T 13: Pixel detectors I

Time: Monday 16:30–18:00 Location: H-HS XIV

T 13.1 Mon 16:30 H-HS XIV

Quality Control Measurements of RD53A on Wafer- and Module Level — •Michael Daas, Markus Frohne, Tomasz Hemperek, Florian Hinterkeuser, Fabian Hügging, Hans Krüger, David-Leon Pohl, Mark Standke, Marco Vogt, Norbert Wermes, and Jochen Dingfelder — Physikalisches Institut der Universität Bonn

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 an overview over preparations for quality control measurements based on the RD53A readout ASIC, developed by the RD53 collaboration. It features a small 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 high occupancy of up to $3 \cdot 10^9$ hits $\cdot$ cm^{-2} $\cdot$ s^{-1}, that is expected in some areas of the ATLAS tracking detector of the upgraded LHC.

After an extensive characterization phase in the last years, first module assemblies based on RD53A are now used to develop QC procedures for ATLAS ITk module production. This talk covers the development of a wafer probing setup for quality control of bare readout ASICS on wafer level, as well as the first preparations for a module test setup. Since the University of Bonn is one of the largest module production sites within the ATLAS collaboration, many of the about 10000 modules for the ATLAS ITk Pixel Detector will be assembled and tested here.

T 13.2 Mon 16:45 H-HS XIV

Characterization of RD53A modules using x-ray fluorescence — •Sascha Dungs[1,2], Kevin Kröninger[2], Susanne Kühn[1], Lingxin Meng[1], and Heinz Pernegger[1] — [1]CERN — [2]TU Dortmund, Experimental Physics IV

As part of the Phase-II upgrade of the ATLAS detector, the current tracking detector will be replaced by an all-silicon detector, the Inner Tracker (ITk). For this, a new generation of silicon hybrid pixel modules are currently being developed. There are different techniques to investigate the properties of these modules. X-ray fluorescence can be used for energy calibration. An x-ray source is pointing on a target material, which leads to emission of photons with monochromatic energy. By using various target materials a wide energy range can be evaluated.

In this talk, results of x-ray fluorescence measurements of unirradiated and irradiated planar pixel modules with RD53A readout chips will be presented.

T 13.3 Mon 17:00 H-HS XIV

Charge Calibration and Crosstalk Measurements with RD53A Assemblies — •Georgios Giakoustidis — Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn, Germany

The RD53 collaboration designed a new prototype hybrid pixel readout chip using the 65 nm CMOS technology for the High-Luminosity LHC upgrade. Thinner silicon sensors chosen to cope with the prospective high radiation levels in ATLAS require lower threshold of the readout electronics making the tunings more challenging. Thus, calibration of the charge injection circuitry of RD53A assemblies with different sensor geometries was conducted using the precise TDC method. At low thresholds crosstalk becomes more perceptible and should be considered for the final sensor design selection. Therefore RD53A assemblies with sensors of different pixel structure and geometries were tested by injecting artificial charge to neighbouring pixels in various patterns. Events of cluster size one and two are analysed, leading to a transfer function with slope of (10.37 ± 0.10) e/DAC and offset of (180 ± 60) e. Calibration results for different thresholds showed no significant difference. Assemblies with the same pixel geometry between the sensor and the readout chip exhibited crosstalk of about 1%, whereas 7% to 16% crosstalk was observed for assemblies with geometry mismatch. Since no significant differences observed between charge calibration of different RD53A assemblies and thresholds, the final transfer function is of global use. A sensor with a non-matching pixel geometry to the readout chip is not ideal for the RD53A. Sensors with smaller implants reduce the crosstalk levels by 30%.

