HK 64: Combined Instrumentation Session: Gaseous Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: J-HS C

HK 64.1 Fri 11:00 J-HS C

Study of gas gain in GEM detectors — •Henning Keller, Thomas Hebbeker, Kerstin Hoepfner, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The Gas Electron Multiplier (GEM) technology is quite popular among the gaseous detector community due to the excellent performance, even in high-rate environments; it has strong resistance to aging as well as a flexible design. The heart of the detector consists of GEM foils with an etched hexagonal pattern of holes. The detection principle relies on electron multiplictation inside the holes, where a high electric field is apparent. GEM detectors are currently being installed in the CMS Muon system at the LHC in preparation for Run-3. New etching techniques have been used for the production of large-size ($\mathcal{O}(1\ m^2)$) GEM foils needed for CMS. The new techniques result in different hole geometries inside the GEM foil. In order to better understand the gas gain dependance on the hole geometry, several measurements have been performed, and have been complemented by GARFIELD++ simulations. The findings are compared with other recent studies.

HK 64.2 Fri 11:15 J-HS C

Studies on a structured cathode to increase the detection efficiency of gaseous detectors — •Katrin Penski, Otmar Biebel, Bernhard Flierl, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Maximilian Rinnagel, Sebastian Trost, Chrysostomos Valderanis, and Fabian Vogel — LMU München

Micropattern gaseous detectors show extremely good spatial resolution and high-rate capability. Nevertheless, due to the low density of the gas detector they exhibit only low detection efficiency for neutral particles such as e.g. high energy photons or neutrons. For these particles the detection efficiency can be increased by using a solid converter cathode e.g. of high-Z materials as gold for photons or materials with a large neutron interaction cross section e.g. ^{10}B for neutrons. In order to obtain even higher efficiencies several tilted converter layers can be stacked with large overlap. For photons several studies were performed to optimize the detection efficiency in regard to cathode geometry and detector performance. Especially, measurements of the drift electron movement and investigations of the improvement of the efficiency are presented and compared to results of corresponding simulations. These measurements were performed using a prototype cathode and a GEM detector.

HK 64.3 Fri 11:30 J-HS C

Charge transfer properties of a GEM stack – simulations and measurements — •Jan Paschek, Philip Hauer, Jonathan Ottnad, Markus Ball, and Bernhard Ketzer — Universität Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

Gas Electron Multipliers (GEM) are a micropatterned structure widely used as an amplification stage in gaseous detectors exposed to a high rate particle flux, e.g. Time Projection Chambers. Typically, a GEM consists of a polyimide foil which is coated with thin copper layers on both sides. Through a photolitographic process large numbers of holes are etched into this structure. In order to obtain the desired amplification a suitable voltage needs to be applied between both metal layers.

Typically, detectors consist of stacks of multiple GEM foils. The performance of a detector is highly influenced by the charge-transfer properties within the stack. To study these effects, a Monte-Carlo program simulating the charge transfer in a GEM stack using the frameworks Garfield++ and Ansys has been written. This program allows us to predict the properties of a GEM stack from the geometry of the GEM-foils and the applied fields. In order to verify the predictions a test detector has been assembled with a configuration corresponding to the quadruple GEM stack of the new readout chambers for the ALICE TPC. The talk will discuss the simulation program and compare the predictions to measurements with this test detector.

Supported by BMBF.

HK 64.4 Fri 11:45 J-HS C

The Charge-Up Effect in GEM Detectors – Simulations and Measurements — •Philip Hauer, Karl Flöthner, Dimitri Schaab, Markus Ball, and Bernhard Ketzer — Univ. Bonn, Helmholtz-Institut für Strahlen- und Kernphysik, Bonn, Germany

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. Typically, the GEM consists of a polyimide foil which is coated from both sides with thin layers of copper. Holes are etched into this structure in which electrons can get multiplied.

During the multiplication process, some electrons and ions diffuse to the polyimide part of the GEM and are adsorbed there, which change the electric field inside the holes. This is known as the *charge-up effect*. Many publications suggest that it is causing a change of the effective gain with time but a quantitative description is often missing.

