

Aging suppression timing Multi-Strip Multi-Gap Resistive Plate Counter for high counting rate experiments

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The high counting rate MSMGRPC (Multi-Strip, Multi-Gap Resistive Plate Chamber) prototypes developed for the CBM experiment at FAIR, operated with C₂H₂F₄ and SF₆ based gas mixtures, showed in laboratory cosmic-ray tests a very good performance. Later on, the obtained results were confirmed in the in-beam tests with reaction products, in the high counting rate test the efficiency being better than 90% with ~50 ps single counter time resolution up to 30 kHz/cm² exposure on the whole active area. However, as it is well known, a long operation time of Multi-Gap RPCs with gas mixtures based on C₂H₂F₄ and SF₆ leads to aging effects reflected in an increase of the dark current and dark counting rate, with impact on the chamber performance and artificial increase of the data volume in a free-running data acquisition mode. The aging studies performed by us using a high activity ⁶⁰Co source evidenced a gas pollution effect by the deposition of different radicals on the anode surfaces and by ablation/etching processes on the cathode surfaces of the resistive electrodes. Enhanced depositions and higher dark rates were also evidenced around the nylon spacers used for defining the gas gaps between resistive electrodes. For the mitigation of the effects mentioned above, MSMGRPC prototypes designed with a direct gas flow through the gas gaps (instead of classical gas exchange via diffusion process), with 100% gas transmission through the active volume and minimization of the number of spacers in the electric field, were developed. Three prototypes with this new design, differentiated by their strip length of 56 mm, 96 mm and 196 mm, corresponding to different granularities of the polar angle regions of the inner zone of the CBM-TOF wall, were assembled and investigated. Construction details of the new developed architectures, results of the comprehensive aging tests using a high X-ray flux, as well as the efficiency, time and position resolutions obtained in the cosmic-ray tests will be reported.

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