Hadronic and Nuclear Physics Division
Fachverband Physik der Hadronen und Kerne (HK)

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Overview of Invited Talks and Sessions

(Lecture halls H1, H2, H3, H4, H5, H6, and H8)

Plenary Talks of the Hadronic and Nuclear Physics Division

PV IV	Tue	9:45–10:30	Audimax	**Superheavy Element Research at GSI** — •Michael Block
PV IX	Fri	9:00– 9:45	Audimax	**Renaissance of nuclear physics at the LHC** — •Laura Fabbietti

Invited Talks

HK 1.1	Mon	11:00–11:30	H1	**Recent results of collinear laser spectroscopy in the vicinity of the magic tin isotopes** — •Liss Vázquez Rodríguez
HK 1.2	Mon	11:30–12:00	H1	**Highlights from the COMPASS Experiment and the AMBER Proposal** — •Boris Grube
HK 1.3	Mon	12:00–12:30	H1	**Characterizing baryon dominated matter with HADES measurements** — •Szymon Harabasz
HK 7.1	Tue	11:00–11:30	H1	**First observation of neutrinos from the CNO fusion cycle in the Sun** — •Daniele Guffanti
HK 7.2	Tue	11:30–12:00	H1	**The Compressed Baryonic Matter experiment at FAIR** — •Alberica Toia
HK 7.3	Tue	12:00–12:30	H1	**Ab initio perspectives on strongly correlated nuclei** — •Alexander Tichai
HK 16.1	Wed	14:00–14:30	H1	**Short-Range Correlations in neutron-rich nuclei** — •Meytal Duer
HK 16.2	Wed	14:30–15:00	H1	**The BGOOD experiment at ELSA - exotic structures in the light quark sector?** — •Thomas Jude
HK 16.3	Wed	15:00–15:30	H1	**The Muon g-2 Experiment at Fermilab** — •Martin Fertl
HK 16.4	Wed	15:30–16:00	H1	**The muon (g-2) from lattice QCD and experiments: 4.2 sigma, indeed?** — •Zoltan Fodor
HK 21.1	Thu	11:00–11:30	H1	**Charming bound states of the strong interaction** — •Frank Nerling
HK 21.2	Thu	11:30–12:00	H1	**Baryon Spectroscopy with the CBELSA/TAPS experiment at ELSA** — •Annika Thiel
HK 21.3	Thu	12:00–12:30	H1	**Mass measurements of the most exotic nuclei and their relevance for nuclear structure** — •Timo Dickel, FRS Ion Catcher Collaboration, TITAN Collaboration
HK 26.1	Fri	11:00–11:30	H1	**Studying the Universe from deep underground: the LUNA experiment** — •Rosanna Depalo
HK 26.2	Fri	11:30–12:00	H1	**Double parton scattering and double parton distributions** — •Peter Plössl
HK 26.3	Fri	12:00–12:30	H1	**BSM physics in hadronic and nuclear beta decays: challenges and opportunities** — •Chien Yeah Seng

Invited talks of the joint symposium Neutron stars (SYNS)

See SYNS for the full program of the symposium.

SYNS 1.1	Thu	14:00–14:40	Audimax	**Binary neutron stars: from gravitational to particle physics** — •Luciano Rezzolla
SYNS 1.2	Thu	14:40–15:20	Audimax	**Probing subatomic physics with gravitational waves** — •Tanja Hinderer
SYNS 1.3	Thu	15:20–16:00	Audimax	**A NICER view of neutron stars** — •Anna Watts

Sessions

HK 1.1–1.3	Mon	11:00–12:30	H1	**Invited Talks - I**
HK 2.1–2.7	Mon	16:30–18:30	H1	**Heavy-Ion Collisions and QCD Phases I**
HK 3.1–3.7	Mon	16:30–18:30	H2	**Instrumentation I**
HK 4.1–4.7	Mon	16:30–18:30	H3	**Hadron Structure and Spectroscopy I**
HK 5.1–5.7	Mon	16:30–18:30	H4	**Nuclear Astrophysics**
HK 6.1–6.6	Mon	16:30–18:15	H5	**Instrumentation II**
HK 7.1–7.3	Tue	11:00–12:30	H1	**Invited Talks - II**
HK 8.1–8.7	Tue	14:00–16:00	H1	**Instrumentation III**
HK 9.1–9.7	Tue	14:00–16:15	H2	**Outreach**
HK 10.1–10.6	Tue	14:00–16:00	H3	**Hadron Structure and Spectroscopy II**
HK 11.1–11.7	Tue	14:00–16:00	H4	**Instrumentation IV**
HK 12.1–12.7	Tue	16:30–18:30	H1	**Heavy-Ion Collisions and QCD Phases II**
HK 13.1–13.6	Tue	16:30–18:15	H2	**Instrumentation V**
HK 14.1–14.7	Tue	16:30–18:30	H3	**Hadron Structure and Spectroscopy III**
HK 15.1–15.6	Tue	16:30–18:30	H4	**Structure and Dynamics of Nuclei I**
HK 16.1–16.4	Wed	14:00–16:00	H1	**Invited Talks - III**
HK 17.1–17.7	Wed	16:30–18:30	H1	**Heavy-Ion Collisions and QCD Phases III**
HK 18.1–18.7	Wed	16:30–18:30	H2	**Instrumentation VI**
HK 19.1–19.6	Wed	16:30–18:15	H3	**Hadron Structure and Spectroscopy IV**
HK 20.1–20.6	Wed	16:30–18:45	H4	**Fundamental Symmetries**
HK 21.1–21.3	Thu	11:00–12:30	H1	**Invited Talks - IV**
HK 22.1–22.7	Thu	16:30–18:30	H1	**Heavy-Ion Collisions and QCD Phases IV**
HK 23.1–23.7	Thu	16:30–18:30	H2	**Instrumentation VII**
HK 24.1–24.7	Thu	16:30–18:30	H3	**Hadron Structure and Spectroscopy V**
HK 25.1–25.7	Thu	16:30–18:45	H4	**Astroparticle Physics**
HK 26.1–26.3	Fri	11:00–12:30	H1	**Invited Talks - V**
HK 27.1–27.8	Fri	14:00–16:15	H1	**Heavy-Ion Collisions and QCD Phases V**
HK 28.1–28.6	Fri	14:00–15:45	H2	**Instrumentation VIII**
HK 29.1–29.7	Fri	14:00–16:00	H3	**Hadron Structure and Spectroscopy VI**
HK 30.1–30.8	Fri	14:00–16:30	H4	**Structure and Dynamics of Nuclei II**

HK 1: Invited Talks - I

Time: Monday 11:00–12:30 Location: H1

Invited Talk HK 1.1 Mon 11:00 H1

Recent results of collinear laser spectroscopy in the vicinity of the magic tin isotopes — •Liss Vázquez Rodríguez — Experimental Physics Department, CERN, 1211 Geneva 23, Switzerland — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany

High-resolution collinear laser spectroscopy has been performed in a long sequence of tin (Z=50) species, spanning from N=58 to the very neutron-rich isotopes beyond the N=82 shell closure. Hyperfine structures and isotope shifts have been measured using the COLLAPS instrumentation at ISOLDE/ CERN. Simple linear and quadratic trends are observed for the electromagnetic moments and differences in charge radii between the lowest 1/2, 3/2, and 11/2 states in 117-131Sn. These regular patterns will be discussed in the framework of nuclear structure.

Invited Talk HK 1.2 Mon 11:30 H1

Highlights from the COMPASS Experiment and the AMBER Proposal — •Boris Grube — Physik-Department E18, Technische Universität München

The COMPASS experiment, which is the largest multi-purpose fixed-target spectrometer setup at the CERN Super Proton Synchrotron, studies the structure and spectrum of hadrons by scattering high-energy beams of hadrons and polarized muons off various targets. The broad physics program aims at a deeper understanding of the strong interaction, which is described by quantum chromodynamics (QCD). The studied processes include soft reactions of hadrons to test the breaking of the chiral symmetry of QCD, production and decay of meson resonances to perform detailed studies of the excitation spectrum of light-quark mesons, and scattering of high-energy muons and pions off nucleons to unravel the role of spin and internal dynamics in the quark-gluon structure of the nucleon. We will present highlights from recent analyses.

Based on the very successful running of COMPASS, the new AMBER experiment was proposed recently. The physics program includes a wide variety of measurements addressing fundamental questions of QCD. We will discuss the first part of the proposed program, which is intended to start 2022 and aims, among other things, at a measurement of the charge radius of the proton via elastic scattering of high-energy muons off target protons in order to shed more light on the proton-radius puzzle.

Invited Talk HK 1.3 Mon 12:00 H1

Characterizing baryon dominated matter with HADES measurements — •Szymon Harabasz for the HADES-Collaboration — TU Darmstadt / GSI, Darmstadt, Germany

In heavy-ion reactions at beam energies of a few GeV per nucleon on stationary targets, QCD matter is substantially compressed (2-3 times nuclear saturation density) while temperatures are expected not to exceed T = 70 MeV. Matter under such conditions is being studied with HADES at SIS18.

This contribution discusses new experimental results on the mechanisms of strangeness production, the emissivity of matter and the role of baryonic resonances herein. The multi-differential representations of hadron and dilepton spectra, collective effects and particle correlations will be confronted with results of other experiments as well as with hitherto model calculations.

To provide a deeper understanding of the temperature and density dependence of the intriguing results obtained in the Au+Au and Ar+KCl runs, HADES has completed a run studying Ag+Ag collisions at $\sqrt{s_{\mathrm{NN}}} = 2.55$ GeV, optimized to reach a high enough beam energy for abundant strangeness and vector meson production while yet realizing a large interaction volume. The results obtained for heavy-ion collisions are confronted to studies of elementary reactions serving as a reference for medium effects.

HK 2: Heavy-Ion Collisions and QCD Phases I

Time: Monday 16:30–18:30 Location: H1

Group Report HK 2.1 Mon 16:30 H1

Space-charge distortions in the ALICE TPC in Run 3 — •Matthias Kleiner for the ALICE-Collaboration — 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 require 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, such as variations in the number of collisions for a given time interval, cause fluctuations of the space-charge distortions on very short time scales. These fluctuations have to be corrected in time intervals of 5-10 ms to preserve the intrinsic space point resolution of the TPC of 100 μm. To accomplish this challenging task, a dedicated correction scheme based on data-driven machine learning techniques is developed.

In this talk, an overview about space-charge distortions and distortion fluctuations in the ALICE TPC in Run 3 will be presented, along with simulations of the expected distortions and the planned correction procedures.

Supported by BMBF and the Helmholtz Association

HK 2.2 Mon 17:00 H1

Reconstruction of Bottom Jets in Proton-Proton Collisions at $\sqrt{s} = 13$ TeV with ALICE — •Katharina Demmich for the ALICE-Collaboration — Westfälische Wilhelms-Universität Münster

When traversing the Quark-Gluon Plasma (QGP), partons lose energy via collisional and radiative processes. The amount of lost energy depends on the particle mass and manifests in a reduced jet multiplicity in heavy-ion collisions with respect to proton-proton collisions, for which no QGP is expected to form. A detailed knowledge about the charm and bottom-jet production in proton-proton collisions is thus inevitable for further investigations on particle energy loss within the QGP.

Owing to the relatively large lifetimes and the cascade of weak decays of B hadrons, transverse impact parameter spectra, as a measure for the distance between particle tracks and the primary vertex, offer a great opportunity to investigate the bottom-jet production. Results of a performance analysis of a bottom-jet selection algorithm based on transverse impact parameter spectra will be presented for 13 TeV proton-proton collisions.

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HK 2.3 Mon 17:15 H1

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

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.

HK 2.4 Mon 17:30 H1

Identification of photon conversions from Monte-Carlo simulations in ALICE using XGBoost — •Xuan-Xuyen Nguyen — Physikalisches Institut, Heidelberg, Baden Württemberg

ALICE measures photons by reconstructing photon conversions in the detector material. In the standard analysis a photon candidate sample is obtained by applying a sequence of manually set cuts. In order to improve the photon identification, a XGBoost classifier was trained on Monte-Carlo simulated data in this study. The simulated events were obtained by propagating proton-proton collisions generated with PYTHIA and lead-lead collisions generated with HIJING through the detector setup using the GEANT simulation package. The XGBoost models achieve a more constant and an up to 10% higher signal efficiency than the cut-based model at the same purity. A comparison between the XGBoost and the Random Forest models showed that both make similarly good predictions.

HK 2.5 Mon 17:45 H1

Studies of the ALICE material budget between TPC and TOF — •Oscar Castro Serrano and Ivan Vorobyev for the ALICE-Collaboration — Technische Universität München

The material located between the Time Projection Chamber (TPC) and Time-of-Flight (TOF) detectors is one of the most dense parts of the ALICE apparatus at mid-rapidity, with the main contribution coming from the Transition Radiation Detector (TRD). However, the description of this material budget used in Monte Carlo simulations was not yet validated with experimental data. The knowledge of this material budget plays significant role in various ALICE analyses which employ TOF detector for particle identification.

In this talk we show the method which facilitates validation of the ALICE detector material between TPC and TOF with pure sample of protons and pions, for which the inelastic cross sections for interactions with matter are well known from the experiment. The analysis is performed in p-Pb collisions at 5.02 TeV using pure samples of protons from lambda decays and pions from K0 decays reconstructed with the Inner Tracking System (ITS) and TPC detector. The number of protons and pions matched to a hit in the TOF detector is compared with the number of protons and pions in the TPC. The obtained TOF/TPC matching efficiency is compared to the results from full-scale ALICE simulations using GEANT3 and Geant4 toolkits for propagation of particles through the ALICE detector. As a result, the material budget between TPC and TOF can be validated in the momentum range of 0.5<p<5.0 GeV/c within ~5% precision.

HK 2.6 Mon 18:00 H1

Spadic response to single photon ionization based signals — •Marius Kunold for the CBM-Collaboration — Goethe-Universität Frankfurt am Main, Deutschland

The aim of the Compressed Baryonic Matter experiment at the Facility for Antiproton and Ion Research is to explore the QCD phase diagram in the region of high net-baryon densities. The Transition Radiation Detector is designed to identify light nuclei and deliver information for the global track reconstruction. Therefore, 4 layers of multi-wire proportional chambers with a segmented cathode readout will be installed. The signals will be readout by the Self-triggered Pulse Amplification and Digitization ASIC (SPADIC). For a successful particle identification a precise knowledge of the originally deposited energy and the position and time of the traversing particle is mandatory. Therefore, it is of high importance to have a detailed knowledge about the response of the SPADIC to the signals on the cathode plane.

The poster presents an analysis of the SPADIC response to single photons from a ^{55}Fe source. Especially the theoretical expectations are compared to the measured signal-shapes. The investigation is an initial step towards more elaborate time and charge reconstruction methods. To extract the charge and absolute time of the single signals a fit of the ADC sample distribution, based on the theoretical response function together with effective parameters, is performed. This new method is compared to the old charge extraction by reproducing an iron-spectrum.

HK 2.7 Mon 18:15 H1

Using CMOS technologies in ALICE for high luminosity experiments — •Abhishek Nath for the ALICE-Collaboration — Physikalisches Institut, Ruprecht Karl University of Heidelberg, Germany

The LHC may extend the heavy-ion program to Run 5 (2033) using lighter ions to achieve a large luminosity increase. To further contribute to the characterization of the macroscopic QGP properties with unprecedented precision, the ALICE Collaboration is writing an LOI of a next-generation multipurpose detector, the ALICE 3. It is a fast and light detector based on the use of monolithic active pixel sensors (MAPS) in combination with deep sub-micron commercial CMOS technologies. It has an excellent vertexing and tracking performance (Si tracker of about 100 m^2), and a large pseudorapidity coverage of $\Delta\eta = 8$. The rate capabilities should be a factor of about 50 higher with respect to ALICE in Run 4, being able to exploit the whole delivered p−A and A−A luminosity. The physics potential of the ALICE 3 experiment is very broad. For example, the search for de-confinement and coalescence with multi-charmed baryons, precision measurements of dileptons and in-medium interaction. Moreover, the unprecedented low momentum reach and particle identification properties of the detectors can be used to carry on searches in low energetic dielectrons and photons giving an opportunity to test theories like Low's theorem. In this talk, an overview of the ALICE 3 experiment and its capabilities to identify low energetic electrons via preshower detector will be presented.

HK 3: Instrumentation I

Time: Monday 16:30–18:30 Location: H2

Group Report HK 3.1 Mon 16:30 H2

Status of the Upgraded ALICE TPC — •Philip Hauer for the ALICE-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Bonn

During the long shutdown 2 of the LHC, the ALICE Time Projection Chamber (TPC) was upgraded in order to cope with the increased Pb-Pb interaction rate of 50 kHz planned for Run 3. The MWPC-based amplification system was replaced by Gas Electron Multipliers (GEM). These avoid the long dead time caused by the ion gating grid of the MWPC, and allow for a continuous readout. To this end, also the front-end and readout electronics had to be replaced.

In August 2020, the TPC was moved back to its designated position at LHC interaction point 2 and an extensive commissioning program was started. It includes measurements of laser tracks, cosmic particles and the irradiation of the TPC with an X-ray source to carry out a pad-by-pad gain calibration. During this measurement campaign, the TPC operated at nominal conditions and the continuous readout capability was tested successfully.

The talk will summarise the performance and challenges during the commissioning phase. Furthermore, the present status and plans for the future will be discussed.

Supported by BMBF.

HK 3.2 Mon 17:00 H2

Simulations of the X-ray spectrum measured with the ALICE TPC — •Ankur Yadav, Philip Hauer, Philipp Bielefeldt, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The ALICE Time Projection Chamber (TPC) was upgraded with a Gas Electron Multiplier (GEM) readout. In the scope of a commissioning program, several measurements were already conducted. This includes the irradiation of the TPC with an X-ray source. The pulse height spectrum recorded with the new front end electronic showed three distinct peaks on a Bremsstrahlung background. In addition to the characteristic peak of the Ag anode, the second peak could be attributed to fluorescence from the Cu layer of the GEM.

In order to clarify the origin of the third peak, the GEANT4 toolkit was used to simulate the interaction of X-rays and associated secondary particles with the detector gas and the surrounding passive material. A complete detector simulation chain was developed, including drift, diffusion and gas amplification.

In the talk, we will present the comparison of the simulation with the measured data.

Supported by BMBF.

HK 3.3 Mon 17:15 H2

Photon detection with THGEMs — •Thomas Klemenz[1], Laura Fabbietti[1], Piotr Gasik[2], and Roman Gernhäuser[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum für Schwerionenforschung

Traditional devices for photon detection like Photomultiplier tubes 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 that drift into the THGEM holes 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 3.4 Mon 17:30 H2

Characterizing new (TH)GEM coating materials using spectroscopy methods — •Berkin Ulukutlu[1], Piotr Gasik[2], Tobias Waldmann[1], Lukas Lautner[1], and Laura Fabbietti[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum für Schwerionenforschung

Gas Electron Multiplier (GEM) has become a commonly employed technology for modern high-rate particle and nuclear physics experiments. Nonetheless, one of the key limitations to the long-term sustainability of these devices are electrical discharges which might occur during high gain operation. Discharge events lead to dead-times and can even result in irreparable damage on the detector components, therefore, there has been extensive research aiming to develop methods to mitigate or subdue such events. This effort has yielded great success and enabled the development of very reliable and stable instruments. However, there are still major unanswered questions remaining concerning the fundamental mechanisms leading to the formation of electrical discharges in GEMs. In our studies, we investigated discharge formation in GEMs and Thick-GEMs (THGEM) produced with various conductive layer materials replacing the standard copper with aluminium, molybdenum, tantalum, and tungsten. Moreover, we employed optical spectroscopy to study the light emitted from such discharges as a probe to analyze the material content of the formed plasma. The measurements provide new insight into the mechanism of the secondary discharge creation.

HK 3.5 Mon 17:45 H2

Validation studies of Lightyield non-linearity implementation within the PandaRoot simulation framework — Kai-Thomas Brinkmann, •Simon Glennemeier-Marke, and Markus Moritz for the PANDA-Collaboration — Justus-Liebig-University Giessen

The PANDA detector at FAIR/GSI Darmstadt will utilize an electromagnetic calorimeter to measure the energies of photons being generated in proton-antiproton collisions. The calorimeter will use tapered PWO-II crystals and will cover a significant fraction of the 4π solid angle. These crystals show a strong tapering along their length. Due to this asymmetric geometry and absorption phenomena, the light yield varies non-uniformly along the long axis of the crystals. This project utilizes simulations within the PandaRoot simulation framework to validate the computational implementation of the non-uniformity and compare it to experimental results of previous studies. This project was supported by BMBF, GSI and HFHF.

HK 3.6 Mon 18:00 H2

Machine Learning based calibration of Low Gain Avalanche Detector — •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 Joachim Schmidt Christian[2] — [1]Technische Universität 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 status of a machine learning based calibration for LGAD using deep learning and neural network (NN). Experimental data from proton beam run at the COoler SYnchrotron (COSY) facility in Jülich is used to train the calibration model.

**This work has been supported by DFG under GRK 2128.*

HK 3.7 Mon 18:15 H2

Experiments and reconstruction methods for NeuLAND, the New Large Area Neutron Detector — •Jan Mayer and Andreas Zilges for the R3B-Collaboration — Institute for Nuclear Physics, University of Cologne

NeuLAND, the New Large Area Neutron Detector, is a core component of the Reactions with Relativistic Radioactive Beams (R^3B) setup at the Facility for Antiproton and Ion Research (FAIR), Germany.

In this talk, we give an overview of the detector performance achieved in experiments performed at the upgraded GSI facility. Reconstruction of the multiplicity and the first interaction points from the complex hit patterns is challenging. We present challenges, possible solutions, and results obtained with a diverse set of approaches including classical statistical methods and Machine Learning.

Supported by the BMBF (05P19PKFNA) and the GSI (KZILGE1416).

HK 4: Hadron Structure and Spectroscopy I

Time: Monday 16:30–18:30 Location: H3

Group Report HK 4.1 Mon 16:30 H3

Observation of a structure in the M(pη) invariant mass distribution at 1700 MeV in the γp - p $\pi\eta$ reaction — •Volker Metag and Mariana Nanova for the CBELSA/TAPS-Collaboration — II. Physikalisches Institut Universität Giessen

The present work extends earlier studies of the $\gamma p \to p\pi^0\eta$ reaction and has been motivated by the recently claimed observation of a narrow structure around an excitation energy of 1678 MeV [1]. The existence of this structure cannot be confirmed. Instead, for E_γ = 1400 - 1500 MeV and the cut $M_{p\pi^0} \leq 1190$ MeV a statistically significant structure in the $M_{p\eta}$ invariant mass distribution near 1700 MeV is observed with a width of $\Gamma \approx 35$ MeV.The most likely interpretation is that it is due to a triangular singularity in the $\gamma p \to pa_0 \to p\pi^0\eta$ reaction.

[1] V. Kuznetsov *et al.*, JETP Lett. **106**, 693 (2017).

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HK 4.2 Mon 17:00 H3

$K^0_S\Sigma^0$ photoproduction at the BGOOD experiment — •Katrin Kohl for the BGOOD-Collaboration — Physikalisches Institut, Nussallee 12, D-53115 Bonn

The BGOOD experiment at the ELSA accelerator facility uses an energy tagged bremsstrahlung photon beam to investigate hadronic excitations in meson photoproduction.

The associated photoproduction of K^0_S and hyperons is of particular interest. A cusp-like structure observed in the $\gamma p \to K_S^0\Sigma^+$ reaction at the K^* threshold is described by models including multi-quark resonances through dynamically generated vector meson-baryon interactions. This is the same model which predicted the P_C pentaquark states observed at LHCb through D^*-Σ_c interactions. In analogy, in the s-quark sector a peak like structure in $K_S^0\Sigma^0$ photoproduction off the neutron is predicted, associated with a K^*-Σ type configuration.

This talk presents the measurement of the $\gamma n \to K_S^0\Sigma^0$ differential cross section from threshold to a beam energy of 2600 MeV. Within the available statistics the results appear consistent with the predicted peak like structure.

*Supported by DFG projects 388979758/405882627 and the European Union's Horizon 2020 programme, grant 824093.

HK 4.3 Mon 17:15 H3

a_0 photoproduction at the BGOOD experiment — •Adrian Sonnenschein for the BGOOD-Collaboration — Physikalisches Institut, Nussallee 12, D-53115 Bonn

In recent years hadron spectroscopy has experienced a renaissance due to the discovery of tetra- and pentaquark systems including c and b quarks. Similar structures are expected similar structures are expected in the sector of light u,d,s quarks. The BGOOD experiment at the ELSA electron accelerator facility is studying this through the photoproduction of mesons close to production threshold. Recent results suggestthat the $K\bar{K}$ threshold is of particular interest.

This is where the isovector meson resonances $a_0(980)$ is located, slightly below the $K\bar{K}$ threshold. Photoproduction of a $\pi^0\eta$ pair off a proton $\gamma p \to \pi^0\eta p$ is a favourable reaction channel to study the $a_0 p$ threshold, since $a_0(980)$ has a dominant $\pi_0\eta$ decay mode.

This talk presents the measurement of the $\pi_0\eta$ mass distribution and the determination of differential cross sections.

*Supported by DFG projects 388979758/405882627 and the European Unions's Horizont 2020 programm, grant 824093.

HK 4.4 Mon 17:30 H3

Determination of the target asymmetry T in the reaction $\gamma p \to p\pi^0$ — •Sebastian Ciupka — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Photoproduction experiments provide a tool to further our understanding of the experimentally observed nucleon excitation spectra, which show discrepancies to predictions based on e.g. lattice QCD. Since the resonances are strongly overlapping, a partial wave analysis is needed to disentangle the states. To unambiguously determine the complex amplitudes of the analysis, it is not enough to conduct unpolarised measurements, therefore measurements with a polarised beam, a polarised target or with a recoil nucleon polarimeter have to be realised.

At the CBELSA/TAPS experiment in Bonn a linearly polarised photon beam and a longitudinally or transversely polarised target are provided, giving access to single and double polarization observables. The two main detectors of the experiment are the Crystal Barrel (CB) calorimeter and the MiniTAPS calorimeter in forward direction, which in combination provide nearly 4π coverage.

This talk presents preliminary results for the target asymmetry T in π photoproduction, determined from data collected after the upgrade of the CB readout system at the end of 2017. The data are compared with previously collected data and theoretical predictions.

HK 4.5 Mon 17:45 H3

Prospects for a Partial Wave Analysis of the $\overline{\Xi}\Lambda K^-$ Final State at $\overline{\text{P}}$ANDA — •Jennifer Pütz and James Ritman for the PANDA-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

For a deep insight 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 $\bar{\text{p}}$p cross section is associated to final states with a baryon-antibaryon pair together with additional mesons, giving access to excited states both in the baryon and the antibaryon channel.

