HK 34: Instrumentierung

Zeit: Mittwoch 16:30–19:00 Raum: HZ 8

Gruppenbericht HK 34.1 Mi 16:30 HZ 8

The Silicon Tracking System of the CBM experiment — •Tomas Balog for the CBM-Collaboration — GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany

The Compressed Baryonic Matter (CBM) experiment at FAIR will explore the phase diagram of strongly interacting matter at the highest net-baryon densities in nucleus-nucleus collisions with interaction rates up to 10 MHz. As the core tracking detector of CBM the Silicon Tracking System (STS) will be installed in the gap of the 1 T super conducting dipole magnet for reconstruction of charged particle trajectories and its momenta. The requirement on momentum resolution, $\Delta p/p = 1\%$, can only be achieved with an ultra-low material budget, imposing particular restrictions on the location of 2.5 million channel front-end electronics dissipating 40 KW in the fiducial volume of about 2 m^3. The concept of the STS is based on a modular structure containing 300 μm thick double-sided silicon microstrip sensors read out through ultra-thin multi-line micro-cables with fast self-triggering electronics. As central building blocks the modules consisting of each a sensor, micro-cable and front-end electronics will be mounted with lightweight carbon fiber support structures onto 8 detector stations. At the station periphery infrastructure such as power and cooling lines will be placed. The status of the STS development is summarized in the presentation, including an overview on sensors, read-out electronics, prototypes, and system integration.

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

Gruppenbericht HK 34.2 Mi 17:00 HZ 8

Der Mikrovertex-Detektor des PANDA-Experiments — •Hans-Georg Zaunick für die PANDA-Kollaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, 35392 Gießen

Das PANDA-Detektorsystem am derzeit im Aufbau befindlichen Beschleunigerkomplex FAIR in Darmstadt ist konzipiert für die Untersuchung der starken Wechselwirkung in Proton-Antiproton-Annihilationen. Der experimentelle Aufbau besteht aus einem das stationäre Target umgebenden Targetspektrometer und dem Vorwärtsspektrometer, das den stark in Vorwärtsrichtung geboosteten Event-Topologien Rechnung trägt. Um Charm-haltige Kanäle mit hoher Effizienz registrieren zu können, umgibt den Interaktionspunkt ein Mikrovertex-Detektor (MVD), welcher durch hohe Spur- und Vertexauflösung u.a. kurzlebige Charmonium-Zustände vom Untergrund zu unterscheiden vermag.

Der MVD wird aus vier Lagen dünner Silizium-Detektoren bestehen, davon zwei Lagen Pixelsensoren und zwei Lagen doppelseitige Streifensensoren (DSSD), sowie mehreren Pixel/Streifen Vorwärts-Disks. Dieser Beitrag konzentriert sich auf die technologischen Aspekte von Design und Konstruktion des Detektors in Hinblick auf die herausfordernden experimentellen Bedingungen, wie z.B. die Abwesenheit eines Hardware-Triggers, hohe Ortsauflösung, begrenztes Verlustleistungs-Budget oder die Strahlenhärte aller Komponenten. Es werden aktuelle Prototypen und bisher mit ihnen durchgeführte Strahltests vorgestellt und deren Ergebnisse diskutiert.

Gefördert durch BMBF und HIC4FAIR

HK 34.3 Mi 17:30 HZ 8

Characterization of silicon microstrip sensors with a pulsed infrared laser system for the CBM experiment at FAIR — •Pradeep Ghosh[1,2] and Juergen Eschke[2,3] for the CBM-Collaboration — [1]Goethe Univ., Frankfurt — [2]GSI — [3]FAIR

The Silicon Tracking System (STS) for the Compressed Baryonic Matter (CBM) experiment at FAIR will comprise more than 1200 double-sided silicon microstrip sensors. For the quality assurance of the prototype sensors a laser test system has been built up. The aim of the sensor scans with the pulsed infrared 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 laser system measures the sensor response in an automatized procedure at several thousand positions across the sensor with focused infrared laser light ($\sigma \approx 15$ μm, $\lambda = 1060$ nm). The duration (5 ns) and power (few mW) of the laser pulses are 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 from the characterization of monolithic active pixel sensors, to understand the spot-size of the laser, and laser scans for different sensors will be presented.

Supported by Helmholtz International Center for FAIR, HGS-HIRe and H-QM.

HK 34.4 Mi 17:45 HZ 8

Implementation of the FPGA-based cluster finder for the CBM-MVD — •Qiyan Li for the CBM-MVD-Collaboration — Goethe-University, Frankfurt

The Micro Vertex Detector (MVD) of the CBM experiment at FAIR is optimized to identify rare open-charm particles by their decay topology, which requires a high demands on its spatial resolution, radiation hardness and rate capability. The MVD will be equipped with CMOS Monolithic Active Pixel Sensors. Those sensors feature an on-chip zero suppression and 1-dimensional cluster finding.

