Minimizing distortion with segmented GEM electrodes and DLC based sectorization

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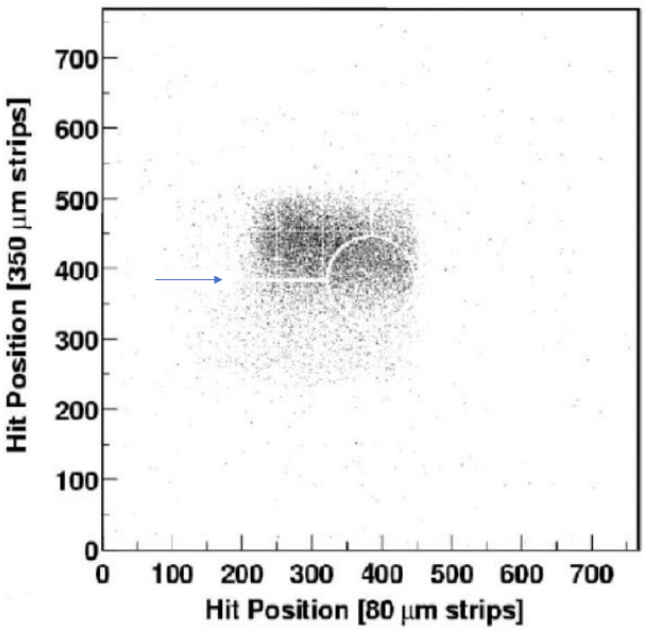
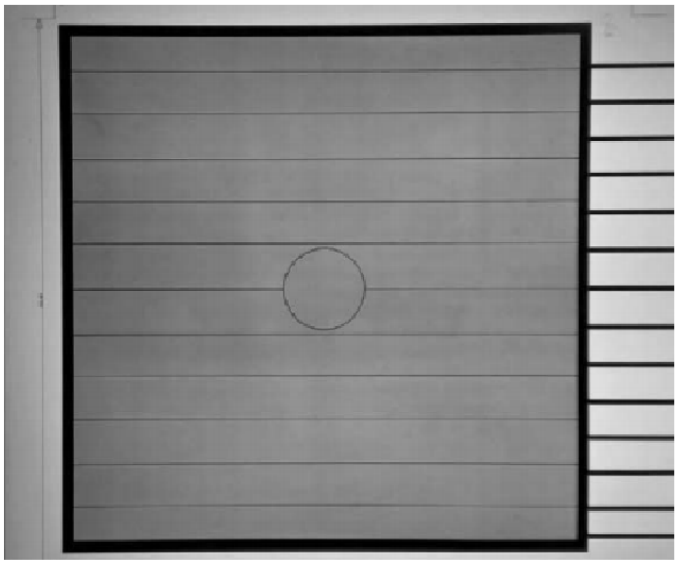
About me

- Taking a master's degree in Engineering Physics at University of Coimbra, Portugal.
- 2 summer internships (2017, 2018) at LIP (Laboratory of Instrumentation and Experimental Particles Physics) working on ion mobility studies in several gaseous mixtures.
- Next year will begin my thesis in NEXT (Neutrino Experiment with a Xenon) group at the Instituto de Física Corpuscular (IFIC) in Valencia, Spain (collaboration to search for the neutrinoless double beta decay of the Xe-136 isotope).

Distortion at sector borders of large-area GEM detectors

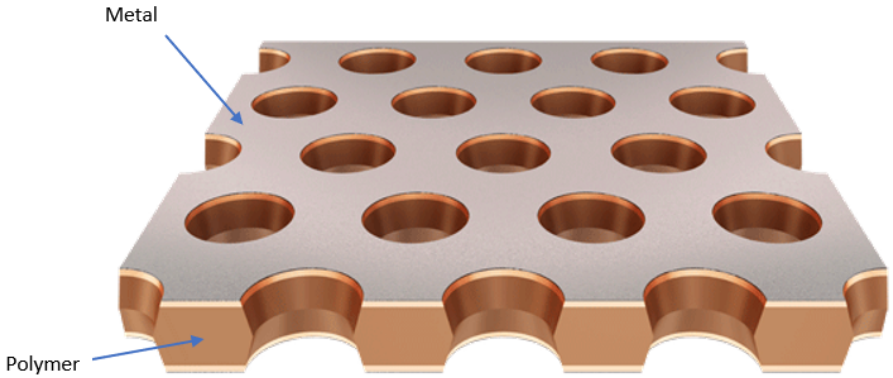




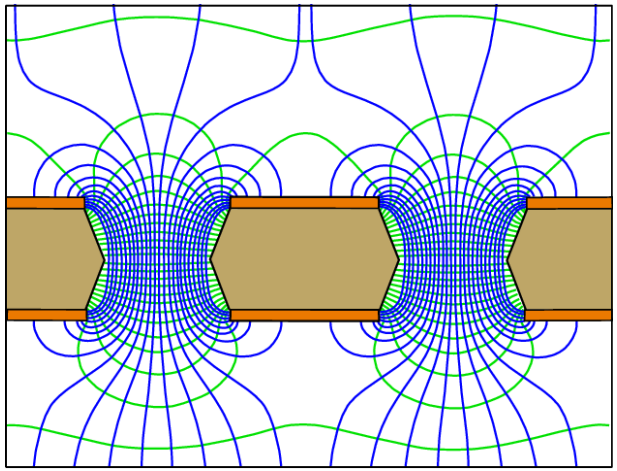
Sector border effect of triple-GEM tracking detector for COMPASS[1]

