HK 62: Combined Instrumentation Session: Silicon Strip Detectors (joint session HK/T)

Time: Friday 11:00–13:00 Location: H-HS XIII

HK 62.1 Fri 11:00 H-HS XIII

Investigation of Irradiated silicon strip Sensors using the Trasient Current Technique — •Nicky Potters[1], Christian Scharf[2], Heiko Lacker[2], Ingo Bloch[3], and Johanna Stachel[1] — [1]Ruprecht-Karls-Universität Heidelberg, Heidelberg ,Germany — [2]Humboldt-Universität zu Berlin, Berlin, Germany — [3]Deutsches Elektronen-Synchrotron (DESY), Zeuthen, Germany

A new edge-TCT setup has been built and commissioned at DESY Zeuthen. The setup allows for charge injection at defined depth or at the surface of un-irradiated and irradiated ATLAS17LS silicon strip sensors using red and infrared laser light with 100 ps pulse width and a minimum beam diameter of $w_0 = 7\mu$m. The current induced by the injected carriers is measured with GHz bandwidth electronics in up to four channels and information on the electric field and other quantities can be extracted at defined positions in the sensors. Results of the commissioning of the setup using non-irradiated silicon strip sensors as well as measurements of irradiated strip sensors will be presented. The sensors were irradiated with 70 MeV/c protons to equivalent fluences of $1.0 \cdot 10^{13}$ cm^{-2}, $3.7 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{15}$ cm^{-2}, $1.3 \cdot 10^{16}$ cm^{-2} and with 1 MeV neutrons to $4.0 \cdot 10^{14}$ cm^{-2}, $1.0 \cdot 10^{14}$ cm^{-2}, $1.3 \cdot 10^{15}$ cm^{-2}, and $5.0 \cdot 10^{16}$ cm^{-2}. The position-dependent electric field has been determined by using a new method of fitting the edge-TCT data. Additionally, strip sensors with different strip metal and strip implant widths have been studied.

HK 62.2 Fri 11:15 H-HS XIII

Analysis of 2.7 GeV proton-beam measurements with the STS detector for the CBM experiment — •Patrick Pfistner for the CBM-Collaboration — Karlsruhe Institute of Technology

The Compressed Baryonic Matter (CBM) experiment at the future Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany, aims to explore the quantum chromodynamics phase diagram for highest baryon densities. CBM will measure rare probes with high statistics which requires fast and radiation hard detectors combined with free-streaming readout electronics. One of the core detectors of CBM is the Silicon Tracking System (STS). The STS is the key detector for measuring the momentum and tracks of up to 800 charged particles produced in Au+Au collisions happening at interaction rates of up to 10 MHz. In order to evaluate the detector performance, comprehensive tests have been performed with a minimum ionizing particle beam at the COSY accelerator in Jülich in November 2019. During the beamtime, one fully assembled prototype module consisting of a double-sided Silicon microstrip sensor, 32 low-mass aluminum microcables, 16 STS-XYTER 2.1 readout ASICs and two front-end boards (FEB-8), has been exposed to a 2.7 GeV proton beam. We will present the status of the beamtime data analysis and discuss the related detector performance metrics.

HK 62.3 Fri 11:30 H-HS XIII

First beam test with the final readout scheme of Phase-2 CMS Outer Tracker 2S prototype modules — •Christian Dziwok[2], Lutz Feld[1], Katja Klein[1], Martin Lipinski[1], Alexander Pauls[1], Oliver Pooth[2], Max Rauch[1], Nicolas Röwert[1], and Tim Ziemons[2] — [1]I. Physikalisches Institut B, RWTH Aachen University — [2]III. Physikalisches Institut B, RWTH Aachen University

For the upcoming Phase-2 Upgrade for the operation of CMS at the HL-LHC a new silicon tracker design will be implemented. With extended acceptance and giving additional input of track p_T to the level-1 trigger, the new Outer Tracker will consist of 2S modules with two coplanar strip sensors and PS modules with a macro-pixel sensor and a strip sensor. Therefore, for these specialized detector modules the p_T information of a track is already available online. Based on cluster size and position in a module's sensors and its sensor spacing, a first p_T trigger information is generated in its front-end ASIC and then constantly streamed to the back end at bunch crossing rate.

The final front-end ASIC CBC 3.1 was used alongside the concentrator ASIC CIC v1 and the serializer- and slow control ASICs GBTx and SCA without additional interface card for the first time. This final readout scheme of 2S modules has been tested with up to 4 modules at once at the test beam facility of DESY Hamburg using a 4 GeV electron beam and the AIDA telescope. This talk will showcase the efficiency of the new p_T discrimination mechanism and the test on synchronicity of modules.

HK 62.4 Fri 11:45 H-HS XIII

Abschätzung des Signal- und Leckstromverhaltens im äußeren CMS Phase-2 Spurdetektors — Felix Bögelspacher, Tobias Bravich, Alexander Dierlamm, Umut Elicabuk, Jan-Ole Gosewisch, Ulrich Husemann, •Marius Metzler und Thomas Müller — Institut für Experimentelle Teilchenphysik, Karlsruher Institut für Technologie

Im September 2019 wurde die finale Entscheidung bezüglich des verwendeten Sensormaterials für den äußeren Bereichs des zukünftigen CMS-Spurdetektors gefällt. Der jetzige Spurdetektor wird im Rahmen der Phase-2 Aufrüstung des CMS-Detektors komplett ausgetauscht und durch neuere Komponenten ersetzt. Die verwendeten Streifensensortypen, der 2S und der PS-s, sowie der Makropixelsensor PS-p, werden auf FZ290 Siliziumwafern prozessiert werden. Dabei handelt es sich um float zone Wafer mit einer physikalischen Dicke von 320 μm und einer 30 μm dicken, hochdotierten Rückseitenimplantation, welche die aktive Dicke auf 290 μm reduziert.

