RD51 Mini Week

April 24, 2013

Results of a dynamical method for charging-up calculations on GEMs and THGEMs

Speaker: Pedro Correia, University of Aveiro

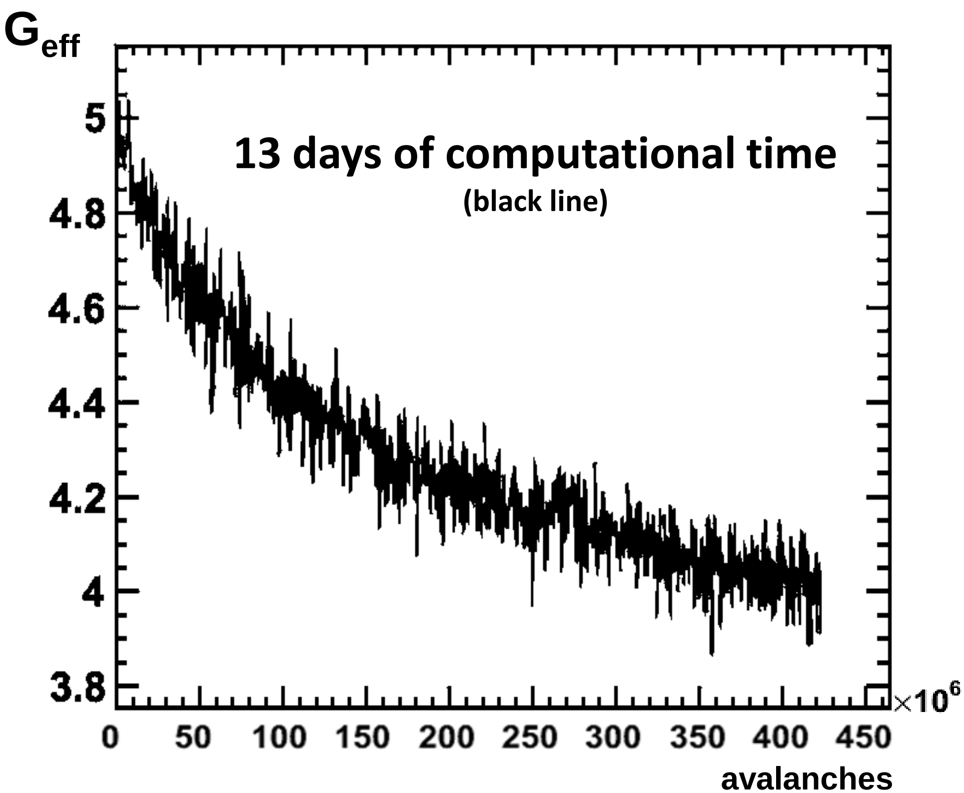
Co-Authors: Rob Veenhof, CERN
Carlos Oliveira, University of Aveiro, University of Berkeley
João Veloso, University of Aveiro

IMPORTANT TOPICS

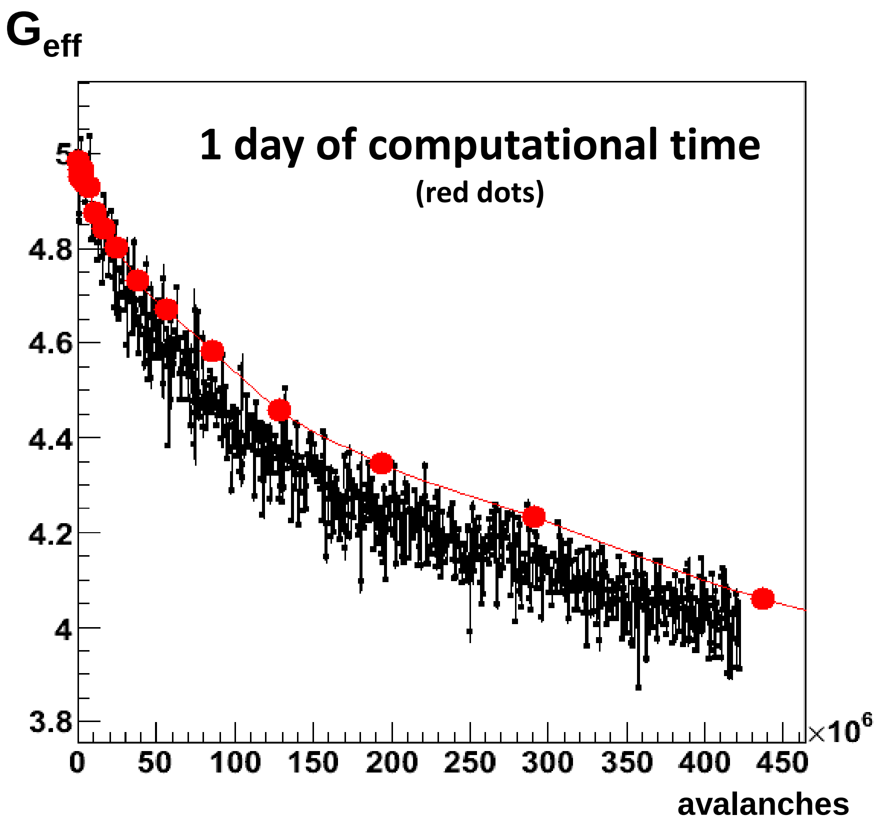
- Application of a dynamic method of charging-up calculations on GEMs and THGEMs
- Comparison between charge gain and deposition of charges on insulator surfaces
- Conclusions and Future Work

