T 114: Pixeldetektoren 6 (gemeinsam mit HK)

Zeit: Donnerstag 16:45–19:00 Raum: F 073

Gruppenbericht T 114.1 Do 16:45 F 073

The CBM-MVD: Group Report — •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, background rejection in dielectron spectroscopy and reconstruction of weak decays of multi-strange baryons. The detector comprises up to four stations placed next to the target in the vacuum. The stations are populated with 50 μm thin, highly-granular customized Monolithic Active Pixel Sensors, featuring a spatial resolution of <5 μm, a readout speed of less than 10 μs/frame, a radiation tolerance of $>10^{13}$ n_{eq}/cm^2 and 3 Mrad. This contribution will summarize recent activities towards constructing the MVD, that involve in particular: CMOS sensor development, characterization and read-out, integration and cooling aspects as well as MVD performance simulations.

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T 114.2 Do 17:15 F 073

Passive CMOS pixel sensors as large area alternatives for HL-LHC trackers — •Ivan Dario Caicedo Sierra[1], Jochen Dingfelder[1], Tomasz Hemperek[1], Toko Hirono[1], Fabian Hügging[1], Jens Janssen[1], Hans Krüger[2], Anna Macchiolo[1], David-Leon Pohl[1], and Norbert Wermes[1] — [1]Physikalisches Institut der Universität Bonn — [2]Max-Planck-Institut für Physik in München

The large area and intensity requirements of the inner tracking detector for the High Luminosity upgrade of the Large Hadron Collider call for detector developments at an affordable cost for mass production. In this talk, we present a passive CMOS sensor as a suitable option for new hybrid pixel detector designs which could fulfill the aforementioned demands.

The devices under test were n-in-p backside biased sensor prototypes in 150 nm LFoundry CMOS technology with a thickness of 100 and 300 um. Each sensor has both AC- and DC- coupled pixel regions, bump bonded to the ATLAS FE-I4 chip.

Results from measurements with these sensors show noise levels, leakage current and charge collection efficiency -before and after irradiation- comparable to those of the current ATLAS-IBL planar sensors.

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Development of radiation-hard 3D pixel sensors for the HL-LHC — •Jörn Lange, Emanuele Cavallaro, Fabian Förster, Sebastian Grinstein, Ivan Lopez Paz, Maria Manna, Stefano Terzo, and David Vazquez Furelos — IFAE Barcelona, Spain

3D silicon detectors, with cylindrical electrodes that penetrate the sensor bulk perpendicular to the surface, present a radiation-hard sensor technology. Due to a reduced electrode distance, trapping is less and the operational voltage and power dissipation after heavy irradiation is significantly lower than for planar devices. During the last years, the 3D technology has matured and 3D pixel detectors are already used in HEP detectors where superior radiation hardness is key: the ATLAS IBL and the ATLAS Forward Proton detector.

For the High-Luminosity upgrade of the Large Hadron Collider (HL-LHC), the radiation-hardness requirements are even more demanding with fluences up to $1\text{–}2{\times}10^{16}$ n_{eq}/cm^2 for the innermost pixel layers of the ATLAS and CMS experiments. Moreover, for occupancy reasons, smaller pixel sizes of 50×50 or 25×100 μm^2 are planned.

In this work, the suitability of 3D pixel sensors for the HL-LHC innermost pixel layers is studied. Firstly, the radiation hardness of the already existing IBL/AFP generation is investigated up to HL-LHC fluences. Secondly, a new dedicated HL-LHC generation of 3D sensors is developed and tested, which is designed for the smaller pixel sizes and to even further improve the radiation hardness with smaller electrode distances. Laboratory and beam test results of 3D pixel detectors before and after irradiation will be presented.

T 114.4 Do 17:45 F 073

Design studies on the MimoSIS pixel sensor for the CBM-MVD — •Philipp Sitzmann for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Compressed Baryonic Matter experiment at FAIR (CBM) is a dedicated fix-target experiment design to explore the QCD phase diagram in the region of high net-baryon density. One of the main physics goals is the reconstruction of short living Open Charm Mesons and Multi-Strange Hyperons. The Micro Vertex Detector (MVD) is designed to significantly increase the secondary vertex resolution and to boost near vertex tracking and reconstruction of low-momentum tracks. This detector will be equipped with CMOS Pixel Sensors developed at IPHC Strasbourg. A new generation of the sensor (MimoSIS) is developed with an improved readout aiming at a much faster readout speed below 10 μs/frame. The internal readout concept and its corresponding limitations to the occupancy is simulated in the CBM-Root Framework and tested assuming the expected beam intensities and fluctuations.

This work will present the newest results on required internal bandwith, limitations and resulting design guidelines for the employment of the new MimoSIS sensor in the CBM-MVD.

