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HIGH VOLTAGE MONOLITHIC ACTIVE PIXEL SENSORS FOR THE PANDA MICRO VERTEX DETECTOR*

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Abstract

The Micro Vertex Detector (MVD) is the most inner part of the PANDA directly surrounding the interaction point. In order to achieve a very high spatial and momentum resolution in the reconstruction of charged particle tracks, which is necessary for the determination of displaced vertices, a combination of silicon pixel sensors for the inner layers and silicon microstrip detectors for the outer layers of the MVD will be used.

Within this project the usage of High Voltage Monolithic Active Pixel Sensors (HV-MAPS) for the pixel part of the MVD is investigated. This requires a dedicated simulation study within the PANDAroot framework, the common software package of PANDA. As a first step, the performance of the reconstruction of charged D mesons with their delayed decays are investigated by using the recent implementation of the hybrid pixel sensors.

HV-MAPS

HV-MAPS combine the advantage of a monolithic design where the frontend electronics are already integrated in the chip with fast charge collection and signal generation by using a fully depleted sensors by applying a high bias voltage to the substrate [1]. The MuPix8 sensor is the most recent prototype of the chip family which was initially developed for the Mu3e collaboration at PSI. It is the first large scale sensor with a physical size of about 1 cm x 2 cm and a pixel size of 81 µm x 80 µm. Having these sensors in hands and tested one could think about using them in the pixel part of the PANDA MVD.

MICO VERTEX DETECTOR

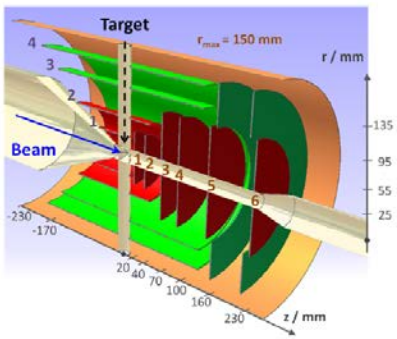

Figure 1: Scheme of the PANDA MVD, green indicates the strip part and red the pixel part.

The recent design of the MVD is shown in Fig. 1. The strip part (green) consists of two barrel and two discs layers which will be instrumented with silicon microstrip detectors. The pixel part (red) has two barrel layers and six disc layers built with hybrid pixel sensors. The complete MVD is implemented in PANDAroot with all active (sensors) and passive materials as holding structure and cooling structure. For the reconstruction of the particle hits in the pixel part two criteria were used: the hit information which provides the position of the hits on the sensor if the energy deposition was larger than a certain threshold, and the amount of the deposited energy. This allows to identify neighbouring hits as clusters where the deposited energy of the particle track is shared between neighbouring pixels. By weighing the hit position with the amount of energy deposited a better spatial resolution is reached.

The usage of HV-MAPS has the advantage of being having about a factor of 4 less material of the sensors (together with the FEE) and thus less multi-scattering of all particle tracks. Also, the pixel size of the HV-MAPS is 20% smaller, however, there is no information about the energy deposition. The improvement in terms of spatial and momentum resolution and of the reconstruction of the vertices has to be determined using Monte Carlo simulations.

RESULTS

Since the project started in September the first time was spent to learn the framework and tools provided by PANDA. The event reconstruction within PANDAroot including vertex and kinematic fitting is understood. Fig. 2 shows the first results from this study using the recent design with the hybrid pixel sensors. With the two distributions the precision of the reconstruction is shown.

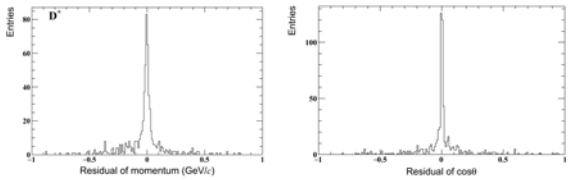

Figure 2: Resolution of the (left) momentum and (right) spatial reconstruction, cosθ, of D^+ mesons.

Next steps are to proof the correctness of the event reconstruction and provide measures for the future comparison of the sensor types. Afterwards the design of the pixel part of the MVD is going to be modified and then the complete system will be optimized. Issues which have to be taken into account are to minimize passive material and to provide a geometrical model which can be built.

REFERENCES

[1] I. Perić, "A monolithic pixelated particle detector implemented in high-voltage CMOS technology", in *Nucl. Instr. and Meth. A, 582*, Dec 2007, pp. 876-885. doi : 10. 1016/ j . ni ma. 2007. 07. 115

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