FIRST TRY - THGEM CHARGING-UP

EFF.GAIN FOR 1000V STANDARD VS DYNAMICAL STEP



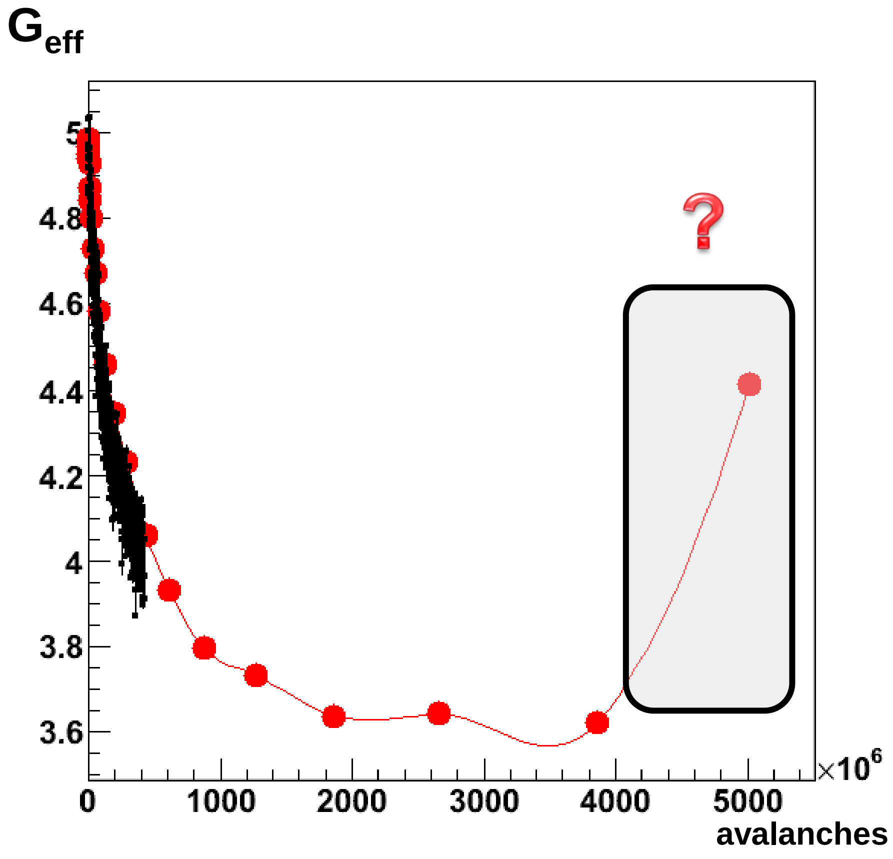
Standard method



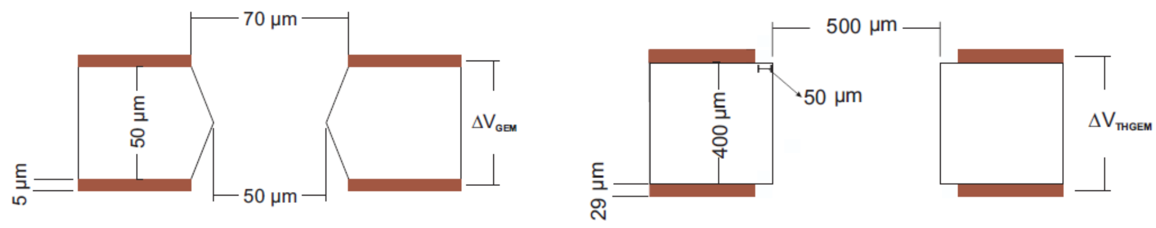
- Red points represent the dynamical step – only 20 dots are needed to represent the same information obtained before ≈ **1 day of computational time**
- Small deviation from previous results – See presentation of Miniweek in January 2013 for details