T 13.4 Mon 17:15 H-HS XIV

Characterization of a depleted monolithic active pixel sensor in 180 nm TowerJazz technology — Ivan Berdalovic[2], •Christian Bespin[1], Ivan Caicedo Sierra[1], Leyre Flores Sanz De Acedo[2], Tomasz Hemperek[1], Toko Hirono[1], Fabian Hügging[1], Hans Krüger[1], Thanusan Kugathasan[2], Cesar Augusto Marin Tobon[2], Konstantinos Moustakas[1], Heinz Pernegger[2], Walter Snoeys[2], Tianyang Wang[1], Norbert Wermes[1], and Jochen Dingfelder[1] — [1]Physikalisches Institut, Universität Bonn — [2]CERN, Genf

The planned upgrade of LHC leading to the High-Luminosity Large Hadron Collider (HL-LHC) imposes new requirements on the detectors. With the availability of highly resistive silicon in commercial CMOS processes, there have been efforts to build depleted monolithic active pixel sensors (DMAPS) for high energy particle detectors. TJ-MonoPix is a prototype of such a pixel sensor in 180 nm TowerJazz technology. It is designed for usage in high radiation environments such as the HL-LHC. The pixels with a small collection electrode design and pixel pitch of 36 μm $\times$ 40 μm are read out using a FE-I3-like column drain readout architecture. Different flavors allow for a study of minor modifications in the pixel design.

In this talk, results from radioactive sources and X-ray irradiations will be presented. Furthermore, an overview of ongoing work towards a future chip in this CMOS technology will be shown.

T 13.5 Mon 17:30 H-HS XIV

Characterization of Planar Pixel Sensors for the CMS Phase 2 Upgrade — •Finn Feindt[1], Aliakbar Ebrahimi[1], Erika Garutti[1], Caroline Niemeyer[1], Daniel Pitzl[2], Georg Steinbrück[1], Jörn Schwandt[1], and Irene Zoi[1] — [1]Institute for Experimental Physics, Hamburg University, Luruper Chaussee 149, D-22761 Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron, Notkestraße 85, D-22607 Hamburg, Germany

The CMS Pixel Detector for the Phase 2 Upgrade of the CMS Experiment will have to withstand a 1 MeV neutron equivalent fluences ϕ_{eq} of up to $2{\times}10^{16}$ cm^{-2} at 2.8 cm distance from the beam and enable tracking in a high track multiplicity environment caused by up to 200 proton collisions per bunch crossing.

To meet these requirements, planar pixel sensors with pixel sizes of $50{\times}50$ μm^2 or $100{\times}25$ μm^2 and an active thickness of 150 μm were designed, produced and characterized after proton or neutron irradiation to ϕ_{eq} above $5{\times}10^{15}$ cm^{-2}, corresponding to the fluence expected in the second layer of the CMS Pixel Detector. The sensors differ in the design of implantation, metalization and biasing scheme and the pixel isolation technology.

The presented results show that the irradiated planar pixel sensors fulfill the requirement of efficiency $\epsilon = 0.99$ at operation voltages below 800 V. In addition, the characterization and comparison of the different sensor designs provide valuable input for the final choice of the sensor design.

T 13.6 Mon 17:45 H-HS XIV

Capacitance measurements on silicon pixel sensors for ATLAS ITk — •Evelyn Kimmerle, Hans Krüger, and Norbert Wermes — Physikalisches Institut, Universität Bonn, Nussallee 12, 53115 Bonn, Deutschland

The pixel capacitance is a sensitive parameter when it comes to pixel sensors and signal processing. It has influence on noise performance, time resolution and power consumption so its precise knowledge is important.

For this purpose, a dedicated integrated circuit was developed. The so-called PixCap65 chip provides a powerful tool for pixel sensor capacitance measurement with unprecedented sub-femtofarad precision.

The PixCap65 chip is compatible with the next generation of pixel sensors with small 50μm x 50μm pixels that are deployed in the future hybrid pixel detectors of the ATLAS and CMS experiments.

In this presentation, the functional principle of the PixCap65 chip and measurement results of various sensor pixel geometries are discussed.