THGEM production progress from Trieste + CERN + ELTOS

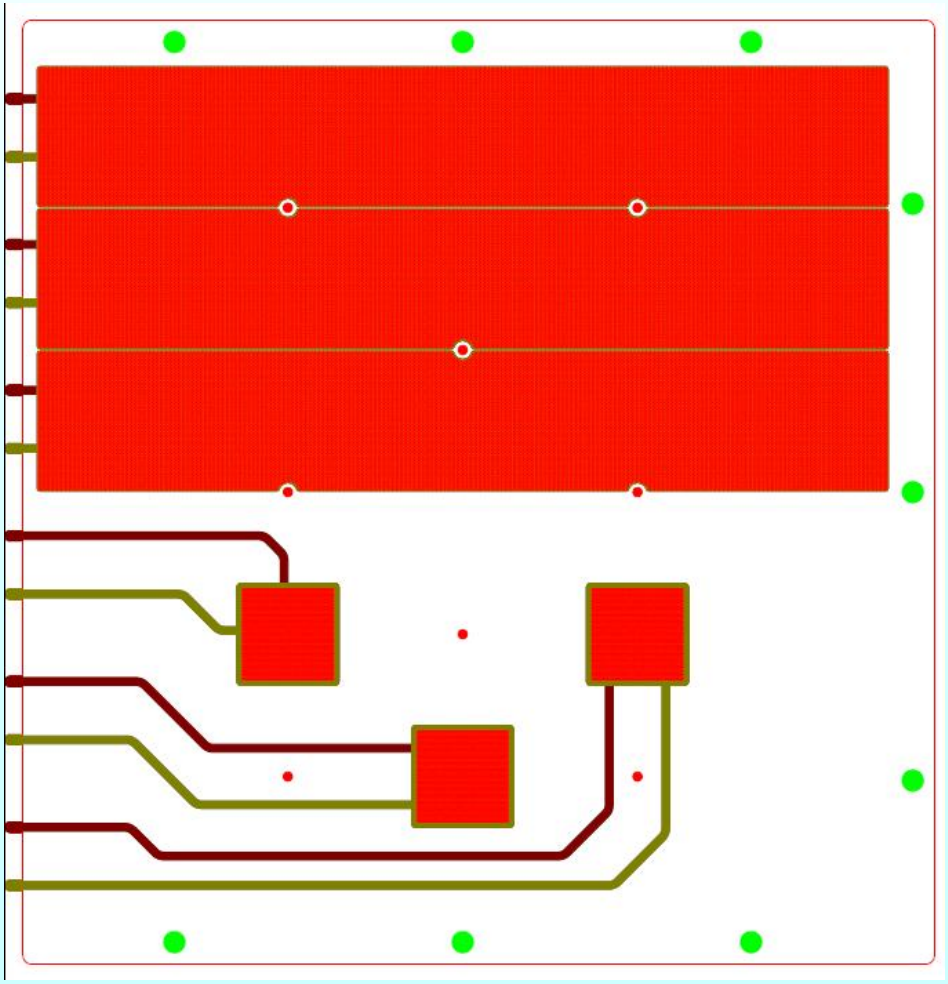
Fulvio Tessarotto

Large THGEM behavior at Test Beam

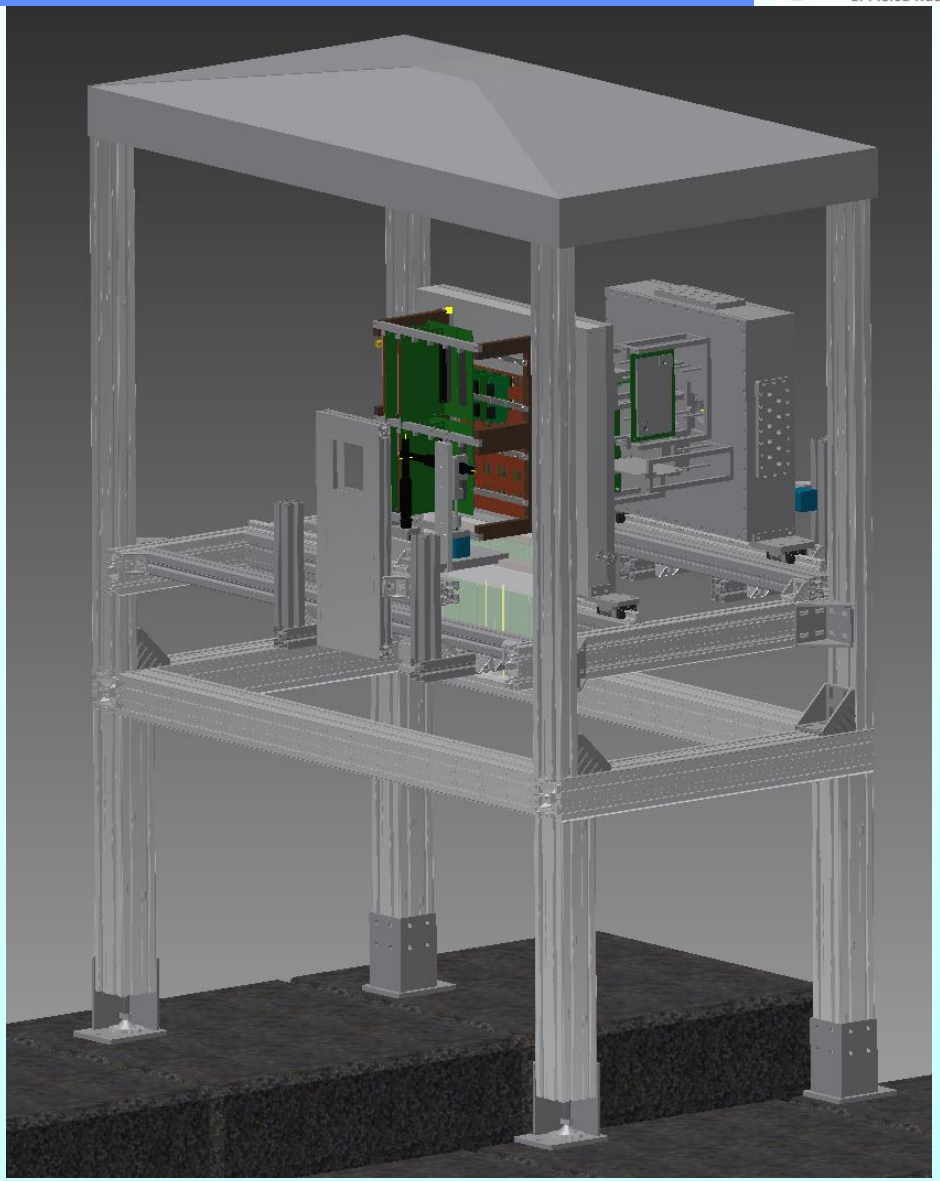
The polyurethane coating

The thickness tolerances

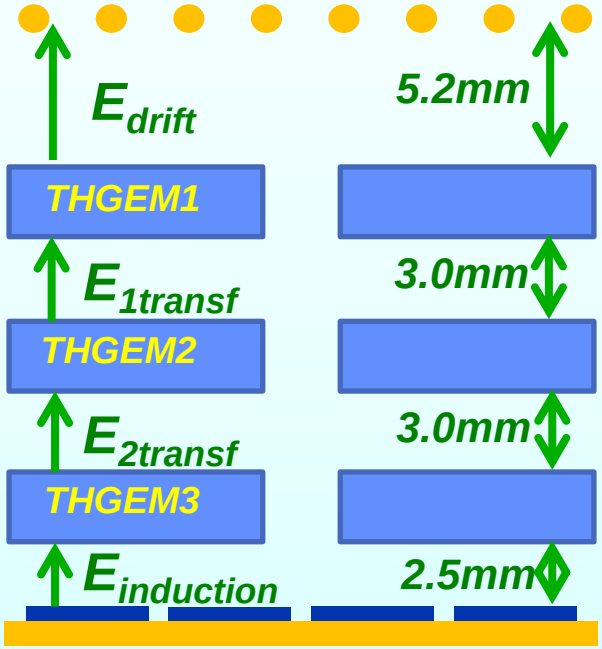
Plans for improvements

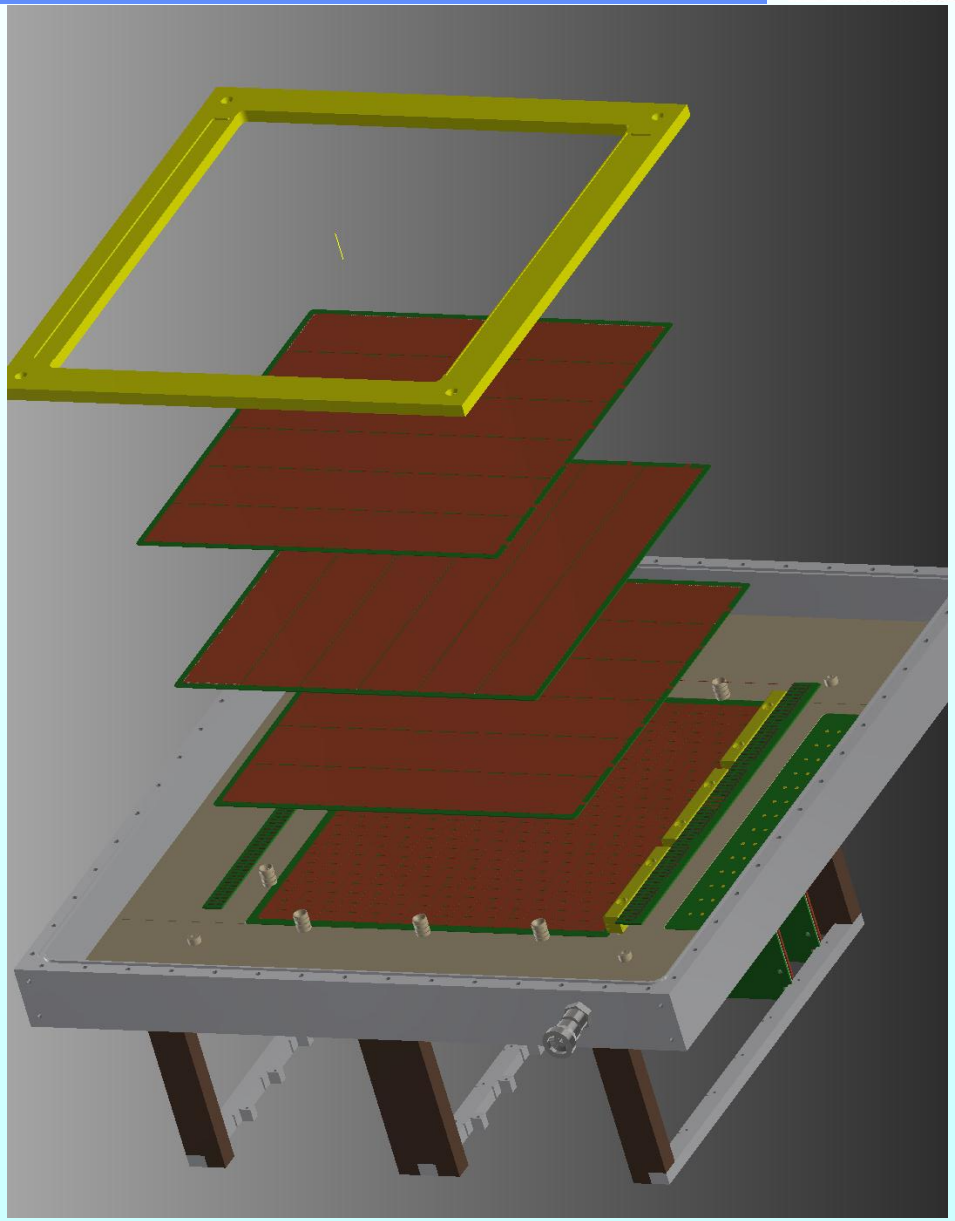


Set-up at T10



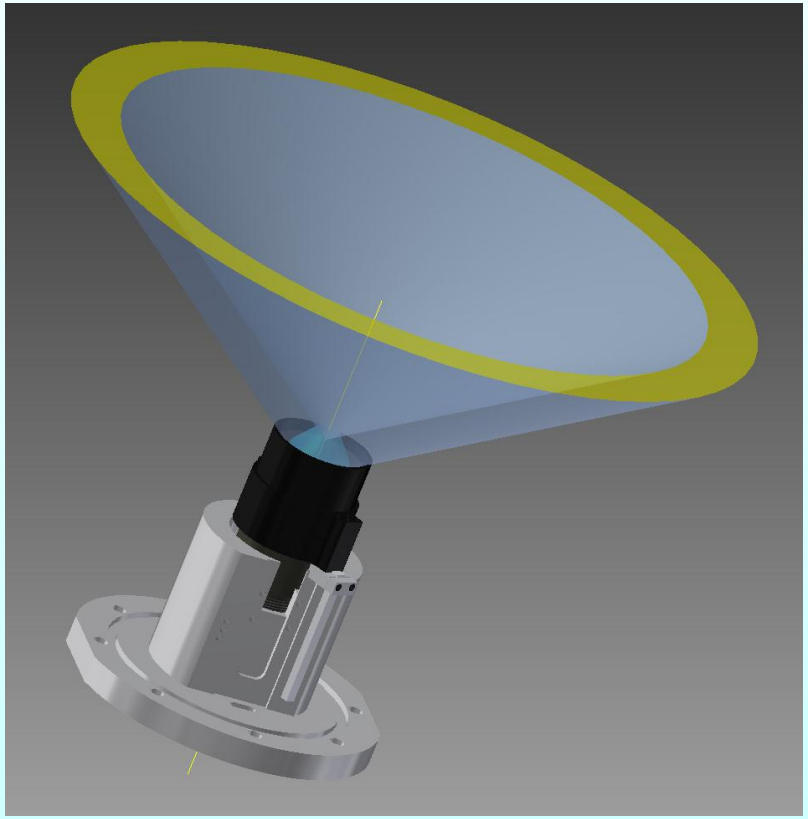
Triple THGEM 300 mm x 300 mm

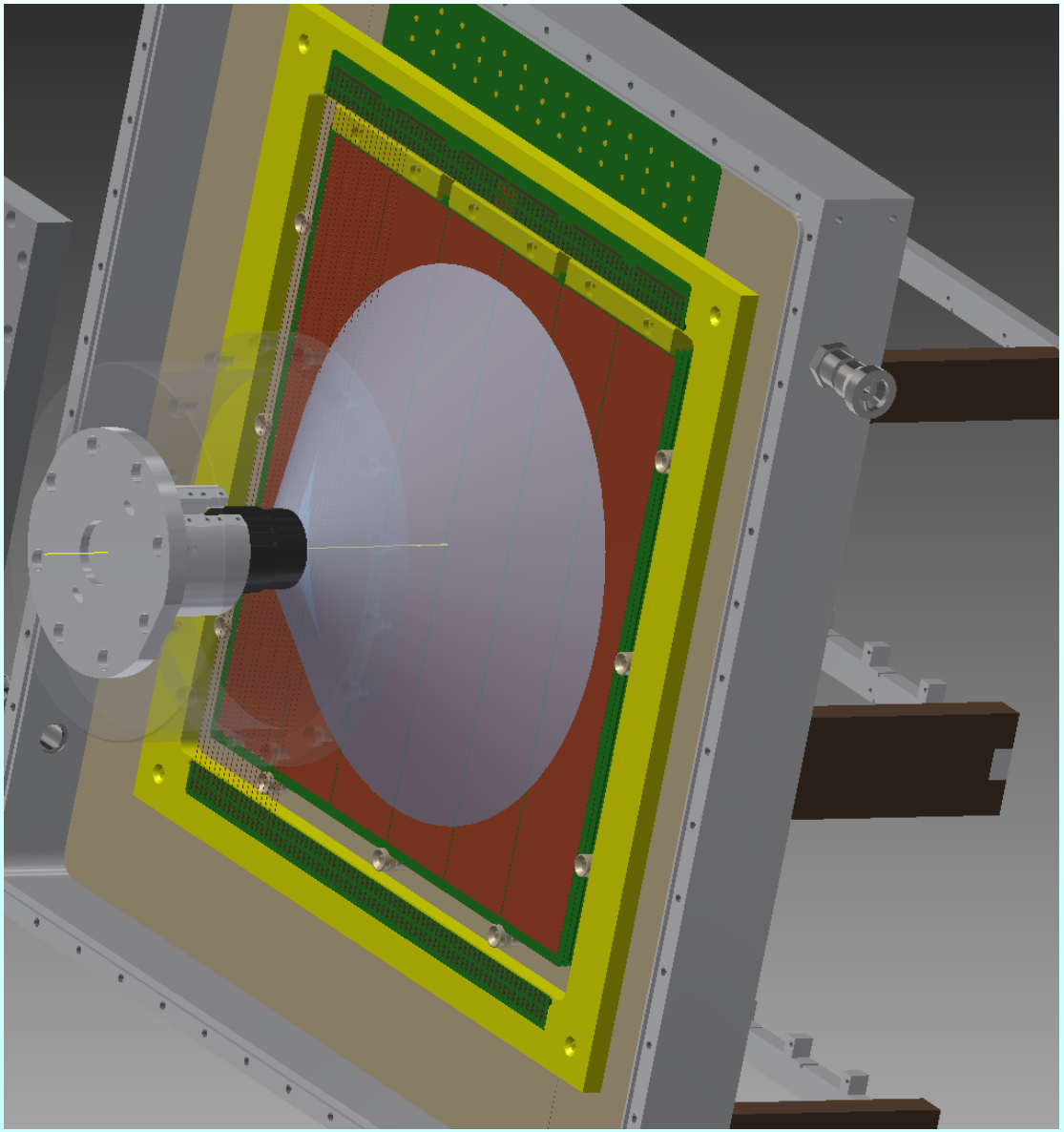




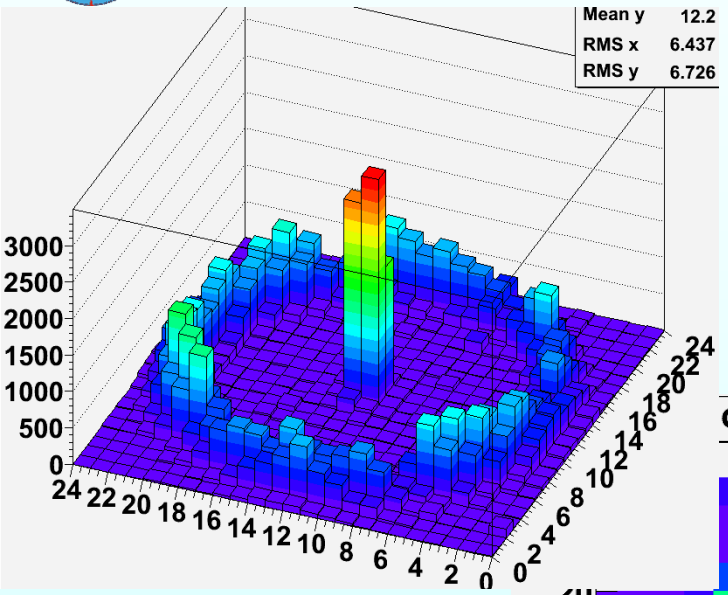
Layer	Pitch / mm	$Ø_{hole}$ / mm	Thickness / mm	RIM / µm
THGEM1	0.8	0.4	0.4	< 5
THGEM2	0.8	0.4	0.8	< 5
THGEM3	0.8	0.4	0.8	< 5