First Try - THGEM charging-up Dynamical step

- Standard method – black dots
- Dynamical method – red dots
- With more interactions the gain reaches a plateau (similar to experimental results)
- Some more iterations, but at some point the method vanished – **it was a bug in code**

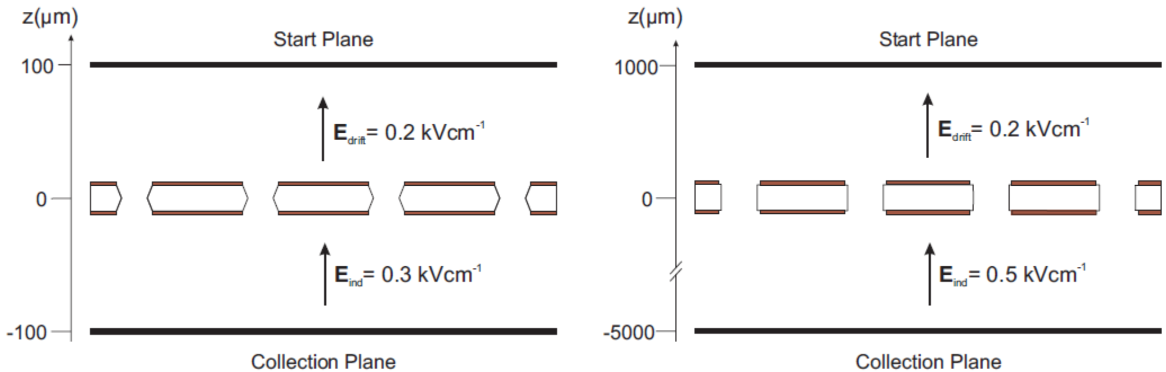


GEM AND THGEM GEOMETRIES



(a) GEM cross section.

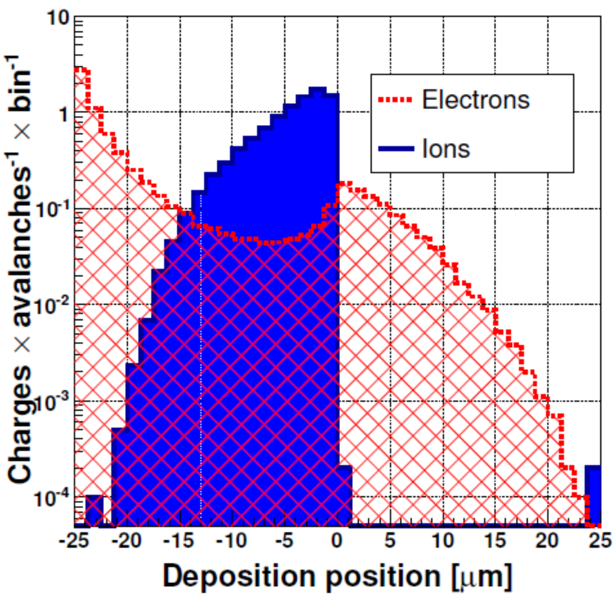
(b) THGEM cross section



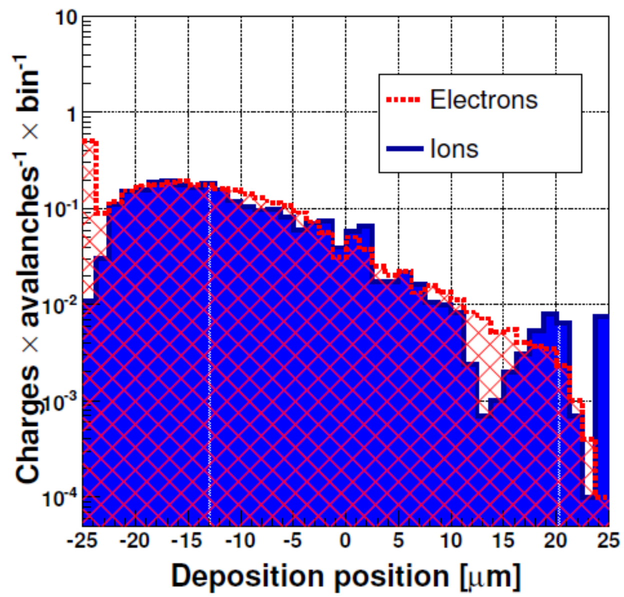
(c) Applied fields configuration for a GEM. (d) Applied fields configuration for a THGEM.

