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Study of space charge phenomena in GEM based detectors

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Gas Electron Multipliers (GEM) are widely used for various high energy particle physics experiments world-wide. Thorough understanding of the working of GEM detectors are, thus, a matter of priority. Space charge accumulation within GEM holes is one of the vital phenomena which affects many of the key working parameters of such detectors through its direct influence on the resulting electric field in and around the holes. This accumulation is found to be significantly affected by the initial primary charge configurations and operating parameters of the detector since they determine charge sharing and the subsequent evolution of detector response. A recent numerical study on the possible effect of charge sharing on space charge accumulation in GEM holes has motivated us to investigate the phenomenon in greater detail. It has been observed that charge sharing among a larger number of holes allows higher gain since the space charge accumulation effect also gets shared among these holes. In this work, we have studied the effects of space charge on different parameters of single, double and triple GEM detectors using numerical simulation. A hybrid approach has been adapted, as given below:

1) **Geant4, Garfield / Garfield++, neBEM, HEED, Magboltz** have been used to identify the primary cluster, transport properties and resulting charge sharing.

2) **2D-axisymmetric** and **3D** hydrodynamic model based on COMSOL Multiphysics have been developed to simulate the temporal evolution of primary cluster, model space charge effects and to estimate the detector response. Finally, an attempt has been made to optimize the 3D-hydrodynamic model to make it computationally economical.

Collaboration

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