T 65: Silicon Strip Detectors

Time: Wednesday 16:15–18:15 Location: T-H24

T 65.1 Wed 16:15 T-H24

Optical inspection of silicon strip sensors for the Phase-2 Upgrade of the CMS Tracker — Anna Becker[1], Christian Dziwok[2], Lutz Feld[1], Patrick Juraschitz[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

During the Long Shutdown 3 the LHC will be upgraded to the High Luminosity LHC with a planned instantaneous luminosity of at least $5 \cdot 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$. For this purpose the current strip tracker of the CMS experiment will be entirely replaced by a new system consisting of innovative silicon detector modules. RWTH Aachen University as one of the assembly centers is responsible for manufacturing around 1000 so-called 2S modules, which are equipped with two vertically stacked strip sensors having an active area of $10 \cdot 10\,\mathrm{cm}^2$.
During module production the inspection of the silicon sensors is crucial in order to detect damage or contamination caused by the assembly process which could seriously affect the successful operation of the module. For this purpose an automated optical inspection setup has been developed. It consists of a 24 mega pixel camera equipped with a macro lens and an xy-stage.
This talk presents the setup, the approach to detect damages, and results obtained from images taken in the course of the assembly of a 2S module prototype featuring preproduction sensors.

T 65.2 Wed 16:30 T-H24

Testing results of the latest Service Hybrid prototypes for CMS silicon strip modules — Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Daniel Louis[1], •Alexander Pauls[1], Oliver Pooth[2], Matej Repik[1], Nicolas Röwert[1], Michael Wlochal[1], and Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The CMS Collaboration is developing silicon strip modules for the second phase of the CMS tracker upgrade. This upgrade will enable the CMS experiment to utilize the high luminosity provided by the future HL-LHC. The modules' Service Hybrids are responsible for the sensor bias voltage and low voltage distribution on the module and the data transmission via optical links to the back-end electronics. Multiple batches of Service Hybrid prototypes have been produced. The latest use the final ASIC set with its most recent available versions and materials and geometries as foreseen in the detector. The prototyping campaign and present measurements of the hybrid performance are summarized. The measurements were performed with setups similar to the foreseen production test system, which is also presented.

T 65.3 Wed 16:45 T-H24

Vermessung von Streifenmodulen für das CMS Phase-2 Tracker Upgrade bei Betriebstemperatur — Christian Dziwok[2], Lutz Feld[1], •Patrick Juraschitz[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Nicolas Röwert[1], Michael Wlochal[1] und Tim Ziemons[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

Im Zuge des HL-LHC Upgrades im Long-Shutdown 3 (2025-2027) muss der Silizium-Spurdetektor des CMS Experiments ausgetauscht werden. Das Phase-2 Outer Tracker Upgrade umfasst neue Module, welche aus zwei übereinander parallel ausgerichteten Sensoren bestehen. Diese ermöglichen es durch die Analyse der Teilchendurchgänge bereits im Auslesechip eine Abschätzung des transversalen Impulses zu erhalten. Die relative Ausrichtung der Sensoren zueinander beeinflusst dabei maßgeblich die Qualität dieser Abschätzung. Die Alignierung wird mittels doppelseitiger Metrology gemessen, wobei das Modul von zwei Kameras betrachtet wird.
Der Phase-2 Spurdetektor soll bei einer Temperatur von -35°C betrieben werden. Daher ist das Verhalten der Module im Hinblick auf die Ausrichtung bei Betriebstemperatur von besonderem Interesse.
Es wird ein Verfahren präsentiert, welches es ermöglicht, Module mit einer Kühlmaschine zu kühlen und im Anschluss zu vermessen. Die Ergebnisse werden mit Messungen bei Raumtemperatur verglichen, um mögliche Auswirkungen der Temperatur auf die Ausrichtung der Sensoren zueinander nachzuvollziehen.

T 65.4 Wed 17:00 T-H24

Stress testing optical readout components for CMS 2S modules — •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, Aachen, Germany — [2]RWTH Aachen University - Physics Institute III B, Aachen, Germany

For the upcoming CMS Phase-2 Outer Tracker upgrade, new detector modules will be installed. There are two general types of modules, one consisting of two co-planar silicon strip sensors (2S) and one of a macro pixel and a strip sensor (PS). The communication and the auxiliary support are supplied by a so called SErvice Hybrid (SEH) in case of a 2S module. At the RWTH Aachen University the SEHs are qualified regarding power and communication stability in a so called test board setup, where the SEHs will undergo additional thermal cycling while being tested. This talk will focus on the data tests of this setup.

