T 33: Silicon Detectors IV

Time: Tuesday 16:15–18:15 Location: KH 01.022

T 33.1 Tue 16:15 KH 01.022

Production of Outer Barrel pixel detector modules for the ATLAS ITk pixel detector at the FTD in Bonn — •Matthias Schüssler, Yannick Dieter, Jochen Dingfelder, Florian Hinterkeuser, Fabian Hügging, Hans Krüger, Matthias Hamer, and Maximilian Mucha — Physikalisches Institut der Universität Bonn, Bonn, Germany

With the upgrade of the Large Hadron Collider (LHC) to the High-Luminosity LHC (HL-LHC), the instantaneous luminosity will increase by a factor of 5 with respect to its design value from 2030 onward. This results in unprecedented hit rates and radiation levels which require major upgrades of the detectors at the HL-LHC.

For the upgrade of the ATLAS detector, a new all-silicon inner tracking detector (ITk detector) consisting of silicon strip and pixel modules will be installed to replace the currently operated Inner Detector. In total, approximately 10.000 new pixel detector modules have to be built and carefully tested to ensure that only functional detector modules are installed. During the currently ongoing 2-year production of the ATLAS ITk pixel detector, at least 1600 pixel detector modules are being built and tested at the Forschungs- und Technologiezentrum Detektorphysik (FTD) in Bonn.

This large-scale production requires a dedicated quality control (QC) effort to assure the functionality of the final detector. This talk provides an overview of the assembly and testing procedures that are ongoing at the FTD in Bonn, including an overview of the production so far.

T 33.2 Tue 16:30 KH 01.022

Experience with the production of ATLAS ITk pixel detector modules for the HL-LHC upgrade in Siegen — Markus Cristinziani[1], Qader Dorosti[1], Olivier Fox[1], Daniel Groth[1], Luke Hammer[1], Stefan Heidbrink[2], Lasse Jäderberg[1], Nils Krengel[1], Leonie Krippendorf[1], Denise Müller[1], Jason Müller[1], Lina Reifenberg[1], •Noah Siegemund[1], Waldemar Stroh[2], Darshil Vagadiya[1], Wolfgang Walkowiak[1], Jens Winter[2], Michael Ziolkowski[2], and Alessia Zuev[1] — [1]Center for Particle Physics Siegen, Experimentelle Teilchenphysik, Universität Siegen — [2]Elektronikentwicklungslabor Physik, Universität Siegen

With the High-Luminosity upgrade of the Large Hadron Collider (HL-LHC), the innermost layer of the ATLAS detector will be replaced by a new Inner Tracker (ITk) pixel detector. The University of Siegen contributes to this upgrade by producing quad modules for the outer barrel region of the pixel detector. A quad module is designed as a hybrid structure consisting of a flexible printed circuit board (PCB) glued onto a bare module in a cleanroom environment. That bare module is composed of a silicon-based sensor and four front-end readout chips (FEs). Electrical connection between the FEs and the PCB is provided by about 700 wirebonds. Extensive quality control (QC) procedures are performed before and after assembly, including metrology, visual inspections, and electrical characterization. In this contribution, the production chain of quad modules at the University of Siegen will be presented, with focus on the non-electrical aspects of the QC workflow.

T 33.3 Tue 16:45 KH 01.022

The ATLAS ITk cell integration site in Bonn — •Alexandra Wald, Klaus Desch, Matthias Hamer, Florian Hinterkeuser, Jochen Dingfelder, Nico Klein, and Dominik Hauner — Physikalisches Institut, Universität Bonn, Deutschland

In conjunction with the high luminosity upgrade of the Large Hadron Collider at CERN, the current tracking system of the ATLAS experiment will be replaced by the Inner Tracker (ITk), an all-silicon detector consisting of 5 layers of pixel detectors and 4 layers of strip detectors. More than 8000 modules will be installed in the pixel layers, which together have an active area of approximately 13m2 and cover a pseudorapidity of up to 4. In order to build such a large detector in time, the integration of the ITk Pixel modules on their local support structures (longerons or incliend halfrings(IHR)), as well as the quality control of individual loaded local supports will be distributed over many institutes. One of the assembly lines will be setup at the University of Bonn, with technicians from other German locations also helping with cell integration. Due to the serial powering scheme of the ITk Pixel Detector, the quality control of a loaded local support is challenging in several aspects, as the simultaneous operation of multiple modules is necessary for any tests. A large number of different components must hence be integrated into the quality control setup, such as an optical readout system, an interlocks system, industrial power supplies and a scalable DCS. In this presentation, the loaded local support assembly line and the QC setup in Bonn are presented, with particular attention to recent operational developments and the latest tests.

T 33.4 Tue 17:00 KH 01.022

Integration Test with 2S Modules for the CMS Phase-2 Outer Tracker Upgrade — Max Beckers[2], Lutz Feld[1], Nina Höflich[2], Katja Klein[1], Martin Lipinski[1], •Vanessa Oppenländer[1], and Oliver Pooth[2] — [1]1. Physikalisches Institut B, RWTH Aachen — [2]3. Physikalisches Institut B, RWTH Aachen

The new operating conditions of the future HL-LHC require a replacement of the complete silicon tracking system of the CMS experiment as part of the CMS Phase-2 Upgrade. For the Phase-2 Outer Tracker new silicon strip modules, so-called 2S modules, have been developed that consist of two silicon sensors stacked on top of each other. By correlating the measured hits of both sensors, this module design enables the inclusion of tracking information in the Level-1 trigger at CMS for the first time. For the new Phase-2 tracker the endcap region is known as the Tracker Endcap Double-Disks (TEDD) and is composed of five double-disks on each detector side that feature PS modules at smaller radii as well as 2S modules at larger radii. Each disk will be composed of two half disks that are called dee. After the careful assembly of the modules they are integrated onto the dees, which serve as the cooling and support structure for the modules. In this talk measurements and results from a dee integration test at DESY with 8 of the first pre-production 2S Modules built at RWTH Aachen will be shown.

