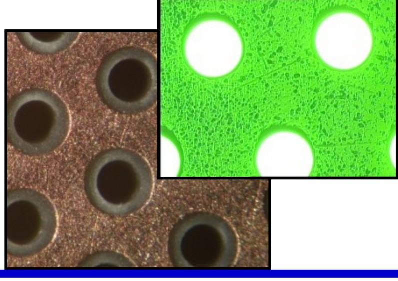


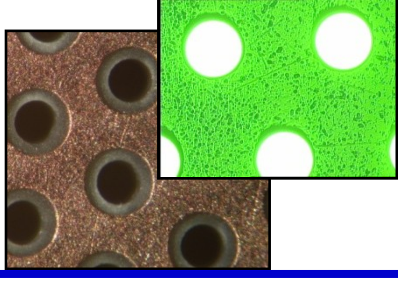
R&D toward THGEM-based PHOTON DETECTORS,

an update

S. Dalla Torre

on behalf of an

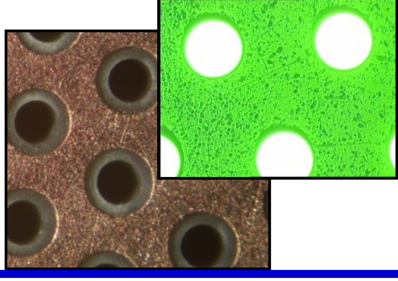
Alessandria ,CERN, Freiburg, Liberec, Prague, Torino, Trieste Collaboration



LAY-OUT

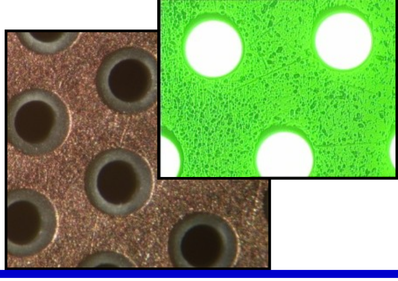
- **THGEM PRODUCTION ASPECTS**
  - THGEM & RIM
  - THGEM TREATMENTS FOR BETTER PERFORMANCE
- **LAB & TEST BEAM 2010 RESULTS**
  - THGEMS W/O RIM
  - DIAGNOSTIC OF PHOTOELECTRON EXTRACTION
  - RESPONSE STABILITY vs TIME, MORE
  - NEW LAB EQUIPMENTS
- **ELECTROSTATIC CALCULATIONS**
- **ENGENEERING ASPECTS**

AN UPDATE SINCE THE MEETING IN BARI October 2010



PRODUCTION ASPECTS

- THGEM & RIM
- THGEM TREATMENTS FOR BETTER PERFORMANCE



PBCs with RIM 1/3

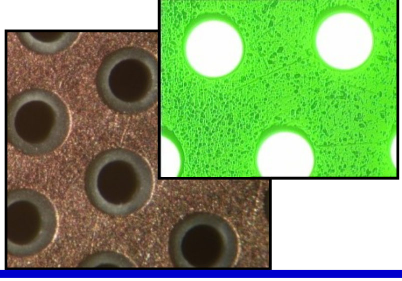
ABOUT RIM, our choice: small rims (~ 10 μm)

In fact:

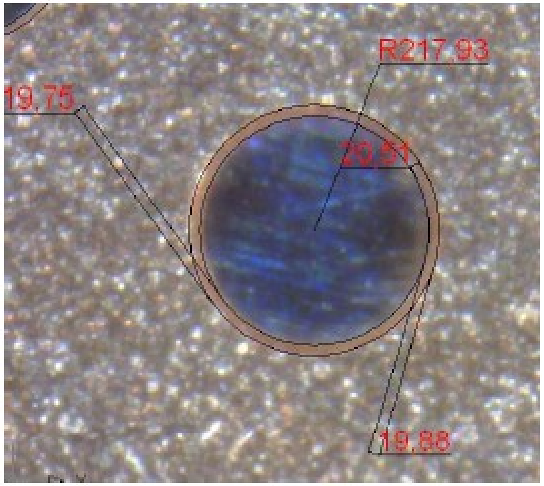
- Large rim →
  - large gain
  - large variation of the detector response variation vs time
- Small rim:
  - Smaller gain, even if larger than w/o rim
  - Tolerable variation of the detector response variation vs time

First tests of industrial production (~ 2 y ago): positive indications

Now there is clear evidence that industry does not master the rim control at the precision level required for reproducible detector construction →



PBCs with RIM 2/3

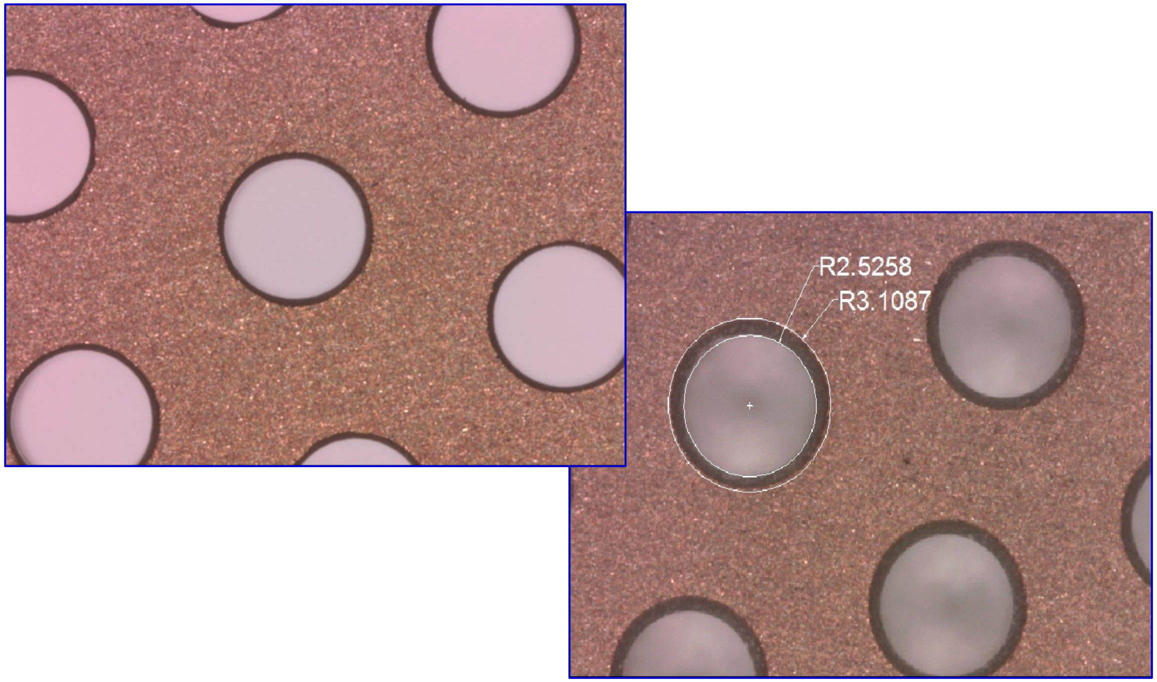


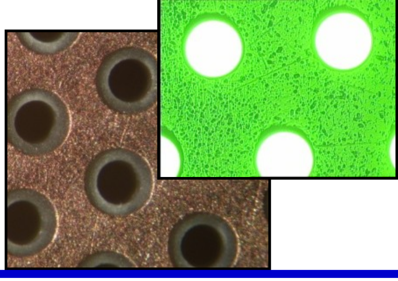
RIM measurement, method:

- *Microscope Image*
- *imported in AutoCad*
- *fit of the circles*
- *scale calibration using the radius of the hole (mechanics, i.e. good precision)*

Bad control of the rim size at production; just an example:

- Nominal : 20 μm
- Ranging: 20-70 μm

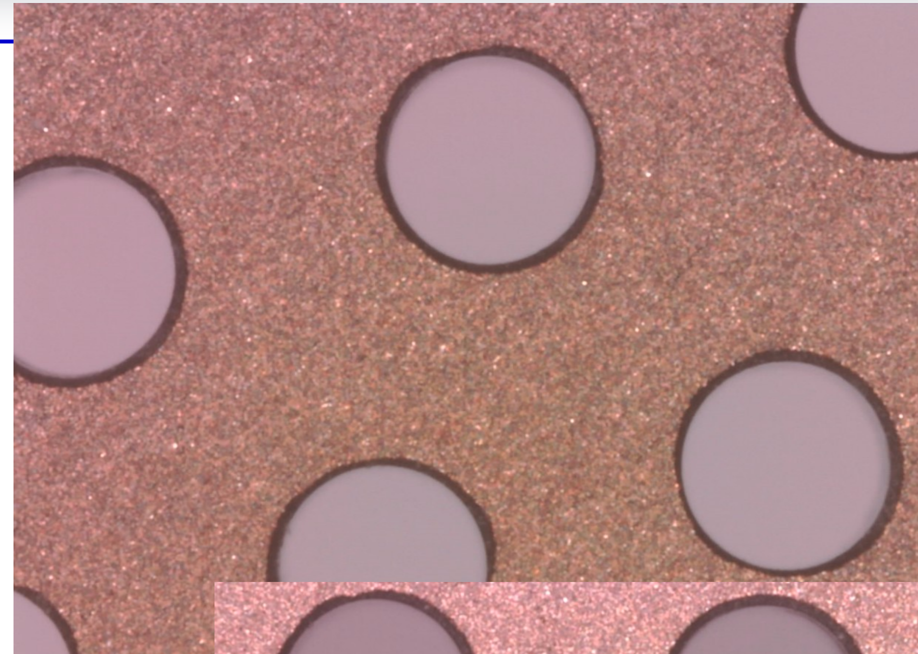


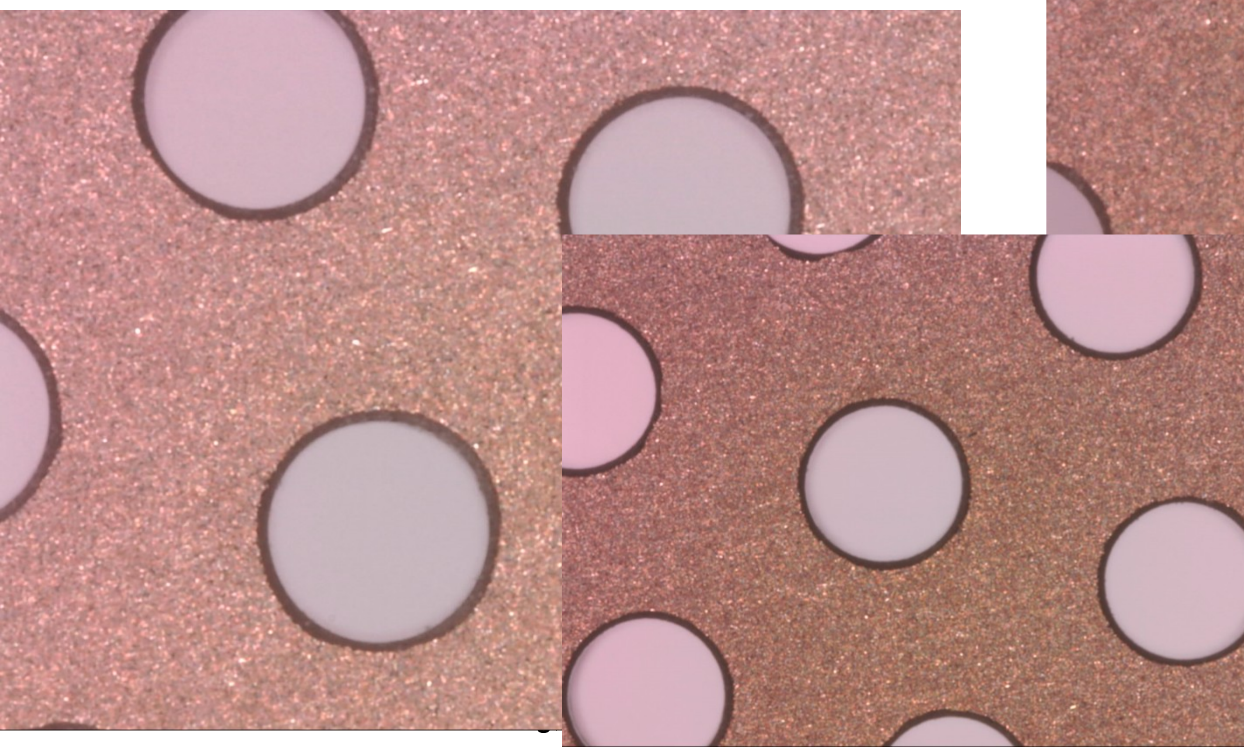


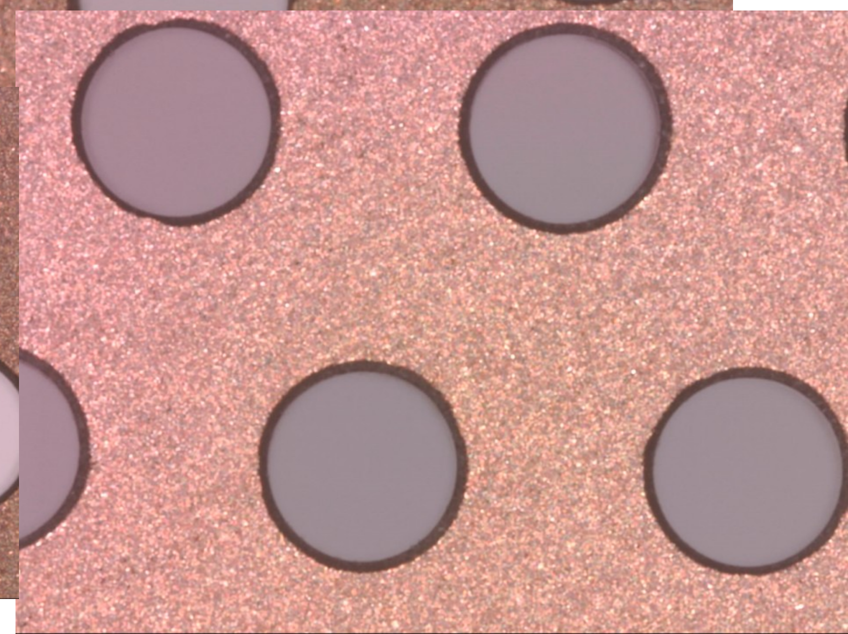
PBCs with RIM 3/3

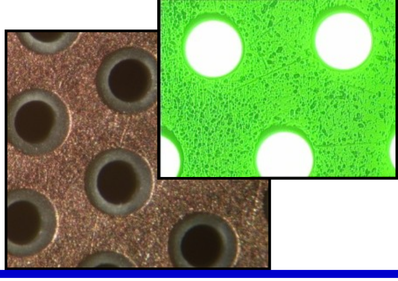
More difficulties:

- **Chemical residuals present at intermediate step of the rim formation can prevent good quality rims**



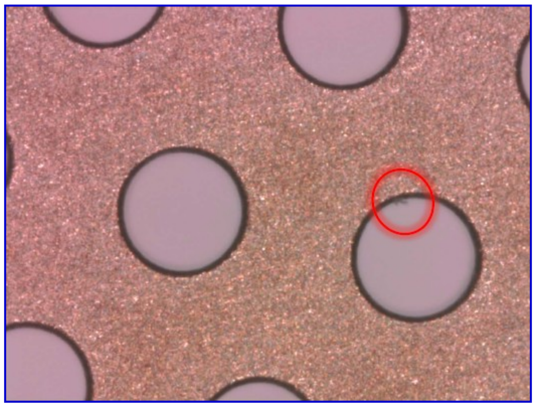


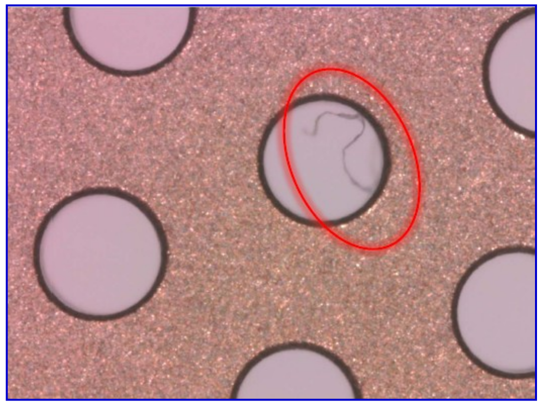




THGEM PCBs, TREATMENTS

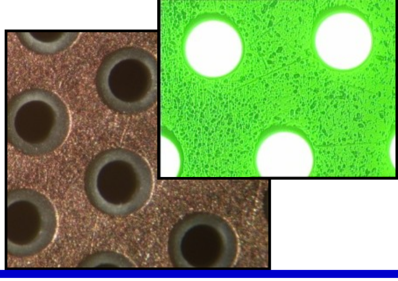
- Residuals can be removed in ultrasonic bath, water at 60 ^{o}C





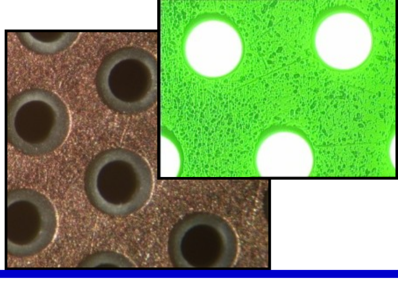
- Increase the electrical stability removing water from the fiberglass, a procedure suggested by Rui d.O.: 2 h in Oven at 135 ^{o}C

THGEM board	max ΔV initial (Volts)	max ΔV after oven (Volts)
CS1	950	1380
CS2	900	1320
CS3	950	1250
CS4	900	1400
CS6	950	1300

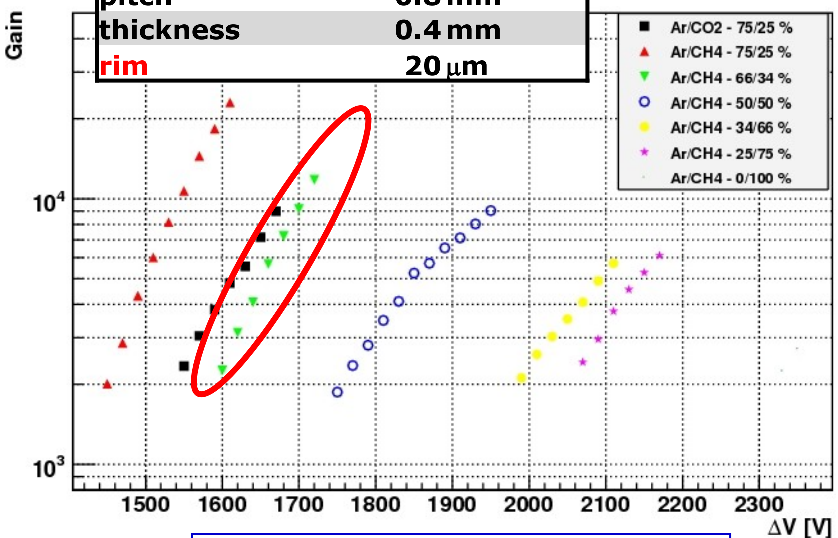


LAB & 2010 TEST BEAM RESULTS

- THGEMS W/O RIM
- DIAGNOSTIC OF PHOTOELECTRON EXTRACTION
- RESPONSE STABILITY vs TIME, MORE
- NEW LAB EQUIPMENTS

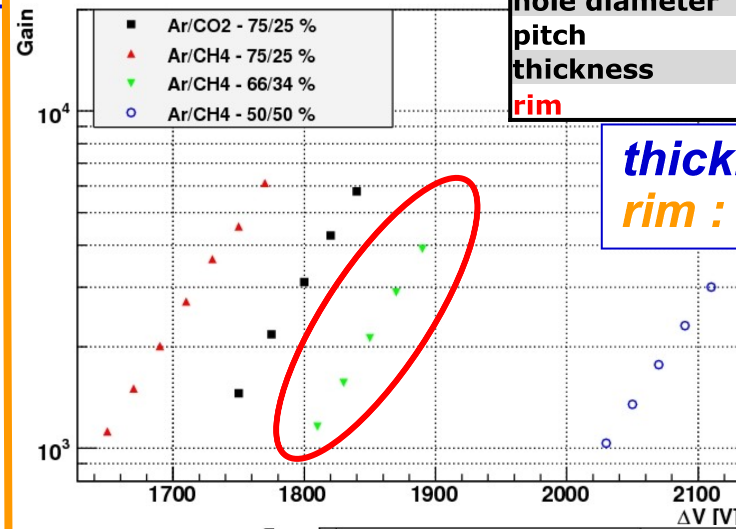


THGEM W/O RIM vs THGEM W RIM



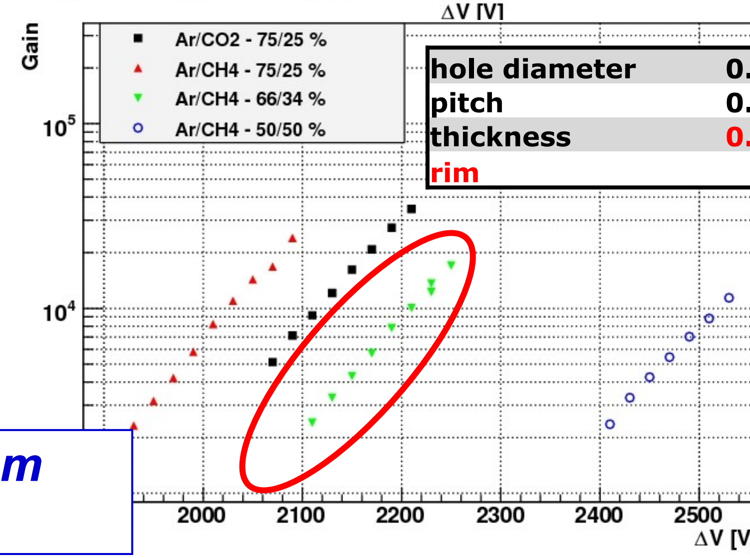
hole diameter	0.4 mm
pitch	0.8 mm
thickness	0.4 mm
rim	20 μm

