HK 35: Instrumentation

Zeit: Dienstag 14:00–16:15 Raum: WIL-A221

Gruppenbericht HK 35.1 Di 14:00 WIL-A221

The Silicon Tracking System of the CBM experiment — •Johann M. Heuser — GSI Helmholtzzentrum für Schwerionenforschung GmbH

In the Compressed Baryonic Matter (CBM) experiment at FAIR, the Silicon Tracking System (STS) will perform track reconstruction and momentum determination of the charged particles created in interactions of heavy-ion beams with nuclear targets. The STS consists of 8 tracking layers located at distances between 30 cm and 100 cm downstream of the target inside the 1 T magnetic dipole field. The required momentum resolution of the order of $\Delta p/p = 1\%$ can only be achieved with an ultra-low material budget, imposing particular restrictions on the location of power-dissipating front-end electronics in the fiducial volume. The concept of the STS is based on 300 μm thick double-sided silicon microstrip sensors mounted onto lightweight carbon fiber support ladders. The sensors will be read out through ultra-thin multi-line micro-cables with fast self-triggering electronics at the periphery of the stations where cooling lines and other infrastructure can be placed. The mechanical construction of the STS will allow extracting the detector system and replacing individual ladders e.g. in case of radiation damage.

The status of the STS project is summarized in the presentation. An important milestone was achieved in December 2012 with the submission of the STS Technical Design Report to FAIR.

Supported by EU-FP7 HadronPhysics3, CRISP, MC-PAD, BMBF, LOEWE, HGS-HIRe, H-QM, GSI, ISTC, JINR and ROSATOM.

HK 35.2 Di 14:30 WIL-A221

Upgrade des ALICE Inner Tracking Systems und die Auswirkung auf Messungen schwerer Quarks — •Johannes Stiller für die ALICE-Kollaboration — Physikalisches Institut, Heidelberg

Während der zweiten langen Betriebspause des LHC im Jahr 2018 plant die ALICE Kollaboration die Installation eines neuen, modernisierten Spursystems (Inner Tracking System, ITS) im zentralen Bereich des Experiments. Dieses System wird aus sieben Schichten Siliziumdetektoren bestehen, die ab einer radialen Entfernung von 2.2 cm um den Wechselwirkungspunkt aufgebaut werden. Dabei wird die Materialdicke auf bis zu 0.3 % Strahlungslängen pro Schicht reduziert, und die räumliche Punktauflösung auf bis zu 4 μm verbessert. Des weiteren wird die Ausleserate in Pb–Pb Kollisionen auf bis zu 50 kHz erhöht, so dass neue, einzigartige Messungen von schweren Quarks, z.B. charm und beauty, ermöglicht werden. Mittels detaillierter Monte Carlo Simulationen von pp und Pb–Pb Kollisionen untersuchen wir die Auswirkung des Upgrades auf verschiedenen Messungen schwerer Quarks. Als Maßstab dienen hier die jeweilige Produktion von charmed Mesonen und Baryonen, z.B. über die hadronischen Zerfallskanäle $D^0 \to K^- \pi^+$ und $\Lambda_c^+ \to pK^-\pi^+$, sowie beauty Mesonen und Baryonen mittels versetzter Zerfallsvertices von z.B. $B^+ \to \overline{D}^0 \pi^+$ and $\Lambda_b \to \Lambda_c^+ \pi^-$.

HK 35.3 Di 14:45 WIL-A221

Development of the Pion Tracker for HADES spectrometer — •Rafal Lalik for the HADES-Collaboration — Excellence Cluster "Universe", TU München, Boltzmannstr.2, 85748 Garching, Germany

We are working on the development of the beam detector for experiments with pion beams at HADES spectrometer in GSI Darmstadt. Pions are created impacting nitrogen or proton beams on a secondary beryllium target and are then delivered through a chicane to the experimental areas. The expected momentum spread of the secondary pion beam is about 8% and the main goal of this beam detector is to deliver information about the pion momentum for each beam particle.

The challenging issue is to achieve an accurate measurement ($\approx$ ‰) of each pion in a high intensity (10^8 part./spill) environment along the pion-bean chicane. This translates into a rate of 10^6 pion/spill with a kinetic energy of 1–2 GeV at the HADES target point.

We are currently testing a tracker system, based on double-sided silicon strips detectors with higher radiation hardness and n-XYTER ASIC readout. For prototyping we have prepared the acquisition system compatible with the CBM data acquisition system, for the future employment with HADES we are currently working on acquisition based on the novel TRB3 board.

In this talk we are showing current status and performance of the system, and recent results obtained in the laboratory and with proton beams.

HK 35.4 Di 15:00 WIL-A221

Kaon Detection at 0° Scattering Angle at MAMI — •Florian Schulz for the A1-Collaboration — Institut für Kernphysik, Johannes Gutenberg-Universität, Mainz

At the Mainz Microtron MAMI experiments in the strangeness sector are being performed by the A1 Collaboration; most recently the decay-pion spectroscopy of electro-produced Λ-hyperons.

A first pioneering experiment aimed to the detection of K^+, with the Kaos spectrometer placed at 0° scattering angle, in coincidence with π^- from weak decays. The momentum of the pion emitted in two-body decays is related to the not precisely known mass of any produced Λ-hypernucleus. By its detection with high-resolution magnetic spectrometers the expected mass resolution is < 30 keV.