Im Zuge des Forschungs- und Entwicklungsprozesses wurden Bestrahlungsstudien mit Signal- und Leckstrommessungen an FZ290 Sensoren für durchgeführt. Der Vortrag zeigt, wie diese Daten verwendet werden können, um die jährliche, optimale Operationsspannungen für verschiedene Bereiche des äußeren CMS Phase-2 Spurdetektors abzuschätzen. Daraus lassen sich dann Leckstrom und die benötigte Kühlleistung ableiten.

HK 62.5 Fri 12:00 H-HS XIII

Quality assurance of the CBM Silicon Tracking System sensors — •Evgeny Lavrik for the CBM-Collaboration — Facility for Antiproton and Ion Research, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment at FAIR aims to study the properties of nuclear matter at high net-baryon densities. The Silicon Tracking System is the key detector to reconstruct charged particle tracks created in heavy-ion interactions. In order to assure the quality of more than 1100 silicon sensors including spares, highly efficient and highly automated procedures were developed.

In this contribution we report on the optical and electrical quality assurance procedures for silicon sensors. We describe dedicated hardware setups to perform basics tests and full characterization and their application for the quality assurance of the STS sensors. We present the results of ongoing QA campaign of sensors from mass production which begun in November 2019.

HK 62.6 Fri 12:15 H-HS XIII

Silicon strip detector set-up for α-particle detection at MAGIX — •Jennifer Geimer for the MAGIX-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz, Germany

The MAGIX experiment will take place at the energy recovering superconducting electron accelerator MESA in Mainz. At MAGIX high-precision electron scattering experiments will be performed. The experimental set-up is currently under development, it comprises a windowless gas target and two identical high-resolution magnetic spectrometers including a GEM-based TPC. Additionally, a silicon strip detector is planned to detect recoil particles in the scattering chamber. Its resolution requirements are derived from simulation studies of the ^{16}O(γ*,α)^{12}C reaction, which we will examine to determine the S-factor of the nucleosynthesis reaction of carbon and alpha. The design of this detector system and first performance studies will be presented in this talk.

HK 62.7 Fri 12:30 H-HS XIII

Studying magnet-induced wire-bond oscillations for the ATLAS ITk Strip Detector — •Ben Brüers[1], Ruchi Gupta[1], Ksenia Solovieva[2], Dennis Sperlich[3], and Edoardo Rossi[1] — [1]DESY — [2]Imperial College London — [3]Albert-Ludwigs-Universität Freiburg

For the high luminosity phase of the LHC, the ATLAS collaboration plans to upgrade its current tracking detector with a new, all silicon Pixel and Strip Detector, referred to as Inner Tracker (ITk). The ITk Strip Detector modules will contain printed circuit flex boards carrying

the read-out and powering chips. All chips will be connected to the printed circuit flex boards using 25 μm thick aluminium wire-bonds. Several of these wire-bonds will carry alternating currents. In the 2 T solenoid magnetic field of ATLAS surrounding the ITk, these wire-bonds can start oscillating. Damage by oscillations have been observed e.g. at the CDF detector, when the trigger frequency (and with that the alternating current frequency) accidentally aligned with the resonance frequency of the wire-bonds. To study the potential danger of resonant wire-bond oscillations for the ITk Strip Detector, a prototype module was exposed to a 1 T magnetic field and triggered at multiple frequencies between 0.1 kHz and 350 kHz. To observe oscillations, an innovative observation setup was employed and several hours of video material collected. While the module was not damaged, the search for wire-bond oscillations in the video material is on-going. This talk will introduce the procedure and show the latest results on assessing the resonant frequencies and sensitivities of the ITk Strip Detector wire-bonds to magnet-induced oscillations.

HK 62.8 Fri 12:45 H-HS XIII

characterization and operation of the frontend electronics of the CBM silicon tracking system — •Osnan Maragoto Rodriguez for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment is a fixed-target heavy-ion physics experiment at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, Germany. The CBM physics program aims at exploring the QCD phase diagram at very high baryon densities. For high-statistics measurements of rare probes, CBM is designed to cope with very high interaction rates up to 10 MHz. To achieve this high rate capability, the CBM experiment will be equipped with fast and radiation hard detectors employing free-streaming readout electronics. The Silicon Tracking System (STS) is the essential component for tracking up to 1000 charged particles per event in A+A collision. The experimental conditions pose demanding requirements in terms of channel density and read-out bandwidth. The STS-XYTER is a dedicated ASIC for the readout of the double-sided silicon micro-strip sensors. It is a low power, self-triggering ASIC with 128 channels, 5-bit ADC charge and 14-bit timing information. It needs to be fully integrated into a very confined space and it should perform in a highly irradiated environment with strong magnetic field. Several tests are carried out to check chip functionalities, full detector modules performance and integration aspects. An overview of the frontend electronic, module tests and experimental results, for different data taking scenarios, will be presented.