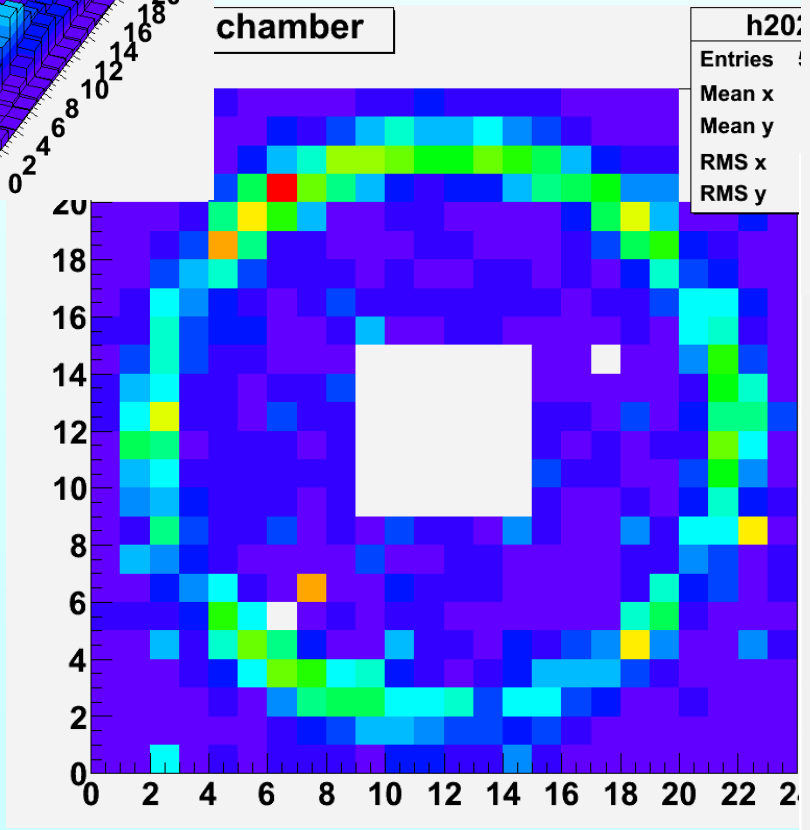
Conical fused silica radiator

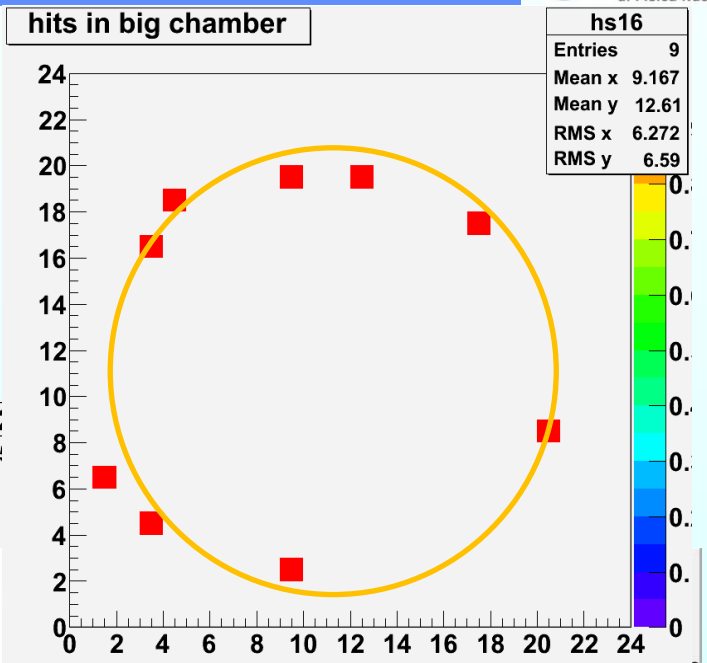


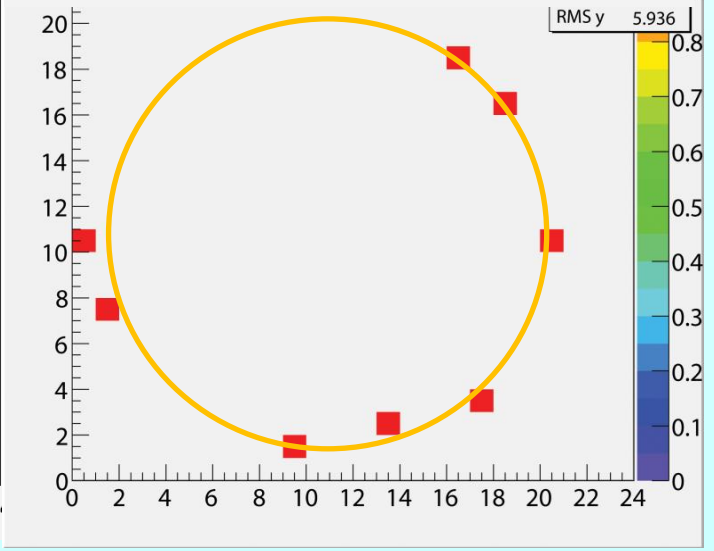


Nice rings

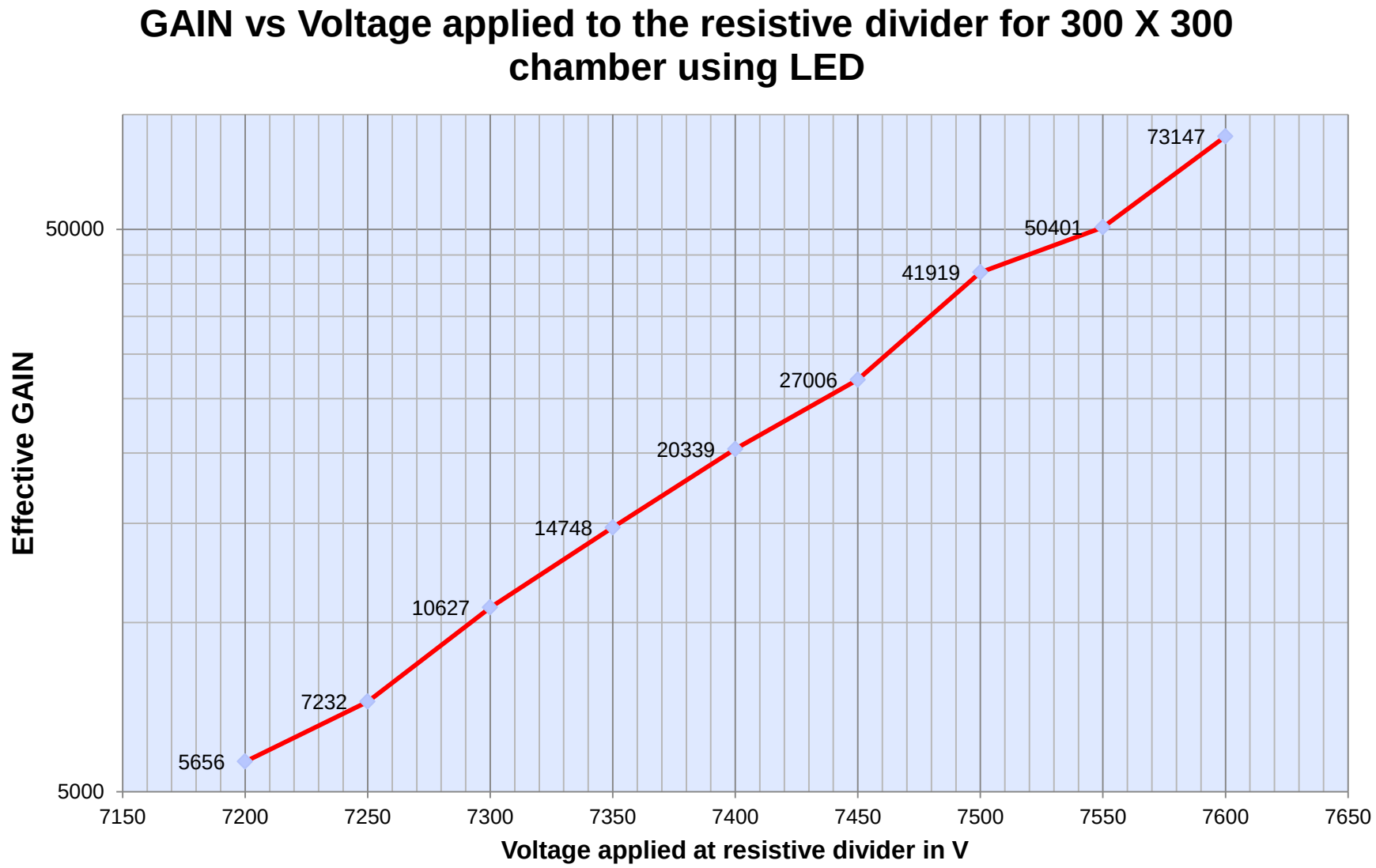

Mean y 12.2
RMS x 6.437
RMS y 6.726


chamber
h20
Entries
Mean x
Mean y
RMS x
RMS y

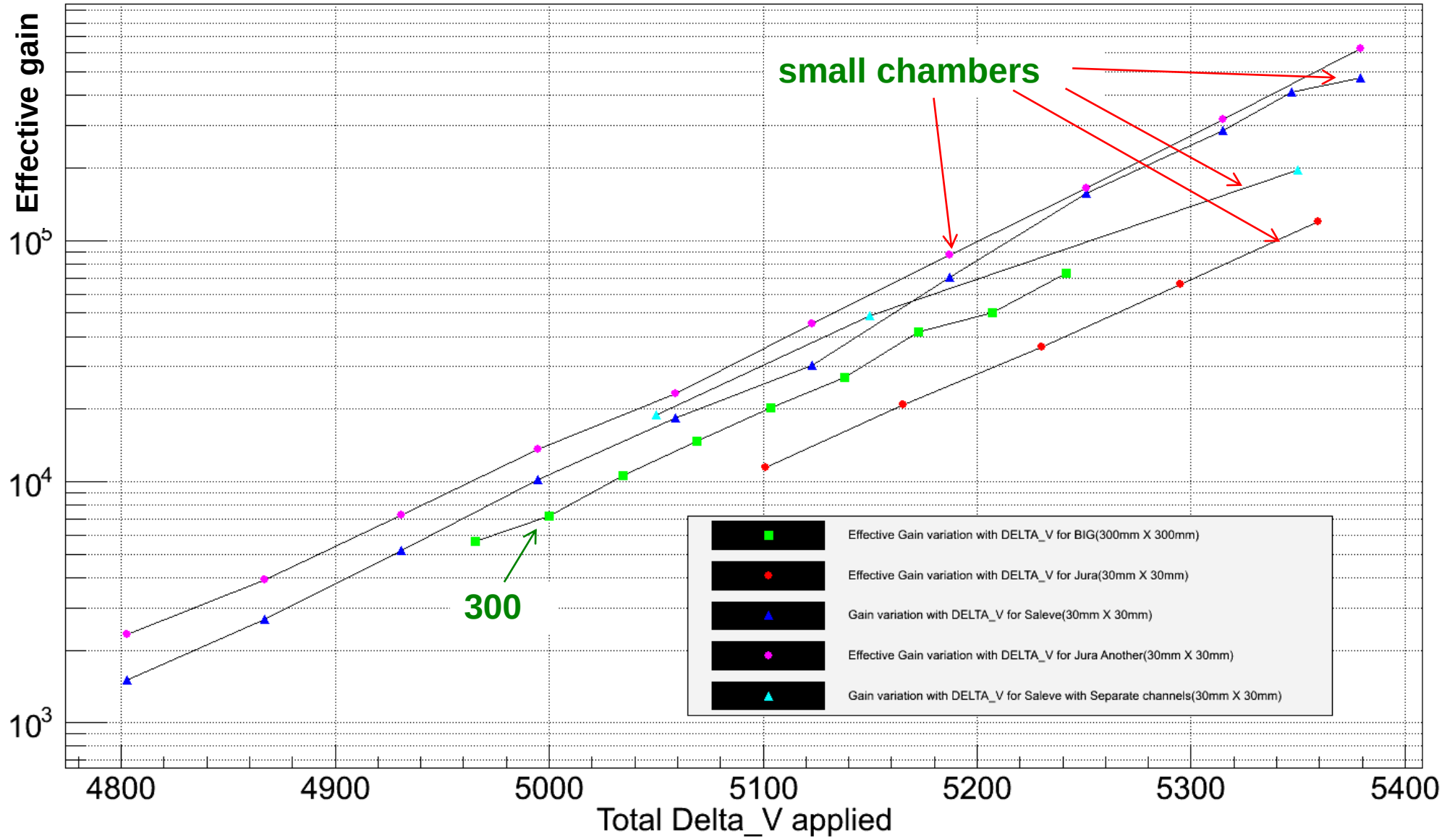

hits in big chamber
hs16
Entries 9
Mean x 9.167
Mean y 12.61
RMS x 6.272
RMS y 6.59


RMS y 5.936

Gain of the 300 at Test Beam

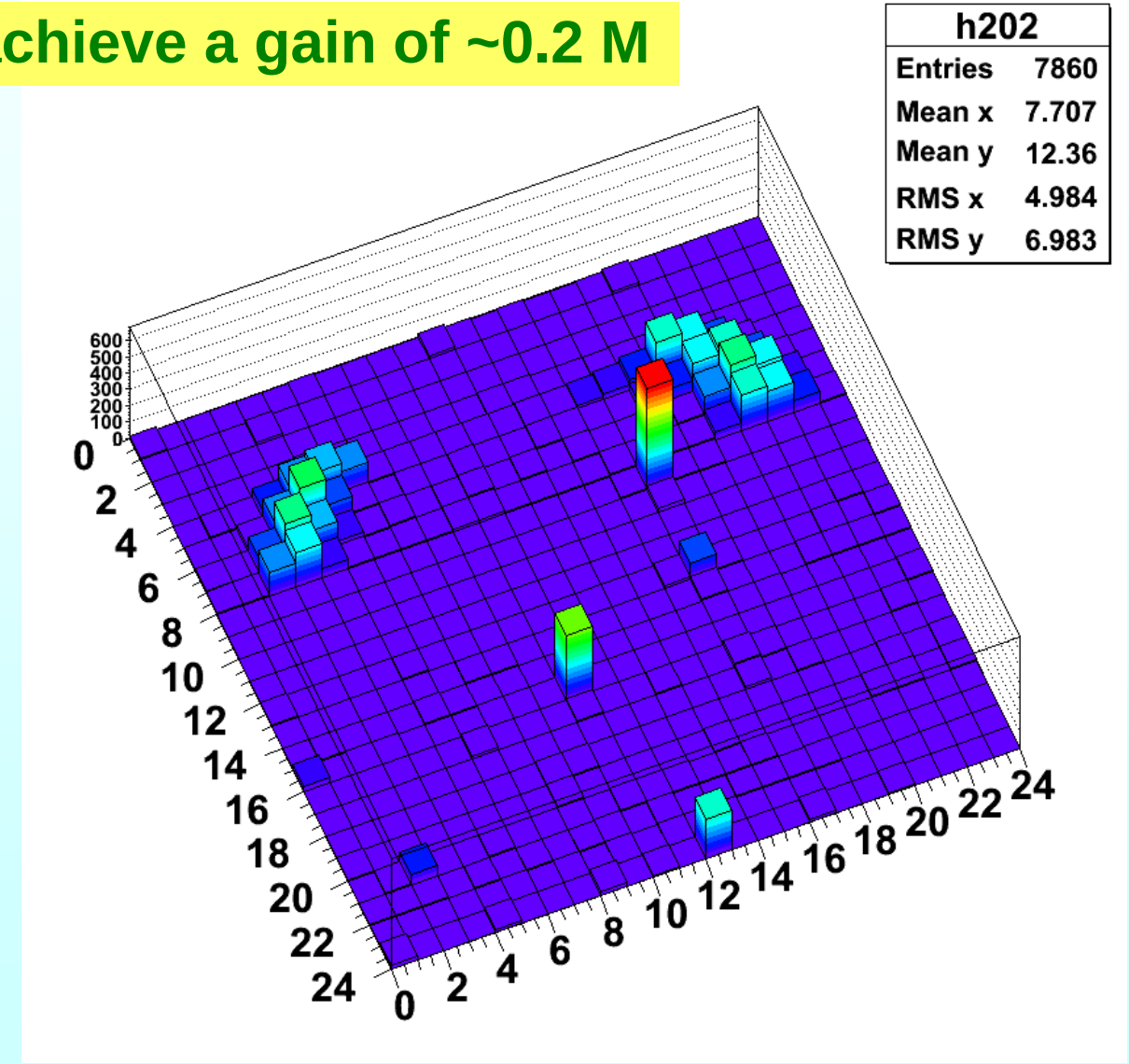


Effective gain of THGEMs



Operating one sector only

we could achieve a gain of ~0.2 M

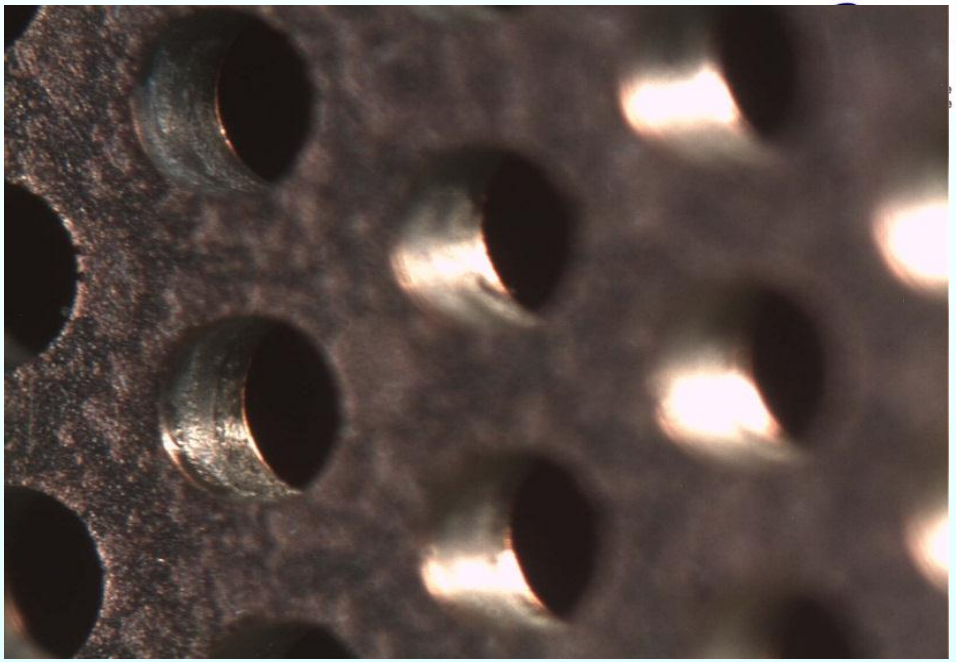


PU Coating

THGEMs used in the Test Beam: **Active area: 300 x 300 mm²**

Layer	Pitch / mm	$Ø_{hole}$ / mm	Thickness / mm	RIM / µm
THGEM1	0.8	0.4	0.4	< 5
THGEM2	0.8	0.4	0.8	< 5
THGEM3	0.8	0.4	0.8	< 5

