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Study of system integration for the pixel detector of the PANDA experiment

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The PANDA experiment will make use of antiproton cooled beams of unprecedented quality, that will become available at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, featuring up to 2•10ˆ11 antiprotons and momentum between 1.5 –15 GeV/c.
To handle forward particle distribution due to the Lorentz boost, the apparatus is arranged in an asymmetric layout around the interaction point between antiprotons and pellet or gas jet target.
This peculiarity requires a tracking detector with a forward design and in particular an innermost Micro Vertex Detector (MVD) based on silicon devices with an innovative design in an unusual geometry. The material budget of this silicon tracker has to be minimized in view of particle momenta ranging from few hundreds of MeV/c up to several GeV/c. Besides high interaction rate asks for fast data readout being PANDA without low-level trigger selection and particle identification is planned over the full range of energies.
To cope with these requirements MVD includes innermost layers made of thinned epitaxial silicon hybrid pixel detectors and outermost composed of double side silicon micro strips.
In particular the mechanics integration of the pixel detector is a challenge due to the compact volume of the MVD asking for specific solutions as carbon foam both to increase the heat dissipation towards the cooling pipes and acting as mechanics supports.
To cope with high data rate new non-triggered readout chips developed in 130 nm CMOS technology feature high speed readout and charge measurement with Time over Threshold, and to deal with the limited material budget request new aluminium strips are developed for data transmission and specific busses design are under study.
Results concerning the developments of prototypes to solve critical items will be presented.

Summary

The PANDA experiment will make use of antiproton cooled beams of unprecedented quality, that will become available at the Facility for Antiproton and Ion Research (FAIR) in Darmstadt, featuring up to 2•10ˆ11 antiprotons and momentum between 1.5 –15 GeV/c.
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To cope with these requirements MVD includes four cylindrical layers in the region around the interaction point, the barrels, and six planar layers in the forward region, the disks, equipped with silicon detectors: hybrid pixel detectors in the innermost layers and double sided micro strip in the outermost layers.
In particular the mechanics integration is a challenge due to the compact volume of the MVD.
First hybrid pixel prototypes based on thinned epitaxial silicon sensors have been developed as a detector technology capable to sustain the expected radiation levels at room temperature.
Besides the handling of high data rate in a triggerless mode suggested a new non-triggered readout ASIC, for the hybrid pixel detector, that has been developed in 130 nm CMOS technology. This one provides time

information via a time stamp synchronous with the 155.5 MHz global clock signal and energy information via the Time over Threshold technique. High speed serial links and early electrical to optical conversion are adopted to reduce the amount of cables and material.
Besides to cope with the limited material budget request new aluminium strips are developed for data transmission and specific busses design are under study.
Thermal power produced by the dedicated electronics, evaluated as
˜ 1 W/cmˆ2 is removed by a water cooling system operating below atmospheric pressure mode.
For the cooling system design a material with low density, high thermal conductivity, low thermal expansion coefficient, easily machined, feasible to glue, stable at different temperatures and radiation resistant has been searched. The material which answer to all these requirements is the carbon foam: his open pore structure graphite combined with a dense graphite matrix produces a material with high thermal properties and low density. The material properties, mechanical and thermal, were studied for radiation hardness.
Besides, this material acts as mechanics support too for the pixel disks.

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