Study of space charge phenomena in GEM based detectors

Promita Roy [1], Prasant Kumar Rout [2], Jaydeep Datta [3], Purba Bhattacharya [4], Supratik Mukhopadhyay [1], Nayana Majumdar [1] and Sandip Sarkar [1]*

[1] Saha Institute of Nuclear Physics, Kolkata - 700064, a CI of the Homi Bhabha National Institute, Mumbai - 400094, India, [2] National Central University, Taiwan, [3]Université libre de Bruxelles, Av. Franklin Roosevelt 50, 1050 Bruxelles, Belgium, [4]School of basic and applied sciences, Adamas University, Kolkata-700126

*Retired Professor

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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:

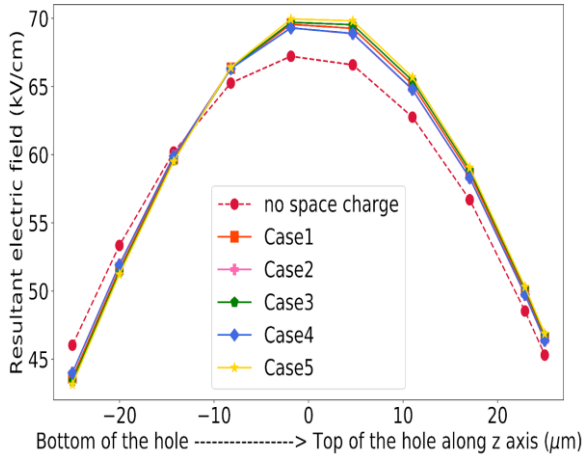
- ❑ Spatial distribution of primary seed cluster
- ❑ Mean z-position (height) of the primary seed cluster in the drift gap
- ❑ Applied GEM voltage

Simulation results:

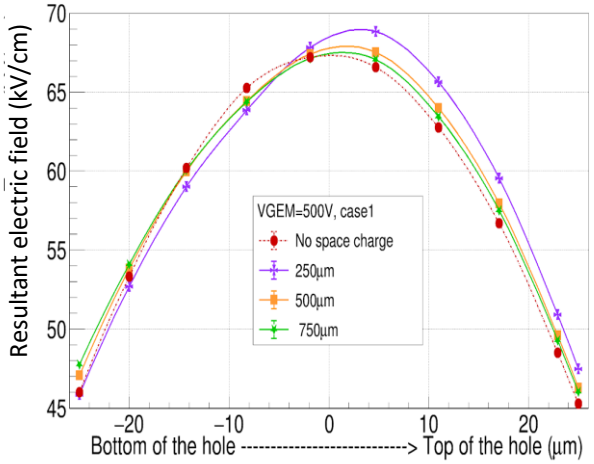
Five combinations of Fe55 primary seed clusters have been chosen:

Cases	Description	Spread in r (μm)	Spread in z (μm)
Case 1	Mean	132	154
Case 2	Enlarged	203	234
Case 3	Compact	61	74
Case 4	r-elongated	203	74
Case 5	z-elongated	61	234

1. Variation of electric field with the spatial distribution of primaries



2. Variation of electric field with different heights of primaries in drift gap



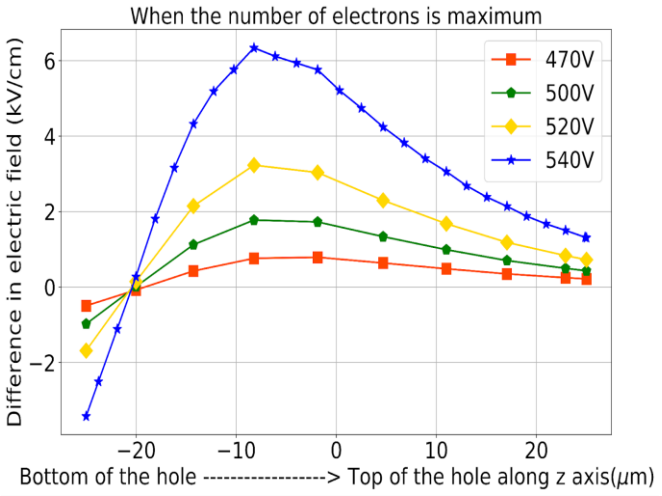
3. Variation of electric field due to space charge accumulation with increasing GEM voltages

E_{WO} = Electric field without space charge effect

E_W = Electric field with space charge effect

then the difference in electric field is

$$\Delta E = E_W - E_{WO}$$



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 (ΔE) increases with increasing GEM voltage.