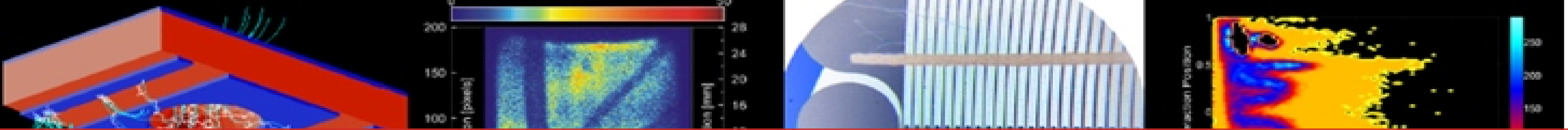

Charging-up studies: the case of GEM and THGEM

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abstract

The charging-up of the insulator surfaces in Micro Patterned Gas Detectors (MPGDs) has been pointed as one of the responsible for the difference between experimental and Monte Carlo simulations.

Previous simulations of the charging-up were already done for GEM transparency [1]. In this work we study its effect on the gain response.

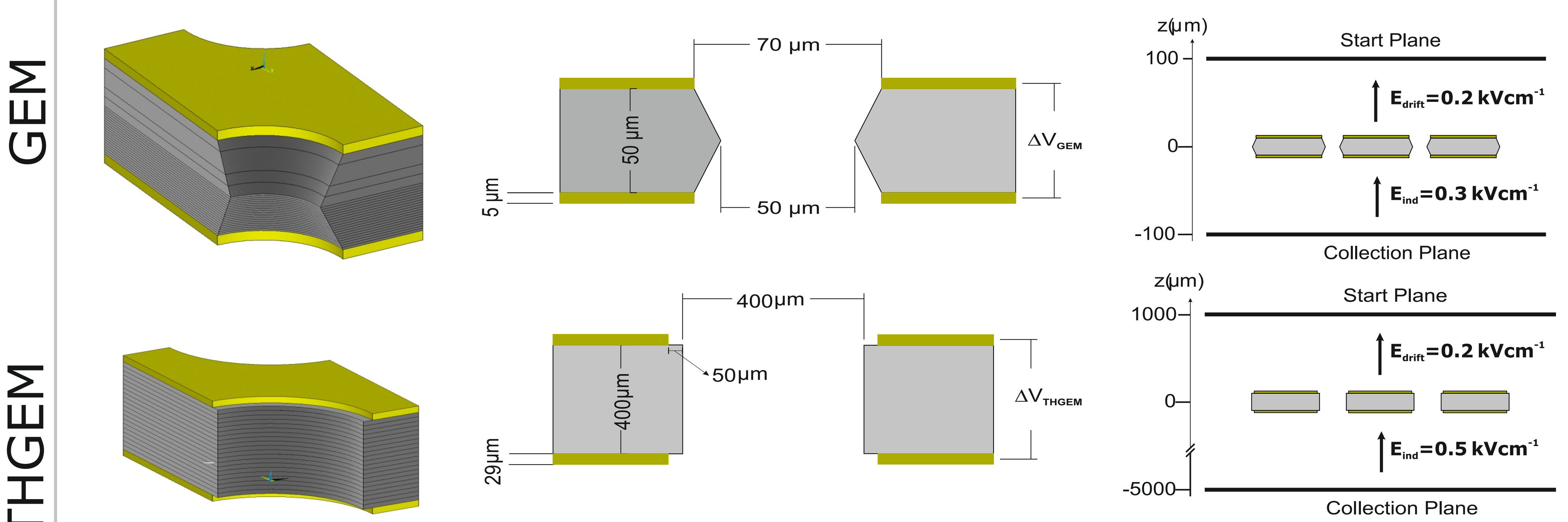
An iterative method to simulate the charging-Up in Gas Electron Multiplier (GEM) and in the Thick-Gas Electron Multiplier (THGEM) is propose.

This method consists on the simulation of the avalanches time evolution using a dynamical step that accelerates the simulation process. These method is sensitive to abrupt changes on the electric field configuration, due to charge accumulation on insulator surfaces, increasing or decreasing the avalanche step in fuction of the major or minor changes on the electric field. We consider that once the charge stops the drift in the insulator surface, it will not move during all the charging-up process. Standard tempeature of 293 K and presure of 760 Torr were used. Gases mixtures of Ar-CO_2 (70%-30%) and Ne-CH_4 (95%-5%) were used for GEM and THGEM, respectively.

In this work, simulated and experimental results for different GEM and THGEM configurations and for different applied voltages will be presented including a comparison between them.

