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Numerical simulation of charging up, accumulation of space charge and formation of discharges

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Aging and stability of gaseous ionization detectors are intricately related to charging up, accumulation of space charge and formation of discharges. All these phenomena, in their turn, depend on the dynamics of charged particles within the device. Because of the large number of particles involved and their complex interactions, the dynamic processes of generation and loss of charged particles, and their transport within the detector volume are extremely expensive to simulate numerically.
In this work, we propose and evaluate possible algorithms / approaches that show some promise in relation to the above-mentioned problems. Several important ionization detectors having parallel plate configurations, such as GEM, Micromegas, RPCs and THGEMs, are considered for this purpose. Information related to primary ionization is obtained from HEED, while all the transport properties are evaluated using MAGBOLTZ. The transport dynamics have been followed using two different approaches. In one, particle description using neBEM-Garfield++ combination has been used. For this purpose, the neBEM solver has been significantly improved such that perturbations due to the charged particles present within the device are considered while estimating electric field. In the other approach, the transport is simulated following hydrodynamic model using COMSOL during which the electric field is also provided by COMSOL where it is easy to set up space charge effects. A comparison between these possible approaches will be presented. Effect of different simulation parameters will also be demonstrated using simple examples.

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