T 75: Detektorsysteme III

Zeit: Mittwoch 16:45–18:30 Raum: VMP8 SR 205

T 75.1 Mi 16:45 VMP8 SR 205

Micro-channel cooling for ATLAS silicon sensors — •Nils Flaschel and Kerstin Tackmann — Notkestraße 85, 22607 Hamburg

The ATLAS experiment at the LHC has been taking data since November 2009. The innermost tracking systems of the ATLAS detector are silicon pixel and strip detectors. In LHC experiments, the silicon detectors, which are positioned very close to the proton-proton interaction point, receive considerable radiation doses. The sensors need to be kept at low temperatures to keep the leakage current small, avoid thermal run-away and to avoid uncontrolled annealing. The cooling system typically adds a significant amount of material and hence radiation lengths to the detector. As part of the planned detector upgrade for the HL-LHC the ATLAS inner tracking system will be replaced by an all-silicon system, with a larger number of detector layers compared to the current detector, increasing the amount of material in the detector.

Micro-channel cooling is considered to be a promising technology to reduce the material per layer in current and future HEP detectors. As the channels are etched directly into silicon, the cooling system can be brought into direct thermal contact with the sensor.

A prototype micro-channel layout has been designed, produced and tested in collaboration with CNM in Barcelona. A test stand has been prepared to characterize both the thermal and mechanical properties of the micro-channel device. First results for the thermal properties and ongoing developments are presented.

T 75.2 Mi 17:00 VMP8 SR 205

Investigation of the impact of mechanical stress on the properties of silicon sensor modules for the ATLAS Phase II Upgrade — •Martin Stegler, Luise Polay, Dennis Spehrlich, and Ingo Bloch — DESY, Zeuthen, Germany

The new ATLAS tracker for phase II will be composed of silicon pixel and strip sensor modules. Such a module consists of silicon sensors, boards and readout chips. In a currently ongoing study new adhesives to connect the modular components thermally and mechanically are examined. It was shown that the silicon sensor is exposed to mechanical stress when part of a module. Mechanical stress can cause damage to a sensor and can change the tensors of electrical properties. The study of the effects of mechanical stress on characteristics of the silicon sensor modules are the focus in this presentation. The thermal induced tensile stress near to the surface of a silicon sensor build in a module was simulated. A four point bending setup was used to measure the maximum tensile stress of silicon and to verify the piezoresistive effect on ATLAS07 sensors. The results of the electrical measurements and simulations of stressed silicon sensor modules are shown in the presentation.

T 75.3 Mi 17:15 VMP8 SR 205

System Tests with Silicon Strip Module Prototypes for the Phase-2-Upgrade of the CMS Tracker — Lutz Feld, Waclaw Karpinski, Katja Klein, and •Marius Preuten — I. Physikalisches Institut B, RWTH Aachen University

To prepare the CMS experiment for the High Luminosity LHC and its instantaneous luminosity of $5 \cdot 10^{34}\mathrm{cm}^{-2}\mathrm{s}^{-1}$, in the Long Shutdown 3 (around 2024) the CMS Silicon Tracker will be replaced.

The Silicon Strip Modules for the new Tracker will host two vertically stacked sensors. The combination of hit information from both sensors will allow the estimation of the transverse momentum (p_T) of charged particles in the module front-end. This can be used to identify hits from potential interesting high-p_T tracks (above 2 GeV) for the first trigger level.

The CMS Binary Chip (CBC) provides the analogue readout of two sensors and a digital section, into which the momentum discrimination is integrated. The modules will host a new DC-DC converter chain, which will allow individual powering of each module. First measurements with early prototypes on the interplay between DC-DC powering and the read-out functions of the module will be presented in this talk.

T 75.4 Mi 17:30 VMP8 SR 205

FE-I4b Quad Module Serial Powering Stave Prototype for ATLAS ITk upgrade — •Viacheslav Filimonov, Laura Gonella, Fabian Hügging, and Norbert Wermes — University of Bonn, Bonn, Germany

ATLAS ITk is a new inner tracker that will be built for the Phase II upgrade in order to meet the requirements of increased Luminosity.

Current detector modules are powered according to the parallel (direct) powering scheme: each detector module is powered with an independent power supply and a set of cables. With this powering scheme modules can be operated individually, which is a big advantage. However, due to increased granularity of the detector more cables are needed for powering. Increased FE current consumption leads to increase in cable cross section. All these increases power losses in the cables as well as the amount of passive material in the active detector volume. Finally, it results into unwanted interactions of particles with the inactive part of the detector and degradation of the detection performance.