- Simulated geometries and electric fields applied to study dynamic method of charging-up.

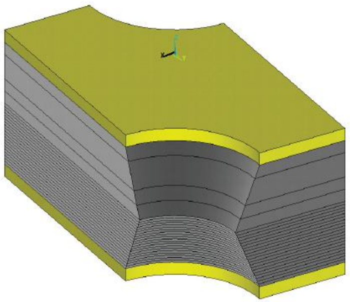
GEM CHARGING-UP
CONSTANT VS DYNAMIC



(a) Uncharged GEM



(b) Charged GEM

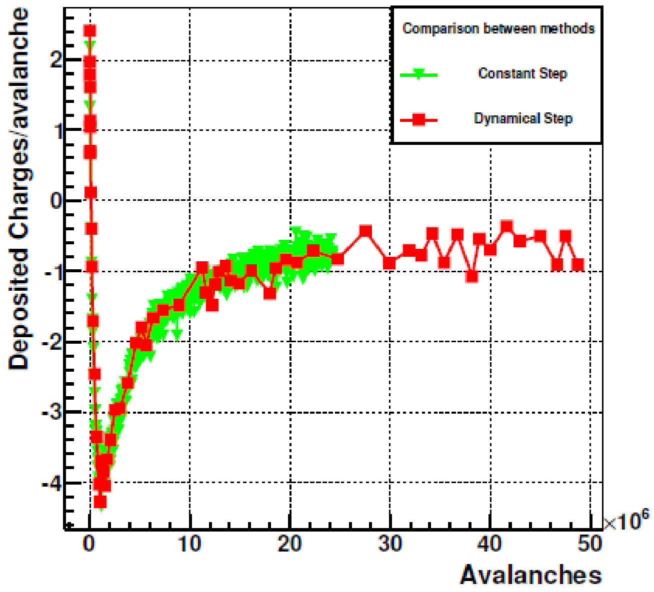


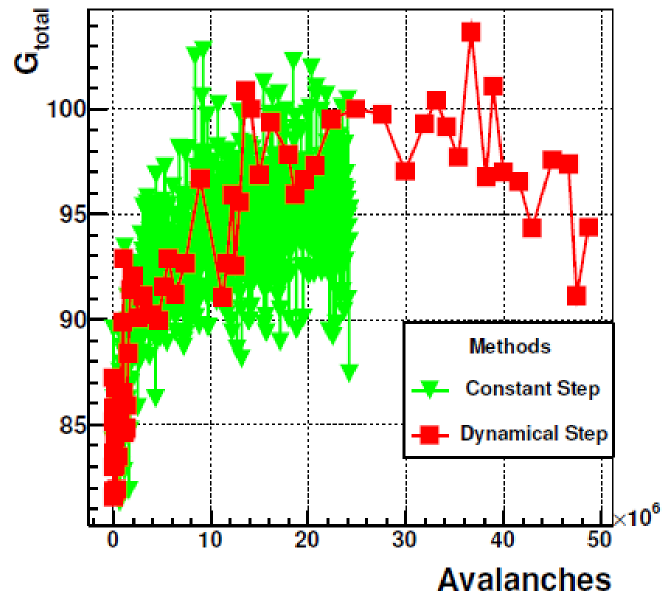
(a) GEM unity cell.

- ❑ VGEM=400V
- ❑ Ar 70% CO_2 30%
- ❑ 50 μm and 70 μm of int. and ext. diameter.
- ❑ Pitch 140 μm
- ❑ 760torr 293K
- ❑ Insulator 50 μm

- ❑ Fixed the bug, we start to apply the dynamic method to GEM and compare with constant method results.. 40 bins on each histogram.
- ❑ We can see the distribution pattern for uncharged and charged GEMs (before and after charging-up) along the hole (z coordinate), and the GEM unity cell computed on Ansys, 24 slices on insulator were used.
- ❑ We can see that after the GEM is charged, the number of deposited ions and electrons compensate each other.

