The PANDA GEM-Tracker Prototype 'GEM2D', Simulations and Pad-Plane design

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In the PANDA experiment particles emitted at angle in the range 5°-22° will be tracked with a set of three large-area planar gaseous micro-pattern detectors based on Gaseous-Electron-Multiplier (GEM) foils as amplification stages [1]. According to simulations [2] of the particle flux of up to 140 kHz/cm^2 the granularity of the read-out structures, the so called 'pad planes', is purely driven by the required resolution of 150μm, not by particle occupancy.

Simulations of a triple-GEM system have been performed using the Garfield++ toolkit. The ANSYS model of the single conical GEM cell with a top diameter of 70 μm and a bottom diameter of 50 μm was used as an input. According to these simulations the expected gain, which is the number of electrons produced per number of initial electrons is 4000, which reproduces the COMPASS triple GEM detector data within a factor of 2. The endpoints of electrons at the pad plane exhibit a 2-dimensional Gaussian distribution with σ=270 μm, which is in agreement with the simple estimation $\sigma = \sqrt{L} \times D$ =240μm, where L is a 1cm drift gap and D is the transverse diffusion coefficient extracted from the Magboltz program. If the size of an electron cloud could be neglected with respect to the strip/pad size, the resolution would be simply $Pitch/\sqrt{12}$. For a pitch of 400μm it would be 115μm and would be significantly improved in case of a weighted mean calculation (best achievable ~30μm, see Fig. 1).

In order to verify the feasibility of the targeted spatial resolution of 150μm, a ~200μm thin pad plane was designed realizing two-dimensional readout structures on both faces. The structure of the *top* projection (see Fig. 2 left) consists of vertical stripes with 75μm width to provide information on the *x* coordinate and interconnected pads with the sizes 100×100μm to provide information on the *y* coordinate. In such a configuration the pitch in *x* and *y* coordinates is the same and equals 400μm. The structure of the *bottom* projection (see Fig. 2 right) is almost the same as on top, but rotated by 45°, which increased the pitch by factor of $\sqrt{2}$ (400×$\sqrt{2}$=566μm), which additionally allows us to test different strip capacitances. The active area of the 'GEM2D' GEM-Tracker prototype exploiting this design is 310×310mm^2 and exhibits 3072 readout channels in total (see Fig. 3. which are routed to high-density connectors. The readout is done exploiting 12 nXYTER-based GEMEX front-end boards[3].

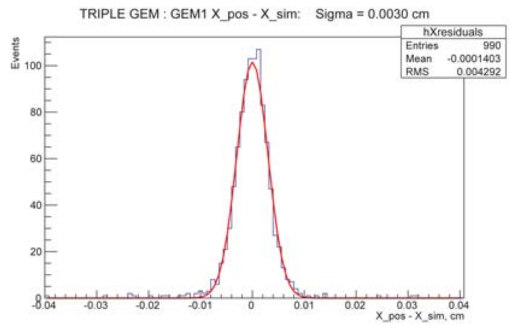

Figure 1: Distribution of the residuals between the generated and the reconstructed track X-positions.

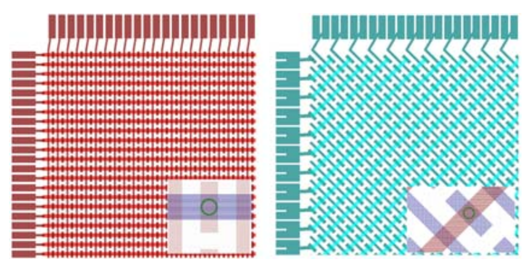

Figure 2: Top (left) and Bottom (right) projection patterns. The insets visualize details of the structures.

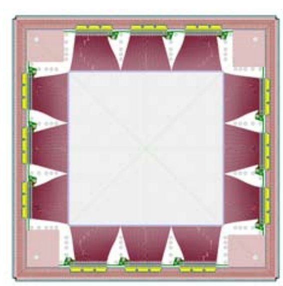

Figure 3: Outer part of the GEM2D PadPlane. The blanked inner part is patterned with structures shown in fig.2

References

[1] Voss B. et al., GSI Scientific Report 2008, GSI Report 2009-1, p.242.

[2] Voss B. et al., GSI Scientific Report 2009, GSI Report 2010-1, p.338.

[3] Voss B. et al., GSI Scientific Report 2011, GSI Report 2012-1, p.247.

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