In earlier Monte Carlo studies, it has been demonstrated that with an expected cross section in the order of μb $\overline{\text{P}}$ANDA will be able to observe the $\overline{\Xi}^+\Lambda K^-$ channel with a negligible background contribution. In this study, the feasibility of $\overline{\text{P}}$ANDA to determine the mass, width, spin and parity of two specific Ξ resonances, $\Xi(1690)$ and $\Xi(1820)$, is investigated by making use of a partial wave analysis employing the PAWIAN framework.

HK 4.6 Mon 18:00 H3

Two-particle correlations with high-p_T Λ baryons and K_S^0 mesons in pp collisions at ALICE — •Lucia Anna Husová — IKP, WWU Münster, Germany

Complementary to jet reconstruction, two-particle correlations in $\Delta\eta$ and $\Delta\varphi$ are used to study jets, in particular, their particle composition. While in Pb–Pb collisions, this is done to characterize the Quark-Gluon Plasma, pp and p-Pb collisions serve as a reference and are of interest on their own for their input into the understanding of particle production mechanisms. Recent ALICE results on the production of strange particles in small systems (pp and p–Pb collisions) reveal the possibility of having similar strange hadron production mechanisms in all collision systems. We study two-particle correlations triggered with strange hadrons ($\text{K}_\text{S}^0, \Lambda, \bar{\Lambda}$) in pp collisions at 13 TeV.

In this talk, the dependence of the per-trigger yields of primary charged hadrons on the wide range of the transverse momenta of the trigger and associated particles, as well as on the event multiplicity, will be presented on both the near-side and away-side. Moreover, the ratios of these yields to the yields extracted from the h-h correlation function will be shown. The presented results will be compared among the three hadron species. In addition, a comparison to different MC generators will be presented, which will allow us to better understand the strangeness production in jets.

supported by BMBF ErUM FSP-T01 ALICE 0519PMCA1

HK 4.7 Mon 18:15 H3

New experimental limits on the effective hadron interaction with strangeness = -3 by ALICE — •Georgios Mantzaridis for the ALICE-Collaboration — Technische Universität München

Accessing experimentally the hadron-hadron interactions for systems of various quark content is essential to validate theoretical calculations, first principles and effective models alike. In the case of nucleon-nucleon (NN) interactions scattering experiments provide good constrains for the theory. However, the nucleon-hyperon (NY) interaction is difficult to access with traditional experimental techniques, and mostly limited to the strangess -1 sector.

Recent results from the ALICE collaboration demonstrated the feasibility of using two-particle correlation techniques to investigate the interaction between pairs containing multi-strangeness. We present measurements in the strangeness -3 sector using the p-Ω^- and the Λ-Ξ^- channels, both studied 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. In particular the p-Ω^- system couples to Λ-Ξ^- and the strength of this coupling depends on the strength of the interaction itself. Thus, we have measured the Λ-Ξ^- correlation and compared the results to chiral effective field theory calculations. A shallow Λ-Ξ^- interaction is supported, which is compatible with a weak contribution to the p-Ω^- correlation.

HK 5: Nuclear Astrophysics

Time: Monday 16:30–18:30 Location: H4

Group Report HK 5.1 Mon 16:30 H4

Investigation of nuclear physics properties for p process nucleosynthesis — •Martin Müller, Felix Heim, Yanzhao Wang, Svenja Wilden, and Andreas Zilges — Institute for Nuclear Physics, University of Cologne

More than 60 years after the ground breaking paper by Burbidge, Burbidge, Fowler and Hoyle [1] many questions about the nucleosynthesis of neutron deficient nuclei in the p process remain unsolved. While the number of p nuclei is small, the number of reactions involved in their production is extremely large, necessitating a detailed and precise theoretical description. This talk will provide a brief overview of our group's contributions to the experimental determination of nuclear cross sections as well as studies of the underlying nuclear physics parameters such as the γ-ray strength function, the nuclear level density and the α-optical model potential. Recent experiments on proton- and α-induced reactions along with comprehensive comparisons with statistical model calculations will be presented [2-5].

Supported by the DFG (ZI 510/9-1).

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HK 5.2 Mon 17:00 H4

Gravitational wave signatures of the hadron-quark phase transition in binary neutron star mergers — •Matthias Hanauske[1,2], Horst Stöcker[1,2], and Luciano Rezzolla[1,2] — [1]Institut für Theoretische Physik, Max-von-Laue-Straße 1, 60438 Frankfurt, Germany — [2]Frankfurt Institute for Advanced Studies, Ruth-Moufang-Straße 1, 60438 Frankfurt, Germany

The long-awaited detection of a gravitational wave from the merger of a binary neutron star in August 2017 (GW170817) marked the beginning of the new field of multi-messenger gravitational wave astronomy. Reaching densities a few times that of nuclear matter and temperatures up to 100 MeV, such mergers also represent potential sites for a phase transition from confined hadronic matter to deconfined quark matter (HQPT). The appearance of a HQPT in the interior region of the merger remnant and its conjunction with the spectral properties of the emitted gravitational wave can be calculated by fully general-relativistic hydrodynamic simulations. The results show, that binary neutron star mergers probe a broad region of the QCD phase diagram, with matter crossing the phase boundary over a large range in densities and temperatures. Depending on the properties of the HQPT, a gravitational wave signature can be created promptly after the merger or during the post-merger evolution. Especially during the postmerger evolution of the produced hypermassive/supramassive hybrid star the occurrence of a "delayed HQPT" might give a clear gravitational wave signature of the production of quark matter.

HK 5.3 Mon 17:15 H4

Long-time simulations of neutron star mergers — •Maximilian Jacobi[1], Federico Guercilena[1], Almudena Arcones[1,2], Wolfgang Kastaun[3,4], Takami Kuroda[3], Bruno Giacomazzo[5,6,7], and Martin Obergaulinger[8] — [1]Technische Universität Darmstadt — [2]GSI Helmholtzzentrum für Schwerionenforschung — [3]Max Planck Institute for Gravitational Physics — [4]Leibniz Universität Hannover — [5]Universitá degli Studi di Milano - Bicocca — [6]INFN, Sezione di Milano-Bicocca — [7]INAF, Osservatorio Astronomico di Brera — [8]Universitat de València

Merging binary neutron stars (BNS) typically form a massive accretion disk around a compact object that can eject mass for up to several seconds. Explosive r-process nucleosynthesis in these ejecta make up a large contribution to the total mass of heavy elements produced in the event and play an important role in its optical and infrared transient (kilonova). Therefore, to interpret multi-messenger events such as GW170817, it is essential to perform long-term simulations. I will present GR simulations of BNS mergers following the in-spiral, merger, and accretion disk phases. Shortly after merger, we transition from 3D to 2D which significantly reduces the computational cost of the simulation. This setup allows us to simulate merging neutron stars consistently from the in-spiral to the accretion disk phase on the time scale of seconds.

HK 5.4 Mon 17:30 H4

Weak r-process nucleosynthesis: the impact of (α,xn) reactions — •Athanasios Psaltis[1], Almudena Arcones[1,2], Melina Avila[3], Max Jacobi[1], Zach Meisel[4], Peter Mohr[5], Fernando Montes[6], and Wei Jia Ong[7] — [1]TU Darmstadt, Germany — [2]GSI, Darmstadt, Germany — [3]Argonne National Laboratory, Argonne, IL, USA — [4]Ohio University, Athens, OH, USA — [5]ATOMKI, Debrecen, Hungary — [6]NSCL/MSU, East Lansing, MI,USA — [7]Lawrence Livermore National Laboratory, Livermore, CA, USA

'Light' heavy elements (Z = 38 – 47) can be synthesized in the neutrino–driven ejecta of core–collapse supernovae via the weak r–process [1]. This nucleosynthesis scenario exhibits uncertainties from the absence of experimental data from (α,xn) reactions on neutron–rich nuclei, which are currently based on statistical model calculations. A recent sensitivity study identified the most important (α,xn) reactions that can affect the production of 'light' heavy elements under different astrophysical conditions [2]. The current status of weak r–process nucleosynthesis calculations and the planning of experiments to experimentally determine (α,xn) reaction rates using the MUSIC detector at Argonne National Laboratory [3] and the SECAR recoil separator at FRIB [4] will be discussed.

References

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[2] J. Bliss et al., Phys. Rev. C 101, 055807 (2020)
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[4] G. Berg et al., NIM A 877, 87 (2018)

HK 5.5 Mon 17:45 H4

Mass Measurements of Proton-Rich Strontium Isotopes for rp-Process Studies — •Tobias Murböck[1], Jack Henderson[1,2], Zach Hockenbery[1,3], Ania A. Kwiatkowski[1,4], and Daniel Lascar[1,5] for the TITAN-Collaboration — [1]TRIUMF, Vancouver, Canada — [2]Univ. of Surrey, England — [3]McGill Univ., Montreal, Canada — [4]Univ. of Victoria, Victoria, Canada — [5]Northwestern Univ., Evanston, Illinois, US

The rp-process (rapid proton-capture process) consists of a series of radiative proton captures along the N=Z line up to the proton dripline. It is believed to be the primary source of nuclei that are not generated via either the rapid or slow neutron-capture process.

The energy released during the rp-process may power type-I X-ray bursts which occur in binary star systems where a neutron star accretes material from its larger partner. The calculated luminosity from an X-ray burst crucially depends on the mass values of the involved nuclei, which affect the reaction flow through the the rp-process waiting points. Here we present high-precision mass measurements of the neutron-deficient isotopes $^{74-76}$Sr. Specifically, the mass of ^{74}Sr allows one to determine the two-proton separation energy of the 2p reaction from the waiting point ^{72}Kr. The achieved uncertainties of a few 10 keV/c^2 are precise enough to provide stringent constraints on the nuclear reaction rates in this region of the rp-process. The experiment has been performed with the multi-reflection time-of-flight mass spectrometer (MR-ToF-MS) which has been recently added to TRIUMF's Ion Trap for Atomic and Nuclear science (TITAN).

HK 5.6 Mon 18:00 H4

Measurement of ^{39}K(p,γ)^{40}Ca resonance strengths below 900 keV for classical novae nucleosynthesis — •Philipp Scholz, Richard J. deBoer, Joachim Görres, Rebeka Kelmar, Shahina Shahina, and Michael Wiescher — Department of Physics, University of Notre Dame, IN

Classical novae are one of the most frequent explosive nucleosynthesis events in our universe but are still not sufficiently understood.

To this day, nuclear astrophysics cannot explain the endpoint of the nucleosynthesis networks in classical novae which is mainly due to a scarce experimental data base of nuclear reaction rates of proton-induced reactions in the the mass-region above silicon at temperatures between 0.1 GK and 0.4 GK.

Because some nova ejecta hint on the production of elements in the calcium range (Centauri V1065) and some possibly even up to the iron region (Cygni V1974), it is of utmost interest to investigate possible paths towards heavier elements.

Here we report on new measurements of resonance strengths of the ^{39}K$(p,\gamma)^{40}$Ca reaction below 900 keV at the 5U accelerator of the University of Notre Dame and their implications on the (p,γ) reaction rate on ^{39}K.

HK 5.7 Mon 18:15 H4

Production and study of new neutron-rich nuclei via a novel MNT-induced process using 238U+164Dy — •Deepak Kumar[1], Paul Constantin[2], and Timo Dickel[1] for the FRS Ion Catcher-Collaboration — [1]GSI Helmholtz Center for Heavy Ion Research and Justus-Liebig University of Giessen, Germany — [2]ELI-NP/IFIN-HH, Magurele, Romania

The crux of measuring the nuclear properties of heavy neutron-rich exotic nuclei and nuclear data with reduced uncertainties for known nuclei is to explore the r-process abundance pattern of the elements heavier than iron (Fe). However, the production of these neutron-rich nuclei is beyond the accessible limit of conventional methods. Nevertheless, a new possible alternative is the Multi-Nucleon Transfer (MNT) approach that manifests a strong potential to achieve this goal. In order to establish a new direction of research for the MNT-induced neutron-rich products using the FRS Ion Catcher (IC) facility at GSI, the 238U beam at 500 MeV/u has been proposed to deliver from the SIS18 and allowed to bombard on 164Dy target at 10 MeV/u placed inside the Cryogenic Stopping Cell (CSC). It offers a promising way to produce a significant amount of several new neutron-rich nuclei that have been speculated by the most reliable state-of-the-art Langevin-type model calculations. This research direction is based on a universal, fast, and efficient method to measure production cross-section and broadband masses of reaction products, including long-lived isomers. The developed methods and instrumentation will be extended to be utilized for LEB at the Super FRS facility with neutron-rich unstable beams.

HK 6: Instrumentation II

Time: Monday 16:30–18:15 Location: H5

Group Report HK 6.1 Mon 16:30 H5

The new APD Based Readout of the Crystal Barrel Calorimeter — •Christian Honisch, Peter Klassen, Johannes Müllers, and Martin Urban for the CBELSA/TAPS-Collaboration — HISKP, University of Bonn, Nussallee 14-16, 53115 Bonn

The Crystal Barrel is an electromagnetic calorimeter located at the electron accelerator ELSA. The detector consisting of 1320 CsI(Tl) scintillator modules is used to detect the decay products of baryon resonances, $\vec{\gamma}\vec{\mathrm{n}} \to N^* \to \mathrm{n}\pi^0 \to \mathrm{n}\gamma\gamma$.
To comprehensively study reactions that have no charged particles in the final state, an exchange of the readout electronics was necessary to achieve a high and uniform trigger efficiency for such reactions.
The upgrade was finished in 2017 and this talk gives an overview over the key challenges:
- Fast signals from CsI(Tl) while maintaining a reasonable SNR,
- Clustering in the 26 matrix in 100 ns,
- APD gain measurement and stabilization.
The talk will introduce the new readout and present its achieved performance in prototype tests and the first production beamtimes.

HK 6.2 Mon 17:00 H5

Energy resolution optimization for the $\overline{\text{P}}$ANDA EMC regarding the LAAPD gain — •Kim Tabea Giebenhain for the PANDA-Collaboration — Justus-Liebig-Universität, Gießen, Deutschland

For the future Facility for Antiproton and Ion Research, the $\overline{\text{P}}$ANDA experiment will be a unique opportunity to study proton antiproton collisions. One of the most crucial detector parts is the electromagnetic calorimeter. In order to meet the high precision demands in reconstruction and particle identification, its energy resolution is an important factor. The energy resolution depends on the signal to noise ratio of the front-end, especially at the crucial low energies. To improve the calorimeter performance beyond its design goal, for potential future even more demanding requirements, a study was done to find the optimal bias voltage for the utilized Large Area Avalanche Photo Diodes for energy ranges between 10 MeV and 2 GeV, using a light pulser system to simulate the PWO-II scintillation light. Since the dynamic range of the read-out chain is limited, additional simulation studies were conducted to find out, if the optimum bias voltage can be used for higher beam momenta.

Supported by BMBF, GSI/FAIR, HFHF

HK 6.3 Mon 17:15 H5

APD-Gain optimization for the $\overline{\text{P}}$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 PANDA Experiment will provide an excellent energy resolution over a wide dynamic range. In order to reveal the full potential of its readout, the gain of the APDs can still be further optimized. With the goal to detect high energy photons over a wide energy range from a few dozens of MeV up to 15 GeV, the system must provide a most excellent energy resolution over the whole spectrum whilst maintaining the required dynamic range of the individual readout-electronics. The progress made on this subject over the last two years shall be briefly summarized in this contribution. Various measurements have been made on a complete setup, including an accelerator experiment at MAMI with tagged photons, that is very close to the final read out of the $\overline{\text{P}}$ANDA EMC. To match environmental conditions during operation, the setup was cooled to −25 °C. The analysis of the data is still in progress to this date. This project is supported by BMBF, GSI and HFHF.

HK 6.4 Mon 17:30 H5

Construction and testing 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 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 the near future. 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 was conceived to measure ISR at low 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 construction of the detector as well as test measurements using the read out electronics are presented.

HK 6.5 Mon 17:45 H5

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalić[1], Thomas Aumann[1,2], Martin Baumann[1], Patrick Von Beek[1], Ioana Gheorghe[3], Heiko Scheit[1], and Dmytro Symochko[1] — [1]TU Darmstadt — [2]GSI Helmholtzzentrum — [3]"Horia Hulubei" National Insitute for R&D in Physics and Nuclear Engineering (IFIN-HH), 30 Reactorului 077125 Bucharest-Magurele

The photoneutron cross sections of 112Sn,116Sn,120Sn and 124Sn were measured in(g,xn)reactions, where x =1-4, using a quasi-monochromatic laser Compton-scattering g-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 g 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. After the cross sections are obtained they will be compared to both data sets.The talk will be focused on current results of the analysis of the data from 2019. measured at NewSUBARU facility.

HK 6.6 Mon 18:00 H5

PANDA backward end-cap calorimeter support system — •David Rodriguez Pineiro[1], Alaa Dbeyssi[1], Frank Maas[1,2,3], Luigi Capozza[1], Oliver Noll[1], Sahra Wolff[1], Peter-Bernd Otte[1], Dong Liu[1], Alexander Christian Geriner[1], Julian Moik[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 Cluster of Excellence, Mainz, Germany

The PANDA experiment will be one of three experimental pillars at the new accelerator facility FAIR in Darmstadt. The PANDA detector system has been designed to record antiproton annihilations at high rate and with high resolution and thus contribute to the understanding of the strong interaction in the nonperturbative regime. The group in Mainz is constructing the backward end-cap (BWEC) of the PANDA electromagnetic calorimeter, which will be used at the MAMI electron accelerator for a FAIR/Phase0 experiment at Mainz.

In order to mount and calibrate the detector a support system has been designed and built. All mechanical parts (shafts, bearings, connecting elements and a high ratio worm gearbox) have been chosen to comply with a safety factor of about two. It allows for a rotation by 90° changing between assembling position (mounting plate horizontal - crystals vertical) and working position. Both positions will also be used for the calibration with cosmic muons. The mechanical design of the backward end-cap will be discussed.

HK 7: Invited Talks - II

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

Invited Talk HK 7.1 Tue 11:00 H1

First observation of neutrinos from the CNO fusion cycle in the Sun — •Daniele Guffanti — Institute of Physics and Excellence Cluster PRISMA, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

The Sun, as all the other stars, is fuelled for most of its life by the fusion of hydrogen into helium taking place in its core. Neutrinos produced in such reactions are the only direct probe to the innermost part of our star and real time messengers of its engine. Decades of experimental and phenomenological efforts allowed us to study in detail the driving energy production mechanism in the Sun, the proton-proton chain, which is responsible for $\approx 99\%$ of the solar luminosity. The fusion processes accounting for the remaining 1% are believed to be catalysed by the presence of Carbon, Nitrogen and Oxygen (CNO-cycle) in the solar interior, but a direct evidence of the occurrence of such mechanism was still missing.

After years-long efforts, the Borexino experiment at the Gran Sasso National Laboratories has recently reported the first direct observation of solar neutrinos produced in the CNO-cycle. In this talk I will present the Borexino findings and I will discuss the importance of CNO neutrinos for astrophysics and for our understanding of the Sun.

Invited Talk HK 7.2 Tue 11:30 H1

The Compressed Baryonic Matter experiment at FAIR — •Alberica Toia for the CBM-Collaboration — Goethe University Frankfurt — GSI

The study of QCD matter at extreme temperature and density such as existing shortly after the Big Bang or in the core of neutron stars, can bring new insights into the innermost structure of matter and the fundamental forces between its building blocks.

While gravitational wave events reveal a glimpse of QCD matter at these extreme conditions, the future Facility for Antiproton and Ion Research (FAIR) will directly create and investigate its properties in the laboratory. For the very high net-baryon densities, produced by nucleus-nucleus collisions at SIS100 beam energies (3.5-12 AGeV), phenomena such as first order phase transition between hadronic and partonic matter which may terminate at a critical point or even more exotic phases may be expected.

The Compressed Baryonic Matter (CBM) experiment is a dedicated heavy-ion investigation designed to explicitly access rare observables sensitive to the detector media, employing fast and radiation hard detectors, self-triggered detector front-ends and a free-streaming readout architecture.

Several of the CBM detector systems, the data read-out chain and event reconstruction for several of the CBM detector subsystems are commissioned and already used in experiments for FAIR phase 0 and for a full-system setup at GSI SIS18. The physics program of CBM will be reviewed and the current status of the experiment will be reported.

Invited Talk HK 7.3 Tue 12:00 H1

Ab initio perspectives on strongly correlated nuclei — •Alexander Tichai — Institut für Kernphysik, Darmstadt, Germany

The description of nuclear many-body systems has witnessed tremendous progress in the last years due to the development of i) high-precision nuclear interaction models derived from chiral effective field theory and ii) the development of many-body expansion techniques building upon a suitably chosen A-body reference state [1]. The mild computational scaling of such expansion methods extends the reach of ab initio calculations that were previously limited by the capacity of large-scale diagonalization techniques. Nowadays, this allows for targeting up to one hundred interacting nucleons from first principles [2]. In this talk, I review the status of many-body expansion techniques applied to strongly correlated open-shell systems and discuss challenges that emerge for heavy nuclei well above the tin region.

For the description of open-shell nuclei symmetry-breaking techniques have been shown to provide a simple alternative to conceptually more involved multi-reference techniques [3]. Therefore, recent developments will be reviewed that build upon deformed mean-field states to capture the static correlations that emerge in nuclei away from shell closures. Finally, I provide an outlook on future perspectives for heavy nuclei that are out of reach of current ab initio technology [4].

[1] H. Hergert, Front. Phys. 8, 379 (2020) [2] T. Morris et al., Phys. Rev. Lett. 120, 152503 (2018) [3] A. Tichai et al., Phys. Lett. B, 786, 195 (2018) [4] A. Tichai et al., arXiv:2105.03935 (2021)

HK 8: Instrumentation III

Time: Tuesday 14:00–16:00 Location: H1

Group Report HK 8.1 Tue 14:00 H1

The Silicon Tracking System of the CBM experiment: towards series production — •Adrian Rodriguez Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Silicon Tracking System (STS) is the central detector for charged-particle identification and momentum determination in the future CBM experiment at the new FAIR accelerator facility. It is designed to measure up to 1000 charged particles in nucleus-nucleus collision at interaction rates up to 10 MHz, achieve a momentum resolution better than 2% inside 1 Tm magnetic field, and identify complex particle decays topologies. The STS comprises eight tracking stations equipped with double-sided silicon microstrip sensors. Two million channels are read out with self-triggering electronics, matching the experiment's data streaming and online event analysis concept. The STS functional building block is the detector module. It consists of a sensor, micro-cables, and two front-end electronics boards, carrying the custom-developed readout ASIC. The test and characterization of the first detector modules, part of the pre-series production, have been performed in the laboratory and the beamline as part of the FAIR Phase 0 activities. This presentation shows an overview of the STS project and its focus towards the series production; special emphasis is drawn to the quality assurance and current status of the module components, readout chain, and system integration.

HK 8.2 Tue 14:30 H1

The Silicon Strip Detector setup for the MAGIX Experiment

— •Jennifer Geimer for the MAGIX-Collaboration — Institute for Nuclear Physics, Mainz, Germany

The MAGIX-Experiment (Mainz Gas Injection Target Experiment) will be a high precision electron scattering experiment located at the MESA accelerator at the *Institute for Nuclear Physics* in Mainz. The experimental setup comprises a windowless gas jet target which allows direct interaction between beam electrons and target nuclei. It can be operated with different types of target gas and therefore allows investigation of a wide physical program. While the scattered electrons will be detected by two magnet spectrometers, the detection of nuclear fragments of the target will be done by using several recoil detectors. The centerpiece of the recoil detector design is a *Silicon Strip Detector* with size of 50 x 50 mm^2. To completely stop protons with an energy of $\mathcal{O}$(70 MeV), the silicon detector will be equipped with an additional plastic scintillator layer read out by silicon photomultipliers. The channels of the silicon detector as well as the silicon photomultipliers will be processed by the APV25 Chip, while the trigger signal is simultaneously produced using an additional frontend board.
This presentation gives a short overview of the MAGIX experiment and the resulting design parameters for the recoil detector. It focuses on the working principle and the current state of development of the *Silicon Strip Detector.*

HK 8.3 Tue 14:45 H1

Characterization of the MAGIX windowless gas jet target in high-intensity electron beams

— •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 linac mode of the accelerator which allows to reach beam currents of at least 1 mA. This operation mode requires a very 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.

At the existing A1 multi-spectrometer facility at the electron accelerator MAMI detailed studies have been carried out using hydrogen as the target gas. This talk will show the results of these studies, the challenges of the operation and the performance of the target under real beam condition.

HK 8.4 Tue 15:00 H1

Development of a lithium target for ${}^3_\Lambda H$ observation

— •Julian Geratz[1], Patrick Achenbach[1], Philipp Eckert[1], Philipp Herrmann[1], Pascal Klag[1], Josef Pochodzalla[1], and Marcell Steinen[2] for the A1-Collaboration — [1]Inst. für Kernphysik, JGU Mainz — [2]Helmholtz Institut Mainz

Studies of light hypernuclei offer insights into the strong nuclear force. For this purpose, the ${}^4_\Lambda H$ has been observed at the electron accelerator MAMI in Mainz through pionic decay. In this experiment, beryllium was used as target material. Observation of the hypertriton, the lightest hypernucleon, by this method would require an increase in luminosity by about a factor of 10. To study the ${}^3_\Lambda H$ a new target was designed and has been tested. This new target for hypertriton observation uses lithium as target material. As target material, lithium offers higher ${}^3_\Lambda H$ yield than beryllium, as it has fewer possible fragmentation channels. Furthermore, its low density enables a new target geometry, with a thick target along the beam and a small transverse dimension, thus limiting the energy loss variations of the decay pions.
The dimensions of the target are 1.5 × 50 × 50 mm^3, the electron beam will travel through 50 mm of lithium. As a material, lithium is difficult to handle due to its low melting point and high reactivity.
The challenges of using lithium as target material, their solutions and the advantages of lithium are the topic of this presentation.
Supported by DFG (PO 256/7-1) and by the European Union's Horizon 2020 programme, No 824093.

HK 8.5 Tue 15:15 H1

Measurements of the accelerator beam quality and lifetime at COSY with the $\overline{\text{P}}$ANDA Cluster-Jet Target

— •Hanna Eick, Philipp Brand, Benjamin Hetz, Daniel Klostermann, Christian Mannweiler, Sophia Vestrick, and Alfons Khoukaz for the PANDA-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The internal, windowless $\overline{\text{P}}$ANDA Cluster-Jet Target developed at WWU Münster will be the Day-1 target of the antiproton storage ring facility HESR, which is currently under construction at the future GSI/FAIR facility. With a target thickness of more than 2×10^{15} atoms/cm^2 without temporal substructures and a distance from the target nozzle of more than 2 m to the interaction point, it is suitable for 4π experiments with a high luminosity. Of particular interest during the test beam time at COSY are the studies of the beam-target interaction. In August 2019, special attention was paid to the measurements of the accelerator beam quality and lifetime in conjunction with the $\overline{\text{P}}$ANDA target and the elements of the stochastic cooling of the HESR also installed at COSY. An overview of the $\overline{\text{P}}$ANDA Cluster-Jet Target and measurements performed at COSY in August 2019 will be presented in this talk.

