RD 51 Mini Week

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Gas gain in a single GEM: charge deposited on the dielectric

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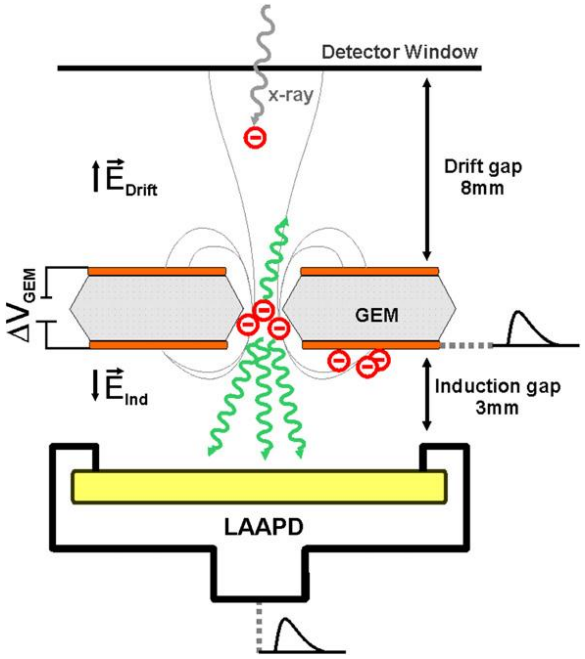
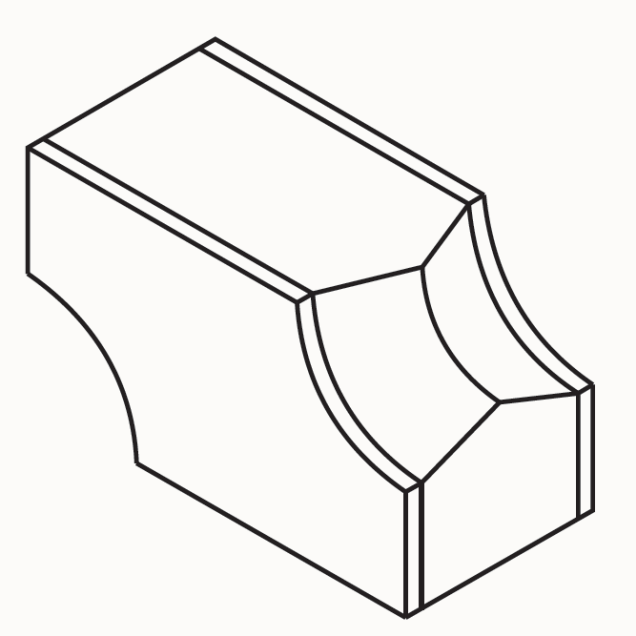
IMPORTANT TOPICS

- Difference between experimental and simullated GEM gain
- Charging-up effect on electric field and on gain
- Work status (simulations)
- Conclusions and Future Work

Experimental Data (EL)

