T 94: Silicon Strip Detectors 2

Time: Thursday 16:15–18:00 Location: T-H25

T 94.1 Thu 16:15 T-H25

Status of the CMOS Strip Detector Project in Freiburg — •Niels Sorgenfrei, Leena Diehl, Marc Hauser, Cedric Hönig, Karl Jakobs, Sven Mägdefessel, Ulrich Parzefall, Arturo Rodriguez, and Dennis Sperlich — Albert-Ludwigs Universität, Freiburg, Germany

Due to the increased use of large area silicon detectors in current and future particle detectors and only very few vendors available, which are capable of silicon production and processing fulfilling quality and size requirements, the need for reliable, fast and cost efficient production processes arises. As part of a CERN market survey, CMOS sensors in pixel and strip geometries were developed.

The idea is to utilise the already existing industry infrastructure of the CMOS process. However, typical CMOS foundries are usually only equipped to process smaller sensors compared to what is required in e.g. the strip region of the ATLAS Inner Tracker. Therefore, the process of stitching has to be used. By employing wafer masks where the sensor structure is divided up into different parts, the individual parts can be imprinted multiple times side by side on the wafer resulting in coherent areas larger than the reticles themselves. The effect of stitching on charge collection, electric field strength and configuration, detection efficiency and radiation hardness has to be investigated.

In this talk measurements on passive CMOS strip sensors, produced by LFoundry in a 150 nm process, will be discussed. Three different strip designs are investigated and the results of IV, ^{90}Sr-source and edge-TCT measurements will be presented.

T 94.2 Thu 16:30 T-H25

Humidity Studies on ATLAS ITk sensors — Naim Bora Atlay[2], Ingo Bloch[1], Heiko Lacker[2], •Ilona Stefana Ninca[1], and Christian Scharf[2] — [1]Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany — [2]Humboldt-Universität zu Berlin, Berlin, Germany

This study aims to investigate electrical breakdown in the periphery of silicon sensors, with a focus on humid conditions. The study will take advantage of the large number of silicon strip sensors produced for the ATLAS Upgrade in order to probe their behavior. The sensors are investigated using the transient current technique (TCT). The TCT setup available at Deutsches Elektronen-Synchrotron in Zeuthen employs both red and infrared laser light. This setup can be used to study the transport of free charge carriers in the sensors at the surface and inside the bulk. Additionally, to better understand the electric properties of the sensors, simulations using Technology Computer Aided Design were produced. ATLAS ITk silicon miniature diodes were investigated in a humid environment. We are planning to use a dedicated camera to localize the critical spots where breakdown occurs on the surface of the diodes through luminescence of hot carriers. Using the information provided by the TCT measurements, the humidity dependence of the electric field at the breakdown point is planned to be studied. Understanding these dependencies will help us propose better geometries for future sensors and potentially allow us to develop improved operation scenarios for the future ATLAS ITk strips detector.

T 94.3 Thu 16:45 T-H25

Recent results from the End-of-Substructure card for the ATLAS Strip Tracker Upgrade — •Rickard Stroem[1], Artur Boebel[1], Harald Ceslik[1], Mogens Dam[2], Sergio Diez Cornell[1], Peter Goettlicher[1], Ingrid Gregor[1], James Keaveney[3], Max Nikoi Van Der Merwe[3], Jan Oechsle[2], Stefan Schmitt[1], Marcel Stanitzki[1], and Jane Wyngaard[3] — [1]DESY, Germany — [2]Niels Bohr Institute, Denmark — [3]University of Cape Town, South Africa

The silicon tracker of the ATLAS experiment will be upgraded for the High-Luminosity Upgrade of the LHC. The main building blocks of the new strip tracker are modules of silicon sensors and hybrid PCBs hosting the read-out ASICs. The modules are mounted on rigid carbon-fibre substructures, known as staves in the central barrel region and petals in the end-cap regions, that provide services to all the modules. At the end of each stave/petal, a so-called End-of-Substructure (EoS) card facilitates the transfer of data, power, and control signal between the modules and the off-detector systems. The module front-end ASICs transfer data to the EoS card on 640 Mbit/s differential lines. The EoS connects up to 28 data lines to one or two lpGBT chips that provide data serialisation and uses a 10 GBit/s versatile optical link (VL+) to transmit signals to the off-detector systems. We will here present the EoS card's design, results from various stress tests, and the design and status of the dedicated production quality control test-stands in the Detector Assembly Facility at DESY.