This project has received funding from BMBF (05P19PMFP1) and the European Union's Horizon 2020 programme (824093).

HK 8.6 Tue 15:30 H1

Angular error correction by analysing the Fresnel diffraction in an undulator interferometer

— •Pascal Klag[1], Patrick Achenbach[1], Philipp Eckert[1], Toshiyuki Gogami[2], Philipp Herrmann[1], Masashi Kaneta[3], Sho Nagao[3], Satoshi Nakamura[3], Josef Pochodzalla[1], and Yuichi Toyama[3] for the A1-Collaboration — [1]Johannes Gutenberg-Universität Mainz — [2]Kyoto University, Kyoto — [3]Tohoku University, Sendai

The Mainz Microtron is an electron accelerator, which delivers electron energies up to 1.6 GeV, with a small spread of the energy $\sigma_{beam} < 13keV$. The uncertainty for the absolute energy for all available beam energies was limited to 160 keV. A novel method is used to improve the uncertainty for energies of 180 and 195 MeV. The method is based on interferometry with two spatially separated light sources (undulators) driven by relativistic electrons. The improved resolution of the setup revealed the modification of the undulator interference by Fresnel diffraction. A detailed analysis allowed to compensate for this structure and led to an enhanced accuracy of the measurement. The determination of the angle of observation strongly benefited from the diffraction. High precision beam stabilization has been used to fix the electron beam at optimal conditions. Supported by DFG (PO 256/7-1) Supported by the European Union's Horizon 2020 programme, No 824093.

HK 8.7 Tue 15:45 H1

Studies and Developments for the $\overline{\text{P}}$ANDA Cluster-Jet Target

— •Philipp Brand, Daniel Bonaventura, Hanna Eick, Clara Fischer, Jost Froning, Benjamin Hetz, Niklas Humberg, Christian Mannweiler, Jeremy Runge, Sophia Vestrick, Michael Weide, 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 at 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. The cluster-jet is then pumped away using a beam dump which is again more than 2 m below the interaction point. The long and narrow jet pipe in between makes a precise adjustment of the complete target system and the use of various monitor systems at different positions necessary. Therefore, a new beam dump is developed which allows the integration of monitor systems. Additionally, due to the large distances between the vacuum pumps of this 4π detector, it is crucial to understand the complete vacuum system including the source of residual gas. For this purpose, extensive studies and calculations are ongoing. Furthermore, studies on the production of new Laval nozzles and the process of cluster formation are performed. Within this talk, the current and future developments at the $\overline{\text{P}}$ANDA cluster-jet target will be discussed. This project has received funding from BMBF (05P19PMFP1), GSI FuE (MSKHOU1720 and MSKHOU2023) and the EU's Horizon 2020 programme (824093).

HK 9: Outreach

Time: Tuesday 14:00–16:15 Location: H2

Group Report HK 9.1 Tue 14:00 H2

Netzwerk Teilchenwelt als bundesweite Plattform für Outreach in der Hadronen- und Kernphysik sowie in der Teilchen- und Astroteilchenphysik — •Uta Bilow[1], Achim Denig[2], Christian Klein-Bösing[3], Michael Kobel[1] und Barbara Valeriani-Kaminski[4] für die Netzwerk Teilchenwelt-Kollaboration — [1]Technische Universität Dresden — [2]Johannes Gutenberg-Universität Mainz — [3]Westfälische Wilhelms-Universität Münster — [4]Universität Bonn

Für die "Physik der kleinsten Teilchen" existiert mit dem Netzwerk Teilchenwelt eine einzigartige Struktur, in der sich bundesweit Forschungsgruppen aus 30 Instituten zusammengeschlossen haben, um ihre wissenschaftliche Arbeit einem breiten Publikum zugänglich zu machen. Jugendliche lernen bei Projekttagen die faszinierende Forschung an Beschleunigern kennen oder führen eigene Messungen mit Detektoren durch. Interessierte Schülerinnen und Schüler können mehrtägige Programme an Forschungseinrichtungen absolvieren. Junge Studierende vernetzen sie sich über ein Fellow-Programm frühzeitig mit den Forschungsgruppen. Außerdem werden junge Forscherinnen und Forscher zur Wissenschaftskommunikation motiviert und befähigt. Seit 2010 stellt Netzwerk Teilchenwelt Programme und Strukturen für diese Aktivitäten bereit, die vom BMBF durch das Projekt KONTAKT/KONTAKT2 gefördert werden. Wir berichten über Erfahrungen und Entwicklungen im Projekt; außerdem stellen wir die Angebote sowie Beteiligungsmöglichkeiten für interessierte Forscherinnen und Forscher vor.

Group Report HK 9.2 Tue 14:30 H2

PANDA Outreach Projects — •Mustafa Schmidt — II. Physikalisches Institut, Justus-Liebig-Universität Gießen

PANDA is a fixed-target experiment that is going to address a wide range of open questions in the hadron physics sector by studying the interactions between antiprotons and a stationary proton target. In 2019, a small outreach task force was founded by the PANDA collaboration with the main intention of de- signing a dedicated PANDA Masterclass for the Netzwerk Teilchenwelt (NTW). Since then, the number of participants has increased constantly and many new outreach projects were initiated. The most advanced one is a 1:10 scale LEGO model of the PANDA detector that has been designed purely virtually with the software LeoCAD and will be constructed after finalizing the tendering process. In addition to that, a new exhibition model, that mainly consists of 3D printed parts, of the PANDA detector with the same scale as the LEGO model is currently under development in Bochum. With the help of LED strips that are connected to a microcontroller, certain events, simulated with the PANDA simulation framework PandaRoot, will be displayed within the model and on a computer screen. A new project in Upsala focuses on the implementation of the PANDA geometry into the graphics engine Unity. This is considered to be the first step of creating a framework for Virtual Reality (VR) glasses with a virtual 3D model of the PANDA detector in combination with selected events. Two more projects will additionally be discussed in this talk: a card game to easily explain the fundamental parameters related to hadron physics, and the graphics rendering of the final detector.

HK 9.3 Tue 15:00 H2

Streubretter - Ein mechanisches Analogen zu Fixed-Target Experimenten — •Stephan Aulenbacher[1], Achim Denig[1] und Wiebke Kött[2] — [1]Institut für Kernphysik, Mainz, Germany — [2]Institut für Physik, Mainz, Germany

Streuexperimente wie sie an Beschleuniger Anlagen durchgeführt werden, sind für Menschen ohne physikalischen Hintergrund nur schwer zu begreifen. Wie kann das beschießen eines Materials mit Teilchen Aufschluss über die Struktur der Materie geben? Um diese frage der Öffentlichkeit zugänglich zu machen, wurde an der Johannes-Gutenberg Universität Mainz ein mechanisches Analogon zu solchen Experimenten entwickelt. Kleine Stahlkugeln werden an einer Geometrischen Form gestreut, welche nach dem Streuprozess durch Lichtschranken rollen, um den Streuwinkel detektieren. Aufgrund der so entstehenden Histogramme kann die geometrische gestalt des Streuzentrums identifiziert werden. Das experiment kann sowohl in Schülerversuchen als auch als Demonstrationsobjekt in Öffentlichen Vorträgen genutzt werden. Einfache geometrische Strukturen wie ein Dreieck bis hin zum 3D gedruckten 1/r Potential können als Streuzentrum eingesetzt werden. Als didaktische Hilfsmittel stehen den Experimentatoren interaktive Simulations Tools zur verfügung. Erfahren Sie in diesem Vortrag die Bauweise, das Didaktische Konzept im Detail und die Grenzen der Streubretter.

HK 9.4 Tue 15:15 H2

OPAL Masterclass mit maschinellem Lernen — •Nicolas Tiltmann und Christian Klein-Bösing für die Netzwerk Teilchenwelt-Kollaboration — Institut für Kernphysik, WWU Münster, Germany

Die Teilchenphysik-Masterclasses sind eine inzwischen etablierte Methode zur Vermittlung aktueller Forschung. In diesem Vortrag wird ein Konzept vorgestellt, welches Teilchenphysik-Inhalte mit Methoden des maschinellen Lernens kombiniert.

Die Basis bildet die schon bestehende Masterclass zum OPAL-Experiment. Dort wurden Z-Bosonen über deren Zerfallsprodukte mit Hilfe des Event-Displays identifiziert. Hier wird statt der Erkennung per Hand ein künstliches neuronales Netz mit einem kleinen Teil der gesamten Datenmenge trainiert, um anschließend die restlichen Ereignisse auf Basis der gelernten Merkmale automatisch klassifizieren zu lassen. Die Programmierung erfolgt in Python mittels Jupyter-Notebooks und ist so vereinfacht, dass keine Vorkenntnisse nötig sind.

Neben Aspekten der Teilchenphysik wird den Teilnehmenden insbesondere ein Gefühl für die Funktionsweise von maschinellem Lernen vermittelt und auch Probleme und Grenzen dieser Methoden thematisiert.

Gefördert durch BMBF KONTAKT 05P19PMOA1.

HK 9.5 Tue 15:30 H2

Virtuelle Führung am Beschleuniger MAMI — •Stephan Aulenbacher[1], Denig Achim[1] und Kött Wiebke[2] — [1]Institut für Kernphysik, Mainz, Deutschland — [2]Institut für Physik, Mainz, Deutschland

Führungen durch die Beschleuniger Anlage MAMI für Interessierte aller Art, haben in Mainz, am Institut für Kernphysik eine langjährige Tradition. Jährlich werden mehrere hundert Schüler, Studenten, Politiker oder einfach Physik interessierte durch die Anlage geführt. Währen der Covid-19 Krise konnten diese Führungen leider nicht stattfinden. Daher erstellte das Mainzer Outreach team ein Virtuelles Konzept für eine solche Führung, welches auch nach der Covid-19 Krise in Kombination mit der physischen Führung weiter bestand haben soll, da sich zeigte dass die Virtuelle Führung viele, in der reellen Führung nicht umsetzbare, Vorteile bietet. In diesem Vortrag werden die Mittel zur Umsetzung so wie das Didaktische Konzept der Virtuellen Führung präsentiert.

HK 9.6 Tue 15:45 H2

3D und Virtual-Reality-Umgebung zur Vermittlung von Grundlagenforschung am Beispiel des ALICE-Detektors am CERN-LHC — •Christian Klein-Bösing[1], Philipp Bhatty[2], Stefan Heusler[3] und Reinhard Schulz-Schaeffer[2] für die Netzwerk Teilchenwelt-Kollaboration — [1]Institut für Kernphysik, WWU Münster, Germany — [2]Department Design, HAW Hamburg, Germany — [3]Institut für Didaktik der Physik, WWU Münster, Germany

Detektoren in der Elementarteilchenphysik, wie der ALICE-Detektor am LHC, können in der Regel der breiten Öffentlichkeit nur an Hand von Bildern oder Filmen präsentiert werden. Die Darstellung in einer Echtzeit-3D-Umgebung, wie einer Virtual-Reality- und Web3D-Applikation, ermöglicht hingegen direkt die Größe des Experimentes erfahrbar zu machen, aber auch neue, virtuelle Handlungsräume und Handlungsoptionen zu erforschen und zielgruppengerecht einzusetzen.

Die Entwicklung einer solchen Web3D-Lernumgebung sowie einer VR- Lernapplikation, inklusive der empirischen Bewertung verschiedener Darstellungsoptionen, der Gestaltung von Nutzerinteraktion und interaktiver Lernaufgaben, erfordert eine enge Kooperation zwischen Grundlagenforschung in der Elementarteilchenphysik, der Didaktik der Physik und der Wissenschaftsillustration.

Wir präsentieren den aktuellen Entwicklungsstatus basierend auf einer interaktiven Visualisierung des ALICE-Detektors in VR und Web-3D erste Anwendungen im Kontext eines Workshops für Jugendliche zur Konstruktion des ALICE-Detektors aus LEGO.

HK 9.7 Tue 16:00 H2

Konzeption und Bau eines ALICE Lego Modells im Rahmen einer Erlebnisstation — •Marcus Mikorski[1], Christian Klein-Bösing[2] und Sascha Mehlhase[3] für die Netzwerk Teilchenwelt-Kollaboration — [1]Goethe Universität Frankfurt, Institut für Kernphysik, 60438 Frankfurt — [2]Wilhelmsuniversität Münster, Institut für Kernphysik, 48149 Münster — [3]Ludwig-Maximilians-Universität München, Fakultät für Physik, 80799 München

Im Rahmen einer ALICE-Erlebnisstation für den ErUM-Forschungsschwerpunkt wurde ein ALICE-Lego-Modell konzipiert und gebaut und dabei durch BMBF FSP T01 und BMBF KONTAKT unterstützt. Ziel war es, ein Modell gemeinsam mit Jugendlichen am Computer zu designen und real mit Legosteinen zusammenzubauen. Das Projekt diente dazu, Schüler*innen und jüngeren Studierenden die Möglichkeiten zu geben, sich mit der Detektortechnologie und den Physikfragen von ALICE auseinanderzusetzen und das Arbeiten in einer Forschungskollaboration zu erfahren. Von Januar 2021 bis Juni 2021 waren 17 Teilnehmende damit beschäftigt das Modell digital zu entwerfen und an einem Wochenende an den Standorten Frankfurt und Münster zusammen zu bauen. Die beim realen Bau gewonnen Erfahrungen dienen der weiteren Optimierung und sollen demnächst zur Veröffentlichung des ALICE-Modells führen. Das Konzept dieses Projekts lässt sich auf andere Detektoren und Großanlagen übertragen, sowohl zur Konzeption neuer Modelle als auch zum Nachbau bestehender Modelle, begleitet durch entsprechende Einblicke in die aktuelle Forschung.

HK 10: Hadron Structure and Spectroscopy II

Time: Tuesday 14:00–16:00 Location: H3

Group Report HK 10.1 Tue 14:00 H3

Experimental Inputs to the Hadronic Light-by-Light Contributions to $(g-2)_\mu$ from BESIII — •Max Lellmann, Achim Denig, and Christoph Florian Redmer — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz

The long-standing discrepancy between Standard Model prediction and direct measurement of the muon anomalous magnetic moment $a_\mu = (g-2)_\mu/2$ has recently been confirmed by a new measurement by the Muon-g-2-collaboration at Fermilab. In order to establish the significance of the discrepancy between the prediction and direct measurement of currently 4.2σ, both, experiment and theory, need to be improved.

The Standard Model prediction of a_μ is limited by its hadronic contributions, due to the non-perturbative nature of the strong interaction at the relevant energy scales. A large contribution to the uncertainty of the Standard Model calculation stems from the hadronic light-by-light scattering contribution. Its accuracy depends heavily on the knowledge of transition form factors of light pseudoscalar mesons and the production of meson systems from two-photon collisions.

The BESIII experiment, a τ-charm-factory located at the Institute of High Energy Physics in Beijing, China, offers a perfect test bed for the investigation of two-photon processes in the momentum transfer range, which is most relevant to the a_μ calculations. In this presentation we discuss recent results, ongoing projects, and future prospects of the measurements of transition form factors at BESIII.

Group Report HK 10.2 Tue 14:30 H3

Experimental Inputs to the Hadronic Vacuum Polarization Contribution to the Anomalous Magnetic Moment of the Muon at the BESIII Experiment — •Riccardo Aliberti — JGU Mainz

The recent result from the 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. To understand the origin of this discrepancy further improvements of experiment and theory are necessary.

The uncertainty on the SM prediction is dominated by hadronic contributions and particularly by the Hadronic Vacuum Polarization (HVP) component, which is evaluated with a dispersive formalism from the measurement of hadron production cross sections in electron-positron annihilations. Therefore, improvements in the cross section measurements directly reflect in a reduction of the uncertainty on the HVP contribution to a_μ

The BESIII Experiment, located at the BEPCII collider in Beijing, has collected the world largest dataset of 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.

The author of this talk is supported by DFG.

HK 10.3 Tue 15:00 H3

Small Angle ISR Analysis of the Pion Form Factor with BESIII — •Yasemin Schelhaas and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The anomalous magnetic moment of the muon $a_\mu = (g_\mu - 2)/2$ is one of the most precisely measured variables in modern physics. However, there is a discrepancy of 4.2 standard deviations between the Standard Model (SM) prediction and the experimental average of the latest direct measurements, known as the Muon $(g-2)$-puzzle. The main uncertainty of the SM prediction arises from hadronic contributions and can be improved systematically using experimental 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 $3.1\,\mathrm{fb}^{-1}$ 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 Initial State Radiation (ISR) 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 presentation an overview of the current status of the analysis is given.

Supported by DFG.

HK 10.4 Tue 15:15 H3

Feasibility Studies of Axial Meson Production in Two-Photon Fusion Processes at BESIII — •Nick Effenberger, Christoph Redmer, and Achim Denig for the BESIII-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Deutschland

The Standard Model prediction of the muon's anomalous magnetic moment, a_μ, is completely limited in precision by the knowledge of the hadronic contributions. Data driven approaches have been developed to improve the calculations. Recent estimates demonstrate the importance of axial mesons with masses larger than 1 GeV for the hadronic Light-by-Light scattering contribution to a_μ.

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 axial mesons decaying into the four pion final state containing charged pions only.

HK 10.5 Tue 15:30 H3

Measurement of proton–deuteron correlations in pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ — •Michael Jung[1] and Bhawani Singh[2] for the ALICE-Collaboration — [1]Goehte-Universität Frankfurt — [2]Technische Universität München

The first measurement of p–d two-particle correlations in high-multiplicity pp collisions at $\sqrt{s} = 13\,\mathrm{TeV}$ will be presented. The studies of source sizes in these collision systems by the ALICE Collaboration enabled the possibility to study final-state interactions using two-particle momentum correlations. The measured correlation functions as well as comparisons with theoretical predictions using the Lednický-Lyuboshits model will be presented. The theoretical correlations include two interaction models using only the Coulomb force as well as both Coulomb and strong interaction. For the later the measured scattering lengths of proton–deuteron pairs from scattering experiments were taken. However both predictions cannot reproduce the measured correlation function. This deviation might give a hint for a different production mechanism of deuterons such as a late formation of these light nuclei in high-energy pp collisions. Finally we present briefly the status of an analysis of Λ–d correlations.

HK 10.6 Tue 15:45 H3

Investigation of the p–ϕ and p–D interaction in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Emma Chizzali for the ALICE-Collaboration — TUM, Munich, Germany

The strong hadron-hadron interaction can be investigated with high precision using two-particle momentum correlations, as demonstrated by recent ALICE studies performed in pp collisions. This also includes hyperons (Y), for which the existing experimental uncertainties related to their two- and three-body interaction with nucleons (N) prohibits theoretical calculations to obtain firm conclusions on the nuclear equation of state (EoS). This has a direct consequence on the modeling and composition of neutron stars. In this context, the strong Y–Y interaction can be mediated by the ϕ meson within certain effective meson exchange models. This requires experimental input related to the N–ϕ and Y–ϕ systems. Additionally, understanding the N–ϕ interaction provides valuable input to interpret the signs of partial restoration of chiral symmetry in the nuclear medium. The latter can further be studied by means of the interaction between open charm hadrons and nucleons. An experimentally accessible system is the p–D, which has the benefit of also providing information regarding the nature of the newly observed heavy quarkonium-like states and charm pentaquarks. In this talk, the first direct experimental investigation, using correlation techniques, of the p–ϕ and p–D systems will be presented. This has been achieved by the ALICE collaboration, using data from high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV. These results are capable of providing new constraints to existing theoretical models.

HK 11: Instrumentation IV

Time: Tuesday 14:00–16:00 Location: H4

Group Report HK 11.1 Tue 14:00 H4

A new free running DAQ for future measurements at the M2 beamline at CERN — •Benjamin Moritz Veit for the AMBER DAQ-Collaboration — Institut für Kernphysik der Johannes Gutenberg-Universität, Mainz

Several new measurements with muon and hadron beams at the M2 beamline of the CERN SPS were approved. For the experiments, it is planned to transform the current classical DAQ approach to a free running (streaming) DAQ scheme, which is based on a trigger-less readout of all detectors with local data processing and later online and offline data reduction stages based on FPGA and X86 filter technologies (High-Level Triggers). Few levels of FPGA multiplexers perform real-time tasks of processing timestamped hit information from the detectors, buffering, merging, and distributing data between read-out computers. The read-out computers transfer data to a local storage system. From this storage, an asynchronous running HLT system is fetching the data. On the HLT system, the data will be partially reconstructed, analyzed, and eventually reduced before it is written to permanent storage. One of the approved experiments is the measurement of the proton charge radius by elastic muon proton scattering. For this experiment, two data taking phases are foreseen. For the first phase, with a low-intensity muon beam, a full, not reduced data sample will be written to disk. This allows a complete unbiased data analysis and the validation of the filtering scheme. An overview of this novel DAQ and filtering approach will be presented.

HK 11.2 Tue 14:30 H4

Recent developments 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 an Electromagnetic Calorimeter (EMC) inside a 2 T solenoid. Due to the required energy resolution, timing and spacial constraints, the individual high-voltage adjustments for the Large Area Avalanche Photodiodes (LAAPDs) that read out the EMC crystals demand innovative and specialized electronics, such as, for example, the individual bias voltage adjustments for the Photodiodes need to be accurate down to 0.1V. At the same time, space constraints in the inner detector volume limit options for individual cable routing and connections for the LAAPD bias voltage. The key elements of the high voltage adjustment concept will be described, with a special focus on the first and the second iteration of the dedicated control ASICs for the front-end bus system, the so-called SerialAdapter ASICs (SAA). The SAAs are also utilized for the communication and control of the APFEL preamplifier ASICs, which read out the APD photodetectors. The different versions of the SerialAdapter ASICs were utilized in the preproduction versions of the High-voltage control for the LAAPDs. The results of these preproduction tests will be presented. *gefördert durch das BMBF, GSI und HFHF.

HK 11.3 Tue 14:45 H4

Implementation of a MiniTAPS Trigger Board for the CBELSA/TAPS Experiment — •Lisa Richter, Annika Thiel, Janis Hoff, Peter Klassen, and Christian Honisch for the CBELSA/TAPS-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The nucleon excitation spectrum is probed by the CBELSA/TAPS experiment by studying different photoproduction reactions using real photon beam on a polarized or unpolarized target. The experimental setup comprises mainly two electromagnetic calorimeters, the Crystal Barrel and the MiniTAPS detector, focusing on neutral mesons in the final state that decay to photons. Since the CBELSA/TAPS is a fixed target experiment, many decay particles are boosted in forward direction.

Here, the MiniTAPS detector is located, which consists of 216 hexagonal BaF2 crystals which are read out via photomultiplier tubes. It covers the forward angle between 1° and 12° and can capture photons with energies between 10 MeV and 2.0 GeV. To avoid wrong trigger information due to overlapping clusters, the crystals are arranged in four sectors and the number of hits in a sector in one event is determined by the trigger. The new MiniTAPS trigger replaces the old MCU (multiple coincidence unit) electronics. It is realized by a single FPGA in a VME module. This not only simplifies the electronics but also allows for more sophisticated trigger algorithms including e.g. a fast cluster finder. The new setup of the trigger and the current status of the analysis will be presented in this presentation.

HK 11.4 Tue 15:00 H4

Designing FPGA Readout Firmware with the help of Vivado HLS — •David Schledt for the CBM-Collaboration — 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 Baryionic 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 radiation hard 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 detector data is marked with timestamps by the FEE, which has to be sorted in time to speed up the online event finding. This requires complex data processing inside the FPGA. In this talk I will present how the readout firmware for the CBM Transition Radiation Detector (TRD) was developed aided by Vivado HLS.

This work is supported by BMBF-grant 05P19RFFC1.

HK 11.5 Tue 15:15 H4

HLS C++ Template Library for Detector Readout and Data-Preprocessing using FPGAs — •Thomas Janson and Udo Kebschull — IRI, Goethe-Universität Frankfurt am Main, Max-von-Laue-Straße 12, 60438 Frankfurt am Main, Germany

In this talk, we discuss a methodology of implementing massive parallel algorithms using the C++ high-level synthesis. We show that the methodology is applicable for preprocessing in FPGA based detector readout widely used in high-energy physics experiments. The focus is on feasibility for this field by using modern C++ programming techniques with the help of generic template programming. It has been shown that with this methodology the resource consumption remains acceptable low compared to an HDL implementation. The Intel HLS compiler and C++17 language features are used to implement algorithms in the style of data flow programming, which are particularly well suited for processing data streams. The idea is to present an algorithm as a data flow graph and implement it as a deep pipeline on an FPGA. For this we are developing an HLS C++ template library for detector readout and data pre-processing targeting FPGAs. A first draft of this library is shown in this talk.

HK 11.6 Tue 15:30 H4

The HADES electromagnetic calorimeter upgrade: Current status and future perspectives* — •Adrian Rost for the HADES-Collaboration — FAIR GmbH, Darmstadt, Germany — TU Darmstadt, Darmstadt, Germany

The HADES spectrometer at GSI Helmholtzzentrum für Schwerionenforschung GmbH in Darmstadt was recently upgraded with a new electromagnetic calorimeter (ECAL). In March 2019 a four week physics production beam time with an "Ag+Ag" beam at 1.58A GeV was carried out. In this contribution the performance of the new detector system under beam conditions will be presented. Particular emphasis will be put on its FPGA-TDC based read-out electronics and the performance.

**This work has been supported by BMBF ErUM - FSP C.B.M. (05P18RDFC1), by DFG under GRK 2128 and European Union's Horizon 2020 research and innovation programme (871072).*

HK 11.7 Tue 15:45 H4

Low Gain Avalanche Diodes for timing applications in HADES — •Wilhelm Krueger[1], Tetyana Galatyuk[1,2], Vadym Kedych[1], Sergey Linev[2], Jan Michel[3], Jerzy Pietraszko[2], Adrian Rost[1,4], Michael Traeger[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

A reaction-time (T0) determination with a precision of $\sigma_{T0} < 50$ ps is required by the HADES physics program in order to ensure e.g. an excellent particle identification via Time-of-Flight measurements. In addition, monitoring of beam properties such as position, width and time structure is necessary. In order to fulfill these tasks, the recently emerged Low Gain Avalanche Diode (LGAD) technology seems to be a fitting candidate. A timing precision of $\sigma_t \approx 47$ ps was demonstrated with an LGAD based prototype T0 detector at COSY (Juelich), with a 1.92 GeV proton beam. Therefore, it is planed to use LGADs in upcoming experiments with proton, pion and possibly ion beams. The so far reached results will be presented in this contribution. In addition, future plans on development of dedicated ASICs capable of dealing with high rates and a high number of read-out channels will be mentioned. This work is supported by F&E, TU Darmstadt and HGS-HIRe.