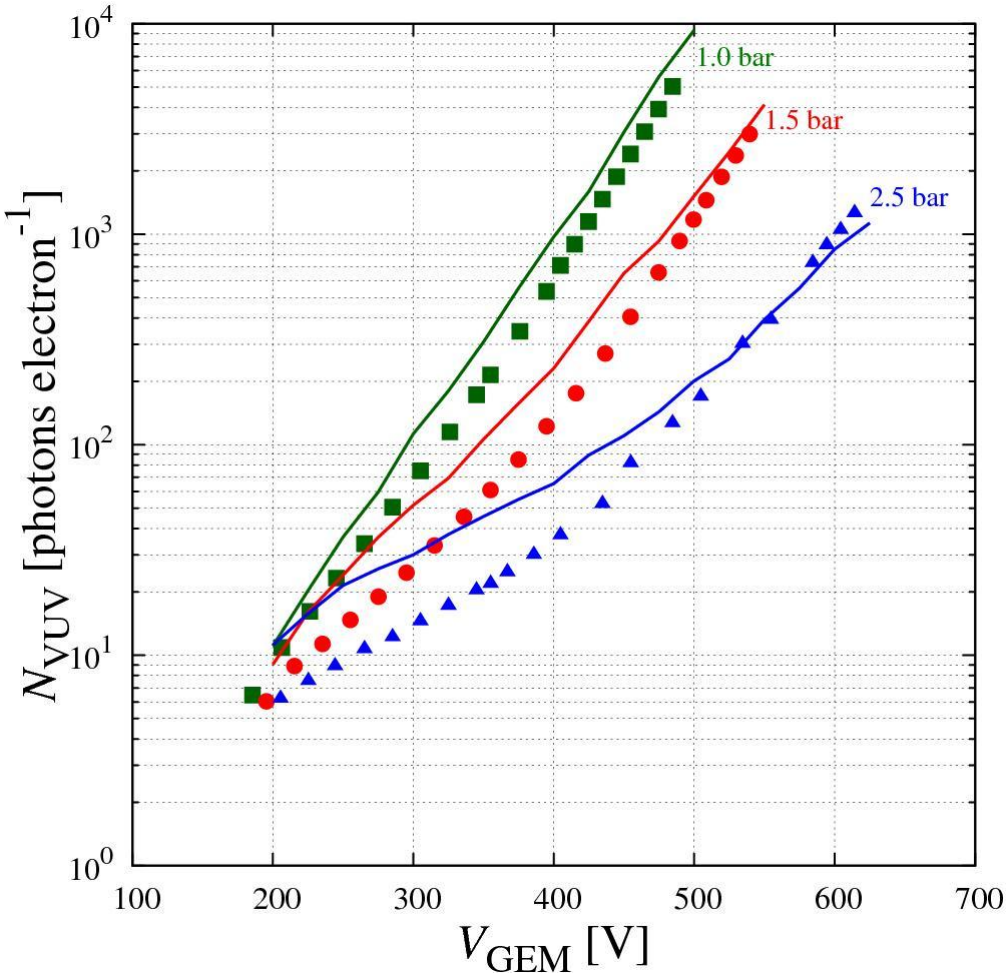




- Experimental parameters*:
  - Pure Xenon at 300K
  - Pression 1-2.5 bar
  - ΔVGem 200-600V

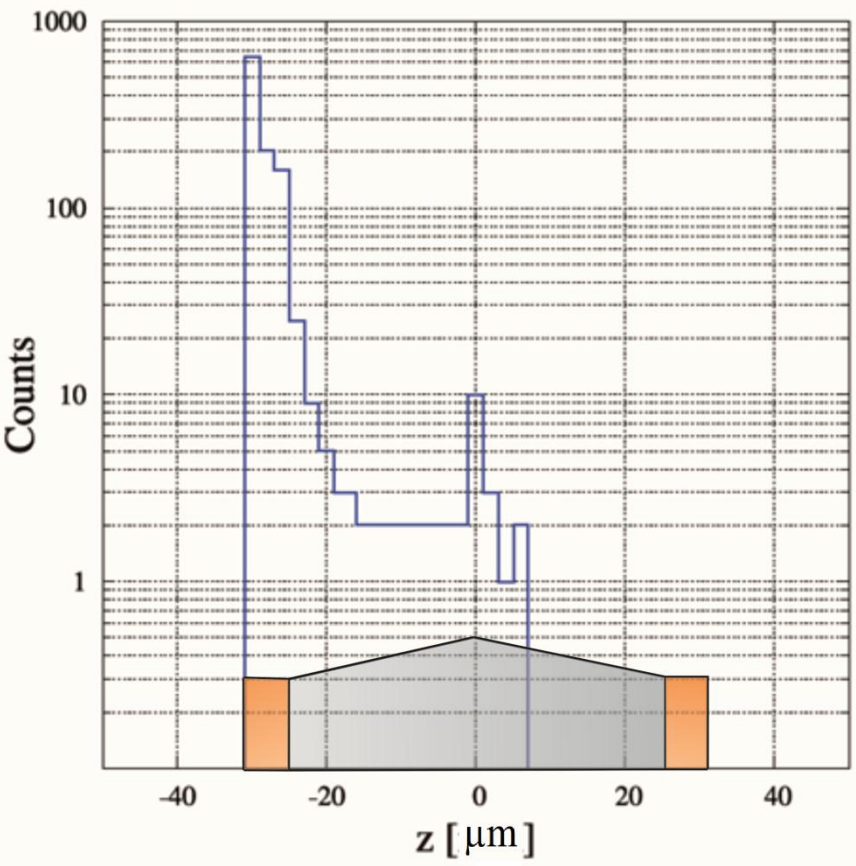
*C. M. B. Monteiro, A. S. Conceição, F. D. Amaro, J. M. Maia, A. C. S. S. M. Bento, L. F. R. Ferreira, J. F. C. A. Veloso, J. M. F. dos Santos, A. Breskin, e R. Chechik. Secondary scintillation yield from gaseous micropattern electron multipliers in direct Dark Matter detection. Phys. Lett. B, 677:133, 2009.