GEM CHARGING-UP
CONSTANT VS DYNAMIC





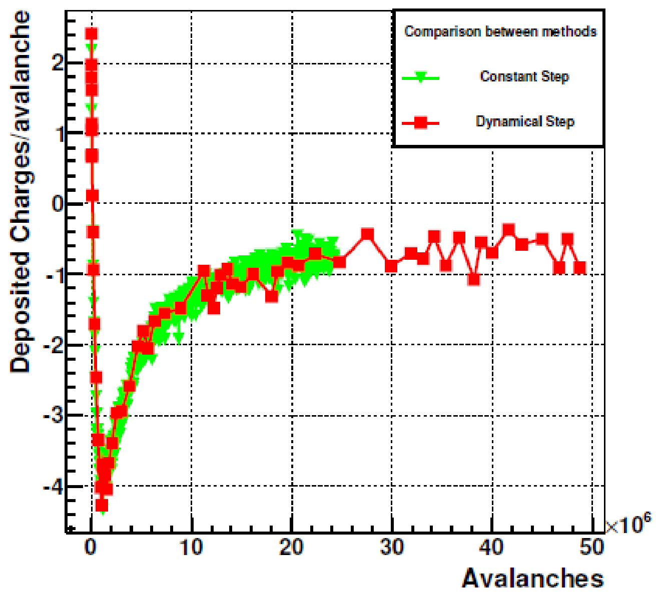
(a) Total number of deposited charges per avalanche, for bothconstant and dynamical method.

(b) Comparation of the absolute gain, along avalanches, between the constant and dynamical method.

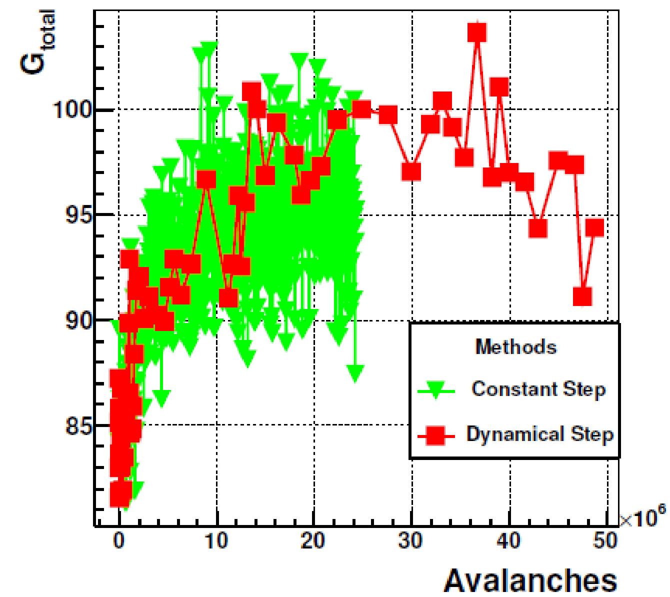
- At left we can see the variation of deposited charges (negative values means more electrons than ions). We can see the fast variation of the function in the beginning, manly due to the reduction of deposited ions.
- For later iterations, the number of ions and electrons tends to be equal (the functions tends to zero (actually, a lit bit more electrons are deposited near bottom electrode, but the contribution to variation of electric field is very small).

GEM CHARGING-UP

CONSTANT VS DYNAMIC



(a) Total number of deposited charges per avalanche, for bothconstant and dynamical method.

