10th RD51 Collaboration Meeting

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GEM and THGEM charging up calculations

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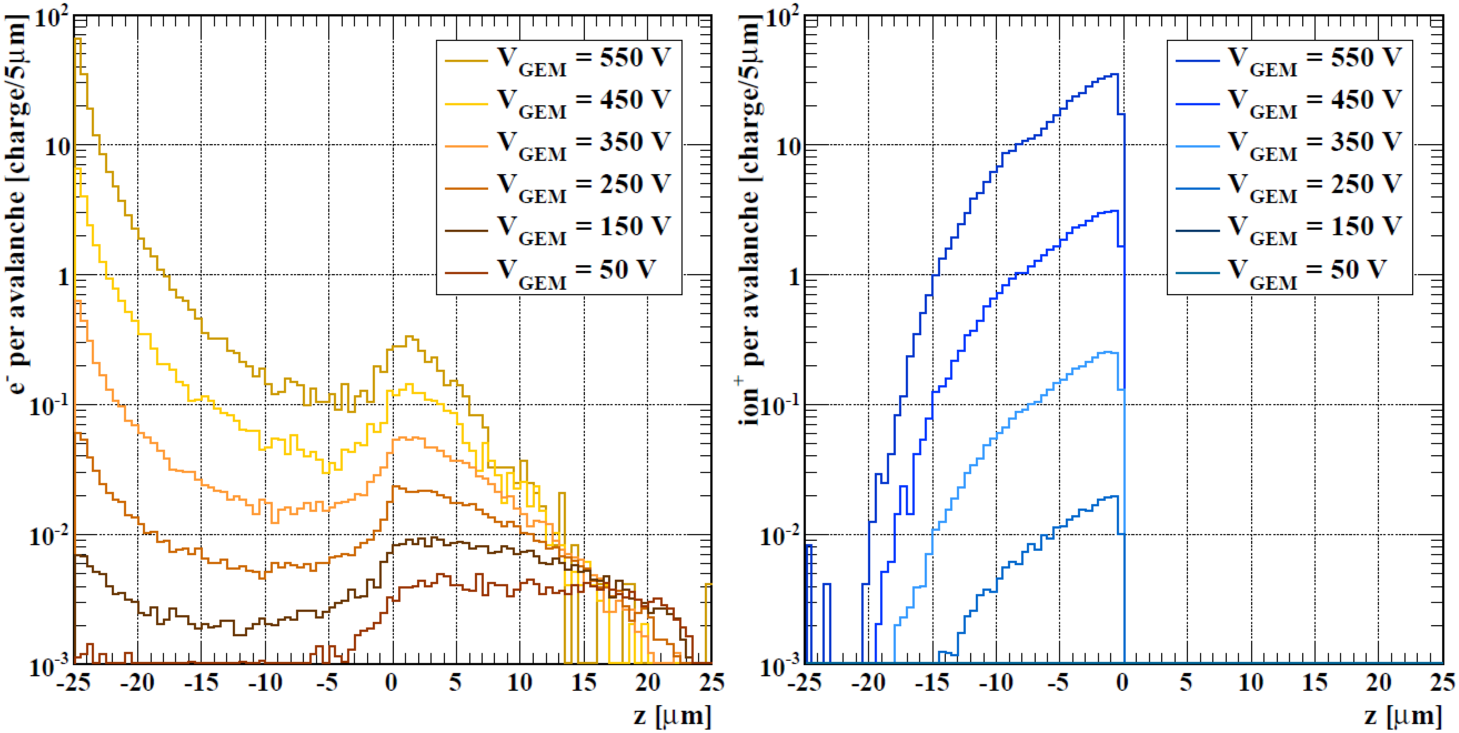
Important topics

