T 25: Silizium-Streifen-Detektoren II / Pixel-Detektoren

Zeit: Dienstag 16:30–18:45 Raum: Philo-HS2

T 25.1 Di 16:30 Philo-HS2

Konzipierung einer temperaturstabilisierten Teststation zur elektrischen Charakterisierung von Siliziumsensormodulen für das CMS-Experiment — Tobias Barvich, Felix Bögelspacher, Alexander Dierlamm, Ulrich Husemann, •Roland Koppenhöfer und Stefan Maier — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Im Rahmen des Phase-2-Upgrades des CMS-Experiments wird der gesamte CMS-Spurdetektor ausgetauscht. Der neue äußere CMS-Spurdetektor wird aus zwei verschiedenartigen Siliziumsensormodulen bestehen (PS- und 2S-Module). Um einen stabilen Betrieb der Module zu gewährleisten, werden die Sensoren mittels eines Kühlsystems bei einer Temperatur von ca. $-20°$C betrieben. Am Ende des Herstellungsprozesses der Detektormodule in den Produktionszentren muss die Funktionalität der Module unter den späteren Betriebsbedingungen im CMS-Detektor überprüft werden. Das Institut für Experimentelle Teilchenphysik am Karlsruher Institut für Technologie ist eines der Produktionszentren für 2S-Module und hat für die elektrische Charakterisierung der Module eine temperaturstabilisierte Teststation entwickelt. Der Vortrag stellt den Aufbau und die Funktionsweise der entwickelten Station vor.

T 25.2 Di 16:45 Philo-HS2

LYCORIS - Large Area Strip Telescope — Ties Behnke, •Uwe Krämer, Marcel Stanitzki, Dimitra Tsionou, and Mengqing Wu — DESY, Hamburg, Germany

The DESY II test beam facility provides an electron/positron beam with an energy of up to 6 GeV used for detector development. To meet the user requirements, a number of different devices are provided at the test beam facility such as the EUDET-type silicon telescopes based on the Mimosa26 chip and a large 1 T solenoid with a 85 cm usable inner diameter. While the EUDET-type telescopes have excellent performance, their comparably small active area of 1×2 cm^2 and large support structure, prevent their use with a large Device Under Test (DUT) within the solenoid.

As part of the AIDA2020 project, a new telescope, providing a large coverage area of 10×20 cm^2 with minimal support structure and able to be installed within the solenoid is being developed. The telescope consists of three sensitive layers on each side of the DUT. Each layer consists of two 10×10 cm^2 SiD silicon strip sensors that are read out via a KPiX readout chip bump bonded directly onto the sensor. In this talk, the current status of the project, including the readout and the sensors is presented.

T 25.3 Di 17:00 Philo-HS2

Investigation of the impact of mechanical stress on the properties of silicon strip sensors — •Martin Stegler, Luise Poley, and Ingo Bloch — DESY, Platanenallee 6, Zeuthen, Germany

Over the next few years the luminosity of the Large Hadron Collider (LHC) at the European Organization for Nuclear Research (CERN), will be increased to accumulate higher number of collisions to gain access to rare processes. It is planned to reach in 2023 an instantaneous luminosity at the LHC of $\mathcal{L} = 6 \cdot 10^{34}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$. Due to the resulting higher radiation level, the ATLAS Inner Detector is foreseen to be replaced with the ATLAS Inner tracker, consisting of a pixel tracker and a strip tracker. The upgraded strip tracker will consist of 18000 silicon strip detector modules, each consisting of silicon sensors, circuit boards and readout chips. Adhesives are used to connect the modular components thermally and mechanically. Due to different coefficients of thermal expansion of the various involved materials, temperature changes between construction (22 °C) and operation (-30 °C) lead to the exertion of mechanical stress on the sensor. This contribution shows measurements quantifying the impact of mechanical stress on sensors and investigating resulting sensor damages. A cooled module was tested in comparison with simulations of the thermal induced tensile stress near to the surface of a silicon sensor in a module. A four-point bending setup was used to measure the electrical properties for two versions of ATLAS strip sensors. In a setup with a beta source, the influence of the changes of the electrical properties on the silicon strip sensor module performance were measured.