[1] https://doi.org/10.1016/S0168-9002(02)00910-5

GEM



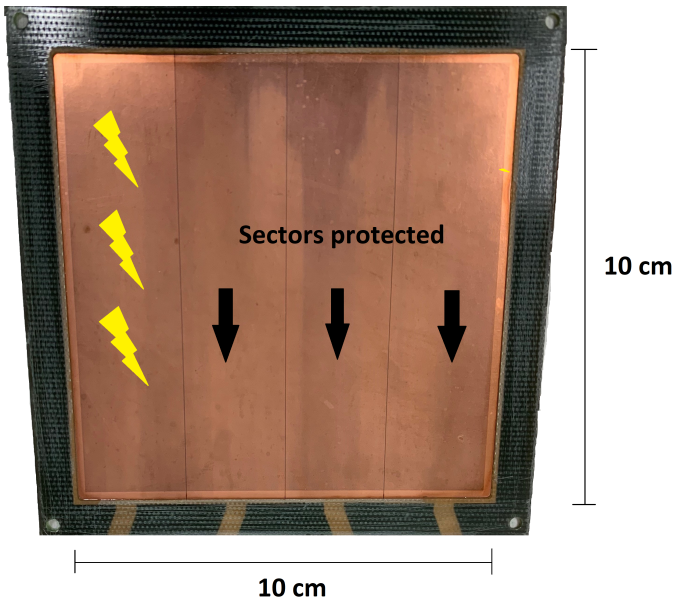
GEM model



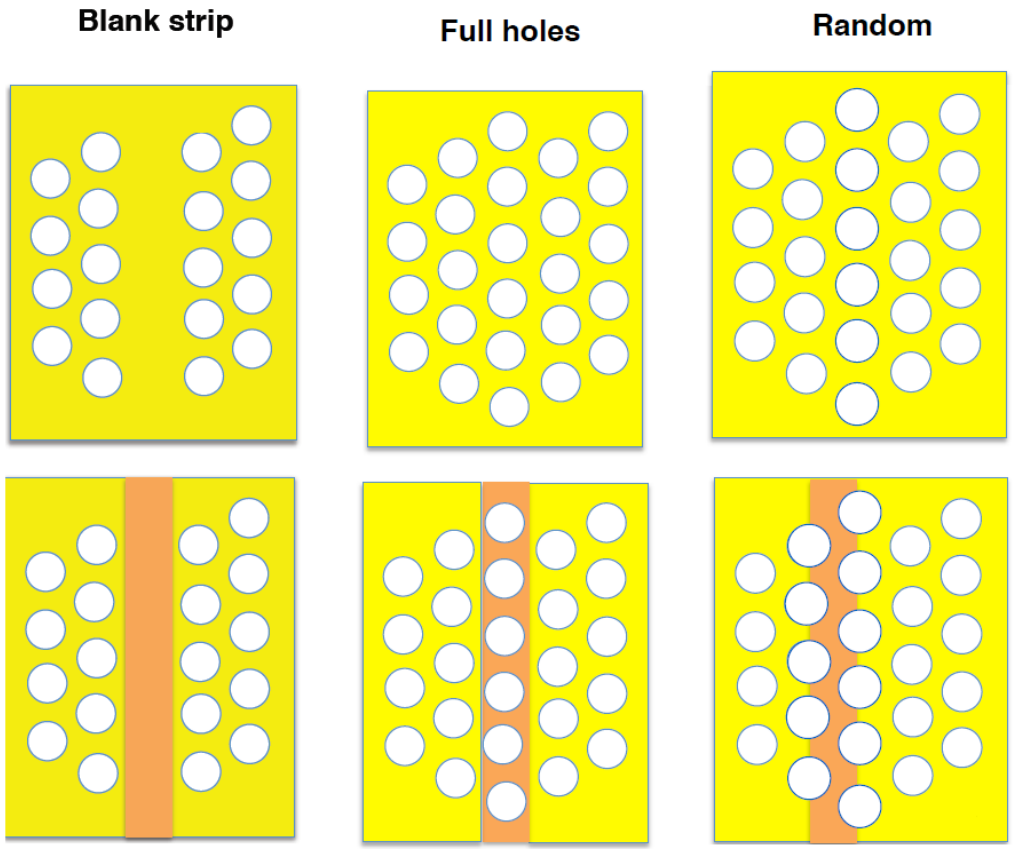
Electric field lines in the holes

Purpose of sectorization

- Protects the sectors from the effect of a discharge on other sectors by reducing the energy of each discharge, but implies signal distortion
- The capacitance effect is quite important on large area GEMs

