T 109: Combined instrumentation session III: Silicon pixel detectors (joint session HK/T)

Time: Friday 11:00–12:45 Location: J-HS K

T 109.1 Fri 11:00 J-HS K

ATLASPix3 – A reticle sized HV-CMOS Detector for Construction of Multi-Sensor Modules — •Rudolf Schimassek[1], Felix Ehrler[1], Mridula Prathapan[1], Alena Weber[1,2], Winnie Wong[3], Hui Zhang[1], and Ivan Perić[1] — [1]Karlsruher Institut für Technologie — [2]Universität Heidelberg — [3]Université de Genève

Monolithic High-Voltage CMOS (HV-CMOS) detectors are a sensor type planned to be used for tracking in several particle physics experiments. HV-CMOS Sensors are especially well suited for applications with strict constraints on mass and spatial resolution. In addition, low power and radiation hardness, along with good time resolution are possible. Furthermore, the usage of standard CMOS processes makes the detectors highly available and cheap.

To overcome the mask size limit of HV-CMOS processes, the ATLASPix3 detector is designed to be used in multi-chip modules. It is a 2×2.1 cm^2 three side buttable pixel sensor, designed for the environment of layer 4 of the ATLAS inner tracker upgrade for High-Luminosity LHC. A single data input and a single data output are sufficient to control and read out the detector using protocols that are RD53 compatible. The detector was produced on a high resistivity substrate and the first production shows a good yield. In this contribution, measurements of the detector features and performances will be presented.

T 109.2 Fri 11:15 J-HS K

CMS Phase-1 pixel detector never sleeps: results from the Hamburg group — •Irene Zoi, Finn Feindt, Alexander Froehlich, Erika Garutti, Johannes Haller, Andreas Hinzmann, Viktor Kutzner, Torben Lange, Malte Mrowietz, Yuval Nissan, Peter Schleper, Dennis Schwarz, Jory Sonneveld, Georg Steinbrueck, and Benedikt Vormwald — University of Hamburg

The CMS Phase-1 Pixel detector has already been successfully operated for two years and has collected more than a 100 fb^{-1} of data and consequently radiation. During the ongoing shut down it has been extracted from the experiment and has been kept cold and monitored in a clean environment. The Hamburg group has been involved in all these operations and continues to control the status of the detector, to study the collected data to improve our knowledge of radiation damage and make predictions for future data taking. In this talk a broad overview of the achievements of the group will be offered. The radiation study on data and simulation will be covered. These are based on leakage current and cluster charge. The progress in detector monitoring in clean room and in the on-line monitoring tools and database will be presented. The improvements for the future data acquisition will be also described.

T 109.3 Fri 11:30 J-HS K

First measurements with an ALPIDE MAPS telescope in an 40-Ar test beam at GSI — •Pascal Becht for the ALICE-Collaboration — GSI Helmholzzentrum für Schwerionenforschung, Darmstadt, Germany

In the framework of the ALICE Inner Tracking System (ITS) upgrade during LHC's long shutdown 2, a new silicon sensor chip was developed and produced. This ALICE Pixel Detector (ALPIDE) chip is entirely built up of Monolithic Active Pixel Sensors (MAPS) and can be thinned down to 50 μm. It features a low material budget of only 0.05% X/X_0 as well as a position resolution in the order of 5 μm, which makes it suitable for the use in high-resolution beam telescopes.

In order to investigate the detector performance different beam tests with e. g. proton or pion beams have been performed using an ALPIDE MAPS telescope. To study the performance of such telescopes being irradiated with highly ionising particles, a 7-layer ALPIDE MAPS telescope has been brought to GSI and installed in a test beam area. In this talk, first results of this 50 MeV/u 40-Ar beam test at GSI are discussed.