HK 12: Heavy-Ion Collisions and QCD Phases II

Time: Tuesday 16:30–18:30 Location: H1

Group Report HK 12.1 Tue 16:30 H1

Charm production and hadronisation at the LHC with ALICE — •Jianhui Zhu for the ALICE-Collaboration — GSI Helmholtz Centre for Heavy Ion Research

Recent measurements of charm-baryon production at midrapidity by the ALICE collaboration show baryon-to-meson yield ratios significantly higher than those in e^+e^- collisions for different charm-hadron species, suggesting that the charm fragmentation is not universal across different collisions systems. Thus, measurements of charm-baryon production are crucial to study the charm quark hadronisation in proton–proton collisions, relevant also for the description of heavy-flavour mesons. In large systems such as Pb-Pb collisions, the charm baryon-to-meson yield ratio is expected to be further enhanced if charm quarks hadronise via recombination with the surrounding light quarks in the QGP.

In this talk, the measurements of Λ_c^+, $\Xi_c^{0,+}$ and the first measurement of Ω_c^0 baryons performed with the ALICE detector at midrapidity in pp collisions at $\sqrt{s} = 5.02$ and 13 TeV, as well as the total charm cross section and charm fragmentation fractions will be presented. In Pb-Pb collisions, the measurement of Λ_c^+ production, the nuclear modification factor and the Λ_c^+/D^0 ratio will be discussed. These results will be compared to predictions from Monte Carlo event generators and theoretical calculations based on the statistical hadronisation model and on the hadronisation via coalescence.

HK 12.2 Tue 17:00 H1

Λ_c^+ cross section in p–Pb collisions down to $p_T = 0$ at $\sqrt{s_{NN}} = 5.02$ TeV measured with ALICE — •Annalena Sophie Kalteyer for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

In this contribution, the latest ALICE measurement of Λ_c^+ production performed down to $p_T = 0$ in p–Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV is presented. This allows to show the first measurement of Λ_c^+/D^0 and Λ_c^+ nuclear modification factor (R_{pPb}) down to $p_T = 0$ in this system. The baryon-to-meson ratio is significantly enhanced with respect to the one in e^+e^- collisions, suggesting that the charm fragmentation is not a universal process across different collision systems. Furthermore, the ratio as a function of the transverse momentum is shifted to higher p_T in p–Pb collisions with respect to pp collisions. The reason for this momentum shift could be a modification of the charm hadronisation mechanism and/or the presence of radial flow in p–Pb collisions. Typically this is observed in heavy-ion collisions where a hot deconfined medium is created. In addition, the R_{pPb} is useful to investigate possible initial state effects such as shadowing in the collisions of a proton with a heavy nucleus. R_{pPb} can help disentangling initial from final state effects, which would involve the presence of a medium. The results are compared with theoretical calculations including initial and final state effects.

HK 12.3 Tue 17:15 H1

Blast-wave description of Upsilon elliptic flow at LHC energies — Klaus Reygers[1], Alexander Schmah[1], •Anastasia Berdnikova[1], Nadine Gruenwald[1], and Xu Sun[2] — [1]Physikalisches Institut, Ruprecht-Karls-Universitat Heidelberg, Heidelberg, Germany — [2]Georgia State University, Atlanta, Georgia 30303, USA

A simultaneous blast-wave fit to particle yields and elliptic flow (v_2) measured as a function of transverse momentum in Pb–Pb collisions at LHC energies is presented. A compact formula for the calculation of $v_2(p_T)$ for an elliptic freeze-out surface is used which follows from the Cooper-Frye ansatz without further assumptions. Over the full available p_T range, the Υ elliptic flow data is described by the prediction based on the fit to lighter particles. This prediction shows that, due to the large Υ mass, a sizable elliptic flow is only expected at transverse momenta above 10 GeV/c.

HK 12.4 Tue 17:30 H1

Heavy-quark diffusion current in the Quark-Gluon Plasma — •Federica Capellino[1,2], Andrea Dubla[2], Stefan Floerchinger[3], Eduardo Grossi[4], Silvia Masciocchi[1,2], Jan M. Pawlowski[3], Ilya Selyuzhenkov[2], and Johanna Stachel[1] — [1]Physikalisches Institut Heidelberg, Universität Heidelberg, 69120 Heidelberg, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — [3]Institut für Theoretische Physik, Universität Heidelberg, 69120 Heidelberg, Germany — [4]Center for Nuclear Theory, Department of Physics and Astronomy, Stony Brook University, Stony Brook, New York 11794-3800, USA

A hydrodynamic approach to the transport of heavy quarks in the Quark-Gluon Plasma is presented. We exploit the conservation of the number of heavy quark - antiquark pairs within the evolution of the plasma to construct causal second-order hydrodynamic equations of motion. The hydrodynamic transport coefficients associated to the heavy-quark diffusion current are then compared with the momentum-diffusion coefficients obtained in the standard Fokker-Planck formalism. The purpose of the present work is to provide further insights on the level of thermalization of charm and bottom quarks inside the expanding Quark-Gluon Plasma by investigating the relation between the two approaches and determining if their merging is able to capture the complexity of the heavy-quark in-medium dynamics. This work is funded via the DFG ISOQUANT Collaborative Research Center (SFB 1225).

HK 12.5 Tue 17:45 H1

Measurements of J/ψ production in p–Pb collisions at $\sqrt{s_{\rm NN}} = 8.16$ TeV with ALICE — •Minjung Kim for the ALICE-Collaboration — Physikalische Institut, Unversität Heidelberg, Heidelberg, Germany

Measurements of J/ψ production in p–Pb collisions are a valuable probe to study cold–nuclear–matter effects as well as possible final state mechanisms, which can modifiy its production with respect to the one in pp collisions.
In ALICE (A Large Ion Collider Experiment), J/ψ production is measured at midrapidity via the dielectron decay channel relying on the electron identification capability provided by the Time Projection Chamber (TPC). Excellent track pointing resolution provided by the Inner Tracking System (ITS) allows the contribution of J/ψ from a weak decays of beauty hadrons (non-prompt J/ψ) statistically separated based on the long life time of beauty hadrons.
In this presentation, we will show measurements of inclusive and non-prompt J/ψ production in p–Pb collisions at $\sqrt{s_{\rm NN}} = 8.16$ TeV from a high–$p_{\rm T}$ electron enriched data sample collected using the trigger capabilities of the Transition Radiation Detector (TRD).

HK 12.6 Tue 18:00 H1

Recent measurements of charged-particle production in ALICE — •Youssef El Mard Bouziani for the ALICE-Collaboration — Institut für Kernphysik, Goethe-Universität Frankfurt

The ALICE experiment at the LHC is designed to investigate the properties of the Quark-Gluon Plasma by studying high-energy A–A collisions. Medium effects like parton energy loss can be examined by comparing the production of charged particles at high transverse momentum ($p_{\rm T}$) in heavy-ion collisions with the one in pp collisions where no hot QCD medium is expected. This comparison is usually expressed by means of the nuclear modification factor $R_{\rm AA}$. In addition, the correlation between $p_{\rm T}$ spectra and event multiplicity of charged particles can give insight in the different production mechanisms.
In this talk, we report on a study of charged-particle production in pp, p-Pb, Xe–Xe and Pb–Pb collisions at all available LHC beam energies. By comparing to QCD-inspired models, this measurement can help to understand the energy and system size dependence of charged-particle production at LHC.

Supported by BMBF and the Helmholtz Association.

HK 12.7 Tue 18:15 H1

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 gives us 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 and further discuss preliminary results.
Due to the fact, that these strange hadrons are produced at or below the free nucleon-nucleon production threshold, they are a good probe for in-medium effects with respect to their steep excitation function. Furthermore, comparing the production yields in pheripheral collisions to those in central collisions will provide additional information about the system size dependence of strangeness production.
The work has been supported by BMBF (05P19RFFCA), 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 13: Instrumentation V

Time: Tuesday 16:30–18:15 Location: H2

Group Report HK 13.1 Tue 16:30 H2

CBM TRD performance at DESY and in mCBM at FAIR-Phase0 — •Adrian Meyer-Ahrens for the CBM-Collaboration — Institut für Kernphysik, Münster, Deutschland

The Transition Radiation Detector (TRD) of the Compressed Baryonic Matter (CBM) experiment is composed of irregular polyethylene (PE) foam radiators and Multi-Wire Proportional Chambers (MWPCs). It will serve as intermediate tracker and for heavy fragments and electron identification. A high yield of TR generated by electrons passing through the radiator is crucial for electron identification. In a dedicated electron testbeam campaign, two TRD chambers were set up at DESY in August of 2019 and tested with electron beams using various radiator thicknesses.

In the first part of this talk, results on the performance of the detector in this testbeam campaign as well as comparisons to radiator simulations will be presented. The second part focuses on the participation of the TRD in the mCBM campaigns at GSI at SIS18. High-rate collisions on a fixed-target are used here for CBM detector and readout performance measurements. This talk presents the TRD performance in continuous readout mode in the measurement campaigns of 2020 and 2021.

This work is supported by BMBF grant 05P19PMFC1.

HK 13.2 Tue 17:00 H2

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

At the Large Hadron Collider (LHC) at CERN significant production rates of light (anti-)(hyper-)nuclei have been measured in heavy-ion collisions. The production of such nuclei has recently become a topic of high interest. One interesting example is the lifetime of the lightest hypernucleus, the hypertriton (a bound state of a proton, a neutron and a Λ hyperon). Several measurements have shown a significant deviation from the theoretical expectation, in particular in heavy-ion collisions. Therefore, it is important to also measure these rare nuclei in p–p 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 p–p 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 nuclei trigger in terms of enhancement factors and transverse momentum sensitive effieciencies for the different light nuclei will be shown. In addition, the current status of a hypertriton analysis on p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV will be presented.

HK 13.3 Tue 17:15 H2

Design of a luminosity monitor for the P2 parity violating experiment at MESA — Sebastian Baunack[1], Kathrin Imai[1], Rahima Krini[1], Frank Maas[1,2,3], •Tobias Rimke[1], David Rodriguez Pineiro[2], and Malte Wilfert[1] — [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 precision of 0.15% at a low four-momentum transfer of $Q^2 = 4.5 \cdot 10^{-3}$ GeV^2. In order to achieve this precision, 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 and testing an air Cherenkov luminosity monitor will be discussed in this talk.

HK 13.4 Tue 17:30 H2

The filling process in 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 with spin flip loading. Due to the neutron's magnetic moment, very low-energetic neutrons (ultracold neutrons, UCN) with a maximum energy of $\approx 50\,\mathrm{neV}$ can be stored in the magnetic trap with a volume of $\approx 10\,\mathrm{L}$. Counting surviving UCN after varying storage times, the neutron lifetime can be extracted from an exponential fit. The target uncertainty in the neutron lifetime is $\Delta\tau_n = 1.0\,\mathrm{s}$ in phase I of the experiment.

The overall measurement duration to achieve this goal is currently limited by UCN statistics, so an optimised filling process is crucial. Two filling techniques have been investigated so far, which are using either one or two adiabatic fast passage spin flippers.

This talk will give a short introduction into spin flipping UCN in τSPECT as well as the current status of the filling optimisation process.

HK 13.5 Tue 17:45 H2

Measuring the free neutron lifetime with τSPECT — •Noah Yazdandoost for the tauSPECT-Collaboration — Department of Chemistry, Johannes Gutenberg University, Mainz

The τSPECT experiment aims to measure the free neutron lifetime. Neutrons with energies in the range of nano electron-volts are loaded by spin flipping into τSPECT's storage volume, where they are confined by magnetic fields only. Magnetic storage of the neutrons will reduce the systematic errors with respect to previous experiments with material confined neutrons since there is no interaction between stored neutrons and wall atoms. With the τSPECT experiment, the free neutron lifetime can be extracted by counting the surviving neutrons in the storage volume after different storage times. This talk gives an overview of the magnetic field configuration, the measurement process, and the data analysis strategies of the τSPECT experiment.

HK 13.6 Tue 18:00 H2

Performance Studies of Micromegas based Detectors — •Tobias Waldmann[1], Rossana Facen[1], Berkin Ulukutlu[1], Piotr Gasik[2], and Laura Fabbietti[1] — [1]Technische Universität München — [2]GSI Helmholtzzentrum

Micro Mesh Gaseous Structures (Micromegas) and Gas Electron Multipliers (GEM) 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. One method to improve their performance even further is to stack a Micromegas and a GEM. Still, a huge limiting factor to the performance is the formation of electrical discharges between the electrodes, 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, hence, investigated the performance of a Micromegas and a GEM + Micromegas detector. Firstly, we performed scans of the various parameters contributing to the detector performance, including the applied electric fields and the geometry of its components. Here, a special focus was put on ion backflow reduction and energy resolution optimization. Optimal working regions with respect to a set of boundary parameters can thus be defined. Secondly, we investigated the discharge stability of the two detectors, which provides further limits for the safe working regions.

HK 14: Hadron Structure and Spectroscopy III

Time: Tuesday 16:30–18:30 Location: H3

Group Report HK 14.1 Tue 16:30 H3

Exploring the 3D nucleon structure with CLAS at JLAB and PANDA at FAIR — •Stefan Diehl for the CLAS and PANDA-Collaboration — II. Physikalisches Institut, JLU Gießen, 35390 Gießen, Germany — University of Connecticut, Storrs, Connecticut 06269, USA

Exploring the 3-dimensional structure of the nucleon can help to understand several fundamental questions of nature, such as the origin of the nucleon spin and the charge and density distributions inside the nucleon. The 3D momentum distribution of the partons can be accessed by transverse momentum dependent distribution functions (TMDs) measured in semi-inclusive deep inelastic scattering (SIDIS) or Drell-Yan processes, while the distribution in transverse coordinate and longitudinal momentum space is described by generalized parton distributions (GPDs), which can be accessed by deeply virtual Compton scattering (DVCS) and hard exclusive meson production (DVMP). Based on the high quality data of CLAS and the recently upgraded CLAS12 detector at Jefferson Laboratory (JLAB), a detailed study of these distribution functions can be performed. In the future also PANDA at FAIR will be able to contribute to this field in various aspects of 3D nucleon structure studies. The talk will present the results of recent SIDIS and DVMP studies with CLAS and CLAS12 and their impact on the understanding of the 3D nucleon structure. In addition the potential of PANDA to contribute to this field will be presented.
*The work is supported by BMBF and HFHF

HK 14.2 Tue 17:00 H3

Analysis of COMPASS data on DVCS — •Johannes Giarra — on behalf of the COMPASS collaboration - Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Johann-Joachim-Becher-Weg 45, 55099 Mainz

In 2016 and 2017 a measurement of the exclusive single photon production was performed at the M2 beamline of the CERN SPS, scattering a 160 GeV positive and negative charged muon beam off a liquid hydrogen target. During the measurement all particles participating in the process were measured. To perform an exclusive measurement the COMPASS spectrometer was supplemented by an additional electromagnetic calorimeter to increase the acceptance for the detection of large angle photons. The recoiling protons were measured by a time of flight (TOF) detector surrounding the target.
The talk will summarize the current status of the analysis to determine the cross section of the Deeply Virtual Compton Scattering (DVCS). Thereby the focus will be on determining the Bethe-Heitler contribution to the cross section as well as the method to determine and remove the π^0 contamination from the exclusive single photon sample.

HK 14.3 Tue 17:15 H3

Measuring Generalized Distribution Amplitudes from the $\bar{p}p \to \pi^0\gamma$ channel with PANDA at FAIR — •Faiza Khalid, Stefan Diehl, and Kai Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, 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 $\bar{p}p$ annihilation. One of the channels of interest for the measurement of Generalized Distribution Amplitudes (GDAs) is $\bar{p}p \to \pi^0\gamma$. Several simulations for different antiproton beam momenta of $s = 2.5\ \mathtt{GeV}/c$, $s = 5\ \mathtt{GeV}/c$, $s = 10\ \mathtt{GeV}/c$ and $s = 15\ \mathtt{GeV}/c$ were done for both the signal channel ($\bar{p}p \to \pi^0\gamma$) and for the main background channel ($\bar{p}p \to \pi^0\pi^0$) 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 $\bar{p}p \to \pi^0\gamma$ 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 14.4 Tue 17:30 H3

Improving Kaon-Pion Identification with Machine Learning Techniques for CLAS12 — •Áron Kripkó, Stefan Diehl, and Kai-Thomas Brinkmann for the CLAS-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

For semi-inclusive deep inelastic scattering (SIDIS), a reliable particle identification and background estimation is a key requirement. This is especially true for Kaon SIDIS, where a strong pion contamination can be expected at high momenta if only time of flight measurements are used for the particle identification. For the SIDIS Kaon production from the scattering of 10.6 GeV electrons in the recently upgraded CLAS12 detector, Kaons are hardly distinguishable from pions above 3 GeV with a pure time of flight based PID. Currently a RICH detector, which will provide good separation above 3 GeV is only available in one sector. Here advanced PID methods based on neural networks, exploiting the information from all detector components can help improve the situation.

In this talk machine learning methods, which could complement the other traditional particle identification methods, are described and compared. Based on multiple independent checks, the best method can efficiently reduce the pion contamination in the kaon sample in the whole momentum range, by still keeping the statistics on a reasonable level.

This work is supported by HFHF.

HK 14.5 Tue 17:45 H3

Electromagnetic form factors of the proton with the PANDA experiment at FAIR — •Alaa Dbeyssi[1], Frank Maas[1,2,3], Iris Zimmermann[1], Manuel Zambrana[1], Luigi Capozza[1], Oliver Noll[1], David Rodriguez Pineiro[1], Sahra Wolff[1], Alexander Greiner[1], Julian Moik[1], Samet Katilmis[1], Dong Liu[1], and Peter-Bernd Otte[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

Precise measurements of the proton electromagnetic form factors in the time-like region are planned at the future PANDA experiment at FAIR using the $\bar{p}p \to \ell^+\ell^-$ ($\ell = e,\ \mu$) annihilation processes. The feasibility of measuring these processes with the PANDA detector are investigated. Simulations on signal reconstruction efficiency and background rejection are performed using PANDARoot, the simulation and analysis software of the PANDA experiment. The expected precisions on the measurements of the proton form factors at PANDA are determined taking into account the staged approach for the detector setup and for the delivered luminosity from the accelerator. In addition, first order radiative corrections to the reaction $\bar{p}p \to e^+e^-$ are calculated including virtual and real photon emission. A Monte Carlo event generator to be used in the framework of the PANDA experiment is developed on the basis of the calculated radiative cross section. The results of these studies will be reported in this talk.

HK 14.6 Tue 18:00 H3

Azimuthal single- and double-spin asymmetries in semi-inclusive deep-inelastic lepton scattering by transversely polarized protons — •Gunar Schnell — University of the Basque Country UPV/EHU & IKERBASQUE, Bilbao, Spain

A comprehensive set of azimuthal single-spin and double-spin asymmetries in semi-inclusive leptoproduction of pions, charged kaons, protons, and antiprotons from transversely polarized protons is presented. These asymmetries include the previously published HERMES results on Collins and Sivers asymmetries, the analysis of which has been extended to include protons and antiprotons and also to an extraction in a three-dimensional kinematic binning and enlarged phase space. They are complemented by corresponding results for the remaining four single-spin and four double-spin asymmetries allowed in the one-photon-exchange approximation of the semi-inclusive deep-inelastic scattering process for target-polarization orientation perpendicular to the direction of the incoming lepton beam. Among those results, significant non-vanishing cos(phi-phi_s) modulations provide evidence for a sizable worm-gear (II) distribution, g_1T. Most of the other modulations are found to be consistent with zero with the notable exception of large sin(phi_s) modulations for charged pions and positive kaons.

HK 14.7 Tue 18:15 H3

Inclusive production of two hadrons in electron-positron annihilation at Belle — •Gunar Schnell — University of the Basque Country UPV/EHU & IKERBASQUE, Bilbao, Spain

Fragmentation functions (FFs), describing the formation of hadrons from partons, are an indispensable tool in the interpretation of hadron-production data, e.g., in the investigation of nucleon structure via semi-inclusive deep-inelastic scattering. The cleanest process to access FFs is hadron production in electron-positron annihilation. However, little information can be derived on charge-separated FFs from single-inclusive hadron production. A better handle on the flavor contributions can be gotten by flavor correlations or tagging: the hadron type in one hemisphere puts constraints on the parton flavor in the other hemisphere and thus on the flavor decomposition of the hadronization process. This can be exploited in inclusive hadron-pair production in electron-positron annihilation. While two hadrons in the same hemispheres, e.g., originating from the same parton, open an avenue to an unusual class class of FFs, dihadron-FFs, two hadrons in opposite hemispheres can be used for flavor and polarization tagging of single-hadron FFs. These scenarios have recently been subject to renewed studies at the Belle experiment. The dependences of the production cross section of pairs of identified light mesons (charged pions and kaons) as well as of (anti)protons on the individual z of the hadrons or on the combined z will be presented in this talk. In addition, azimuthal modulations of such cross sections for pions and the eta meson, related to the spin-dependent Collins effect, will be discussed.

HK 15: Structure and Dynamics of Nuclei I

Time: Tuesday 16:30–18:30 Location: H4

Group Report HK 15.1 Tue 16:30 H4

Recent results from the FRS Ion Catcher — •Gabriella Kripkó-Koncz for the FRS Ion Catcher-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

The atomic masses of exotic nuclei provide key information for the understanding of nuclear structure and astrophysics. The FRS Ion Catcher experiments at the FRagment Separator FRS at GSI enable high precision mass measurements or isobar and isomer separation with thermalized projectile and fission fragments by combining a Cryogenic Stopping Cell (CSC) and a Multiple-Reflection Time-Of-Flight Mass Spectrometer (MR-TOF-MS). Incorporating several novel and unique concepts, the MR-TOF-MS enables the highest performance, such as a mass resolving powers at FWHM of up to 1,000,000 and relative mass accuracies down to $1.7 \cdot 10^{-8}$.

Mass and half-life measurements of projectile fragments in the vicinity of ^{100}Sn were performed, including the first mass measurement of the ^{101}In ground state and the discovery of a new isomeric state in ^{97}Ag. A novel technique for measuring half-lives and decay branching ratios was developed and demonstrated experimentally. These results including the most recent experiments, recent technical upgrades, and the status of the next-generation CSC for the Low-Energy-Branch of the Super-FRS at FAIR will be presented.

Group Report HK 15.2 Tue 17:00 H4

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 Köln, Germany

The Doppler-shift attenuation method (DSAM) has been used in recent years to successfully determine lifetimes of excited low-spin states of various nuclei in the sub-picosecond range [1,2]. Especially by the use of particle-γ coincidence data taken at the SONIC@HORUS spectrometer in Cologne [3], the direct selection of levels via their excitation energy is possible. This greatly reduces background and eliminates feeding from levels of higher energies, as well as gives complete knowledge over the reaction kinematics. This contribution will give an overview of the method and show recent results from experiments on Ru, Sn [2] and Te isotopes. Additionally, a complementary approach to the conventional DSA technique to extract lifetimes from weak transitions and excited states with low statistics will be presented. A first estimation of its feasibility is discussed.

Supported by the DFG (ZI-510/9-1).

[1] A. Hennig *et al.*, Nucl. Instr. and Meth. A **794** (2015) 717.
[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 15.3 Tue 17:30 H4

High-precision mass measurements in the direct vicinity of the doubly magic ^{100}Sn(N=Z=50) at ISOLDE/CERN — •Jonas Karthein for the ISOLTRAP-Collaboration — CERN, 1211 Geneva, Switzerland — Max-Planck-Institut für Kernphysik, 69117 Heidelberg, Germany — present address: Massachusetts Institute of Technology, Cambridge, MA 02139, USA

This contribution reports on high-precision mass measurements of $^{99-101}$In isotopes and isomers with the ISOLTRAP mass spectrometer at ISOLDE/CERN. Applying the Multi-Reflection Time-of-Flight (MRToF) method, the masses of ^{99}In and ^{100}In (the β-decay daughter of ^{100}Sn) were measured for the first time with high precision. Additionally, the recently implemented Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique [S. Eliseev et al. PRL 110 (2013) 082501] will be discussed in the context of these measurements. This revolutionary Penning-trap mass spectrometry technique allowed for the first time a direct mass determination of both the ground and the isomeric states of ^{101}In in a Penning trap with resolving powers exceeding m/Δm $> 5*10^5$ in only 62 ms phase-accumulation time. Our mass spectrometry results, recently accepted for publication in *Nature Physics*, will be compared with pioneering *ab-initio* many-body calculations in this heavy mass region. The 100-fold improvement in the precision of the ^{100}In mass value highlights a discrepancy in the so-far published atomic mass values of ^{100}Sn, which could previously only be derived from β-decay results.

HK 15.4 Tue 17:45 H4

Nuclear structure investigations on $^{253-255}$Es by laser resonance ionization spectroscopy — •Steven Nothhelfer — 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 are required to reveal valuable information about the structure of their atomic nuclei. In this talk 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 was measured in all three Es isotopes, and four additional ground-state transitions were measured in ^{254}Es. Hyperfine structure analysis resulted in spin values of $I(^{254}\text{Es}) = 7$ and $I(^{255}\text{Es}) = 7/2$. From the extracted coupling constants, nuclear magnetic dipole moments as well as spectroscopic electric quadrupole moments were derived. The literature value of the nuclear magnetic dipole moment for ^{254}Es obtained from the angular anisotropy of ^{254}Es α-radiation deviates from our more precise value of this quantity.

HK 15.5 Tue 18:00 H4

Precision calculation of deuteron form factors in chiral effective field theory — Arseniy A. Filin[1], •Daniel Möller[1], Vadim Baru[1,2,3], Evgeny Epelbaum[1], Hermann Krebs[1], and Patrick Reinert[1] — [1]Ruhr-Universität Bochum, Fakultät für Physik und Astronomie, Institut für Theoretische Physik II, D-44780 Bochum, Germany — [2]Institute for Theoretical and Experimental Physics, B. Cheremushkinskaya 25, 117218 Moscow, Russia — [3]P.N. Lebedev Physical Institute of the Russian Academy of Sciences, 119991, Leninskiy Prospect 53, Moscow, Russia

We employ the precise two-nucleon potentials worked out to fifth order in chiral effective field theory to perform high-accuracy calculations of the deuteron form factors. The corresponding electromagnetic charge and current operators are derived and regularized consistently with the potentials. The single-nucleon contributions to these operators are expressed in terms of the proton and neutron form factors, for which up-to-date empirical parametrizations are employed. The short-range two-nucleon operators contain undetermined parameters which are fixed from the deuteron static moments and/or the world data of deuteron form factors, allowing for different kinds of predictions. A comprehensive error analysis is carried out, including a Bayesian analysis of the uncertainty stemming from the truncation of the chiral expansion.

