The PANDA GEM-TPC prototype*

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A Time-Projection Chamber (TPC) [1] is an ideal candidate for the central tracking device inside the target spectrometer of PANDA@FAIR due to its excellent tracking performance and particle identification capabilities, combined with a small material budget. Its operation in the antiproton storage ring HESR at a 'standard' rate of $2 \cdot 10^7$ pp-bar annihilations per second, however, requires a continuous sampling of incoming signals leading to event mixing. The use of GEM technology for charge amplification provides the means to achieve the required resolution and to suppress the accumulation of space charge in the drift volume. We currently foresee 3 stages with 8 cake-like sectors per foil in CERN 'standard' configuration (Cu/Kapton® 5/50µm thickness and double-conical hole pattern 50/70/140µm $\varnothing_{Cu}/\varnothing_K$/distance). The leakage current at 550V has been measured to be (3.1±1.8) nA for 10 foils with a maximum value of 6.3 nA which is very well acceptable.

For in-lab tests, a pad plane with ~10000 hexagonal pads as shown in fig. 1 has been built. Its shape conforms to the design values within an accuracy of well below 0.1mm. It features common electrical support, coding of the front-end boards and a variety of sensor controls.

For test purposes it is foreseen to read out the detection systems using a future version of the data driven XYTER ASIC offering 128 ch/chip of charge sensitive amplifiers, fast (30 ns) & slow (150 ns) shapers, a peak detector, 1 ns time stamping and a de-randomizing, sparsifying 32 MHz token-ring readout. The measured noise value of σ~425e⁻ @5..10pF is close to the design-value of 370e⁻@10pF / 550e⁻@20pF and sufficient for the PID by the TPC. The current version AMS-CMOS-0.35µm technology needs 21 mW/ch of power requiring an effective cooling system to get rid of ~0.5 kW heat dissipated. For this purpose, a heat-piping system (see fig. 2) with a minimized number of joints is operated with liquid coolant HFE7100 under ~4 bar overpressure and turbulent flow of ~3 l/h.

Most of the ongoing work is now focussing on the construction and testing of the field-defining system (see fig. 3). Its length has been extended to 702 mm to cope with the needs of the crystal-barrel experiment at ELSA /Bonn. The simulations show that a strip width and gap of the staggered strip-lines of 1 mm and 0.5 mm, respectively, keep the field inhomogeneities in the vicinity of the walls in an acceptable range. The GEM-TPC prototype will be tested early 2010 at CB@ELSA and FOPI@GSI

References

[1] Voss B. et al., GSI Scientific Report 2008, GSI Report 2009-1, p.238.

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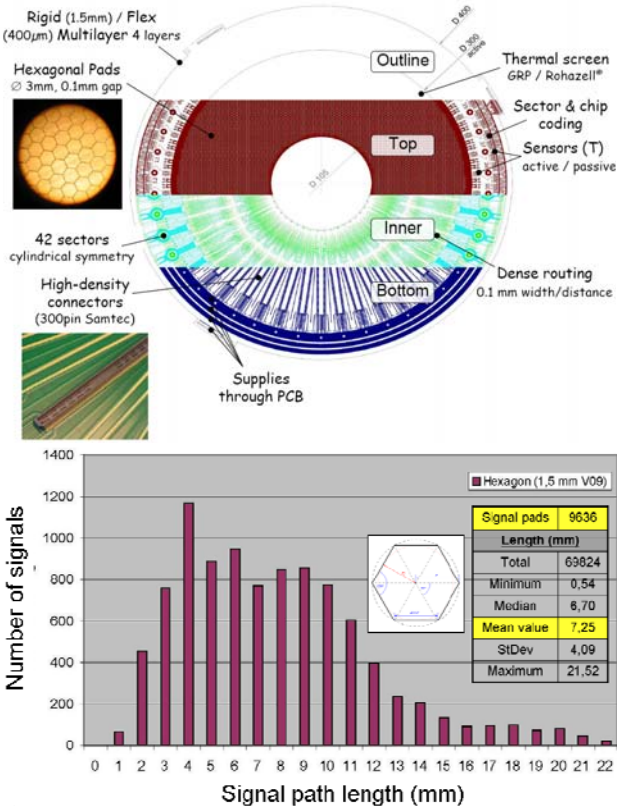

Figure 1: Features and characteristics of the pad plane.

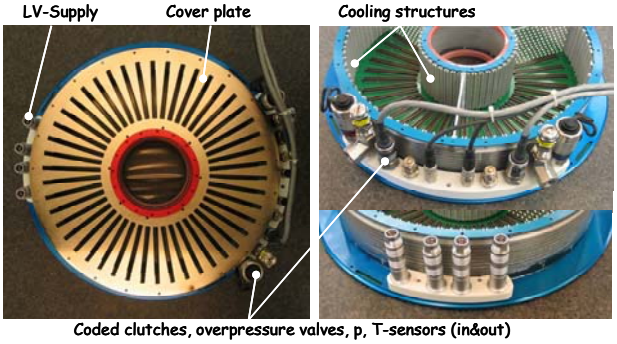

Figure 2: Details of the heat piping system.

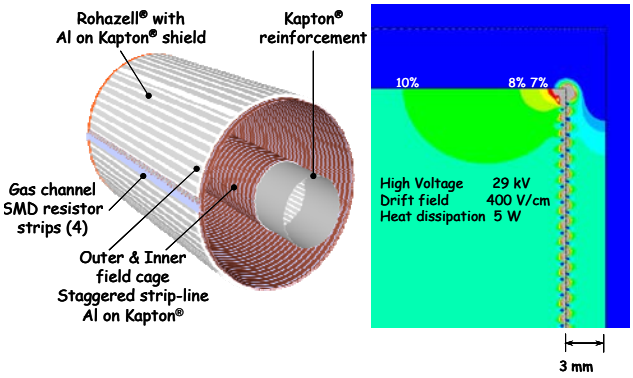

Figure 3: Design and simulation details of the field-cage.