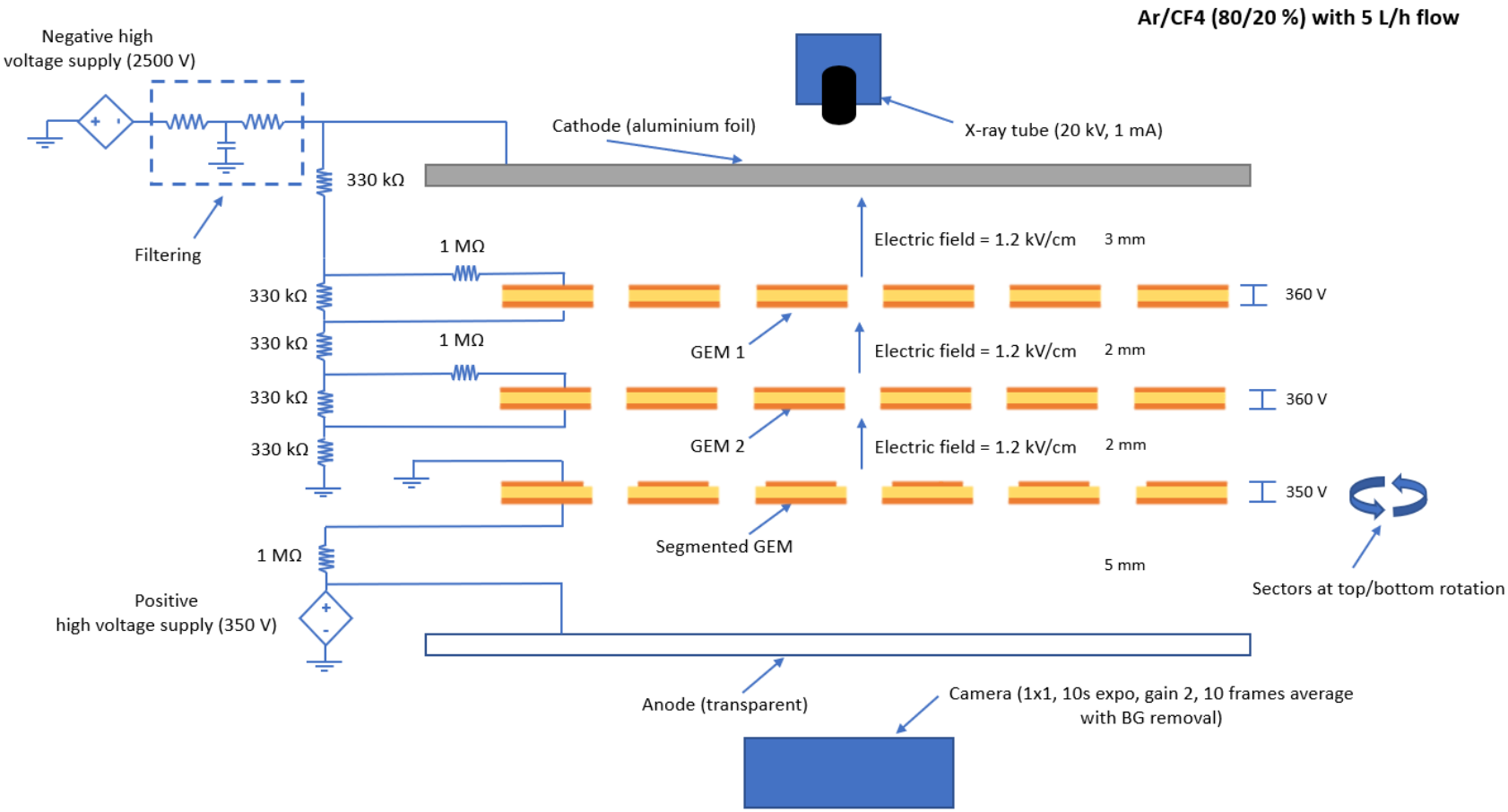


Sectorization hole pattern

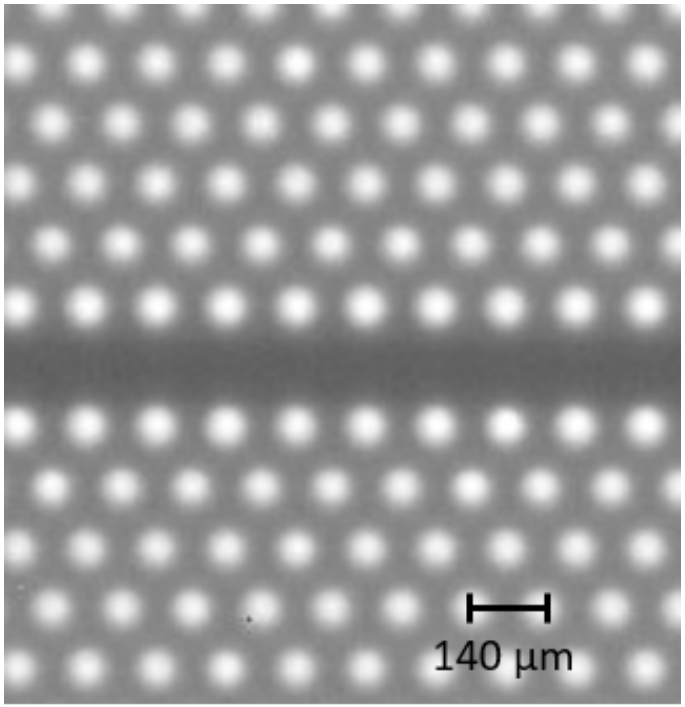


Adapted from Sauli, Fabio

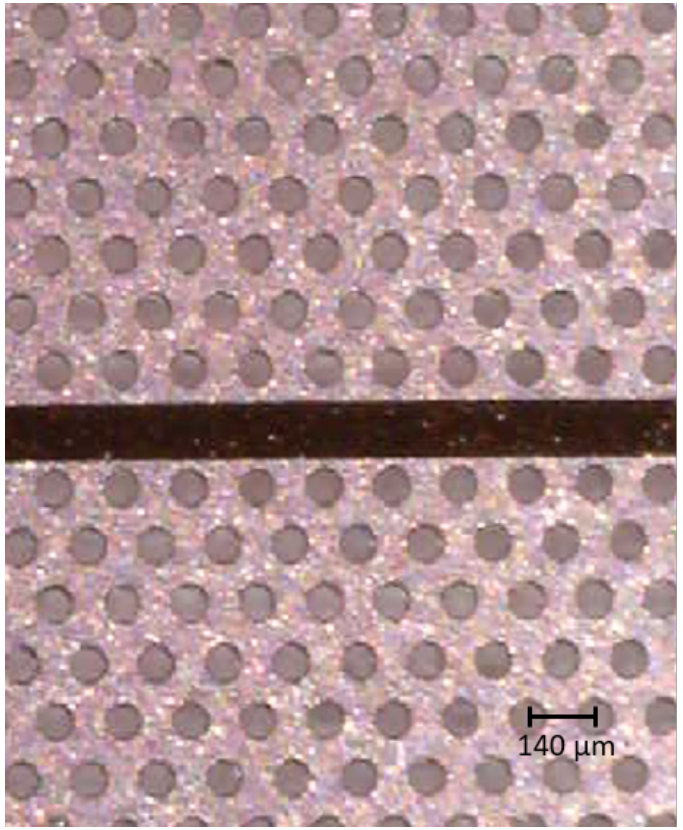
Blank strip triple-GEM stack



Blank strip GEM

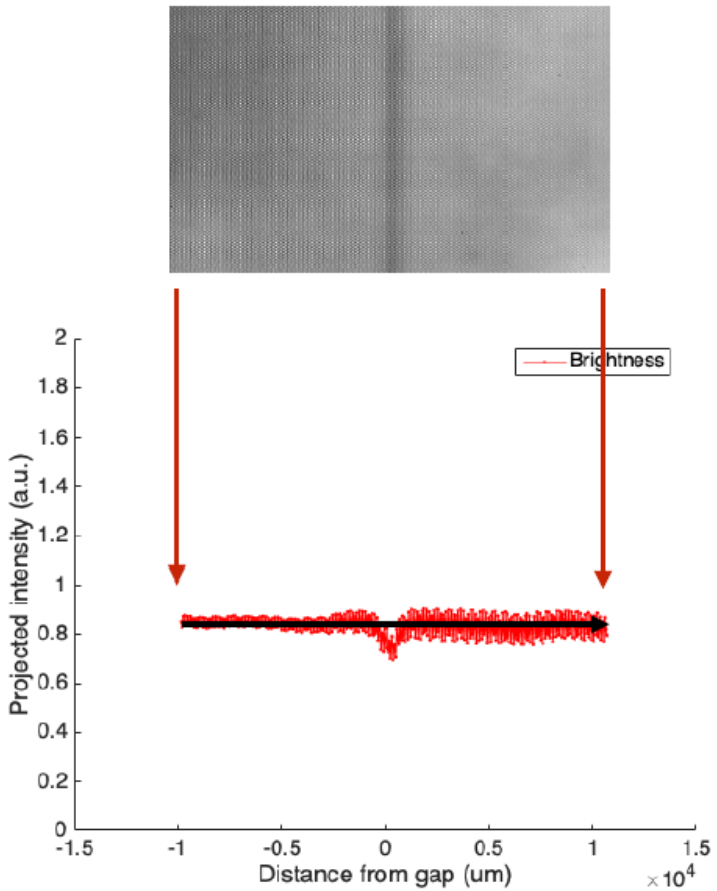


Optical picture

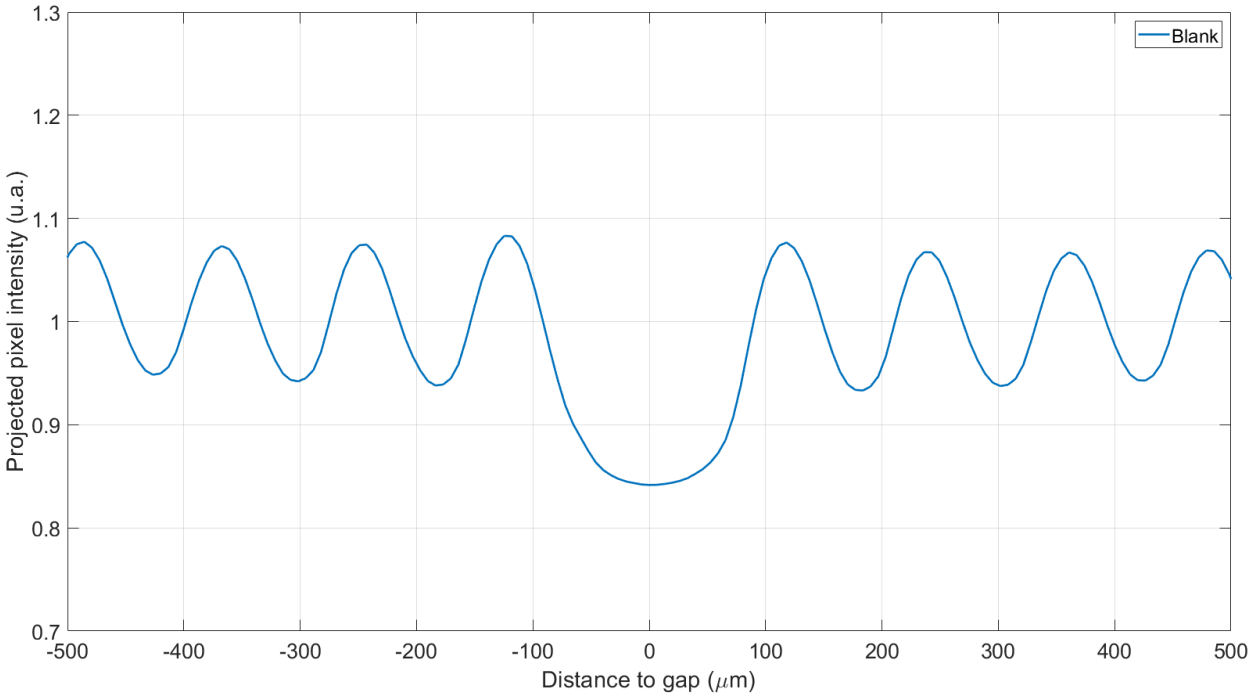


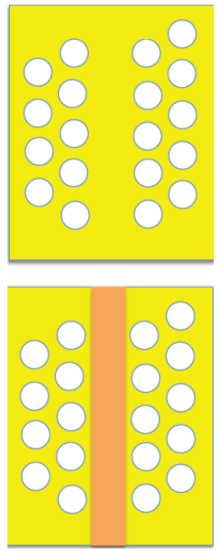