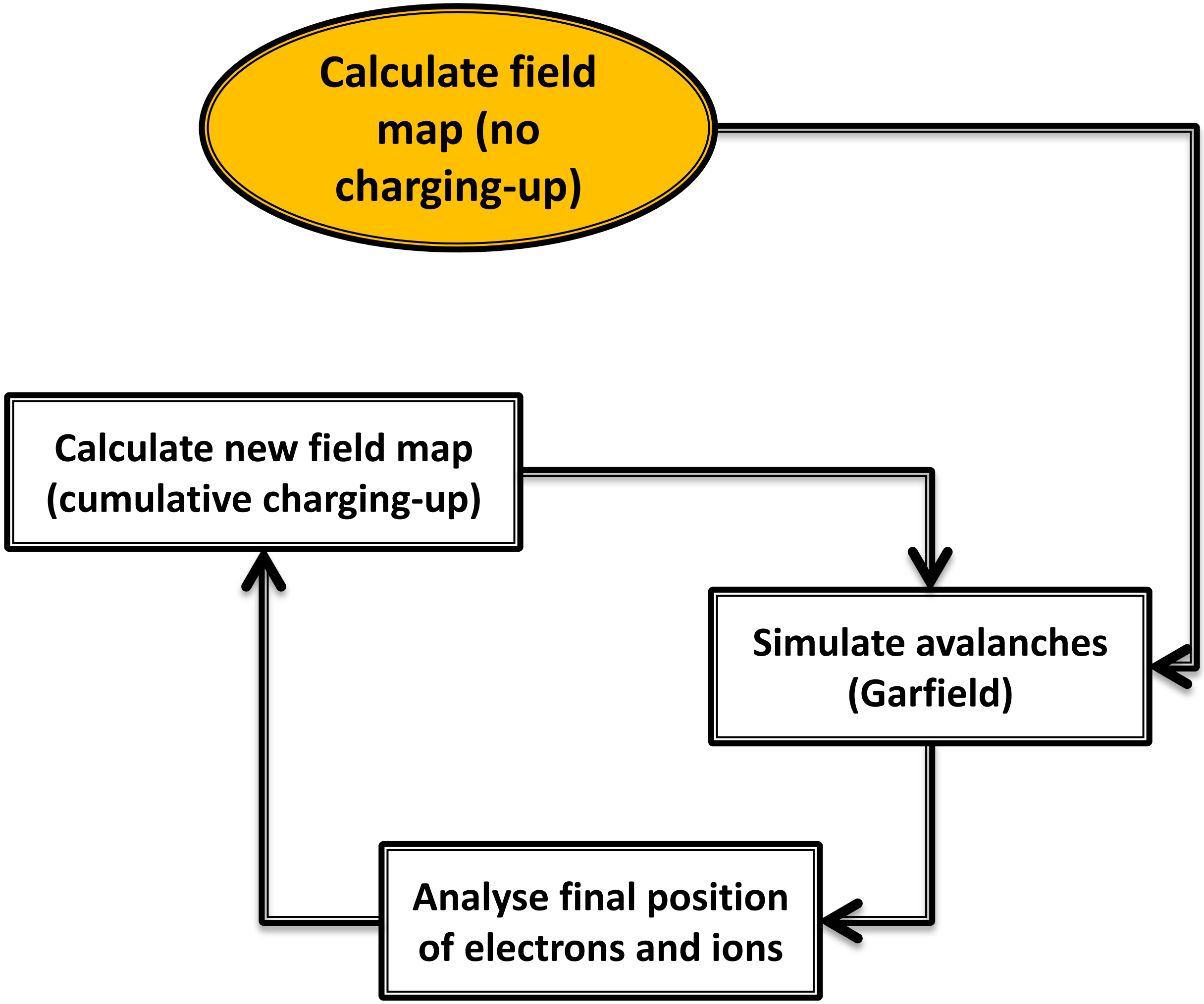
- Charging up for **electrons and ions** on GEM and THGEM
- Simulations for various voltages:
  - GEM -> 220V, 300V, 400V and 500V
  - THGEM -> 1000V
- Effective gain, influence of inner diameter on GEM, charges deposition distribution and ionizations positions on z axis
- Conclusions and Future Work

CHARGE DEPOSITION ON INSULATOR



- ❑ Charge deposition pattern in an uncharged GEM, calculated for rP = 0.7 and various V_{GEM} , at left the electrons and on right the ions

