High counting rate test of the basic structure for the inner zone of the CBM RPC-TOF *

A. Bălăceanu[1], *V. Aprodu*[1], *D. Bartoş*[1], *G. Caragheorgheopol*[1], *F. Constantin*[1], *I. Deppner*[2], *V. Duţă*[1], *N. Herrmann*[2], *P. Loizeau*[2], *M. Petriş*[1], *M. Petrovici*[1], *L. Prodan*[1], *A. Radu*[1], *L. Rădulescu*[1], *V. Simion*[1], *and C. Simon*[2]

[1]NIPNE, Bucharest, Romania; [2]Physikalisches Institut der Universität Heidelberg, Germany

A basic structure for the inner zone of the CBM-TOF wall using multi-strip multi-gap low resistivity glass RPCs was designed, built and successfully tested in terms of time resolution and efficiency [1]. The performance as a function of counting rate was tested exposing the counter in high intensity proton beam of 2.5 GeV/c at COSY-Jülich on a rather limited surface corresponding to the size of the beam spot [2]. In the present contribution we report for the first time results obtained exposing the whole detector surface at counting rates up to 10^4 particles/(cm^2·s).

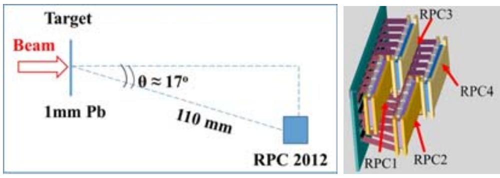

Figure 1: Left side - experimental geometry. Right side - the architecture based on four RPC cells

The in-beam test was performed at the SIS18 accelerator of GSI-Darmstadt. The RPC prototype was exposed to charged particles produced by colliding 1.7 A·GeV Ni ions with a 1 mm thick Pb - target at the highest intensity per spill delivered by SIS18. Fig. 1 shows the geometry of the experiment (left side) and the staggered structure of the 4 RPC cells (right side). The spill length was varied between 5 s and 2.5 s. The analysis is based on ROOT [3] and Go4 [4]. The detector was operated in a standard gas mixture of 85% $C_2F_4H_2$+10% SF_6+5% iso C_4H_{10} and at an electric field strength of 157 kV/cm. Signals of 16 strips of each cell were processed by NINO fast amplifiers [5], their differential outputs being converted by FPGA TDCs [6]. The

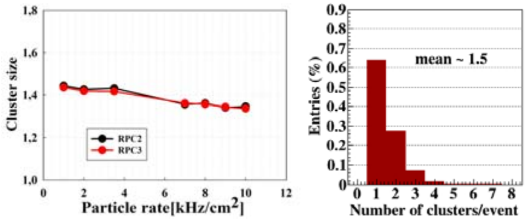

Figure 2: Left side - cluster size as a function of counting rate. Right side - number of clusters per event for a counting rate of 8x10^3 part/(cm^2·s) .

number of simultaneously recorded signals (calles cluster size) is shown in Fig.2 left side as function of the counting rate. A decrease of about 7% is observed. On the right side of Fig.2 the number of clusters per event is represented for one of the RPC cells.

The time resolution was obtained using the time difference between two RPC cells overlapped along the strips, i.e. RPC2-RPC1 or between two RPCs overlapped across the strips, i.e. RPC1-RPC3. For the first case, where the overlap is at the edge of the strip, some influence of edge effects is not excluded. After walk correction, a time resolution of ≈70 ps was obtained, including electronic resolution and considering an equal contribution of the two RPC cells. For the overlap across the strips a time resolution of ≈60 ps was obtained. The corresponding time difference spectrum for a flux of 10^4 part/(cm^2·s) is presented in Fig.3 left side. The non-Gaussian tails are at the level of 1-2%. The time resolution as a function of counting rate is shown in Fig.3 right side. A slight deterioration of the time resolution of about 5% is observed up to 3·10^3 particles/(cm^2·s) counting rate followed by a levelling off, within the error bars, up to 10^4 particles/(cm^2·s), the highest counting rate accessed in the experiment.

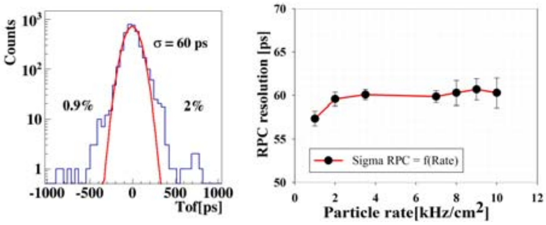

Figure 3: Left side -time difference between two overlapped strips of RPC1 and RPC3 cells. Right side - time resolution as a function of particle rate.

These results together with the previous reported ones [1],[2] show that such RPC architecture, based on low resistivity glass electrodes conserves their excellence performance in counting rates up to 10^4 particles/(cm^2·s) on the whole area of the detector. Such tests will continue at even higher rates and longer exposure periods in order to confirm that these type of RPCs can be used even for the most forward regions of the CBM-TOF wall with negligible ageing effects.

References

[1] M. Petris et al.,CBM Progress Report 2012, p. 68
[2] M. Petrovici et al., JINST 7 (2012) P11003
[3] R. Brun and F. Rademakers Linux Journal 1998 July Issue 51
[4] J. Adamczewski et al, IEEE TNS 51(2004)565
[5] F. Anghinolfi et al., Nucl.Instr.and Meth. A533(2004)183
[6] J. Frühauf et al., CBM Progress Report 2012, p. 71

* Work supported by EU-FP7/HP3 Grant No 283286, NASR/CAPACITATI-Modul III contract nr. 179EU and NASR/NUCLEU Project PN09370103

doi:10.15120/GR-2014-1-NQM-CBM-26