PCB material: Panasonic R-1566



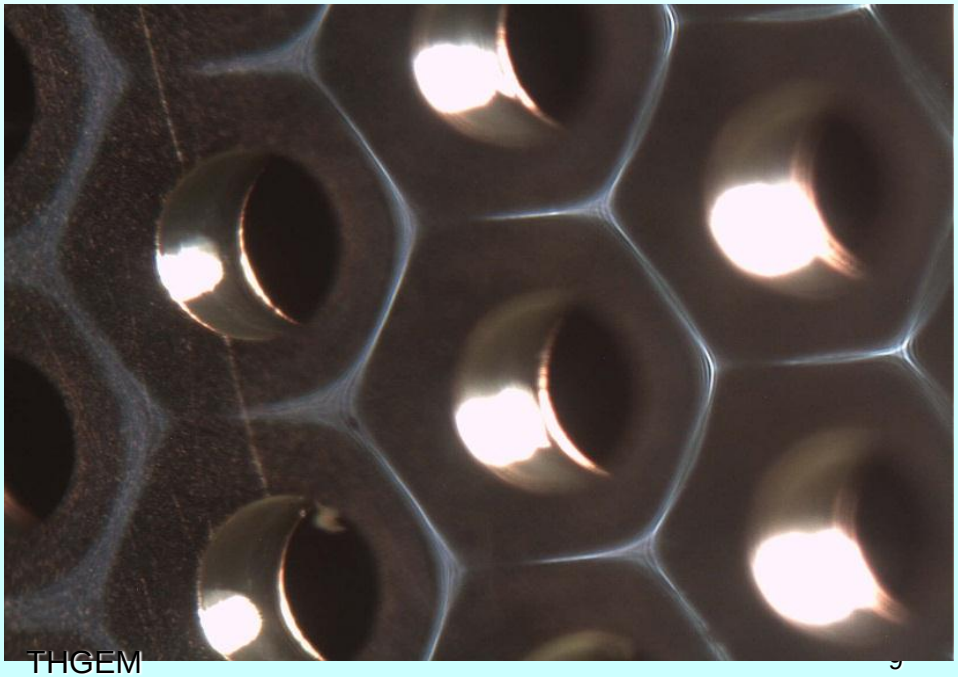
Produced by ELTOS; treated by Rui.

THGEM1: After cleaning: breakdown voltage is around 1600 V (Paschen ~ 2200 V for 0.4mm).

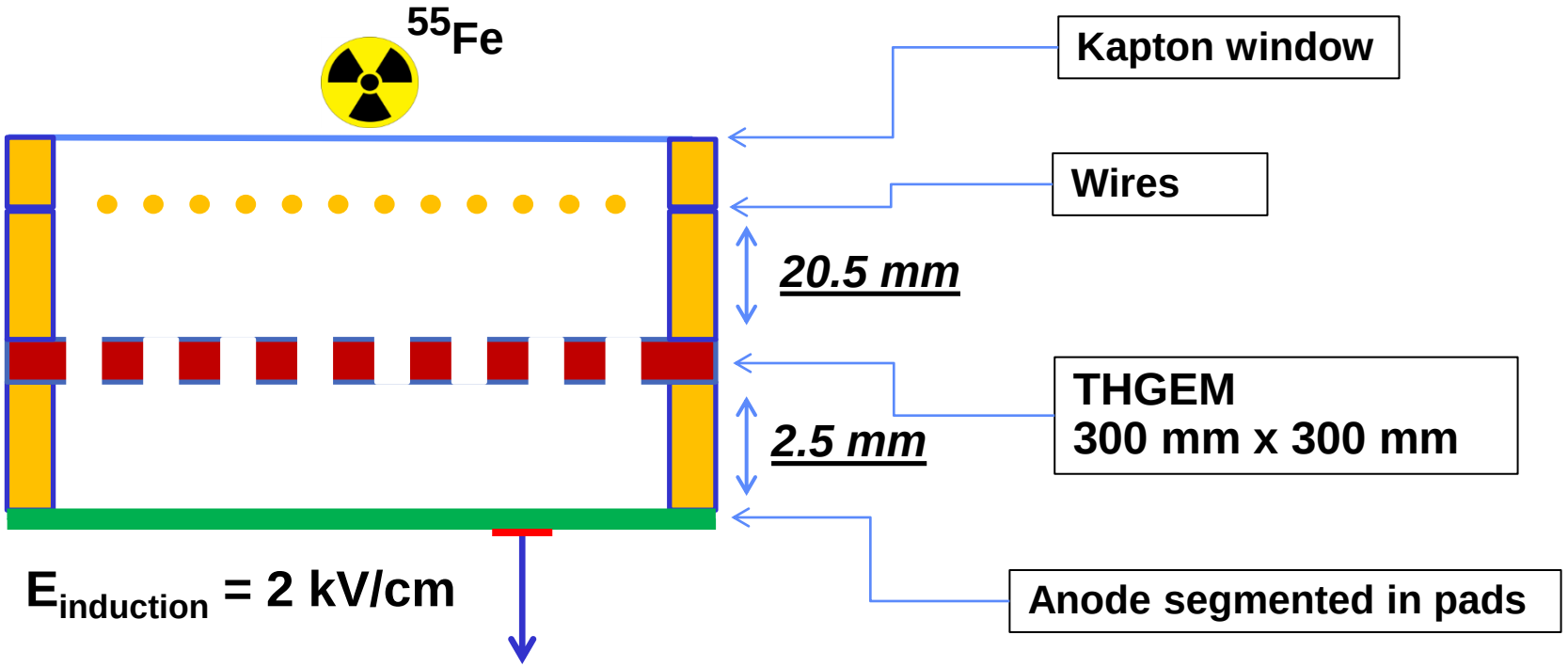
Rui does apply a polyurethane coating.

After polyurethane deposit the breakdown voltage is almost 2.2 on all sectors.

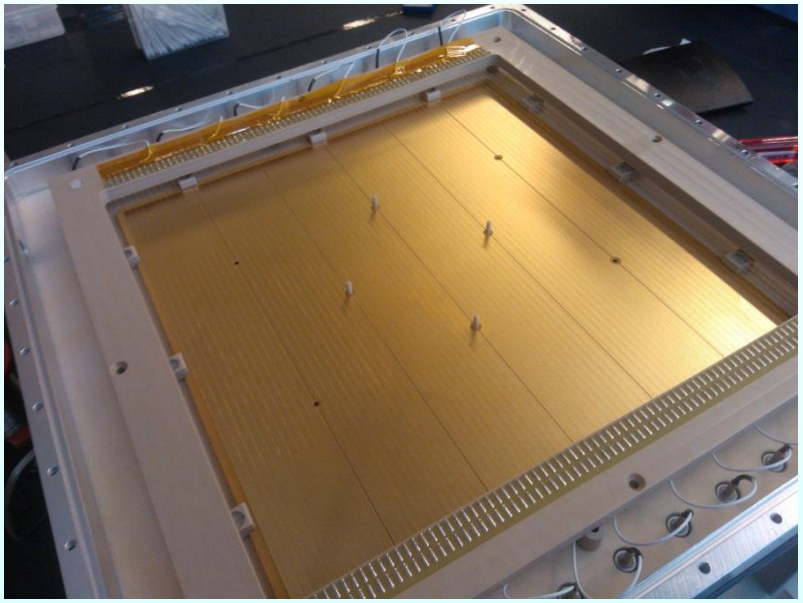
After Au coating, the THGEM breakdown voltage is slightly reduced: 2.1 to 2.15 kV.

