HK 35: Instrumentation XI

Zeit: Mittwoch 14:00–16:00 Raum: Audimax H1

HK 35.1 Mi 14:00 Audimax H1

Track Reconstruction for the CBELSA/TAPS TPC — •Philipp Bielefeldt, Markus Ball, Jonathan Ottnad, and Bernhard Ketzer for the CBELSA/TAPS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

The current set-up of the CBELSA/TAPS experiment at the ELSA electron accelerator facility in Bonn is well-suited for the detection of neutral particles. It conducts measurements on the entire excitation spectrum of nucleons using a polarised photon beam on a polarised target. For a future upgrade, a gas-filled Time Projection Chamber with Gas Electron Multiplier read-out (GEM-TPC) is being developed. It will allow studies of charged particles in the final state and will improve particle identification and background suppression capabilities.

Track reconstruction within the GEM-TPC is developed based on GENFIT II, a sophisticated, experiment-independent tracking and reconstruction framework. GENFIT II will be used as a plug-in for ExPlORA, an analysis software developed for CBELSA. This framework, based on ROOT, allows the user to easily apply analysis and visualisation techniques, facilitating analyses through an XML frontend.

In this talk, the implementation of the GENFIT II framework for the GEM-TPC at CBELSA/TAPS will be explained. An overview of ExPlORA and the plug-ins used will be given. The pattern recognition and fitting performance of GENFIT II within the framework will be presented.

HK 35.2 Mi 14:15 Audimax H1

Quality Assurance of GEM-based Readout Chambers for the Time Projection Chamber of ALICE — •Lukas Kreis for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — Universität Heidelberg, Germany

The ALICE Time Projection Chamber is the main device for tracking and particle identification. Starting from 2021, LHC will provide Pb-Pb collisions at a rate of 50 kHz, about 4 times higher than the present collision rate. Recording collisions at this rate would not be possible with the current readout scheme which is based on multi-wire proportional chambers (MWPC) with a gating grid. Therefore during the LHC long shutdown, which is scheduled for 2019 - 2020, the MWPCs will be replaced by readout chambers based on gaseous electron multipliers (GEMs). The new readout chambers use a stack of 4 GEMs to preserve the present energy resolution while keeping the ion backflow into the drift volume of the TPC below 1 percent. At GSI Helmholtzzentrum für Schwerionenforschung, half of the outer readout chambers (OROC) are assembled and their performance is checked. In this talk we will present the ongoing production and the qa procedures and their results, which ensure that all chambers meet the specifications. These include tests of the leakage current of GEM foils, the gain and ion backflow uniformity and the stability in the presence of high-level ionizing radiation, as well as the gas tightness.

HK 35.3 Mi 14:30 Audimax H1

Investigation of ion transport properties of a GEM-stack — •Fabian Liebske for the ALICE-Collaboration — Institut für Kernphysik - Goethe Universität Frankfurt, Frankfurt am Main, Germany

With the Upgrade of the ALICE Time Projection Chamber (TPC) it is planned to replace the present MWPC-based readout chambers with detectors that employ stacks of Gas Electron Multipliers (GEMs). A key parameter of a GEM stack is the amount of ions that emerges from the amplification holes back into the drift volume. It limits the rate capability of the system because excessive ion back-flow leads to space-charge distortions of the drift field. In order to investigate the ion transport properties of GEM stacks, a dedicated test setup was developed. In a reversed-field configuration, ion currents can be studied in detail without the disturbing effects of electrons from amplification avalanches. In this talk, the test setup will be presented and results on the ion transport properties will be discussed.

HK 35.4 Mi 14:45 Audimax H1

The readout system of the upgraded ALICE TPC — •Lars Bratrud for the ALICE-Collaboration — Institut für Kernphysik - Goethe Universität, Frankfurt, Germany

With the planned upgrade of the ALICE Time Projection Chamber for operation at Pb-Pb interaction rates of up to 50 kHz, a new continuous readout system based on point-to-point links will be implemented.

A new Front-End Card (FEC) based on 5 SAMPA front-end ASICs has been developed, which allows to read 160 channels from the new GEM-based readout chambers. The data is sent via two radiation hard GigaBit Transceivers (GBTs) to the Common Readout Unit (CRU) in the counting room at a total data transfer rate of 1.1 GB/s per FEC. Data processing will be performed in the CRU: Data decoding, channel mapping, common mode correction, and cluster-finding. One downlink to the FEC is used for control and configuration through a dedicated Slow Control Adapter chip – the GBT-SCA. To monitor the header-less data stream from the FEC, the SAMPA ADC clocks are sent together with the actual data stream. The generation of a synchronization pattern in the SAMPA, triggered by the readout system, ensures correct (global) alignment of the data on all FECs.

Several verification studies have been performed with the new FEC to make sure that it meets the required specifications for resolution, dynamic range, data transfer rate, and reliability. In order to allow early testing of the Front-End Cards without CRU hardware, a temporary readout solution based on the current readout cards of ALICE was developed and parts of this system will be reused in the CRU.