thickness: 0.4 mm
rim : 20 μm



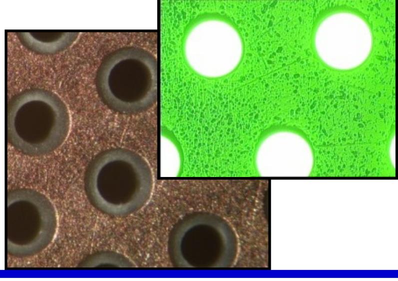
hole diameter	0.4 mm
pitch	0.8 mm
thickness	0.6 mm
rim	0

thickness: 0.6 mm
rim : 0



hole diameter	0.4 mm
pitch	0.8 mm
thickness	0.8 mm
rim	0

thickness: 0.8 mm
rim : 0

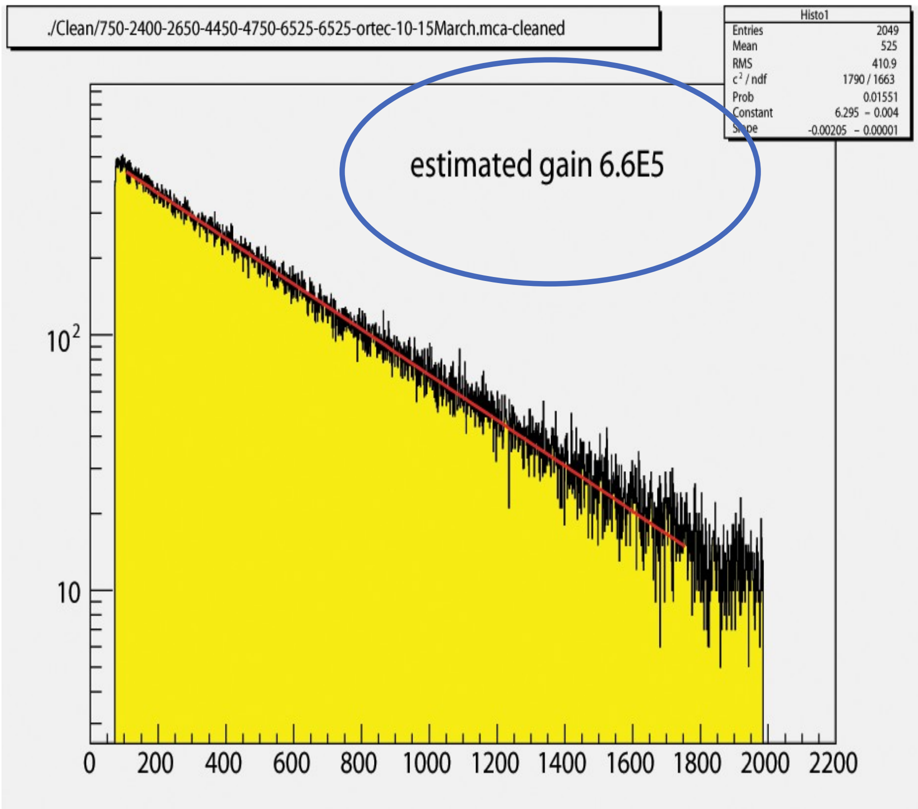


MULTILAYERS W/O RIM

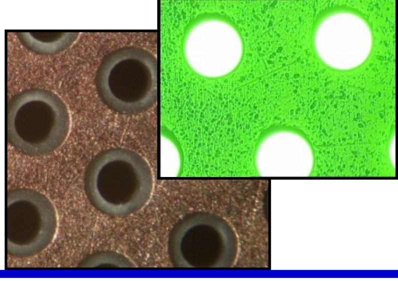
PRELIMINARY

- **3 layers:**

hole diameter	0.4	mm
pitch	0.8	mm
thickness	0.8	mm
rim	0	



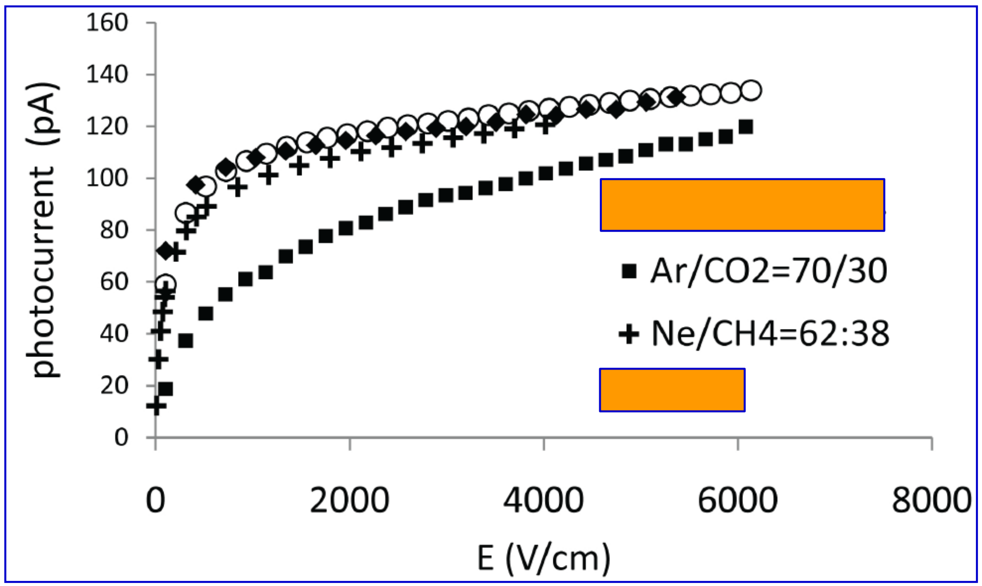
3kV/cm Ind field
DV3=1650Volt
TF2=1kV/cm
DV2=1800 Volt
TF1=1.2kV/cm
DV1=1775 Volt
0 kV/cm Drift Field
PDE laser @5.6 Volt, ~ 2kHz rate

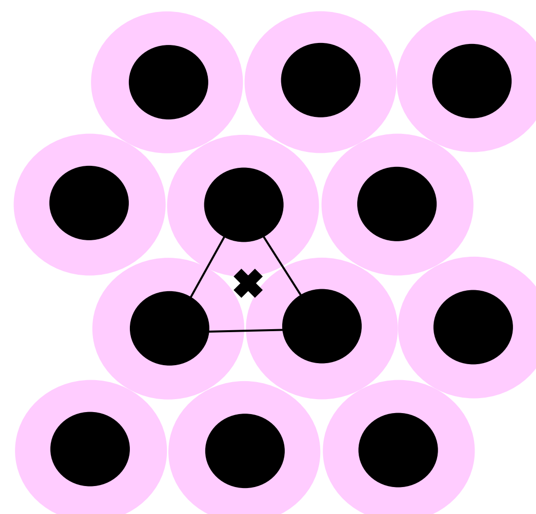


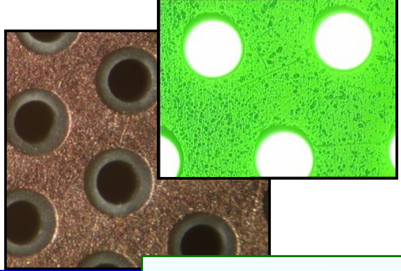
PHOTOELECTRON EXTRACTION FROM TIME RESPONSE 1/3

The electric field (component hortogonal to the THGEM surface) must ensure an effective photoelectron extraction

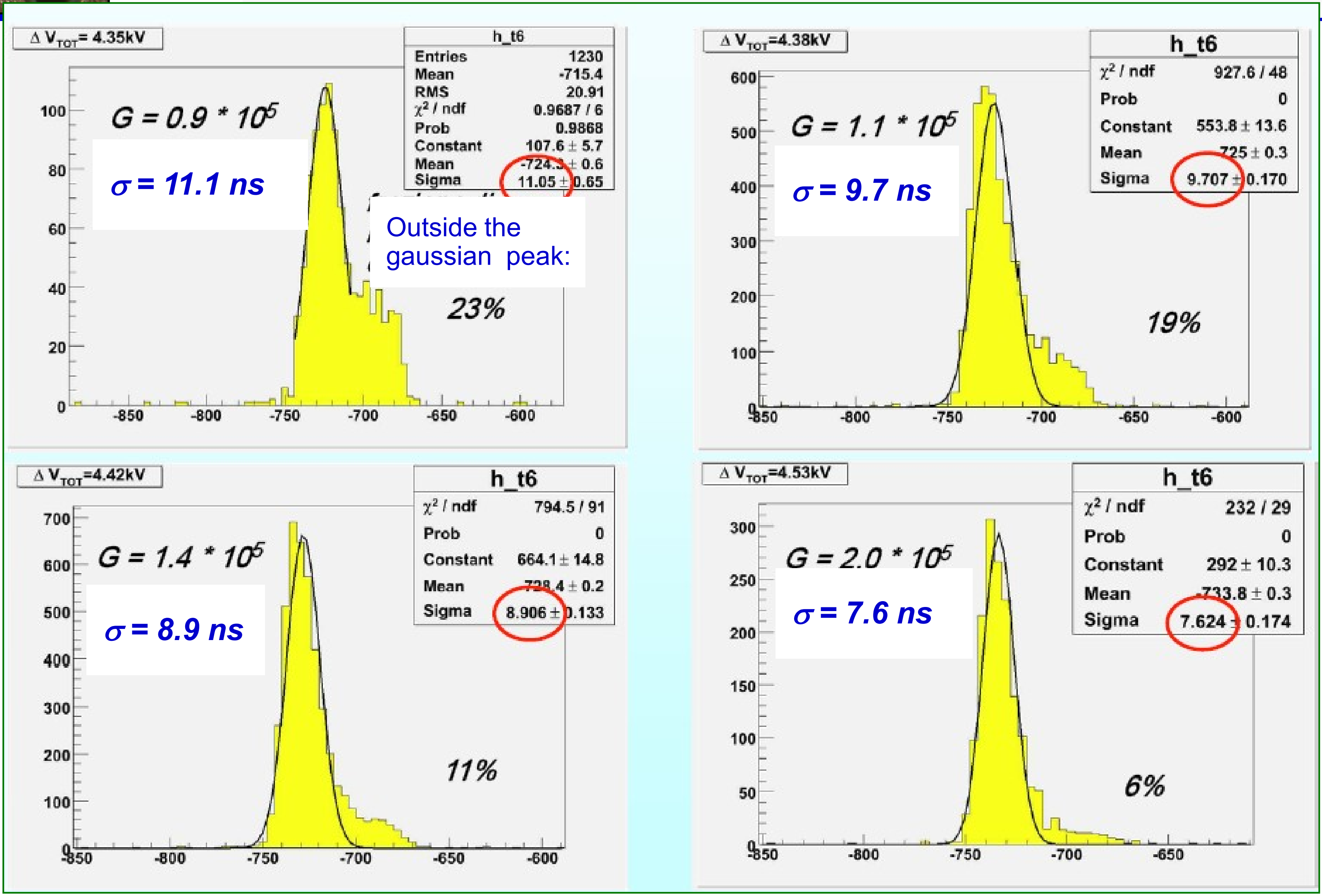
The most critical point: the centre of the triangle