Experimental vs Simulated



POSSIBLE EXPLANATION

- Charging-up in the kapton surface
- The kapton surface goes from -25µm to +25µm

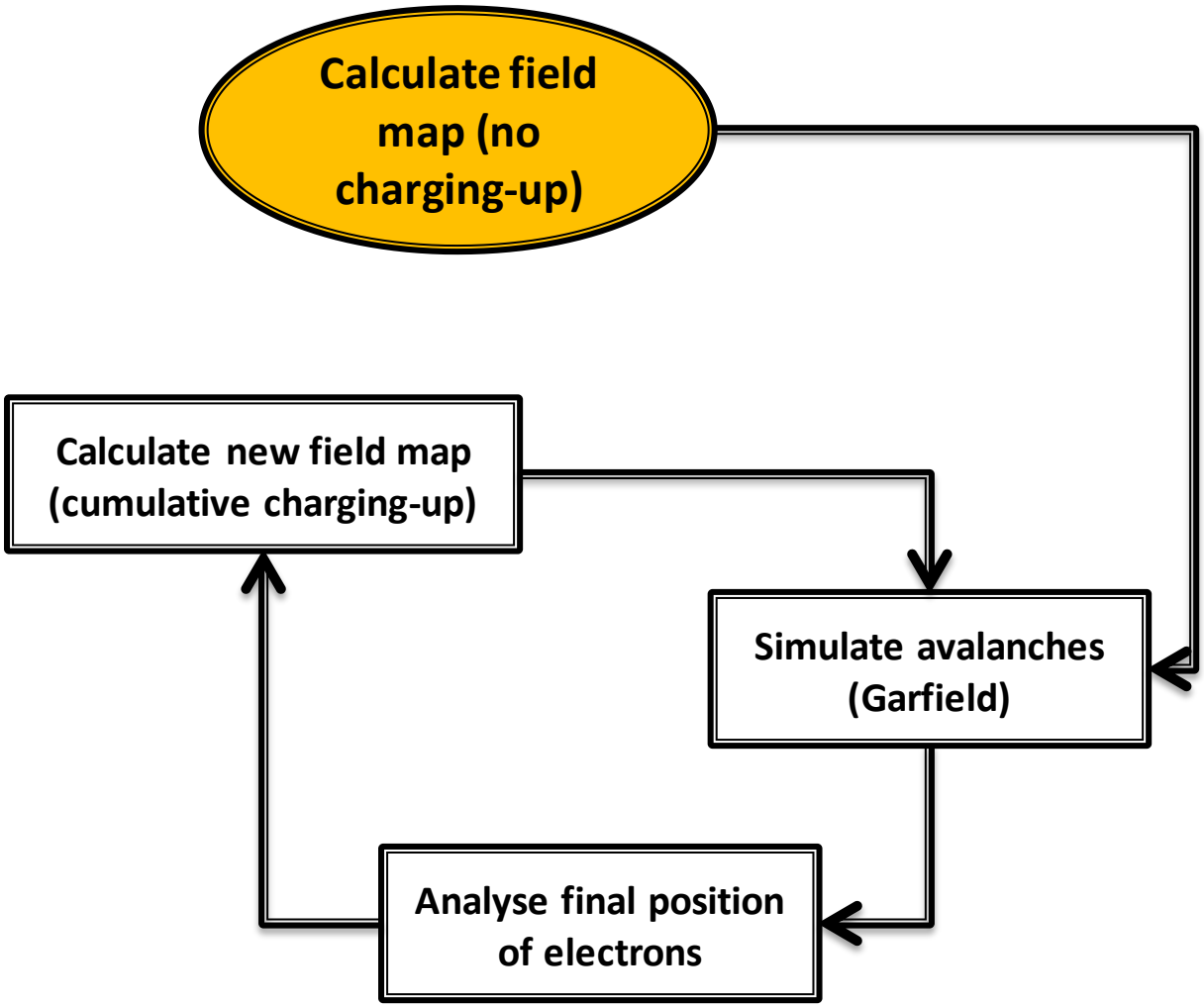


- Some electrons end on the surface of the kapton!
- Changes the local Electric field

SIMULLATIONS WITH CHARGING-UP

- Our simullations were done with:
  - Primary electrons starts with z=200µm above the GEM
  - Voltage of VGEM=400V
  - Pression at 1 bar (760 torr)
  - Temperature of 293K

