HK 51: Instrumentation XI

Time: Thursday 15:45–17:15 Location: SR Exp1A Chemie

Group Report HK 51.1 Thu 15:45 SR Exp1A Chemie

The Outer Tracker Barrel of ALICE3 — •Laszlo Varga for the ALICE Germany-Collaboration — Technische Universitaet Muenchen, Munich, Germany

The large area Outer Tracker (OT) of ALICE3 will be fully based on Monolithic Active Pixel Sensor technology. Its four barrel layers follow a cylindrical geometry, with a support structure segmented into independent staves populated by interconnected detector modules. The whole concept, the layout of a stave and the implementation of the infrastructure is based on the cooling of the detectors.

We will discuss the different cooling options and the corresponding mechanical implementations and compare them to simulations carried out using the COMSOL Multiphysics finite element tool. In parallel the prototype development has already started and we will present detailed measurements on the heat dissipation, mechanical precision and flow induced vibrations, which will significantly influence the performance of a system designed for high precision tracking on the micrometer scale.

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HK 51.2 Thu 16:15 SR Exp1A Chemie

Front-end pixel grouping for the ALICE 3 Outer Tracker — •Johannes Hensler for the ALICE Germany-Collaboration — Physikalisches Institut, Ruprecht-Karls-Universität Heidelberg, Heidelberg, Germany

The ALICE collaboration is advancing plans for a novel detector with outstanding pointing resolution, excellent tracking, and particle identification over a large pseudorapidity range using cutting-edge silicon detector technology. This detector, called ALICE 3, is intended to replace the current experimental setup and start operation in 2036.

Central to ALICE 3 is a fully silicon-based monolithic active pixel sensor (MAPS) tracking detector built using a 65 nm technology node. The tracking system includes a Vertex Detector, Middle Layers, and an Outer Tracker, covering a total of 60 m^2 of active sensor area.

This large-area tracking device poses significant challenges in sensor design. Achieving the required intrinsic position resolution of 10 μm is essential for accurate pointing and momentum measurements. For the Outer Tracker, a pixel pitch of O(50 μm) was chosen to balance resolution, power, and channel counts. However, larger pixel pitches have been found to reduce efficiency, especially at pixel corners.

To address these challenges, the potential of grouping the response of multiple pixels is being explored. This work presents input capacitance measurements on the CE65 chiplet as a starting point, along with initial tests of pixel grouping implemented directly in the analog front-end.

HK 51.3 Thu 16:30 SR Exp1A Chemie

Timing resolution of the Analogue Pixel Test Structure — •Lars Döpper for the ALICE Germany-Collaboration — Helmholtz-Institut für Strahlen- und Kernpyhsik — Forschungs- und Technologiezentrum Detektorphysik

The ALICE collaboration plans a complete overhaul of its detector for Long Shutdown 4 of the LHC titled ALICE 3. This new detector will utilize a fully MAPS-based detector for charged particle tracking. To achieve the envisioned time binning of 500 ns, a timing resolution of 100 ns is required for the sensor.

The Analogue Pixel Test Structure (APTS), a prototype sensor developed in the scope of the Inner Tracking System 3 project, offers direct access to the analogue waveforms of the sensor diodes. As the 65 nm production process used for APTS will also be used for the final sensor of ALICE 3, testing the timing resolution of APTS offers insight into the performance of sensors fabricated in this production process. In this talk I present a novel approach to measure the timing resolution of APTS without the need for any external time reference.

This work is supported by BMBF.

HK 51.4 Thu 16:45 SR Exp1A Chemie

Status of Sensor and Detector Integration of the CBM MVD* — •Franz Matejcek for the CBM-MVD-Collaboration — Goethe-Universität Frankfurt

The Micro Vertex Detector (MVD) of the Compressed Baryonic Matter Experiment (CBM) will consist of four planar stations, each built of four independent quadrants, that will be equipped with dedicated CMOS pixel sensors (MIMOSIS) and will operate in vacuum. Each detector plane will feature a material budget x/X_0 ranging between 0.3 and 0.5 %. The sensors will be glued onto 380 μm thick TPG (Thermal Pyrolytic Graphite) carriers and then wire-bonded to dedicated flex cables connecting the front end electronics which will be mounted on a heat sink sitting outside the acceptance. The integration is mechanically challenging as the sensors have to be glued and bonded on both sides of the carrier to maximize the acceptance.

This contribution will present the current status of the integration activities with a focus on sensor mass qualification and the finalized engineering design which is currently validated in a full-scale mechanical mock-up to prepare for detector pre-production.

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HK 51.5 Thu 17:00 SR Exp1A Chemie

Ladder production and characterization of the Silicon Tracking System for the CBM experiment — •Lady Maryann Collazo Sánchez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Silicon Tracking System (STS) for the CBM experiment is designed to handle a 10 MHz interaction rate. A specialized integration approach, where the readout electronics are located outside the sensitive volume, minimizes the material budget to 2 - 8% X_0 while ensuring high granularity, precision, and timing accuracy. Each detector module features a double-sided silicon strip sensor connected to two Front-End Boards (FEBs) with eight custom-designed STS-XYTER ASICs via microcables.

After assembly, rigorous quality control procedures are performed, including time and amplitude calibration of all module ASICs and thermal stress tests to ensure reliable operation and precise data analysis. After testing, the modules are attached to low-mass carbon fiber ladders, each with up to 10 modules. The three first-of-series ladders have undergone further evaluation to confirm consistent functionality, including IV measurements, functional tests, simultaneous noise (ENC) characterization, long-run stability, and radioactive source irradiation measurements.

This study presents the current status of module and ladder testing results during the STS detector's series production. It offers key insights into the detector's development and performance, with detailed studies on noise levels and signal response.