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Impact of the gas choice and the geometry on the breakdown limits in MPGD detectors

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In this study we investigate the intrinsic stability limits of GEM, Thick GEM and Micromegas detectors upon irradiation with alpha particles. The measurements are performed in Ar- and Ne- based mixtures with different CO2 content to study the influence of the gas on discharge probability and critical charge limits. The latter are evaluated by comparing the experimental data to results obtained within a Geant4 simulation framework. The measurements provide a direct comparison between GEMs and THGEMs and allow us to evaluate the influence of geometrical parameters, such as hole size, pitch and (TH)GEM thickness, on the stability of a structure and the resulting critical charge value, estimated to be within a range of (3-7)´106 electrons. Surprisingly, the results for both amplification structures nicely agree with each other, in spite of the clear geometrical differences and different electric field configuration inside GEM and THGEM holes. We observe that the breakdown limit is strongly dependent on the gas, and that and that a higher amount of quencher in the mixture does not necessarily correlate with higher stability. The results obtained with Micromegas detectors, employing meshes with different optical transparency and geometry of wires, confirm the observed gas dependency on the discharge stability. In addition, we observe discharge probability scaling with the wire pitch which suggests that a Micromegas mesh cell can be treated as an independent amplification unit, similar to a hole in a GEM foil. The outcome of these studies provides a valuable input for further optimization of MPGD detectors, multi-layer stacks in particular.

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