Microscopic picture

1D projection of pixel intensity

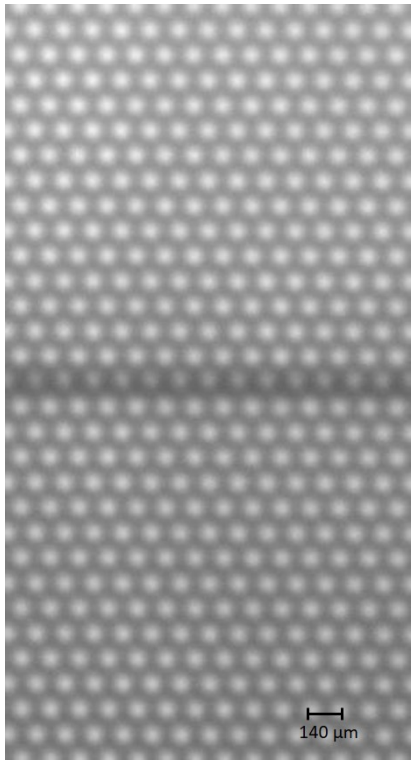


1D projection: blank strip GEM

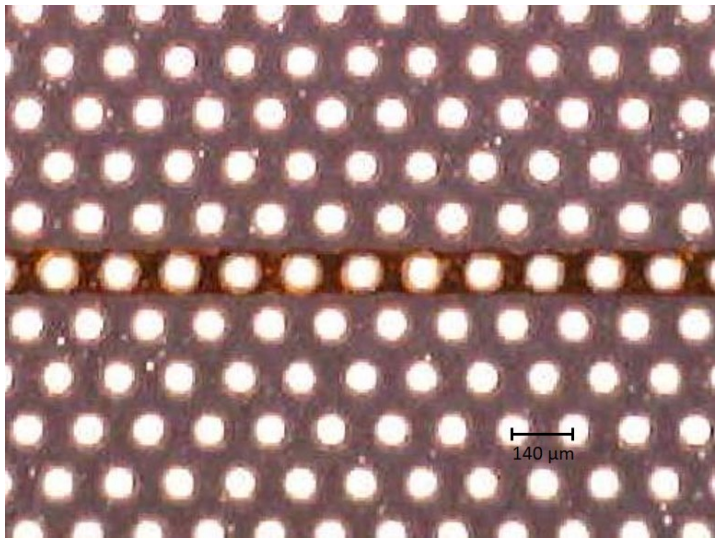




Full holes non-DLC GEM

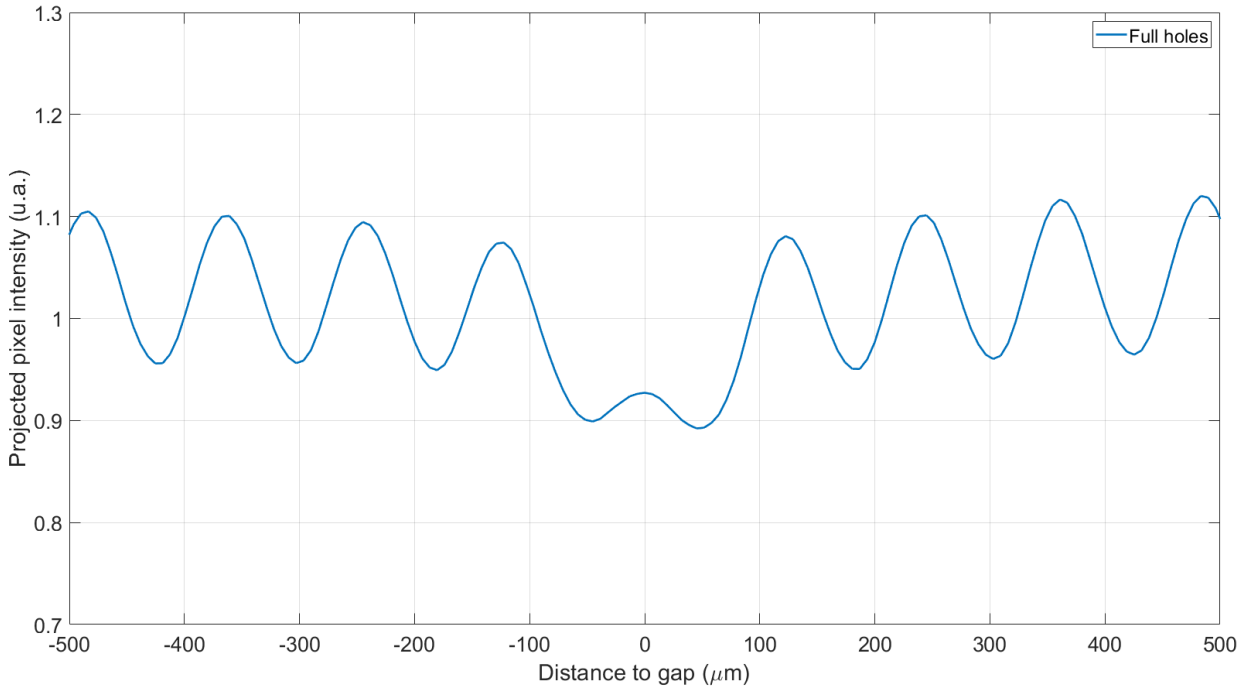


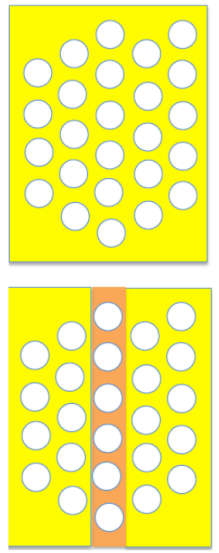
Optical image



Microscopic picture

1D projection: full holes non-DLC GEM



