T 51: Halbleiterdetektoren III

Zeit: Mittwoch 16:00–18:15 Raum: H03

T 51.1 Mi 16:00 H03

Testbeam results of a high voltage monolithic active pixel sensor prototype for the ATLAS experiment — •Adrian Herkert for the ATLAS AMS/TSI-CMOS-Pixel-Collaboration — Physikalisches Institut Heidelberg

In the context of the High-Luminosity LHC the ATLAS Inner Tracker will be fully replaced. While the baseline design for the new pixel layers foresees hybrid detectors there are different approaches to monolithic pixel sensors that could be valid alternatives. Using monolithic pixel sensors for the outermost pixel barrel could lead to a significant reduction of production cost and time. Beyond that, these novel technologies have great potential with regard to future large scale pixel detectors. ATLASPix1 is a high voltage monolithic active pixel sensor (HV-MAPS) prototype produced in the commercial aH18 process by AMS. This talk will cover results from testbeam campaigns with unirradiated as well as neutron and proton irradiated ATLASPix1 samples.

T 51.2 Mi 16:15 H03

Total ionizing dose effects on the perfomance of RD53A — Michael Daas, Jochen Dingfelder, Tomasz Hemperek, Hans Krüger, •Marco Vogt, Norbert Wermes, Piotr Rymaszewski, Ahmed Qamesh, and Yannick Dieter — Physikalisches Institut der Universität Bonn

The phase-2 upgrade of the LHC will substantially increase the instantaneous luminosity. Especially for the pixel detector, which sits close to the interaction point, this requires novel pixel readout chips with highly complex digital architectures, which deliver hit information at drastically increased data rates and unprecedented radiation tolerance.

The large-scale prototype chip RD53A has been designed and manufactured by the RD53 collaboration in a 65 nm CMOS process, suitable for the innermost layers of both the ATLAS and the CMS experiment.

In order to verify the radiation hardness design goal of 500 Mrad, RD53A has been irradiated to a total ionizing dose of 600 Mrad using X-rays. The radiation effects on the performance of the data link, PLL, reset circuit and the analog front-ends have been investigated and will be presented in this talk.

T 51.3 Mi 16:30 H03

TCAD Simulation of High-Voltage Monolithic Active Pixel Sensors — •Annie Meneses Gonzalez, Heiko Augustin, and Andre Schoning — Physikalisches Institut, Universitat Heidelberg

The requirements for precision physics and the experimental conditions of several Particle Physics experiments lead to tight constraints for its tracker detectors. High-Voltage Monolithic Active Pixel Sensors (HV-MAPS) implemented in a commercial 180-nm High-Voltage CMOS process are under study as the technology for the Mu3e Pixel Tracker and as a candidate for other future detector applications like the ATLAS outermost pixel layer.

Laboratory measurements and beam test with prototypes are complemented by Technology Computer Aided Design (TCAD) simulations aiming for a comprehensive understanding of the sensor behavior and charge collection process. In this work TCAD simulation results of HV-MAPS prototype sensors will be presented. These include electric field distribution, breakdown voltage, leakage current, interpixel capacitance, and transient response to minimum

T 51.4 Mi 16:45 H03

Time Resolution of the Mupix8, a large HV-MAPS prototype — •Jan Hammerich for the Mu3e-Collaboration — Physikalisches Institut, Universität Heidelberg

The Mu3e experiment is searching for the charged lepton flavor violating (cLFV) decay $\mu \to eee$ with a planned sensitivity of 2 in 10^{15} decays for phase I. To achieve such a sensitivity, a fast, high resolution tracking detector is required which has a material budget of 0.1 % per tracking layer to reduce multiple Coulomb scattering.
A suitable technology for these requirements is the High Voltage Monolithic Active Pixel Sensor (HV-MAPS) concept. It combines fast charge collection via drift with a fully monolithic architecture of sensor and readout in one chip which can be thinned to 50 μm.
The MuPix8 is the first large scale HV-MAPS prototype for Mu3e with a size of 1 × 2 cm^2. It features circuitry to measure charge information which is used to correct for time walk. The time resolution of the system using time walk correction is presented.

T 51.5 Mi 17:00 H03

Characterization of RD53A, a readout ASIC prototype for the Phase-II upgrades of ATLAS and CMS — •Michael Daas, Jochen Dingfelder, Tomasz Hemperek, Florian Hinterkeuser, Fabian Hügging, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, and Norbert Wermes — Physikalisches Institut der Universität Bonn, Bonn, Deutschland

The Large Hadron Collider (LHC) at CERN will be upgraded for higher luminosities in 2025. The increased luminosity poses new demanding requirements for its detectors.

This talk gives a comprehensive overview over front-end characterization measurements on the RD53A pixel detector readout chip. It was developed by the RD53 collaboration, a joint research and development initiative of the ATLAS and CMS experiments. The RD53A readout chip features a smaller pixel pitch of $50 \times 50\,\mu m^2$ to mitigate single-pixel pile-up, higher data rate capabilities and high radiation tolerance. This enables the chip to cope with the very high occupancy, that is expected close to the interaction points of the upgraded LHC due to the higher luminosity.

The chip was characterized with regard to the performance of the three different analog front-end implementations in order to conclude the front-end R&D phase and decide which flavor will be used in the final production chip for the pixel tracking detectors of ATLAS and CMS. Measurement results comparing all three front-end flavors will be presented in this talk.