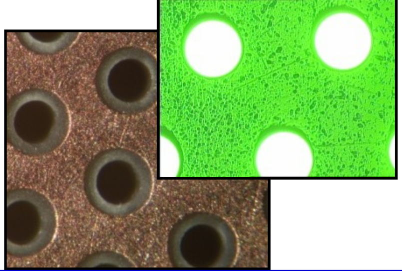


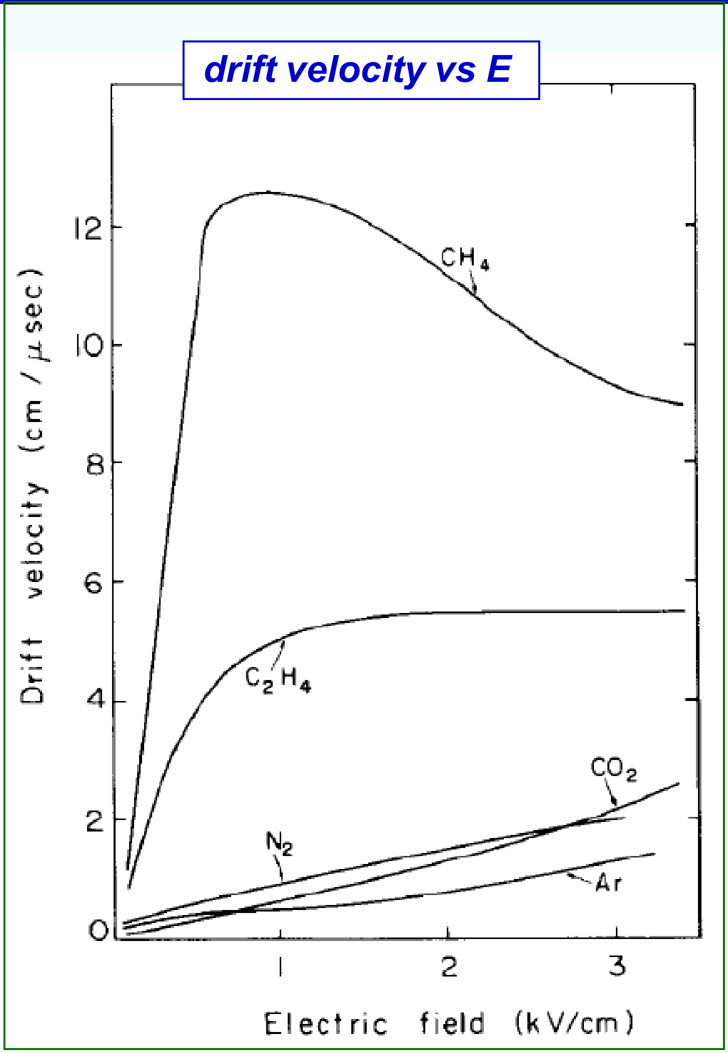


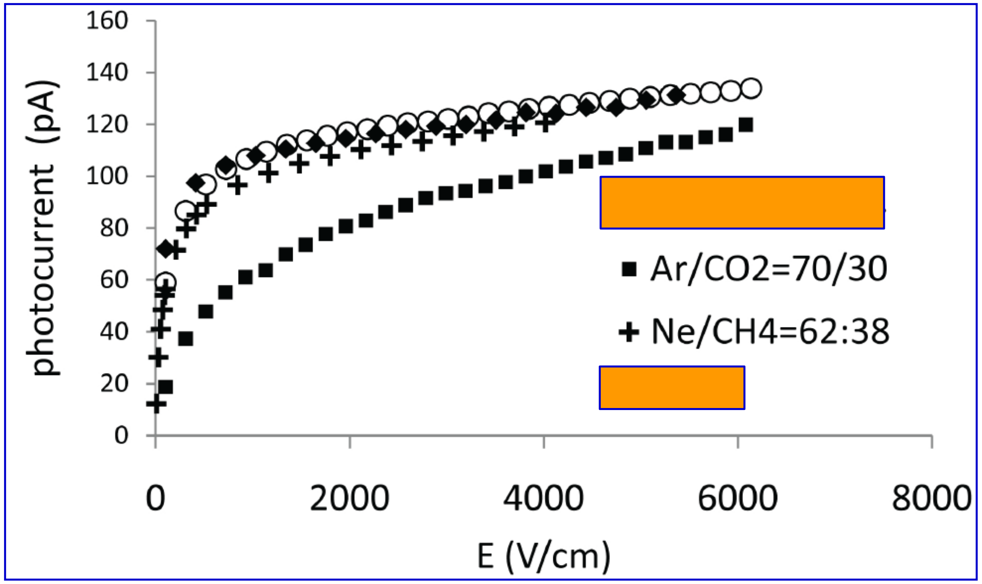
PHOTOELECTRON EXTRACTION FROM TIME RESPONSE 2/3



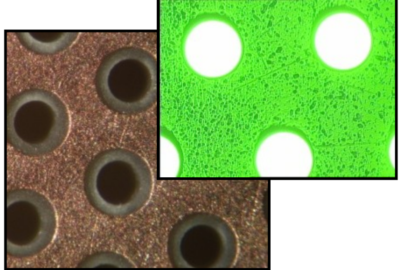
PHOTOELECTRON EXTRACTION FROM TIME RESPONSE 3/3





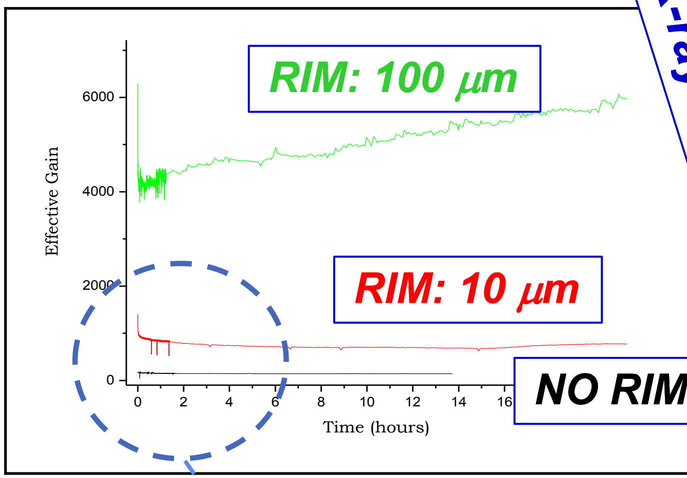


correlation between the tail of the timing peak and the reduced extraction efficiency: an effective method to check the field conditions

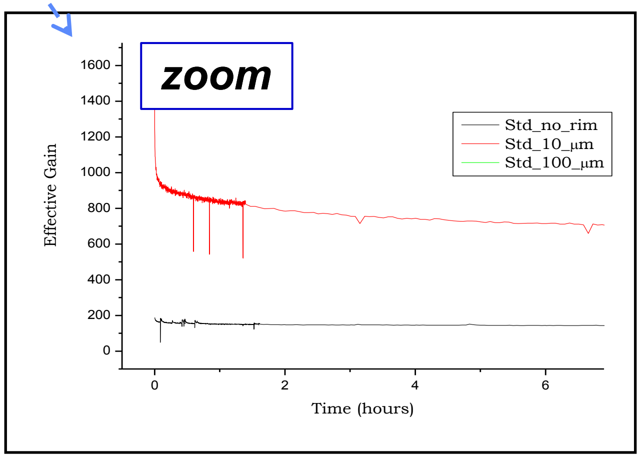


THGEM TIME RESPONSE STABILITY, MORE

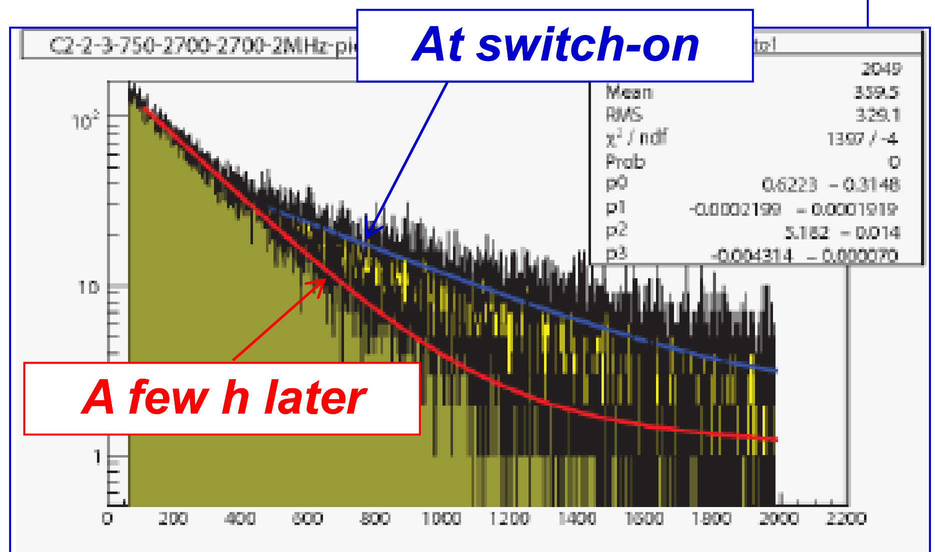
- **RECALL**

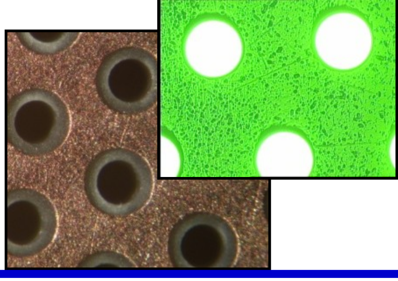


X-ray measurements



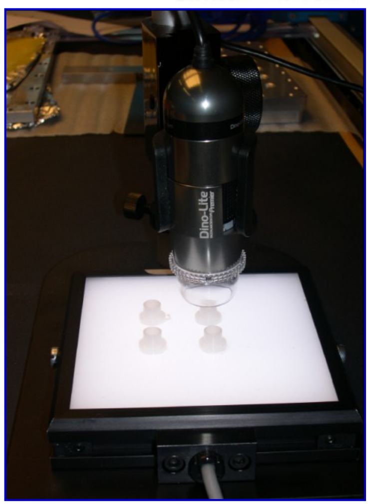
- **Detecting single photons** (20µm rim)

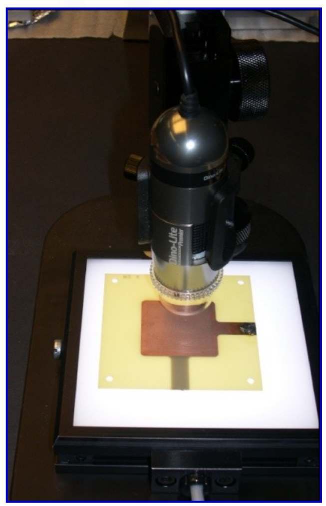




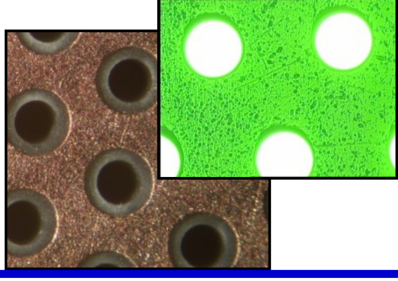
NEW LAB EQUIPMENTS

- **Microscope with direct USB interface to any PC:**
  Dino-Lite AM7013 MZT
  (x 250, 5 Mpixels)

