T 112: Silicon trackers 5

Time: Friday 9:00–10:30 Location: Geb. 30.22: kl. HS A

T 112.1 Fri 9:00 Geb. 30.22: kl. HS A

Timing studies of a depleted monolithic pixel sensor in 180 nm technology — •Christian Bespin, Ivan Caicedo, Jochen Dingfelder, Hans Krüger, Lars Schall, and Norbert Wermes — Physikalisches Institut, Universität Bonn, Deutschland

The increasing availability of commercial CMOS processes with high-resistivity wafers has fueled the R&D of depleted monolithic active pixel sensors (DMAPS) for usage in high energy physics experiments. One of these developments is a series of monolithic pixel detectors with column-drain readout architecture aiming to meet ATLAS ITk outer pixel layer requirements. The TJ-Monopix series features a small collection electrode and is fabricated in a 180 nm CMOS imaging process.

The latest iteration, TJ-Monopix2, features a pixel size of 33 um x 33 um and 25 ns time-stamping capabilities. The front-end aims at a low power consumption (1 uW per pixel) while maintaining high signal-to-noise ratio and time resolution. This talk presents recent results of timing studies on non-irradiated devices in the laboratory and in particle beams, evaluating their time efficiency and resolution.

T 112.2 Fri 9:15 Geb. 30.22: kl. HS A

Timing studies of MAPS in 65 nm imaging process — •Manuel Alejandro Del Rio Viera — Deutsches Elektronen-Synchrotron (DESY) — Rhenish Friedrich Wilhelm University of Bonn

The goal of the TANGERINE project is to develop the next generation of monolithic silicon pixel detectors using a 65 nm CMOS imaging process, which offers a higher logic density and overall lower power consumption compared to currently utilized feature sizes. The Analogue Pixel Test Structure (APTS) are sensors designed and developed by ALICE with readout boards developed by CERN EP R&D using a 65 nm imaging process to study the capabilities of this technology. In order to study the timing capabilities, the sensor is tested at the DESY-II test beam facility. For each hit produced by an incident particle, the analogue signal output is recorded using an oscilloscope for offline analysis and track reconstruction. From this analysis, relevant timing parameters are compared with studies obtained through Technology Computer-Aided Design (TCAD) and Monte Carlo (MC) simulations. In this contribution, the sensor and setup, results obtained at the DESY-II Test Beam facility, laboratory characterization measurements using Fe-55, and a comparison with simulations will be presented.

T 112.3 Fri 9:30 Geb. 30.22: kl. HS A

Laboratory and Beam-Test Measurements for proton-irradiated, large-scale depleted MAPS in 150nm CMOS technology — •Lars Schall, Jochen Dingfelder, Christian Bespin, Ivan Caicedo, Fabian Hügging, Hans Krüger, Norbert Wermes, and Sinuo Zhang — University of Bonn

The increasing availability of high-resistivity silicon substrate with high-biasing capabilities in commercial CMOS processes facilitates the use of monolithic active pixel sensors (MAPS) in modern high-energy physics experiments. An improvement in radiation hardness is achieved by fully depleting the sensitive volume, as done for depleted MAPS (DMAPS), increasing the initial input signal and providing fast charge collection by drift. This makes DMAPS a promising alternative to conventional hybrid pixel detectors for use in high-rate, high-radiation environments, such as for the ATLAS Inner Tracker upgrade.

LF-Monopix2 is a large-scale 1x2cm^2 DMAPS with a 150x50μm^2 pixel pitch designed in 150nm LFoundry CMOS technology. The placement of the in-pixel electronics inside the large charge-collection electrode relative to the pixel pitch facilitates a homogeneous electric field with short drift distances across the sensitive sensor volume. Sensors have successfully been thinned down to 100μm thickness and backside processed. Laboratory measurements have proven the general functionality of proton-irradiated samples up to fluences of 2e15neq/cm^2. In this contribution, the latest beam-test studies of irradiated LF-Monopix2 sensors are presented. Special emphasis is put on hit-detection and in-time efficiencies after irradiation.

