Development of ceramics RPC for high rate capability timing detector application

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The installation of timing Resistive Plate Chambers (RPC) is under consideration for the very forward, high rate environment of the Compressed Baryonic Matter (CBM) experiment [1]. For that purpose prototype timing RPC were developed at Helmholtz-Zentrum Dresden-Rossendorf (HZDR). Electrodes with a volume resistivity of about $10^9\,\Omega$cm [2, 3] are considered for detectors with high rate capability $\leq 2{\cdot}10^4\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$. Special ceramics composites were developed and processed.

In 2010 two prototypes with dimensions of the ceramics electrodes of $10\times10\,\mathrm{cm}^2$ and one prototype with $20\times20\,\mathrm{cm}^2$ were exposed at the electron accelerator ELBE at HZDR to 32 MeV single-electron beam pulses. The flux of the primary beam is tunable from few electrons/s to 10^7 electrons/s. The exposed region amounts to about $10\,\mathrm{cm}^2$. Position-dependent efficiency and time resolution distributions (Fig. 1) were measured over the full detector area by moving the RPC perpendicular to the beam axis.

The behaviour of both small RPCs is very similar, even though the surface roughness differs by one order of magnitude (40 nm resp. 400 nm). A four times larger RPC was assembled as a more realistic demonstrator for the innermost CBM-TOF segment. The construction differs in few details only. No additional inner support structure was provided, although both linear dimensions increased by a factor of two. A two-dimensional efficiency plot is shown in Fig. 2 for a beam flux of $4.2{\cdot}10^4\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$. For all RPCs the highest applied field amounts to 105 kV/cm in the four gas gaps of 300 μm width.

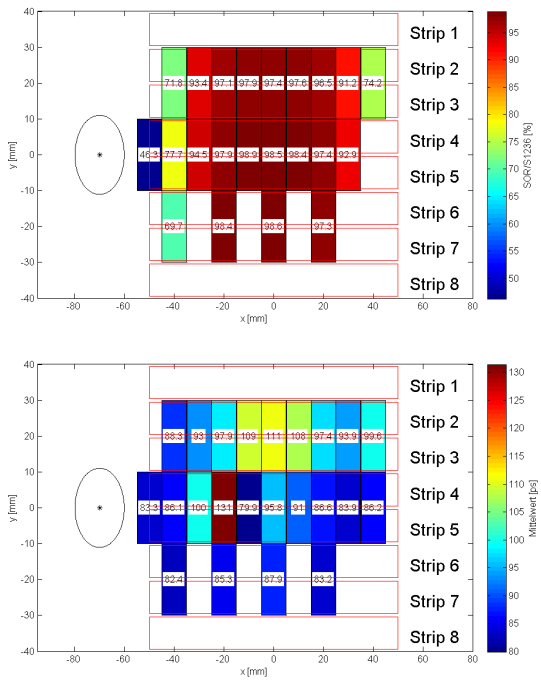

Figure 1: Efficiency (top) and time resolution (bottom) of the $10\times10\,\mathrm{cm}^2$ RPC as a function of the beam position for an electron flux of $2{\cdot}10^5\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$

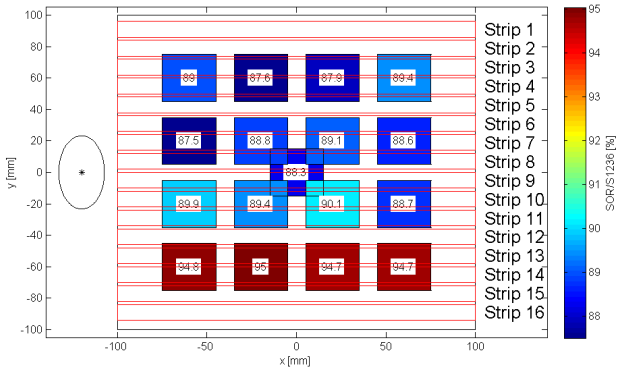

Figure 2: Efficiency of the $20\times20\,\mathrm{cm}^2$ RPC as a function of the beam position for an electron flux of $4.3{\cdot}10^4\,\mathrm{s}^{-1}\mathrm{cm}^{-2}$

References

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[2] L. Naumann *et al.*, Nucl. Instrum. Meth. **A 628** (2011) 138

[3] L. Naumann *et al.*, Nucl. Instrum. Meth. **A** (2010), doi:10.1016/j.nima.2010.09.121