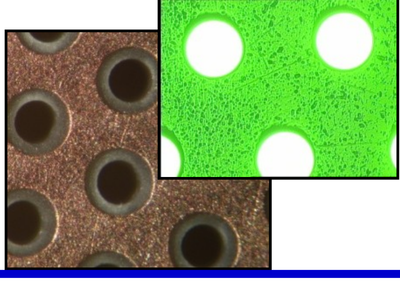




- **Digital insulation tester:**
  Megger S1054/2
  (up to 7.5 TΩ)

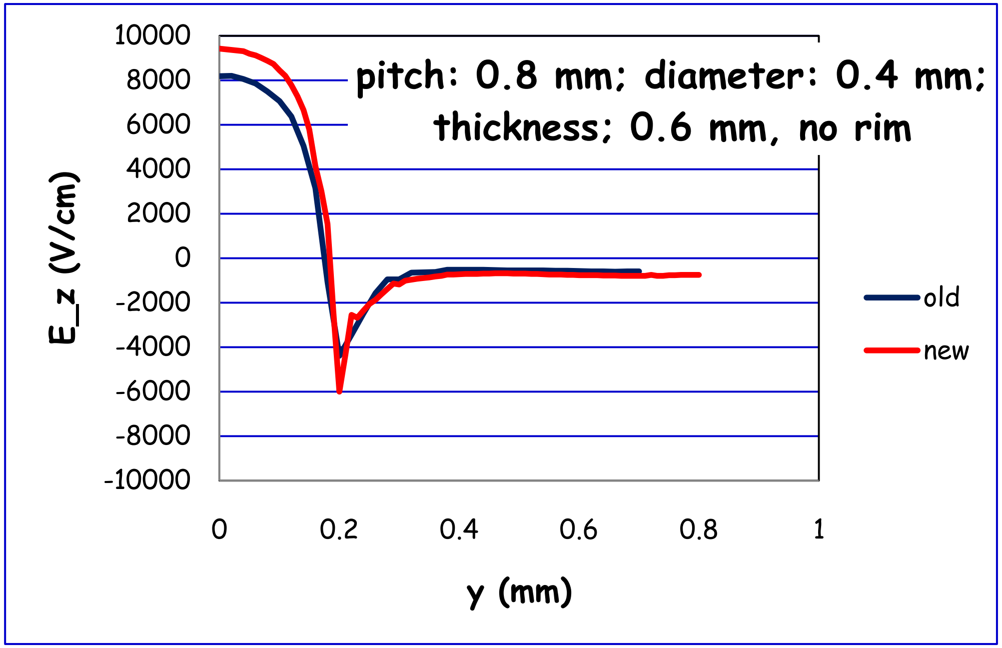


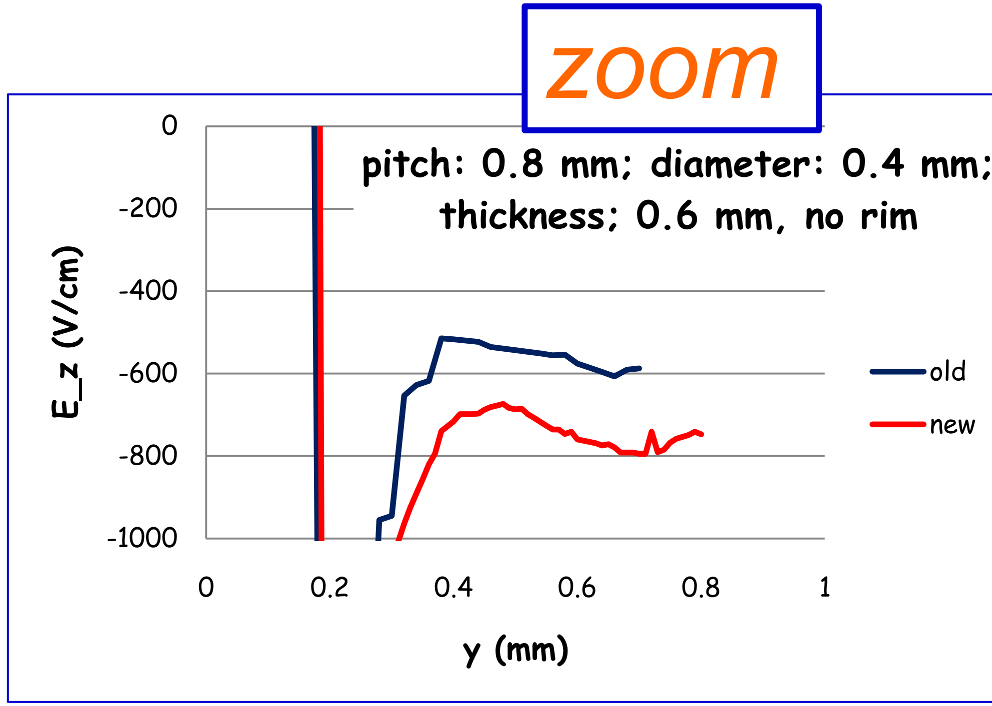
ELECTROSTATIC CALCULATIONS



CONFIDENCE IN THE OUTCOMES

2 evaluations of E by ANSYS varying the grid parameters, using Garfield as user interface





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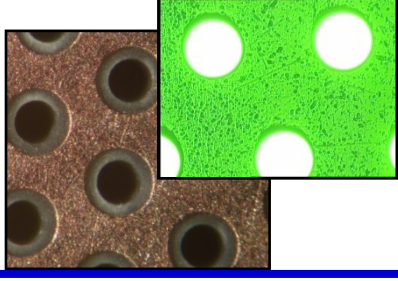
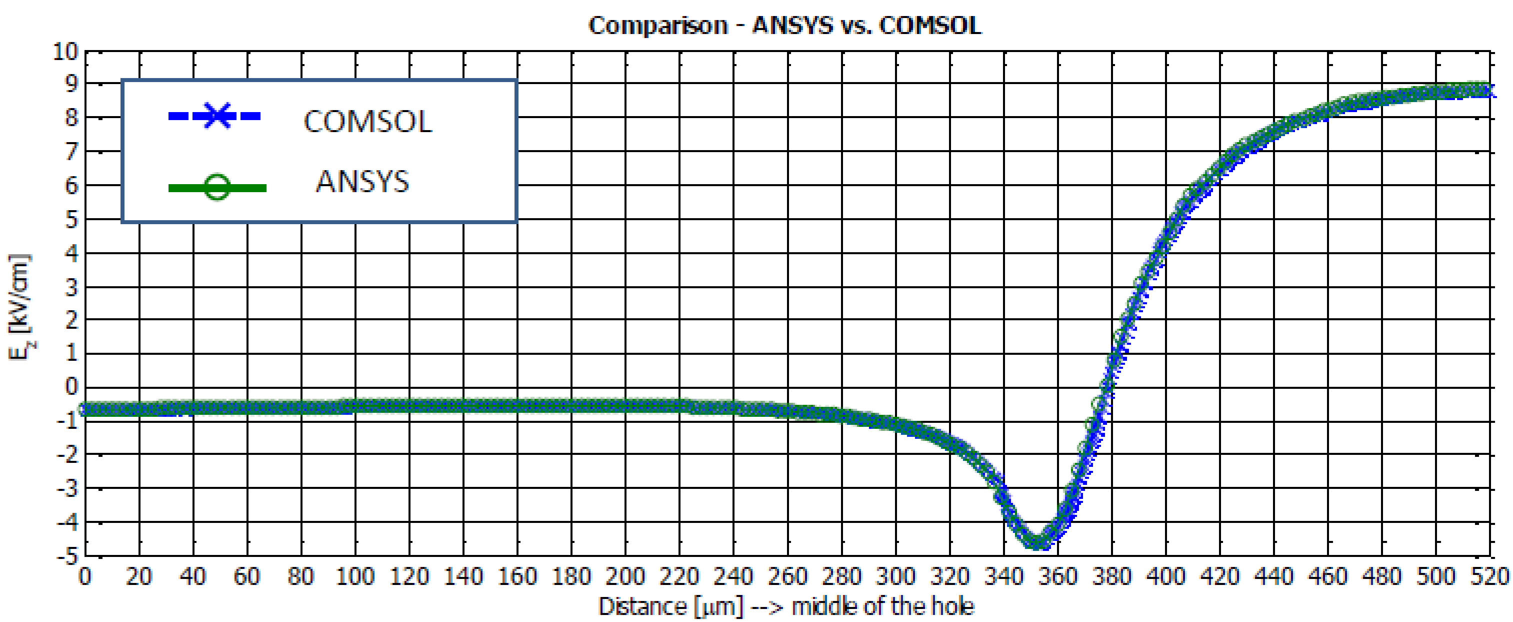
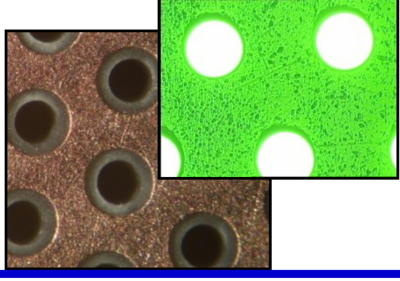


Ansys® and Comsol® Comparison

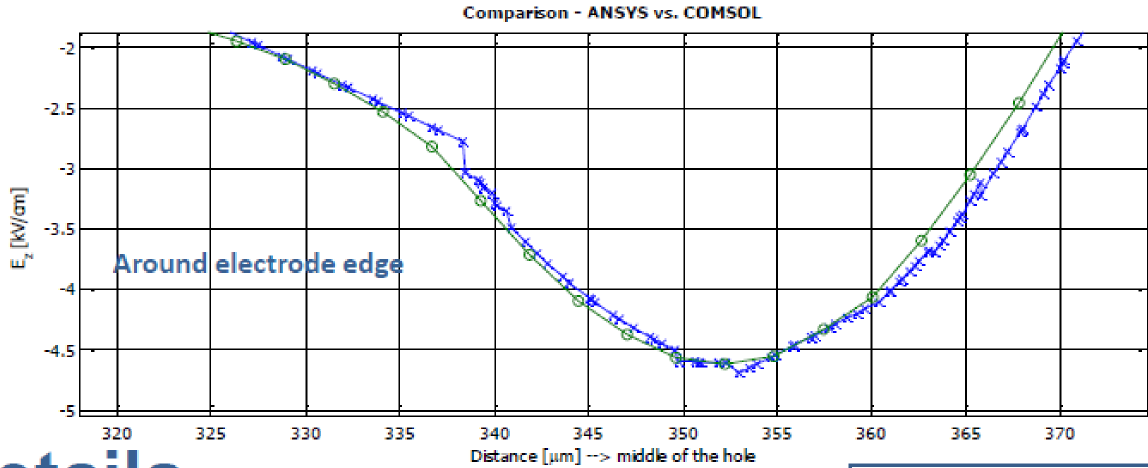
After a couple of months of efforts and after understanding that the Ansys output is some what distorted by Garfield:

THGEM (d= 0.3 mm, p= 0.6 mm, t = 600 mm, no rim)