Method



10.000 primary electrons per iteration

Repeated for 100 iterations

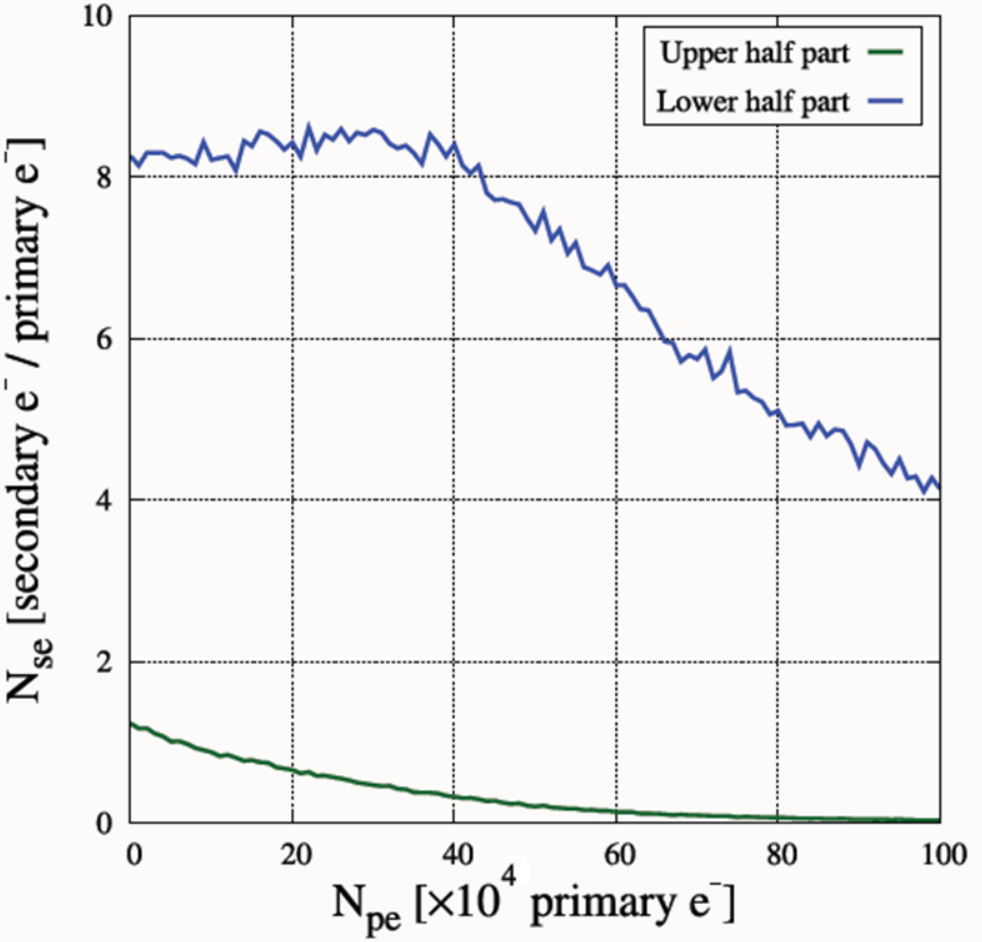
FINAL POSITION OF ELECTRONS

- At the end of each iteration, the electrons ending with z between -25µm and +25µm are counted

- The upper surface ($0 < z < 25\mu m$) and the lower surface ($-25\mu m < z < 0\mu m$) of the kapton are studied independently (remember slide 5)

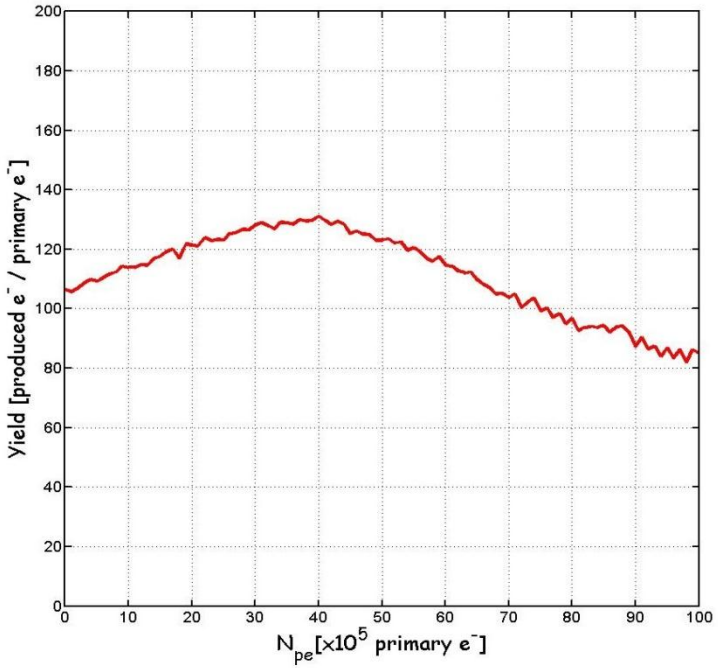
- Finally, the correspondent charge density of each surface is added (to the field map) and a new set of avalanches is simulated