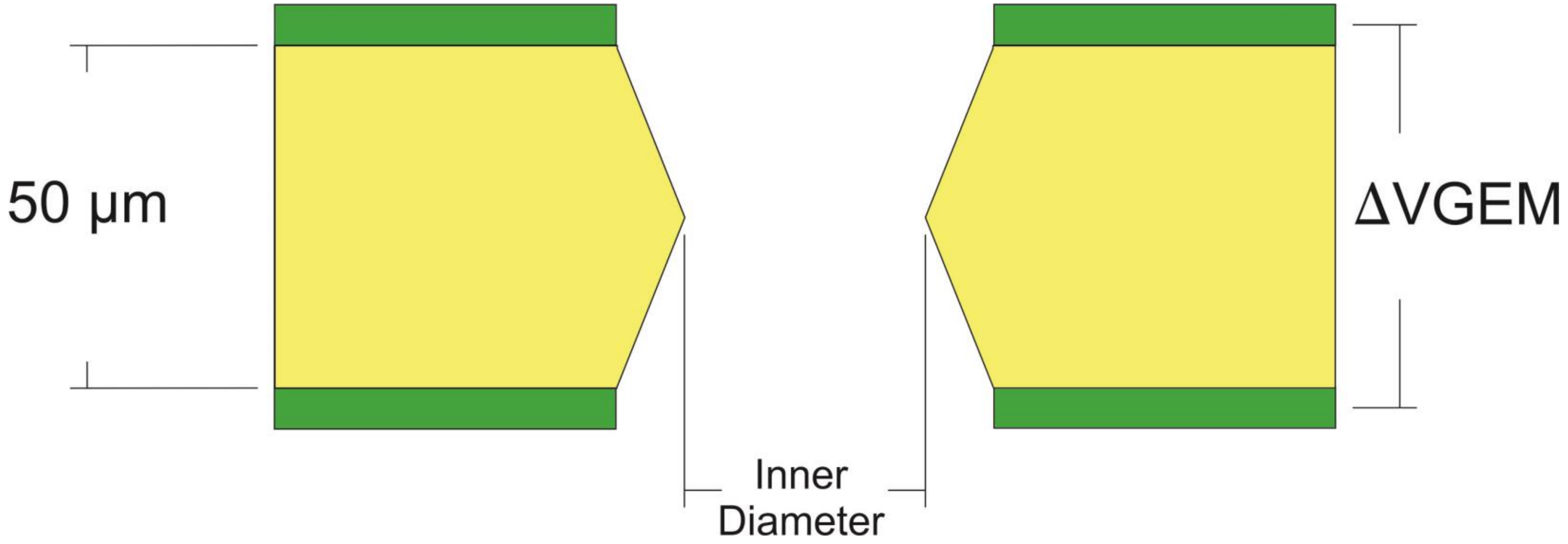
Remember the Method



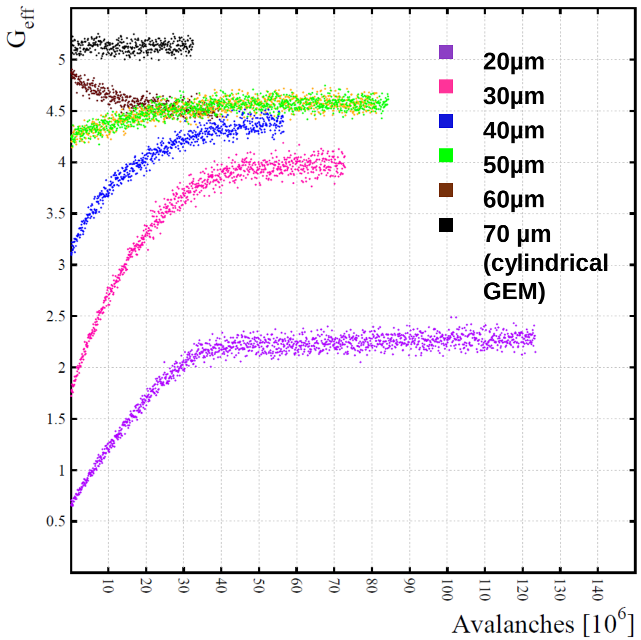
GAIN STUDIES FOR VARIOUS INNER DIAMETERS

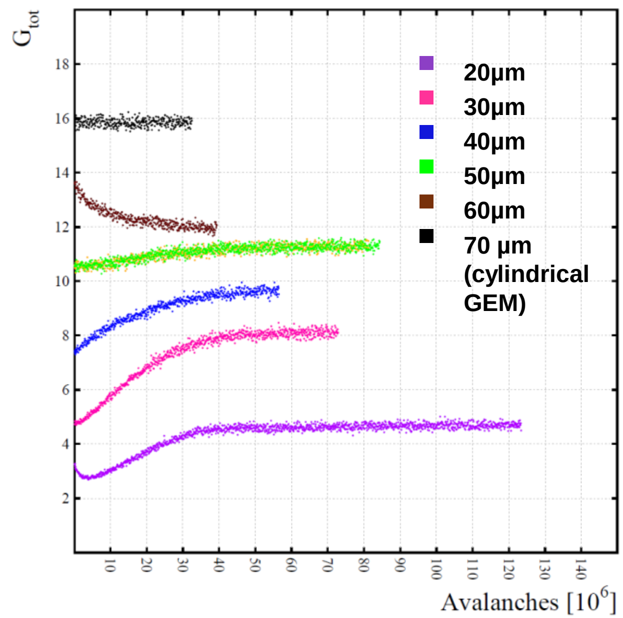
- On last June (RD51 mini week) we show that ions and electrons compensate each other and lead to stabilization of gain, on GEM.

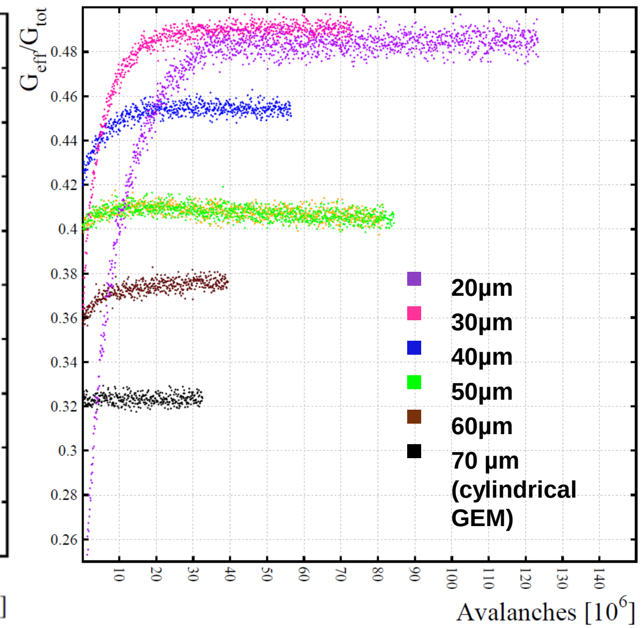
- We now extended the study for different inner diameters, at different voltages ΔV_{GEM}



