T 91: Silicon Detectors VIII (MAPS, misc.)

Time: Friday 9:00–10:30 Location: VG 1.101

T 91.1 Fri 9:00 VG 1.101

All-Silicon Modules — Hans Krüger, Marco Vogt, •Andreas Ulm, and Jochen Dingfelder — Universität Bonn

Silicon pixel detectors are an essential part of modern tracking systems for high energy physics experiments as they meet the requirements of high spatial and time resolution, and relatively low material budget. To cover large areas in the detector volume individual chips are combined to create modules. These modules are easier to assemble to full tracking systems. However gluing, additional flex PCBs, cooling and support structures, and also structural silicon can introduce significant amounts of material.

To reduce the material budget of tracking detectors as much as possible, a new concept of module building is investigated. By post-processing monolithic chip wafers, redistribution layers can be built on top of the chips for electrical connections to 4 chips in a row. By using low-power monolithic chips air cooling may be feasible and mechanical support is not necessary for thin ladder structures of up to 15 cm in length with thicknesses around 400 microns.

This talk will discuss concepts, ideas and first steps to prototyping such all-silicon modules.

T 91.2 Fri 9:15 VG 1.101

Performance of irradiated TJ-Monopix2 depleted monolithic active pixel sensors — •Lars Schall, Christian Bespin, Ivan Caicedo, Jochen Dingfelder, Fabian Hügging, Hans Krüger, Rasmus Partzsch, Norbert Wermes, and Sinuo Zhang — Physikalisches Institut der Universität Bonn, Bonn, Germany

Monolithic active pixel sensors with depleted substrates present a promising option for pixel detectors in high-radiation environments. Leveraging high-resistivity silicon substrates and high bias voltages in commercial CMOS technologies facilitates full depletion of the charge sensitive volume and enhances the radiation tolerance and charge collection performance. TJ-Monopix2 is the most recent large-scale chip in its respective development line, originally designed for the outer layers of the ATLAS Inner Tracker. TJ-Monopix2 is designed in 180 nm TowerJazz CMOS technology and features a small charge collection electrode, which requires the separation of the in-pixel electronics into p-wells. Process modifications in form of an additional n-type implant minimize regions with low electric field and improve the charge collection efficiency impaired by the long drift distances. The small pixel size of 33 x 33 μm^2 reduces the detector capacitance to approximately 3 fF enhancing noise and power performance. This contribution focuses on the performance of TJ-Monopix2 chips after irradiation to 5e14 neq/cm^2 NIEL fluence and 100 Mrad in total ionizing dose. Latest laboratory and beam test measurements are presented.

T 91.3 Fri 9:30 VG 1.101

Grazing Angle Test Beam Studies of the Hybrid-to-Monolithic MAPS Prototype — •Ono Feyens, Sara Ruiz Daza, Finn King, and Simon Spannagel — Deutsches Elektronen-Synchrotron DESY, Germany

The TANGERINE (Towards Next Generation Silicon Detectors) project at DESY investigates and develops fully integrated Monolithic Active Pixel Sensors (MAPS) using a novel 65 nm CMOS imaging technology. MAPS are an attractive technology for vertex detectors at future lepton colliders where a unique combination of high spatial resolution ($\leq$ 3 μm), fast timing ($\sim$ ns) and low material budget ($\leq$ 50 μm) are required. The 65 nm technology enables the production of MAPS with an increased density of in-pixel logic.

The H2M (Hybrid-to-Monolithic) prototype is the latest chip in a series of technology demonstrators. Its design ports a hybrid pixel-detector architecture into a monolithic chip with a pixel matrix of 64x16 square pixels of size 35x35 μm^2. To investigate the internal electric field and charge collection characteristics of H2M, grazing angle studies are performed at the DESY II Test Beam Facility. Here, particles impinge the sensor at very shallow angles, enabling the extraction of charge collection as a function of depth. This contribution will provide an overview of the experimental setup and will show first results of the grazing angle measurements.

