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New timing Multi-Strip Multi-Gap Resistive Plate Chamber architecture with aging suppression for high counting rate experiments

A long time operation of Multi-Gap Resistive Plate Chambers with gas mixtures based on $C_2H_2F_4$ and SF_6 leads to aging effects reflected in an increase of the dark current and dark counting rate, with impact on the chamber performance. Moreover, the higher noise rate leads to an artificial increase of the data volume in a free-streaming data acquisition operation used in high counting rate experiments.

For the mitigation of the gas pollution effects observed in high counting rate Multi-Strip Multi-Gap Resistive Plate Chambers (MSMGRPCs) exposed to high irradiation doses, a new MSMGRPC architecture based on discrete spacers and direct flow of the gas mixture through the gas gaps was designed and assembled. The aging investigations of the chambers with the new design demonstrated negligible aging effects even for rather low gas flow rate. Prototypes with such a direct flow architecture were tested in real operation conditions, in an in-beam test performed at the SIS18 accelerator of GSI Darmstadt with reaction products. The obtained results demonstrate the performance of the prototypes in terms of efficiency ($>95\%$) and time resolution (~ 55 ps). Therefore, such direct flow MSMGRPCs will be implemented in the modular configuration of the low polar angle region of the TOF wall (inner wall) of the CBM experiment at the FAIR facility in Darmstadt, where a challenging counting rate up to 30 kHz/cm^2 is anticipated. The modular architecture of the CBM-TOF inner wall encompasses 12 modules staggered in space such to assure an uniform detection area. Details about the implementation of the direct flow MSMGRPCs of different granularities in the first module of CBM-TOF inner wall, the most complex one whose assembling is in progress, are included.

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