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High rate, high time resolution, 2D-position sensitive and aging effect suppression Multi-Strip Multi-Gap Resistive Plate Counter

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Compressed Baryonic Matter (CBM) is a fixed target experiment at the future Facility for Anti-proton and Ion Research (FAIR), dedicated to explore the phase diagram of QCD matter at high net baryon densities. With the goal to perform high precision measurements of very rare probes with enough statistics in heavy ion collisions at $\sqrt{s_{NN}}$=2-5 GeV, CBM is designed to run at unprecedented interaction rates of 10^7 interactions/s. Therefore, CBM-TOF wall, based on Multi-gap RPCs (MRPCs), will be exposed at the low polar angles to challenging high counting rates up to 30 kHz/cm^2. Designed to cope with the mentioned high counting rates, the Multi-Strip, Multi-Gap Resistive Plate Counters (MSMGRPCs) developed for the inner zone of the CBM-TOF wall will be equipped with electrodes made of lower resistivity material (˜10^{10} Ωcm). The MSMGRPC prototypes shows an efficiency better than 90% with ∼50 ps single counter time resolution up to 30 kHz/cm^2 (highest delivered counting rate in the in-beam test), exposing the whole active area. As it is well known, the long period operation of MRPCs with $C_2H_2F_4$ and SF_6 based gas mixtures leads to aging effects. For this reason, detailed studies of the effect of the high density avalanches induced by a high irradiation dose on a MSMGRPC were performed. The gas pollution effect was evidenced by the deposition of the different radicals produced by polymerization on the anode surface and by the ablation/etching processes on the cathode surface of the resistive electrodes. Enhanced depositions and higher dark rates were also observed around the spacers used for defining the gas gaps between resistive electrodes. Such effects might limit the counter lifetime, therefore it is desirable to keep the electrode surfaces as clean as possible. In the reported aging studies, the gas exchange in the counter gas gaps occurred via the diffusion process. It is well known and also indirectly evidenced by our measurements that an enhanced gas exchange into the gaps is expected to decrease the chemical radical deposition on the surfaces of the glass plates. Based on these considerations, a MSMGRPC prototype with a directed gas flow through the gas gaps and minimization of the number of spacers in the electric field was developed as mitigation solution of the observed effects. Construction details and results of the comprehensive tests performed with the new developed architecture will be reported.

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