T 51.6 Mi 17:15 H03

Development of a small collection electrode monolithic pixel sensor in a novel 180 nm process for the ATLAS ITk upgrade — •Konstantinos Moustakas[1], Ivan Berdalovic[2], Christian Bespin[1], Ivan Caicedo[1], Tomasz Hemperek[1], Toko Hirono[1], Hans Krüger[1], Thanusan Kugathasan[2], Cesar Augusto Marin Tobon[2], Heinz Pernegger[2], Walter Snoeys[2], Tianyang Wang[1], Sinuo Zhang[1], and Norbert Wermes[1] — [1]Physikalisches Institut, University of Bonn, Germany — [2]CERN, Geneva, Switzerland

Monolithic pixel sensors are currently in consideration for the outer layers of the ATLAS ITk. Implementations that are based on a small collection electrode are advantageous in terms of power consumption and timing performance but can be sensitive to bulk radiation damage effects. A large-scale demonstrator chip, called TJ-Monopix01 has been developed in a modified 180 nm process that employs an implanted n-layer to achieve full depletion and enhanced radiation tolerance. It consists of $36x40\,\mu m^2$ pixels arranged in a 224x448 matrix and features sensor capacitance $\leq 3\,fF$, a synchronous "column-drain" readout architecture and total power consumption of $120\,mW/cm^2$. Laboratory measurements demonstrate the high signal to noise ratio by means of $ENC \approx 10\,e^-$ and fast timing response. These promising results encouraged the ongoing design of TJ-Monopix02, which addresses the challenges of a full-scale matrix ($2x2\,cm^2$) and will include further optimization of the process modification and improvements in the front end and pixel design to withstand radiation dose up to $1 \cdot 10^{15}\,n_{eq}/cm^2$ towards an ATLAS ITk compatible monolithic sensor.

T 51.7 Mi 17:30 H03

Charge Collection Efficiency Simulation of a Small Fill-Factor 180 nm Monolithic Pixel Detector — •Sinuo Zhang, Christian Bespin, Ivan Caicedo, Tomasz Hemperek, Toko Hirono, Fabian Hügging, Hans Krüger, Konstantinos Moustakas, David-Leon Pohl, Piotr Rymaszewski, Tianyang Wang, Jochen Dingfelder, and Norbert Wermes — Physikalisches Institut, University of Bonn, Nussallee 12, Bonn, Germany

For the ATLAS experiment at the HL-LHC, the innermost pixel tracking detector will be upgraded. As a potential replacement of the hybrid pixel detector, monolithic CMOS pixel detectors in 180 nm technology are developed. Such monolithic pixel detectors placed at the outer barrel layer suffer from silicon bulk damage after irradiation with the expected dose of 10^{15} neq/cm^2 that significantly enhances charge carrier trapping through impurity energy levels in the band gap. This causes a degradation in charge collection efficiencies which has been simulated with Synopsis Sentaurus TCAD by assuming effective defect levels according to the Perugia model. The obtained results revealed that enhancements of charge collection performance can be achieved by modifications of the electric field by changing biasing condition and implantation profile. The simulation results will be presented by comparing different biasing conditions, pixel geometries, and irradiation doses.

T 51.8 Mi 17:45 H03

Analysis of the behavior of the poly-crystalline diamond sensors of the BCM1F detector and luminosity measurement at the CMS Experiment — •Valerie Scheurer, Moritz Guthoff, and Andreas Meyer — DESY, Hamburg

For determination of the cross sections of physical processes, it is essential to measure the luminosity as accurately as possible. This is done by measuring the event rate. From the visible cross section of a so-called luminometer the total luminosity can be extrapolated. The visible cross section is determined in calibration measurements (Van der Meer scans). If the visible cross section is known for a luminometer, the instantaneous luminosity can be measured in real-time.

Several luminometers are used in the CMS experiment. One of these detectors is the Fast Beam Condition Monitor (BCM1F). The BCM1F detector is located directly at the beam pipe, on both sides at a distance of 1.8 m from the interaction point. However, the efficiency of these sensors shows a dependency on the absolute event rate. For its calibration the per bunch luminosity changing during a fill of the collider has to be considered. Also the total Luminosity, which for example depends on the number of bunches in a fill, has an influence on the efficiency of the sensors.

In the talk the luminosity measurement at the CMS experiment as well as the calibration of BCM1F are presented.

T 51.9 Mi 18:00 H03

Timepix3 (TPX3) Luminosity Determination of 13 TeV Proton-Proton Collisions at the ATLAS Experiment — •Andre Sopczak[1], Cyprien Beaufort[1], Benedikt Bergmann[1], Thomas Billoud[2], Bartholomej Biskup[1], Jan Broulim[1,3], Pavel Broulim[3], Petr Burian[1,3], Davide Caforio[1], Erik Heijne[1], Petr Fiedler[1], Claude Leroy[2], Catalina Lesmes Ramierez[1], Stanislav Pospisil[1], Thomas Seidler[1], and Michael Suk[1] — [1]Czech Technical University in Prague — [2]University of Montreal — [3]University of West Bohemia in Pilsen

Medipix and Timepix devices, installed in the ATLAS cavern at LHC, have proved to provide valuable complementary luminosity information. Results are presented from a new measurement network, based on the latest Timepix3 chip. In contrast to previously employed frame-based data acquisition, the TPX3 detector remains active continuously, sending information on pixel hits as they occur. Hit- and cluster-counting methods were used for the luminosity determination of the LHC proton-proton collisions. By counting the number of clusters, instead of just pixel hits, the precision of the luminosity determination could be improved. The LHC luminosity versus time is determined using these two methods, and fitted to a simple model incorporating luminosity reduction from single bunch and beam-beam interactions. The internal precision and long-term time stability of the TPX3 luminosity measurement were determined. The TPX3, owing to its precise time resolution, is able to resolve the time structure of the luminosity due to the collisions of individual LHC proton bunches.