In order to advance to an efficient physics run with sufficient statistics, it was nessesary to reduce the electromagnetic background produced at very forward angles by the 1.5 GeV electron beam. Therefore an energy-degrader of up to 12 cm lead was added directly in front of the detector system of Kaos.

The method of kaon identification, upgrades of the detector system, and performance of the recently completed next stage of the experiment, which improved luminosity by one order of magnitude, will be covered in this talk.

HK 35.5 Di 15:15 WIL-A221

Characterization of double sided silicon micro-strip sensors with a pulsed infra-red laser system for the CBM experiment — •Pradeep Ghosh[1] and Juergen Eschke[2] for the CBM-Collaboration — [1]Goethe Universitaet, Frankfurt — [2]GSI Helmholtzzentrum and FAIR GmbH, Darmstadt

The Silicon Tracking System (STS) of the Compressed Baryonic Matter (CBM) experiment at FAIR is composed of 8 tracking stations consisting of 1292 double sided silicon micro-strip sensors.

For the sensor development and for the quality assurance of produced sensors a laser test system has been built up. The aim of the sensor scans with the pulsed infra-red laser system is to determine the charge sharing between strips and to measure the uniformity of the sensor response over the whole active area. The prototype sensors tested with the laser system so far have 256 strips with a pitch of 50 μm on each side. They are read out by the self-triggering n-XYTER prototype read-out electronics.

The laser system measures the sensor response in an automatized procedure at several thousand positions across the sensor with focussed infra-red laser light ($\sigma_{spotsize} \approx 15$ μm, λ=1060 nm). The duration ($\sim$5ns) and power (few mW) of the laser pulses is selected such, that the absorption of the laser light in the 300 μm thick silicon sensors produces a number of about 24k electrons, which is similar to the charge created by minimum ionizing particles in these sensors. Results of laser scans for different sensors will be presented.

Supported by HIC-for-FAIR, HGS-HIRe and H-QM.

HK 35.6 Di 15:30 WIL-A221

Detector module development for the CBM Silicon Tracking System — •Anton Lymanets for the CBM-Collaboration — Physikalisches Institut, Universität Tübingen

The central detector of the CBM experiment at FAIR, the Silicon Tracking System (STS), is being designed to reconstruct hundreds of charged particles produced at rates up to 10 MHz in interactions of ion beams of up to 45 AGeV projectile energies with nuclear targets. The building block of the tracking system is a module suitable for a low-mass detector construction. In a module, the basic functional unit of the STS, radiation tolerant microstrip sensors are read out through low-mass multi-line cables with self-triggering front-end electronics located at the periphery of the system. Light-weight carbon fibre support structures will carry 10 of such modules and build up the STS stations.

In the presentation, the concept of the detector module construction is presented. Quality assurance tests under development for the module components (double-sided silicon microstrip sensors, stacked polyimide microcables, front-end ASICs and boards) and the assembled structures are discussed.

Supported by EU-FP7 HadronPhysics3 and BMBF.

HK 35.7 Di 15:45 WIL-A221

Study of low-mass readout cables for the CBM Silicon Tracking System — •Minni Singla for the CBM-Collaboration — Goethe University, Frankfurt — GSI, Darmstadt

The study of thin multi-line readout cables will be reported. The application is the Silicon Tracking System (STS) of the fixed-target heavy-ion experiment Compressed Baryonic Matter (CBM), under design at the forthcoming accelerator centre FAIR in Germany. These cables will bridge the distance between the microstrip sensors and the signal processing electronics placed at the periphery of the silicon tracking stations. Finite element simulations (using the TCAD package RAPHAEL) have been used to optimize the cables towards minimum possible Equivalent Noise Charge (ENC). Various trace geometries and trace materials have been explored. SPICE modelling has been implemented in Sentaurus Device to study the transmission loss in the cables. The simulations have been validated with measurements. Charge loss in cables of different lengths was determined by injecting charge pulses of known amplitude. An optimized cable design is reported yielding minimum ENC, material budget and transmission loss. Supported by HIC for FAIR, HGS-HIRe and H-QM.

HK 35.8 Di 16:00 WIL-A221

Performance evaluation of a prototype module for the CBM Silicon Tracking System — •Tomas Balog — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany — Comenius University, Bratislava, Slovakia

The building block of the CBM Silicon Tracking System is a detector module, a functional unit of one or several daisy-chained double-sided silicon microstrip sensors, read-out cables and front-end electronics. Ten modules will be located on a detector ladder. Several ladders build up a STS tracking station.

The performance of first prototype modules has been evaluated, resembling the structure of the intended STS module. The prototypes comprise a full-size CBM01 sensor and two 128-channel read-out cables 10, 20 and 30 cm long attached to the read-out pads on either side of the sensor. The cables end in connector boards interfacing to two front-end boards each hosting one n-XYTER chip. The whole setup was mounted into a copper box used as a shield. The hit reconstruction and track finding in the STS requires thresholds to be set at maximum value of 4 ke^-.

The presentation discusses the noise determined for all three prototype modules and the signal-to-noise ratio obtained when testing the systems with a ^{241}Am gamma source.

Supported by MC-PAD and HIC for FAIR.