T 112.4 Fri 9:45 Geb. 30.22: kl. HS A

Quality Control for MuPix11 for the Mu3e Pixel Detector — •Anna Lelia Fuchs for the Mu3e-Collaboration — Physikalisches Institut Universität Heidelberg

The Mu3e experiment will search for the charged lepton flavour violating $\mu^+ \rightarrow e^+e^-e^+$ decay with an unprecedented single event sensitivity of $2 \cdot 10^{-15}$ in phase I. To achieve the necessary precision in the spatial and timing resolutions, the Mu3e experiment will feature the first tracking detector composed solely of ultra-thin High-Voltage Monolithic Active Pixel Sensors (HV-MAPS). HV-MAPS integrate readout electronics on the same sensor as the active detector volume, which allows the thinning of wafers to a minimum of 50 μm. The Mu3e detector will be composed of MuPix11 HV-MAPS at thicknesses of 50 μm and 70 μm. A quality control procedure is necessary to ensure the functionality of each sensor before its installation.

This talk will outline the quality control procedure developed for the MuPix11 sensors in the context of pre-production for the Mu3e vertex detector. The quality control evaluates key functions such as HV biasing, powering, global configuration and data readout. First tests were carried out on both 50 μm and 70 μm MuPix11 sensors, and the acquired information used to further develop the quality control procedure. This talk will present the quality control yield and failure profiles for both sensor thicknesses.

T 112.5 Fri 10:00 Geb. 30.22: kl. HS A

Two layers simulations for a modified Phase I of the Mu3e experiment — •Eloy Huidobro Rodriguez for the Mu3e-Collaboration — Physikalisches Institut, Heidelberg, Germany — Max-Planck-Institut für Kernphysik, Heidelberg, Germany

The Mu3e experiment at the PSI aims to observe the decay $\mu^+ \rightarrow e^+e^-e^+$ with a single event sensitivity of $2 \cdot 10^{-15}$ on the branching fraction in phase I. Measuring this decay, which violates lepton flavour conservation, would be a clear sign of new physics, as it is suppressed to unobservable orders in the SM.

Since the two outer pixel tracking layers of the experiment will not be ready for the beamtime in 2024, the performance of a setup consisting of only two inner pixel layers surrounding the stopping target is studied. The absence of the outer tracking layers causes an increase in fake rate due to a loss of redundancy in the track reconstruction, as well as a loss of acceptance and momentum resolution. To overcome these negative effects, it is necessary to reduce the muon stopping rate and increase the magnetic field for this setup. The lower muon stopping rate reduces the hit occupancy and thus the fake rate, while the larger magnetic field increases the rate of recurling tracks in the inner layers and increases the momentum resolution. Results from a simulation study are presented for different magnetic field strengths and a tailored track reconstruction based on recurling tracks measured in only two tracking layers. The achievable sensitivities for different magnetic field configurations are compared.

T 112.6 Fri 10:15 Geb. 30.22: kl. HS A

Multiple Coulomb Scattering Monte Carlo Simulation Model Comparison — •Kevin Dojan[1], Ingrid-Maria Gregor[1,2], Simon Spannagel[2], Paul Schütze[2], and Hakan Wennlöf[2] — [1]Rheinische Friedrich-Wilhelms Universität Bonn — [2]Deutsches Elektronen-Synchrotron (DESY)

Monte-Carlo simulations are a powerful tool in high-energy physics to simulate particle interactions, among others for simulating the traversal of particles through matter. This is particularly important when simulating particle detectors where the dominant factor for the momentum resolution is multiple Coulomb scattering. The standard toolkit for particle-matter interactions is GEANT4. It offers different models to simulate multiple scattering behaviours in numerous applications. The characteristics of multiple Coulomb scattering will be compared for these models.