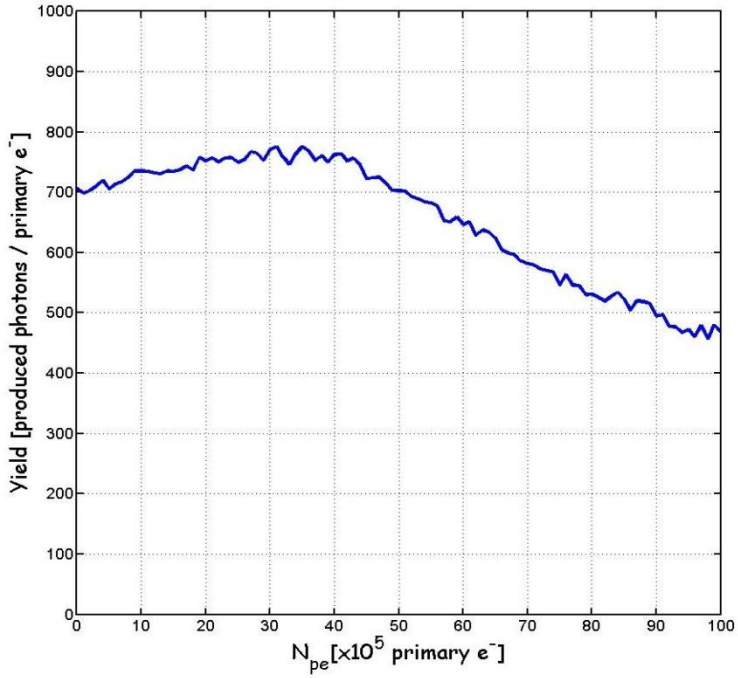
RESULTS



- More electrons in the lower surface than in the upper (slide 5)
- Decreasing of the charge accumulation with time (electric repulsion)