GAIN STUDIES FOR VARIOUS INNER DIAMETERS $\Delta V_{GEM}=300V$





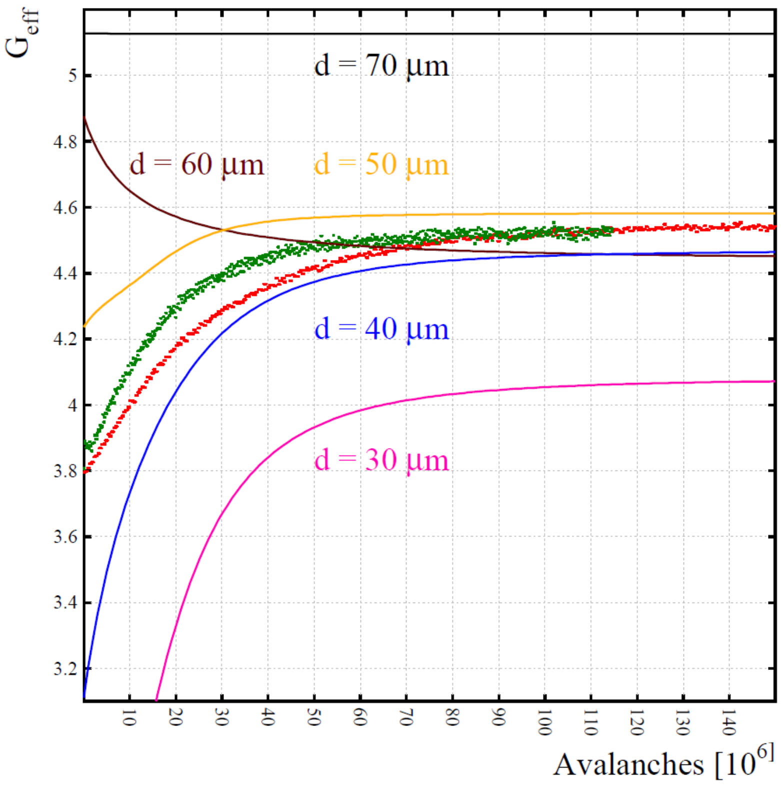


- Simulations for a range of inner diameters
- The less the inner diameter, the more the gain change – huge effect for small inner diameter!
- Cylindrical GEM suffer no visible effect due to charging-up

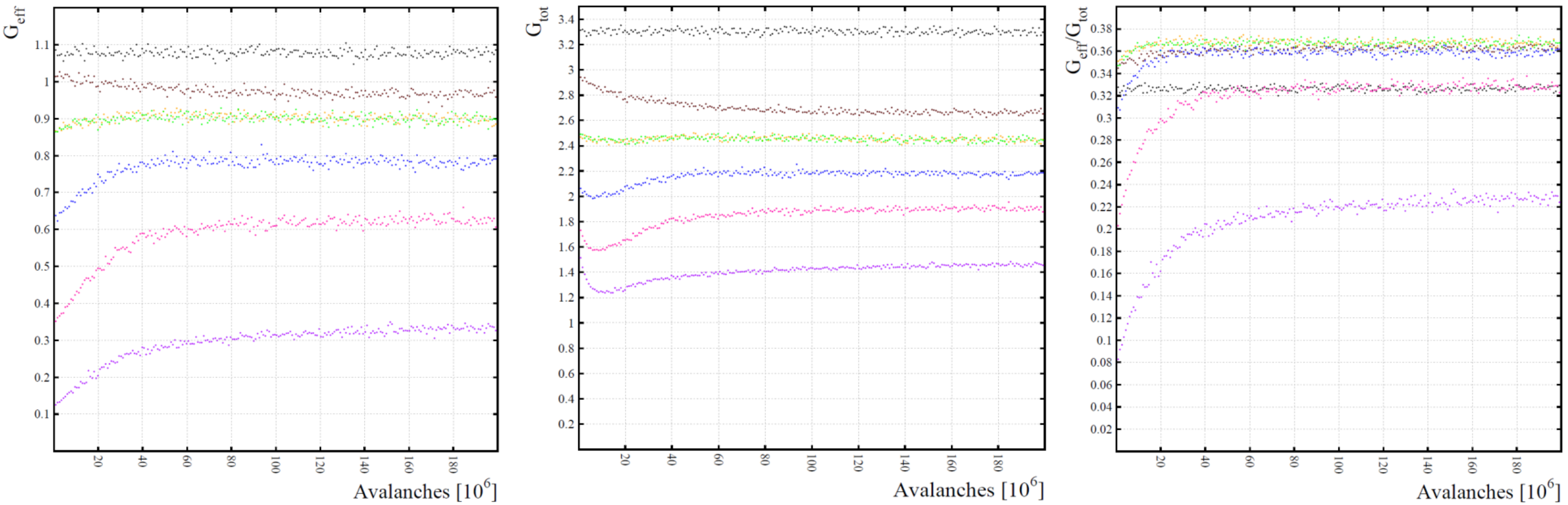
GAIN STUDIES FOR VARIOUS INNER DIAMETERS ΔVGEM=300V

- Same plot of the last slide plus experimental data from Mythra (2012) (green and red curves, taken at different rates for standard GEM with 50 µm of inner diameter)

- We reached good agreement with data, but still have to work on the absolute scale



