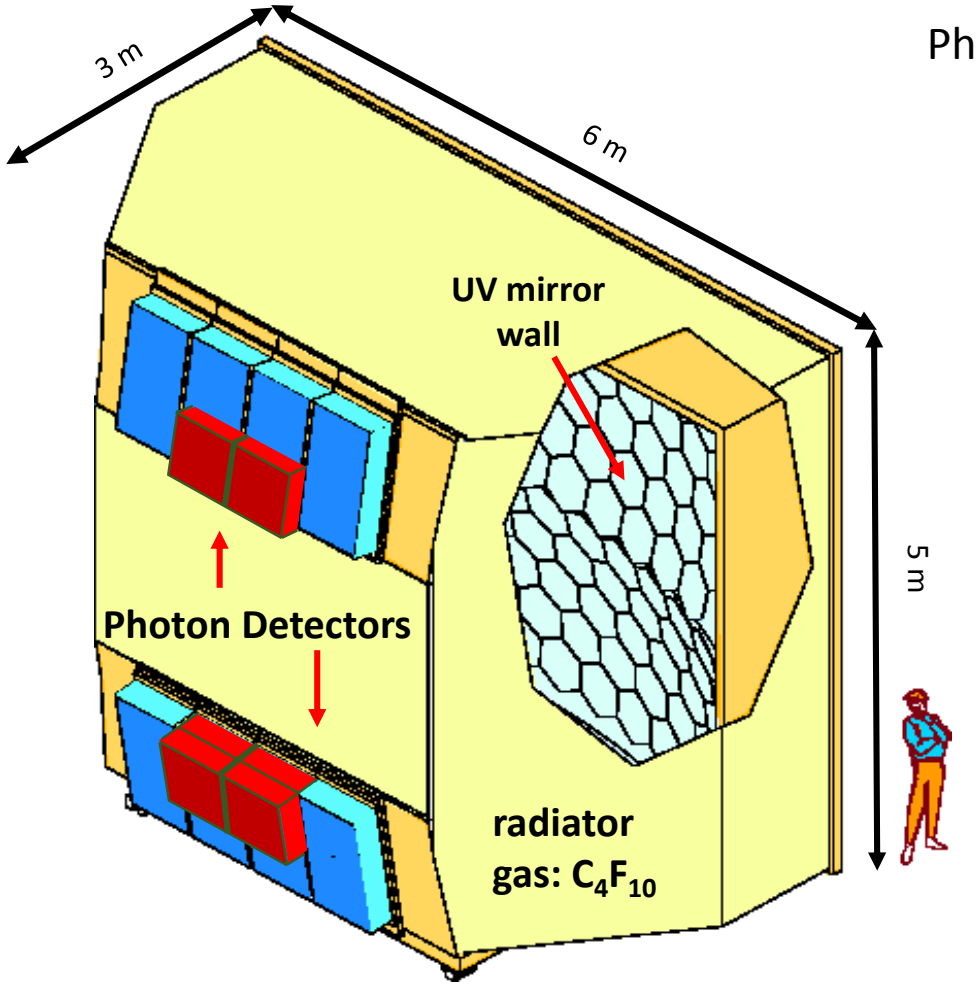
Update on THGEMs and Micromegas production for RICH-1 COMPASS Upgrade

on behalf of THGEM Trieste group

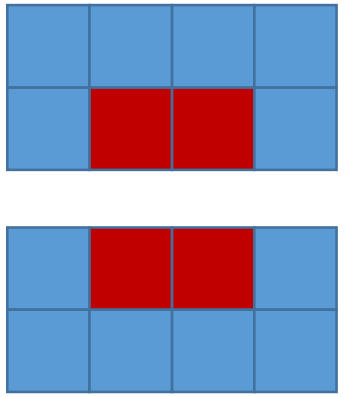
INFN - Sezione di Trieste

S . Levorato

RICH-1 at COMPASS experiment at CERN→ Upgrade starting fall 2015: Reminder



Photon detectors system now:

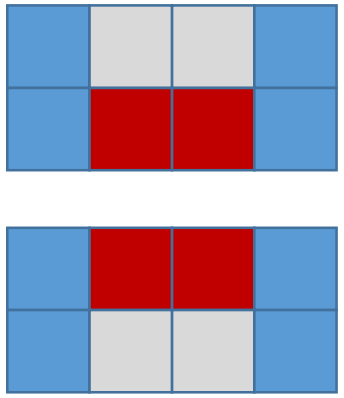


MWPC + CsI

MAPMT

- 12 MWPC + CsI 600 x 600 mm^2
- 4 MAPMT 600 x 600 mm^2 (2006)

… in 2016

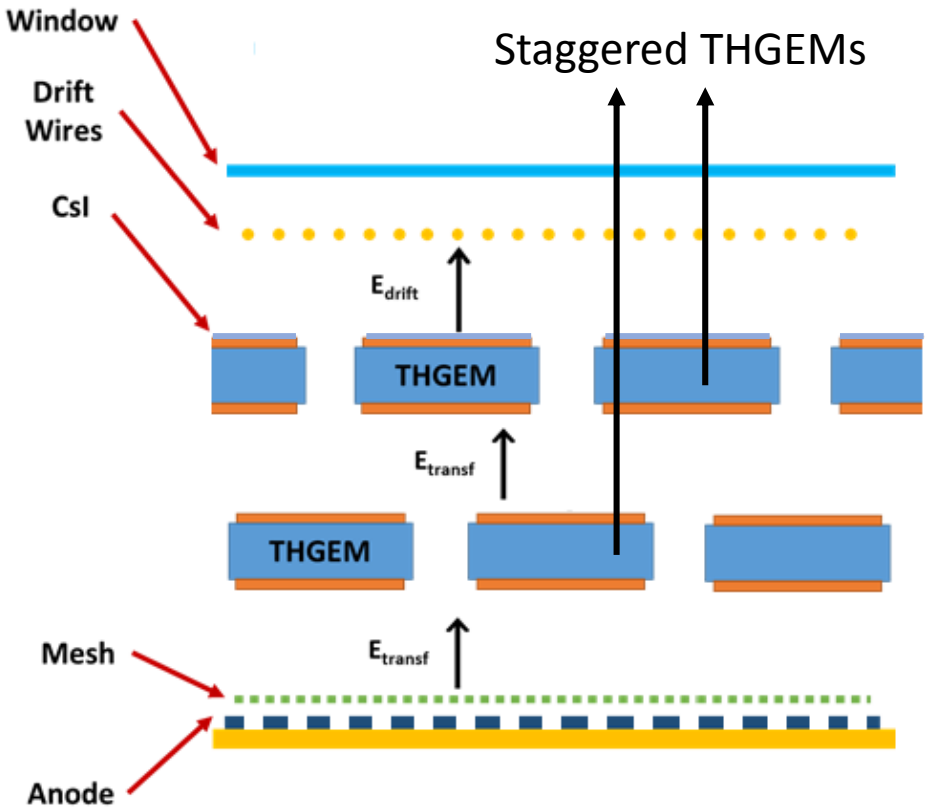


To improve the detector performance in view of the COMPASS phase 2

4 New 600 x 600 mm^2 MPGD based photon detector will be installed for a total sensitive surface of ~ 1.1 m^2
Remark → mechanical constrains to guarantee compatibility with the present structure

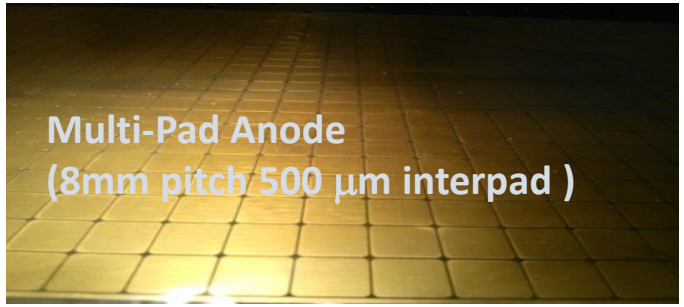
Detector concept: architecture chosen a reminder

Hybrid Detector (2 x THGEM + B-Micromegas)



