HK 9: Instrumentation II

Time: Monday 16:15–18:15 Location: PHIL B 302

Group Report HK 9.1 Mon 16:15 PHIL B 302

Status of the CBM Micro Vertex Detector* — •Franz Matejcek for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Micro Vertex Detector (MVD) is the first downstream detector of the fixed-target CBM Experiment at the future Facility for Antiproton and Ion Research (FAIR). It enables high-precision tracking of low-momentum particles in direct proximity of the target with the first of four stations being placed only 8 cm downstream the interaction point in the target vacuum. ~ 300 MIMOSIS (TJ-180 nm) CMOS Monolithic Active Pixel Sensors (MAPS) provide $> 99\%$ detection efficiency and a 5–6 μm spatial resolution (5 μs frame time), also after irradiation to 5 Mrad and $1 \times 10^{14}\, n_{\mathrm{eq}}/\mathrm{cm}^2$ (TID+NIEL), fulfilling the requirements and preparing for final sensor submission. Sensors are wire-bonded to thin flex cables and glued onto both sides of Thermal Pyrolytic Graphite (380 μm) carriers, which provide stiff, low-X_0 support with excellent thermal conductivity. Actively cooled aluminum heat sinks outside the acceptance extract the heat.

In this contribution, we present the detector concept, highlights from the CBM-compatible readout validated in mCBM, and results from the final MIMOSIS prototype under CBM-like conditions. A focus will be the challenges associated with vacuum operation, stringent material budget constraints (0.3–0.5% X_0), and double-sided integration as we progress toward station assembly and readiness for first beam in 2028.

*This work has been supported by BMFTR (05H24RF5), HGS-HIRe, HFHF, GSI and Eurizon.

HK 9.2 Mon 16:45 PHIL B 302

Results of Recent Testing Campaigns of the Analogue Pixel Test Structure — •Maximilian Spors[1,2], Malte Grönbeck[1,2], Alexander Rachev[1,2], Lars Döpper[1,2], Philip Hauer[1,2], and Bernhard Ketzer[1,2] for the ALICE Germany-Collaboration — [1]Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn, Germany — [2]Forschungs- und Technologiezentrum Detektorphysik

For the Long Shutdown 4 of the LHC, the ALICE Collaboration is planning a major upgrade of its detectors, known as ALICE 3. The tracking system of ALICE 3 will be entirely based on Monolithic Active Pixel Sensors (MAPS), fabricated using TPSCo's 65 nm CMOS imaging process. Dedicated small-scale Analogue Pixel Test Structures (APTS), originally developed for the Inner Tracking System 3 project, are used to study the analogue response to incident radiation. As this technology is also planned to be used for the ALICE3 tracking system, the APTS measurements provide insights into the characteristics of sensors fabricated in this process, such as detection efficiency, spatial resolution and in-pixel efficiencies.

This presentation summarizes the results of recent testing campaigns, consisting of test beam measurements at ELSA, as well as laboratory experiments using X-ray sources.

This work is supported by BMFTR.

HK 9.3 Mon 17:00 PHIL B 302

Status of the MANTA project — •Michael Deveaux — GSI, Darmstadt, Germany

Building a next generation of ultra-light particle tracking detector calls for sensors combining good ($\sim$ 10 μm) spatial resolution with fast ($\sim$ 10 ns) time stamping, very light material budget and low power dissipation.

Thanks to their fine granularity, their low (0.05% X_0) material budget and the possibility of achieving a low energy consumption well below ~ 50 mW/cm^2, next generation CMOS Monolithic Active Pixel Sensors are considered as valuable technology candidate for this application. On the other hand, their time stamping capability and rate capability have still to be improved in order to handle reliably particle fluxes of $10 - 100$ MHz/cm^2.

Being formed under the umbrella of the DRD3, the MANTA collaboration aims to respond to this challenge by developing a versatile sensor design. This design is intended to yield a single ASIC, which may be configured by slow control to the needs of different tracking detectors.

The presentation introduces the vision of MANTA and discusses the underlying technological concept.