To measure experimental gain on THGEM, we use the 8 keV fluorescence X-ray lines from a Cu target. A rate of 2.5 kHz was used, being produced, in average, 269.3 primary electrons per interacting photon[2].

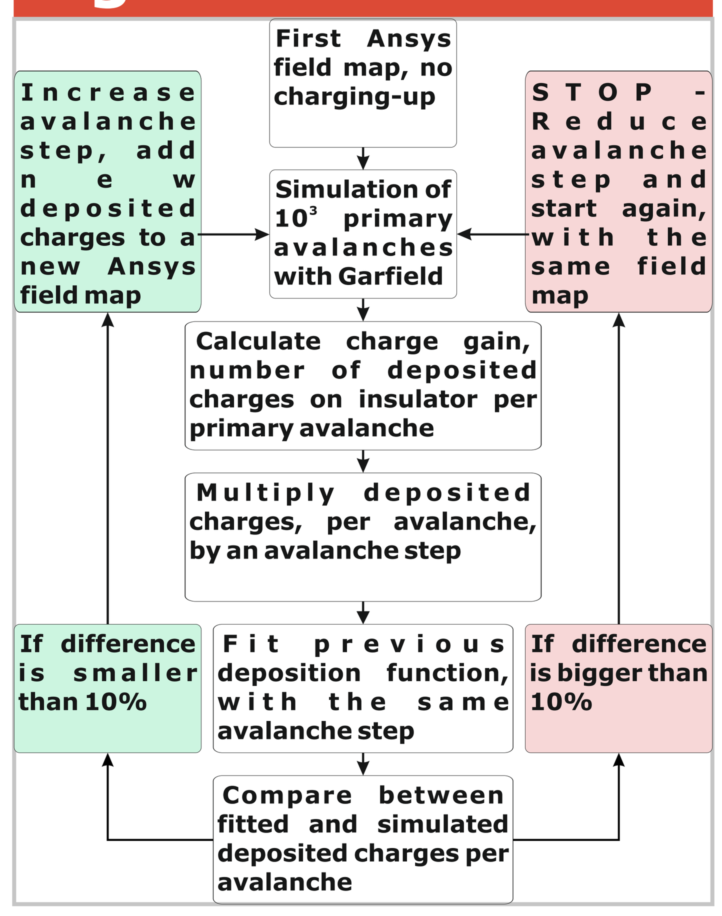
Configuration & Simulations



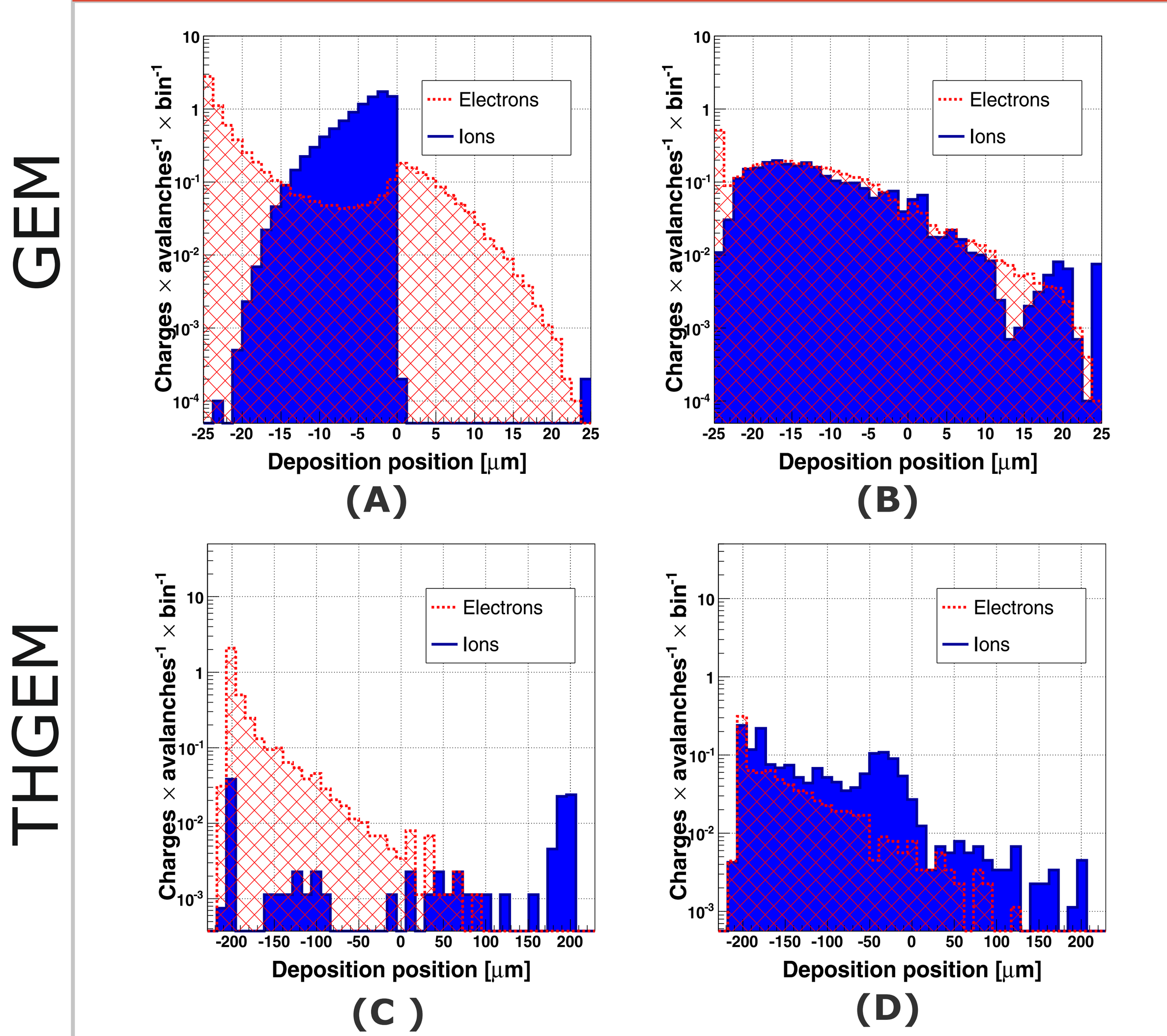
Unitary cell of a GEM and a THGEM, computed with Ansys.