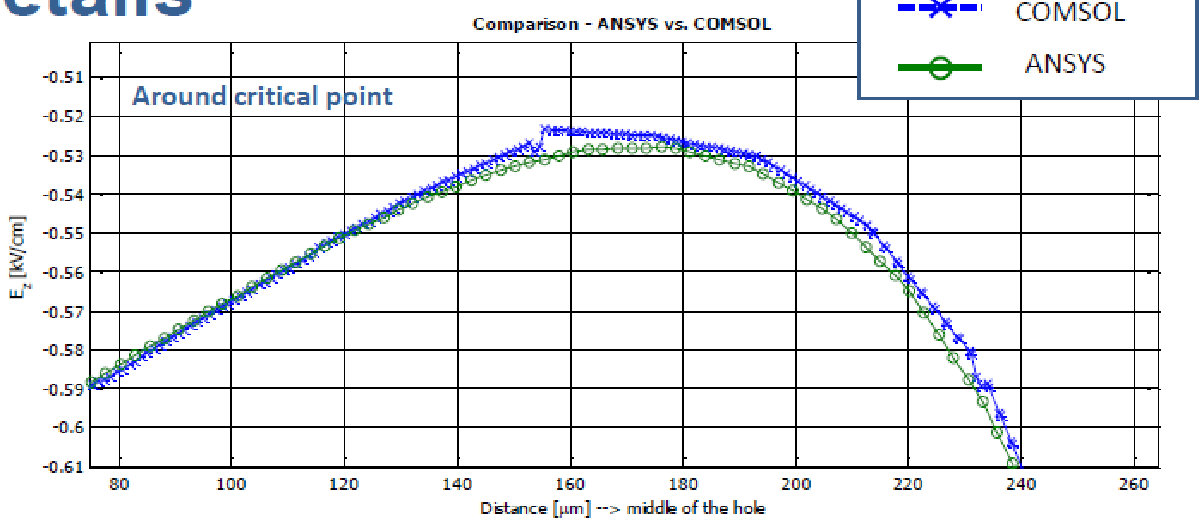




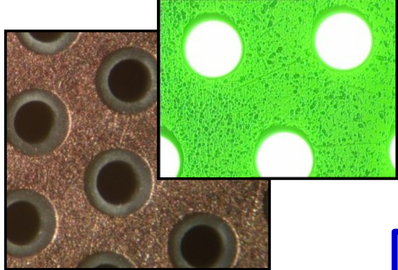
Ansys®12 and Comsol®4.1 Comparison



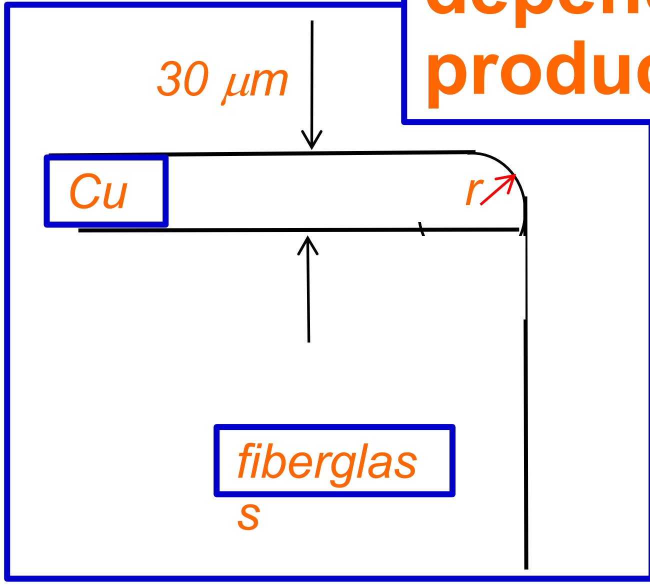
Details

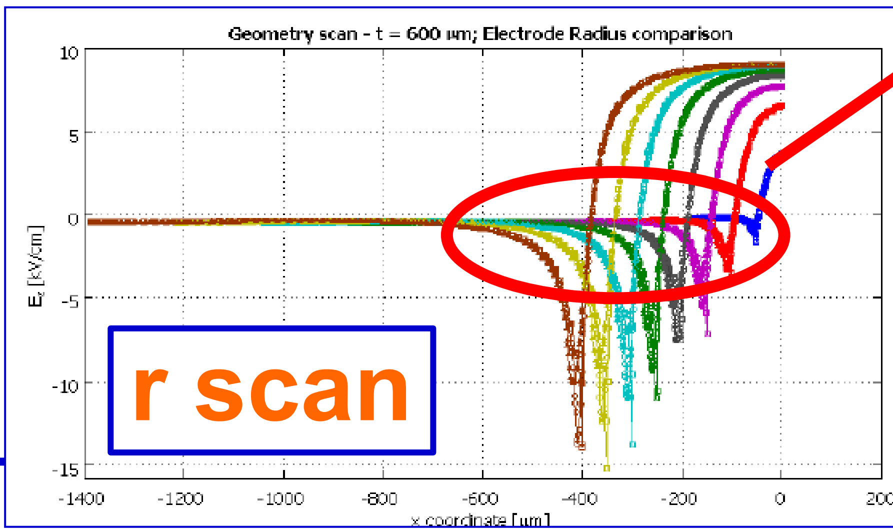


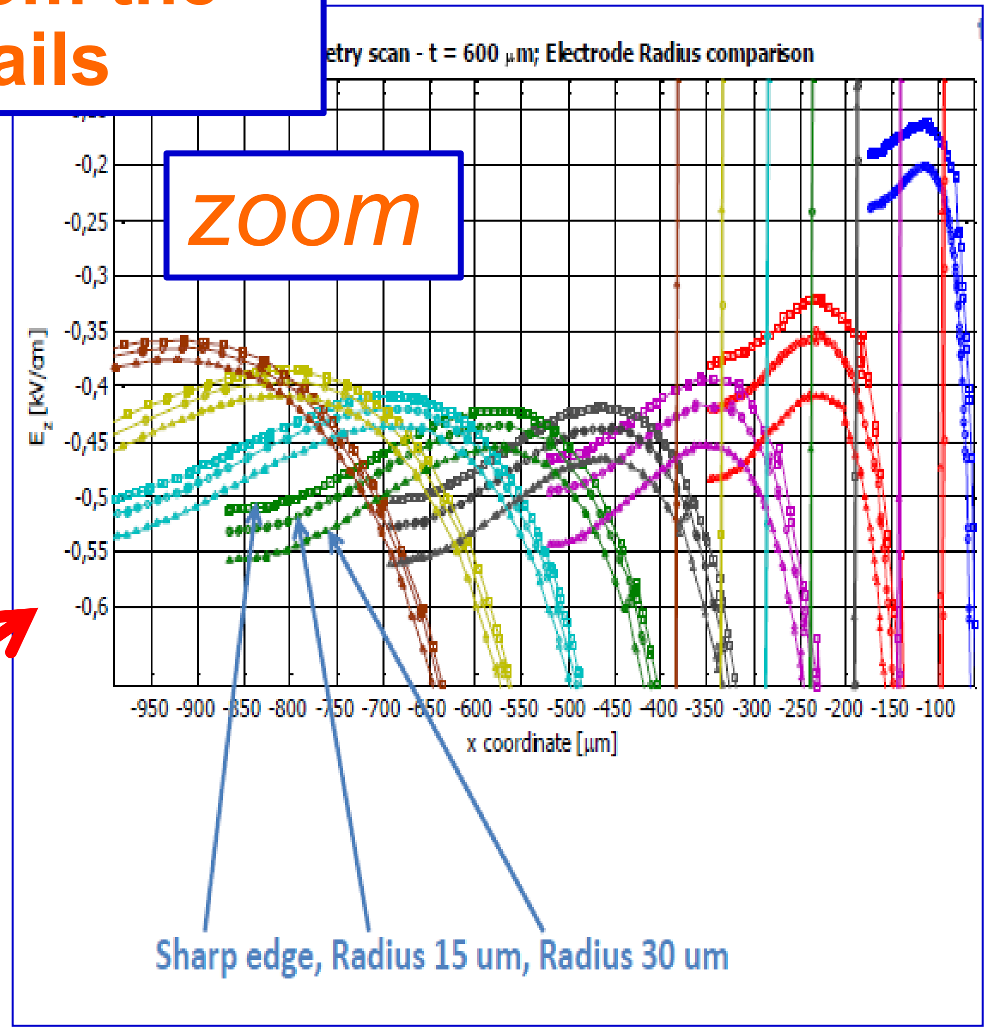
NO RIM – E vs EDGE SHAPE

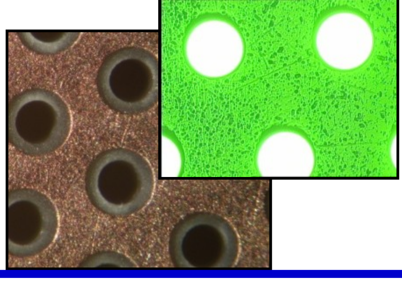


dependance from the production details



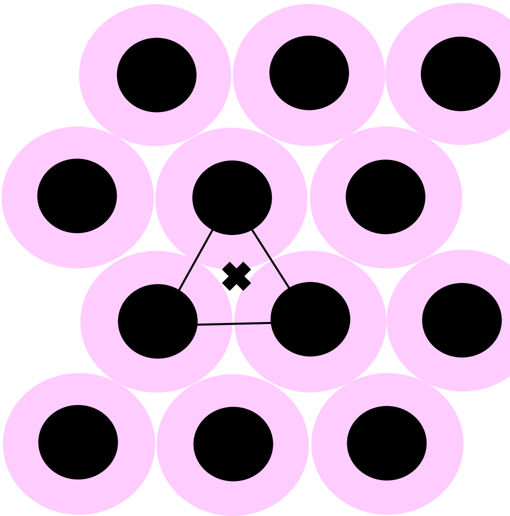


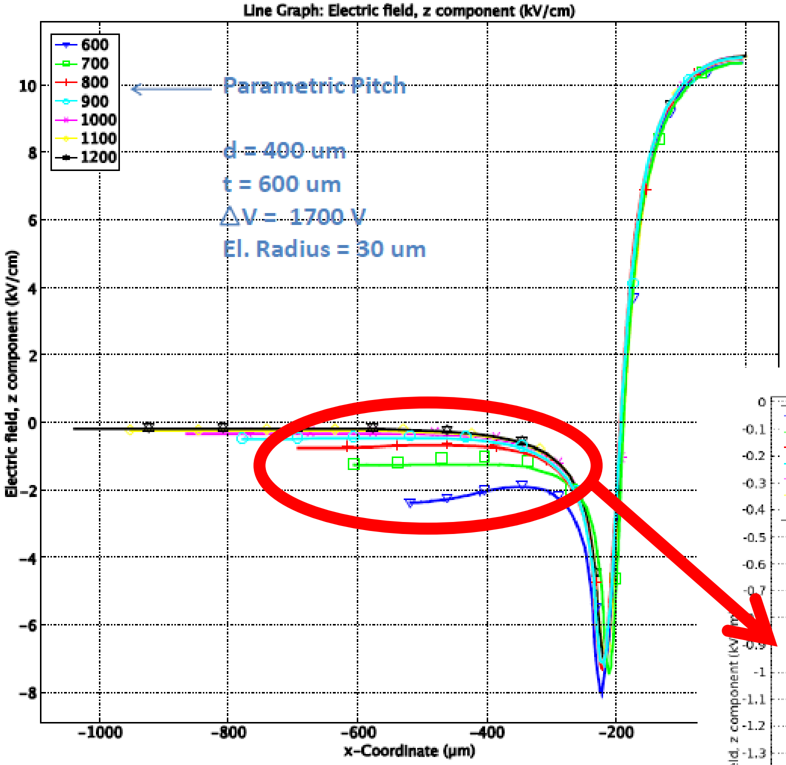




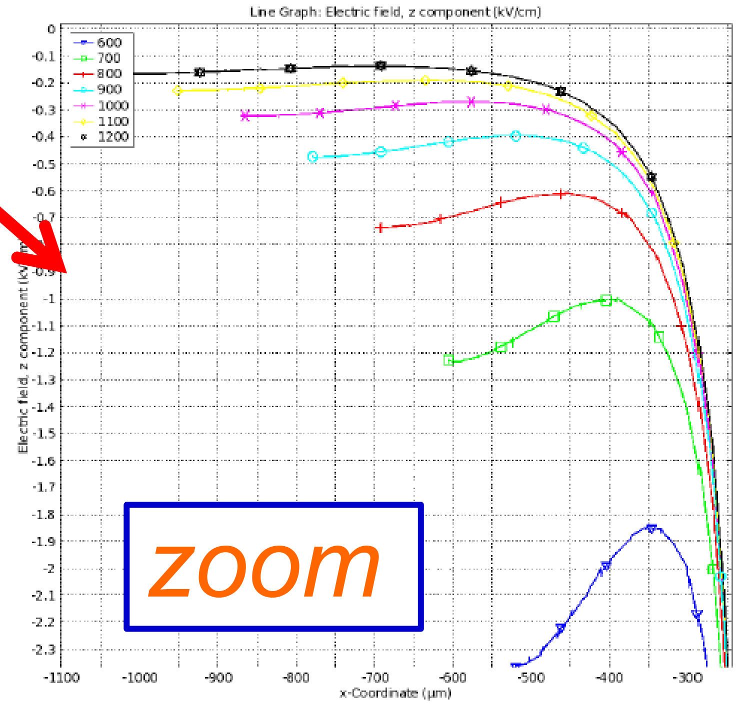