Double THGEM: t = 0.4 mm; p = 0.8 mm; h = 0.4 mm

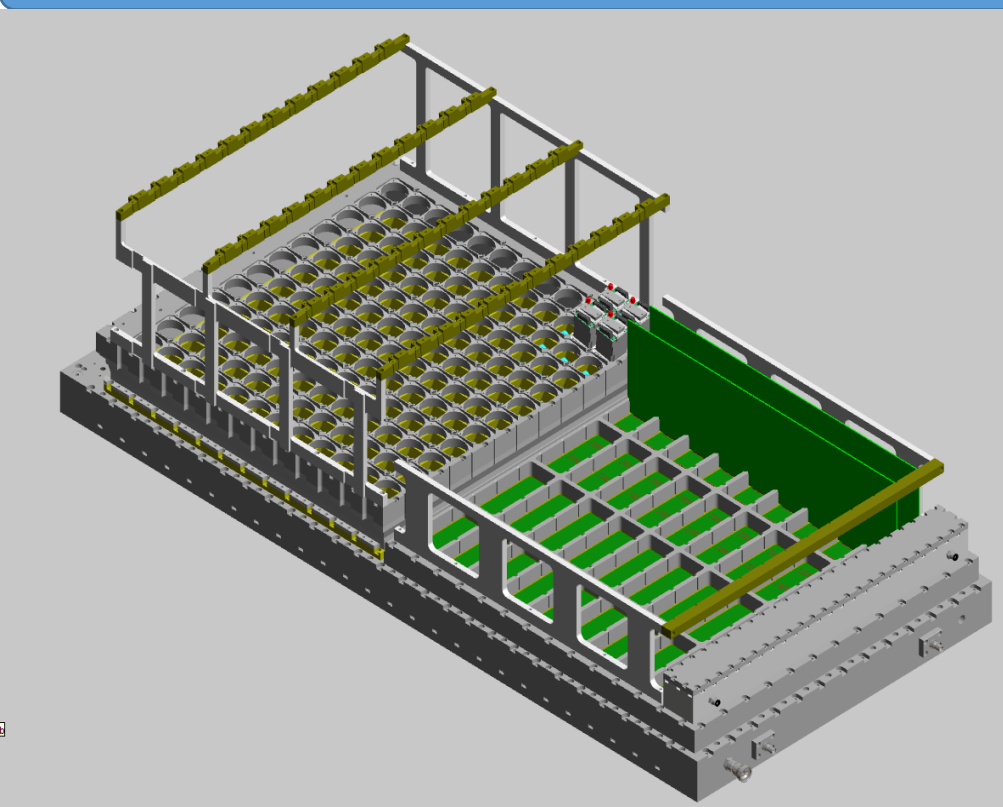
- Simple; robust; cheap;
- High photoelectron extraction efficiency in CH4 rich mixtures;
- Fast signals time resolution $\sigma \approx 10\ ns$;
- Closed Geometry;
- Cascade → $G \approx 10^5$ → single photon detection;
- IBF $< 5\%$;
- Stability: time & high rates

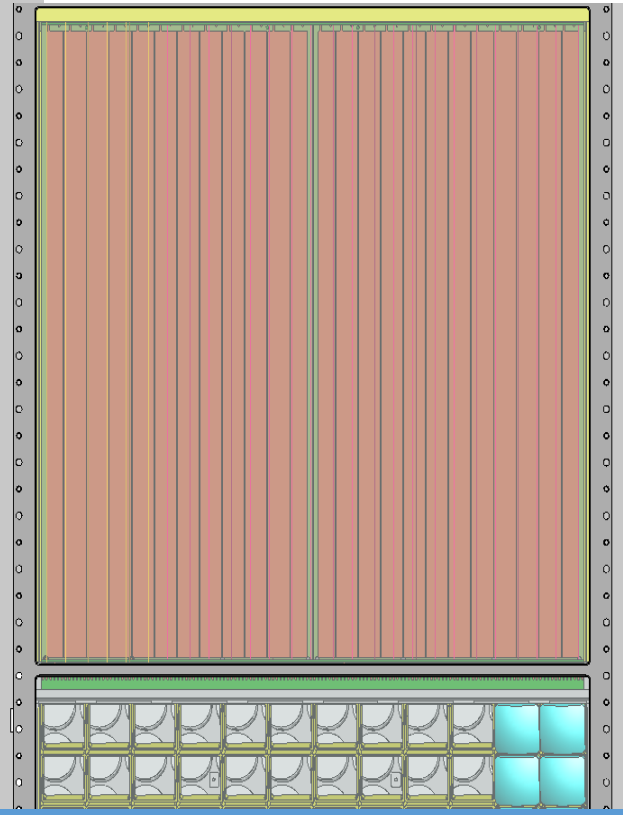


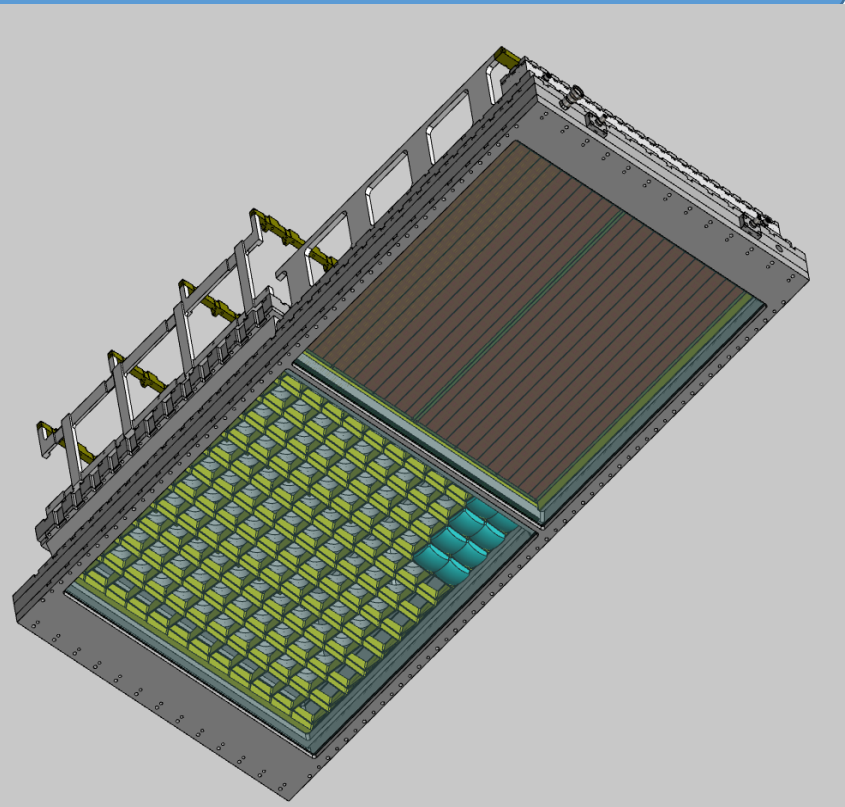
Each 600mmx600mm detector is made of 2 modules
Each of them consisting of:

- 2 300mmx600mm THGEMs
- 1 300mmx600mm Bulk Micromegas

Detector: integration of the new architecture





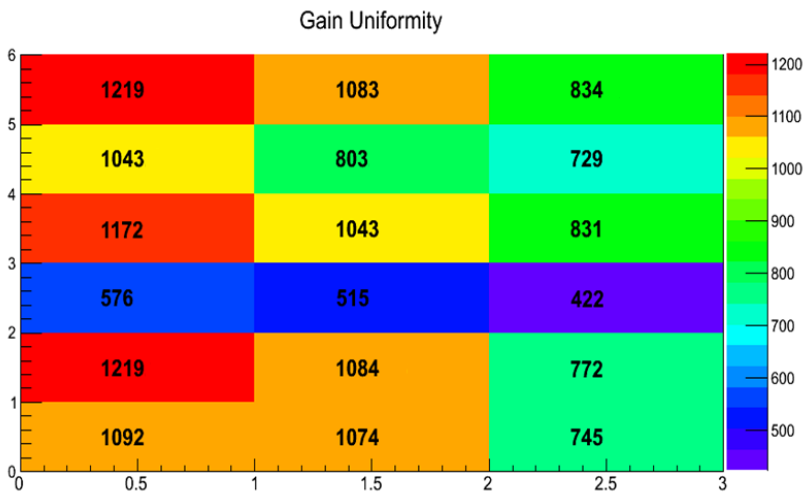


Detector: THGEM production material

Thickness PCB variance as big as 15% for non selected PCB

Need of material preselection
50 foils of raw PCB material bought

Gain Variance > 40%*



example THGEM: t = 0.8 mm; p = 0.8 mm; h = 0.4 mm

Elite Material Co., Ltd.
http:\\www.emctw.com
Technical Data

Lead-free , Halogen-free Material
EM-370(5) / EM-37B(5)