Solution is to use a new powering scheme, different from direct powering. Proposed options are Serial powering and DC-DC converters scheme.

The talk will focus on the investigation of the Serial powering scheme. It will describe a Serial Powering Stave Prototype that was built in Bonn using FE-I4b Quad Modules. Detailed investigation of the Stave performance in the Serial powering scheme will be shown.

T 75.5 Mi 17:45 VMP8 SR 205

Thermische Eigenschaften der 2S-Module für das Phase-2-Upgrade des CMS-Trackers — Lutz Feld, Katja Klein, Marius Preuten, •Max Rauch und Michael Wlochal — RWTH Aachen, 1. Physikalisches Institut B

Im Rahmen des Phase-2-Upgrades von CMS am LHC (CERN) wird der derzeitige Siliziumspurdetektor (Tracker) ausgetauscht werden, voraussichtlich ab dem Jahr 2024.
Im neuen Tracker werden rund 8500 2S-Module eingesetzt werden, in denen zwei Silizium-Streifensensoren beidseitig auf eine Trägerstruktur aus einem Aluminium-Kohlefaser-Verbundmaterial gebaut werden, über die auch die Anbindung an das 2-phasige CO_2-Kühlsystem erfolgt. Die Temperatur der Si-Sensoren soll bei einer CO_2-Temperatur von $-30\,^{\circ}\mathrm{C}$ unter $-20\,^{\circ}\mathrm{C}$ gehalten werden und der Effekt des „Thermal Runaway“ muss vermieden werden. Zusätzlich soll das Materialbudget minimiert werden.
Für die 2S-Module werden Abschätzungen der Wärmeleistungen und thermische FE-Simulationen sowie ein Konzept zur Messung der thermischen Eigenschaften vorgestellt.

T 75.6 Mi 18:00 VMP8 SR 205

Wärmetransporteigenschaften verschiedener Kohlefaserschichten in Kombination mit Hartschaumstoffen für den Einsatz als Supportstrukturen für Siliziumsensormodule — Tobias Barvich, Conny Beskidt, Wim de Boer, Alexander Dierlamm und •Stefan Maier — Institut für Experimentelle Kernphysik (IEKP), KIT

Für das Phase II Upgrade des CMS-Spurdetektors werden sowohl Siliziumpixel-, als auch Streifensensoren in einer Modulbauweise eingesetzt. Die bisherigen Konzepte verursachen durch viele Produktionsschritte mit flüssigem Klebstoff einen hohen logistischen Aufwand, der mit der notwendigen langen Aushärtezeit des Klebstoffes verbunden ist. Am Karlsruher Institut für Technologie wird parallel zum bisherigen Konzept neue Möglichkeiten untersucht, Module ohne flüssigen Klebstoff zu bauen um somit die Anzahl der einzelnen Produktionsschritte zu senken und den logistische Aufwand zu verringern. Hierfür werden Hartschaumstoffe in Verbindung mit unidirektionalen Kohlefaserschichten als Supportstrukturen in Betracht gezogen. Diese Schichten sorgen sowohl für die Stabilität als auch für den Abtransport der entstehenden Wärme. Der Vortrag soll Einblick in die Wärmetransporteigenschaften verschieden kombinierter Kohlefaserschichten geben und die Einsatzmöglichkeiten beleuchten.

T 75.7 Mi 18:15 VMP8 SR 205

Mechanics and Cooling of the Mu3e Detector — René Philipp Austermühl, Lars Henkelmann, •Adrian Herkert, and Yanwing Ng for the Mu3e-Collaboration — Physikalisches Institut, Uni Heidelberg

The Mu3e experiment will search for the charged lepton falvour violat-

ing decay $\mu^+ \to e^+e^-e^+$, which is suppressed to unobservable levels in the Standard Model. A signal would be a clear sign of new physics. The aim is to reach a sensitivity for the branching ratio of 10^{-16}, which requires high momentum resolution. Since the muons will decay at rest on target, the energy of the decay electrons will be $E \leq 53\,\text{MeV}$. In this energy regime the momentum resulotion is limited by multiple scattering in the detector material. Therefore, the Mu3e detector, including support structure and services, has to consist of as little material as possible in the active region. The main component of the detector is a pixel tracker consisting of four barrels of high voltage monolithic active pixel sensors (HV-MAPS) that can be thinned to $50\,\mu\text{m}$. A power consumption of $400\,\text{mW/cm}^2$ is expected. To keep the material budget low, it is planned to cool with gaseous helium.
In this talk results of computational fluid dynamics simulations of the Mu3e cooling system and experimental tests concerning the detector's stability against flow-induced vibrations will be presented.