In this work, the charge-up effect was investigated quantitatively in simulations and measurements. The simulations are based on an iterative approach, where new field maps are calculated with a finite element method and the deposition of charges is simulated with Garfield++. For the measurements, a dedicated test detector was set up with a single (standard) GEM foil as amplification stage. In this talk, the results from both approaches will be shown and compared to each other. A special focus lies on the influence of initial rate, applied voltage and different hole shapes on the charge-up effect.

Supported by BMBF.

HK 64.5 Fri 12:00 J-HS C

Propagation of discharges in a double-GEM detector — •Bogdan 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 from 2021 onward.

In order to cope with this, the ALICE Time Projection Chamber is being upgraded. Readout chambers equipped with a stack of four Gas Electron Multiplier (GEM) foils provide a continuous readout. 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 required.

One of the major challenges GEMs must overcome are electrical discharges, which can short-circuit a GEM segment and render it inactive. Some peculiar aspects of the discharge phenomena are surfacing. This talk is focused on the propagating nature of discharges, from one GEM in a stack to another.

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

Moreover, some new results showing that photons are not solely responsible for the propagation of discharges are discussed. A considerable number of events where the propagation is delayed by more than 300 ns are observed and studied.

HK 64.6 Fri 12:15 J-HS C

Modelling of discharge in parallel-plate-type Micro-Pattern gaseous detectors — •Deb Sankar Bhattacharya, Raimund Ströhmer, and Thomas Trefzger — University of Wüzburg, Physik und ihre Didaktik, Emil-Hilb-Weg 22, 97074, Germany

The Micro-Pattern Gaseous Detectors (MPGD) have been widely adopted in nuclear and particle physics experiments, for their fast response and other excellent characteristics. To achieve the required signal strength and detection efficiency, sometimes they are operated at a high voltage range. This often challenges the limit of high voltage stability of the detector. Discharge in gaseous detectors is a complex process and there are several factors which may directly or indirectly influence. The microscopic geometrical structures of the MPGDs may itself sometimes induce discharges. In this study, we are numerically investigating the discharge phenomena in non-resistive Micromegas. Within the COMSOL framework, a 3-dimensional model is developed to observe the occurrence and the development of discharge in Micromegas. The effect of space charge has been taken into account in the calculation. The model allows to vary the geometrical parameters of the detector as well as to study the effects of gas impurities and a different number of primary charges.

HK 64.7 Fri 12:30 J-HS C

Status of MRPC performance for the endcap-time-of-flight upgrade of STAR — •Philipp Weidenkaff for the CBM-Collaboration — Ruprecht-Karls-Universität Heidelberg

As part of the FAIR phase 0 program, CBM-ToF MRPC modules have been installed as endcap-time-of-flight detectors in STAR for the current beam-energy-scan II (BES II) program in 2019 and 2020. These detectors provide a major improvement to the particle identification capability of the experiment in the forward region ($1.0 < \eta < 1.5$), which is especially necessary for the fixed target program. An Analysis of the MRPC performace in terms of time resolution, efficiency and matching to STAR-TPC tracks will be presentent in this talk. The Results are based on the 2019 run as well as first data of the 2020 run.

The project is partially founded by BMBF 05P15VHFC1.

HK 64.8 Fri 12:45 J-HS C

Development of a High Pressure Time Projection Chamber — •Philip Hamacher-Baumann, Thomas Radermacher, Stefan Roth, and Nick Thamm — III. Physikalisches Institut B, RWTH Aachen University

Gaseous detectors have long been used by particle physics experiments. Their low momentum threshold has made them interesting as active targets for long baseline neutrino experiments. To increase the statistics of neutrino interactions, but retain a low momentum threshold, pressurized Time Projection Chambers (TPCs) have been proposed. The Deep Underground Neutrino Experiment (DUNE) considers building one as part of its near detector complex.

Gas Monitoring Chambers are mini TPCs that are designed to measure gas properties. Such a system with the capability of testing common and new drift gas mixtures can provide input to the design process of new high pressure TPCs. This talk presents a High Pressure Gas Monitoring Chamber (HPGMC), capable of operating up to 10 bar pressure and a maximum drift field close to 1000 V/cm.