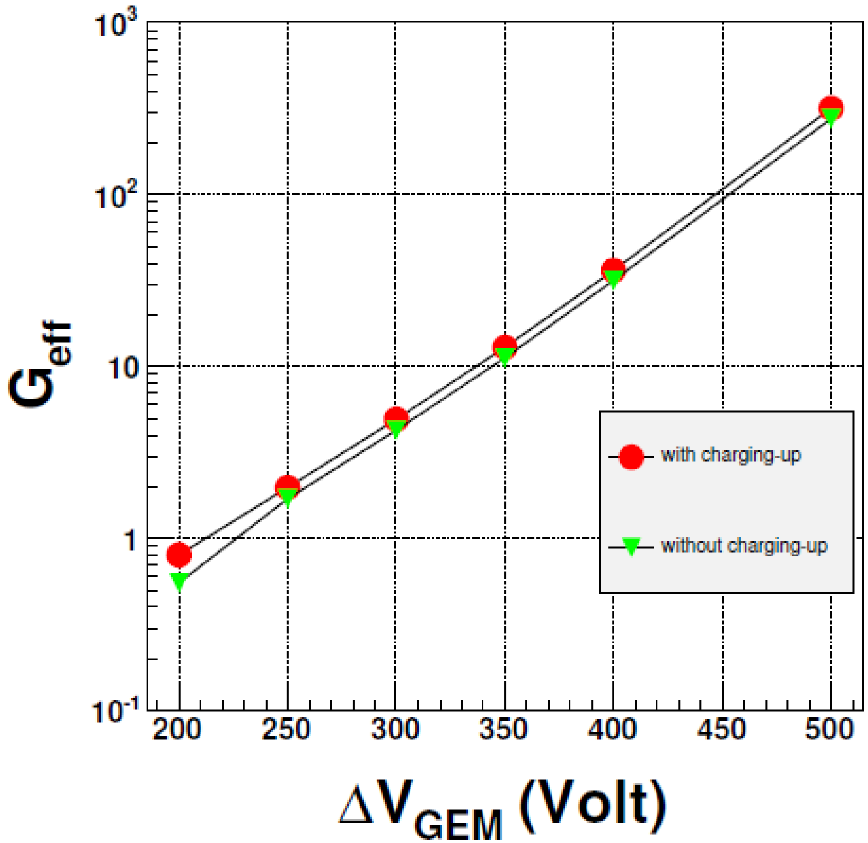


(b) Comparation of the absolute gain, along avalanches, between the constant and dynamical method.

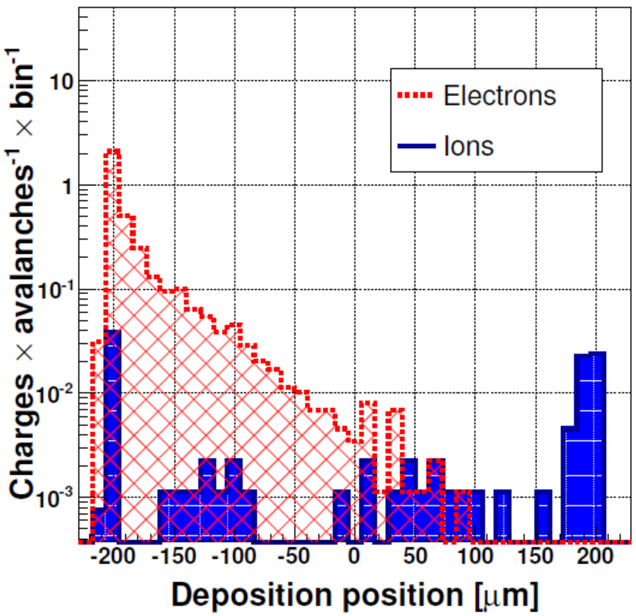
- At right is shown the variation of the absolute charge gain. We can observe the fast variation in the beginning due to the variation of the previous deposited charges function, and then a stabilization is reached.
- In both plots, we can see the agreement between methods - with dynamic method we need about 1/10 iterations, is much faster!

GEM CHARGING-UP
CONSTANT VS DYNAMIC

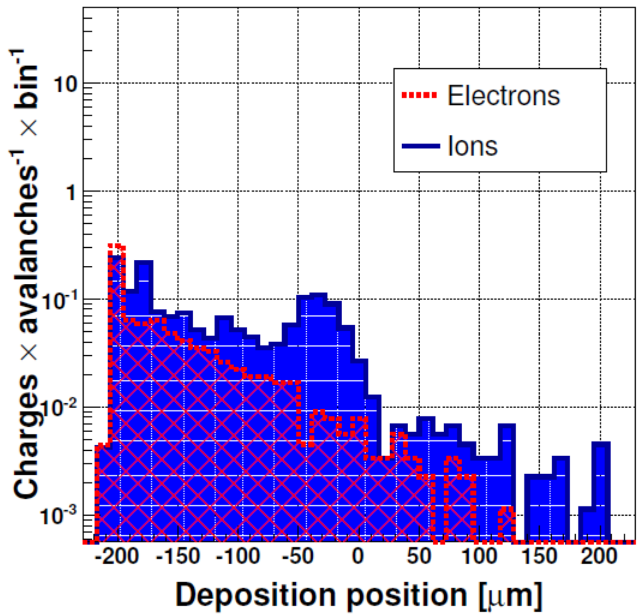
- On this plot we can see the effective gain (number of electrons that reach the collection plane, per primary avalanche), as a function of VGEM, for the uncharged (green) and charged (red) GEMs.
- Difference in gain between uncharged and charged GEMs is about 10-15%
- In this particular GEMs dimensions, the gain increase with charging-up.



