T 11: Silicon trackers 1

Time: Monday 16:00–18:00 Location: Geb. 30.22: kl. HS B

T 11.1 Mon 16:00 Geb. 30.22: kl. HS B

Status update of the ATLAS ITk Pixel cell integration site in Bonn — •Alexandra Wald, Klaus Desch, Matthias Hamer, Florian Hinterkeuser, Nico Klein, Dominik Hauner, Fabian Hügging, and Jochen Dingfelder — PI, Uni Bonn, Germany

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 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 13 m^2 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, as well as the quality control of individual loaded local supports will be distributed over several 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 interlock system, industrial power supplies and a scalable DCS. In this presentation, the status of the loaded local support assembly line and QC setup in Bonn is presented, with particular attention to the data aquisition system based on a Felix server and the integration into the DCS.

T 11.2 Mon 16:15 Geb. 30.22: kl. HS B

ATLAS ITk-Pixel DAQ system — •Wael Alkakhi, Joern Grosse-Knetter, Arnulf Quadt, and Ali Ali — II. Physikalisches Institut, Georg-August-Universität Göttingen

During the ATLAS HL-LHC upgrade, the current inner detector is going to be replaced by an all-silicon Inner Tracker (ITk). The ITk-Pixel DAQ system basic read-out chain includes the YARR software, communicating with the FELIX PCIe board acting as an interface connected through lpGBT transceivers to the on-detector front-end (FE) chips ITkPix. The FEs are grouped in quad modules that are installed on local supports, which are integral parts of the ITk structure. Depending on the specific configuration, each loaded local support (LLS) accommodates between 16 and 28 quad modules for local inclined half rings or 36 quad modules for local longerons. The communication between YARR and FELIX was already validated using NetIO/Felixcore networking interfacing SW module. Nevertheless, the final DAQ system adopts the next generation communication interface called Felix-client (NetIO-Next/Felixstar). Further development was consequently required to validate the new read-out chain achieved first on a lab setup with a couple of ITkPix single chip cards and quad modules. However, as the final ITk-Pixel read-out system will contain about 10000 quad modules, a more representative sub-system on a real LLS should be used. Such a read-out setup can be based on 16 ITkPix quad modules on a real local support from previous serial powering tests and used to validate the YARR software.

T 11.3 Mon 16:30 Geb. 30.22: kl. HS B

Measurement of the Thermal Runaway of a 2S Module on a TEDD-like Structure for the CMS Phase-2 Outer Tracker Upgrade — Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], •Vanessa Oppenländer[1], Alexander Pauls[1], Oliver Pooth[2], and Nicolas Röwert[1] — [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, are being developed that consist of two silicon sensors stacked on top of each other. The radiation conditions of the HL-LHC lead to a high leakage current in the silicon sensors, which is exponentially dependent on the sensor temperature. An evaporative CO_2 cooling system will be used to cool the modules and to ensure a successful operation. In an unstable cooling scenario it is possible that the module enters an uncontrolled self-heating loop called thermal runaway. Therefore it is crucial that the thermal properties and performance of the 2S modules and the cooling structure are tested and characterized. In this talk thermal measurements performed on a small realistic cooling structure similar to the structure foreseen for the endcaps of the CMS Outer Tracker will be presented. The CO_2 temperature at which thermal runaway occurs has been measured. Sufficient margin to the nominal operating CO_2 temperature has been observed.

T 11.4 Mon 16:45 Geb. 30.22: kl. HS B

Module building and quality control for the ATLAS ITk strip sensor endcap — •Elizaveta Sitnikova, Sergio Diez Cornell, Christian Sander, Sarah Heim, Serhat Ördek, Kunlin Ran, Céline Gerdts, Eric Hüpel, Lukas Bayer, and Sören Ahrens — DESY, Hamburg, Germany

The current ATLAS Inner Detector, which has both silicon and gaseous parts, will reach the end of its operating life at the end of LHC Run 3. Before the start of the next run it will be completely replaced by an all-silicon tracker (ITk). DESY plays a significant role in building one of the silicon strip endcaps in collaboration with multiple institutes worldwide. The endcaps, positioned at the forward regions of the detector, are designed to capture particle tracks with small angles with respect to the beam axis. Two out of six module types, used in the endcap, are built at DESY Hamburg, and later the final assembly of the endcap will also take place there. The process of building modules takes multiple steps and requires regular strict quality control. This presentation will focus on the individual steps of the module building process at DESY Hamburg and its quality control. This process involves high precision gluing with custom-made tooling and gluing robots, multiple optical metrology steps, and detailed electrical testing of the completed modules at different temperatures.