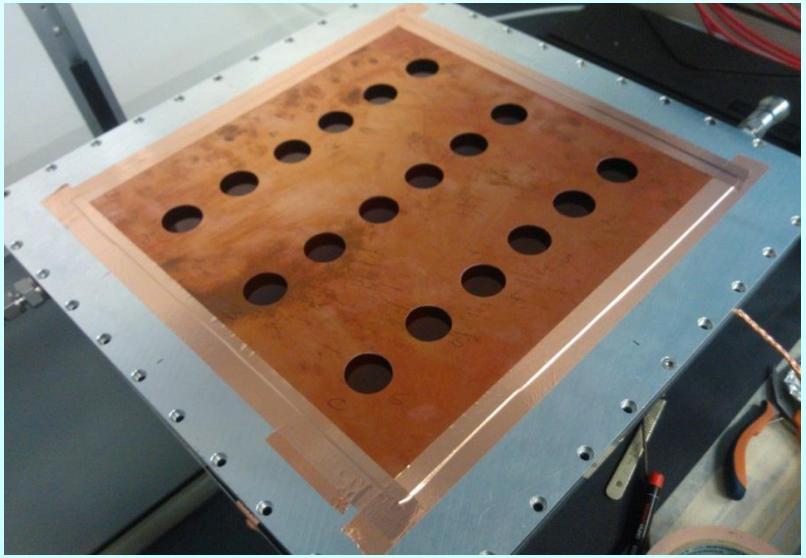


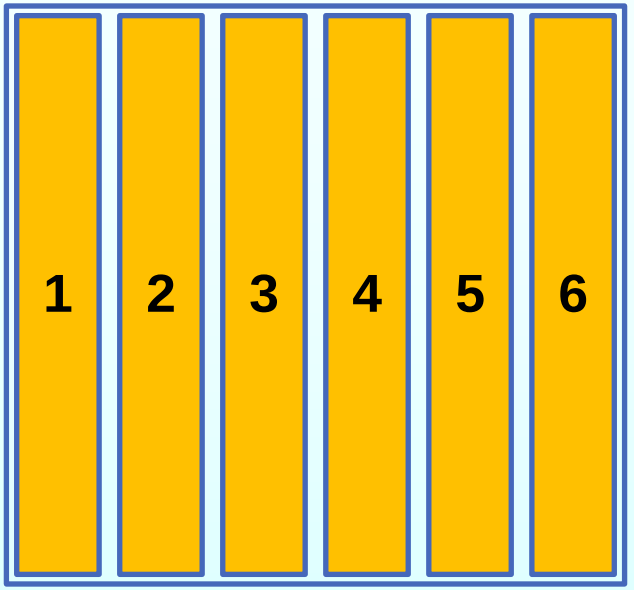
Setup for characterization in single



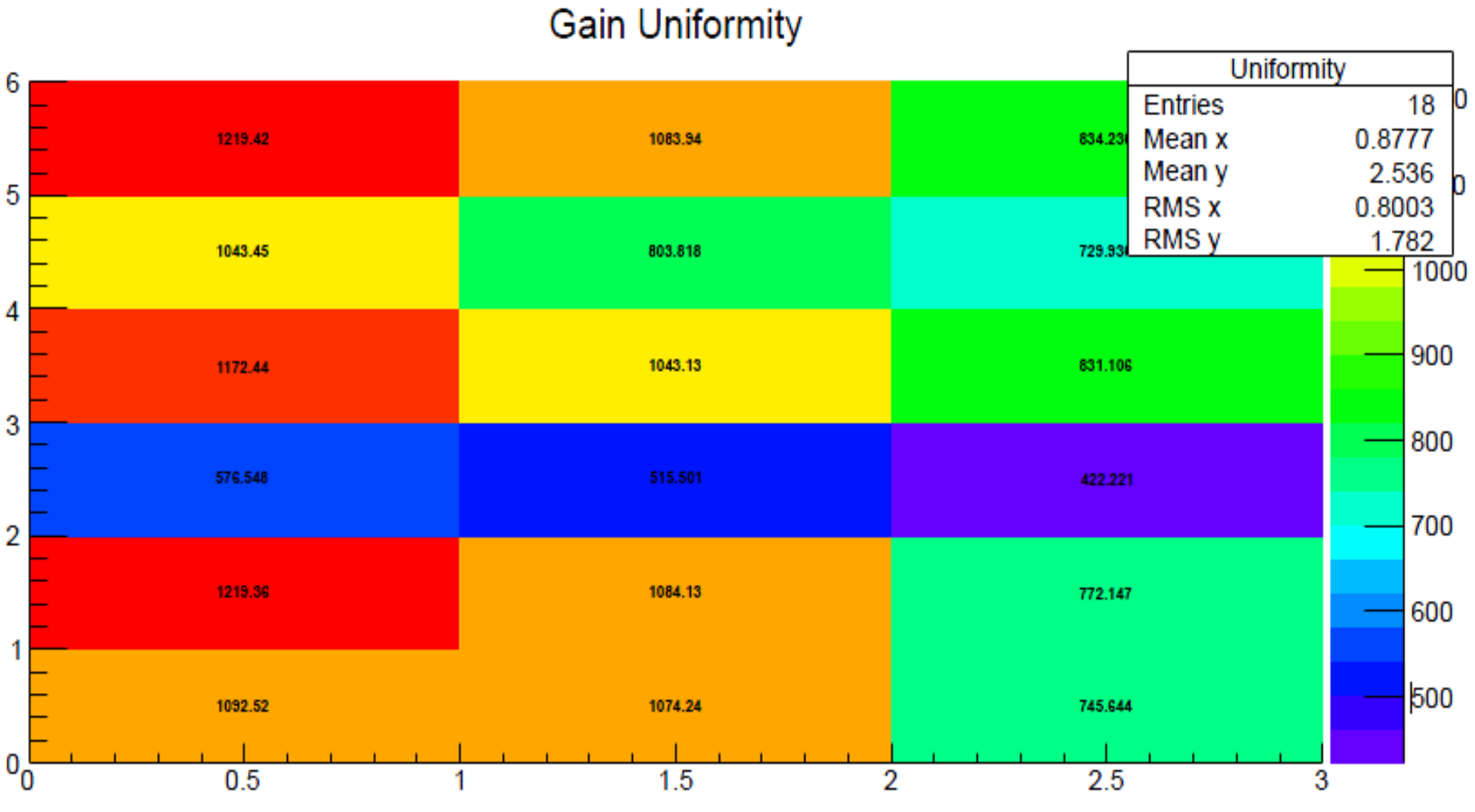
Local characterization of the sectors





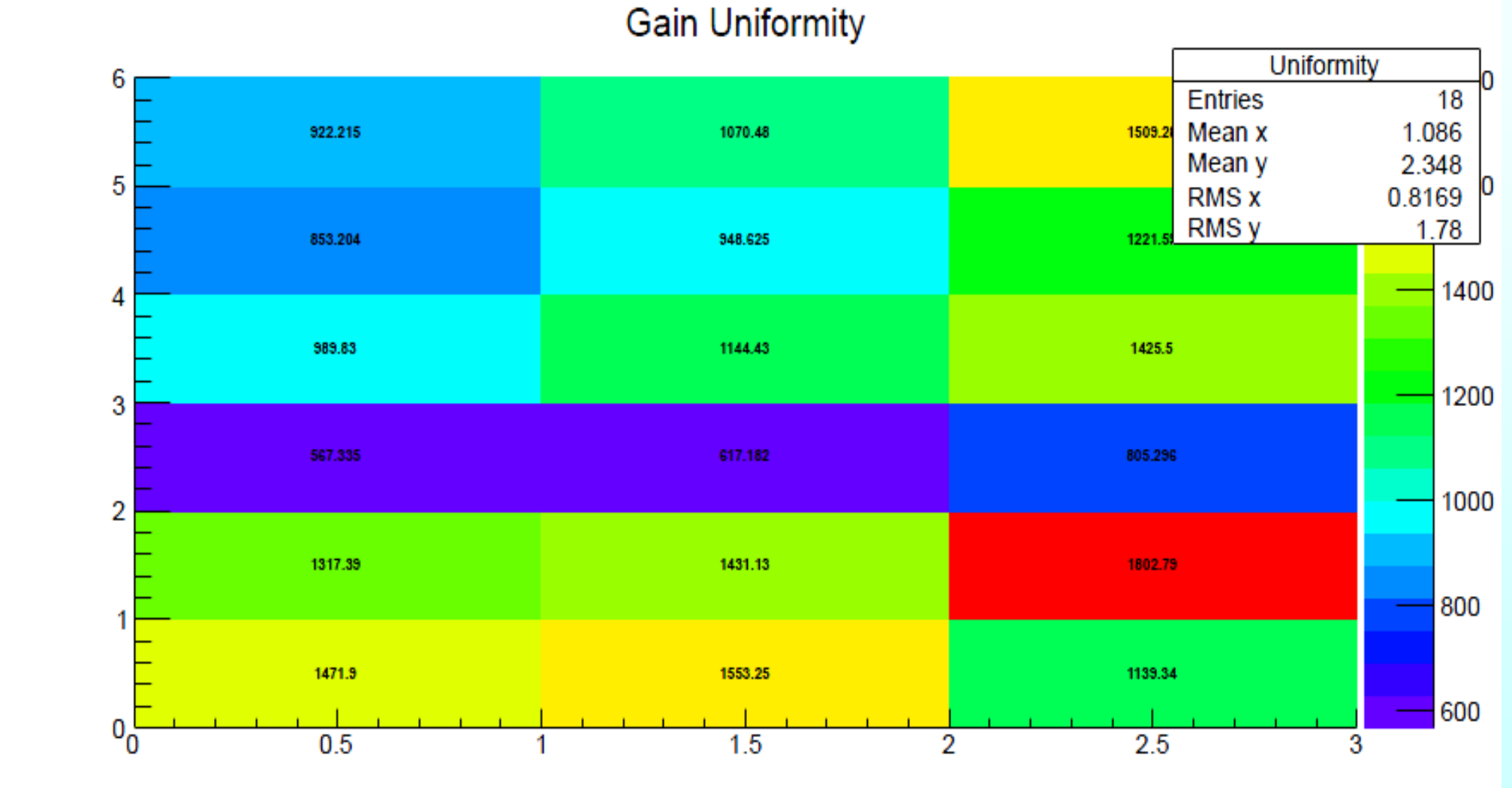


Gain uniformity for THGEM 2



$\Delta V = 2200$ V **Max** $\Delta V = 2200$ V

Gain uniformity for THGEM 3



Thickness survey of "Isola" pcb material

After the Test Beam we decided to investigate the thickness tolerances of the pcb raw material

We did cut ~80 pieces (375mm x 350 mm) at CERN using the Isola DURAVER 156 material (belonging to Rui de Olivera)

(ISOLA UL-NO,E41625 IPC 4101 DURAVER E-CV 156ML-L-92-0610-H1/H1-B-B-4280414)

We built a measuring tool and surveyed all pieces

Thickness specifications

Isola DURAVER 156 technical data sheet:

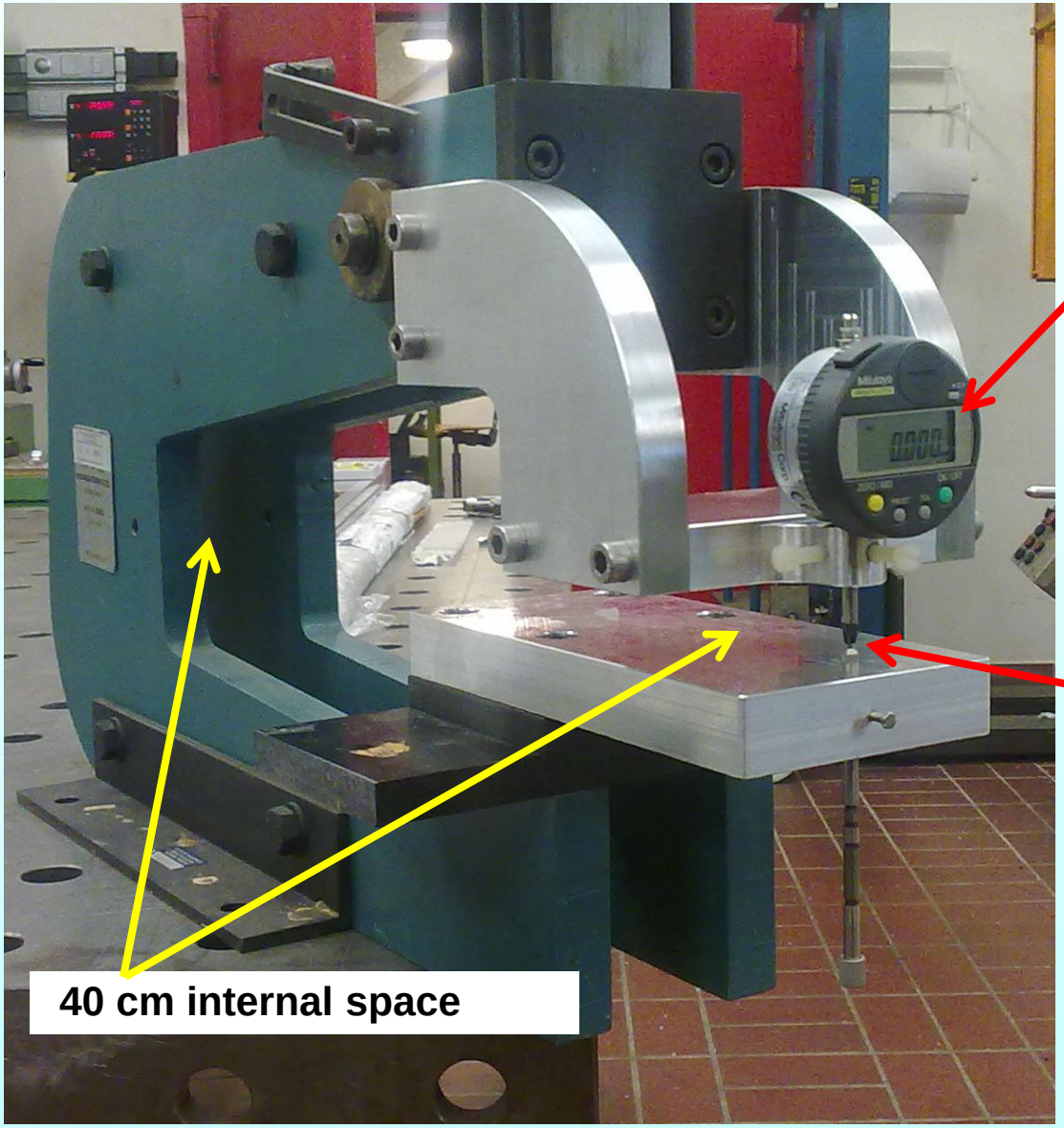
DURAVER®-E-Cu quality 156 ML Standard Laminate Constructions

Nominal thickness		Thickness tolerances		Construction	Mean resin content
		IPC-4101A cl. B	IPC-4101A cl. C		
mm	inch	mm	mm		%
0.050	0.002	± 0.018	± 0.013	1 x 106	74
0.075	0.003	± 0.018	± 0.013	1 x 1080	63
0.100	0.004	± 0.018	± 0.013	1 x 2116	45
0.125	0.005	± 0.025	± 0.018	1 x 2165	49
0.150	0.006	± 0.025	± 0.018	1 x 2157	45
0.200	0.008	± 0.038	± 0.025	1 x 7628M	44
0.250	0.010	± 0.038	± 0.025	2 x 2165	49
0.300	0.012	± 0.050	± 0.038	2 x 2157	45
0.360	0.014	± 0.050	± 0.038	2 x 7628M	39
0.410	0.016	± 0.050	± 0.038	2 x 7628M	44
0.460	0.018	± 0.050	± 0.038	1 x 7628 + 1 x 2125 + 1 x 7628	42
0.510	0.020	± 0.064	± 0.050	3 x 7628	39
0.710	0.028	± 0.064	± 0.050	4 x 7628M	39
0.900	0.035	± 0.100	± 0.075	5 x 7628M	39

For the IPC-4101A class C nominal th. 0.410 a "15%" variation is within tol.