Supported by DFG (CRC 110)

HK 15.6 Tue 18:15 H4

Systematic treatment of hypernuclear data and application to the hypertriton — •Philipp Eckert, Josef Pochodzalla, Patrick Achenbach, Marcell Steinen, Pascal Klag, and Julian Geratz for the A1-Collaboration — JGU Mainz, Germany

A new database is under construction to offer a complete collection of published information on hypernuclei. A key aspect is the combination of measurements to average values in a systematic manner together with a proper treatment of errors. The focus lies on lifetimes, Lambda binding energies and excitations of hypernuclei.

The capability of the database will be demonstrated for the case of the hypertriton.

Supported by the Deutsche Forschungsgemeinschaft, Grant Number PO 256/7-1 and the European Union's Horizon 2020 research and innovation programme No. 824093.

HK 16: Invited Talks - III

Time: Wednesday 14:00–16:00 Location: H1

Invited Talk HK 16.1 Wed 14:00 H1

Short-Range Correlations in neutron-rich nuclei — •Meytal Duer — TU Darmstadt, Darmstadt, Germany

When nucleons come in close proximity they experience the short-range part of the nucleon-nucleon interaction. These states are referred to as Short-Range Correlated (SRC) nucleon-nucleon pairs, with large relative momentum and small cente-of-mass momentum with respect to the Fermi momentum. SRC pairs are formed as temporary fluctuations with high density, several times the nuclear saturation density. These are densities that exist in neutron stars, but are difficult to study in the lab.

Most of the knowledge we have to date about SRC comes mainly from electron scattering experiments. These demonstrated that at any given moment, about 20% of the nucleons in nuclei are members of such neutron-proton SRC pairs. Electron scattering experiments are limited, however, to stable nuclei. To overcome this limitation, to access very neutron-rich nuclei, radioactive-ion beams are the only way to do so. The next generation of proposed experiments includes the use of hadronic probes in inverse kinematics.

Our recent experiment at JINR, Russia showed for the first time that SRC pairs are accessible in inverse kinematics. This showcases a new ability to study SRC in short-lived exotic nuclei at the R3B setup at GSI and in the future at FAIR. The first experiment with radioactive nucleus, ^{16}C, will be performed at R3B in 2022. A successful experiment will pave the way for systematic studies of the neutron excess for example along isotopic chains.

Invited Talk HK 16.2 Wed 14:30 H1

The BGOOD experiment at ELSA - exotic structures in the light quark sector? — •Thomas Jude for the BGOOD-Collaboration — Physikalisches Institut, Universität Bonn

The recent discoveries of the pentaquark, P_C, states and XYZ mesons in the charmed quark sector initiated a new epoch in hadron physics. The existence of exotic multi-quark states beyond the conventional three and two quark systems has obviously been realised. Intriguingly, similar states may be evidenced in the light, uds sector in meson photoproduction. Access to a low momentum exchange and forward meson production region is crucial. The BGOOD photoproduction experiment is uniquely designed to explore this kinematic region; it is comprised of a central calorimeter complemented by a magnetic spectrometer in forward directions.

Our results indicate a peak-like structure in the $\gamma n \to K^0\Sigma^0$ cross section consistent with a meson-baryon interaction model which predicted the charmed P_C states. The same $K^*\Sigma$ molecular nature of this proposed N*(2030) is also supported in our measurement of $\gamma p \to K^+\Lambda(1405)(\to \pi^0\Sigma^0)$. Additionally, a sharp drop in the $\gamma p \to K^+\Sigma^0$ cross section at very forward angles is observed.

In the non-strange sector, coherent meson photoproduction off the deuteron enables access to proposed dibaryon states. Preliminary data supports recent experimental claims of isoscalar and isovector dibaryons.

Supported by DFG projects 388979758/405882627 and the European Union*s Horizon 2020 programme, grant 824093.

Invited Talk HK 16.3 Wed 15:00 H1

The Muon g-2 Experiment at Fermilab — •Martin Fertl for the Muon g-2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

The E989 collaboration has recently published the most precise measurement of the muon anomalous magnetic moment a_μ with an uncertainty of 460 ppb. The new experimental world average of a_μ (with an uncertainty of 350 ppb) differs by 4.2 standard deviations from the Standard Model prediction provided by the Muon g-2 Theory Initiative. The emerging results from ab-initio lattice QCD calculations allow to scrutinize this tantalizing hint for physics beyond the Standard Model for the first time in a three way comparison. To extract the value of a_μ a clock comparison experiment is performed with spin-polarized muons confined in a superbly controlled electric and magnetic field environment. The deviation of the Larmor from the cyclotron frequency, the anomalous spin precession frequency, is determined while a high-precision measurement of the magnetic field environment is performed using nuclear magnetic resonance techniques. I will discuss the most recent result from the first science data run in 2018 and will report on the experimental improvements implemented to achieve the ultimate goal of 140 ppb uncertainty on a_μ.

Invited Talk HK 16.4 Wed 15:30 H1

The muon (g-2) from lattice QCD and experiments: 4.2 sigma, indeed? — •Zoltan Fodor — University of Wuppertal

Twenty years ago, in an experiment at Brookhaven National Laboratory, physicists detected what seemed to be a discrepancy between measurements of the muon's magnetic moment and theoretical calculations of what that measurement should be, raising the tantalizing possibility of physical particles or forces as yet undiscovered. The Fermilab team has just announced that their precise measurement supports this possibility. The reported significance for new physics is 4.2 sigma just slightly below the discovery level of 5 sigma. However, an extensive new calculation of the muon's magnetic moment using lattice QCD by the BMW-collaboration reduces the gap between theory and experimental measurements. The lattice result appeared in Nature on the day of the Fermilab announcement. In this talk the theoretical aspects are summarized with two possible narratives: a) almost discovery or b) Standard Model re-inforced. Details of the lattice calculation are also shown.

HK 17: Heavy-Ion Collisions and QCD Phases III

Time: Wednesday 16:30–18:30 Location: H1

Group Report HK 17.1 Wed 16:30 H1

Global polarization of Λ hyperons as a probe for vortical effects in A+A collisions with HADES — •Frederic Kornas[1], Ilya Selyuzhenkov[2], and Tetyana Galatyuk[1,2] for the HADES-Collaboration — [1]TU Darmstadt, Darmstadt, Germany — [2]GSI Helmholtzzentrum, Darmstadt, Germany

Large orbital momenta occur in non-central heavy-ion collisions which might transfer to the particle spins resulting in a global polarization of the produced particles. Such a global polarization can be measured using weakly decaying particles, e.g. the Λ hyperon. The results of the Λ polarization measurement in Au+Au collisions at $\sqrt{s_{NN}} = 2.4$ GeV and Ag+Ag collisions at $\sqrt{s_{NN}} = 2.55$ GeV will be reported. For the latter, the polarization will be shown as a function of centrality, rapidity and transverse momentum. The magnitude of the measured polarization by HADES follows the increasing trend with decreasing collision energy observed by the STAR and ALICE collaborations at higher energies. In addition, directed flow v_1 measurements of the Λ will be shown. The v_1 slope at midrapidity will be compared to the protons measured in the same collision systems in HADES and put in the context of previous measurement.

HK 17.2 Wed 17:00 H1

Measurement of light (anti-)nuclei production in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE — •Michael Habib[1,2] and Luca Barioglio[3] for the ALICE-Collaboration — [1]GSI Helmholtzzentrum für Schwerionenforschung, Planckstr. 1, 64291 Darmstadt — [2]Institut für Kernphysik, Technische Universität Darmstadt, Schlossgartenstr. 9, 64289 Darmstadt — [3]Physik Department, Technische Universität München, James-Franck-Straße 1, 85748 Garching bei München

Understanding the production mechanism of light (anti-)nuclei is one of the key challenges of contemporary nuclear physics. It has important consequences for astrophysics since it provides input for indirect dark matter searches with space-bound experiments. In this talk, the latest results on light (anti-)nuclei production obtained with ALICE in pp collisions at $\sqrt{s} = 13$ will be presented and compared to coalescence and thermal model predictions. In particular, the measured coalescence parameters for deuterons and helium nuclei will be compared with parameter-free theoretical predictions. The latter are constrained by femtoscopic source radius measurements and they depend directly on the nuclear wave functions.

HK 17.3 Wed 17:15 H1

Machine Learning Application for Λ Hyperon Reconstruction in CBM at FAIR — •Shahid Khan[1], Ali Imdad 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 Tübingen — [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 in the region of high net-baryon densities (B > 500 MeV) in the collision energy range of $\sqrt{s_{NN}}$ = 2.7-4.9 GeV with high interaction rate, up to 10 MHz, provided by the SIS100 accelerator. Enhanced production of strange baryons can signal a transition to a new phase of the QCD matter. Λ hyperons are the most abundantly produced strange baryons. They weakly decay, with a branching ratio of 64%, into a proton (p^+) and a pion (π^-). To reconstruct the $\Lambda \to p^+ + \pi^-$ decay kinematics, Particle-Finder Simple package is used. It uses the mathematics of the Kalman Filter Particle package and provides a convenient interface to control the reconstruction parameters. For the reduction of combinatorial background specific selection criteria need to be applied to the proton and π^- tracks and Λ-candidates decay topology.

In this work, the performance for Λ reconstruction in CBM with Machine Learning algorithms such as XGBoost will be presented. These algorithms allow efficient, non-linear and multi-dimensional selection criteria to be implemented whilst achieving high signal to background ratio in the region around the Λ candidate invariant mass peak.

HK 17.4 Wed 17:30 H1

Comparison of light (hyper-)nuclei from PHQMD simulations with experimental data from heavy-ion collisions — •Susanne Glässel[1], Christoph Blume[1,2], Elena Bratkovskaya[1,2], and Gabriele Coci[2] — [1]Goethe University Frankfurt — [2]GSI Darmstadt

Simulations of light nuclei production in heavy-ion collisions up to date have been limited to the modeling of a sudden transition from a dynamical transport model to clusterization (via coalescence or statistical model). However, a better understanding of the cluster formation and of how such weakly bound objects are formed and survive in the dense and hot environment created in heavy-ion collisions cannot be established that way. The newly developed Parton-Hadron-Quantum-Molecular-Dynamics (PHQMD) approach allows a dynamical cluster formation continuously during the time evolution of the collision. The microscopic n-body transport model describes the interactions between baryons on the basis of Quantum Molecular Dynamics (QMD) which allows to propagate n-body correlations in phase-space, essential for the cluster formation. The clusters are recognized by the Minimum Spanning Tree (MST) algorithm. Collisions among hadrons, the Quark-Gluon-Plasma formation and parton dynamics are adopted from the Parton-Hadron-String-Dynamics (PHSD) transport approach. A comparison of light nuclei and hypernuclei simulated with PHQMD and experimental data from AGS to RHIC energies will be presented, also providing valuable predictions for the upcoming CBM and NICA experiments. DFG-grant BL 982/3-1, DFG-grant BR 4000/7-1.

HK 17.5 Wed 17:45 H1

CBM performance for the measurement of Λ hyperons' directed 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 their 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 Λ hyperon directed flow measurement for the CBM experiment at FAIR. Λ 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 (KFParticle) mathematics, is used to reconstruct $\Lambda \to p\pi^-$ decay kinematics and to optimize criteria for Λ candidates selection. Directed flow of Λ hyperons is studied as a function of rapidity, transverse momentum and collision centrality. The effects on flow measurement 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 17.6 Wed 18:00 H1

Linear and Nonlinear Kinetic Description of Momentum Anisotropies in pp and pA Collisions in RTA — •Clemens Werthmann and Sören Schlichting — Universität Bielefeld, Bielefeld, Germany

Momentum anisotropies caused by collective flow phenomena in HICs have been known to convey a rich amount of information on the collision geometry. In pp and pA collisions the system size is too small for the hydrodynamic description of these anisotropies to be applicable. Instead, a microscopic description of the non-equilibrium dynamics has to be employed. Indeed, kinetic theory simulations have reproduced the anisotropies, but detailed insight into the mechanisms of their emergence is obscured by the algorithmical implementation. This prompts attempts to complement them with analytical treatments, which is highly nontrivial. We present an in-depth study of analyitcal and numerical descriptions of the problem formulated in relaxation time approximation. The analytical description employs an opacity expansion scheme of the Boltzmann equation and a linearization in small anisotropic perturbations on top of an isotropic Gaussian background. The nonlinear numerical description allows to estimate the range of validity of these appoximations via comparison and to study how the flow behaviour evolves from the free-streaming to the hydrodynamic regime.

HK 17.7 Wed 18:15 H1

Relativistic heavy-ion collisions and multiharmonic/large-order flow cumulants — •Seyed Farid Taghavi — Physics department, Technical University of Munich, James-Franck-Straße 1, 85748 Garching bei München

In the past years, significant progress has happened in high-energy nuclear physics models. A more robust and quantitative picture has replaced the qualitative descriptions of heavy nuclei collisions in the earlier days, enabling us to have a clearer picture of different stages of a heavy-ion collision. These models typically have $O(10)$ free parameters. The free parameters are tuned by Bayesian analysis in recent years, where the ALICE measurements are used as inputs.

In this presentation, our focus is on anisotropic flow observables. We introduce a method to extract anisotropic flow cumulants systematically. Employing a Monte Carlo simulation tuned by Bayesian analysis results, we predict the value of few low-order flow harmonic cumulants with significant signals that have not been reported by the LHC so far. We address how the new observables can modify the Bayesian analysis results. The large-order flow cumulant ($v_n\{2k\}$ with large k) contains a unique piece of information about the underlying flow distribution. In particular, we discuss the relation between the nonvanishing Lee-Yang zero phase and large-order flow cumulant ratios at ultra-central, ultra-peripheral, large, and small collision systems.
Based on:
S. F. Taghavi, (2020), arXiv:2005.04742 [nucl-th] (will be appeared in Eur.Phys.J.C)

HK 18: Instrumentation VI

Time: Wednesday 16:30–18:30 Location: H2

Group Report HK 18.1 Wed 16:30 H2

High-D: F&E für hochsegmentierte mehrdimensionale Detektoren für zukünftige Experimente — •Silvia Masciocchi für die High-D-Kollaboration — Universität Heidelberg und GSI

Zukünftige Experimente für Higgs-Präzisionsmessungen, die Suche nach Physik über das Standardmodell hinaus, sowie für die Untersuchung des Quark-Gluon-Plasmas und die Erforschung des QCD-Phasendiagramms, verlangen eine neue Generation von Hochpräzisionsdetektoren mit beispielloser räumlicher, zeitlicher und energetischer Auflösung. Die Anforderungen an solche 5-dimensionale (5D) Messungen können nur durch die Kombination von Detektoren mit extremer Granularität und neuartigen Rekonstruktionsmethoden erreicht werden. Eine höhere Segmentierung wird durch neu zu entwickelnde mikroelektronische Technologien, Halbleiterdesigns, Segmentierungskonzepte und Ausleseelektronik möglich werden. Diese Forschung auf der Detektorseite muß von neuartigen Algorithmen begleitet werden, die die bereitgestellte 5D-Information effektiv nutzt. Sie geht darin weit über einen einzelnen Detektor hinaus, indem sich alle Komponenten von einem Detektorsystem ergänzen, um eine optimale Rekonstruktionspräzision zu gewährleisten. High-D ist ein neuer vom BMBF geförderter Verbund, in dem die Gemeinschaften der Elementarteilchen-, Kern- und Hadronenphysik erstmalig miteinander gemeinsam an der Entwicklung verschiedener grundlegender Technologien zu solchen 5D-Detektoren zusammenarbeiten. Der Vortrag gibt einen Überblick über die geplanten Arbeiten und Projekte.

HK 18.2 Wed 17:00 H2

In-beam characterisation of bent ALPIDE MAPS in view of the ALICE Inner Tracking System 3 — •Pascal Becht for the ALICE-Collaboration — Physikalisches Institut Heidelberg University, Germany

The ALICE Inner Tracking System (ITS) has been recently upgraded to a full silicon detector based on Monolithic Active Pixel Sensors (MAPS). Prospectively, ALICE intends to replace the three innermost layers of this new ITS with a novel vertex detector. The proposed design features wafer-scale, ultra-thin, truly cylindrical MAPS. The new sensors will be thinned down to 20–40 μm, leading to an unprecedented low material budget of below 0.05 % X_0 per layer and will be arranged around the beam pipe, as close as 18 mm from the interaction point.

An extensive R&D programme is established with active participation in the BMBF funded High-D consortium for future particle detector development efforts. Investigating the feasibility of curved MAPS, already existing 50 μm-thick ALPIDE sensors were successfully bent, even below the targeted innermost radius. Their particle detection performance was assessed using electron test beams at DESY. First results from the testbeam data analysis for curved ALPIDE sensors will be presented and show that the current ALPIDE technology (180 nm) retains its properties after bending. The results show an inefficiency that is generally below 10^{-4}, independent of the beam inclination with respect to the sensor surface. This outcome proves curved MAPS to be an exciting possibility for future silicon detector designs.

HK 18.3 Wed 17:15 H2

Developement of a cooling system for the PANDA Barrel - EMC * — •Thorsten Erlen for the PANDA-Collaboration — II. Physikalisches Institut, JLU Gießen, Deutschland and for the PANDA Collaboration

The Electromagnetic Calorimeter (EMC) of the future PANDA-Experiment at the FAIR complex in Darmstadt will use lead tungsten scintillator crystals (PWO II). In its barrel part two Large Area Avalanche Photo Diodes (LAAPD) per crystal will be used to measure the amount of scintillation light created. Main characteristics of both the scintillator and the photosensors are temperature dependent. With decreasing temperature the light yield (photons per MeV) of the scintillators increases and the noise of the photosensors is reduced, while their gain-factor at a fixed voltage increases. The nominal operating temperature for the EMC is -25 °C to meet the desired properties and allow the EMC to perform according to the needs of the experiment. Energy resolution and threshold depend on a system that is capable of achieving and maintaining stable crystal and photosensor temperatures. Topic of this talk will be the ongoing developement of the cooling and monitoring system for the barrel part of the calorimeter. Methods in CAD design and simulation as well as design solutions will be presented in detail.

*gefördert durch das BMBF, GSI und HFHF.

HK 18.4 Wed 17:30 H2

FAIR Phase-0 Readiness of the PANDA Backward Calorimeter — 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], Peter Otte[1], David Rodriguez Pineiro[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 Cluster of Excellence, Mainz, Germany

The $\bar{\text{P}}$ANDA FAIR Phase-0 experiment at the Mainz Microtron Facility (MAMI) is set to determine the double-virtual transition formfactor (TFF) of the pion. As a consequence, the uncertainty in the hadronic light-by-light (HLbL) calculation for the anomalous magnetic moment of the muon can be reduced. The detector system for the experiment is a modified version of the $\bar{\text{P}}$ANDA backward calorimeter, which was developed by the group at HI-Mainz. In contrast to the $\bar{\text{P}}$ANDA experiment, the detector will operate in forward direction at a fixed target electron scattering experiment. Thus, new challenges arise for the radiation load of the components and the handling of high rates with the data acquisition. The talk addresses the major hardware, electronics, and data acquisition modifications to the $\bar{\text{P}}$ANDA backward calorimeter to achieve Phase-0 readiness.

HK 18.5 Wed 17:45 H2

Calibration of Pt100-temperature sensors in an electromagnetic calorimeter — •Samet Katilmis[1], Frank Maas[1,2,3], Alexander Greiner[1], Julian Moik[1], Oliver Noll[1], David Rodriguez Pineiro[1], Sahra Wolff[1], Luigi Capozza[1], Alaa Dbeyssi[1], Peter-Bernd Otte[1], and Dong Liu[1] for the PANDA-Collaboration — [1]HI-Mainz, Mainz, Germany — [2]Institute of Nuclear Physics, Mainz, Germany — [3]PRISMA Cluster of Excellence, Mainz, Germany

The PANDA Backward Endcap Calorimeter (BWEC) consists of tightly packed PbWO scintillators with a highly temperature dependent light yield (LY). The LY increases by 3% per °C with decreasing temperature to a value of 500 photons per MeV at -25°C and thus has to be monitored to avoid a deterioration of the energy resolution. The flat sensors consist of a thin Platinum wire covered by two kapton sheets. They fit between the tight structure of the scintillator matrix of the calorimeter because of their low thickness. The resistance of the platinum wire changes with its temperature and can be measured with the method of "four terminal sensing" which allows the use of long cable lengths. All the flat sensors show a different characteristic resistance-temperature relation and must be calibrated. The flat sensors are calibrated inside subunits (submodules) of the calorimeter (in-situ calibration) with the help of multiple reference temperature sensors and a climate chamber which approaches different temperature plateaus. At the temperature plateaus, calibration points are taken to calibrate the flat sensors with an accuracy of 0.14 °C .

HK 18.6 Wed 18:00 H2

A new calibration system for 180° electron scattering experiments — •Maximilian Spall, Maxim Singer, Johann Isaak, Jonny Birkhan, Peter von Neumann-Cosel, and Norbert Pietralla — Institut für Kernphysik, Technische Universität Darmstadt

An electron scattering experiment at 180° is an excellent tool to investigate magnetic excitations of nuclei, due to the minimum of the longitudinal differential cross section at this angle. The 180° electron scattering system at the QCLAM spectrometer [1] is presently upgraded. A new system for the calibration of the scattering angles has been designed and is currently under construction, since precise knowledge of the horizontal and vertical scattering angles is necessary to reconstruct the experimental scattering angle. With the help of the new calibration system, it is possible to measure the transport matrix for the whole magnetic system, including the QCLAM spectrometer, without the need to change to a normal configuration as described in [1]. In this talk the new calibration system will be presented.

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

[1] C. Lüttge et al., Large-aperture system for high-resolution 180° electron scattering. Nuclear Inst. and Methods in Physics Research, A. 366, 325-331 (1995).

HK 18.7 Wed 18:15 H2

Design of a cryopump for PANDA at FAIR — •Christian Mannweiler, Benjamin Hetz, Daniel Bonaventura, Jeremy Runge, Philipp Brand, Sophia Vestrick, and Alfons Khoukaz for the PANDA-Collaboration — Westfälische Wilhelms Universität, Münster, Deutschland

The PANDA experiment at the future HESR accelerator at FAIR will explore open questions about the strong interaction, the existence of exotic particles as well as other topics by utilising anti-proton-proton collisions. For these studies, optimal vacuum conditions are crucial for event reconstruction, background suppression as well as for antiproton beam lifetime.

To this end, a custom designed cryopump is in development for the antiproton beam line of the PANDA experiment. In a cryopump, activated charcoal is cooled down to cryogenic temperatures of well below 20K. At these temperatures, even hydrogen molecules are adsorbed, creating a highly efficient pumping mechanism.

Several different cryopump geometries were studied with respect to their impact on the vacuum situation at PANDA and the attainable minimum temperatures using the software packages MOLFLOW+ and Autodesk CFD, respectively. Additionally, experimental studies were performed with regard to the capacity and pumping speed of such a cryopump. The results obtained through these studies will be presented and discussed.

This project has received funding from BMBF (05P19PMFP1) and GSI (FuE) - MSKHOU2023

HK 19: Hadron Structure and Spectroscopy IV

Time: Wednesday 16:30–18:15 Location: H3

Group Report HK 19.1 Wed 16:30 H3

Search for resonant states with $c\bar{c}s\bar{s}$ quark content at BaBar and Belle — •Elisabetta Prencipe[1], Dmytro Meleshko[1], Ashish Thampi[2], Soeren Lange[1], and James Ritman[2] — [1]JLU - University of Giessen — [2]Forschungszentrum Juelich

The study of exotics with charm- and strange- quark content has recently gained a lot of attention. In fact, the LHCb collaboration has already published on this topic three papers. In the latest submission, LHCb has shown interesting results by analyzing the invariant mass of the $J/\psi\phi$ and $J/\psi K$ systems in B decays. Former studies were conducted by the CDF, D0, CMS and BaBar collaborations, with controversial interpretation regarding possible resonant states in the $J/\psi\phi$ invariant mass. All previous studies were performed by analyzing B meson decays only, *e.g.* $B \to J/\psi\phi K$. We recently started this study with the whole Belle data set collected at the energy in the center of mass of $\Upsilon(4S)$. We decide to perform the analysis to look for $c\bar{c}s\bar{s}$ exotics at B factories, and combine data sets of 2 experiments (BaBar and Belle) to cure problems of insufficient statistics. We perform our study not only through B decays (charged and neutral B modes), but also in the continuum. This offers the possibility to cross-check the presence of such resonant states -if any- in different decay modes and different production mechanisms. The state of the art of the analysis of $B \to J/\psi\phi K$, $e^+e^- \to J/\psi\phi X$ and $e^+e^- \to D_s^- D_s(2317)^+ X$ is here presented. A DFG project has been submitted and approved on this topic for 3 years.

HK 19.2 Wed 17:00 H3

Search for couplings of vector charmonia to the $p\bar{p}\eta'$ final state at BESIII — •Johannes Bloms[1], Nienke Balz[1], Helge Balzen[1], Anja Brüggemann[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Sascha Lennartz[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 experiment at the Beijing Electron Positron Collider (BEPCII) has collected a large amount of high luminosity data sets at various center-of-mass energies between $\sqrt{s} = 3.7\,\mathrm{GeV}$ and $\sqrt{s} = 4.7\,\mathrm{GeV}$, which offers a unique opportunity to study hadron spectroscopy and enables dedicated studies of exotic charmonia. The $\psi(4230)$ with $J^{PC} = 1^{--}$ and a mass around $m_{\psi(4230)} = 4.23\,\mathrm{GeV/c^2}$ is one example for an exotic candidate. Many detailed investigations regarding the $\psi(4230)$ have been made both experimentally and from theory, but there is still no consensus regarding its inner structure. Surprisingly, only a small coupling to open-charm final states has been found. Instead, the $\psi(4230)$ is prominently observed in charmonium transitions like $\psi(4230) \to J/\psi\pi^+\pi^-$, $\psi(4230) \to h_c\pi^+\pi^-$ and $\psi(4230) \to \psi(2S)\pi^+\pi^-$. So far, no observations have been made of charmless decays of the $\psi(4230)$ to light hadrons. In order to search for those possible decays of the $\psi(4230)$, the final state $p\bar{p}\eta'$ is investigated. The current status of the determination of the energy-dependent Born cross section $\sigma^{\mathrm{B}}(e^+e^- \to p\bar{p}\eta')$ will be presented and discussed. This work is funded by the DFG - 269952272, 271236083 and 443159800.