T 25.4 Di 17:15 Philo-HS2

Rekonstruktion von Spuren und deren Qualitätsberwertung für den Siliziumstreifendetektor am Belle II-Experiment — Florian Bernlochner[1], Thomas Hauth[1], Martin Heck[1], Felix Metzner[1], Eugenio Paoloni[2] und •Sebastian Racs[1] — [1]ETP, KIT, Karlsruhe — [2]INFN, Pisa

Das bald in Betrieb gehende Belle II-Experiment in Tsukuba, Japan weist einen modernen Siliziumstreifendetektor auf. Dieser erlaubt eine Spurrekonstruktion, die eigenständig und in Kombination mit der Driftkammer und dem Pixeldetektor durchgeführt werden kann. Insbesondere wird auch die Vermessung niederenergetischer Teilchen möglich, die die Driftkammer nicht erreichen und durch Vielfachstreuung im Material beeinflusst werden. Die besondere Schwierigkeit bei der Spurfindung besteht darin, eine hohe Spurfindungseffizienz bei im Vergleich zum Vorgängerexperiment höheren Ereignis- und Untergrundraten zu garantieren. Vielfachstreuung und die komplexen Geometrie des vierlagigen Siliziumstreifendetektors ohne Symmetrien erschweren dies weiter.

In diesem Vortrag wird der Spurfindungsalgorithmus des Siliziumstreifendetektors kurz vorgestellt. Im Speziellen wird die Diskriminierung der rekonstruierten Spuren bezüglich Signalteilchenspuren und falsch rekonstruierter Spuren mittels Qualitätsberwertung besprochen.

T 25.5 Di 17:30 Philo-HS2

Beam induced background measurements with the semiconductor tracking detector at ATLAS — Saverio D'Auria[1], •Jihyun Jeong[2], and Christian Sander[2] — [1]University of Glasgow, UK — [2]DESY, Hamburg, Germany

The beam induced background is one of the important backgrounds in mono-jet analysis and searches for new particle with a disappearing track signature. Therefore, understanding the characteristics of beam induced background is crucial to estimate and reject this background.

In this talk, the analysis of the beam induced background of the data recorded in 2016 is presented. To enrich the events from beam induced background, the unpaired and isolated proton bunches are used. The events are selected by two different triggers: one is using the beam condition monitor which is a diamond detector close to the beam pipe, and another one is making a requirement on the minimum number of hits in the semiconductor tracking detector(SCT) end-cap disks. Furthermore, the triggered events are selected at analysis level by the asymmetric hit distribution in the SCT end-cap disks.

The trigger rates and the beam induced background selection rates are discussed, and additionally the interaction between collision debris and the detector material, so called afterglow, is presented.

T 25.6 Di 17:45 Philo-HS2

Simulation Studies on the Robustness of the ATLAS Pixel Detector for the HL-LHC — •Timo Dreyer, Stan Lai, and Jason Veatch — II. Physikalisches Institut, Georg-August-Universität Göttingen

In mid-2026, the LHC will start the high luminosity phase (HL-LHC), during which more than $3000\,\mathrm{fb}^{-1}$ of p-p collision data is expected. In addition to the physics benefits of the increased amount of data, new technical challenges will arise. These include an increased amount of pileup in the collison events and exposure of the detector components to larger radiation doses.

To face these challenges, the ATLAS experiment will undergo a major upgrade during the LHC shutdown period from 2024 to mid-2026, that will precede the HL-LHC phase. The current inner detector will be completely replaced by a new silicon based inner tracker (ITk) consisting of an inner pixel detector and an outer silicon strip detector.

This talk presents studies performed to evaluate the robustness of the planned ITk pixel detector under conditions where sub-components are defective. The methodology for masking pixel modules and channels is introduced and comparisons between the expected performance under different failure modes are presented.