T 91.4 Fri 9:45 VG 1.101

Charge calibration and reconstruction from binary hit data with MALTA2 a monolithic active pixel sensor — •Lucian Fasselt[1,2] and Steven Worm[1,2] — [1]DESY, Zeuthen, Germany — [2]Humboldt University, Berlin, Germany

MALTA2 is a depleted monolithic active pixel sensor (DMAPS) designed for tracking at high rates and is produced in the modified Tower Jazz 180nm CMOS technology. The sensing layer of the pixels with 36.4um pitch consists of either high resistivity epitaxial or Czochralski silicon. A small collection electrode features a small pixel capacitance and offers low noise. Typically, the detection threshold is around 200e-. A simple procedure is developed to calibrate the threshold to electrons making use of a dedicated charge injection circuit and an Fe-55 source with main charge deposition of 1600e-.

In this contribution, MALTA2 sensors are characterised in terms of hit detection efficiency inside the pixel and cluster size at fine threshold steps, for samples produced with different doping concentration of the internal n- layer, substrate voltage and irradiation dose. Test beam data was taken at CERN SPS in 2023 and 2024, using a MALTA beam telescope consisting of multiple sensor planes with 4um spatial and 2ns timing resolution. A reconstruction of the signal amplitude from binary hit data is performed. Through the charge calibration a two-dimensional map of the collected charge is obtained with sub-pixel resolution. The presented method provides an in-beam alternative to grazing angle studies or Edge-TCT for determining a charge collection profile.

T 91.5 Fri 10:00 VG 1.101

TelePix2: A HV-CMOS pixel sensor for Fast Timing and Region of Interest Triggering — •Arianna Wintle[1], Andre Schöning[2], David Immig[2], Felix Sefkow[1], Heiko Augustin[2], Ivan Peric[3], Lennart Huth[1], Lucas Dittmann[2], Marcel Stanitzki[1], and Ruben Kolb[2] — [1]Deutsches Elektronen-Synchrotron — [2]Heidelberg University — [3]The Karlsruhe Institute of Technology

The DESY II Test Beam Facility offers electrons with a user selectable momentum from 1-6 GeV primarily for detector characterisation. TelePix2, a HV-CMOS sensor, is the latest new user infrastructure at the test beam facility used as an arbitrary Region of Interest (ROI) trigger and a timing plane, for efficient small prototype testing and ambiguity suppression.

This contribution will highlight the importance of TelePix2 in the context of user operation at the test beam facility whilst providing an insight into test beam user infrastructure. The latest performance metrics of TelePix2 including an efficiency above 99 %, a timestamp resolution below 4 ns, and a ROI trigger time resolution below 2.5 ns will be presented.

T 91.6 Fri 10:15 VG 1.101

Investigation of the Belle II Pixel Detector Power Supply Network — •Paula Scholz[1], Florian Bernlochner[1], Jochen Dingfelder[1], Hans Krüger[1], Jannes Schmitz[1], and Botho Paschen[2] — [1]Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn — [2]Lawrence Berkeley National Laboratory

During beam loss events at the particle accelerator SuperKEKB in Japan, large amounts of radiation can severely damage the innermost layers of the Belle II detector, the Pixel Detector (PXD). Due to an increasing frequency of these events, the PXD has been shut down since May 2024 to prevent further harm.

The PXD consists of silicon pixel matrices based on the DEpleted P-channel Field Effect Transistor (DEPFET) technology. To control these matrices, Application-Specific Integrated Circuits (ASICs), the so-called „switchers“, are implemented on each module. During each readout cycle (50kHz), these switchers switch voltage levels of 20 V within a few nanoseconds. Since the PXD has been shown to be safe when the switchers are unpowered, a secure method to rapidly power down modules during beam loss events is needed. However, the powering network that involves 23 interdependent voltages, complicates this task.

To address this issue, a simulation of the PXD powering scheme, which includes more than 15 m long cables, has been developed. The transmission of emergency shutdown signals is studied by comparing simulation results with experimental data. The goal is to identify hardware modifications for safe PXD operation.