ISOLA UL-NO,E41625 IPC 4101 DURAVER E-CV 156ML-L-92-0610-H1/H1-B-B-4280414

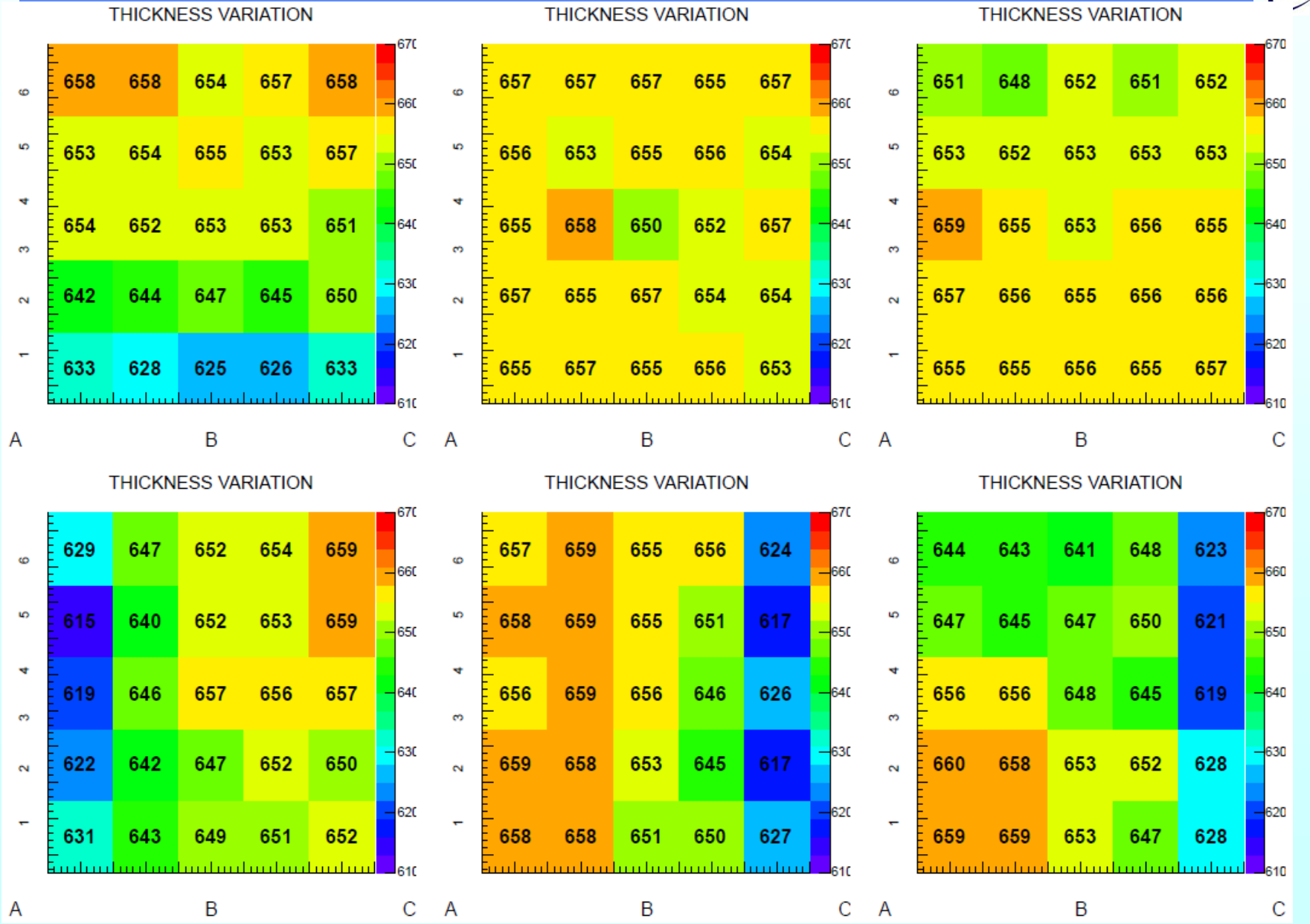
Thickness measurement tool



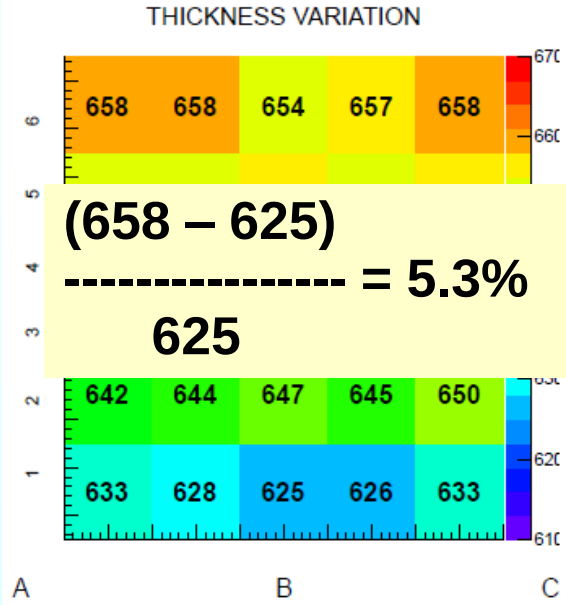
Mitutoyo digital micrometer

“aligned” sphere to sphere contact: the THGEM is inserted here and the upper sphere is lower down until it touches the piece.

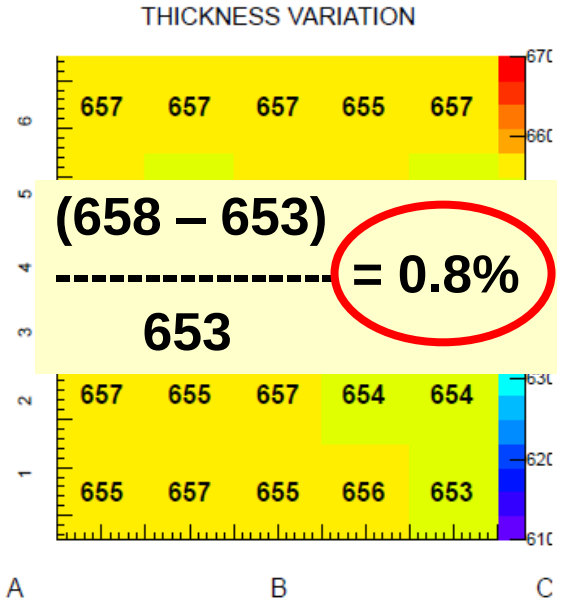
25 points/piece (reading in microns)