HK 9.4 Mon 17:15 PHIL B 302

Status of the MIMOSIS sensor for the CBM Micro Vertex Detector* — •Benedict Arnoldi-Meadows for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The CMOS Monolithic Active Pixel Sensor (MAPS) MIMOSIS will be used as the sensor of the Micro Vertex Detector (MVD) of the CBM experiment, which is foreseen to receive beam on target in 2028. The sensor is currently being developed by IPHC Strasbourg in cooperation with University Frankfurt and GSI, with the MIMOSIS-2.1 sensor being its latest and last prototype.

Both in-beam performance studies validating changes in the sensor, and studies related to the selection, preparation, and operation of suitable sensors in the experiment have been conducted with MIMOSIS-2.1 prototype sensors. This contribution will present the recent progress made towards the final sensor for the experiment.

*This work has been supported by BMFTR (05H24RF5), GSI, Eurizon, HGS-HIRe, and HFHF.

HK 9.5 Mon 17:30 PHIL B 302

Asynchronous Readout for Pixel Detectors — •Tim Stellhorn for the ALICE Germany-Collaboration — Wilhelm-Klemm Straße 9, 48149 Münster

ALICE 3 is a next-generation high-energy physics experiment for the LHC Run 5. The Outer Tracker (OT) of ALICE 3 will be the largest tracker consisting solely of silicon sensors based on Monolithic Active Pixel Sensors (MAPS) with an active area of 60 m^2. To meet its requirement of an improved timing resolution of 100 ns, new readout models are investigated. The asynchronous readout approach is based on Asynchronous Priority Arbiters (APAs) and is implemented in the Sensor Pixel Asynchronous Readout CMOS (SPARC) chiplet.

This talk will focus on simulations of the asynchronous readout with the prototyping framework PixESL. A network in PixESL consists of front-end nodes as well as readout nodes and the communication between these nodes is based on the Transaction Level Modelling (TLM) framework of SystemC. The input to PixESL is a list of pixels with recorded hits and the related Time-of-Arrival (ToA) and the Time-over-Threshold (ToT), which is generated in an Allpix-squared simulation. As a result of the PixESL simulation, readout delays of recorded hits from the pixels to the memory of the chip will be analysed depending on different APA tree architectures.

HK 9.6 Mon 17:45 PHIL B 302

Status of the Readout of the CBM Micro Vertex Detector* — •Benedikt Gutsche for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Compressed Baryonic Matter (CBM) Experiment will be one of the main experiments at the future FAIR facility. Its Micro Vertex Detector (MVD) will be composed of four sensor planes in vacuum and will be equipped with Monolithic Active Pixel Sensors (MIMOSIS). The sensor is being developed by IPHC Strasbourg and will run with a sustained rate of up to 80 MHz/cm^2. Like other parts of CBM, the detector will be read out using radiation hard electronics (GBTx) and PCIe based FPGA boards (CRI).

In this contribution, we report on the integration of a CRI-based readout for a setup consisting of two MIMOSIS sensors, which was the first time the setup was used in the common CBM readout chain. The operation and data consistency has been validated by using correlations with other subsystems of CBM during an experimental run in May 2025. We will present the first in-beam results of this test setup.

*This work has been supported by BMFTR (05H24RF5), GSI, and HFHF.

HK 9.7 Mon 18:00 PHIL B 302

The MADHAT module - A prototype structure for the ALICE 3 Outer Tracker — •Malte Grönbeck for the ALICE Germany-Collaboration — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn — Forschungs- und Technologiezentrum Detektorphysik

ALICE 3 is a novel heavy-ion experiment foreseen to be installed during the Long Shutdown 4 of the Large Hadron Collider. Its key feature will be a 60 m^2 silicon MAPS-based tracking detector, with the active area of the Outer Tracker spanning up to 45 m^2. The sensor tech-

nology will be based on the 65 nm production node of TPSCo. The material-budget target of less than 1% X_0 per layer requires investigations into different cooling systems, electrical interconnections and the mechanical stability. Therefore a prototype sensor called MADHAT (Mechanical Assessment Design for Heat And Thermal solutions) and an associated detector module carrying 8 sensors was designed and built. These simple microchips are capable of emulating the heat dissipation, while simultaneously measuring the surface temperature with an integrated temperature probe.
This talk will discuss the MADHAT module design and its readout electronics.
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