T 11.5 Mon 17:00 Geb. 30.22: kl. HS B

A Silicon Pixel Tracker for μSR Experiments — •Lukas Mandok for the HD-HVMAPS-Collaboration — Physikalisches Institut Universität Heidelberg

Muon spin rotation (μSR) is a long existing baseline technique in condensed matter research, facilitating the exploration of magnetic and superconducting phenomena. Traditional reliance on scintillator-based detectors, limited in rate and spatial resolution, hinders the investigation of novel quantum materials. The use of ultra-thin silicon pixel sensors for precise track reconstruction has the potential to revolutionize μSR spectrometry.

Recent advancements in this direction include the construction of a silicon based μSR spectrometer. It is comprised of four quad module layers made from MuPix11 sensors. Studies conducted at a polarized muon beamline at PSI, focusing on μSR samples, highlight the technology's promising capabilities. Preliminary results showcase muon spin precession measurements comparable to traditional techniques, while eliminating accidental background and enabling resolution of details on a 1 mm scale on the sample.

This technology shows great potential for efficient, high-rate investigations of multiple samples simultaneously, enhancing lateral resolution and even extending observation times.

T 11.6 Mon 17:15 Geb. 30.22: kl. HS B

Characterization of the bi-phase CO2 cooling system MARTA for the ITk pixel detector Quality Control — Klaus Desch, Matthias Hamer, •Dominik Hauner, Florian Hinterkeuser, Nico Klein, and Alexandra Wald — Physikalisches Institut der Universität Bonn

Due to the upgrade of the Large Hadron Collider (LHC) to the High-Luminosity-LHC, a significant upgrade of the ATLAS detector is required, including the complete replacement of the Inner Detector with the new Inner Tracker (ITk) silicon detector. The ITk consists of a silicon strip detector and a silicon pixel detector.

During production, several building blocks of the ITk pixel detector, the modules, services and local supports, will be combined into so-called Loaded Local Supports (LLS) at several institutes. The LLS will undergo a rigorous quality control (QC) process before being shipped to CERN, where they are integrated into the ITk. During operation, the LLS will be cooled with a bi-phase CO2 system. In order to avoid any contamination of the evaporators, such a system will also be used

for the QC of the LLS.

At the University of Bonn, a MARTA CO2 cooling plant has been deployed for this purpose. In this talk I will present the results of a first characterization of MARTA in Bonn and discuss the cooling capacity in regards to the QC.

T 11.7 Mon 17:30 Geb. 30.22: kl. HS B

Developments for tests with the ITk Pixel Outer-Barrel LLS QC setups — •Hans Joos[1,2], Benedikt Vormwald[1], Stan Lai[2], and Leyre Flores Sanz De Acedo[1] — [1]CERN — [2]II. Physikalisches Institut, Georg-August-Universität Göttingen

For the upgrade of the LHC to the High-Luminosity LHC (HL-LHC), the ATLAS tracking detector will be replaced with an all-silicon detector, the Inner Tracker (ITk), as the higher luminosity requires radiation hard components. Given the close proximity to the interaction point, the environment is especially challenging for the pixel detector. The Outer-Barrel layers of the pixel detector will comprise quad chip modules that are combined into serially powered (SP) chains and loaded on ring and stave shaped low mass carbon-fibre local supports (LLS) to reduce the material budget of the detector.

The integration from individual detector components to a final detector is one of the big challenges of the HL-LHC detector upgrades. Five institutes will be integrating modules on an Outer Barrel local support and test this building block of the detector in a Quality Control (QC) setup in order to ensure the electrical and thermal performance of the LLS before being sent to the final integration stage of the ITk Pixel detector.

This talk will explain the developments for operating, controlling and monitoring of the QC setups and new approaches for deploying the necessary software components to many sites. A successful commissioning of the setups ultimately enables the project to move to preproduction of the LLSs.

T 11.8 Mon 17:45 Geb. 30.22: kl. HS B

Design and Production of Pixel Strip Modules for the P2 Tracking Detector — •Lucas Sebastian Binn for the P2-Collaboration — Institute of Nuclear Physics, Johannes Gutenberg-University Mainz, Germany

The P2 Experiment at the new Mainz Energy-Recovering Superconducting Accelerator (MESA), which is currently under construction in Mainz, will measure the weak mixing angle in electron-proton scattering at low momentum transfer with unprecedented precision.

A key parameter for the analysis, the momentum transfer Q^2, is measured by a tracking detector consisting of 4 identical modules arranged in two layers. Each module consists of two sensor planes, with pixel sensors glued and wire-bonded on rigid-flex strips. Different mechanical and electrical designs of the strip module are currently being evaluated. With a total production of 260 strips, processes are semi-automated, with dedicated glue and bonding machines.

This talk gives an overview of the P2 experiment with focus on the tracking detector, as well as the current state of the development of the strip modules.