High granularity, symmetric differential readout - timing multigap RPC

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We report about results of a R&D activity concentrated on the development of a multigap RPC (MRPC) prototype with strip readout for high counting rate and high multiplicity environments as it is required by the low polar-angle region of the CBM-TOF detector. In order to cope with the challenging counting rate requirements at the inner part of the CBM-TOF wall ($\sim$ 2x10^4 part.$\cdot$cm$^{-2}\cdot$s^{-1}), we built a few prototypes using as resistive electrodes a special low-resistivity glass with a resistivity of the order of 10^{10} Ωcm [1, 2].

The obtained results showed that operating a MRPC with very good time resolution at high counting rate environments (up to 16,000 part.$\cdot$cm$^{-2}\cdot$s^{-1}) is feasible. Nevertheless, the low polar-angle region requires not only a high counting rate performance, but also a high granularity detector to meet the multiplicity challenge (up to 1000 tracks/event at 25A GeV Au+Au collisions). For this particular region of the TOF wall, we designed and built a RPC prototype using a readout electrode with short length strips (46 mm).

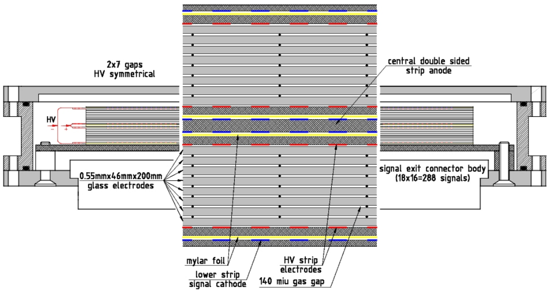

Figure 1: Sketch of the RPC configuration

A cross section through this configuration is shown in Fig. 1. It is a completely symmetric two stack structure, with high voltage electrodes for both positive and negative polarities. Each high voltage electrode has an identical strip structure as the readout electrodes. Each stack has seven gaps of 140 μm each, defined by eight resistive electrodes made from a normal high resistivity float glass ($\sim$ 10^{12} Ωcm). The strips of the high voltage electrodes were in contact with a resistive layer painted on the last glass electrode. The readout electrodes (the cathodes and central double-sided anode) have a strip structure of 2.54 mm pitch and 1.1 mm strip width. The anode and cathode signals are connected by twisted pair cables and sent to the differential FEE based on the NINO chip [3].

The detector was tested in beam at T10 beam line of the CERN PS accelerator with a 6 GeV/c momentum beam of negative pions. A 90% $C_2F_4H_2$ + 5% SF_6 + 5% iso-C_4H_{10} gas mixture was used.

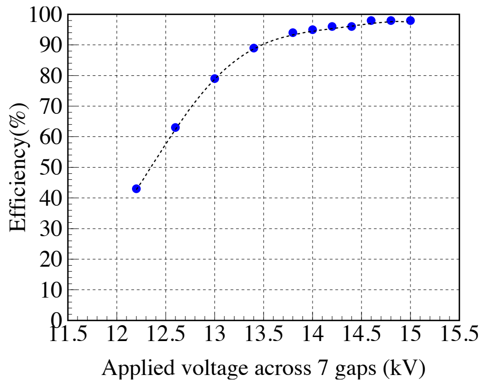

Figure 2: Efficiency as function of applied voltage

Applying a HV larger than 2kV/gap, an efficiency of 95% to 98% was measured, where the efficiency was determined by the number of RPC hits with valid time and time over threshold information divided by the number of triggers. The time of flight distribution was obtained as the mean of the time information recorded at both ends of the used strip relativ to the reference signal delivered by a plastic scintillator. We performed for each measured strip a time walk correction and subtracted quadratically the contribution of the scintillator reference counter (61 ps) and an electronics jitter (33 ps). The resulting time resolution was determined to 57 ps (Fig. 3) at 2.09 kV/gap.

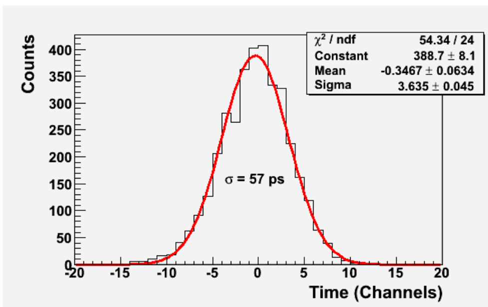

Figure 3: Time of flight spectrum

References

[1] D. Bartoş *et al.*, 2008 NSS/MIC, Vols. 1-9 Book Series: IEEE Nuclear Science Symposium - Conf. Rec. Pg: 1933-1935

[2] M. Petriş *et al.* , Rom. Journ. Phys. (2010), in press

[3] F. Anghinolfi *et al.*, Nucl. Instrum. Meth. **A 533** (2004) 183