T 109.4 Fri 11:45 J-HS K

Results from the MIMOSIS-0 CMOS Monolithic Active Pixel Sensor — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe Universität Frankfurt am Main

The next generation CMOS Monolithic Active Pixel Sensor MIMOSIS is being developed to respond to the challenges imposed by future applications including the CBM Micro Vertex Detector. The project, which is carried out by the PICSEL group of IPHC Strasbourg and the Goethe University Frankfurt, aims for a 50 μm thin and ~ 5 cm^2 sized sensor. This sensor will host 1024×504 pixels with a size of 26.9×30.2 μm^2. The pixels include the amplifier-shaper-discriminator chain known from the ALPIDE chip which was extended to achieve a compatibility with a fully depleted sensing element. Moreover, MIMOSIS will feature a continuous readout suited for a readout time of 5 μs and peak rates of 70 MHz/cm^2.

We show results from measurements performed with the preamplifier of a first prototype called MIMOSIS-0, which indicate that a time resolution well below 1 μs might be within reach. *This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

T 109.5 Fri 12:00 J-HS K

Experiences with long-term operation of a CBM-MVD prototype module. — •Michal Koziel for the CBM-MVD-Collaboration — Goethe Universität Frankfurt

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 with numerous probes, among them open charm. The Micro Vertex Detector (MVD) will contribute to the secondary vertex determination on a 10 μm scale, reconstruction of weak decays of multi-strange baryons, and low-momentum track reconstruction. The detector comprises four stations placed next to the target in vacuum. The stations will be populated with 50 μm thin, highly granular customized CMOS Monolithic Active Pixel Sensors (MAPS) called MIMOSIS.

The integration of the mechanically fragile MAPS to vacuum compatible detector stations was studied within the PRESTO project. This project aimed for building a quarter of a detector station including the necessary vacuum compatible cooling system and the steering electronics. The study was carried out with elder MIMOSA-26 sensors, which are considered as a representative precursor of the final sensor technology. We report the outcome of this study and the observations made while operating PRESTO for several months under vacuum conditions.

*This work has been supported by BMBF ErUM-FSP C.B.M. (05P19RFFC1), GSI and HIC for FAIR.

T 109.6 Fri 12:15 J-HS K

The MuPix10 - design and status — •Alena Weber for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg — Karlsruher Institut für Technologie

The Mu3e experiment is going to search for the charged lepton flavour violating decay $\mu^+ \rightarrow e^+e^-e^+$ with a sensitivity of one in 10^{16} decays (in phase II). High Voltage Monolithic Active Pixel Sensors (HV-MAPS) with a minimal gate length of 180nm will be used for its tracking system which will be the core element of the detector.

In the last years several prototypes of different size for the Mu3e pixel sensors were designed and tested. In 2019 the latest version of the MuPix, the MuPix10, was submitted. MuPix10 is a chip of full reticle size (2.066 x 2.318 cm^2) and contains a pixel matrix with 256 columns each with 250 pixels. The pixel size is 80 um x 80 um. The readout buffer has two different operation modes, one providing ToT measurement and one implementing a two threshold method. Some new elements have been added, for example a delay circuit. The timestamp was extended to 11 bit, the ToT has now 5 bit. The pixels are organized together with the readout buffer and the end of column in a double column architecture.

In this contribution the MuPix10 design and the next steps will be presented.

T 109.7 Fri 12:30 J-HS K

TCAD Simulation of High-Voltage Monolithic Active Pixel Sensors — •Annie Meneses Gonzalez, Heiko Augustin, and Andre Schöning — Physikalisches Institut, Universität Heidelberg

The requirements for precision physics and the experimental conditions of several Particle Physics experiments lead often to challenging tracking detectors. High-Voltage Monolithic Active Pixel Sensors (HV-

MAPS) implemented in a commercial 180 nm High-Voltage CMOS process has been chosen as the baseline for the Mu3e Pixel Tracker and are under study for the application in future detectors like PANDA, P2, CLIC, and LHCb.

A full depletion over the pixel, a fast charge collection, and a high signal-to-noise ratio are essential to achieve highly efficient sensors and good time resolutions.

Technology Computer-Aided Design (TCAD) simulations have been used to develop and optimize HV-MAPS, aiming for a comprehensive understanding of the sensor characteristics. Simulation results of the pixel capacitance for different prototypes and pixel sizes will be presented.