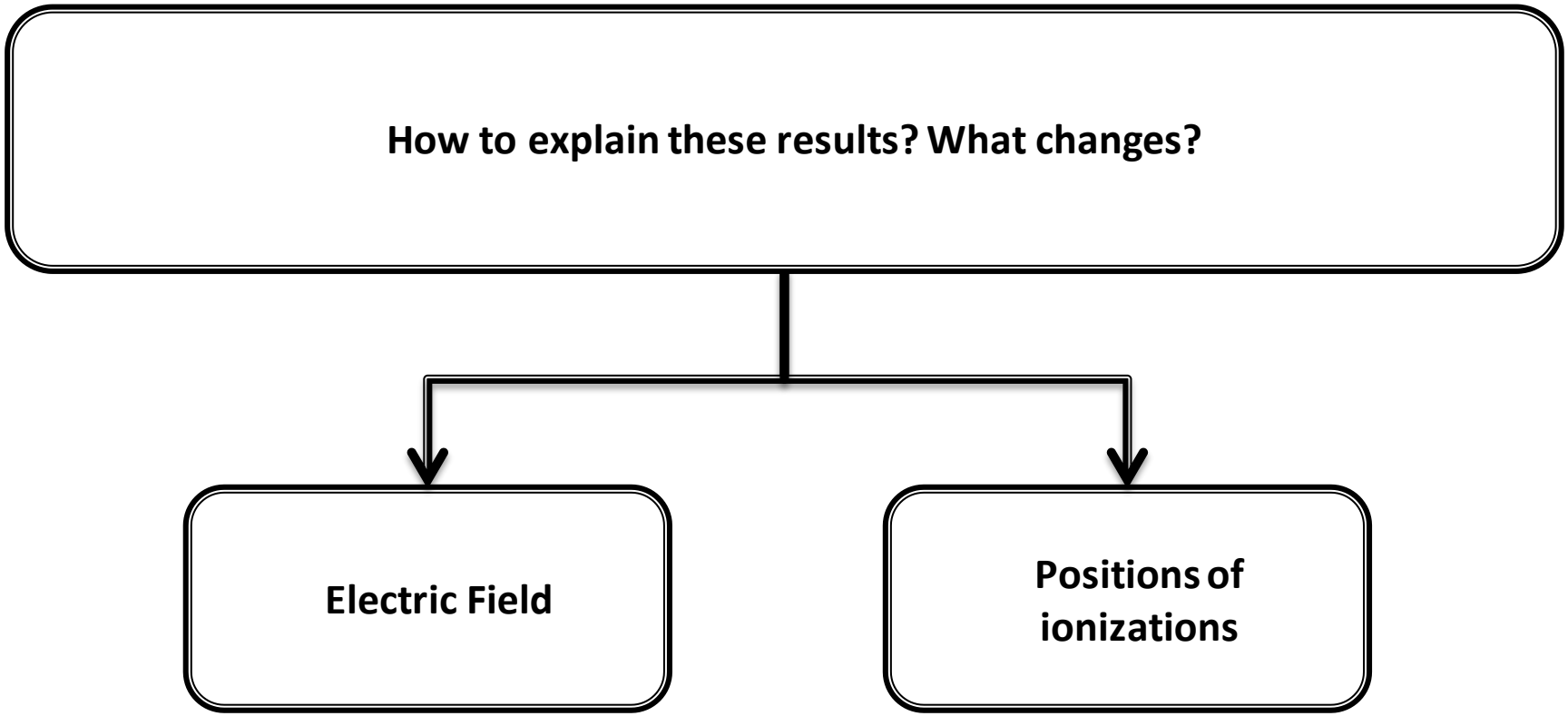
RESULTS



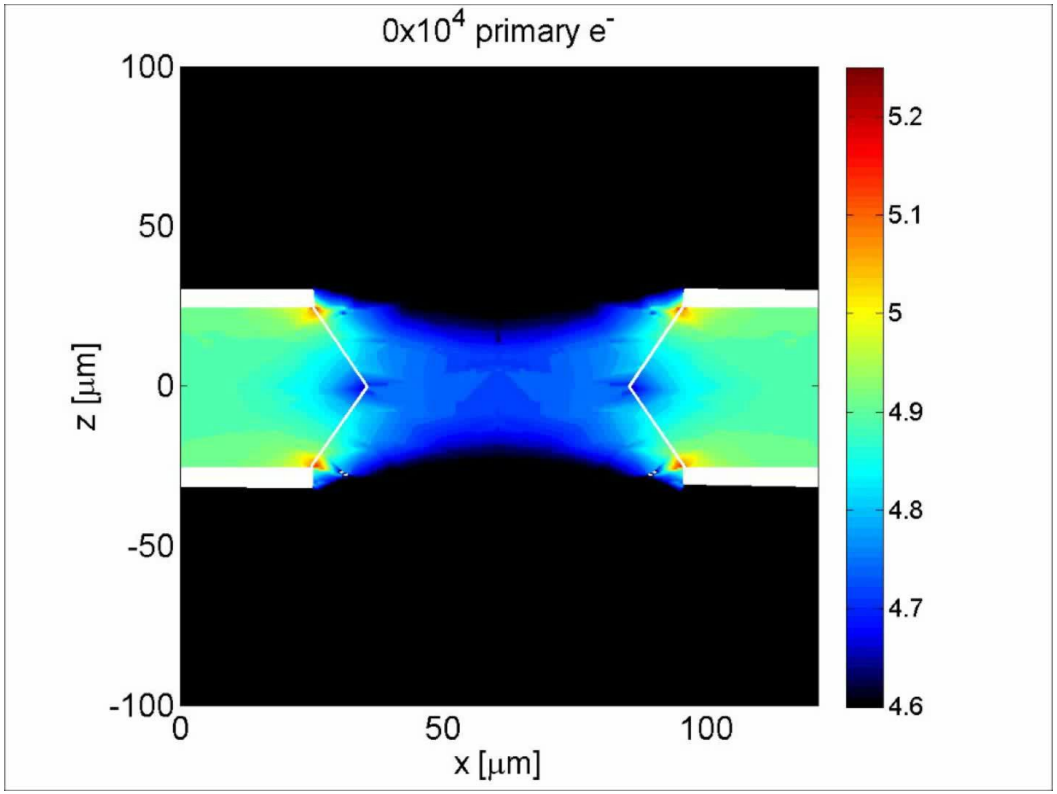


- Initial increase of absolute gain (in charge and in light), followed by a drop!

