Study of space charge phenomena in GEM based detectors

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Accumulation of charges inside the GEM holes results in the modification of the electric field within the GEM foil which in turn can modify the effective gain. Space charge phenomena gets significantly affected by:

- Spatial distribution of primary seed cluster
- Mean z-position (height) of the primary seed cluster in the drift gap
- Applied GEM voltage

Simulation results:

1. Variation of electric field with the spatial distribution of primaries
2. Variation of electric field with different heights of primaries in drift gap
3. Variation of electric field due to space charge accumulation with increasing GEM voltages

\[ E_{WO} = \text{Electric field without space charge effect} \]
\[ E_{W} = \text{Electric field with space charge effect} \]
\[ \Delta E = E_{W} - E_{WO} \]

Conclusion:

- Effect of space charge phenomena is more in radially compact and z-elongated cases (case 3 and case 5).
- Space charge effect is maximum when the primary cluster height is the least in the drift gap.
- Space charge effect (\(\Delta E\)) increases with increasing GEM voltage.