HK 35.5 Mi 15:00 Audimax H1

An approach to optimising the geometry of the Gas Electron Multiplier — •Jonathan Ottnad, Markus Ball, and Bernhard Ketzer for the CBELSA/TAPS-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are a sophisticated technology for the multiplication of charges in gaseous detectors. They are used in experiments like COMPASS, LHCb, and for the upgrades of the CMS muon system and the ALICE TPC at CERN. They will also be used for the CBELSA/TAPS TPC at Bonn. Multi-GEM systems provide stable operation, even at high incoming particle rates. Typically a spatial resolution of the order of $50\,\mu$m and an energy resolution of the order of $10\,\%$ for ^{55}Fe X-rays are reached. Stacking several GEM foils opens a wide parameter space for optimization with respect to experiment-specific demands.

The performance of GEMs is characterized by their ability to collect, multiply, and extract charges. While for a fixed GEM geometry the multiplication of charges (gain) mostly depends on the voltage settings across the GEM, the transfer properties depend on the complete electric field configuration on both sides of the GEM electrodes. Different geometric parameters of the foil, including the pitch of holes and the hole dimensions, modify these characteristics. We measured these properties for various different GEM geometries and compared them to the results of microscopic simulations. As a next step, an attempt to optimise the geometry of GEMs with respect to the transfer properties is made, utilising the same simulation framework.

HK 35.6 Mi 15:15 Audimax H1

Statusbericht der GEM-Entwicklung bei MAGIX — •Pepe Gülker für die MAGIX-Kollaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Deutschland

Das geplante MAGIX-Experiment am im Bau befindlichen Teilchenbeschleuniger MESA wird zwei hochauflösende, drehbare Magnetspektrometer besitzen. Diese werden in einer Quadrupol-Dipol-Konfiguration realisiert und in der Fokalebene sollen GEM basierte Detektoren zum Einsatz kommen.

Es sollen Elektronenstreumessungen im Niederenergiebereich ($<$105 MeV) der Teilchenphysik durchgeführt werden. Dabei soll der Impuls der gestreuten Teilchen mit einer relativen Impulsauflösung von 10^{-4} und der Streuwinkel mit einer Genauigkeit von 0.9 mrad gemessen werden. Die Strahlungslänge des Detektorsystems und die damit verbundene maximale erreichbare Auflösung der Spektrometer ist damit, zusätzlich der geforderten Ortsauflösung der Detektoren und der hohen Ratenfestigkeit, äußerst delikat zu betrachten. Die Ergebnisse und Erkentnisse aus 2 Jahren Prototypenentwicklung und -tests sollen, mit einem Hauptaugenmerk auf dem Wechselspiel zwischen Detektoren und Spektrometern präsentiert und weiterführende Ideen diskutiert werden.

HK 35.7 Mi 15:30 Audimax H1

A model of charge-transfer processes in GEM foils — •Viktor Ratza, Jonathan Ottnad, Markus Ball, and Bernhard Ketzer for the ALICE-Collaboration — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Tracking detectors based on GEM foils are widely used in ongoing experiments and are the choice for numerous upgrades in the near future. An example is the ALICE TPC upgrade at the LHC of CERN where the use of GEM foils will allow the TPC to be employed in a high-rate environment.
In order to optimize and predict the performance of GEM detectors in terms of gain, energy resolution and ion backflow, a good and quantitative understanding of charge-transfer processes of electrons and ions between the individual GEM foils is mandatory. Based on two–dimensional analytic electric flux calculations a model has been established to describe the charge-transfer for GEM foils in terms of the GEM geometry (hole size, pitch and thickness) and the applied electric potentials. Recent advances allow us to calculate the efficiencies in the full range of charge density configurations and as functions of the applied electric fields. Additionally, first three–dimensional approaches will be presented and compared to simulations.

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HK 35.8 Mi 15:45 Audimax H1

dE/dx Resolution Studies of a Pre-Production Read Out Chamber for the ALICE GEM TPC — •Thomas Klemenz for the ALICE-Collaboration — TU München, Physik Department E62, Excellence Cluster 'Universe', Garching

The ALICE Collaboration is planning a major upgrade of its central barrel detectors to be able to cope with the increased LHC luminosity beyond 2019. In order to record at an increased interaction rate of up to 50 kHz in Pb–Pb collisions, the TPC will be operated in an ungated mode with continuous readout. This demands for a replacement of the currently employed gated Multi-Wire Proportional Chambers by GEM-based (Gas Electron Multiplier) readout chambers, while retaining the performance in particular in terms of particle identification capabilities via the measurement of the specific energy loss.

The increase in interaction rate and the requirements of a continuous readout demand for significant modifications of the read out chambers, front-end cards and the corresponding software framework. To validate the performance of a newly built 4-GEM Inner Read Out Chamber from the pre-production equipped with the newly developed front end electronics, the dE/dx resolution was evaluated with a beam of electrons and pions at the CERN proton synchrotron. The results are presented together with an overview on the digitization in the new software framework O^2, which is validated with the test beam data.

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