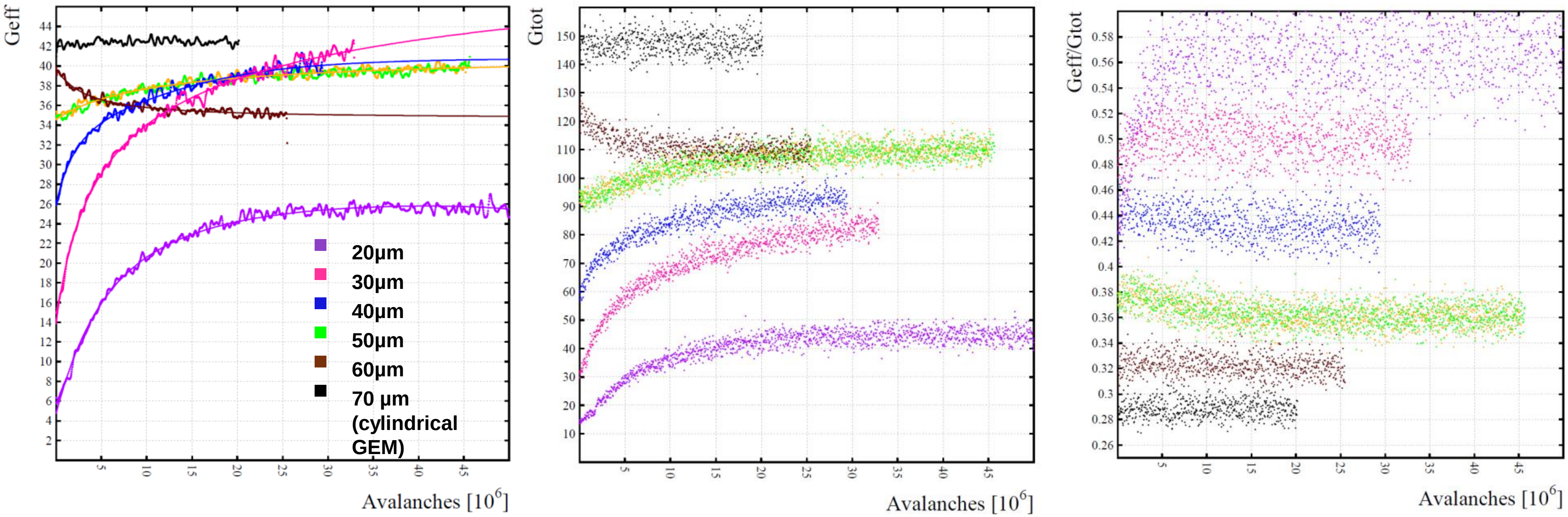
GAIN STUDIES FOR VARIOUS INNER DIAMETERS ΔVGEM=220V



20µm
30µm
40µm
50µm
60µm
70 µm (cylindrical GEM)