Cross section a GEM (above) and a THGEM(below), with simulated dimensions and the correspondent voltage applied between electrodes and the drift and inductions fields applied in each case.

Algorithm

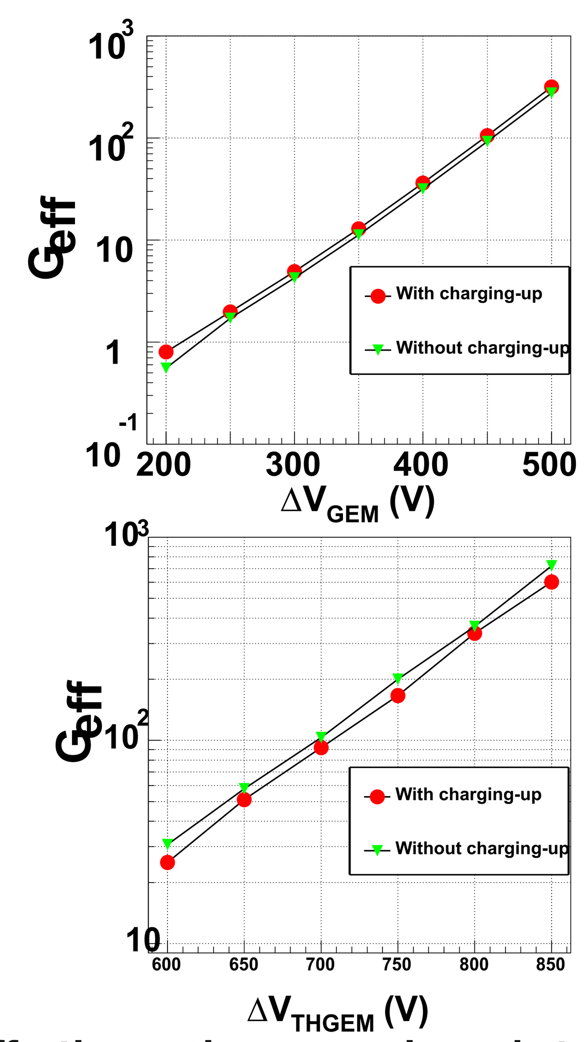


Deposition histogram



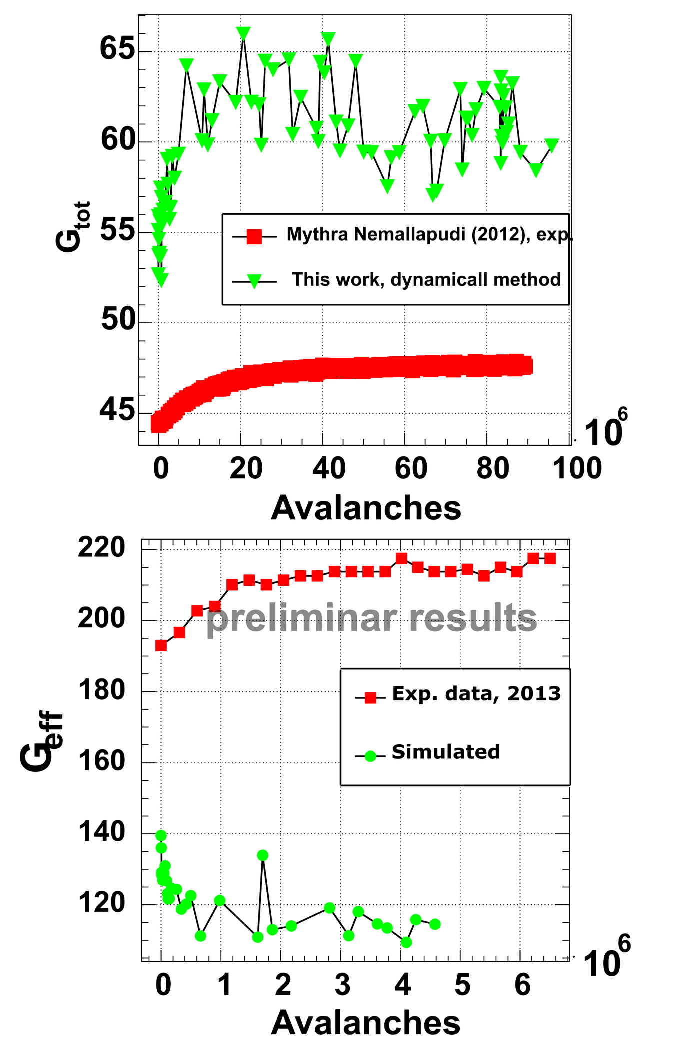
Histograms of the deposition of electrons(red) and ions(blue) on