HK 7: Instrumentation I

Zeit: Montag 14:00–16:00 Raum: HS 11

Gruppenbericht HK 7.1 Mo 14:00 HS 11

MAGIX at MESA — •Sören Schlimme for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

MAGIX will be the multi-purpose flagship experiment at the future MESA energy-recovering superconducting electron accelerator in Mainz. High precision scattering experiments at the low-energy frontier will be performed using a high-resolution magnetic spectrometer setup, covering a wide experimental program including nuclear structure investigations, determination of observables with astrophysical relevance, and the search for exotic particles. Delicate requirements exist for the experimental setup, mainly related to the low energies of the involved particles. In this presentation, the physics program at MAGIX will be outlined and an overview of the apparatus will be given, ranging from the internal cryogenic supersonic jet target to the sophisticated spectrometer magnet design, and from GEM-based Time Projection Chambers to Silicon Strip Detectors.

HK 7.2 Mo 14:30 HS 11

Discharge studies in a double-GEM detector — •Bogdan-Mihail Blidaru for the ALICE-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Large Hadron Collider will provide Pb-Pb collisions at an interaction rate of 50 kHz after 2021, following its Long Shutdown 2.

The ALICE TPC Upgrade project developed a continuous readout based on Gas Electron Multiplier (GEM) technology. The final design will feature a stack of four GEMs at the amplification stage. After installation in the ALICE cavern, the GEM chambers will be inaccessible. Thus, long-term stability and reliable readout over a time span of about 10 years is mandatory.

This talk is focused on one of the major challenges the GEMs must overcome, i.e. discharges: primary discharges that lead to a breakdown of the potential between both sides of a GEM foil and secondary discharges where the potential breaks down in the gap region between two foils. These events can short-circuit a GEM segment and render it inactive.

A small $10{\times}10$ cm^2 detector model with two GEM foils is used to study the evolution of the GEM potentials during and after discharges. Particular emphasis is put on mitigating the appearance of secondary discharges by using decoupling resistors that substantially reduce the propagation probability.

HK 7.3 Mo 14:45 HS 11

Study on two-track separation power of triple GEM detectors at the NA64 Experiment — •Michael Hösgen, Markus Ball, Nabeel Ahmed, and Bernhard Ketzer for the NA64-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik

The NA64 experiment uses an active target beam dump setup to conduct missing energy searches. It utilizes a high-intensity energy beam of 100 GeV energy at the SPS of CERN.

Between 2016 and 2018 a dedicated search for a new short-lived neutral boson X was performed. The X could be produced in Bremsstrahlung interactions $e^-Z \rightarrow e^-ZX$ in the active target tungsten electromagnetic calorimeter and decay into standard-model leptons ($X \rightarrow e^+e^-$). In order to record the two resulting tracks, which are emitted with a very small opening angle, four GEM detectors, each delivering two proections, were installed behind the active target.

The two-track separation power of the GEM detectors is evaluated by superimposing single-track events as well as by studying one of the well known background channels, which is the production of a $\mu^+\mu^-$-pair in the electromagnetic shower.

The talk will present the setup and discuss the results of these studies.

HK 7.4 Mo 15:00 HS 11

Ageing of GEMs in CH_4-based gas mixtures compared to ageing processes in MWPCs — •Michael Jung for the ALICE-Collaboration — Institut für Kernphysik Frankfurt

The Time Projection Chamber (TPC) of ALICE was operated with Multi-Wire Proportional Chambers (MWPCs) until 2018. During these data taking periods, N_2 and CO_2 were used as quenching gas, even if Ar-CH_4 can be considered as classical gas mixture for large-scale TPCs. Especially in high rate experiments like ALICE, it is well known that CH_4 produces hydrocarbons in the plasma of the avalanche, which will cover the electrodes and lead to insulating depositions.

From 2021 on, the TPC will run with a quadruple stack of Gas Electron Multipliers (GEMs) to allow continuous data taking at 50 kHz in Pb-Pb collisions. Since GEMs are considered to have better ageing properties than MWPCs, the possibility to use CH_4-based gas mixtures was evaluated with a GEM ageing test setup. Even if the degradation of the performance of the GEM detector was found to be less than in MWPCs, the usage of CH_4 also leads to insulating deposits on the electrodes of the GEMs. Like in MWPCs, a gain drop as well as a degradation of the energy resolution was measured.

In this presentation the results of long-term irradiation tests with GEMs, operated in Ar-CH_4 (95-5) will be presented together with a microscopic analysis of the irradiated GEMs and a comparison with ageing phenomena in MWPCs.

Supported by BMBF and the Helmholtz Association.

HK 7.5 Mo 15:15 HS 11

Gain uniformity measurements of a single GEM — •Mario Engel, Philip Hauer, Michael Hösgen, Markus Ball, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

The Gas Electron Multiplier (GEM) is a type of micro-pattern gaseous detector. Optimal performance of detectors based on gas amplification in GEMs requires the gain to be uniform across the active area. Non-uniformities may arise from the production process for GEM foils, e.g. due to varying hole diameters and shapes. The holes of the GEM are etched with a photolithographic process into copper ($5\,\mu$m)- polyimide ($50\,\mu$m)- copper ($5\,\mu$m) layers (standard GEM). Measurements of the uniformity of the gain of a single GEM foil are performed by using a setup consisting of a patterned readout electrode with an integrated bulk Micromegas, above which the GEM foil to be tested is mounted. With these two amplification stages, the effective gain of the GEM can be measured directly. As a radiation source, an ^{55}Fe X-ray emitter is used. The gain is measured at different spots over the $10\,\mathrm{cm} \times 10\,\mathrm{cm}$ GEM. The talk will present the setup and measurements with different types of GEM foils.

Supported by BMBF

HK 7.6 Mo 15:30 HS 11

Characterization of chromium GEM foils for MAGIX — •Maximilian Littich for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität Mainz, Deutschland

The MAGIX experiment will be located at the MESA accelerator which is currently being built at the Institut für Kernphysik in Mainz. It will utilize the powerful electron beam with energies of up to 105 MeV and beam currents of up to 1 mA to perform high precision experiments. To identify scattered particles the MAGIX spectrometers will use GEM detectors as their focal plane detectors.

To build a GEM detector with a minimal material budget we characterized ultra-thin chromium GEM foils. This talk will give an overview over the characterization and performance measurements.

HK 7.7 Mo 15:45 HS 11

Measurements of the charge-up effect in Gas Electron Multipliers — Philip Hauer, •Karl Flöthner, Markus Ball, and Bernhard Ketzer — Helmholtz-Institut für Strahlen- und Kernphysik

Gas Electron Multipliers (GEM) are widely used as an amplification stage in gaseous detectors exposed to high rates, e.g. in the Time Projection Chamber of the ALICE (A Large Ion Collider Experiment) experiment after its upgrade. The GEM consists of a polyimide foil coated by two thin copper layers. A GEM foil has a high density of holes, where charges are multiplied if suitable voltages are applied. One critical property is the electrostatic charge-up of GEM. It occurs when drifting ions or electrons end up on the polyimide surface. Since polyimide is a very good electrical insulator, the charge remains there and changes the configuration of the electrostatic field which in turn influences key properties of a GEM such as the effective gain.

This effect was investigated through simulations and measurements. In this talk, the results of dedicated measurements with a test-detector will be presented and compared to the outcome of the simulations. The influence of the rate of incoming radiation on the time constant of the charge-up process will be discussed. A special focus lies on the investigation of the charge-up effect in GEM foils with different hole shapes (e.g. single-conical GEM).

Supported by BMBF.