HK 19.3 Wed 17:15 H3

Study of the $B \to J/\psi\phi K$ decay channel at Belle — •Ashish Thampi[1], Elisabetta Prencipe[2], and James Ritman[1] — [1]Forschungszentrum Juelich, Juelich, Germany — [2]JLU-University of Giessen, Giessen, Germany

Even though the $B \to J/\psi\phi K$ process is most likely a three body decay, it can also proceed as a quasi-two body decay where J/ψ and ϕ are daughters of a hybrid or charmonium state. Investigating this decay is important in the search for possible $c\bar{c}s\bar{s}$ exotic states in the $J/\psi\phi$ invariant mass system. The LHCb has found resonant states in the $J/\psi\phi$ and the $J/\psi K$ invariant mass distributions in the charged B decay mode. In order to provide a better understanding of the process and disclose the nature of these enhancements, we analyze the invariant mass systems in both, charged and neutral B meson decays, $B^\pm \to J/\psi\phi K^\pm$ and $B^0 \to J/\psi\phi K^0_S$. This analysis is performed using the $771 fb^{-1}$ integrated luminosity data collected at the energy in the center of mass of $\Upsilon(4S)$ resonance by the Belle detector. We measure the branching fraction for these B decays and observe resonant states in the $J\psi\phi$ and the $J/\psi K$ invariant mass systems. This analysis is a part of the DFG project no. 389090153.

HK 19.4 Wed 17:30 H3

Search for the X17 boson at the BESIII experiment — •Saskia Plura, Achim Denig, and Christoph Redmer for the BESIII-Collaboration — 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 particle is referred to as the X17 boson, which 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 radiates off an X17. 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 BESIII, located at the BEPC-II collider in Beijing, China, using a collected data sample of 10^{10} J/ψ events. - Supported by DFG.

HK 19.5 Wed 17:45 H3

Studies on Midrapidity J/ψ Production as a Function of Charged-Particle Multiplicity with ALICE — •Ailec de la Caridad Bell Hechavarria and Tabea Eder — Institut für Kernphysik, WWU. Wilhelm-Klemm-Straße 9, 48149 Münster

Previous ALICE studies have shown a stronger than linear relative increase of the inclusive J/ψ production at mid-rapidity as a function of the mid-rapidity charged-particle multiplicity in proton-proton collisions at the LHC. Studies on Monte Carlo simulations with PYTHIA 8 attributed this behavior to autocorrelation effects. In this regard, interesting results were obtained studying the correlation of the J/ψ production with the charged-particle multiplicity in different regions of the azimuthal angle with respect to the flight direction of the J/ψ meson.

With experimental data on pp collisions at $\sqrt{s}$=13 TeV TeV and pPb collisions at $\sqrt{s}$=5.02 TeV, collected with ALICE during Run 2 of data taking at the LHC, current results of the relative J/ψ yield as a function of the charged-particle multiplicity, measured at mid-rapidity (|y|<0.9) in the di-electron decay channel, will be shown and compared to theoretical predictions from the PYTHIA8 Monte Carlo event generator.

HK 19.6 Wed 18:00 H3

Hypertriton production in 13 TeV pp collisions — •Michael Hartung — Institut für Kernphysik, Goethe Universität, Frankfurt, Germany

The $^3_\Lambda$H is a bound state of proton, neutron and lambda. Studying its characteristics provides insights about the strong interaction between the lambda and ordinary nucleons. In particular, the $^3_\Lambda$H is an extremely loosely bound object, with a large wave-function. As a consequence, the (anti-)$^3_\Lambda$H production yields in pp collisions are extremely sensitive to the nucleosynthesis models. Significant hypertriton yields have so far only been measured in Pb−Pb collisions at the LHC. Due to the excellent particle identification through the energy-loss measurement in the Time Projection Chamber in combination with the capabilities to separate primary particles from those from secondary decays, provided by the Inner Tracking System, it is possible to identify the hypertriton in pp collisions. With the precision of the presented production yields some configurations of the Statistical Hadronisation and Coalescence models can be excluded leading to tighter constraints to available theoretical models. Supported by BMBF and the Helmholtz Association.

HK 20: Fundamental Symmetries

Time: Wednesday 16:30–18:45 Location: H4

Group Report HK 20.1 Wed 16:30 H4

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, Dresden, Germany

The Mu2e experiment, 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. In the Standard Model, this process, which violates charged lepton flavor conservation, is highly suppressed and undetectable. However, scenarios for physics beyond the Standard Model predict small but observable rates. The Mu2e experiment aims for a sensitivity which is four orders of magnitude better than previous experiments. This is achieved by rigorous control of all backgrounds that could mimic the monoenergetic conversion electron signal.

At the Helmholtz-Zentrum Dresden-Rossendorf, we use the ELBE radiation facility to study the performance of the detectors that will monitor the rate of stopped muons in the aluminum target. For these detectors we have ported several software analysis algorithms to FPGA hardware using High-Level Synthesis, which will be tested at the next ELBE beamtime. Additionally, we perform extensive Monte Carlo simulations for shielding studies and rate comparisons.

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 shown.

Group Report HK 20.2 Wed 17:00 H4

Parity violating electron carbon scattering at the P2 experiment — Sebastian Baunack[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 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 a precision of 0.15% at a low four-momentum transfer of $Q^2 = 4.5\cdot 10^{-3}\,\mathrm{GeV}^2$. This precision is comparable to existing measurements at the Z pole. The experiment will be built at the future MESA accelerator in Mainz.

In addition to the measurement using a liquid hydrogen target, the possibility of other targets for measuring the parity violating elastic electron scattering are considered. The motivation and challenges for a measurement using a solid carbon target will be discussed in this talk.

Group Report HK 20.3 Wed 17:30 H4

The search for electric dipole moments of charged particles on storage rings — •Vera Shmakova for the JEDI-Collaboration — IKP, Forschungszentrum Jülich, 52425 Jülich, Germany

One of the main problems of modern particle physics is the inability of the Standard Model (SM) of Particle Physics to explain the matter-antimatter asymmetry in the Universe. The pursuit 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, through the CPT-theorem they also violate the combined CP symmetry. Hence, EDM measurements of fundamental particles are capable to probe new sources of CP-violation, and finding an EDM would be a convincing indicator for physics beyond the SM. Storage rings make it possible to measure EDMs of charged particles by observing the effect of the EDM on the spin motion in the ring. The direct search for proton and deuteron EDMs bears the potential to reach sensitivity beyond 10^{-29} e cm. The Cooler Synchrotron COSY at the Forschungszentrum Jülich provides polarized protons and deuterons with momenta up to 3.7 GeV/s, which is an ideal starting point for such an experimental program. The JEDI (Jülich Electric Dipole moment Investigations) collaboration is currently aiming at the first direct (precursor) measurement of the deuteron EDM in COSY. The technical design of the prototype EDM storage ring is the next milestone of the JEDI research program. The talk will present the JEDI program for the measurement of proton and deuteron EDMs and discuss recent results.

HK 20.4 Wed 18:00 H4

Frequency extraction of NMR signal to measure the magnetic field in the Fermilab Muon g − 2 experiment — •Mohammad Ubaidullah Hassan Qureshi, René Reimann, and Martin Fertl 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 collaboration recently published its first result for the anomalous magnetic moment of the muon, a_μ, to an unprecedented precision of 460 ppb. The new result deviates of 3.2σ from the latest Muon g−2 Standard Model Theory Initiative prediction and combined with Brookhaven National Laboratory (BNL) result the deviation increases to 4.2 sigma. The Muon g − 2 experiment determines the ratio of the muon anomalous precession frequency, w_a, to the proton spin precession frequency, w_p. The w_p value allows us to precisely account for the magnetic field experienced by the precessing muons. In this talk I will discuss the current methodology of precisely measuring the magnetic field using nuclear magnetic resonance (NMR) probes. This is achieved by extracting the frequency of the NMR signal generated due to spin precession of hydrogen atoms in our probe. Furthermore, I will also talk through plans for upcoming Run 2/3 analysis to systematically check and improve probe frequency extraction to a value below the Run 1 uncertainty for frequency extraction.

HK 20.5 Wed 18:15 H4

Tracking the magnetic field in the Fermilab Muon g–2 storage ring — •René Reimann, Mohammad Ubaidullah Hassan Qureshi, and Martin Fertl for the Muon g-2-Collaboration — Institute of Physics and Excellence Cluster PRISMA+, Johannes Gutenberg University Mainz, 55099 Mainz, Germany

Recently 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 based on the Run 1 data. 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 by the (free) proton spin-precession frequency. To achieve the ultimate goal of a 140 ppb uncertainty on a_μ, the magnetic field in the storage region of the muons needs to be tracked with an uncertainty better then 70 ppb. The magnetic field tracking is composed of three main components, an absolute calibrated NMR probe, a movable array of NMR probes that can be pulled through the storage region of the muons and a set of NMR probes in the vicinity of the storage region. In this talk, we present the measurement and tracking principle of magnetic field and point out improvements for the upcoming analysis of the Run 2 and 3 data.

HK 20.6 Wed 18:30 H4

Coalescence in MC generators and implications for cosmic ray studies — •Maximilian Horst, Laura Serksnyte, Luca Barioglio, and Laura Fabbietti — Technische Universität München

Coalescence is one of the main models used to describe the formation of light (anti)nuclei in high-energy collisions. It is based on the assumption that two nucleons close in phase space can coalesce and form a nucleus. Coalescence has been successfully tested in hadron collisions with various experiments, from small (pp collisions) to large collision systems (Au-Au and Pb-Pb collisions). However, in Monte Carlo simulations (anti)nuclear production is not described by event generators. A possible solution is given by the implementation of so-called coalescence afterburners, which can describe nuclear production on an event-by-event basis. This idea finds its application especially in astrophysical studies, allowing for precise description of (anti)nuclear fluxes in cosmic rays, which are crucial for indirect Dark Matter searches.

In this talk we present the implementation of event-by-event coalescence afterburners for MC generators. Different approaches to this implementation will be discussed, and the comparison with available experimental results from various collision systems will be shown.

HK 21: Invited Talks - IV

Time: Thursday 11:00–12:30 Location: H1

Invited Talk HK 21.1 Thu 11:00 H1

Charming bound states of the strong interaction — •Frank Nerling — Helmholtz Forschungsakademie Hessen für FAIR (HFHF), Frankfurt, Germany

Quantum chromodynamics, the quantum field theory of the strong interaction, allows for and predicts exotic bound states beyond the simple quark model. Even though experimental searches are performed since decades, most of them were not conclusive — the reported candidates are heavily disputed in the community. The discovery of the first so-called charmonium-like (exotic) XYZ states at the beginning of the millennium, however, has initiated a new era. With the observation of tetraquark candidates, the BESIII experiment has discovered manifestly exotic states in the meson sector. Other facilities such as the upcoming PANDA experiment at FAIR offer unique possibilities to finally clarify the nature of e.g. one of the first and most famous XYZ states that still 15 years after the observation is not yet understood.

Invited Talk HK 21.2 Thu 11:30 H1

Baryon Spectroscopy with the CBELSA/TAPS experiment at ELSA — •Annika Thiel — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The dynamics of the quarks and gluons inside the nucleon are a long-standing question in hadron physics. To shed more light on this topic, the excitation spectrum of the nucleons needs to be measured and compared to theoretical models like constituent quark models or lattice QCD calculations.

The extraction of the resonance spectrum is a recent research project by several different experiments. One of them is the CBELSA/TAPS experiment, which is located at the ELSA accelerator in Bonn. The CBELSA/TAPS experiment features a detector system with nearly full 4π angular coverage and a high detection efficiency for photons, which makes it the ideal tool for the measurement of final states comprising neutral mesons. One of its special features is the use of linearly or circularly polarized photon beams impinging on a longitudinally or transversely polarized butanol target. This allows for the measurement of single or double polarization observables, which are of major importance in the identification of small resonance contributions.

In this presentation, an overview of the recent status in baryon spectroscopy at the CBELSA/TAPS experiment will be given. This includes measurements of different polarization observables, as well as a review of their impact on the excitation spectra of the nucleons.

Supported by the DFG (SFB/TR16).

Invited Talk HK 21.3 Thu 12:00 H1

Mass measurements of the most exotic nuclei and their relevance for nuclear structure — •Timo Dickel[1,2], FRS Ion Catcher Collaboration[1,2], and TITAN Collaboration[3] — [1]GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt — [2]Justus-Liebig-Universität Giessen, Giessen — [3]TRIUMF, Vancouver, Canada

High-performance multiple-reflection time-of-flight mass spectrometers (MR-TOF-MS) developed at Justus Liebig University Gießen have been used for nuclear physics experiments using the FRS Ion Catcher experiment at the in-flight fragment separator FRS at GSI and the TITAN experiment at the ISOL facility ISAC at TRIUMF, Canada. The unprecedented sensitivity and mass resolving powers of these MR-TOF-MS allows to study the nuclear structure and astrophysics at the extremes of the nuclear chart. A wide range of cases will be presented, from investigations of the astrophysical scenario of the r-process to nuclear structure effects like the island of inversion or the shell structure at the outskirts of the nuclear chart.

In addition, the use of these MR-TOF-MS goes even beyond precision mass measurements, e.g., they can be employed to unambiguously identify and analyze ions independent of their decay properties. This enables novel and universal approaches to measure reaction cross-sections, fission yields, half-lives, and branching ratios. Recent highlights and outlook for both experiments at GSI and TRIUMF will be presented.

HK 22: Heavy-Ion Collisions and QCD Phases IV

Time: Thursday 16:30–18:30 Location: H1

Group Report HK 22.1 Thu 16:30 H1

Soft dielectron production in pp and Pb–Pb collisions with ALICE — •Jerome Jung for the ALICE-Collaboration — IKF, Goethe University Frankfurt, Germany

The production of soft dielectrons is an exceptional and versatile tool to study the underlying mechanisms and properties of hadron-hadron and heavy-ion collisions (HIC). In HIC, the STAR collaboration observed first a clear excess of dielectrons produced at low pair momenta which exceeded the hadronic decay background. These soft dielectrons can be attributed to coherent photoproduction originating in the interaction of the highly contracted electromagnetic fields of the colliding ions, a sole QED process. In hadronic collisions, several experiments observed an excess at low momenta for real as well as virtual photons beyond hadronic decays which could not be explained by initial- and final-state bremsstrahlung either. As this soft-photon puzzle is absent in purely leptonic collisions, the origin of the effect seems to be connected to QCD.

In this talk, ALICE measurements of dielectron production in pp and (semi-) peripheral Pb–Pb collisions, will be presented. The pp collisions are recorded with a reduced magnetic field of the central barrel solenoid of 0.2 T. This enables the investigation of a kinematic domain at low invariant mass m_{ee} and pair transverse momentum $p_{\mathrm{T,ee}}$, which was previously inaccessible at the LHC. Comparison of the measured dielectron yield to the hadronic decay cocktail indicates a clear enhancement of soft dielectrons in both systems. Finally, the excess spectra are extracted and compared to theoretical model calculations.

HK 22.2 Thu 17:00 H1

Centrality and system size dependence of the thermal dilepton excess yield in HADES — •Niklas Schild for the HADES-Collaboration — TU Darmstadt, Darmstadt, Germany

Electromagnetic probes offer a unique opportunity to study the conditions in heavy-ion collisions throughout their whole evolution. In particular, the spectral shapes of dilepton distributions entail information about the temperature of the hot and dense fireball, while the integrated dilepton yield can be connected to the lifetime of the colliding system.

The collision centrality as well as the beam energy are arguably the two major determinants for the conditions reached in heavy-ion collisions. Less clear is the impact of the ion species or the spectator matter. For this reason, the HADES collaboration has recorded events for two collision systems at the same energy: Au+Au in April 2012 and Ag+Ag in March 2019, both at 1.23A GeV.

We present first results of the measured Ag+Ag thermal dilepton radiation and compare the extracted temperature of the fireball as well as the normalised excess yield to the measurements from Au+Au collisions.

HK 22.3 Thu 17:15 H1

Thermal dileptons in a coarse-grained transport and hydrodynamics — •Maximilian Wiest[1], Tetyana Galatyuk[1,2], Ralf Rapp[3], Florian Seck[1], Joachim Stroth[2,4], and Jan Steinheimer[4,5] — [1]TU Darmstadt — [2]GSI, Darmstadt — [3]Texas A&M Univ, College Station, USA — [4]Goethe-Universität, Frankfurt — [5]FIAS, Frankfurt

Dileptons provide a unique way to access the properties of the fireball created in heavy-ion collisions. Hadrons are not suited for doing this in the same way, since their properties are subject to the strong interactions in the fireball. We study dilepton production in the SIS18 energy range by utilizing an approach that uses coarse-grained transport simulations to calculate thermal dilepton emission applying state-of-the-art in-medium spectral functions from hadronic many-body theory. To ensure an accurate description of the fireball, we have used several microscopic transport models and compared the effect of the space-time evolution on resulting dilepton spectra. We will also present a systematic comparison of the results for different colliding nuclei as well as for the number of individual participants in the collision (system size) and different collision energies as measured recently by the HADES Collaboration.

Supported by VH-NG-823, DFG CRC-TR 211 and GSI

HK 22.4 Thu 17:30 H1

Direct Photon Production in pp collisions at $\sqrt{s}$ = 13 TeV as a Function of Multiplicity with ALICE — •Ilya Fokin für die ALICE-Kollaboration — Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany

Thermal direct photons are a sign of the production of a quark-gluon-plasma (QGP). They have been measured in PbPb collisions by ALICE while measurements in pp collisions showed no enhancement over the decay photon cocktail. Some collective effects, which could be explained by a QGP, such as long-range two-particle correlations have been observed not only in heavy-ion collisions, but also in high-multiplicity pp collisions. An enhancement of the direct photon production at low transverse momentum in high-multiplicity collisions compared to low-multiplicity collisions would suggest the creation of a QGP also in pp collisions.

In this talk, a measurement of the direct photon production in pp collisions at 13 TeV as a function of the charged particle multiplicity with ALICE is presented. Photons are reconstructed using the photon conversion method, relying on pair conversions in the detector material. π^0 and η mesons are reconstructed via their two-photon decay channels for the calculation of the decay photon cocktail.

HK 22.5 Thu 17:45 H1

Dielectron physics opportunities with ALICE 3 — •Florian Eisenhut for the ALICE-Collaboration — IKF, Universität Frankfurt am Main, Deutschland

The ALICE 3 experiment is planed as a compact, next-generation multipurpose detector at the LHC as a follow-up to the present ALICE experiment. It will provide unprecedented tracking and vertexing capabilities down to a few tens of MeV/c in pp, pA and AA collisions at luminosities up to a factor 50 times higher than what will be possible with the upgraded ALICE detector. Such detector performances allow to study the very soft dielectron productions connected to the electric conductivity of the medium via thermal dielectrons in heavy-ion (AA) collisions. At higher dielectron invariant masses (m_{ee}), the measurement of thermal radiation from the hadron gas is possible, which becomes sensitive to the chiral symmetry mixing between ρ and a_1 mesons. Overall, these conditions will provide unique opportunities for dielectron measurements.

This talk will give an overview of the performance studies for dielectron analyses with the ALICE 3 experiment aiming at specific criteria to optimise the layout of the detector. A possible way to identify electrons using different PID scenarios will be presented together with the resulting track and pair efficiencies and the expected m_{ee} resolution. Finally the capability to reject the heavy-flavour background will be discussed based on the expected raw dielectron yield in central AA collisions as a function of the pair distance-of-closest approach to the primary vertex.

HK 22.6 Thu 18:00 H1

Photon and dilepton rates in the low energy regime and electrical conductivity — •Charlotte Gebhardt and Stefan Flörchinger — Institut für Theoretische Physik, Universität Heidelberg

We combine next to leading (NLO) computations on the thermal spectral function with results from hydrodynamic simulations with mode expansion (FluiduM) to study the eletrical conductivity of the Quark Gluon Plasma (QGP). Therefore we fit and modify the thermal spectral function, such that electrical conductivity can be varied. Further we present how this has an impact on the thermal particle spectra in the low energy regime. Results are shown for a simulated QGP of a Pb-Pb-collision at $\sqrt{s_{NN}} = 2.76\,TeV$ and $\sqrt{s_{NN}} = 5.02\,TeV$. The aim is to find a way to gain insights on the electrical conductivity of the QGP from measurements of thermal photons and dileptons.

HK 22.7 Thu 18:15 H1

Measurement of Neutral Mesons in pp Collisions at $\sqrt{s} = 13$ TeV with ALICE — •Joshua König for the ALICE-Collaboration — IKF, Goethe-Universität Frankfurt

ALICE, the dedicated heavy-ion experiment at the LHC, investigates the properties of the quark-gluon plasma (QGP) that is believed to be produced in central AA collisions at high center-of-mass energies. Measurements in pp collisions provide a baseline for the AA collision system and can furthermore constrain the description of hadronization and fragmentation. Multidifferential measurements of neutral meson (π^0, η, ω) production as function of p_{T} and the multiplicity can give further constraints on the particle production mechanisms. Moreover, these measurements provide the baseline for direct-photon analyses.

The reconstruction of neutral mesons via their two photon-decay channel can be realized in ALICE with several complementary methods, utilizing the calorimeters and the TPC. In this talk, the status of the light neutral meson analyses in pp collisions at $\sqrt{s} = 13$ TeV with ALICE will be presented.

Supported by BMBF and the Helmholtz Association

HK 23: Instrumentation VII

Time: Thursday 16:30–18:30 Location: H2

Group Report HK 23.1 Thu 16:30 H2

Status of the CBM Time-of-Flight project — •Ingo Deppner and Norbert Herrmann for the CBM-Collaboration — 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 large-area Time-of-Flight (ToF) wall equipped with multi-gap resistive plate chambers (MRPC). The MRPC detectors reached by now the close to final design and were extensively tested in several beam campaigns at particle fluxes of up to a 25 kHz/cm^2. Prior to its destined operation at the Facility for Antiproton and Ion Research (FAIR) - starting in 2025 - this high-rate timing MRPC technology 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 will become feasible with a PID backbone consisting of 25 CBM MRPC detectors. Apart from the physics perspectives, these FAIR Phase-0 involvements allow for high rate detector tests and long term stability tests and will help gathering experience in operating the final CBM TOF wall. The current status of the CBM-TOF project and latest achievements from our Phase-0 involvements will be presented.

The project is partially funded by BMBF contract 05P15VHFC1.

HK 23.2 Thu 17:00 H2

Development of a high resolution scintillation time measurement system — Kai-Thomas Brinkmann, •Lara Dippel, Valera Dormenev, and Hans-Georg Zaunick — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

This project is dedicated to the development of a system optimized for coincidence time resolution (CTR) measurements, potentially utilized in the context of scintillation kinetics or time-of-flight measurements. Testing through a selection of different electronic and detector components available in our lab, we were able to assemble a setup with promising results for scintillation kinetics measurements. The most promising setup employs a TDC7200 on a custom board read out by a RaspberryPi and a BaF crystal coupled to a PMT as a reference detector, measuring against another "naked" PMT optimized for fast timing. However, the setup predominantly measures the prompt photons emitted by the material tested, effectively suppressing the slower components. To measure the full-timing response of the material, further adjustments to the setup are needed. This work was carried out in the framework of BMBF Project 05K2019 - UFaCal

HK 23.3 Thu 17:15 H2

Magnetic field performance of the latest 2-inch MCP-PMTs — •Steffen Krauss, Merlin Boehm, Katja Gumbert, Albert Lehmann, and Daniel Miehling for the PANDA-Collaboration — Physikalisches Institut , Universität Erlangen-Nürnberg

The PANDA experiment at FAIR will employ two Cherenkov detectors of the DIRC-type for pion/kaon separation. Since the focal planes of both DIRC detectors 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. Their magnetic field performance is an essential characteristic of the MCP-PMTs and was investigated at conditions similar to those of the later experiment. In this context the most important quantity is the gain behavior as a function of the B-field strength and direction. MCP-PMTs from Photonis with 10 μm pores, varied internal dimensions, and anode layout with 8×8 and 3×100 pixels were investigated. The further studied MCP-PMTs from Photek Ltd with 6 μm pore diameter show a different B-field behavior. Also internal properties like crosstalk and charge cloud width, time resolution and electron recoil distributions were measured with a FPGA based TRB/PADIWA DAQ system. This was done with xy-scans across the photo cathode inside the B-field for the first time.

- Funded by BMBF and GSI -

HK 23.4 Thu 17:30 H2

Performance of highly pixelated Microchannel-Plate PMTs — •Katja Gumbert, Merlin Böhm, Steffen Krauss, Albert Lehmann, and Daniel Miehling — Physikalisches Institut, Universität Erlangen-Nürnberg

In the PANDA experiment at the new FAIR facility two DIRC detectors will be employed to identify hadrons using Cherenkov light. Since the photo-sensors of these detectors will be located inside magnetic fields of $\gtrsim 1$ Tesla, Microchannel-Plate Photomultipliers (MCP-PMTs) are the chosen type of sensors. One of the two DIRCs, the Endcap-Disc-DIRC (EDD), which is located in the forward direction of the interaction point, requires a high spatial resolution in one dimension to reconstruct the Cherenkov angles. For this purpose PHOTONIS has built 2-inch MCP-PMTs with a backplane of 3x100 anode pixels.

In Erlangen measurements are being carried out to verify that these MCP-PMTs meet the performance requirements of the EDD. The sensors must have a high detection efficiency (DQE = QE · CE) because only a small number of single photons is expected per track. Thus the quantum efficiency (QE) and the collection efficiency (CE) have to be high. Furthermore the gain needs to be at least 10^6 and should not drop significantly in the magnetic field. Moreover the sensors are required to have a good time resolution of $\lessapprox 100$ ps and need to sustain high photon rates of up to 10 MHz/tube. The results of the performance measurements of four tubes will be presented in this talk.

- Funded by BMBF and GSI -

HK 23.5 Thu 17:45 H2

Development of a Raspberry Pi high resolution time-to-digital converter board for scintillatior based detectors — Kai-Thomas Brinkmann, Valera Dormenev, •Marvin Peter, and Hans-Georg Zaunick — II. Physikalisches Institut, Justus-Liebig-Universität, Gießen

A Raspberry Pi time-to-digital converter (TDC) board based on the TDC-GPX2 chip from Sciosense has been developed for measuring scintillator-based detector signals with high time resolution. Coincidence time measurements (CTR) based on different scintillator setups have been conducted utilizing the TDC board. Its design and performance measurements will be presented. This work was carried out in the framework of BMBF Project 05K2019 - UFaCal.