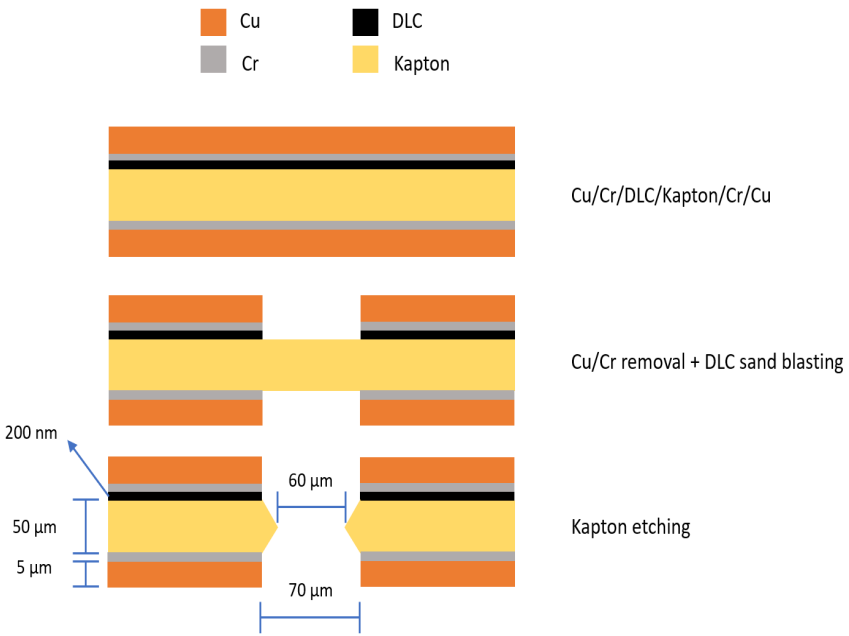


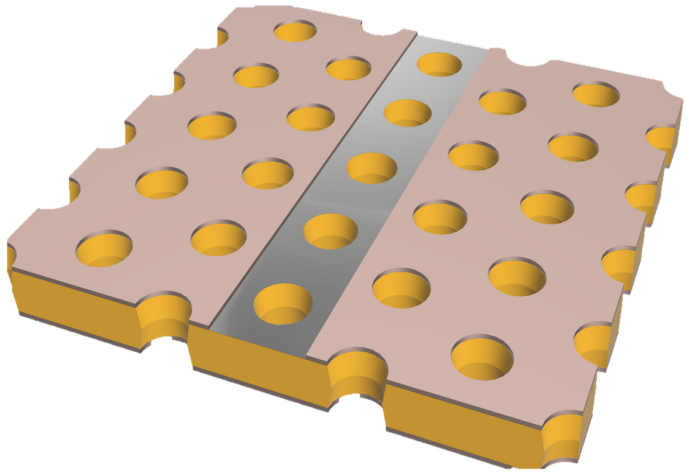
Purpose of the DLC

- Discharges can melt copper that may create leakage paths between the GEM shorting the sides
- In a triple-stack GEM setup, a discharge in one GEM can propagate to others GEMs

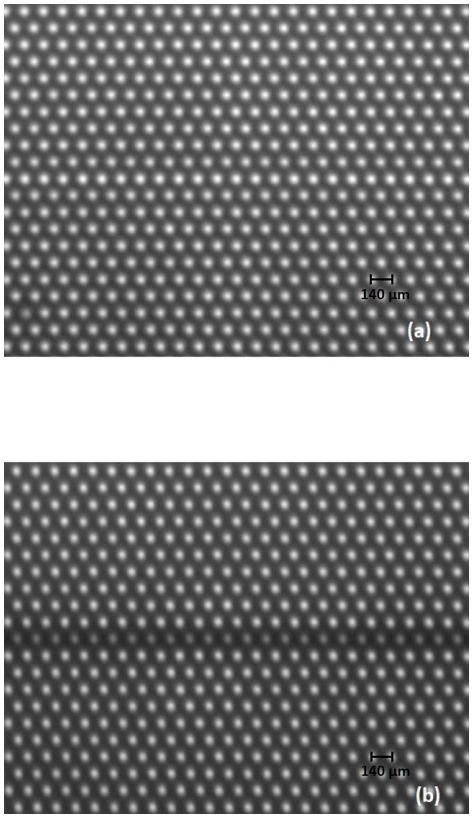