PRODUCT	EM 370-5
Thickness	0.407 mm
Copper	35µ / 35µ
Sheet Size	1 245 x 1 092 mm
Sqm Price	31.55 € / m²
Sheet Price	42.90 € / Sheet

Basic Laminate Property

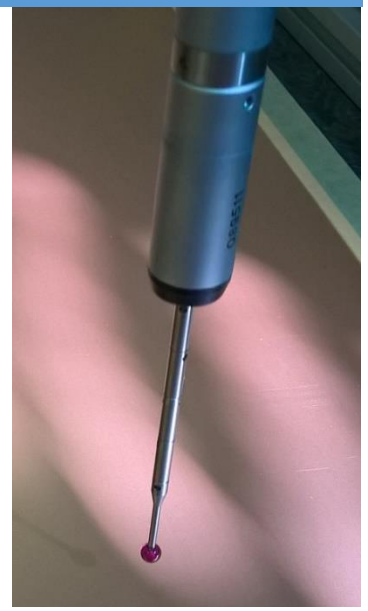
Item		IPC-TM-650	Test condition	Unit	Typical Value
Glass transition temp.		2.4.25	DSC	℃	155
CTE, X-, Y-axis		2.4.24	Pre-Tg, TMA	ppm/℃	12/15
CTE, Z-axis		2.4.24	Alpha 1, TMA	ppm/℃	40
			Alpha 2, TMA	ppm/℃	190
Z-axis Expansion		2.4.24	50~260℃, TMA	%	2.60
Decomposition temp.		2.4.24.26	TGA	℃	385
Thermal stress 10sec 288℃		2.4.13.1	Clad	–	Pass Visual
			Etched	–	Pass Visual
Water absorption		2.6.2.1	E-1/105+D-24/23	%	0.11
Peel strength	0.5 oz	2.4.8	as received	lb/in	7.4
			after thermal stress	lb/in	7.4
	1.0 oz	2.4.8	as received	lb/in	8.6
			after thermal stress	lb/in	8.4
Permittivity (RC 50%)	1 MHz	2.5.5.9	C-24/23/50	–	4.8
	1 GHz			–	4.3
Loss tangent (RC 50%)	1 MHz	2.5.5.9	C-24/23/50	–	0.009
	1 GHz			–	0.013
Volume resistivity		2.5.17.1	C-96/35/90	MΩ-cm	$>10^{10}$
Surface resistivity		2.5.17.1	C-96/35/90	MΩ	$>10^{9}$
Flexural strength	Warp	2.4.4	as received	MPa	560~600
	Fill		as received	MPa	470~510
Flame resistance		UL-94	A&E-24/125	–	V-0

Specification Sheet : IPC-4101C / 127/128

*Standard daq chain Cremat+Ortec+MCA, Ar/CO2 70/30 atmosphere

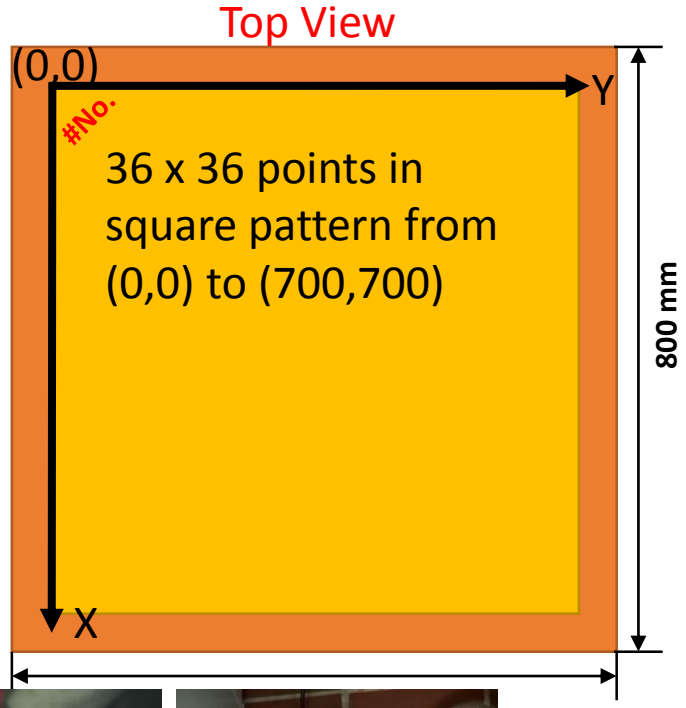
THGEM production: thickness measurement

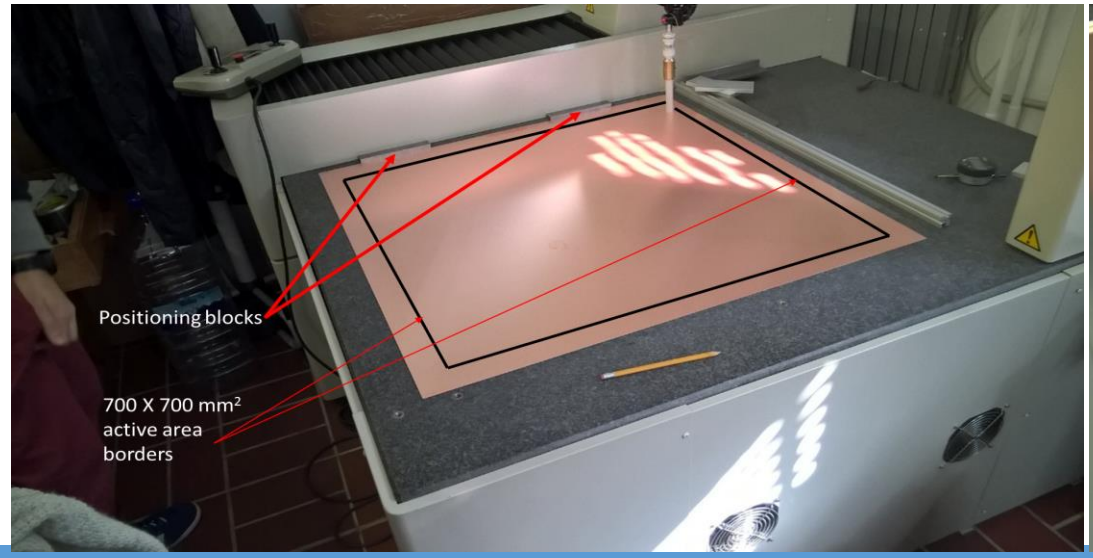
Thermalized room with Mitutoyo EURO CA776

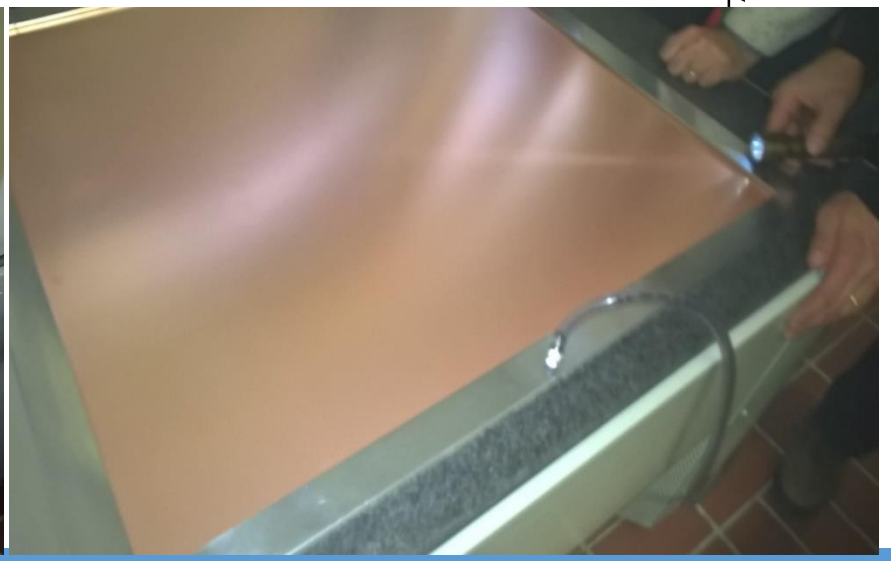


From 1245 mm x 1092 mm
Raw PCB foil XY reduction
Expected more uniform in thickness (production procedure)