To further reduce the load on the event builders and future mass storage systems, we have developed a 2-dimensional cluster finding and characterization algorithm suited for preprocessing and reducing the data streams generated by the free-running pixel sensors. The algorithms are implemented in the FPGA of the readout controller system (ROC) for the MVD. After the sensors' data are cross-checked for possible errors and synchronization problems, they will be stored in a frame buffer, which serves as the input for the cluster finder. Then, the output of cluster finder will be transferred to a readout buffer and shipped forward via TRB-net.

This contribution will present the implementation of the algorithms on the remaining free resources of the FPGAs in the MVD ROCs, followed by presenting test result on compression capability, performance and error-handling. * supported by BMBF (05P12RFFC7), HIC for FAIR, and GSI.

HK 34.5 Mi 18:00 HZ 8

Development of prototype CO_2 cooling system for the CBM Silicon Tracking System — •Evgeny Lavrik for the CBM-Collaboration — Physikalisches Institut der Universität Tübingen, Tübingen, Deutschland

The CBM experiment aims to study the properties of nuclear matter at high net-baryon densities. The STS is the key detector to reconstruct charged particle tracks created in heavy-ion interactions. The foreseen interaction rate of up to 10 MHz requires radiation hard detectors as well as efficient cooling of front-end electronic boards (FEBs). To avoid thermal runaway the system must be kept at -5°C or below all the time. This is rather challenging because the overall thermal load in the 2 m^3 STS enclosure is up to 40 kW.

Because of these requirements liquid CO_2 is used as a cooling agent as it is superior in terms of volumetric heat transfer coefficient compared to other agents.

In our study we built an open cooling system to determine the two-phase CO_2 cooling parameters. Furthermore we designed and built custom heat exchangers adapted to the STS geometry and measured their cooling efficiency. We will present preliminary results of our ongoing work.

Supported by: BMBF and grant 05P12VTFCE

HK 34.6 Mi 18:15 HZ 8

Integration of the strip barrel staves of the PANDA Micro Vertex Detector — •Tommaso Quagli, Kai-Thomas Brinkmann, Robert Schnell, and Hans-Georg Zaunick for the PANDA-Collaboration — II. Physikalisches Institut, Justus-Liebig-Universität Gießen, Gießen, Germany

PANDA is a key experiment of the future FAIR facility, under construction in Darmstadt, Germany. It will study the collisions between an antiproton beam and a fixed proton or nuclear target. The Micro Vertex Detector (MVD) is the innermost detector of the apparatus and is composed of four concentric barrels and six forward disks, instrumented with silicon hybrid pixel detectors and double-sided silicon microstrip detectors; its main task is the identification of primary and secondary vertices. The central requirements include high spatial and time resolution, trigger-less readout with high rate capability, good radiation tolerance and low material budget.

Square and rectangular microstrip sensors will be used in the two

outer barrels of the detector. The sensors and the front-end electronics will be arranged on linear staves, composed of a carbon support structure with an embedded active cooling system. A flexible multilayer bus will be used to route the signals on the stave towards the DAQ system. The design of the stave, its integration concept and some relevant hardware developments will be presented.

Supported by BMBF, HGS-HIRe and JCHP.

HK 34.7 Mi 18:30 HZ 8

A low-power front-end amplifier for the microstrip sensors of the PANDA Microvertex Detector — •Valentino Di Pietro[1], Kai-Thomas Brinkmann[1], Angelo Rivetti[2], Alberto Riccardi[1], Manuel Rolo[2], and Sara Garbolino[2] for the PANDA-Collaboration — [1]II. Physikalisches Institut, JLU Gießen, Gießen, Germany — [2]INFN Sezione di Torino, Torino, Italy

The most common readout systems designed for nuclear physics detectors are based on amplitude measurements. The information that needs to be preserved is the charge delivered by a particle hitting the sensor. The electronic chain employed in these cases is made of two main building blocks: front-end amplifier and ADC. An issue in the implementation of such an architecture in scaled CMOS technologies is the dynamic range, because the charge information is extrapolated through the sampling of the peak of the front-end output signal. It is therefore interesting to explore the use of time-based architectures that offer better performances. In fact, in these topologies the linearity between the charge and the signal duration can be maintained even if some building blocks in the chain saturate. The main drawback is the loss in resolution since a duration measurement involves the difference between two time measurements. This work will present the design of a front-end optimized for fast Time-over-Threshold applications. The circuit has been developed for the microstrip detectors of the PANDA experiment. The architecture of the front-end amplifier will be presented and simulations in a 110 nm CMOS technology will be discussed. Supported by BMBF, HGS-HIRe and JCHP.

HK 34.8 Mi 18:45 HZ 8

Detector module development for the CBM Silicon Tracking System — •Olga Bertini for the CBM-Collaboration — GSI Helmholtzzentrum, Darmstadt

The central detector of the CBM experiment at FAIR, the Silicon Tracking System (STS), is designed to reconstruct hundreds of charged particle tracks 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. The performance of module prototypes has been evaluated, resembling the structure of the intended STS module. The shown prototypes comprise a full-size CBM05 sensor and two 128-channel read-out cables 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.

Supported by EU-FP7 HadronPhysics3.