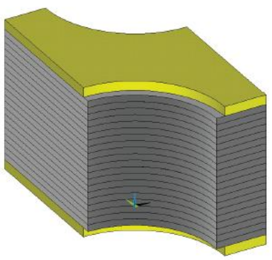
THGEM CHARGING-UP DYNAMIC



(c) Unchaged THGEM



(d) Charged THGEM

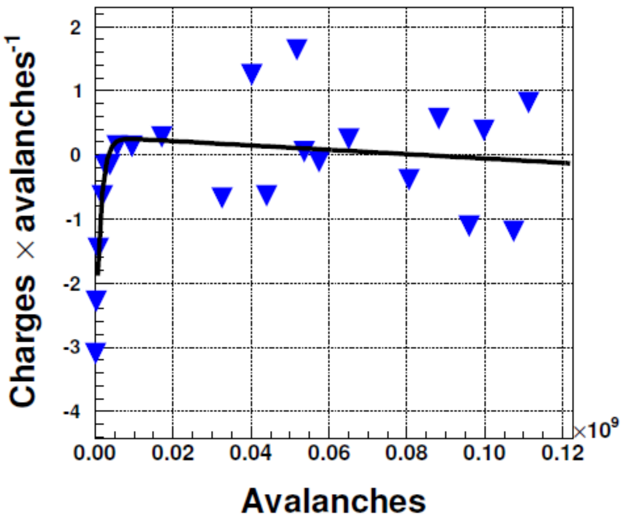


(b) THGEM unity cell.

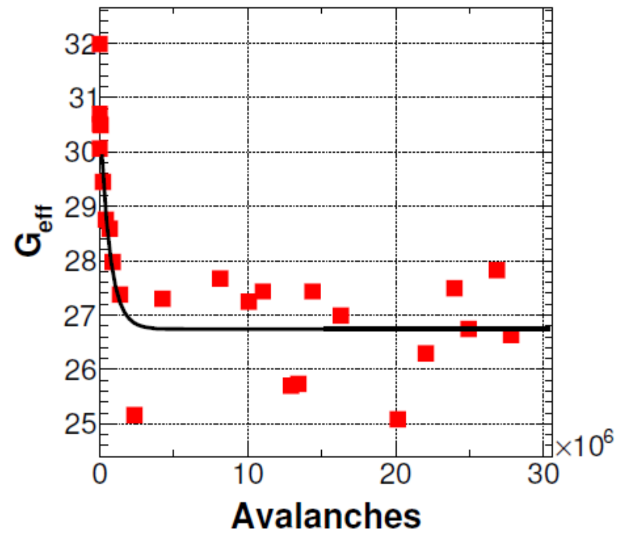
- VTHGEM=600V
- Ne 95% CH_4 5%
- 500 μm diameter.
- 550 μm rim diameter
- Insulator 400 μm
- Pitch 800 μm
- C3 model – Trieste courtesy

- We applied the dynamic method for a THGEM configuration
- The distribution of the number of deposited charges, per avalanche and per bin, after (left) and before (right) charging-up is shown.
- We can see that the number of deposited ions increase to compensate the deposited electrons.

THGEM CHARGING-UP DYNAMIC



(a) Deposited charges on THGEM insulator.

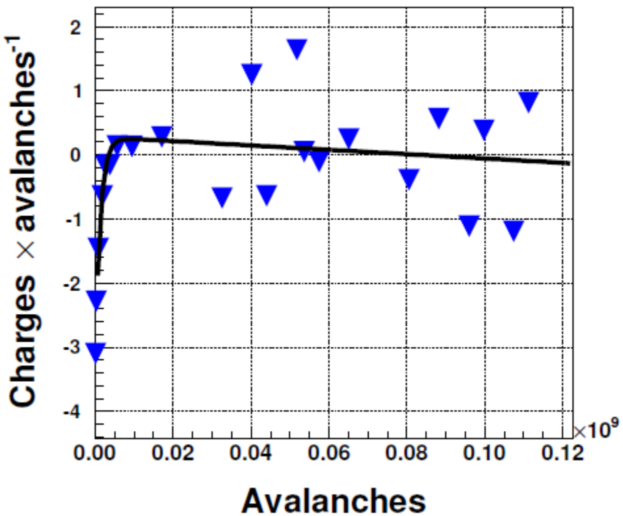


(b) Effective gain variation on a THGEM.