DLC (diamond-like carbon) acts as a resistive material that keeps the same potential through out the GEM. The desired effect is to direct the electrons through the holes to reduce the signal distortion.

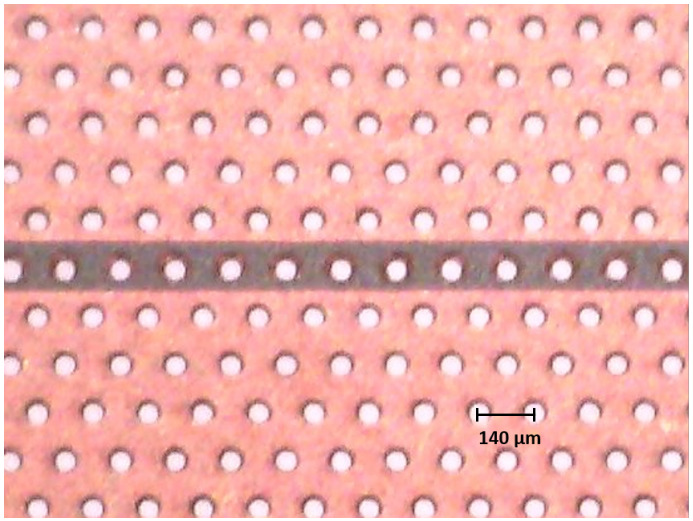
DLC GEM


Cu
DLC
Cr
Kapton
Cu/Cr/DLC/Kapton/Cr/Cu
Cu/Cr removal + DLC sand blasting
Kapton etching
200 nm
50 µm
5 µm
60 µm
70 µm