HK 23.6 Thu 18:00 H2

A Beam Halo Veto Detector for the MAGIX Experiment — •Judith Schlaadt for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

The MESA accelerator will host the MAGIX experiment, which is based on the scattering of an electron beam on a gas jet target. This enables the scattering on gases like hydrogen without scattering on any other materials before and after the scattering process. The gas jet target is realized by using a nozzle to inject the gas into the scattering chamber as well as a funnel-shaped structure called the catcher, into which the gas streams behind the interaction zone.

So-called beam halo electrons can occur in the accelerator. These do not move exactly along the beam axis and can increase background by interacting with the catcher and the nozzle. To reject these scattering reactions, the beam halo veto detector was implemented. This detector is positioned upstream of the gas jet target inside the scattering chamber. It allows the detection of single electrons by using a scintillator, a lightguide and a photomultiplier tube. Therefore, covering the front of the nozzle and the catcher with this detector allows suppressing the described background.

HK 23.7 Thu 18:15 H2

Performance of the MAGIX Jet Target with an optimized Nozzle Geometry — •Philipp Brand, Daniel Bonaventura, Sophia Vestrick, and Alfons Khoukaz for the MAGIX-Collaboration — Institut für Kernphysik, Westfälische Wilhelms-Universität Münster, 48149 Münster, Germany

The MAGIX experiment (MAinz Gas Internal target eXperiment) aims for high precision measurements of, e.g., electromagnetic form factors, the astrophysical S-factor, and to search for light dark matter. It will be located in the energy recovery arc of the MESA accelerator which is currently under construction in Mainz. This extensive physics program requires a windowless gas target, that achieves target thicknesses of more than 10^{18} atoms/cm^2 and that can operate with various gases like, e.g., hydrogen, oxygen, or argon.

Therefore, a cryogenic gas-jet target was developed at the University of Münster which is already installed at the A1 experiment within the MAMI facility at Mainz. The jet leaves the target through a convergent-divergent Laval nozzle and already several millimeter below the nozzle the interaction with the electron beam takes place. The jet is then pumped away through a conical catcher that is connected to a powerful pumping station. The jet divergence is crucial for the target performance, since a smaller jet would increase the target thickness at the interaction point and the efficiency of the catcher system. To reduce the divergence of the jet, different Laval nozzle designs have been studied in numerical simulations. The results of measurements with an optimized nozzle will be presented and compared to the simulations.

HK 24: Hadron Structure and Spectroscopy V

Time: Thursday 16:30–18:30 Location: H3

Group Report HK 24.1 Thu 16:30 H3

Measurement of the proton radius with the PRES experiment at MAMI — •Vahe Sokhoyan — Universität Mainz, Institut für Kernphysik

The so-called "proton radius puzzle" originated due to significant discrepancies between some of the results for the proton charge radius measured in experiments with electronic or muonic hydrogen and in electron-proton scattering experiments. Recently, the PRad Collaboration published new results favoring smaller proton radius compared to many of the previous electron-proton scattering measurements. Further scattering experiments utilizing new concepts for detection of particles in the final state are underway.

We are planning to perform a new measurement of the electron-proton scattering cross section at low momentum transfer at the Mainz Microtron (MAMI). The project is conducted in the framework of the PRES Collaboration with participation of the University of Mainz, Petersburg Nuclear Physics Institute, and collaborators from other contributing institutions. The experimental setup consisting of a Hydrogen Time Projection Chamber, Forward Tracker, and beam monitoring system will allow us to measure the energy and the angle of the recoil proton in combination with the angle of the scattered electron and to determine the electron flux with high accuracy. The performance of this experiment will open avenue for further studies of this kind using deuterium and helium targets. In this talk, the current status of this project and the future plans will be presented.

HK 24.2 Thu 17:00 H3

Isoscalar 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, D-55128 Mainz, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany — [3]PRISMA$^+$ Cluster of Excellence and Institute for Nuclear Physics, Johannes Gutenberg University of Mainz, Johann-Joachim-Becher-Weg 45, D-55128 Mainz, Germany

We present results for the isoscalar electromagnetic form factors of the nucleon computed on the 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. In order to estimate the excited-state contamination, we investigate several source-sink separations and apply the summation method. For the computation of the quark-disconnected diagrams, a stochastic estimation using the one-end trick is employed. By these means, we obtain a clear signal for the form factors including the quark-disconnected contributions, which have a distinguishable effect on our data.

HK 24.3 Thu 17:15 H3

Monte Carlo Simulations to estimate the Efficiency of an Electromagnetic Calorimeter to detect neutral Pions — •Julian Moik[1], Frank Maas[1,2,3], Alaa Dbeyssi[1], Luigi Capozza[1], Oliver Noll[1], David Rodriguez Pineiro[1], Sahra Wolff[1], Peter Bernd Otte[1], Dong Liu[1], Alexander Christian Greiner[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 Cluster 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 group at the Helmholtz Institute in Mainz. For the FAIR Phase-0 experiment at the electron accelerator MAMI it is planned to use this detector for a measurement of the electromagnetic transition form factor of the neutral pion.

To estimate the efficiency of the experimental setup regarding the pion detection, a Monte Carlo simulation of the pion decay and the detection of the decay photons in the software environment *primasoft* was performed. By reconstructing the pion events from the photon energy measurement, the efficiency of the pion detection was determined as a function of the pion energy and momentum direction. This analysis helped to choose between two different calorimeter geometries and allowed for the calculation of the effective cross-section of the pion production in this experimental setup.

HK 24.4 Thu 17:30 H3

Measurement of the $\omega \to \pi^0\gamma$ decay at A2/MAMI, towards an $\omega\pi^0$ transition form factor analysis — •Daniel Maurer, Achim Denig, and Lena Heijkenskjöld — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

Electromagnetic meson Transition Form Factors (TFF) describe the interaction between mesons and photons (real or virtual). Studies of meson TFFs are an important input to the understanding of the anomalous magnetic moment of the muon (a_μ). Currently, the most precise experimental results of a_μ deviate from the Standard Model (SM) predictions by a total of $\sim$4.2σ and thus giving hints at physics beyond the SM. Additionally, the $\omega\pi^0$ TFF is interesting to study due to the significant deviations between existing precise experimental measurements and theory predictions. Data has been collected at the A2/MAMI experiment aiming to improve the precision of the $\omega\pi^0$ TFF. Within the project presented here, the first steps towards such an analysis has been taken by studying the $\omega \to \pi^0\gamma$ channel, which has a $\sim$100 times larger decay width than the rare $\omega \to \pi^0 e^+e^-$ channel. Furthermore, the $\omega \to \pi^0\gamma$ channel is needed as a normalization to the $\omega\pi^0$ TFF analysis. As a result $\sim (420 \pm 1) \cdot 10^3$ $\omega \to \pi^0\gamma$ events were observed with good MC-data agreement.

—Supported by DFG.

HK 24.5 Thu 17:45 H3

Accessing the annihilation dynamics using femtoscopic correlations with ALICE at LHC — •Valentina Mantovani Sarti for the ALICE-Collaboration — TUM

Baryon–antibaryon (B$\overline{\text{B}}$) systems are characterised, already at threshold, by a relevant contribution of several multi-meson channels related to the presence of short-range annihilation processes. Predictions on the formation of bound states (baryonia) from the attractive elastic B$\overline{\text{B}}$ interaction have been suggested but a precise understanding of the role played by the annihilation interaction is required to assess the possibility of forming such states.
In this talk, we will present the most precise measurements on the baryon–antibaryon interaction (p$\overline{\text{p}}$, p$\overline{\Lambda}$ and $\Lambda\overline{\Lambda}$) at low momenta by means of correlation studies in high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV measured by the ALICE Collaboration. The effect of annihilation channels on the correlation function and a quantitative determination of the inelastic contributions in the three different pairs will be discussed.

HK 24.6 Thu 18:00 H3

Antihyperons in nuclear matter at PANDA Phase One — •Falk Schupp[1], Patrick Achenbach[1], Michael Bölting[1], Josef Pochodzalla[2], and Marcell Steinen[2] for the PANDA-Collaboration — [1]Helmholtz Institute Mainz, Mainz, Germany — [2]Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Germany

The PANDA experiment will be located in the Facility for Antiproton and Ion Research (FAIR) currently under construction at GSI in Darmstadt (Germany). Even in the early experimental phase (Phase One) the high energy storage ring (HESR) at FAIR will supply a high intensity antiproton beam in the GeV range respresenting an unparalleled factory for various hyperon-antihyperon pairs. The study of antihyperons in convential nuclear matter provides a unique opportunity to elucidate strong in-medium effects in baryonic systems. Quantitative information on the antihyperon potentials may be obtained via exclusive antihyperon-nuclear interactions. The collision of antiprotons with Neon-20 nuclei is simulated using the hadronic transport model simulation tool GiBUU and different effective antihyperon potentials. The event reconstruction with the PANDA detector is simulated with Geant3/4 using the PandaRoot framework and the effect of the antihyperon potential on the observables studied.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 824093.

HK 24.7 Thu 18:15 H3

The Study of Genuine Three-Body Interactions in pp collisions with ALICE — •Laura Serksnyte for the ALICE-Collaboration — Technische Universität München

The femtoscopic studies done by the ALICE Collaboration provided results with unprecedented precision for the short-range strong interactions between different hadron pairs. The next challenge is the development of the three-particle femtoscopy which will deliver the first ever direct measurement of genuine three-body forces. Such results would be a crucial input for the low-energy QCD and neutron star studies. In particular, the momentum correlation of p–p–p triplets can provide information about genuine three-nucleon forces while the p–p–Λ interaction is a necessary piece to understand if the production of Λ hyperons occurs in neutron stars.
In this talk, the first study of p–p–p and p–p–Λ correlations will be presented. The results were obtained using high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV measured by ALICE at the LHC. The measured three-body correlation functions include both three- and two-particle interactions. The cumulant method was applied to subtract lower-order contributions and infer directly on the genuine three-body forces. The two-particle contributions were estimated both experimentally by applying mixed-event technique, and mathematically by projecting known two-body correlation functions on the three-body systems. The measured p–p–p and p–p–Λ correlation functions and the corresponding cumulants will be shown.

HK 25: Astroparticle Physics

Time: Thursday 16:30–18:45 Location: H4

Group Report HK 25.1 Thu 16:30 H4

Detecting CEvNS and searching for new physics with the CONUS experiment — •Janine Hempfling for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik (MPIK), Heidelberg

The CONUS experiment aims to detect coherent elastic neutrino nucleus scattering (CEvNS) in the fully coherent regime at the nuclear power plant of Brokdorf, Germany. This talk will present the experimental setup of the CONUS experiment with its four very low energy threshold germanium detectors within an elaborate shield at 17 m distance from the 3.9 GW thermal power reactor core. A full spectral analysis of Run-1 and Run-2 data of the running experiment yields the current best limit on CEvNS with reactor antineutrinos. Additionally latest results for analyses of physics beyond the standard model will be discussed, including bounds on non-standard neutrino interactions (NSIs) and light scalar and vector mediators.

HK 25.2 Thu 17:00 H4

Pulse shape discrimination for the CONUS experiment — •Jakob Henrichs for the CONUS-Collaboration — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The CONUS experiment, using four 1 kg-sized point-contact high-purity germanium detectors (HPGe) aims at the detection of coherent elastic neutrino nucleus scattering (CEνNS) in the fully coherent regime. It is located close to the reactor core of the nuclear power plant in Brokdorf, Germany. For the success of the experiment a very good background suppression is crucial. Therefore, a sophisticated shield as well as a muon anticoincidence veto system were installed, to reduce efficiently the overall background.
Further, the analysis of the pulse shape of each event offers a new opportunity for an additional background reduction. Depending on whether the incoming particle interacts in the fully depleted bulk region or in the transition layer of the detector, the resulting pulse shapes are different. The transition layer is an outer layer of the Ge diode, where the charge collection efficiency is below 100%. In this talk a technique to discriminate the different low energy interactions based on a rise time fit of their pulses will be presented. In addition, it will be demonstrated how this technique can also be applied to distinguish between multi-site and single-site events at higher energies.

Group Report HK 25.3 Thu 17:15 H4

Status and Prospects of the XENON Dark Matter Search Experiment — •Sebastian Lindemann — Physikalisches Institut, University of Freiburg, Germany

XENON1T was a dual-phase liquid xenon time projection chamber that operated deep underground at Italy's Gran Sasso National Laboratory from 2016 to 2018. Primarily designed to search for WIMP dark matter, XENON1T featured a ton-scale target mass, keV-scale energy threshold, and ultra low background rate that together led to several world-leading results on a variety of rare-event processes. XENON1T's successor, XENONnT, features a larger target mass and a further reduced background level. It is currently being commissioned and will be able to probe the parameter space of interest with improved sensitivity. This talk will summarize recent XENON1T results and detail the power of its successor XENONnT.

HK 25.4 Thu 17:45 H4

Measurement of the antinuclei nuclear inelastic cross sections with ALICE and implications for indirect Dark Matter searches — •Stephan Königstorfer for the ALICE-Collaboration — Technische Universität München

Light antinuclei in cosmic rays such as antideuteron or antihelium-3 are considered a unique probe for signals from exotic physics like 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 interactions 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, p-Pb 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 can predict the transparency of our galaxy to antihelium-3 nuclei from both dark matter annihilations and high-energy cosmic ray collisions.

In this talk we present the first measurements of the antideuteron and anti-3He absorption cross section with ALICE and we discuss the implications of these results for indirect Dark Matter searches using cosmic antinuclei.

HK 25.5 Thu 18:00 H4

Neutrinoless double beta decay with XENON1T and XENONnT — •Tim Michael Heinz Wolf — Max Planck Institut für Kernphysik, Heidelberg

Liquid xenon (LXe) time-projection-chambers (TPCs), such as XENON1T or its successor XENONnT, are primarily used for low energy Dark Matter (DM) searches but also for other rare decay searches such as neutrinoless double beta (0vbb) decay. The large active mass of LXe (several tonnes) and its low background rate are beneficial for the sensitivity to detect Weakly Interacting Massive Particles (WIMPs) or rare decays such as 0vbb. The isotope Xe136 with a natural abundance of 8.9% is a known emitter of two-neutrino double beta decay and it is a potential emitter of the hypothetical process of 0vbb decay with a Q-value of 2457.8keV. The discovery of the 0vbb process would imply lepton number violation and would confirm the Majorana nature of neutrinos, a property that has never been seen before in nature for fundamental particles. I will review the ongoing efforts in XENON1T and XENONnT in this context.

HK 25.6 Thu 18:15 H4

Monte Carlo simulation of background components in low level Germanium spectrometry — •Nicola Ackermann[1], Hannes Bonet[1], Christian Buck[1], Janina Hakenmüller[1], Gerd Heusser[1], Matthias Laubenstein[2], Manfred Lindner[1], Werner Maneschg[1], Jochen Schreiner[1], and Herbert Strecker[1] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Laboratori Nazionali del Gran Sasso, Via G. Acitelli 22, 67100 Assergi L'Aquila, Italy

This talk presents Monte Carlo simulations of the background spectra of the four gamma-ray Ge-spectrometers GeMPI 1 - 4 at the Gran Sasso Underground Laboratory (LNGS) using the Geant4 based framework MaGe. These detectors are very low background Ge-spectrometers located at a depth of 3800 m w.e. and they currently achieve one of the best sensitivities worldwide for primordial U and Th concentrations in materials at a level of μBq/kg. With these detectors material samples are tested to confirm that they meet the stringent requirements of rare event experiments.

The three main background components that are taken into consideration in the simulations are muons, neutrons and intrinsic contaminations in the detector and shielding materials. A detailed understanding of the composition of the background spectra allows for improvements in the sensitivity of next generation screening detectors.

HK 25.7 Thu 18:30 H4

Suppressing radon emanation by coating techniques — •Hardy Simgen, Florian Jörg, and Mona Piotter — Max-Planck-Institut für Kernphysik / Heidelberg

Radon-induced signals are a challenging source of background in most low-background experiments searching for rare events. The dominant radon source is emanation from detector materials, which contain traces of primordial uranium and thorium. While the problem is usually addressed by dedicated material screening and selection programs, novel radon mitigation techniques are required to fulfill the demanding needs of next-generation experiments.

In this talk we present our work on coating techniques to reduce radon emanation from metallic surfaces. A stable, tight and clean coating should reduce the radon emanation rate of materials significantly. Electro-deposition of copper turned out to be the most promising approach. We will discuss systematic studies of the parameters of our coating process and present achieved reduction factors for the emanation rate of the short-lived ^{220}Rn. Practically more relevant is the emanation of ^{222}Rn due to its much longer half-life. However, appropriate samples are hard to obtain. We present first results on the coating of a ^{222}Rn-emanating stainless steel sample which was custom-produced at the ISOLDE facility at CERN.

HK 26: Invited Talks - V

Time: Friday 11:00–12:30 Location: H1

Invited Talk HK 26.1 Fri 11:00 H1

Studying the Universe from deep underground: the LUNA experiment — •Rosanna Depalo — Università degli Studi di Milano and INFN Milano

Nuclear cross sections are crucial ingredients to understand the production of energy inside stars and the synthesis of the elements. In stars, nuclear reactions take place at energies well below the Coulomb barrier. As a result, their cross sections are often too small to be measured in laboratories on the Earths surface, where the signal would be overwhelmed by the environmental background. An effective way to suppress the background is to perform experiments in underground laboratories. The Laboratory for Underground Nuclear Astrophysics (LUNA) is a unique facility located at Gran Sasso National Laboratories (Italy). The extremely low background achieved at LUNA allows to measure nuclear cross sections directly at the energies of astrophysical interest. Over the years, many crucial reactions involved in stellar hydrogen burning as well as Big Bang Nucleosynthesis have been measured at LUNA. The presentation will provide an overview on underground Nuclear Astrophysics and discuss the latest results and future perspectives of the LUNA experiment.

Invited Talk HK 26.2 Fri 11:30 H1

Double parton scattering and double parton distributions — •Peter Plössl — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Double parton scattering (DPS) describes the situation when two individual hard scattering reactions occur in a single hadron-hadron collision. In some regions of phase space DPS may give sizeable contributions to the production of multi-particle final states and thus constitutes an important background to single parton scattering (SPS) in channels suitable for the search for physics beyond the standard model. Besides this DPS is also an interesting phenomena in its own right, as it gives insight into the correlations of partons inside of hadrons.

A theoretical description of DPS processes from first principles can be achieved by deriving factorisation theorems akin to the ones known from SPS, with a central building block being the double parton distributions (DPDs). However, these DPDs are presently basically unknown as experimental data is still lacking.

As a consequence one has to rely on physically motivated models for DPDs to be able to calculate DPS contributions to a given process. One important constraint for such models is given by number and momentum sum rules for DPDs in close analogy to the well known PDF sum rules. Another constraint can be obtained by observing that in the limit of small distances between the two partons DPDs can in fact be matched onto regular PDFs with perturbative matching kernels.

Invited Talk HK 26.3 Fri 12:00 H1

BSM physics in hadronic and nuclear beta decays: challenges and opportunities — •Chien Yeah Seng — Helmholtz-Institut für Strahlen- und Kernphysik and Bethe Center for Theoretical Physics, Universität Bonn, 53115 Bonn, Germany

In the past years, several significant anomalies have been observed in the beta decay of mesons, nucleon and nuclei, which make them promising avenues for the search of the physics beyond the Standard Model (BSM). However, the current significant level of the observed anomalies is not yet sufficient to declare a discovery, and the major limiting factor is the precision level of the Standard Model (SM) theory inputs instead of experiments. In this talk, I will describe the major theory improvements needed to increase the significance level of the existing beta decay anomalies to 5 standard deviations, assuming that BSM physics is the underlying reason. They include high-precision studies of radiative corrections, isospin-breaking corrections and nuclear structure corrections to various beta decay processes.

HK 27: Heavy-Ion Collisions and QCD Phases V

Time: Friday 14:00–16:15 Location: H1

Group Report HK 27.1 Fri 14:00 H1

New developments in flow analyses techniques — •Ante Bilandzic for the ALICE-Collaboration — Technical University of Munich, Germany

With the advent of large statistics heavy-ion datasets at RHIC and LHC it is becoming feasible to study the properties of Quark–Gluon Plasma with unprecedented precision. One of the most informative probes in such studies is the collective anisotropic flow.

In this talk, we present the new developments in flow analysis techniques. We reconcile for the first time the strict mathematical formalism of multivariate cumulants with the usage of cumulants in anisotropic flow analyses. This yields to the next generation of observables to be used in flow analyses: *Event-by-event cumulants of azimuthal angles*, *Symmetric and Asymmetric cumulants of flow amplitudes*, *Cumulants of Symmetry Plane Correlations*. We show that properties of cumulants are preserved only for the stochastic observables on which the cumulant expansion has been performed directly, and if there are no underlying symmetries due to which some terms in the cumulant expansion are identically zero [1].

We derive for the first time the analytic solutions for the contribution of combinatorial background in the measured 2- and 3-particle correlations [2].

[1] A. Bilandzic, M. Lesch, C. Mordasini, S. F. Taghavi, [arXiv:2101.05619 [physics.data-an]]

[2] A. Bilandzic, [arXiv:2106.05760 [hep-ph]]

HK 27.2 Fri 14:30 H1

Tracing the emergence of collective phenomena in small systems — •Pragya Singh and Soeren Schlichting — University of Bielefeld

Event geometry and initial state correlations have been invoked as possible explanations of long-range rapidity correlations (ridge) observed in high multiplicity pp and pPb collisions. We study initial state momentum correlations and event-by-event geometry in p+Pb collisions at $\sqrt{s}$ = 5.02 TeV by following the approach of extending the impact parameter dependent Glasma model (IP-Glasma) to 3D using JIMWLK rapidity evolution of the incoming nuclear gluon distribution [1].

Investigating the non-trivial rapidity dependence of the observables, we find that geometry is correlated across large rapidity intervals whereas initial state momentum correlations are relatively short range in rapidity. Based on our results, we discuss implications for the relevance of both effects in explaining the origin of collective phenomena in small systems.

[1]. B. Schenke and S. Schlichting, Phys. Rev. C 94,044907, arXiv: 1605.07158 [hep-ph]

HK 27.3 Fri 14:45 H1

Non-Equilibrium Transport of Conserved Charges in High-Energy Heavy Ion Collisions — •Philip Plaschke — 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 derived a new method to calculate time dependent non-equilibrium Green*s functions describing the evolution of energy and momentum perturbations on top of an evolving far-from-equilibrium background. We further extend this formalism to describe the evolution of conserved charges. Within kinetic theory in relaxation time approximation we will study the pre-equilibrium evolution of the homogeneous background for non-vanishing initial charge densities and compute the Green*s functions for the charge current for initial charge perturbations around zero density on top of the background. By calculating the Green's functions, we show that only modes with long wavelength survive up into the hydrodynamic regime.

HK 27.4 Fri 15:00 H1

Exploring the Pre-Equilibrium Dynamics of Longitudinal Fluctuations in Heavy-Ion Collisions — •Stephan Ochsenfeld — Bielefeld University, Bielefeld, 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 derive a new method to calculate time dependent non-equilibrium Green*s functions describing the evolution of energy and momentum perturbations on top of an evolving far-from-equilibrium boost invariant background. As extension to transverse perturbations we also consider fluctuations parallel to the beam direction. By calculating the Green*s functions in relaxation time approximation, we show that in both types of perturbations only modes with long wavelength survive up into the hydrodynamic regime, albeit inhibiting sightly different behavior.

HK 27.5 Fri 15:15 H1

FluiduM: fluid dynamics with mode expansion for fast simulations of relativistic heavy-ion collisions — •Andreas

Kirchner[1], Federica Capellino[2], Giuliano Giacalone[1], Eduardo Grossi[3], Daniel Boness[4], Damir Devetak[8], Andrea Dubla[5], Stefan Floerchinger[1], Dhevan Gangadharan[6], Sarah Görlitz[2], Silvia Masciocchi[5,2], Ilya Selyuzhenkov[5], Christian Sonnabend[2], and Kianusch Yousefnia[7] — [1]ITP Heidelberg — [2]Physikalisches Institut, Universität Heidelberg — [3]Department of Physics, SUNY Stony Brook — [4]Fachbereich Physik, Universität Konstanz — [5]GSI Darmstadt — [6]University of Houston — [7]IPhT, Université Paris Saclay — [8]VINCA Inst. Nucl. Sci., Belgrade

We introduce FluiduM, a code to simulate the quark-gluon plasma (QGP) formed in relativistic heavy-ion collisions. Based on a background-fluctuation splitting of the QGP and its initial conditions, in FluiduM the 2+1D hydrodynamic QGP evolution is replaced with a system of de-coupled 1+1D equations, leading to a reduction of orders of magnitude in computation time compared to more traditional codes. The framework implements state-of-the-art initial conditions, second order Israel-Stuart hydrodynamics, and QGP freeze-out supplemented with viscous corrections and resonance decays. We validate the code through calculations of particle yields and average hadron momenta. FluiduM provides a new powerful tool to test our understanding of heavy-ion collisions, with potentially far-reaching consequences for the realization of the goals of the heavy-ion collision program.

HK 27.6 Fri 15:30 H1

Anisotropic flow coefficients in mode-by-mode hydrodynamics: moving towards precision in heavy-ion collision phenomenology — •Giuliano Giacalone[1], Federica Capellino[2], Andreas Kirchner[1], Eduardo Grossi[3], Daniel Boness[4], Stefan Floerchinger[1], Andrea Dubla[5], Silvia Masciocchi[2,5], and Ilya Selyuzhenkov[5] — [1]ITP Heidelberg — [2]Physikalisches Institut, Universität Heidelberg — [3]Department of Physics, SUNY Stony Brook — [4]Fachbereich Physik, Universität Konstanz — [5]GSI Darmstadt

Anisotropic flow coefficients, v_n, carry information about the transport properties of the quark-gluon plasma (QGP) formed in heavy-ion collisions, and are measured today with an amazing degree of precision at colliders. Theoretically, sophisticated models and tools of data analysis have been developed since the appearance of event-by-event (ebye) hydrodynamic simulations, but the intrinsic issue of the slowness of ebye codes remains present today, tampering with our ability of characterizing the physical properties of the QGP from experimental data. In this contribution, we overcome such an issue by means of the newly-developed FluiduM code, based on a background-fluctuation splitting of the QGP evolution, and mode-by-mode hydrodynamic equations. We show that the calculation of v_n coefficients in Fluidum is faster by orders of magnitud than in standard hydro simulations. We present, thus, results for ultra-central collisions, largely inaccessible to ebye codes, where precision data has been recently collected at LHC and RHIC. These results pave the way for future theory-to-data comparisons of unprecedented quality in the context of heavy-ion collisions.