T 25.7 Di 18:00 Philo-HS2

Auslesearchitektur-Simulation für Pixelsensoren in der Teilchenphysik — •Rudolf Schimassek, Ivan Perić und Felix Ehrler — IPE, Karlsruher Institut für Technologie, Baden-Württemberg

In der Teilchenphysik werden mit dem HL-LHC mit einer geplanten Luminosität, die fünf bis sieben mal der ursprünglichen Design-

Luminosität entspricht, höhere Anforderungen bezüglich der Signalraten an die Detektoren gestellt als bisher. Um diese Raten verarbeiten zu können, müssen neue Konzepte für die Auslese entwickelt und getestet werden.

Zur Abschätzung der Einflüsse dieser Veränderungen wurde die Simulationsumgebung *ReadOut-Modelling-Environment (ROME)* entwickelt, die die Speicherstruktur und Ausleselogik der Sensoren abbildet. Diese Strukturen werden mit Daten aus Physik-Simulationen – wie aus der ATLAS ITk-Simulationskampagne – getestet, um Schwachstellen der Architektur zu finden oder Speicher zu dimensionieren. Neu an dieser Simulationsumgebung ist, dass sie nicht für einen einzelnen Detektor geschrieben ist, sondern allgemein gehalten wurde, um die Simulation möglichst vieler verschiedener Architekturen zu ermöglichen. Auf diese Weise ist auch ein direkter Vergleich verschiedener Architekturen möglich.

Die Detektorstruktur wird zusammen mit den Testdaten in einer Konfigurationsdatei definiert und diese an die Simulation übergeben, sodass keine Kenntnis des Quellcodes für die Nutzung notwendig ist.

Dieser Beitrag beschreibt das System an sich und dessen Möglichkeiten am Beispiel der CMOS-Sensoren für den ATLAS-Spurdetektor.

T 25.8 Di 18:15 Philo-HS2

Allpix Squared - A Generic Pixel Detector Simulation Framework — •Spannagel Simon — CERN, Geneva, Switzerland

Allpix Squared is a generic open-source simulation framework for the simulation of silicon pixel detectors. Its goal is to ease the implementation of detailed simulations for both single detectors and more complex setups such as beam telescopes. Predefined detector types can be automatically constructed from simple model files describing the detector parameters.

The simulation chain is arranged with the help of intuitive configuration files and an extensible system of modules, which implement the separate simulation steps such as realistic charge carrier deposition using the Geant4 toolkit or propagation of charge carriers in silicon using a drift-diffusion model. Detailed electric field maps imported from TCAD simulations can be used to precisely model the drift behaviour of charge carriers within the silicon, bringing a new level of realism to the simulation of particle detectors.

This contribution provides an overview of the framework and a selection of different simulation modules, and presents a first comparison with testbeam data.

T 25.9 Di 18:30 Philo-HS2

Towards a mobile and low-power platform for pixel detectors to be used in educational settings — Oliver Keller[1,2], Sascha Schmeling[1], •Andreas Müller[2], and Mathieu Benoit[2] — [1]CERN, Geneva, Switzerland — [2]University of Geneva, Switzerland

Pixel detector readout chips like the Timepix3 (developed within the Medipix collaboration hosted at CERN) offer numerous advantages for novel physics experiments also in educational settings. This contribution details ongoing development of data acquisition electronics and software geared towards learning environments. The Timepix3 chip is connected to an embedded multi-core processor which consumes considerably less power than the pixel detector itself enabling mobile applications. This novel processor-based approach allows faster development cycles and an overall simplified system design compared to a traditional FPGA-based solution. A compact bias supply circuit for silicon sensors is included which fulfils corresponding safety requirements for accessible parts like the sensor surface. Data output to computers or mobile devices is provided via wired and wireless ethernet. Software features of the platform are chosen to support guided experiments as well as inquiry-based learning in indoor and outdoor scenarios.