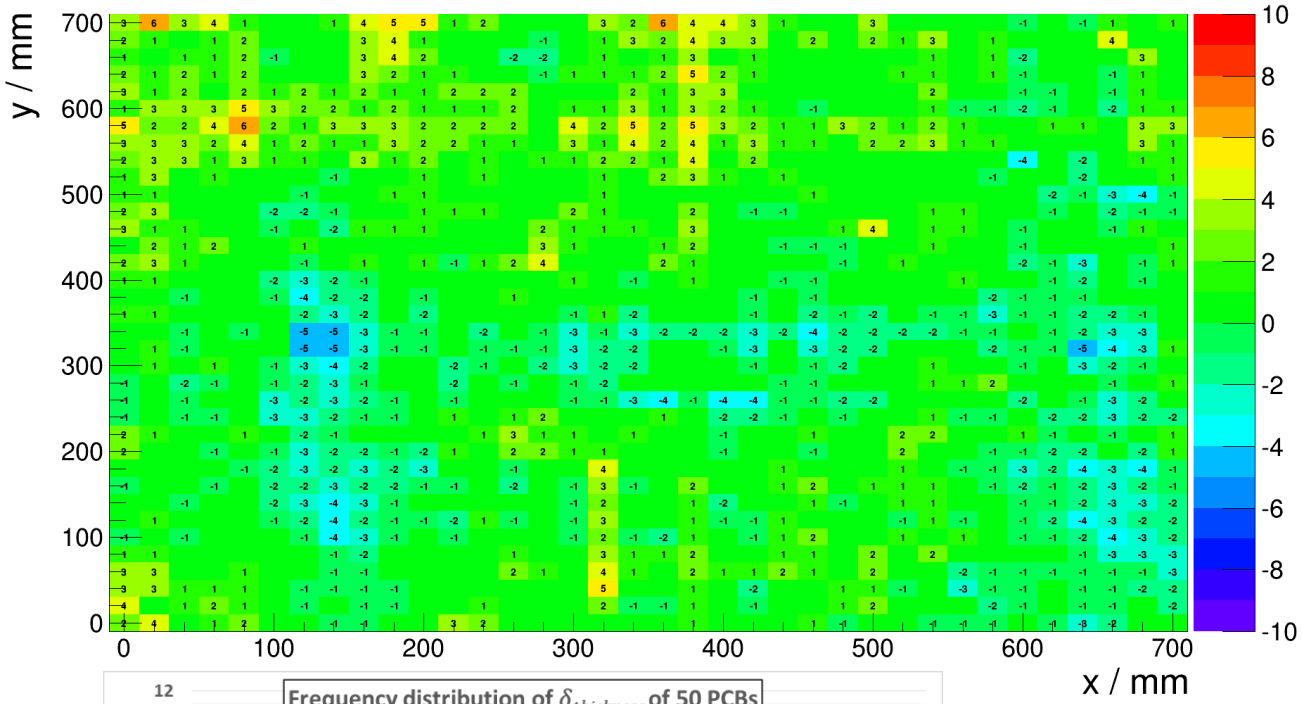
On average 3 measured pcs/day
Each foil has its unique n identifier