- The same observed for 300V, but slower due to very small gain

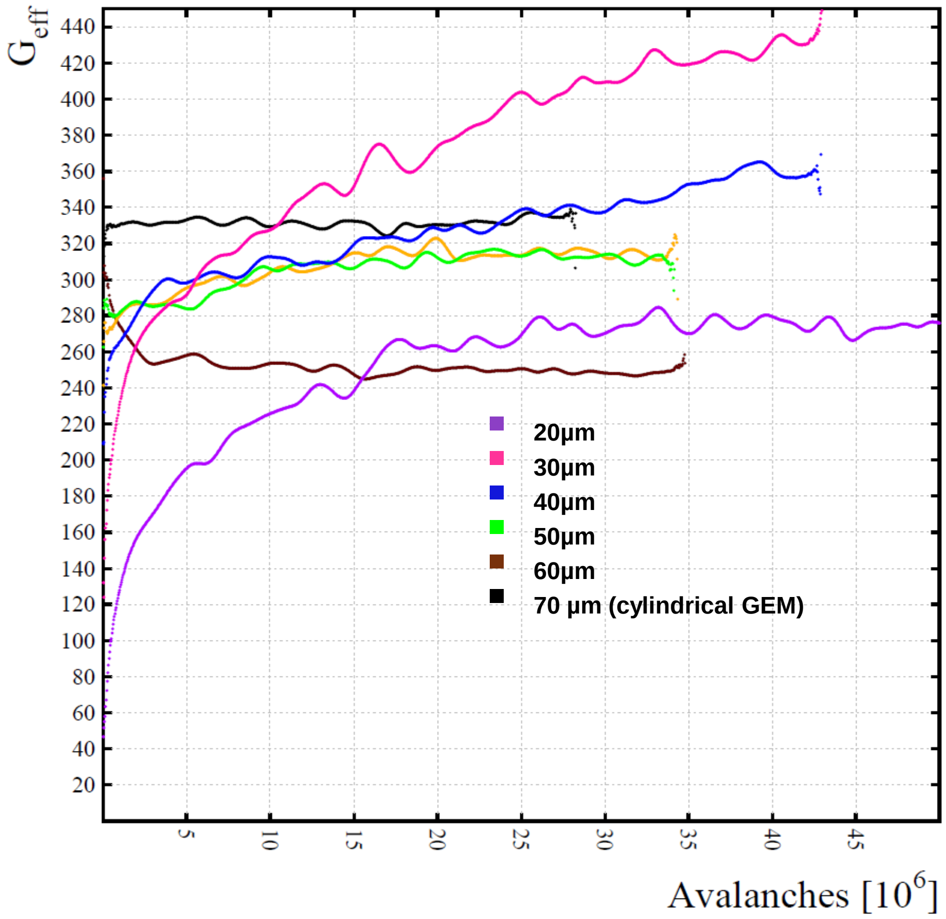
GAIN STUDIES FOR VARIOUS INNER DIAMETERS ΔV_{GEM}=400V



- The effect is faster (need less avalanches) due to large gain at 400V

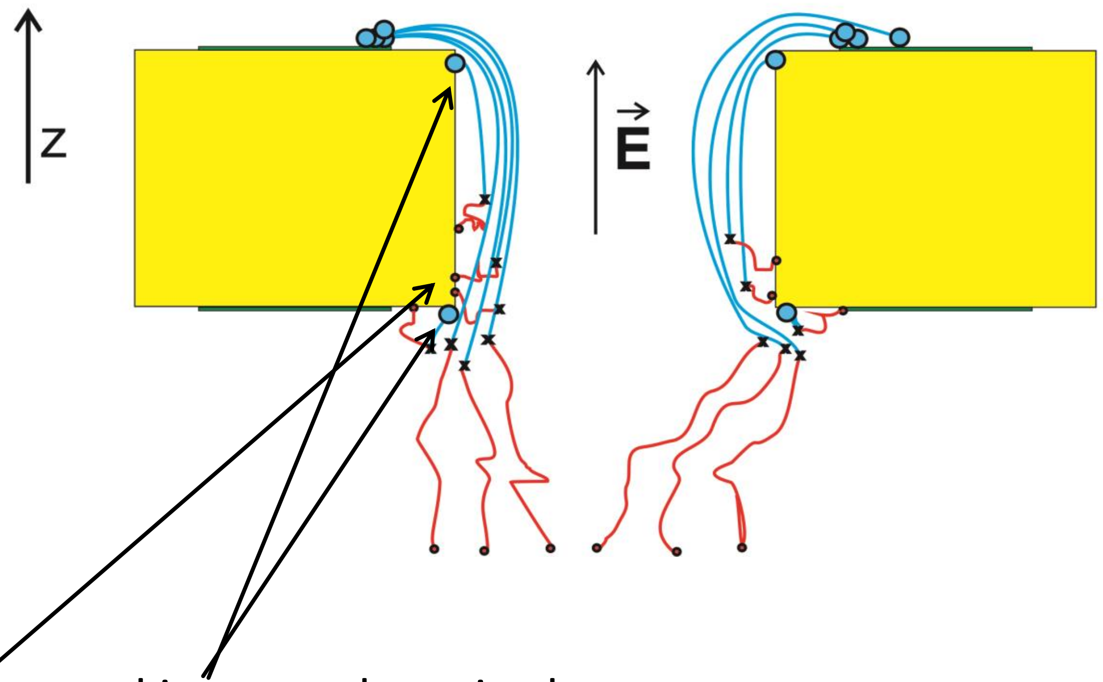
GAIN STUDIES FOR VARIOUS INNER DIAMETERS ΔVGEM=500V

- Larger gains - large simulation times
- We applied an shooting method to calculate the charging-up
- Is observed the same behavior found for lower voltages



THGEM charging-up
Summary description

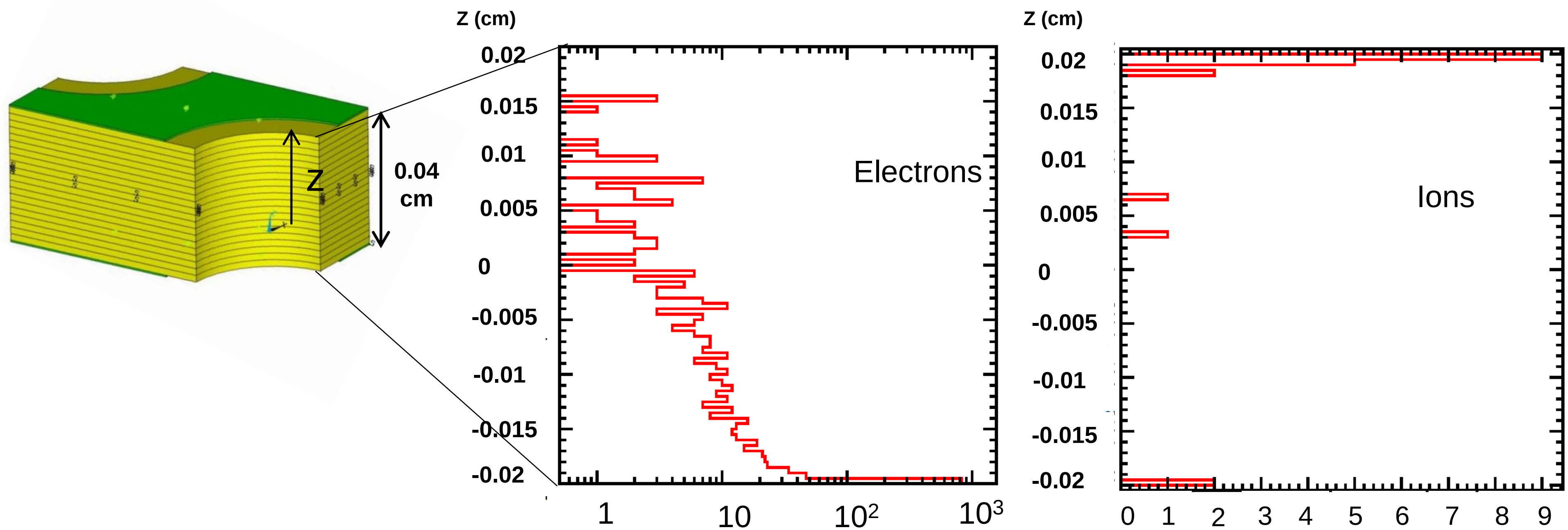
- Example of the charging-up on THGEM (only illustrative image)
- Ionizations are marked with the **x**
- Ions and their drift lines are blue
- Electrons and their drift lines are red