Full holes DLC GEM

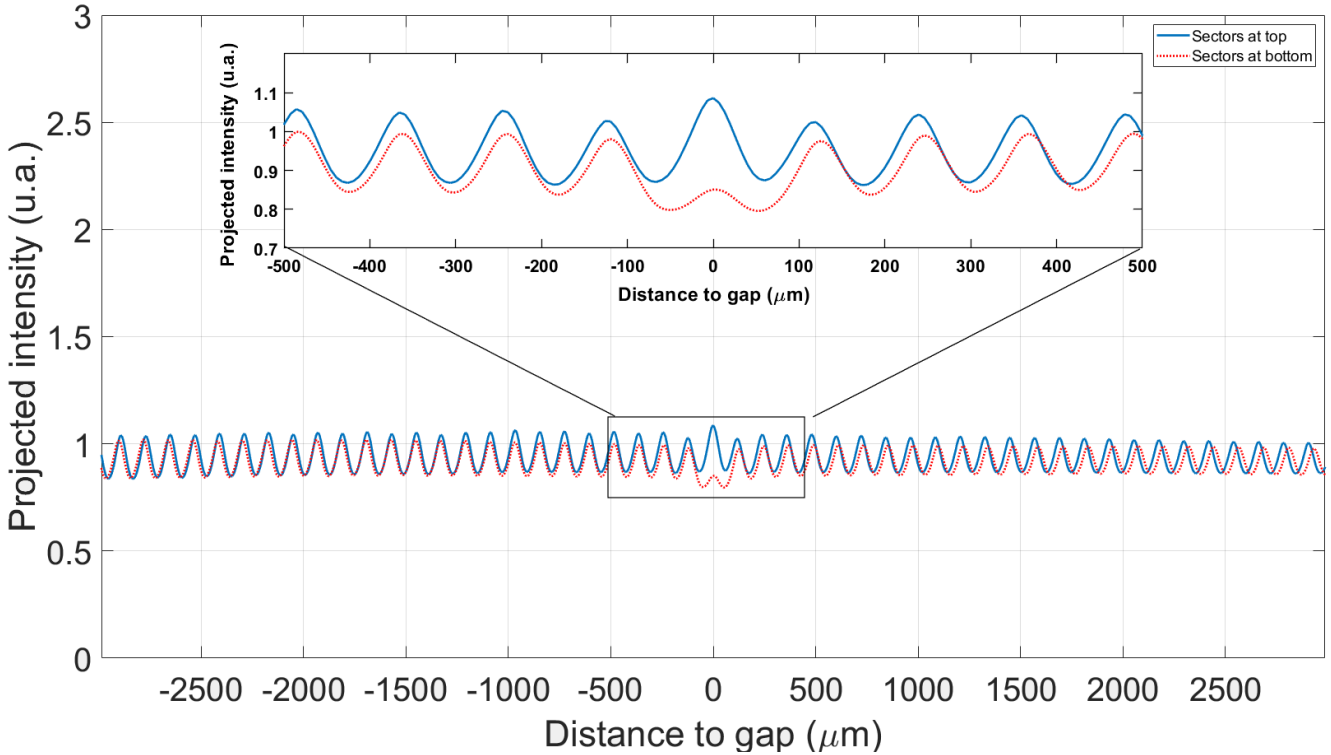


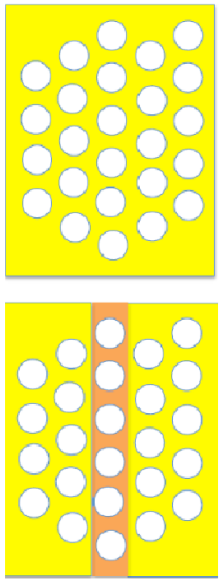


Microscopic picture

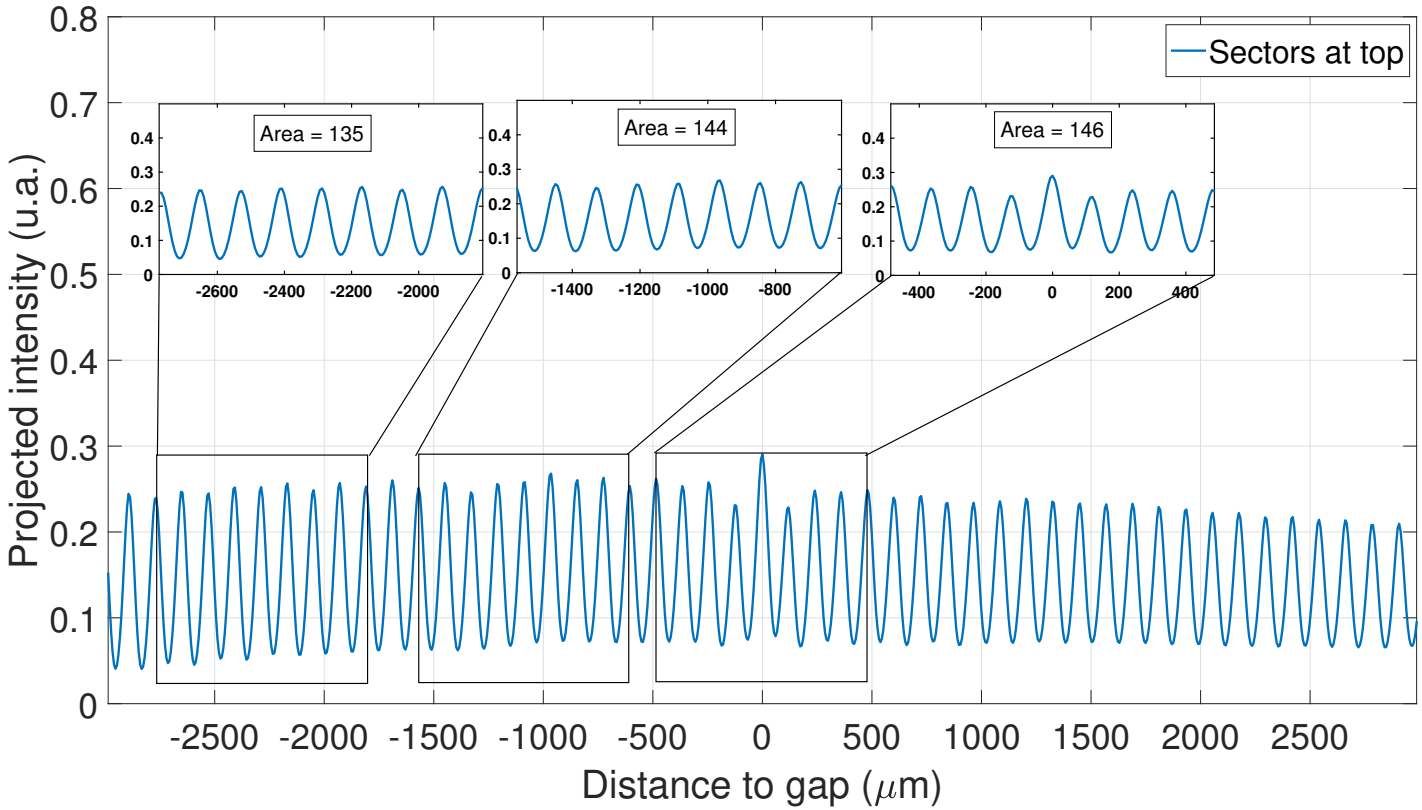
Sectors: (a) at top; (b) at bottom

1D projection: full holes DLC GEM

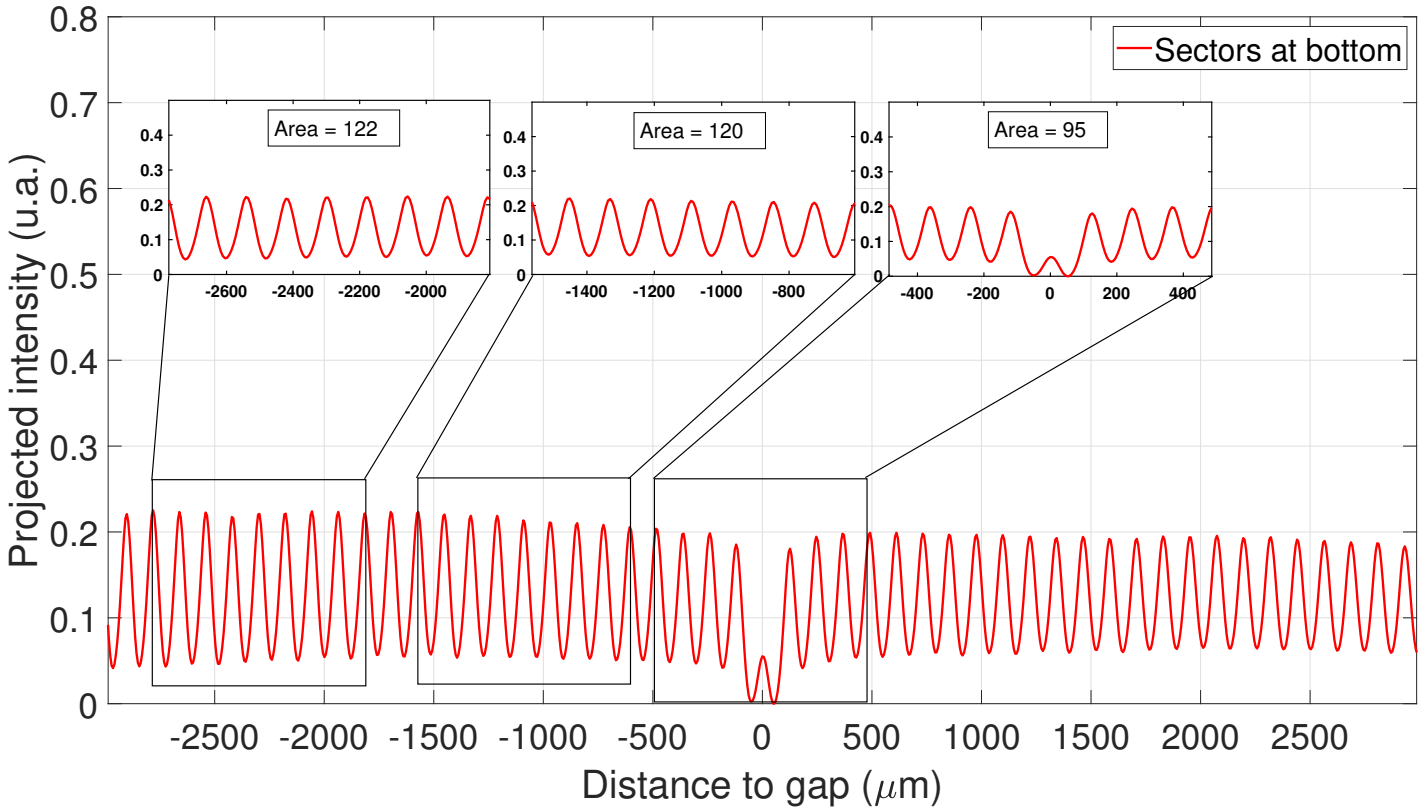




1D projection: full holes DLC GEM (top)



1D projection: full holes DLC GEM (bottom)



Conclusions

- No signal loss for sectors at top orientation (although the integration test is not conclusive)
- The DLC coated GEM seems to reduce signal distortion, specially for the sectors at top orientation

Acknowledgments

I want to thank all the GDD group for giving me the chance to work with them, in particular to Florian for the patience and all the help provided.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