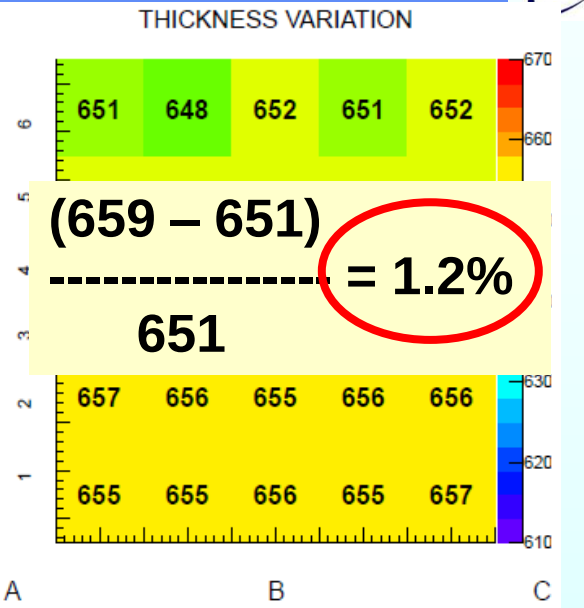
Relative variations are quite different



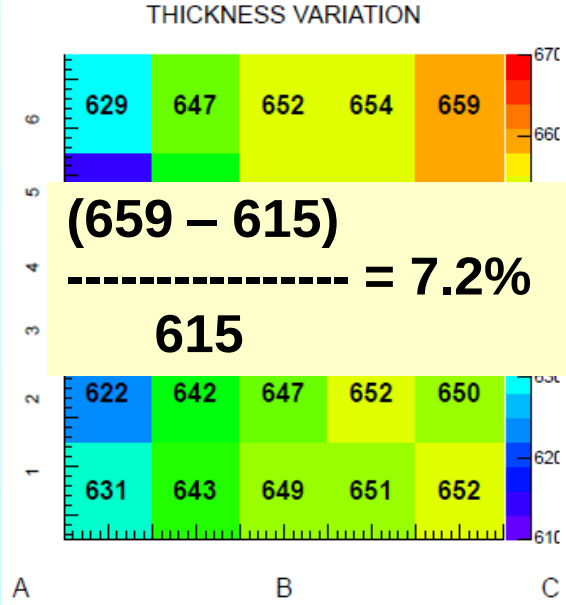
$$\frac{(658 - 625)}{625} = 5.3\%$$



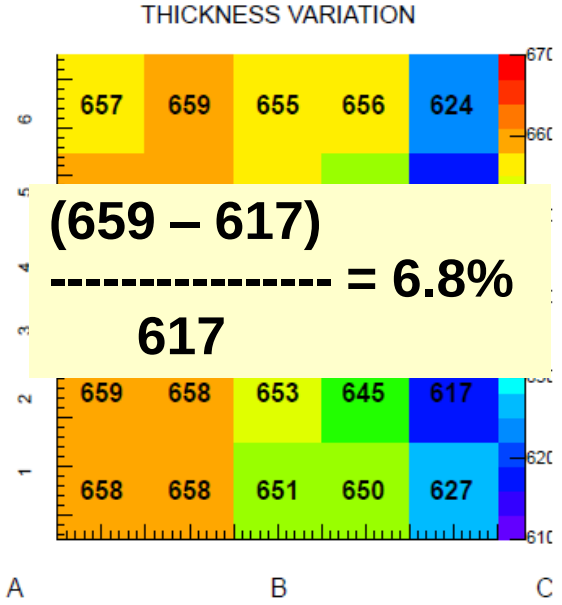
$$\frac{(658 - 653)}{653} = 0.8\%$$



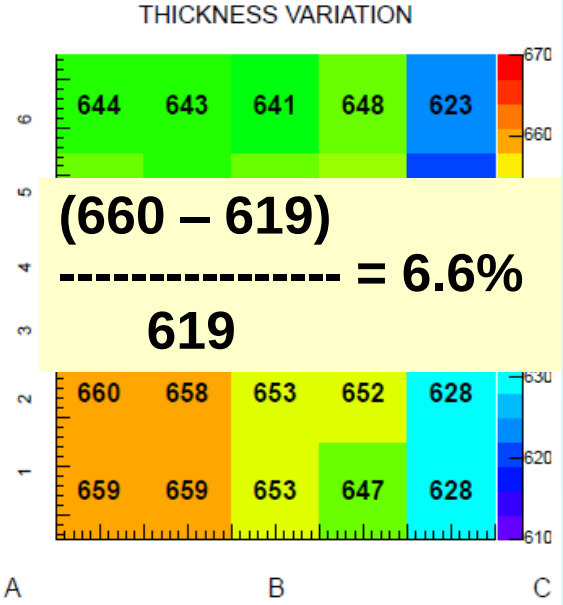
$$\frac{(659 - 651)}{651} = 1.2\%$$



$$\frac{(659 - 615)}{615} = 7.2\%$$



$$\frac{(659 - 617)}{617} = 6.8\%$$



$$\frac{(660 - 619)}{619} = 6.6\%$$

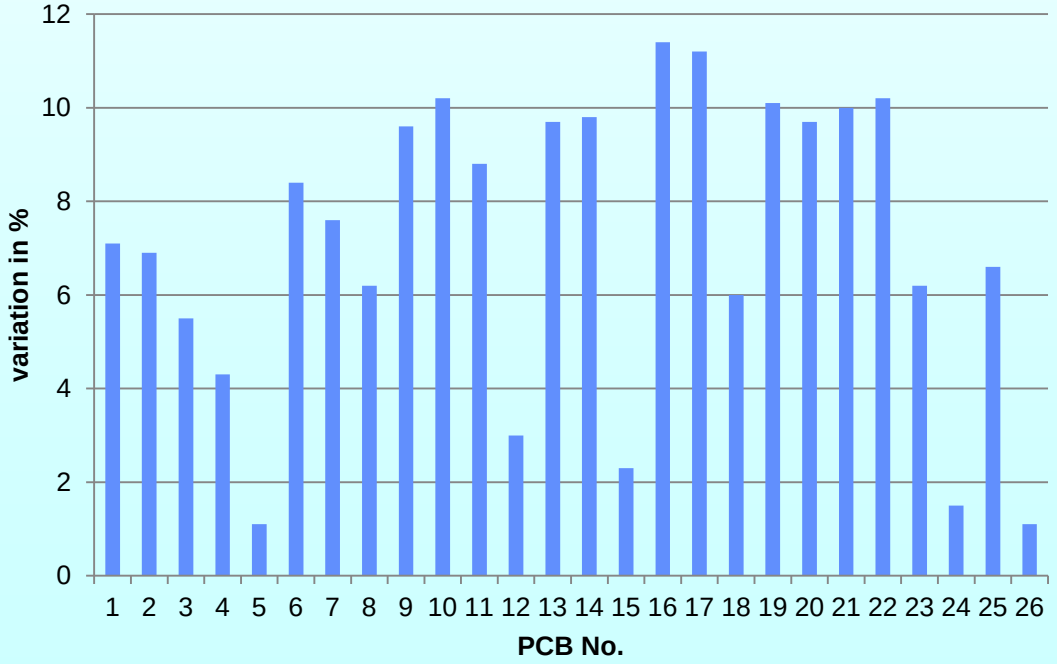
Thickness measurement results

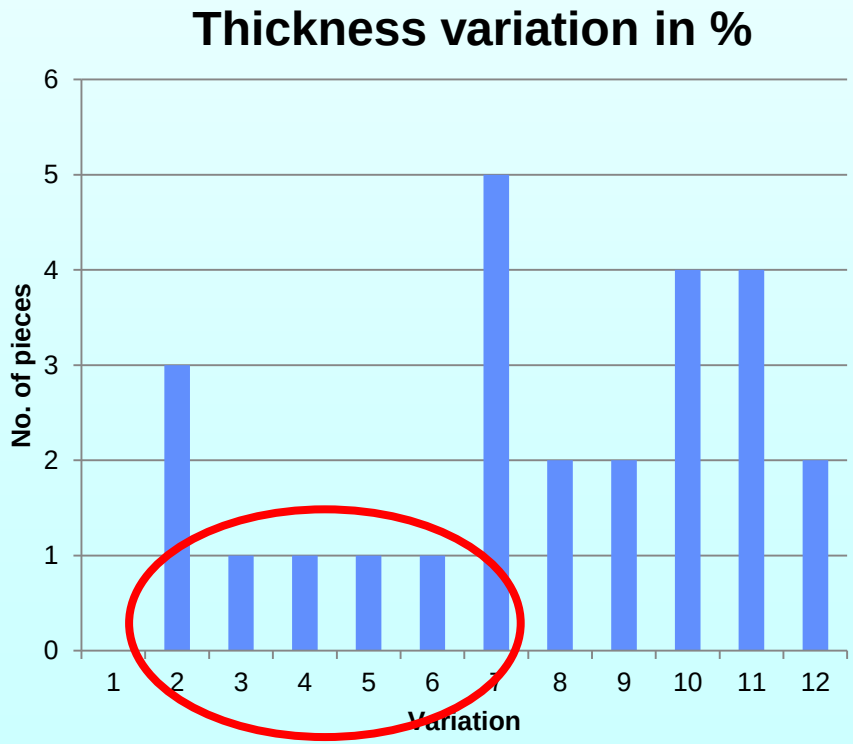
We did cut ~80 pieces (375mm x 350 mm) at CERN using the Isola DURAVER 156 material (belonging to Rui de Olivera)

27 pieces of 0.4 mm thickness have been "measured"

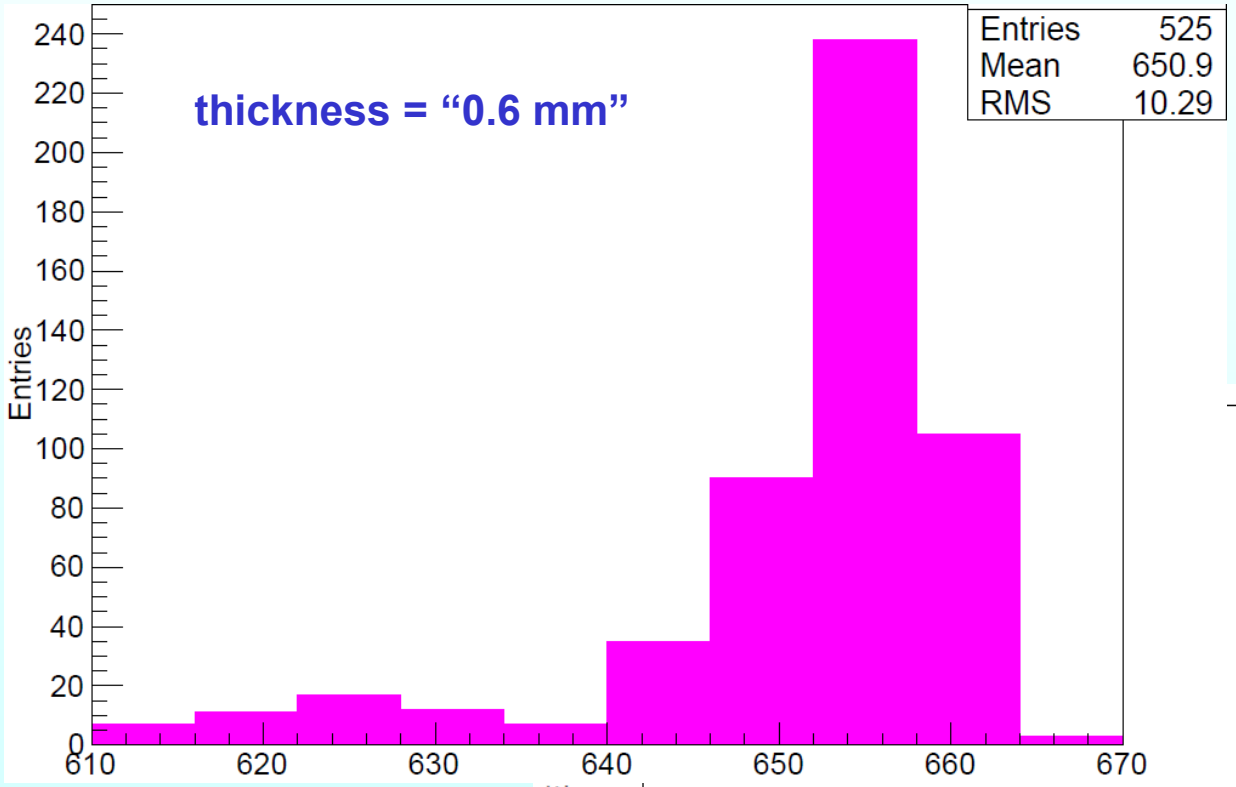
Selected pieces have been sent to ELTOS for new THGEM production