T 65.5 Wed 17:15 T-H24

Functional Testing of Silicon Sensor Modules for the CMS Experiment using Infrared LED Arrays — •Roland Koppenhöfer[1], Tobias Barvich[1], Bernd Berger[1], Justus Braach[2], Alexander Dierlamm[1], Ulrich Husemann[1], Markus Klute[1], Gani Kösker[1], Stefan Maier[1], Thomas Müller[1], Marius Neufeld[1], Hans Jürgen Simonis[1], Pia Steck[1], and Florian Wittig[1] — [1]Institute of Experimental Particle Physics (ETP), Karlsruhe Institute for Technology (KIT) — [2]CERN

In the context of the Phase-2 Upgrade of the CMS experiment, the complete CMS tracker will be replaced. The new CMS Outer Tracker will consist of two types of silicon sensor modules (PS and 2S modules). These modules are built and tested for their full functionality at different assembly centers. The ETP is one of the assembly centers for 2S modules. A dedicated test station for the electrical characterization of 2S modules has been designed and built at ETP. Using infrared LEDs it is possible to generate charge in the silicon sensors and test every module channel. This talk will present the test station developed at ETP and summarize the functional test results of the newest 2S module prototypes.

T 65.6 Wed 17:30 T-H24

Assembly and Test Procedures of 2S modules for the future Outer Tracker of the Phase-2 Upgrade of the CMS Experiment — •Stefan Maier, Tobias Barvich, Bernd Berger, Alexander Dierlamm, Alexander Droll, Umut Elicabuk, Jan-Ole Müller-Gosewisch, Ulrich Husemann, Roland Koppenhöfer, Markus Klute, Gani Kösker, Thomas Müller, Marius Neufeld, Hans Jürgen Simonis, Pia Steck, Lea Stockmeier und Florian Wittig — Institute of Experimental Particle Physics, Karlsruhe Institute of Technology

In preparation for the High Luminosity LHC, the entire tracker of the CMS experiment will be exchanged within the Phase-2 Upgrade until 2027. The new outer tracker will be made of approximately 13000 silicon sensor modules called 2S modules (consisting of two parallel silicon strip sensors) and PS modules (one pixel and one strip sensor combined in a module). These modules provide tracking information to the Level-1 trigger by correlating the hit information of both sensor layers and, thus, allowing to discriminate charged particles by their transverse momentum. To guarantee successful operation of the CMS detector at the HL-LHC, the production of the outer tracker modules has to fulfil strict requirements. The talk will summarize the various assembly and test concepts for the large scale production of 2S modules and will present the latest module prototypes.

T 65.7 Wed 17:45 T-H24

Integration Tests with 2S Module Prototypes for the Phase-2 Upgrade of the CMS Outer Tracker — •Lea Stockmeier, Tobias Barvich, Bernd Berger, Alexander Dierlamm, Alexander Droll, Umut Elicabuk, Ulrich Husemann, Markus Klute, Roland Koppenhöfer, Stefan Maier, Thomas Müller, Jan-Ole Müller-Gosewisch, Marius Neufeld, Hans Jürgen Simonis, Gani Kösker, Pia Steck, and Florian Wittig — Institut für

Experimentelle Teilchenphysik (ETP), Karlsruher Institut für Technologie (KIT)

To deal with the increased luminosity of the HL-LHC, the CMS experiment will be upgraded until 2027. During this Phase-2 Upgrade the CMS Outer Tracker will be equipped with modules each consisting of two silicon sensors. Depending on the position in the tracker, these silicon sensors are pixel or strip sensors. The modules with two strip sensors are called 2S modules. In the barrel region, they are placed on mechanical structures called ladders. A fully equipped ladder contains twelve modules.

Within the prototyping phase of the 2S modules, laboratory and integration tests are performed. This talk summarizes the first integration test on a ladder performed with four modules at Institut Pluridisciplinaire Hubert CURIEN (IPHC) in cooperation with KIT and laboratory tests performed at KIT.

T 65.8 Wed 18:00 T-H24

Commissioning of a Burn-In Setup for PS and 2S Detector Modules for the Upgrade of the CMS Outer Tracker — •Ana Ventura Barroso, Katerina Lipka, and Paul Schütze — DESY, Hamburg, Germany

The high luminosity LHC Upgrade will increase the instantaneous luminosity by a factor of five. The CMS detector will be upgraded in the so called Phase-2 Upgrade in order to meet the new requirements, among others the level of radiation tolerance and coping with larger pileup and thus higher data rates, as well as to add triggering capabilities. The entire silicon tracker will be replaced. The Outer Tracker (OT), consisting of macro-pixel and strip detectors, will be based on silicon modules that must operate at low temperatures ($-33°$ C) due to the exposition at high radiation levels. The probability for defective electronic components to fail is higher after few hours of operation. Moreover, temperature cycles can induce mechanical stress. Therefore a burn-in procedure as well as thorough quality control is needed to ensure the correct operation of each of the OT modules before installation.

For this, a burn-in system is being commissioned at DESY. This setup will perform thermal cycles from room to operation temperature and key measurements to ensure the good performance of the modules. In this talk, the status of the DESY burn-in setup as well as first tests will be presented.