EXPLANATIONS



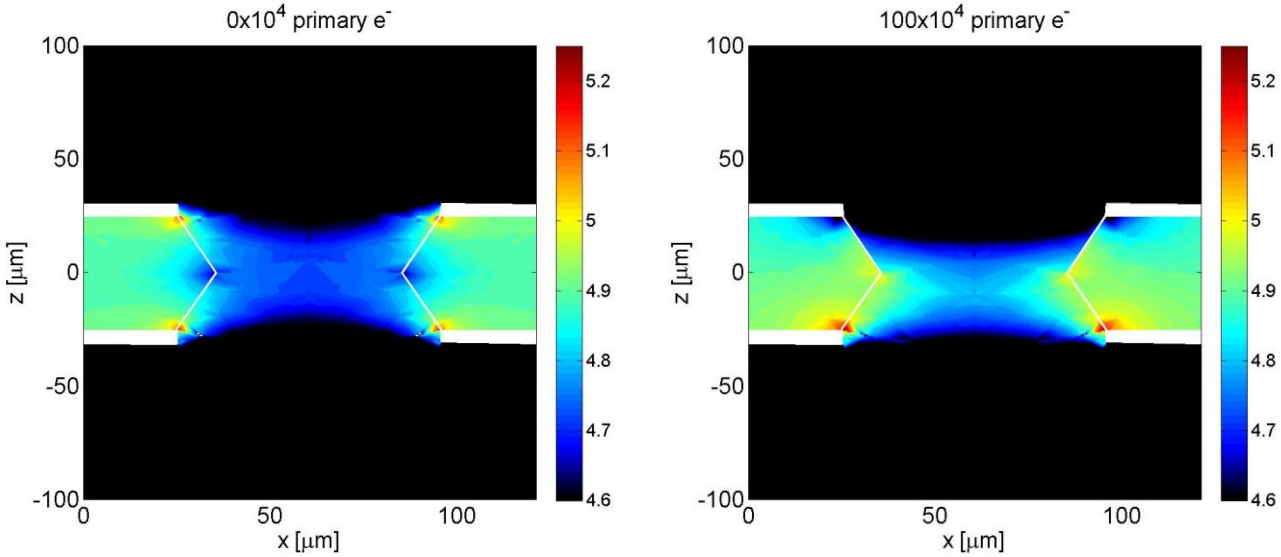
Changes in the Electric Field



Animation attached in the file "Efield.avi"