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T 114.5 Do 18:00 F 073

Edge effects of radiation damaged silicon pad diodes — •Benedict Tohermes, Eckhart Fretwurst, Erika Garutti, Michael Hufschmidt, Robert Klanner, and Jörn Schwandt — Institut für Experimentalphysik, Universität Hamburg

Edge effects for square p+n silicon pad diodes fabricated on high-ohmic silicon are investigated. Using capacitance-voltage measurements of two pad diodes with different areas and 320 μm thickness, the planar and the edge contributions to the diode capacitance are determined. For the non-irradiated pad diodes the doping profile is determined. The results with and without edge corrections differ significantly. Without edge correction the value of the bulk doping determined increases by up to 30 % over the depth of the diode, with edge correction it is uniform within ± 1.5 %, which agrees with expectation.
Edge corrections are determined both for non-irradiated diodes and for diodes irradiated to a fluence of $2.4 \cdot 10^{15} \mathrm{n_{eq}/cm^2}$ with 24 GeV/c protons. The edge correction for irradiated diodes is found to be larger than for non-irradiated ones.

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Optimierung der Sensorparameter von Makropixelsensoren für das Phase II Upgrade des CMS-Trackers — Alexander Dierlamm, Thomas Müller, •Daniel Schell und Florian Wittig — Institut für Experimentelle Kernphysik (IEKP), KIT

Um die erhöhte Datenmenge während der Hochluminositätsphase des Large Hadron Colliders (LHC) verarbeiten zu können, werden für den Spurdetektor des CMS Experiments sogenannte „p_T-Module“ entwickelt, welche Teilchen mit hohem und geringem Transversalimpuls zuverlässig separieren können. Dadurch können Ereignisse mit niederenergetischen Teilchen verworfen und somit die effektive Datenrate reduziert werden. Eines dieser neuen Module ist das sogenannte PS-Modul welches aus einem Makro(P)ixel- und einem (S)treifensensor aufgebaut ist. Während die äußeren Dimensionen sowie die Anzahl der Pixel des Makropixelsensors durch die Moduldimension bzw. den Auslesechips bereits festgelegt sind, müssen Details wie die Peripherie weiter optimiert werden. Ein kritischer Punkt ist hierbei die sogenannte Punch-Through Struktur, welche es unter anderem erlaubt den Sensor vor dem Bump-Bonden der Auslesechips auf mögliche Defekte zu überprüfen. Gleichzeitig soll diese Struktur als Schutz des Auslechips dienen, indem sie hohe Ströme an der Front-End Elektronik des Chips vorbeileitet. Um diese und weitere Anforderungen zu erfüllen, nutzt die Outer-Tracker Sensorgruppe verschiedene Mess- und Simulationsprogramme um einen optimierten Parametersatz für den zukünftigen Makropixelsensor zu finden, welche in diesem Vortrag vorgestellt werden.

T 114.7 Do 18:30 F 073

Finalizing the CBM-MVD Geometry: CAD and Simulation — •Philipp Klaus for the CBM-MVD-Collaboration — Goethe-

Universität, Frankfurt

The Compressed Baryonic Matter experiment (CBM) at FAIR is a dedicated fix-target experiment designed to explore the QCD phase diagram in the region of high net-baryon density. The talk will review the concluding studies on the geometry of its Micro Vertex Detector (MVD) comprising up to four planar stations equipped with monolithic active pixel sensors close to the target. In order to perform optimally in different physics cases, tweaking the station positioning for each case is considered. In addition, recent updates of the sensor dimensions require small changes to the detector geometry.

In this process, it became evident that improved procedures and tools are required to keep mechanical integration models (CAD) and detector simulation models in sync. This contribution will discuss established methods and their advantages/disadvantages.

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T 114.8 Do 18:45 F 073

Serial Powering Pixel Stave Prototype for the ATLAS ITk upgrade — •Viacheslav Filimonov, Laura Gonella, Fabian Hügging, and Norbert Wermes — University of Bonn, Bonn, Germany

ATLAS ITk is a new inner tracker that will be built for the Phase II upgrade in order to meet the requirements of increased Luminosity.

One of the main challenges for the ATLAS ITk Phase II Pixel upgrade is low mass efficient power distribution to power detector modules. This requires a powering scheme alternative to the parallel (direct) powering which is currently used. Serial powering scheme has been chosen as the baseline for the ITk pixel system.

The talk will focus on a serially powered pixel stave prototype which has been built with all the components that are needed for current distribution, data transmission, bypassing and redundancy in order to prove the feasibility of implementing serial powering scheme in the ITk. Detailed investigations of the electrical performance of the detector prototype equipped with FE-I4 quad modules will be shown.