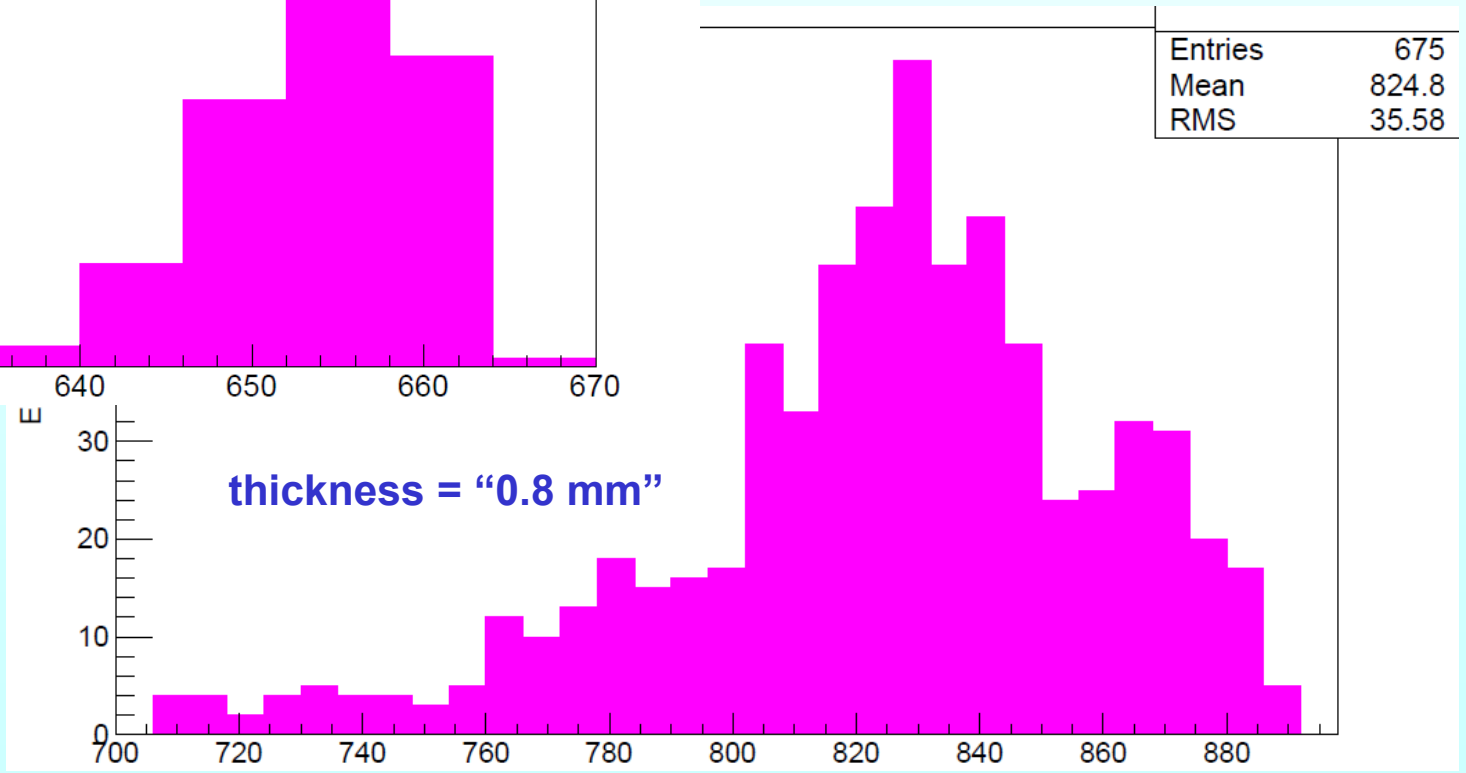
maximum thickness variation in %



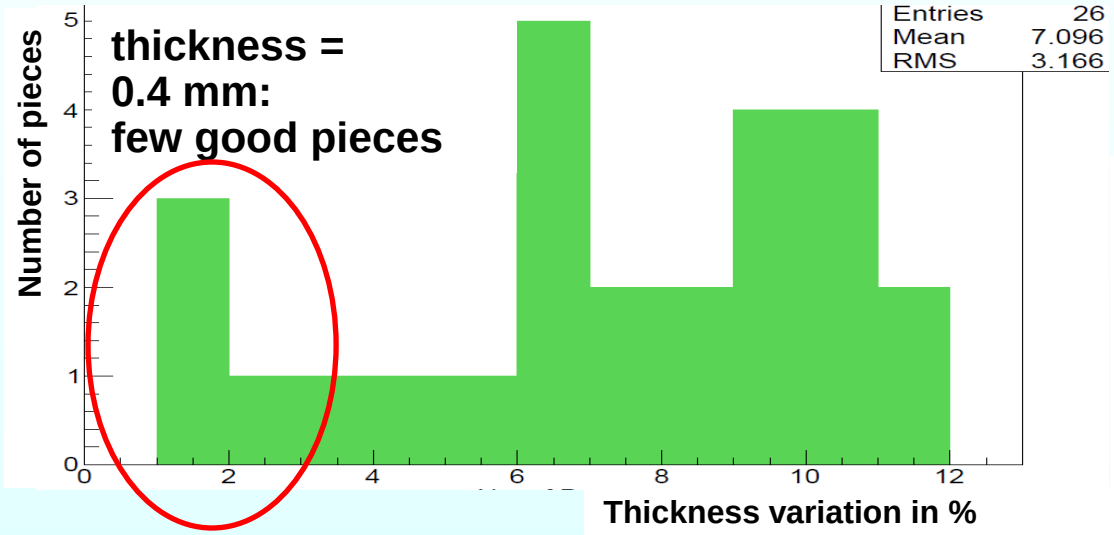


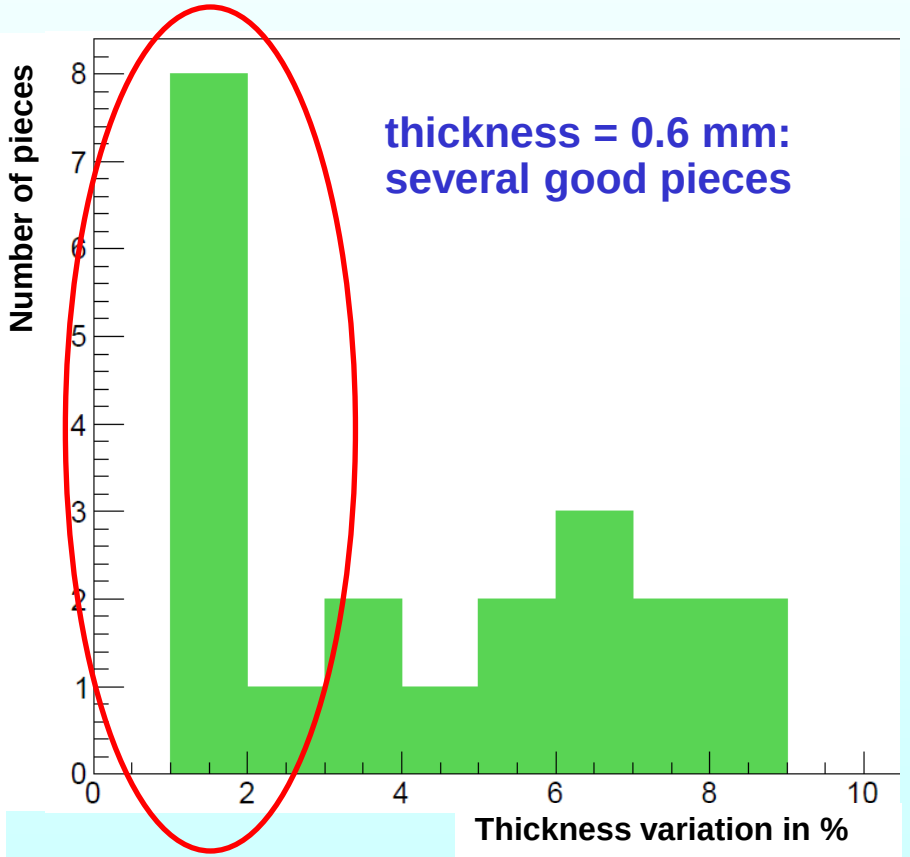
Thickness histogram

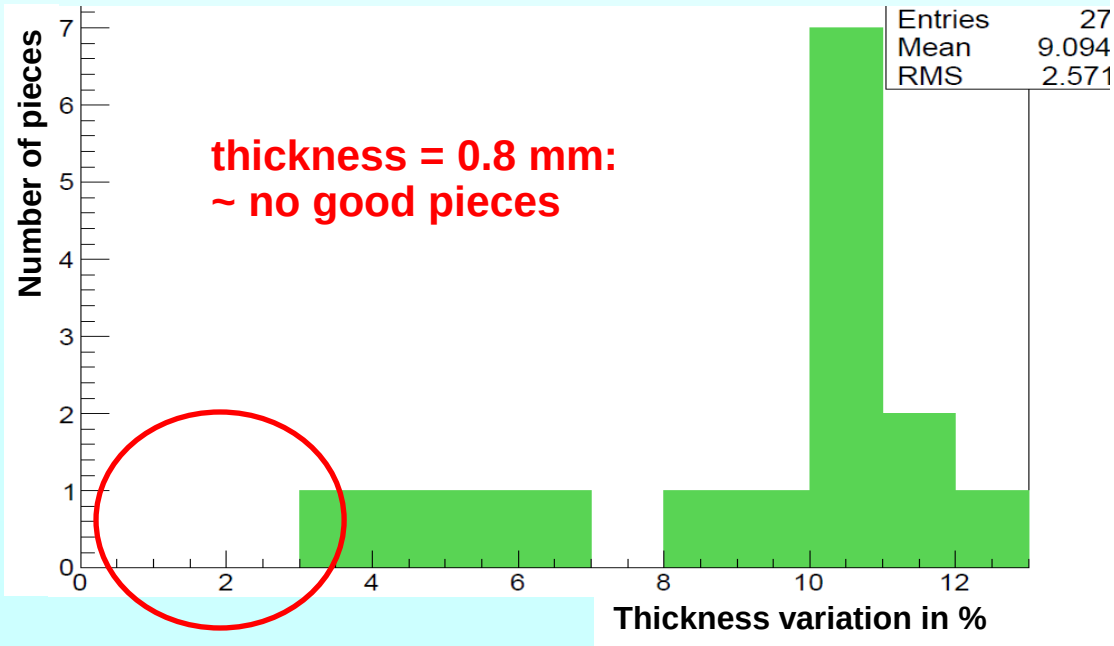




Thickness relative variation



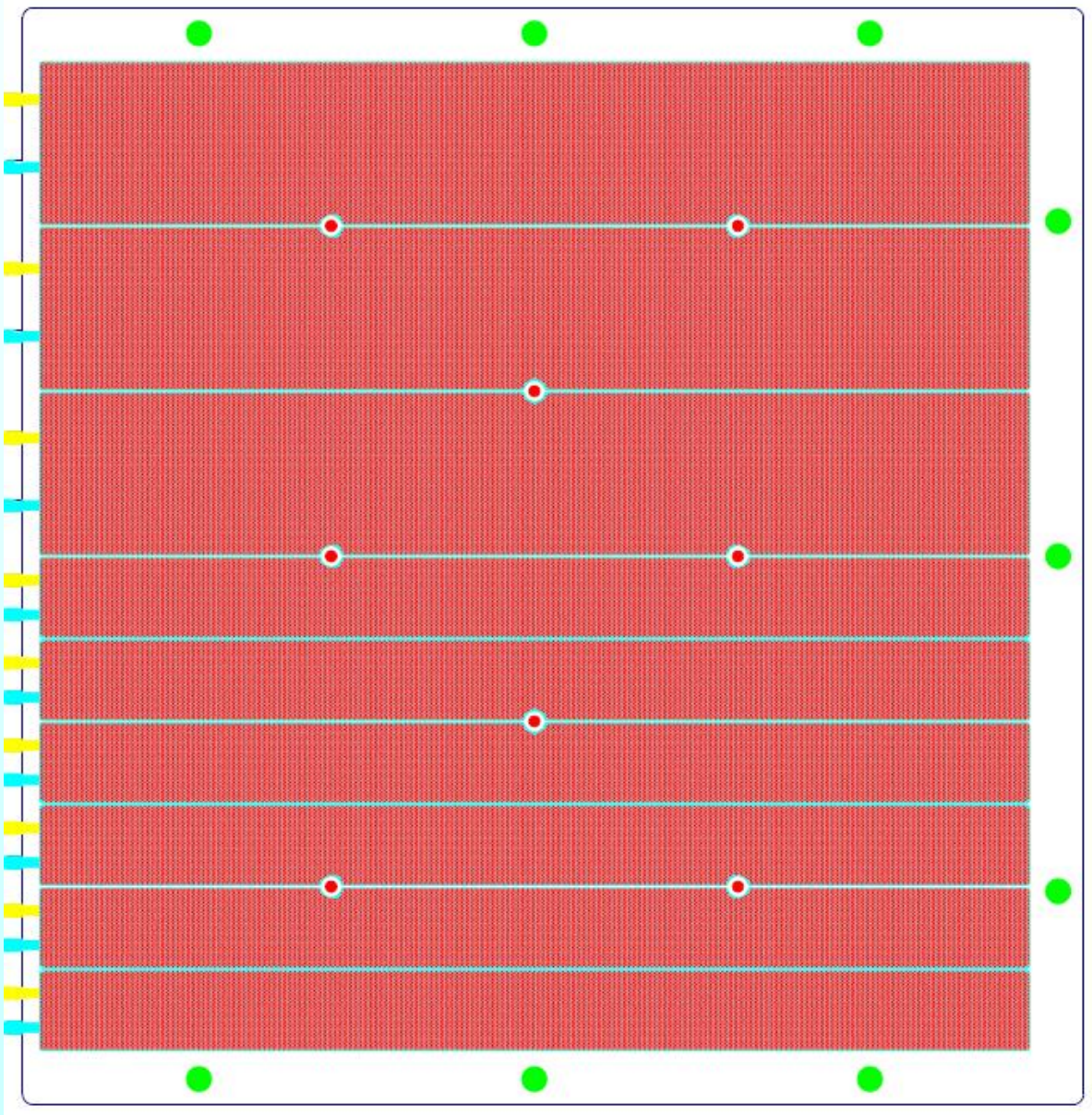




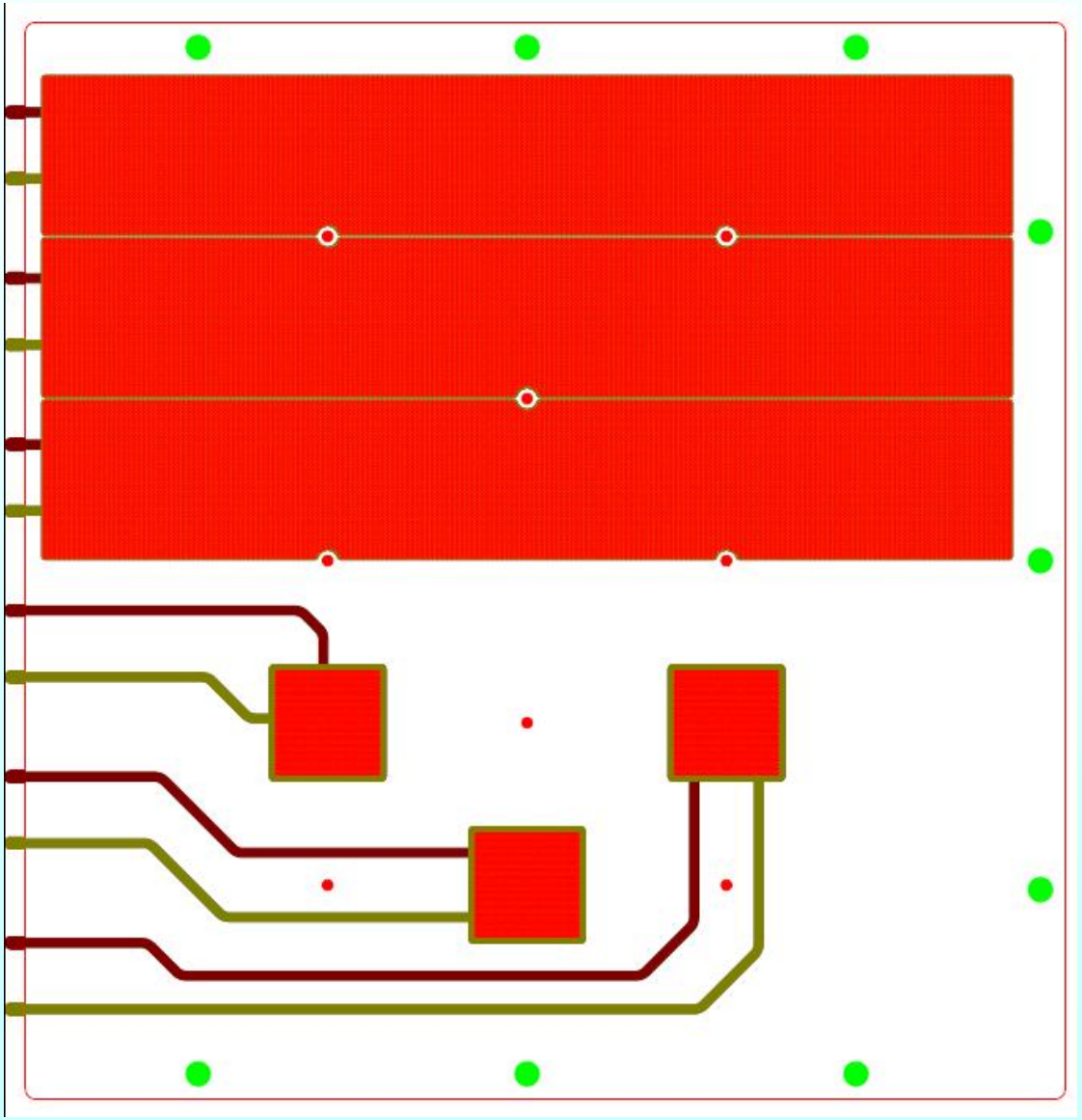
Non pcb material

- **We decided to investigate the possibility to produce THGEMs using better substrates than those provided by standard pcb producers**
- **Nice materials like PEEK are promising (excellent dielectric properties, easy machining, etc.) but Cu coating cannot be done by pcb techniques**
- **A glass fiber + resin base material with better mechanical (and electrical) properties is PERMAGLAS by Resarm Company (B), commonly used for frames; industry can machine it to good tolerances and ELTOS can attach Cu to it with standard pcb techniques.**
- **15 foils of 500 mm x 500 mm have been ordered, with as good thickness tolerances as can be provided by Resarm; thickness of 0.7 mm and 1.0 mm have been asked.**
- **The CINEL Company in Italy is available to try achieving better thickness uniformity from PERMAGLAS pieces.**

Finer segmentation



Unique piece with "30" and "300"



CONCLUSIONS

- **The Photon detector with triple THGEM and 300 mm x 300 mm has been successfully operated at the November Test-Beam.**
- **Its gain performance however is not satisfactory regarding both the maximum stable values and the uniformity.**
- **The origin of the discrepancy with respect to the identical small detectors is being investigated.**
- **The tolerances on the fiberglass thickness have been studied and new THGEMS with stricter tolerances are being produced.**
- **A material different from PCB: rectified PERMAGLASS has been ordered and PERMAGLAS THGEMS will be produced and tested.**
- **A new comparative test of 300 mm vs 30 mm THGEMs has been prepared to clarified the issue of the maximal stable gain.**