- Only points with E larger than 400 Vcm^{-1} are shown

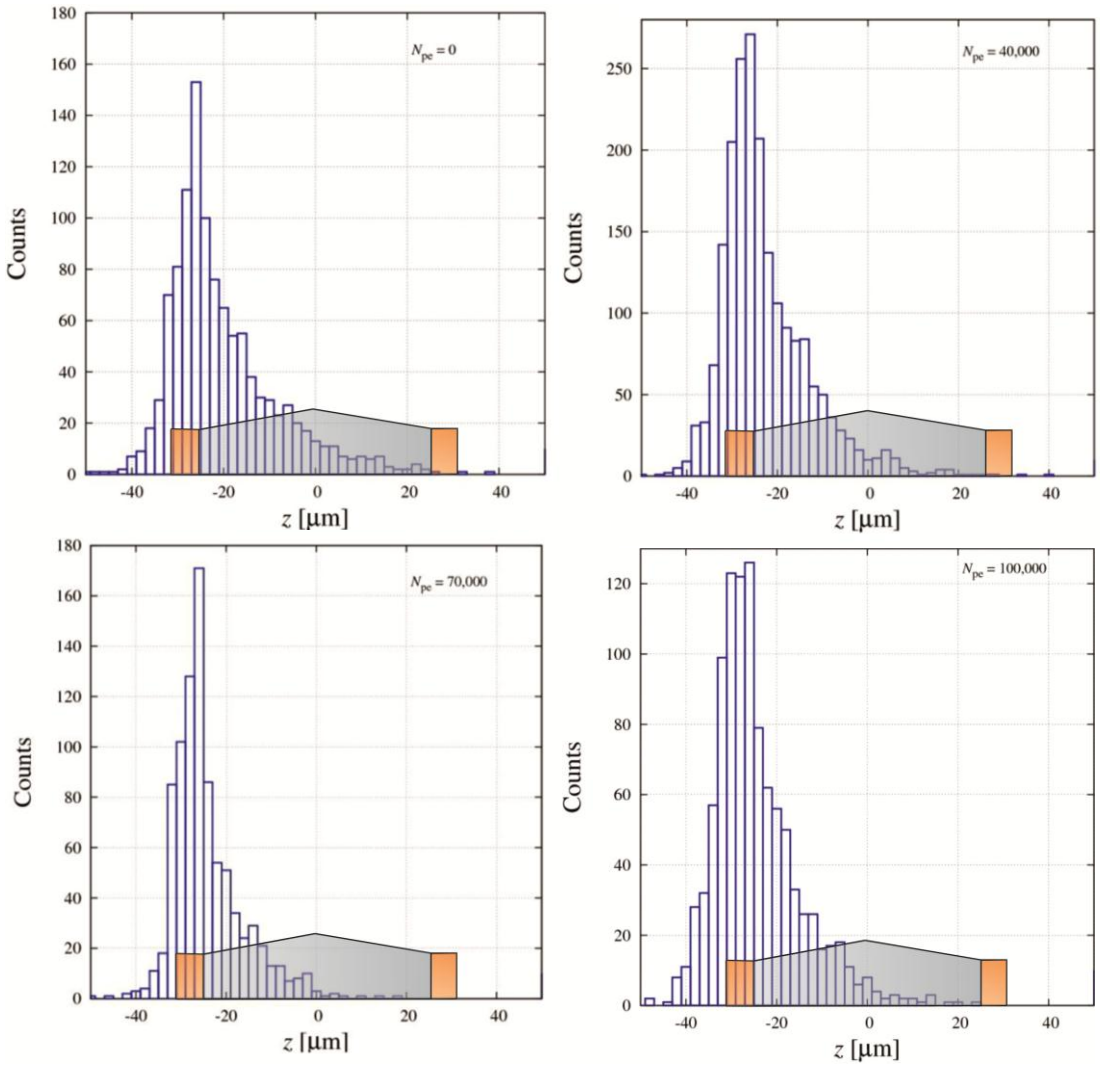
Changes in the Electric Field



- (logarithm) Intensity of the Electric Field increase in the lower electrode and decrease in the upper

- Increase also along the center of the hole

POSITIONS OF IONIZATIONS



- Remember slide 10, the increase until Npe=40x10^4 followed by the drop
- Electrons are created later in the hole!

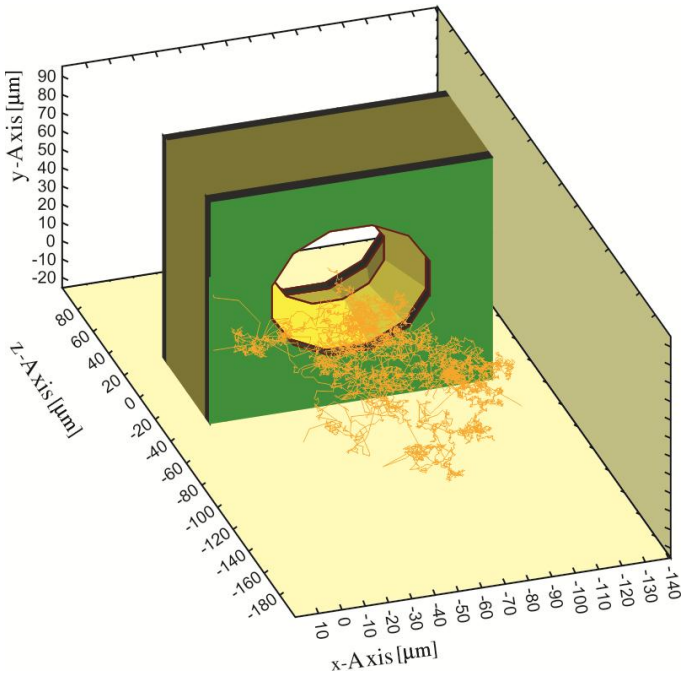
Iteration	Ionizations Mean position
0	-21.89 µm
40	-22.31 µm
70	-23.38 µm
100	-24.47 µm

EXPLANATION

- The increase of the electric field along the center of the hole is responsable for the initial increase of ionizations
- Later, the decrease of the electric field in the upper electrodes will give less energy to the electrons, therefore they will produce less secundary electrons in initial states
- The Ionizations starts later in the hole!

EXPLANATION

- The process of avalanches is exponential - a few less electrons at the beginning will imply a significant lower gain



Conclusions

We can now conclude that charging-up:

- Changes significantly the local Electric Field
- Changes the absolute gain in charge and ligth

Is important to include it in simullations!

But...

- In these simullations, we assume that the electrons simply “wait” in the kapton surface for ever. That it is not true.
- Over some time, the electrons should escape from the kapton (through the surface).
- We also didn’t considerer the ion deposition in the kapton.
- Once the trapped ions gets close to trapped electrons, recombination can happen.

FUTURE WORK

- Simultion of the charging-up for other gases (Ar/CO2) - currently running - results are expected soon
- Implement the possible electrons mobility through the kapton
- Ion contribution:
  - Study the ion charging-up
  - Study the possible recombination between trapped ions and electrons
- Study another Micro-Pattern Gaseous Detectors

END

Thank you for your attention.