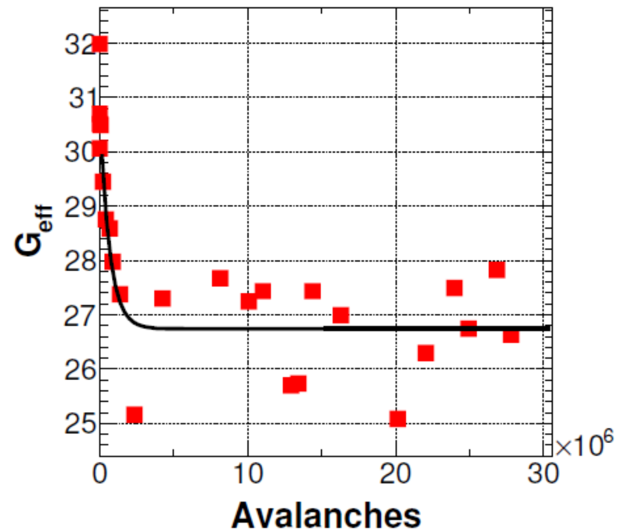
- ❑ Black functions are fits to simulated dots
- ❑ VTHGEM=600V

- ❑ On the left we have the total number of charges deposited on insulator (integral of histograms on slide 10) , per primary avalanche (negative means more electrons)
- ❑ We can see a fast variation of the function on the left, an uncharged THGEM has more deposited electrons than ions, but the number deposited ions rapidly increase and compensate the electrons. The function reach stabilization.

GEM CHARGING-UP DYNAMIC



(a) Deposited charges on THGEM insulator.



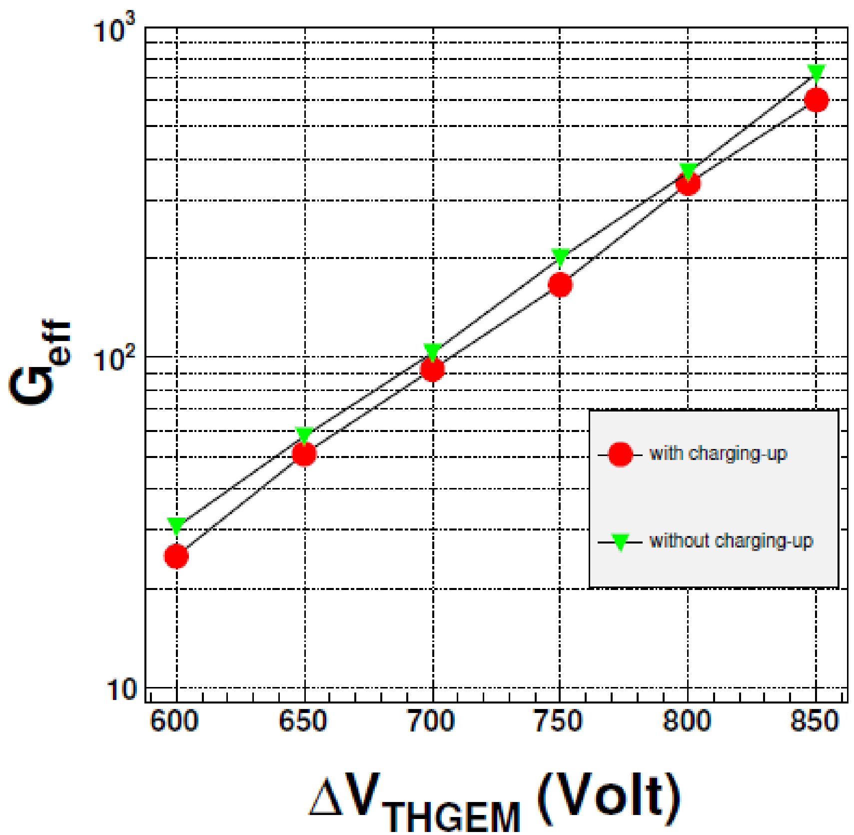
(b) Effective gain variation on a THGEM.

- Black functions are fits to simulated dots
- VTHGEM=600V

- At right is shown the variation of the effective charge gain. We can observe the fast variation in the beginning due to the variation of the function on the left plot (that is the responsible for the variation of the electric field, and therefore, variation of gain).
- In both plots, we can see the agreement between methods - with dynamic method we need about 1/10 iterations, is much faster!

THGEM CHARGING-UP DYNAMIC

- The effective gain (electrons collected on collection plane) as a function of VTHGEM is shown on right plot.
- We can see the variation of gain for charged (red) and uncharged (green) THGEMs
- The effective gain decrease with charging-up, contrary with obtained on GEM – could change with rim dimension, induction and drift fields, insulator thickness.



Conclusions and Future work

- The dynamic method prove to be as effective as previous constant method, but faster.
- Simulations indicate that charging-up change the charge gain on studied MPGDs about 10-15%
- We can now study charging-up must faster and try the method for other voltages, dimensions of the MPGDs, etc
- We are starting to measure THGEM charging-up in our lab, with three different configurations (C3,C4 and DESTRO from Trieste), results are excepted soon.

END

- Thank you for your attention.
- Your comments/suggestions are welcome!