T 33.5 Tue 17:15 KH 01.022

CMS Outer Tracker Beam Test at CHARM — Alexander Dierlamm[1], Andromachi Tsirou[2], Ashling Clare Quinn[3], Guido Magazzu[4], •Ivan Shvetsov[1], John Steven Lawless[5], Piero Giorgio Verdini[4], Prafulla Saha[6], Yuri Gershtein[6], and Garvita Agarwal[7] — [1]Institute of Experimental Particle Physics (ETP),Karlsruhe Institute of Technology (KIT) — [2]National and Kapodistrian University of Athens — [3]Princeton University — [4]University of Pisa — [5]University of Tennessee — [6]Rutgers State University of New Jersey — [7]University of Notre Dame

In the scope of the HL-LHC upgrade the new CMS Tracker will be built. The future tracker will consist of two module types: strip-strip (2S) and pixel-strip (PS) modules. In order to stress the operation of these modules a test beam at the CERN Highly-Accelerated Mixed Field Facility (CHARM) was performed. The facility provides a mixed particle spectrum, which allows to operate the modules in an environment close to realistic conditions of the future detector. The modules were irradiated with a flux of up to $\sim 10^7/cm^2 \cdot s$. The data was successfully collected with a prototype of the final data acquisition chain. Technical details of the test beam operation as well as results of the studies performed during the test beam are presented.

T 33.6 Tue 17:30 KH 01.022

Characterization of the bPOL48V DC-DC converter and Integration Tests with a CMS Phase-2 Strip Module — Lutz Feld, Katja Klein, Martin Lipinski, and •Joëlle Savelberg — 1. Physikalisches Institut B, RWTH Aachen

The bPOL48V is a newly developed DC-DC Point-of-Load (POL) buck converter designed at CERN and characterized at RWTH Aachen University within the DRD7 program, which supports R&D for future electronic systems and technologies for particle-physics experiments. It converts a 48 V input to an adjustable low-voltage output (5-24 V), enabling power delivery at higher distribution voltages and lower cable currents, thereby improving overall system efficiency by reducing Ohmic losses.

The converter features a radiation-hard controller designed at CERN, capable of continuous operation up to 50 Mrad and in magnetic fields above 4 T. It is paired with a EPC2152 GaN power stage. This combination provides performance in harsh radiation and magnetic-field environments, making the bPOL48V a strong candidate for power distribution in future high-energy physics experiments.

At RWTH Aachen, the bPOL48V has been characterized in multiple setups, evaluating its efficiency, stability, temperature dependence, and radiated and conducted noise. This presentation focuses on reducing conducted noise using a pi filter, demonstrating clear improvements consistent with simulation. Additionally, we present results in which the bPOL48V powers a CMS Phase-2 silicon strip module as a proof of principle, confirming its suitability for detector integration.

T 33.7 Tue 17:45 KH 01.022

Verification of a cell isolation test for loaded cells of the ATLAS ITk Pixel detector — •Nico Klein, Klaus Desch, Matthias Hamer, Florian Hinterkeuser, Alexandra Wald, and Dominik Hauner — Physikalisches Institut, Universität Bonn, Deutschland

The high luminosity upgrade for the Large Hadron Collider at CERN requires a complete redesign of the current tracking detector of the ATLAS experiment. The new Inner Tracker, the ITk Detector, will consist of a silicon pixel detector and a silicon strip detector. The ITk Pixel Detector is divided into three subsystems, the Outer Barrel (OB), Outer Endcaps and Inner System. In the OB, modules are loaded on thermally conductive bare module cells (now called loaded cells) before they are mounted on the local supports (so-called longerons and half-rings). The serial powering scheme of the ITk Pixel Detector requires a good electrical isolation of the readout ASICs from the (grounded) local support structures. For the loaded cells a test was developed to verify this isolation and the results obtained, using pre-production cells, are shown in this presentation.

T 33.8 Tue 18:00 KH 01.022

Development of an automated ATLAS pixel detector monitoring website — Marcello Bindi, Arnulf Quadt, and •Tim Schlömer — II. Physikalisches Institut, Georg-August-Universität Göttingen

The ATLAS Pixel Detector records charged particles through the ionisation charge they deposit as they traverse the sensor. A hit is recorded when the collected charge exceeds a programmable threshold, and the corresponding time-over-threshold (TOT) provides an estimate of the deposited charge. The threshold and TOT response are periodically re-tuned to maintain their target values, which drift with accumulated luminosity due to radiation-induced degradation. It is therefore essential to continuously monitor the key operational parameters like charge threshold, TOT, digital-to-analogue converter settings, the number of masked pixels, and the number of disabled columns. Tracking their evolution as a function of time and integrated luminosity is crucial both for ensuring optimal detector performance and contributing to radiation-damage studies.

A dedicated web-based framework presents these operational parameters through a set of automatically updated plots and summary metrics. Following each detector tuning, an automated pipeline refreshes the displayed results while preserving previous versions for reference. The framework also enables users to visualise long-term trends in critical parameters and to compare tunings from different periods of the detector*s operational lifetime.