HK 27.7 Fri 15:45 H1

Recent developments in the measurements of genuine multi-harmonic correlations in Pb–Pb collisions — •Cindy Mordasini for the ALICE-Collaboration — Technische Universität München, James-Franck-Straße 1, 85748 Garching bei München

Recently, one of the fundamental steps in constraining the transport properties of the quark–gluon plasma (QGP) was the definition of the Symmetric Cumulants (SCs), which measured the genuine correlations between two different flow amplitudes. Naturally, questions like the existence of genuine correlations between more than two flow amplitudes arose. Quantifying them would provide new information on the properties of the QGP.

The approach shown here focuses on using the flow amplitudes in the cumulant expansion to define these new observables, contrary to the usual method based on the azimuthal angles[1]. This new formalism is illustrated for the three-harmonic SCs, with the first results obtained with ALICE in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV[2] and 5.02 TeV. Finally, the Asymmetric Cumulants, where the flow amplitudes are raised to different powers, will be introduced[3]. For all these observables, predictions from hydrodynamics models will be shown.

References.

1. C. Mordasini, A. Bilandzic, D. Karakoç, S.F. Taghavi, PRC 102, 024907 (2020)
2. ALICE Collaboration, arXiv:2021.02579 (2021) Submitted to PRL
3. A. Bilandzic, M. Lesch, C. Mordasini, S.F. Taghavi, arXiv:2101.05619 (2021)

HK 27.8 Fri 16:00 H1

Symmetry plane correlations in Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ TeV with ALICE — •Marcel Lesch for the ALICE-Collaboration — Technische Universität München, James-Franck-Straße 1, 85748 Garching bei München

The study of collective phenomena in ultra-relativistic heavy-ion collisions are nowadays to a great extent built on the so-called flow amplitudes v_n and symmetry planes Ψ_n. Both appear as two distinct degrees of freedom in the Fourier series expansion used to parametrize the distribution of azimuthal angles of produced particles. While analyses techniques for flow amplitudes v_n have advanced over the past years, observables used for measuring symmetry planes Ψ_n are often plagued by built-in biases. However, recent developments [1] in this direction introduced the so-called Gaussian Estimator (GE) which provides a new and more precise technique to measure symmetry plane correlations (SPC) in flow analyses.

In this talk, we present first experimental results of SPC measured with this newly developed GE using ALICE data for Pb–Pb at $\sqrt{s_{\rm NN}} = 2.76$ TeV (2010). The results are compared to theoretical predictions for the initial coordinate space provided by the MC-Glauber model and for the momentum space obtained with the state-of-the-art model iEBE-VISHNU.

References:

1. A. Bilandzic, M. Lesch, S. F. Taghavi, "New estimator for symmetry plane correlations in anisotropic flow analyses", Phys. Rev. C 102, 024910 - 2020

HK 28: Instrumentation VIII

Time: Friday 14:00–15:45 Location: H2

Group Report HK 28.1 Fri 14:00 H2

Status of the CBM-MVD* — •Michael Deveaux for the CBM-MVD-Collaboration — GSI Darmstadt

The Compressed Baryonic Matter Experiment (CBM) is one of the core experiments of the future FAIR facility. It will explore the phase diagram of strongly interacting matter in the regime of high net baryon densities. Its Micro Vertex Detector (MVD) will contribute to the secondary vertex determination on a 10 μm scale, background rejection in di-electron spectroscopy and reconstruction of weak decays of multi-strange baryons. The detector comprises four stations placed next to the target in vacuum. The stations will be populated with 50 μm thin, highly-granular dedicated Monolithic Active Pixel Sensors (called “MIMOSIS”), which are being developed aiming at a spatial precision in the order of ~ 5 μm, a readout speed of less than 5 μs/frame, a radiation tolerance of $\sim 7 \times 10^{13}$ $n_{\rm eq}/{\rm cm}^2$ and 5 MRad. This contribution will summarize the status of activities towards constructing the MVD, that involve in particular the commissioning and beam tests of the first full size sensor prototype MIMOSIS-1 carried out in partnership with IPHC-Strasbourg.

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

HK 28.2 Fri 14:30 H2

Test beam performance of a digital pixel calorimeter — •Tim Sebastian Rogoschinski — Institut für Kernphysik, Goethe-Universität Frankfurt

A prototype of a digital pixel electromagnetic calorimeter, EPICAL-2, has been designed and constructed. It consists of alternating W absorber and Si sensor layers, with a total thickness of 20 radiation lengths, an area of 30 mm × 30 mm, and 25 million pixels. The design is the next step in pixel calorimetry, building on and refining a previous prototype using MIMOSA sensors [1]. The new EPICAL-2 detector employs the ALPIDE sensors developed for the ALICE ITS upgrade. This R&D is performed in the context of the proposed Forward Calorimeter upgrade for ALICE, but it also serves the general understanding of a fully digital calorimeter. The Allpix2 framework [2] was used to perform MC simulations of the detector response and shower evolution in EPICAL-2. We will report on first results on calibration from cosmic muons and on the calorimeter performance measured with the DESY electron beam. The prototype shows good energy resolution and linearity, comparable with those of a SiW calorimeter with analog readout. Electron test beam results can be reproduced by simulation.

[1] JINST13 (2018) P01014
[2] NIM A901 (2018) 164-172

HK 28.3 Fri 14:45 H2

Simulation of collision fragments impinging the CBM-MVD* — •Hasan Darwish for the CBM-MVD-Collaboration — Goethe University Frankfurt am Main

The Micro Vertex Detector (MVD) of the CBM experiment will be located close to the target. Consequently, it will be exposed to a dense flux of charged particles from different origins. With respect to the radiation hardness of the sensor, one major question is whether the CMOS Monolithic Active Pixel Sensors of the MVD will be exposed to harmful impacts of nuclear fragments coming from the target, which can potentially lead to a significant damage. We present studies based on GEANT invoking two different models simulating the production of nuclear fragments from relativistic heavy ion collisions. The simulation results and their impact on the requirements for the MVD will be discussed.

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

HK 28.4 Fri 15:00 H2

First Observations from Mimosis-1 Single Event Upset Beam Tests.* — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt am Main

Mimosis-1 is the first full-sized prototype for the final cmos Monolithic Active Pixel Sensor to be used in the cbm Micro Vertex Detector (mvd). In the mvd, the sensors will be placed in close proximity to the beam and thus be exposed to $\sim 1\,\mathrm{kHz/cm^2}$ heavy ions from the beam halo. Moreover, in the event of a failing dipole, the beam will be displaced and may hit sensors.

Two beam tests with mimosis-1 were conducted to determine single event effects induced by $\sim 1\,A\,\mathrm{GeV}$ heavy ions. First and preliminary results from the ongoing analysis of the tests will be presented.

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

HK 28.5 Fri 15:15 H2

Radiation damage and annealing studies of $PbWO_4$ scintillation crystals for the $\overline{\mathrm{P}}$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

Lead tungstate scintillation crystals – PbWO 4 (PWO-II) – will be used in the Electromagnetic Calorimeter (EMC) of the high energy physics experiment $\overline{\mathrm{P}}$ANDA at the high-luminosity accelerator facility FAIR (Darmstadt). During the operation of the experiment a degradation of the optical transmission of these crystals will occur due to creation of color centers via radiation damage and as a consequence this leads to the deterioration of the energy resolution of the calorimeter. In order to partially reverse this radiation damage the phenomenon of the stimulated recovery in scintillation crystals have been investigated via illumination by visible and infrared light.

A model of the radiation-induced absorption and its recovery in lead tungstate crystals will be presented. The mechanisms of the radiation damage under γ-radiation and the recovery under light will be discussed.

This work is supported by BMBF, GSI and HFHF.

HK 28.6 Fri 15:30 H2

Radiation dose simulation for FAIR phase-0 experiment at MAMI — •Alexander Greiner[1], Frank Maas[1,2,3], Oliver Noll[1], Sahra Wolff[1], Luigi Capozza[1], Julian Moik[1], David Rodriguez Pineiro[1], Samet Katilmis[1], Alaa Dbeyssi[1], Peter-Bernd Otte[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

A complex detector system is being developed for the PANDA experiment at the FAIR accelerator facility in Darmstadt.
The group in Mainz is constructing the backward end cap (BWEC) of the PANDA electromagnetic calorimeter, which will be used at the MAMI electron accelerator for a FAIR/Phase0 experiment at Mainz to measure the electromagnetic transition form factor of the $\pi^0 \to \gamma\gamma$ transition.
In order to check whether the planned set-up of the BWEC can withstand the radiation exposure of the experiment without impairing the data acquisition through malfunctions, GEANT4 simulations of the experimental setup were carried out to record the radiation exposure of the entire experimental setup and individual important components. This presentation will explain how the simulations were carried out. We will present the results of the estimated radiation exposure and compare these estimates with various radiation resistance measurements of some components from the R&D phase.

HK 29: Hadron Structure and Spectroscopy VI

Time: Friday 14:00–16:00 Location: H3

Group Report HK 29.1 Fri 14:00 H3

The scalar glueball from radiative J/psi decays — •Eberhard Klempt[1], Igor Denisenko[2], Andrey Sarantsev[3], and Ulrike Thoma[1] — [1]Hiskp, Universität Bonn — [2]Jinr, Dubna — [3]Pnpi, Gatchina

Evidence for the scalar glueball is reported. The evidence stems from an analysis of BESIII data on radiative J/Ψ data into π0π0, KsKs, $\eta\eta$, and $\Phi\omega$. The coupled-channel analysis is contrained by a large number of further data. The data are described by ten scalar isoscalar mesons, covering the range from f0(500) to f0(2330). Five resonances are interpreted as mainly-singlet states in SU(3), five as mainly-octet states. The mainly-singlet resonances are produced over the full mass range, the production of octet state is limited to the 1500 to 2100 MeV mass range. The peak is interpreted as scalar glueball. Its mass, width and yield are determined.

HK 29.2 Fri 14:30 H3

Reconstruction of complex decay channels using genetic algorithm — •Áron Kripkó, Markus Moritz, and Kai-Thomas Brinkmann for the PANDA-Collaboration — II. Physikalisches Institut, Justus Liebig Universität Gießen, 35392 Gießen, Germany

A common problem in the topic of hadron spectroscopy is the reconstruction of complex decay channels. During the procedure cuts are applied to the properties of the reconstructed candidates along the decay tree with the aim of maximizing the significance. In case of complex decay channels, finding the optimal set of cuts is not obvious.

The application of genetic algorithm to this problem was investigated in PANDARoot. Genetic algorithm is an optimization algorithm inspired by the process of natural selection. PANDARoot is the common simulation framework for feasibility studies of the PANDA experiment.

The talk will present the reconstruction for complex decay channels with 9 final state particles for a predicted hybrid charmonium state ($\tilde{\eta}_{c1}$) with $J^{PC} = 1^{-+}$ using genetic algorithm.

This work is supported by GSI, HFHF and BMBF.

HK 29.3 Fri 14:45 H3

Investigation of the decays $\chi_{cJ} \to \eta'\pi^+\pi^-$ and search for the spin exotic meson $\pi_1(1600)$ at 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], Sascha Lennartz[1], and Alfons Khoukaz[1] — [1]Westfälische Wilhelms-Universität, Münster, Germany — [2]Indiana University, Bloomington, USA

In recent years the search for exotic hadrons has produced more and

more states which seem to be incompatible with the conventional classification as a two or three quark state. However, in most of these cases the classification of these particles is inconclusive. An interesting opportunity is given by states with quantum numbers which cannot be produced by the conventional quark model, such as $J^{PC} = 1^{-+}$ in case of the $\pi_1(1600)$, which was seen in multiple experiments.
With the BESIII experiment decays of the χ_{cJ} mesons can be investigated through their production in the radiative decays of the $\psi(2S)$ meson. Here, a large number of events has been recorded by the BESIII detector and additional data taking is ongoing. When considering the decay of these charmonia into three pseudoscalar mesons spin exotic quantum numbers like $J^{PC} = 1^{-+}$ can be accessed. In this talk the current status of the search for the $\pi_1(1600)$ in the decay $\chi_{c2} \to \eta'\pi^+\pi^-$ by the means of a partial wave analysis will be presented.
This work is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - 269952272, 271236083 and 443159800.

HK 29.4 Fri 15:00 H3

Determination of the branching ratio of $\eta_c \to \eta' K^+K^-$ and search for exotic content in K^+K^- intermediate states at BESIII — •Anja Brüggemann[1], Nienke Balz[1], Helge Balzen[1], Johannes Bloms[1], Christopher Fritzsch[1], Titus Heinig[1], Nils Hüsken[2], Sascha Lennartz[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.

We analyse the reaction $\eta_c \to \eta' K^+K^-$ that results from the radiative J/ψ decay to $\gamma\eta_c$. Until now this η_c decay is still unlisted in the particle data group database. We determine the corresponding branching ratio. Furthermore, it is a common approach to search for exotic states in gluon-rich environments of decaying mesons, like the decaying η_c charmonium into hadrons. Thus, our analysis of $\eta_c \to \eta' K^+K^-$ further offers the opportunity to investigate possible exotic content within intermediate states decaying to K^+K^-, that lie in the mass region below 2 GeV/c^2, where the lightest glueball is predicted.

Our study is based on a partial wave analysis, which gives access to the partial decay widths of contributing K^+K^- resonances. 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 29.5 Fri 15:15 H3

Analysis of Light Isovector Resonances in the Diffractively Produced $\pi^-\pi^-\pi^+$ Final State at COMPASS — •Florian Kaspar for the COMPASS-Collaboration — Technische Universität München, Garching bei München, Deutschland

The COMPASS experiment at CERN can help us to better understand the excitation spectrum of light-quark meson resonances, which consist of up, down, or strange quarks. COMPASS collected a world-leading sample of diffractively produced $\pi^-\pi^-\pi^+$ events. We present our improved analysis of the isovector resonances accessible in this data, where we studied in particular systematic effects in the partial-wave analysis of this final state. In addition, we will discuss our new results focusing on the $J^{PC} = 0^{-+}$ sector that contains the $\pi(1800)$ resonance.

HK 29.6 Fri 15:30 H3

Model Dependence of the $\pi_1(1600)$ signal — •Fabian Krinner — Max Planck Institut für Physik, München, Deutschland

The COMPASS experiment has collected a large data set for diffractive $\pi^-\pi^+\pi^-$ production. We use this data set to investigate contradictions found by previous partial-wave analyses of the same channel for the signal of a spin-exotic partial wave with spin, parity and charge conjugation quantum numbers 1^{-+}. We find a strong dependence of the signal for this wave on the used analysis model to cause the observed contradictions. We construct a large analysis model tuned to minimize such model-dependencies and study the robustness of this model with the freed-isobar partial-wave analysis method.

HK 29.7 Fri 15:45 H3

Fit of the $a_1(1420)$ as a triangle singularity — •Mathias Wagner and Bernhard Ketzer — HISKP, Uni Bonn, Germany

In the recent past several new particle candidates were found which do not fit into the simple constituent-quark models for mesons and baryons. Different concepts were introduced in order to find an explanation for these exotic states. One of them is a rescattering effect. Here, triangle diagrams can produce resonance-like signals, both in the intensity and the relative phase of the corresponding partial wave.

One prominent example is the $a_1(1420)$ signal, observed by the COMPASS experiment in the $J^{PC} = 1^{++}$ partial wave decaying to $f_0(980)\pi$ in a P-wave.

We present the fit results of the finalized model, where we properly include all involved spins via a dispersive integral over a partial wave projection of the $K\bar{K}\pi$ final state onto the 3π final state. It shows that the $a_1(1420)$ can be fully explained by the decay of the ground-state $a_1(1260)$ into $K^*\bar{K}$ and subsequent rescattering through a triangle singularity into the observed final state $f_0(980)\pi$ without the need of a new genuine a_1 resonance. The effect of the triangle singularity, which is expected to be present, is sufficient to explain the observation. (accepted PRL)

HK 30: Structure and Dynamics of Nuclei II

Time: Friday 14:00–16:30 Location: H4

Group Report HK 30.1 Fri 14:00 H4

Studying the Low-Energy Electric Dipole Response of Different Nuclei with SONIC@HORUS — •Michael Weinert, Florian Kluwig, Miriam Müscher, Julius Wilhelmy, Barbara Wasilewska, and Andreas Zilges — University of Cologne, Institute for Nuclear Physics, 50937 Cologne, Germany

The specific structures that generate the low-energy electric dipole response (LEDR) in medium to heavy mass nuclei have been highly debated and investigated over the past two decades. Deeper knowledge was obtained by comparing direct measurements of the nuclear photoresponse in real-photon scattering experiments with the response to other probes, such as alpha particles or high energy protons, and trying to reproduce the differing responses with theoretical models. This contribution will present the recent developments in Cologne, where specific single-particle structures in the LEDR of ^{120}Sn could be studied in a $(d,p\gamma)$ reaction at E_d=8.5 MeV using the SONIC@HORUS setup, extending the established capabilities of the transfer reaction [1]. Also, for the first time, a consistent theoretical approach was developed to predict the shape of the LEDR, and also the excitation and decay behavior in the experiment. A comparison to $^{120}\mathrm{Sn}(\alpha,\alpha'\gamma)$ under forward angles will be drawn and results from $^{124}\mathrm{Sn}(p,p'\gamma)$ [2] and a recent $^{40,44,48}\mathrm{Ca}(p,p'\gamma)$ campaign with SONIC@HORUS will be presented.

[1] M. Spieker, *et al.*, Phys. Rev. Lett. **125**, 102503 (2020)
[2] M. Färber, *et al.*, Eur. Phys. J. A (2021) 57:191

Group Report HK 30.2 Fri 14:30 H4

Study of the dipole response in ^{58}Ni — •Isabelle Brandherm[1], Johann Isaak[1], Peter von Neumann-Cosel[1], Hiroaki Matsubara[2], Achim Richter[1], Marcus Scheck[3], Jaqueline Sinclair[3], and Atsushi Tamii[2] — [1]IKP, TU Darmstadt, Germany — [2]RCNP, Osaka, Japan — [3]UWS, Paisley, UK

Inelastic proton scattering at very forward angles is an excellent tool for studying the dipole response in nuclei [1]. Reactions with intermediate proton energies and scattering angles close to 0° are particularly suited to investigate the isovector spin-flip M1 resonance. In addition the electric dipole response can be measured over a wide excitation energy range. This provides information about the electric dipole polarizability which is related to the neutron-skin thickness and the density dependence of the symmetry energy. In this talk the analysis of an experiment with a 295 MeV proton beam on a ^{58}Ni target will be presented, which was performed at the Research Centre for Nuclear Physics (RCNP) in Osaka. The dipole strength distribution of ^{58}Ni has been extensively measured with nuclear resonance fluorescence [2,3] and inelastic electron scattering [4]. A comparison of the different methods can shed light on various features of nuclear structure such as spin and orbital contributions to the magnetic dipole strength. [1] P. von Neumann-Cosel and A. Tamii, Eur. Phys. J. A 55, 110 (2019). [2] M. Scheck et al., Phys. Rev. C 88, 044304 (2013). [3] J. Sinclair, priv. com. (2019). [4] W. Mettner et al., Nucl. Phys. A473, 160 (1987). Supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - Project-ID 279384907, SFB 1245.

HK 30.3 Fri 15:00 H4

Status report on the progress on the analysis of the NewSUBARU data — •Nikolina Lalić[1], Thomas Aumann[1,2], Takashi Ariizumi[3], Martin Baumann[1], Patrick van Beek[1], Ioana Gheorghe[4], Philipp Kuchenbrod[1], Heiko Scheit[1], Dmytro Symochko[5], and Hiroaki Utsunomiya[3] — [1]TU Darmstadt, Germany — [2]GSI Helmholtzzentrum, Germany — [3]Department of Physics, Konan University, Japan — [4]"Horia Hulubei" National Insitute for R & D in Physics and Nuclear Engineering (IFIN-HH), 30, Reactorului 077125, Bucharest-Magurele, Romania — [5]Physikalisch-Technische Bundesanstalt (PTB), Bundesallee 100, 38116 Braunschweig, 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 30.4 Fri 15:15 H4

Collinear laser spectroscopy across the ^{56}Ni doubly magic nucleus — •Sommer Felix[1], König Kristian[2], Rossi Dominic[1], Everett Nathan[2], Garand David[2], de Groote Ruben[3], Incorvati Anthony[2], Imgram Phillip[1], Kalman Colton[2], Klose Andrew[5], Lantis Jeremy[2], Liu Yuan[4], Miller Andrew[2], Minamisono Kei[2], Nörtershäuser Wilfried[1], Pineda Skyy[2], Powel Robert[2], Renth Laura[1], Romero-Romero Elisa[4], Sumithrarachchi Chandana[2], and Teigelhöfer Andrea[6] — [1]Technische Universität Darmstadt — [2]Michigan State University — [3]University of Jyväskylä — [4]Oak Ridge National Laboratory — [5]Augustana University — [6]TRIUMF

We will present laser spectroscopic measurements of neutron-deficient nickel isotopes at and across the N=28 neutron shell closure. Nickel is a particularly interesting case to study nuclear shell evolution. Its isotopic chain includes the N=Z=28 doubly magic nucleus ^{56}Ni, which is the first self-conjugated doubly magic nucleus that occurs due to a shell gap driven by the spin-orbit force and is considered to be a soft core. Using the BECOLA facility at the National Superconducting Cyclotron Laboratory at Michigan State University, we achieved the first determination of the mean-square charge radii of ^{54}Ni, ^{55}Ni, and ^{56}Ni as well as an updated value of the magnetic dipole moment of ^{55}Ni. Details of the experiment and results will be discussed.

HK 30.5 Fri 15:30 H4

Mass measurements of neutron-deficient Yb isotopes and nuclear structure at the extreme proton-rich side of the N = 82 shell — •Beck Sönke[1,2], Kootte Brian[3,4], and Dedes Irene[5,6] for the TITAN-Collaboration — [1]Justus-Liebig Universität, Giessen — [2]GSI, Darmstadt — [3]TRIUMF, Vancouver, Canada — [4]University of Manitoba, Winnipeg, Canada — [5]Polish Academy of Sciences, Kraków, Poland — [6]Marie Curie-Skłodowska University, Lublin, Poland

The nuclear mass reflects the binding energy of a nucleus and provides key information for nuclear structure, nuclear reactions and related fields like nuclear astrophysics.

High-accuracy mass measurements of neutron-deficient Yb isotopes were performed at TRIUMF using TITAN's multiple-reflection time-of-flight mass spectrometer (MR-TOF-MS). For the first time, the novel technique of mass selective re-trapping was used in an on-line experiment with short-lived ions. With this technique, the MR-TOF-MS can act as its own isobar separator, enabling measurements two isotopes further away from stability.

The ground state masses of ^{150,153}Yb and the excitation energy of the long lived $J^\pi = 11/2^-$ isomer ^{151}Yb^m were measured for the first time. As a result, the persistence of the $N = 82$ shell with almost unmodified shell gap energies was established up to the proton dripline. Furthermore, the puzzling systematics of the $h_{11/2}$-excited isomeric states of the $N = 81$ isotones were unraveled using state-of-the-art mean field calculations.

HK 30.6 Fri 15:45 H4

Mass measurements and spectroscopy of actinides at IGISOL and FRS Ion Catcher — •Ilkka Pohjalainen for the FRS Ion Catcher-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany

There is a significant lack of experimental data on fundamental nuclear properties such as nuclear masses of actinides. At the IGISOL facility of the University of Jyväskylä, Finland, light-ion fusion reactions with actinide targets provide unique possibilities to perform decay- and optical spectroscopy as well as direct mass measurements of actinide isotopes. Recently, decay spectroscopy of several short-lived isotopes including ^{225,226}Pa have been performed with protons (up to 65 MeV) on ^{232}Th targets. Penning trap mass spectrometry utilizing the Phase-Imaging Ion Cyclotron Resonance method at JYFLTRAP is to be used for high-precision mass measurements, but also to obtain production yield of long-lived isotopes such as ^{229}Th, which is of special interest due to the extremely low energy isomer. A wider range of isotopes is now also available due to more exotic targets fabricated via a novel drop-on-demand printing technique at the Nuclear Chemistry Institute of Johannes Gutenberg-Universität of Mainz.

In addition, the recently performed mass measurements in the actinide region at the FRS Ion Catcher (FRSIC) at the Fragment Separator at GSI will be presented. By impinging a 1 GeVA ^{238}U beam on a Be target, the isotopes are produced in fragmentation reactions. The ions are stopped in the cryogenic stopping cell and measured with the high resolution multiple-reflection time-of-flight mass spectrometer.

HK 30.7 Fri 16:00 H4

High-precision mass spectrometry of heavy and superheavy nuclides at SHIPTRAP: overview of the latest experiments — •Francesca Giacoppo for the SHIPTRAP-Collaboration — GSI Darmstadt, Germany — HIM Mainz, Germany

In 2018 high-precision Penning Trap Mass Spectrometry (PTMS) crossed the doorway towards the region of superheavy elements (Z≥104) with the first direct mass measurement of the ground state of ^{257}Rf accomplished with a small number of detected ions (<10) with the SHIPTRAP setup. This was made possible by the first application of the highly efficient Phase-Imaging Ion-Cyclotron-Resonance (PI-ICR) technique in the region of the heaviest nuclides. In addition, exploiting the superior mass resolving power and precision of PI-ICR, several low-lying isomeric states in elements with $Z = 102 - 103$ have been probed with high accuracy. These results have been achieved thanks to careful investigations and improvements of the efficiency of the SHIPTRAP setup. In an online run in 2020, the rate of ^{257}Rf extracted from the cryogenic gas cell was increased by about an order of magnitude. This boost allowed in the latest campaign in spring 2021 to carefully investigate both the ground state and the low-lying isomer of ^{257}Rf and the more exotic element dubnium with Z=105, available at even lower yields. The PI-ICR technique, established nowadays as a complementary tool to decay spectroscopy, was also applied to disentangle many isomeric states in heavy nuclei with $Z = 82 - 98$. In this contribution, the results of the latest campaigns performed within the FAIR Phase-0 program will be reviewed.

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Subatomic particles represented as focal points — •Osvaldo Domann — Stephanstr. 42, 85077 Manching

Examples of approaches to represent subatomic particles (SPs) are point-like, strings, wave-packets, etc. The present work is based on an approach where (SPs) are represented as focal points of rays of Fundamental Particles (FPs) that move from infinite to infinite. FPs are emitted from the focal point and at the same time regenerate it. FPs store the energy of a SP as rotation defining angular momenta. Interactions between SPs are the product of the interactions of the angular momenta of their FPs. One important finding 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. The charge quantum number Q of a quark is now interpreted as the relative charge of electrons and positrons. No fractional charges Q are required and the charge of an electron or positron is thus the unit charge of nature. Another important finding is that all four forces are electromagnetic forces and described by QED. As quantum-mechanics rely heavily on classical physics, all new findings of the latter have repercussions on the former. More at: www.odomann.com