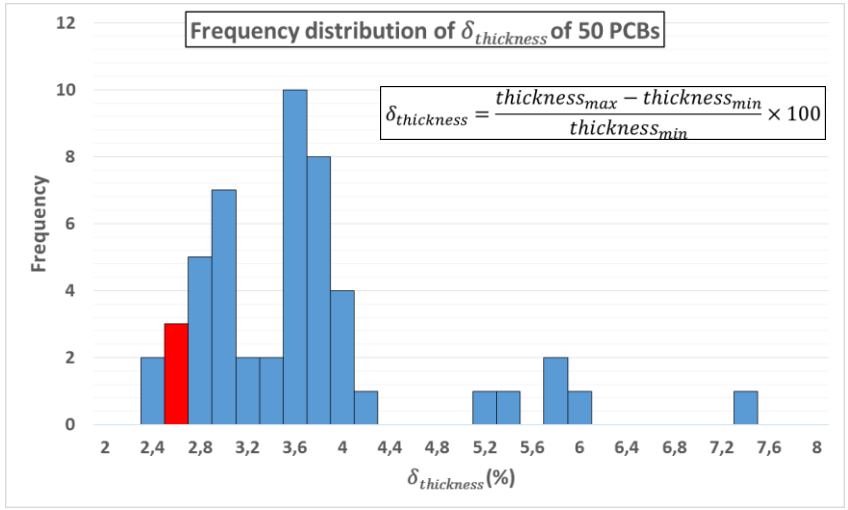






THGEM production, material seection

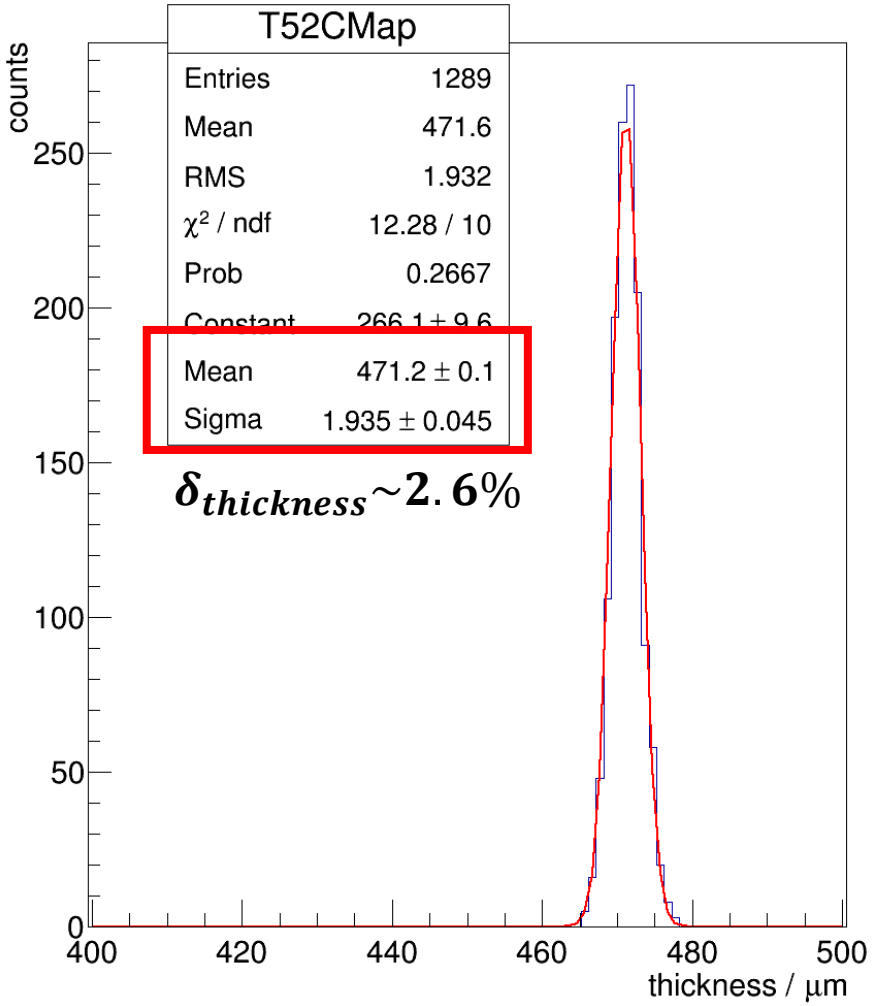




50 PCBs

700 x 700 mm^2

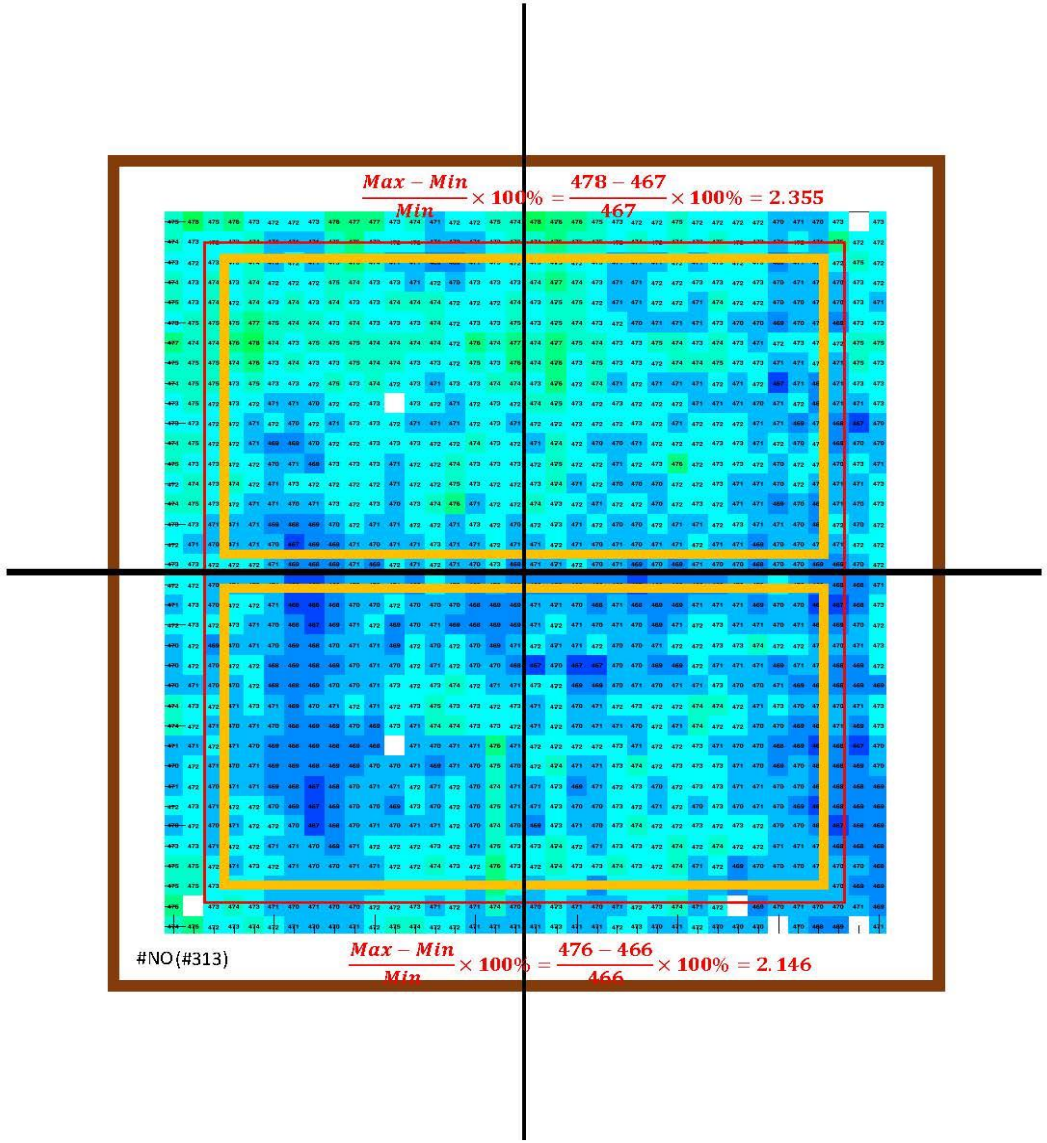
$\delta_{thickness}(43\ thgems) \leq 4\%$