the insulator surface of the GEM detector, before (A) and after (b) charging-up, for 400V and for the THGEM , before (C) and after (D) charging-up, for 600V.

Gain vs Potential



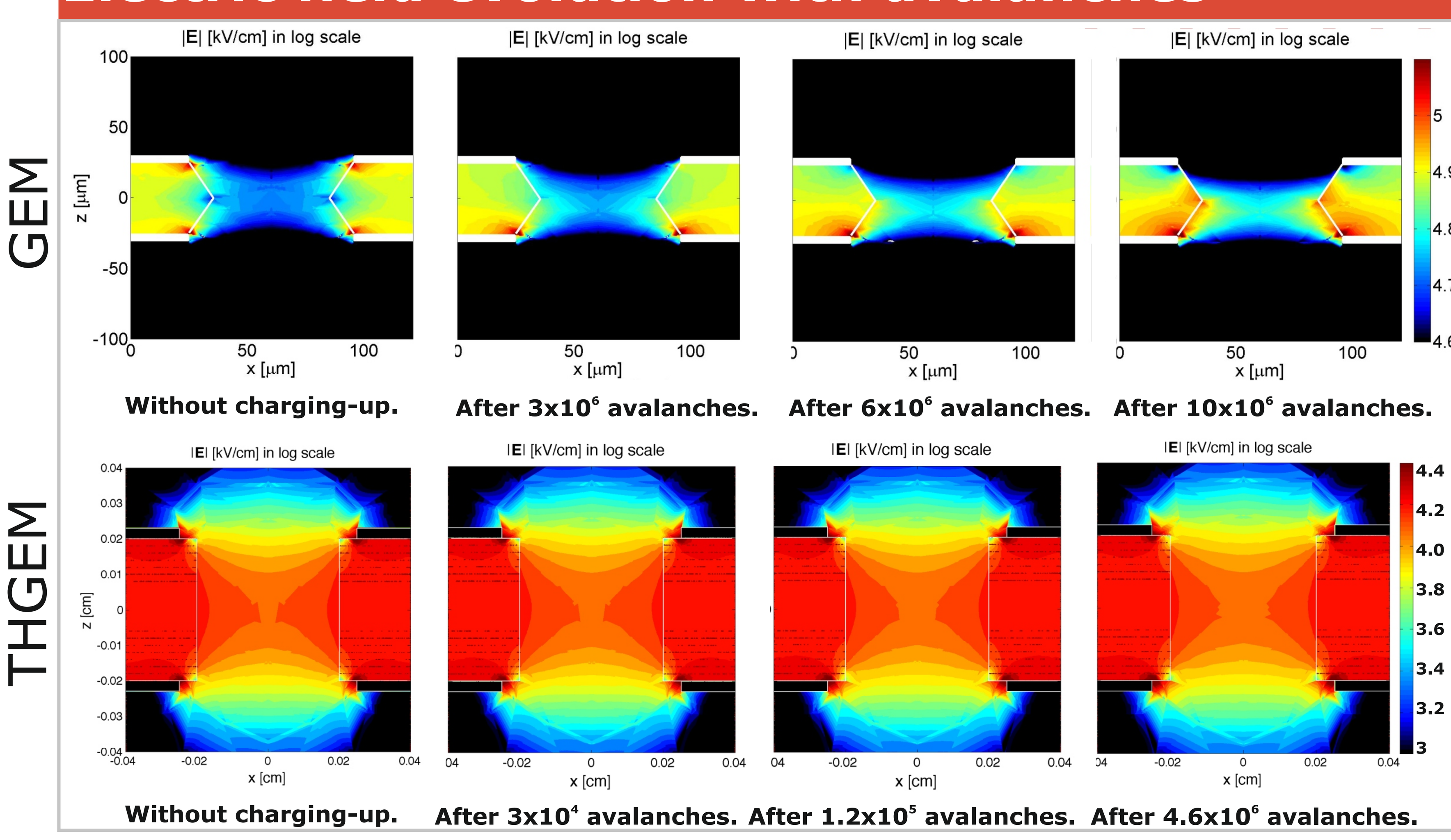
Effective gain comparison between charged (red) and uncharged (green) GEM (above) and THGEM (bellow), for diferent voltage between electrodes.