E-FIELD AT THE THGEM SURFACE 1/2

recall





Pitch scan



zoom

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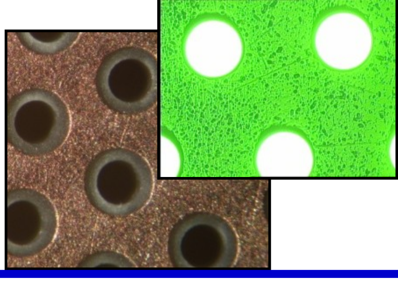
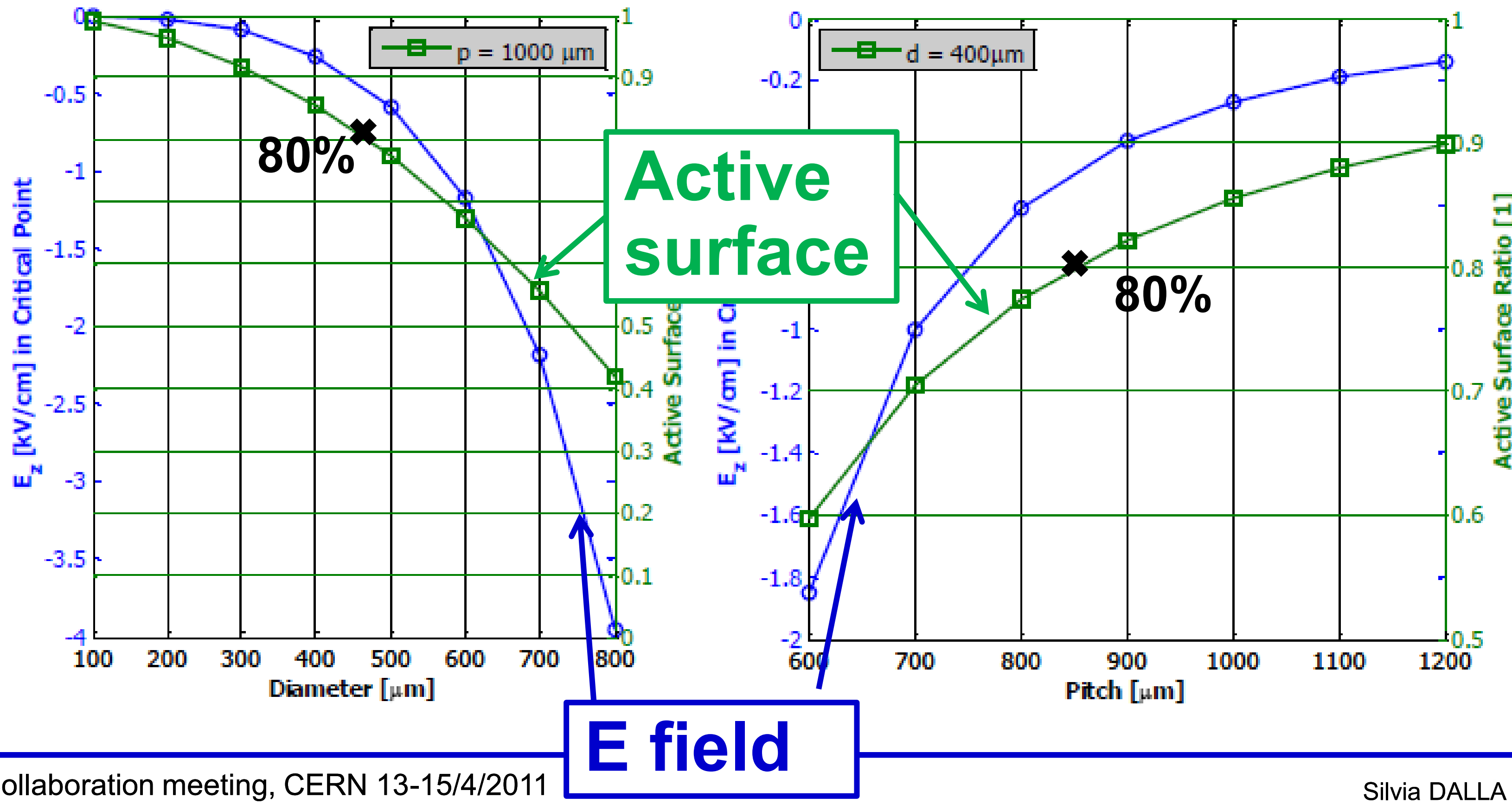
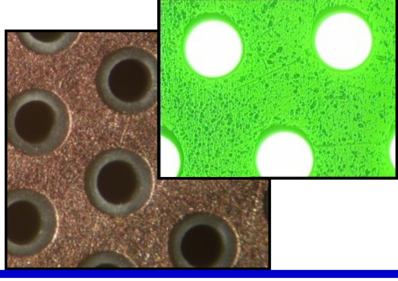


E-FIELD AT THE THGEM SURFACE 2/2

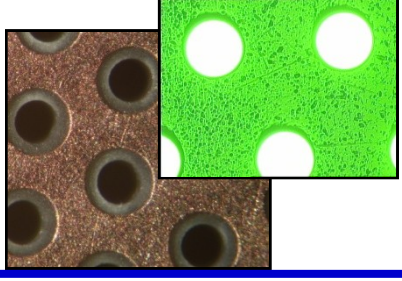
E @ critical point

vs hole diameter   vs pitch





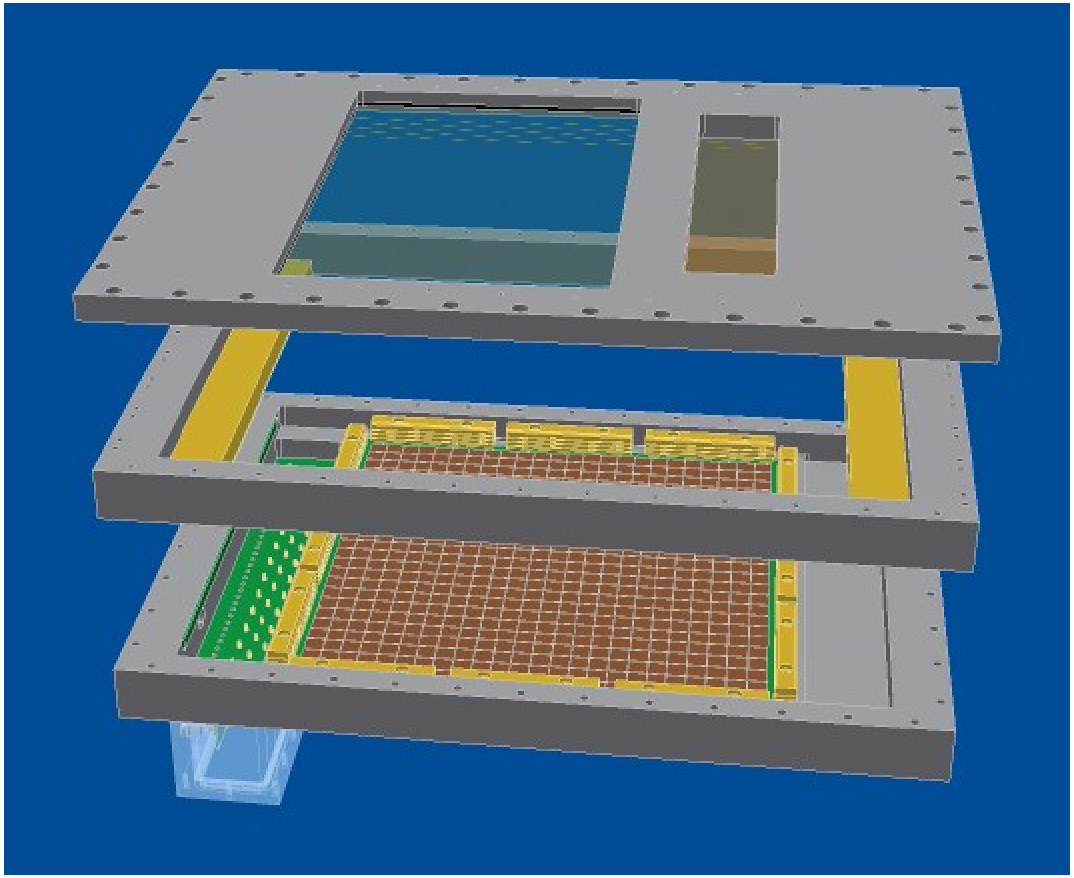
ENGINEERING ASPECTS

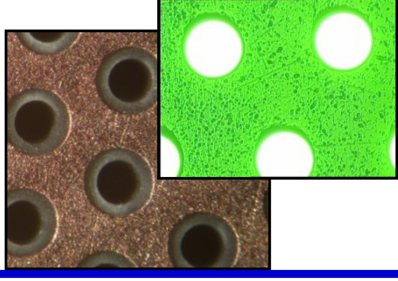


300 x 300 mm² PROTOTYPE, in progress 1/4

Main goal :

