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 $s = 2.5$ GeV/c , $s = 5$ GeV/c , $s = 10$ GeV/c and $s = 15$ 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.