T 94.4 Thu 17:00 T-H25

Beam Test Studies with Silicon Sensor Modules for the CMS Experiment — •Florian Wittig[1], Tobias Barvich[1], Bernd Berger[1], Alexander Dierlamm[1], Alexander Droll[1], Umut Elicabuk[1], Ulrich Husemann[1], Markus Klute[1], Gani Kösker[1], Roland Koppenhöfer[1], Stefan Maier[1], Thomas Müller[1], Jan-Ole Müller-Gosewisch[1], Andreas Nürnberg[2], Marius Neufeld[1], Hans Jürgen Simonis[1], Pia Steck[1], and Lea Stock[1] — [1]Institute of Experimental Particle Physics (ETP), Karlsruher Institute of Technology (KIT) — [2]Deutsches Elektronen-Synchrotron (DESY)

In the context of the Phase-2 Upgrade of the CMS Experiment, the whole tracker will be replaced. The new CMS Outer Tracker will be equipped with two different types of silicon sensor modules called PS and 2S modules. During the LHC runtime, the modules and especially the silicon sensors will accumulate radiation damage, which lowers the signal measured by the module. In order to ensure the full functionality of the 2S modules during the entire operation time of CMS, modules in the advanced prototyping phase have been built. One of the prototypes features sensors that have been irradiated to fluences that are expected at the end of the CMS runtime. These unirradiated and irradiated prototypes have been tested at the DESY beam test facility. This talk summarizes the results gathered at the beam tests.

T 94.5 Thu 17:15 T-H25

test beam analysis of a silicon-strip module for the CMS phase-II tracker upgrade — •Chun Cheng — DESY, Hamburg, Germany

The foreseen Large Hadron Collider upgrade is expected to deliver an integrated luminosity that is one order of magnitude larger after 2027. Rare processes and new phenomena may be observed in this high luminosity era. The Phase-II Outer Tracker upgrade of the CMS experiment is required to surmount higher radiation and increased event rate. Transverse momentum (PT) discrimination is introduced in the design and will contribute to the Level-1 Trigger. A CMS 2S silicon strip module with PT discrimination concept was built by the DESY Outer Tracker group and has undergone a test beam experiment at the DESY test beam facility.

The talk will briefly summarize the assembly of the DESY 2S module, sensor studies and the data acquisition scheme during the beam test. The main focus will be on the results from recent test beam measurements. The analysis will be done based on corryvreckan framework, a modular concept of test beam reconstruction chain. Hit efficiency of the sensors under a bias scan, the performance over the large module area, and on-module PT discrimination functionality will be presented.

T 94.6 Thu 17:30 T-H25

Beam test of 2S module prototypes for the Phase-2 CMS Outer Tracker — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], and •Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

The CMS detector will be upgraded in the Phase-2 Upgrade for the operation at the HL-LHC. Among others, the silicon tracking system will be completely replaced by a new system providing an extended acceptance, an improved granularity and the feature to include tracking information into the level-1 trigger. The new Outer Tracker will consist of 2S modules with two strip sensors and PS modules with a macro-pixel sensor and a strip sensor, specialized detector modules with onboard p_T discrimination.

The functionality of current generation prototype 2S modules has been tested at the test beam facility at DESY Hamburg in November 2019. With a 4 GeV electron beam, various studies are performed like

efficiency scans at different positions of the module or at varying inclination angles to mimic different p_T particles. In this talk, efficiency studies are presented.

T 94.7 Thu 17:45 T-H25

A new high rate electron beam line at DESY II — •Dohun Kim — DESY, Notkestraße 85, 22607 Hamburg

The R-Weg is a former transfer beam line from the DESY II synchrotron to DORIS. Recently, it has been refurbished to serve as a high-rate electron beam line. The full DESY II beam with up to several $10^{10} e^-$ can be dumped at a rate of 12.5 Hz. The available rates allow many detector tests that require high particle rates, but this also allows to use the beam line has a facility for electron irradiation.

Before the R-Weg is put into full operation, it is necessary to understand the beam parameters and the radiation field in detail. Therefore, the R-Weg has been simulated and studied using FLUKA, which is a MC simulation framework for the interaction and transport of particles in materials.

The beam divergence, stability, beam profile etc. have been simulated.To verify the results, a suite of measurements has been prepared and compared. In addition, the neutron and gamma background from the beam dump are studied to ensure safe operation and to enable the use as a electron irradiation facility.

This presentation is going to explain details of the R-Weg and present the simulation result. Finally, an outlook into future measurements at the R-Weg is given.