- We can see where the electrons and ions are deposited

THGEM CHARGING-UP SIMULATION

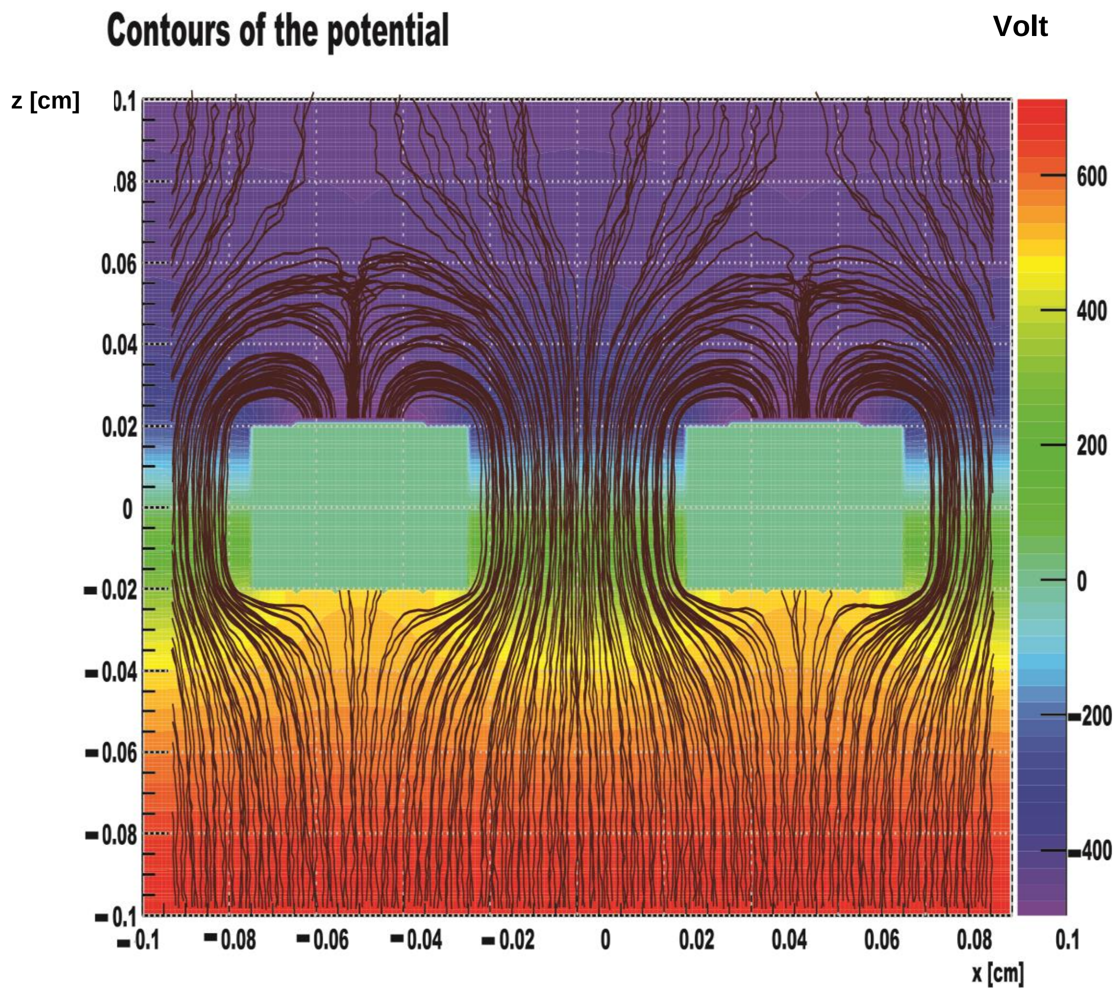
- First try to simulate other MPGD than GEM
- We extended the method for Thick-GEM with an insulator thickness of 0.4mm and 1mm pitch, 0.05 mm hole diameter and 0.07 rim diameter



Number of charges deposited on insulator (hole surface) after 5000 avalanches

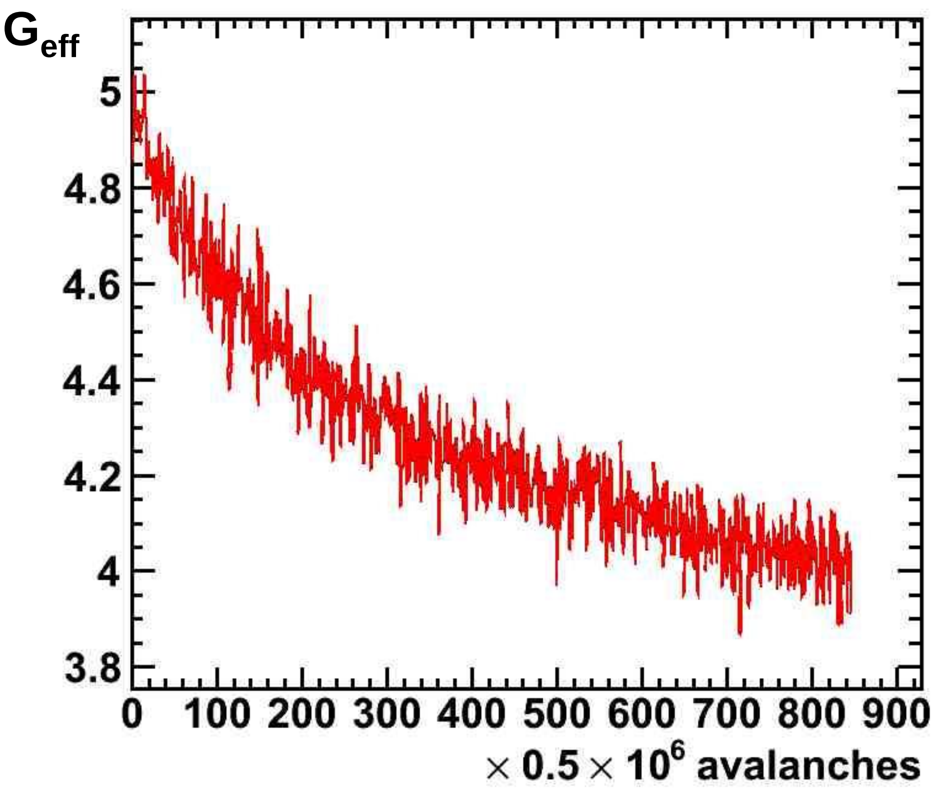
THGEM CHARGING-UP
POTENTIAL AND DRIFT LINES (FOR IONS)

