estimated using simulations with Geant4 and experimental data found in literature to be in the order of 10^7 n/cm^2/s.

AKBP 14.3 Thu 16:00 P

Nitrogen-doping of niobium for SRF cavities — •Márton Major, Lambert Alff, Michaela Arnold, Jens Conrad, Stefan Flege, Ruben Grewe, and Norbert Pietralla — Technische Universität Darmstadt, Darmstadt, Germany

Niobium is the standard material for superconducting radio-frequency (SRF) cavities for particle acceleration. Superconducting materials with higher critical temperature or higher critical magnetic field allow cavities to work at higher operating temperatures or higher accelerating fields, respectively. One direction of search for new materials with better properties is the modification of bulk niobium by nitrogen doping. In the Nb-N phase diagram, the cubic δ-phase of NbN has the highest critical temperature.

Niobium samples were annealed and doped with nitrogen in the high-temperature furnace at TU Darmstadt and investigated at its Materials Research Department with respect to structural modifications. X-ray diffraction (XRD) confirmed the appearance of Nb_4N_3 and Nb_2N phases on the surface of the samples. A single cell cavity was annealed under optimized doping conditions. The test samples treated together with the cavity showed almost single Nb_4N_3 phase. XRD pole figures also showed grain growth during sample annealing.

The work was supported by the German Federal Ministry for Education and Research (BMBF) through grant 05H18RDRB2 and the German Research Foundation (DFG) via the AccelencE Research Training Group (GRK 2128).

AKBP 14.4 Thu 16:00 P

Improving the lifetime of GaAs-photo-cathodes with cryogenic components — •Tobias Eggert, Yuliya Fritzsche, and Joachim Enders — Institut für Kernphysik, TU Darmstadt, Germany

GaAs photocathodes provide a suitable source for polarized lectron beams. However, the operational lifetime is limited by a mandatory negative-electron-affinity (NEA) coating consisting of a cesium and oxygen. This layer gets corroded by oxygen over time and destroyed by ionized residual gas molecules hitting the surface. The latter is called ion back-bombardment (IBB) and is one of the main lifetime limiting factors. Improving the vacuum conditions around the cathodes surface is expected to reduce IBB and corrosion and therefore increase operational time. At the Institut für Kernphysik at TU Darmstadt a dedicated test stand is set up to develop a new kind of GaAs electron source, which uses cryocooling of a sub-volume to increase the vacuum condition around the cathode. In addition to the sub-volume, the cathode itself ets cooled to compensate for the temperature rise from high laser power.

This project is supported by DFG (GRK 2128) and BMBF (05H18RDRB1).

AKBP 14.5 Thu 16:00 P

Electro-thermal studies of quadrupole resonator designs — •Piotr Putek[1], Shahnam Gorgi Zadeh[2], Marc Wenskat[3,4], Simon Adrian[1], and Ursula van Rienen[1] — [1]Universität Rostock, Rostock, Germany — [2]CERN, Meyrin, Switzerland, — [3]Universität Hamburg, Hamburg, Germany — [4]Deutsches Elektronen-Synchrotron, Hamburg, Germany

Exploring the fundamental properties of materials such as niobium or Nb3Sn in terms of high precision surface resistance measurements is crucial for the further development of SRF technology. To precisely determine the radio frequency (RF) properties of superconducting materials, a calorimetric measurement is carried out with the aid of a so-called Quadrupole Resonator (QPR). However, the measurement procedure is affected by various uncertainties, such as geometrical deviations of the cavity design and the accuracy of numerical simulations. Additionally, the measurement bias for the third operational mode is observed in the pre-existing QPR designs, including the QPRs built at CERN and HZB. It motivated us to re-design the QPR to improve the measurement accuracy for the third operational mode (1.3 GHz). We compare the pre-existing QPR designs with optimized configurations from the perspective of electro-thermal simulations.

AKBP 14.6 Thu 16:00 P

Superconducting solenoid field analysis and optimization — •Shuai Ma[1,2], André Arnold[1], Anton Ryzhov[1], Jana Schaber[1,3], Petr Zwartek[1], Jochen Teichert[1], Rong Xiang[1], Paul Zwartek[1], Wolfgang Hillert[2], and Houjun Qian[4] — [1]HZDR — [2]Hamburg University — [3]Technische Universität Dresden — [4]Photo Injector Test Facility at DESY, Zeuthen site

The superconducting solenoid for SRF Gun III at ELBE will be installed and measured. Both the longitudinal and transverse fields will be measured and analyzed. The field axis can be derived from the field and it is helpful for the alignment of the solenoid. Formalism form to the transverse field will be used to analyze the multipole field.

AKBP 14.7 Thu 16:00 P

SRF Cavity and HOM Coupler Design for the W Working Point of the FCC-ee — •Sosoho-Abasi Udongwo[1], Shahnam Gorgi Zadeh[1], Rama Calaga[2], and Ursula van Rienen[1] — [1]University of Rostock, Rostock, Germany — [2]CERN, Geneva, Switzerland

The Future Circular electron-positron Collider (FCC-ee) is planned to operate with beam energies from 45.6 to 182.5 GeV and beam currents from 5.4 to 1390 mA to study the four operation points, the **Z**, **W**, **H** and $\mathbf{t\bar{t}}$. The energy and current specifications for the **W** working point are 80 GeV and 147 mA, respectively. Due to strong higher-order mode (HOM) effects, 2-cell 400 MHz elliptical SRF cavities are proposed for operation at this working point. This contribution summarises the RF design and optimization of the 2-cell cavity and its HOM couplers compatible with the **W** working point.

AKBP 15: Members' Assembly

Time: Thursday 18:00–19:00 Location: AKBP-MV

Members' Assembly