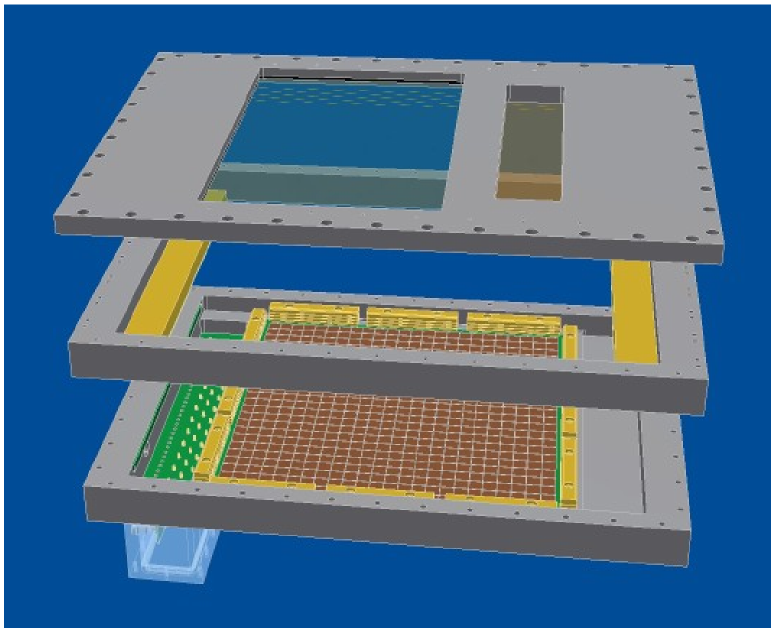
- an opportunity to approach the large size, reduced dead zone detectors, as required for RICH-1 – engineering effort

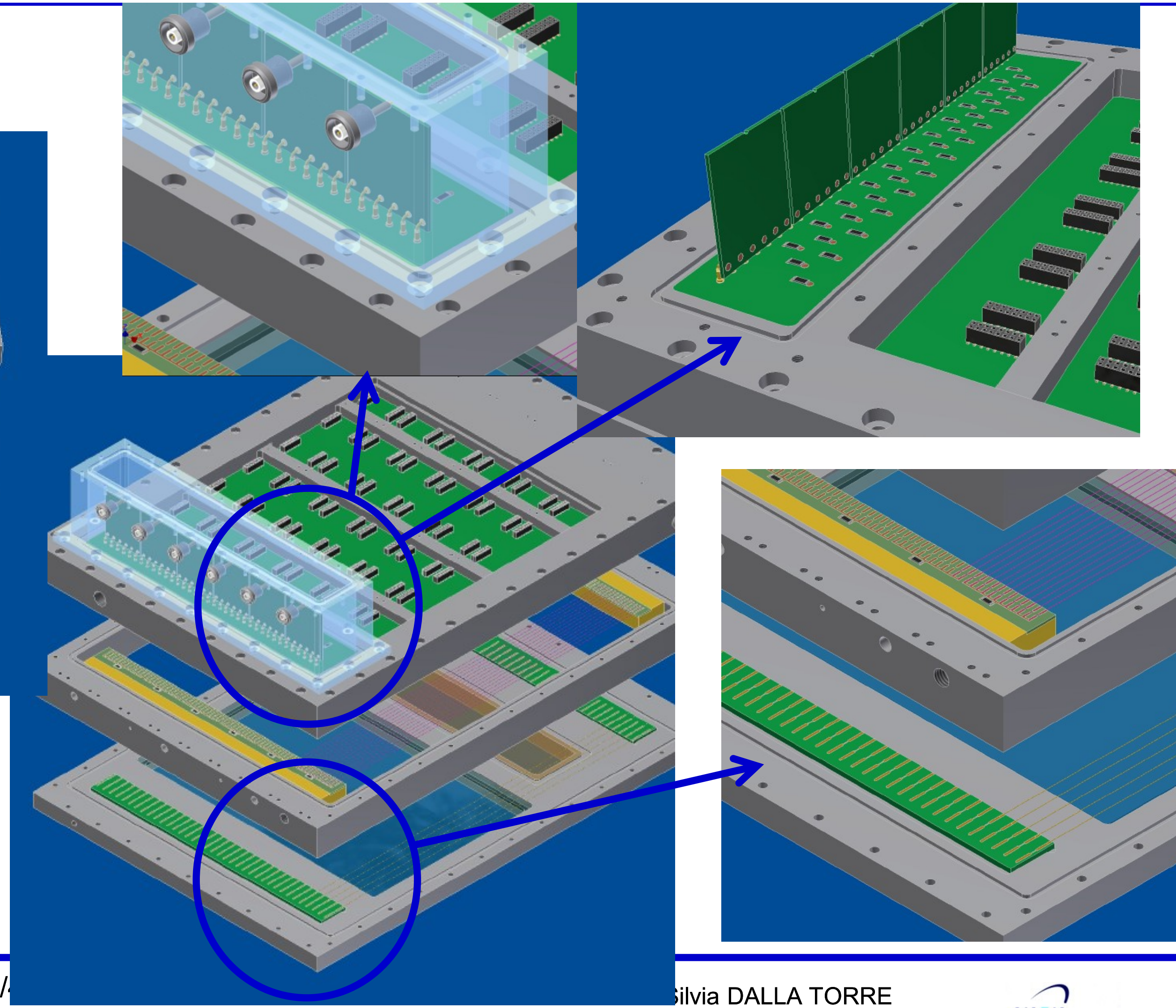


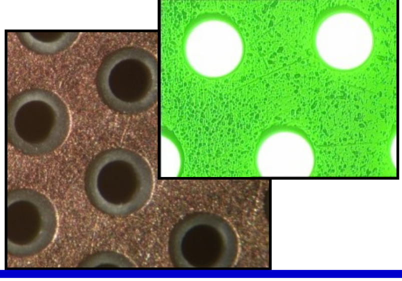


300 x 300 mm^2 PROTOTYPE, in progress 2/4

Some details

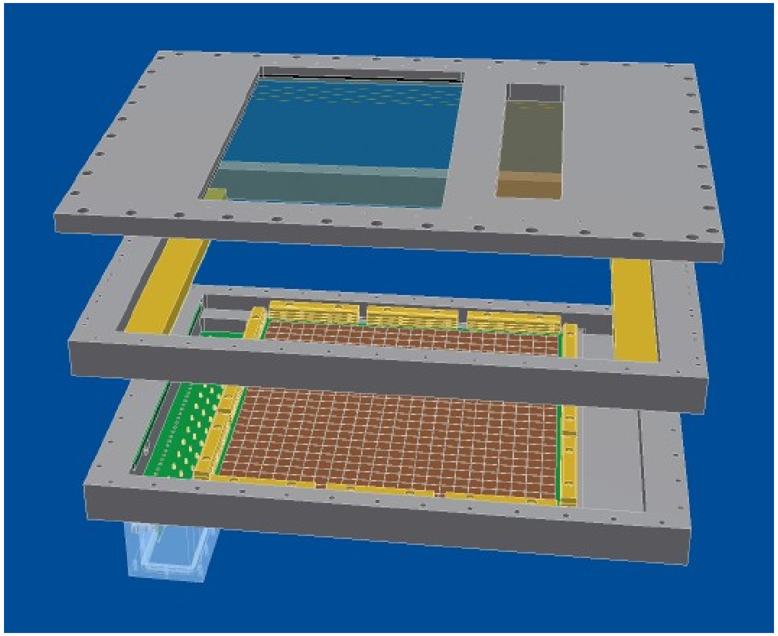


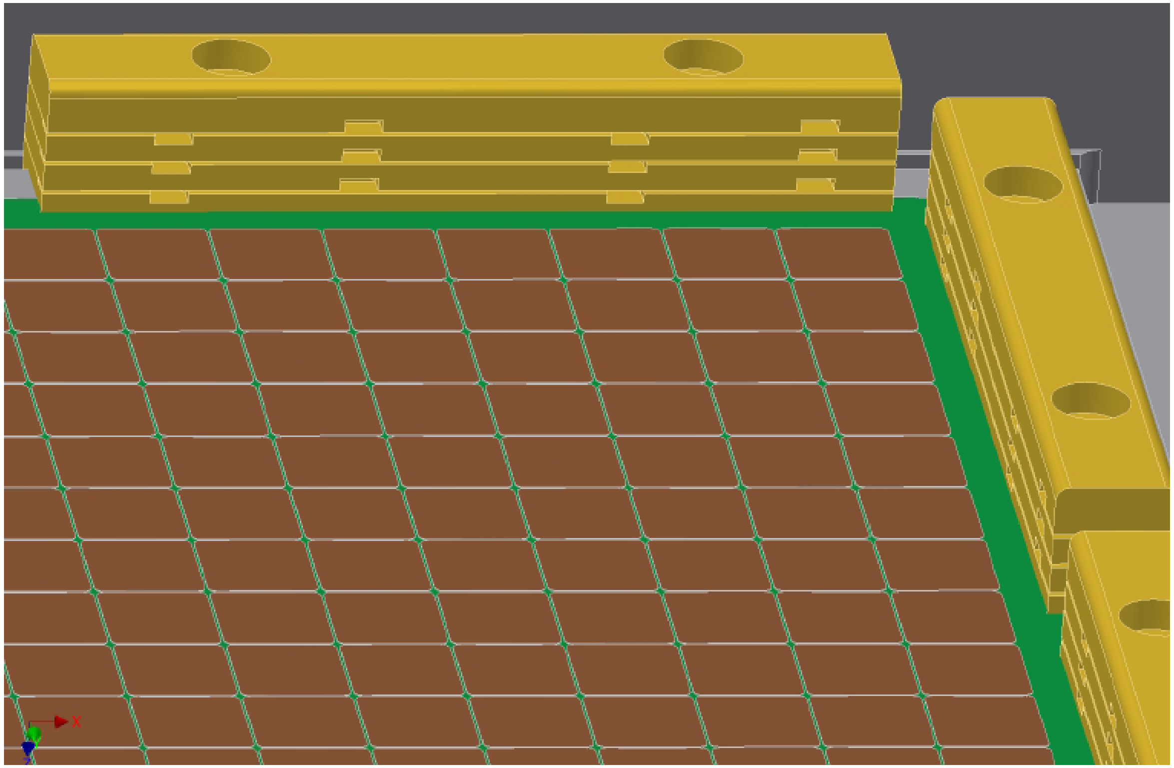


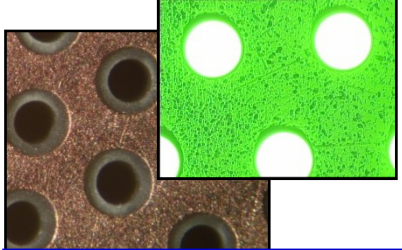


$300 \times 300\ mm^2$ PROTOTYPE, in progress 3/4

more details







300 x 300 mm^2 PROTOTYPE, in progress 4/4

Some pictures