- Cross section of the studied THGEM
- ΔV_{THGEM}=1000V
- Ar/CH_4 (95%/5%)
- 293K , 1 atmosphere
- Drift field = 0.1 kV/cm
- Induction field= 3 kV/cm
- Drift path of free ions gives us the “field lines” (very similar)



THGEM charging-up
Eff.Gain for 1000V

- We observe a decrease on gain, that appear to reach some stabilization
- We will try to measure this in the next months on lab
- The effect needs much more avalanches that on GEM (perhaps due to THGEM having bigger insulator surfaces)

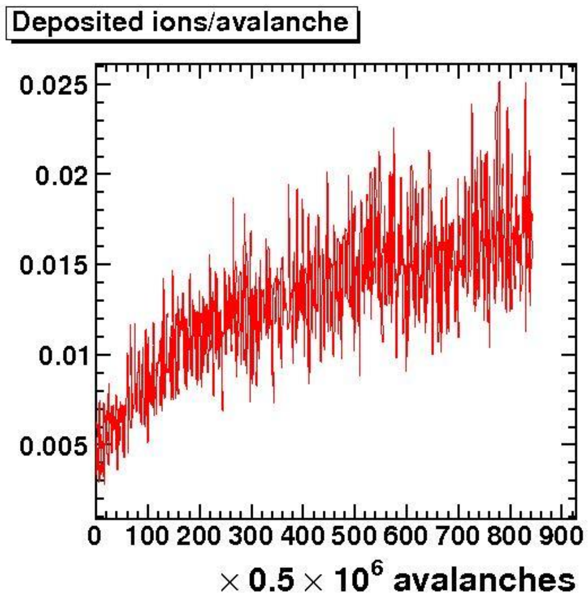


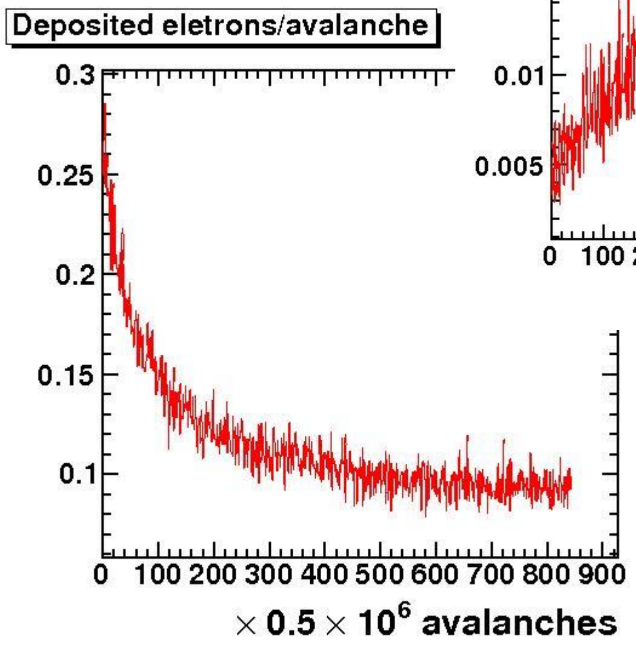
THGEM charging-up
Charging-up evolution

- As seen on slide 11, we have much more deposition of electrons than ions

- It could be related to the cylindrical hole, the ions follow very well the field lines and only deposit on the ends of the hole and on rim surface

- The ions number increase could be explained by the negative density of charges accumulated on the hole surface





THGEM charging-up
Some conclusions for THGEM

- The charging-up on THGEM is expected to be slower than on GEM
- The electrons deposition is manly located on the exit of the hole and on bottom rim surface
- The ions deposition is mainly located on first µm on entrance of the hole and on the bottom rim surface - according to simulations, we have virtually no ion deposition in along the hole

FUTURE WORK

- Study other voltages and dimensions for THGEMs
- Measure charging-up on lab, for Ar/CH4 mixture
- Study other drift mediums (Xenon?, Neon?, Ar/Co2? – you tell us)
- Improve charging up calculations (develop the shooting method) in order to get faster results

END

- Any suggestions are welcome.

- Thank you for your attention.

Auxiliary slides

Gain studies for various inner diameters
Main conclusions

- The charging up is more important for reduced inner diameters on GEMs

- The gain (both absolute and effective) is influenced at different levels depending on the aperture of the center of hole

- The simulated results are in agreement with experimental data, but we still need to work on absolute scale.