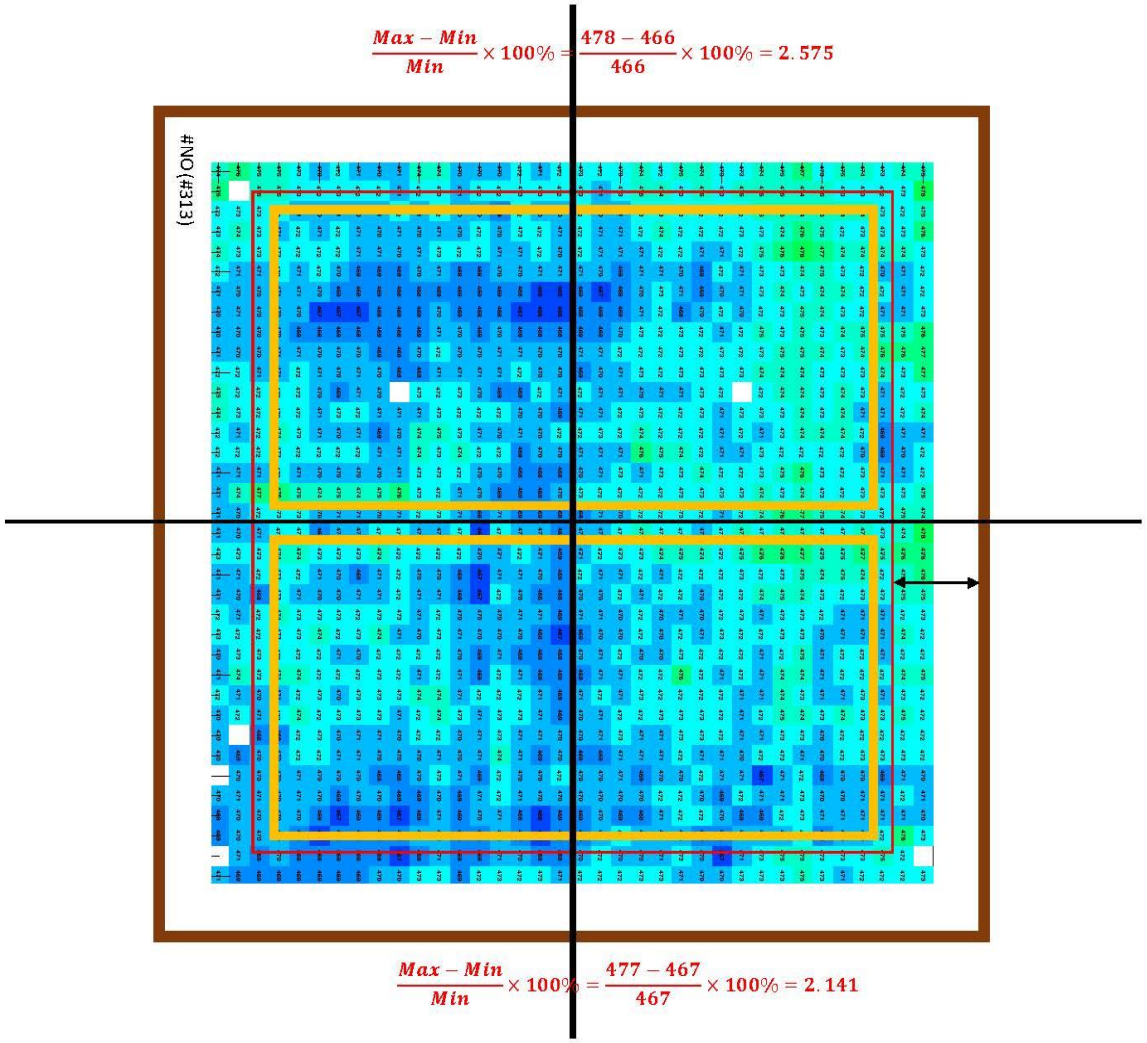


$\delta_{thickness} \sim 2.6\%$

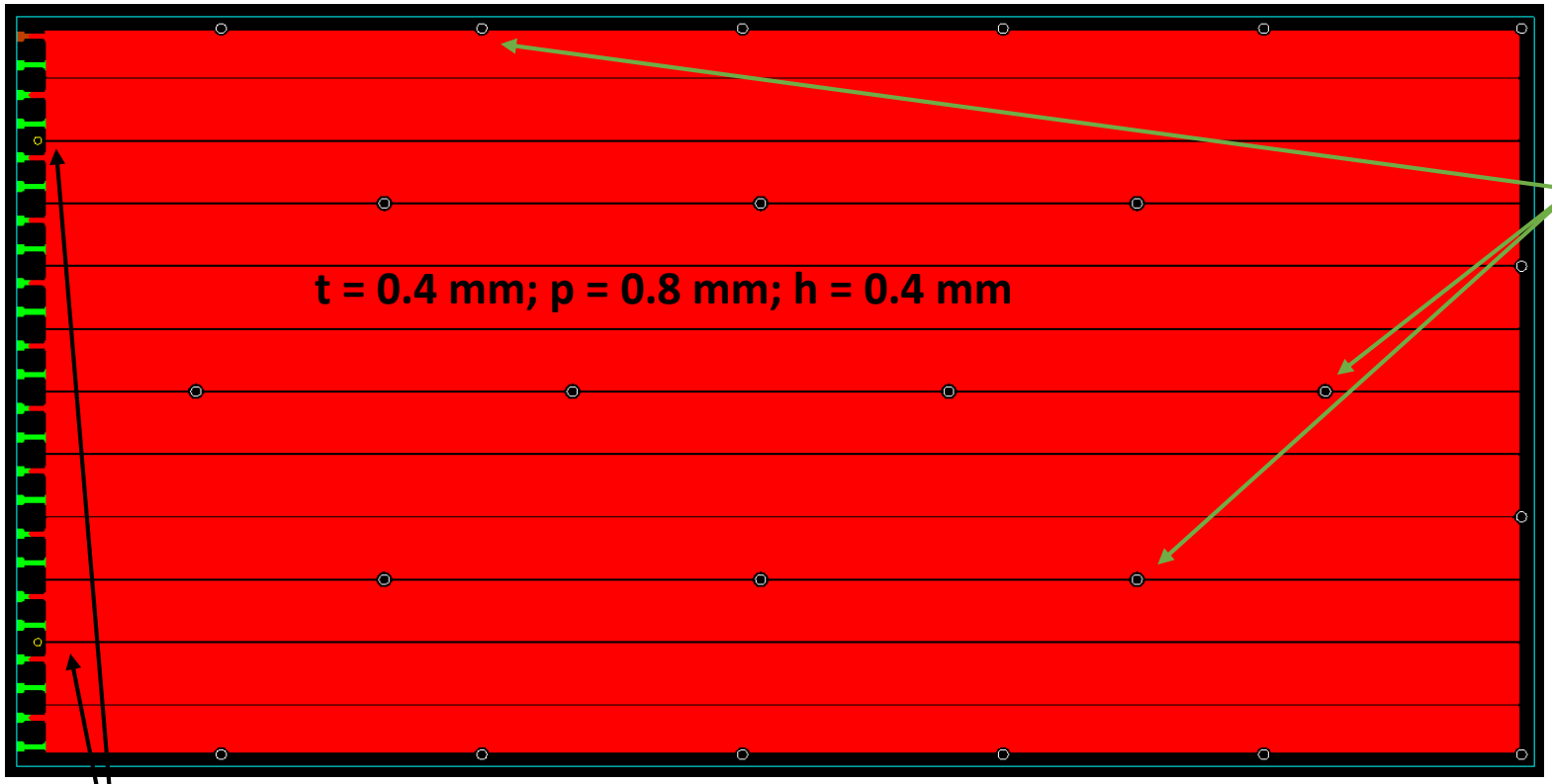
N pieces needed (300mm x 600 mm): 16, we can easily select 8 foils with $\delta_{thickness}$<3% (reminder 5% in thickness → 15% in gain)

THGEM production, material selection



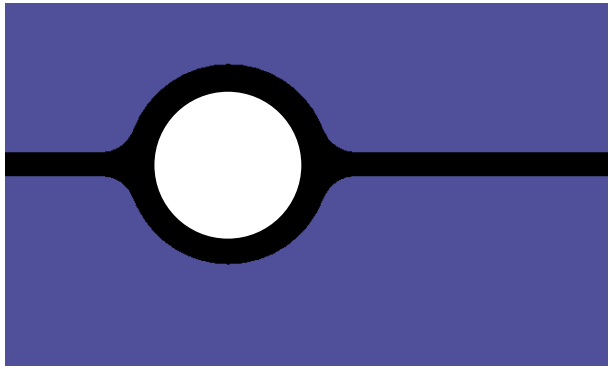


THGEM production



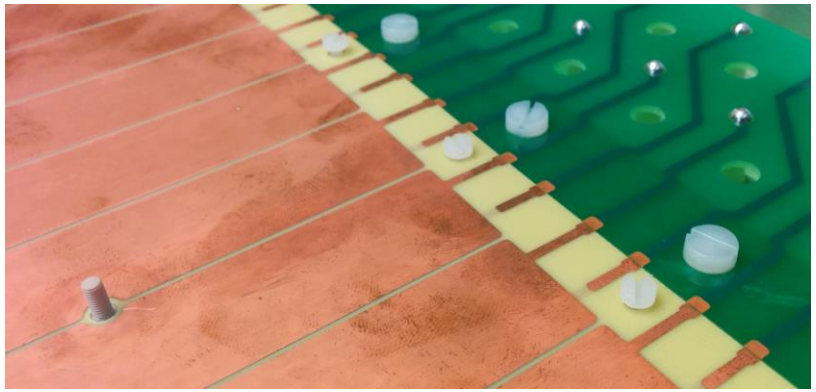
24 fixation points to guarantee THGEMs flatness and positioning Pillars in PEEK