Gain vs Avalanches



Gain comparison between measuremments (red) and simulated (green) results, on GEM (above) at 380V V_{GEM} [3] and THGEM (below) at 690V V_{THGEM}.

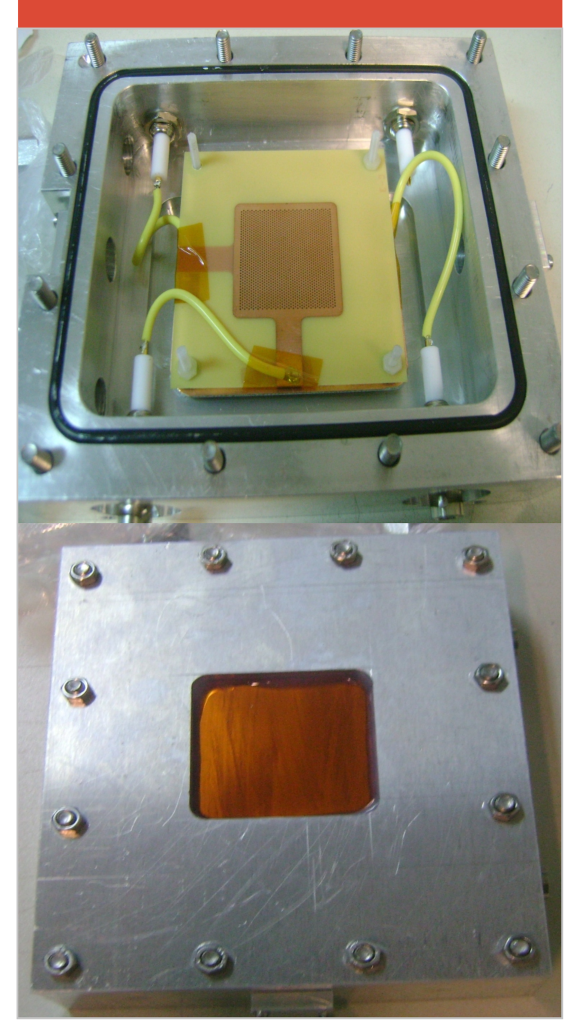
Electric field evolution with avalanches



Evolution of the intensity of the electric eld, on a GEM cross section. Computed with Ansys. Colorbar refers to logarithm of E. Only intensities above 4.6 kVcm^{-1} are shown for GEM and above 3 kVcm^{-1} for THGEM.

Variations on the electric field on GEM are more visible near the upper and lower electrodes, while on THGEM the major variations on the electric field is in the hole.

THGEM detector



Conclusions

Charging-up is responsible for variations on the electric field intensity in the hole regions of the GEM and THGEM. These affects the measured gain of the detector, and is one of responsibles causes of the variation of the gain during measurements with these detectors.

Variations on the gain of the order of 10-15% are obtained, both in GEM and THGEM, in experimental and simulated gain.

We obtained good agreement between measurements and simulations for GEM. On the case of THGEM, the experimental gain results are not consistent with simulations. For this case, more systematic results are needed.

future work

Improvement of the algorithm, until reaching the agreement with THGEM detectors, and get systematic measurements.

Application the method for other hole type detectors.

Study the movement of the deposited charges on the insulator.

acknowledgements

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