Segmentation in 12 sectors

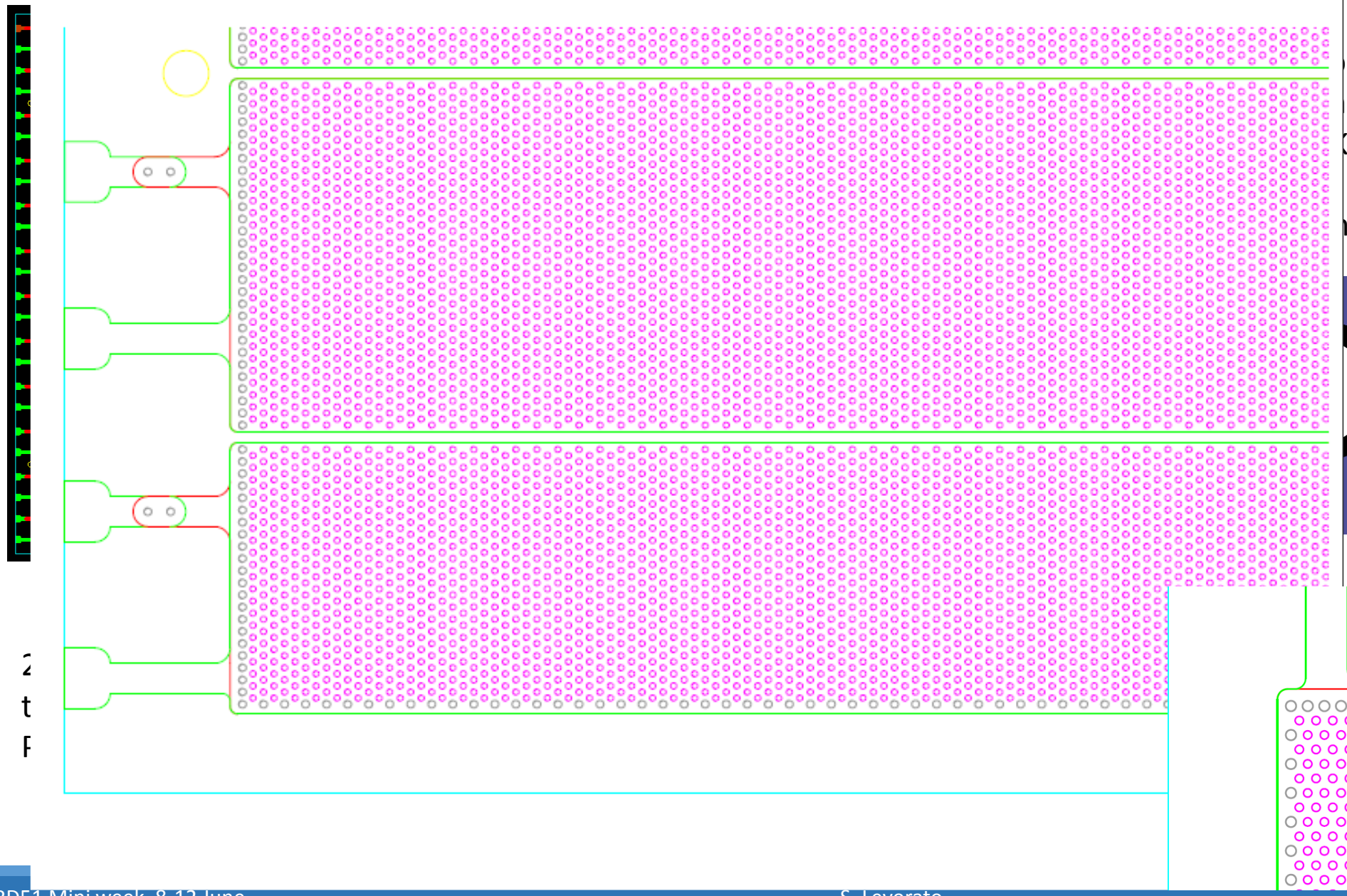


0.7 mm sector separation

2 reference holes to guarantee the THGEMs staggering PCB for alignment and spacing

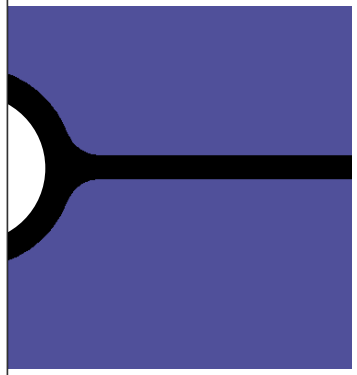


THGEM production

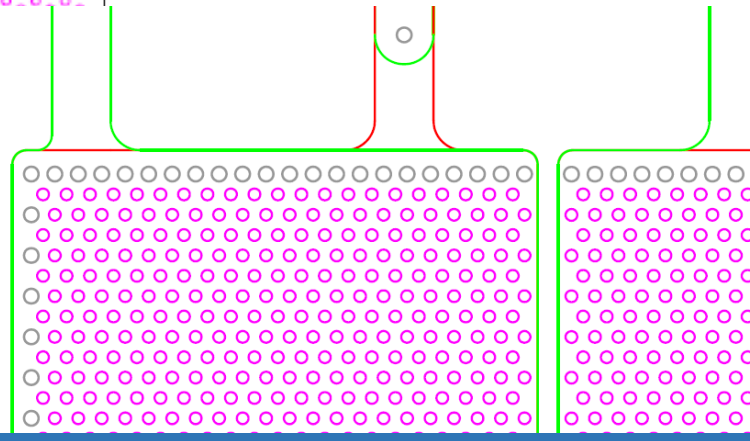


ints to guarantee
ess and positioning

in 12 sectors

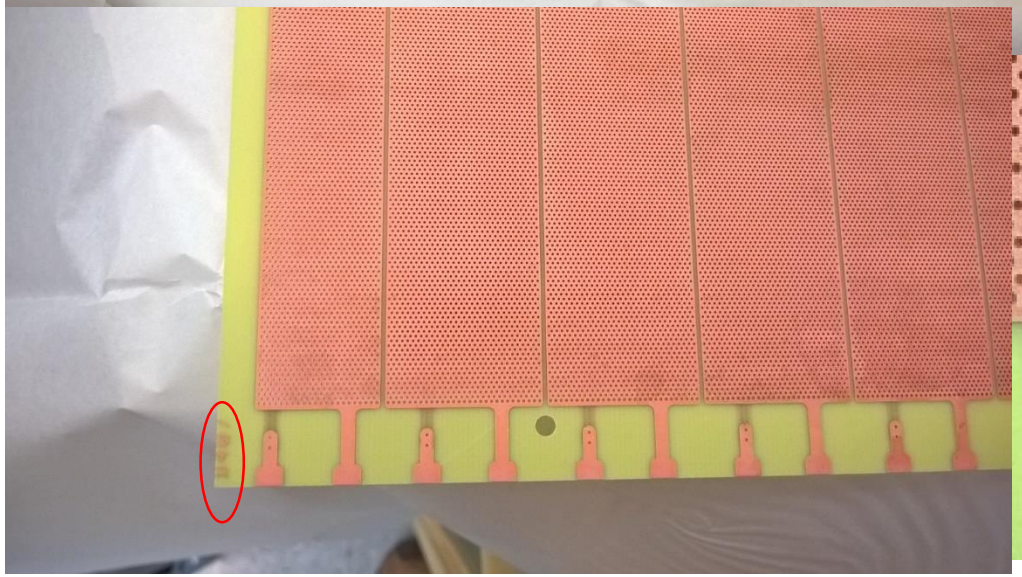


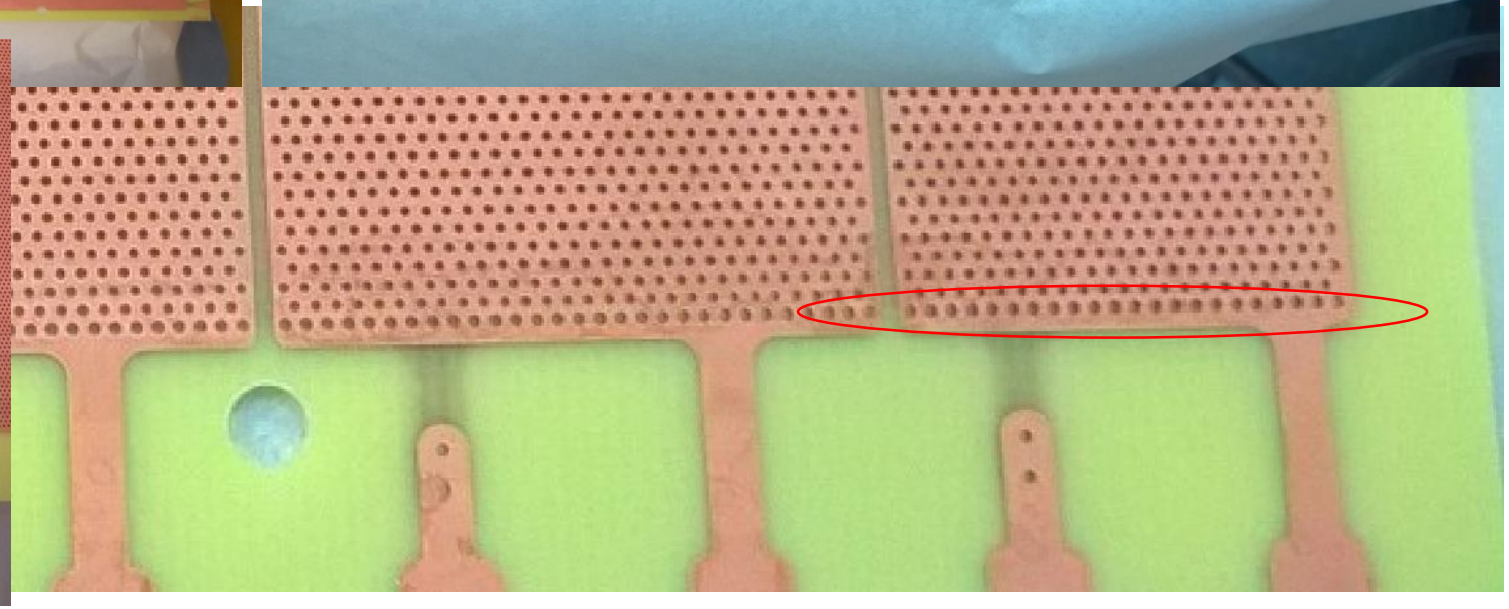
0.7 mm
sector
separation



THGEM production

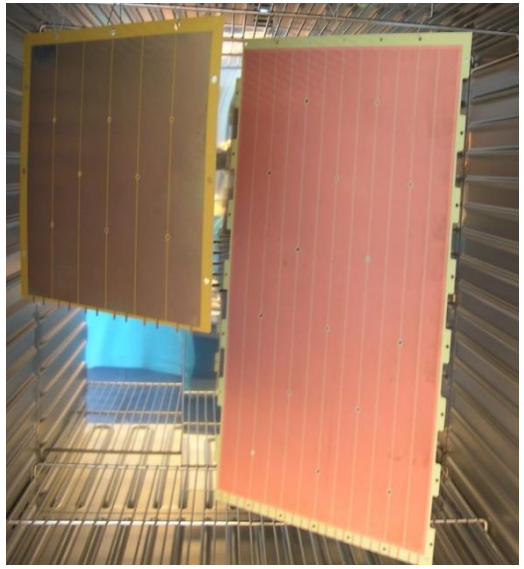
PCB material Sent to ELTOS for production, Agreed on procedure with ELTOS first batch delivery 08/06/2015:

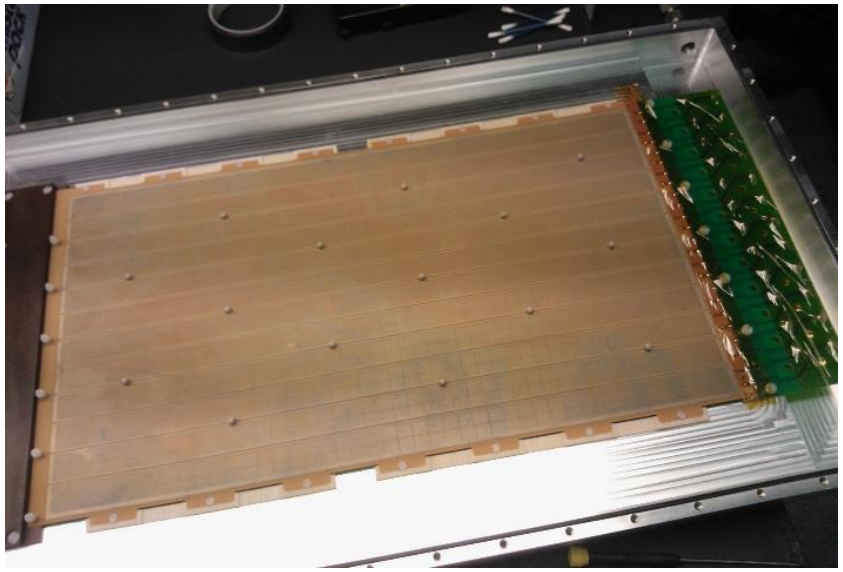




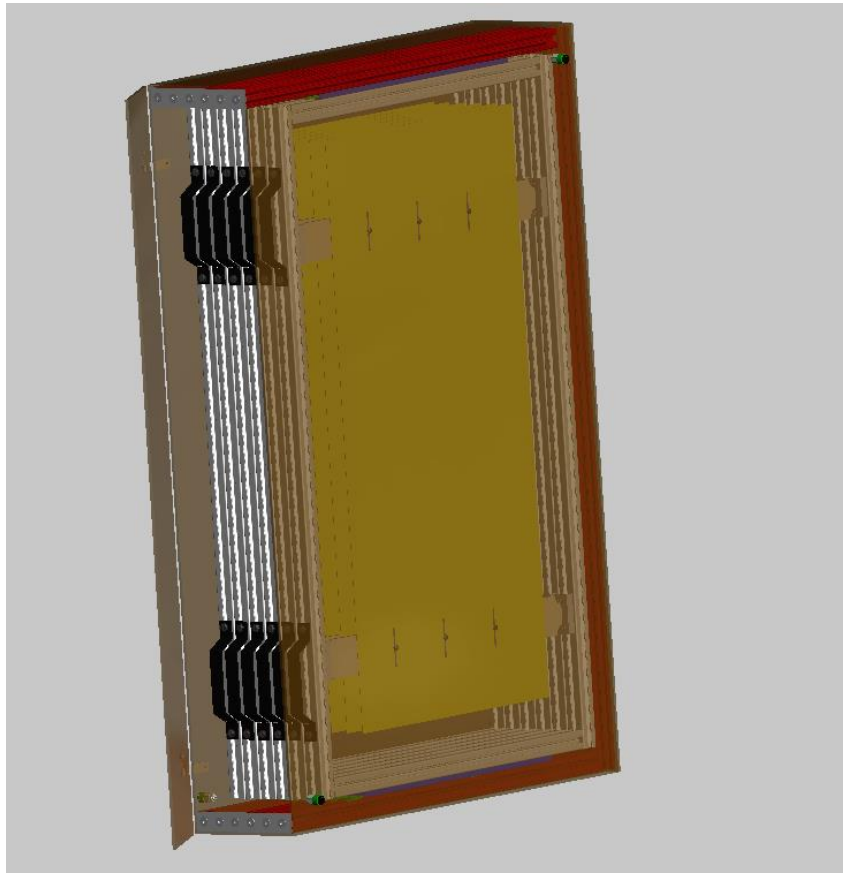
THGEM characterization

In Trieste Cleaning procedure will be applied : polish, high pressure water cleaning, ultrasonic Bath + microetching, distilled water rinsing and oven @ 160 ºC, final step Gain Characterization

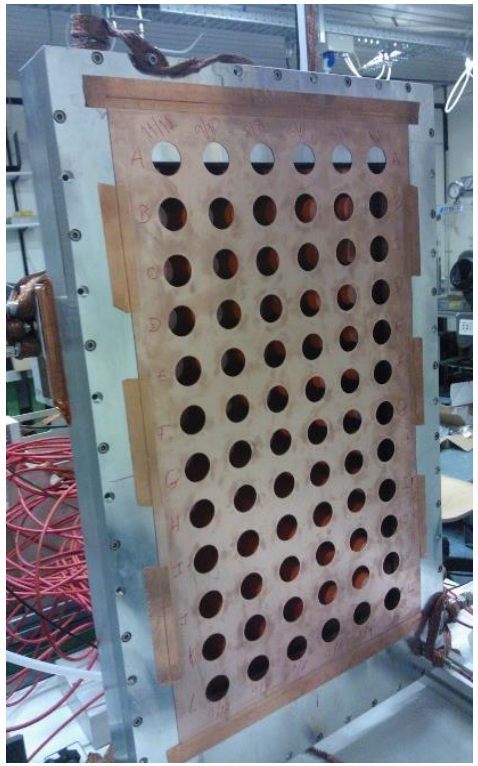




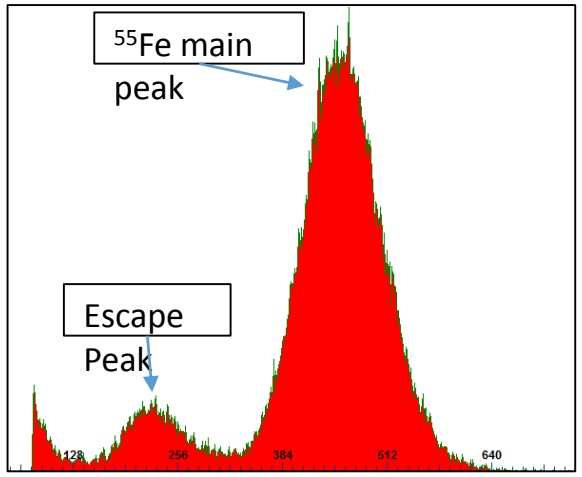
THGEMs stored for transport in dedicated boxes for gold coating to CERN.



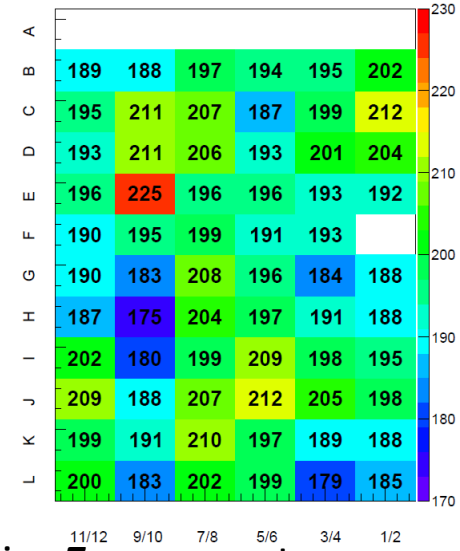
THGEM characterization: proof of the principle

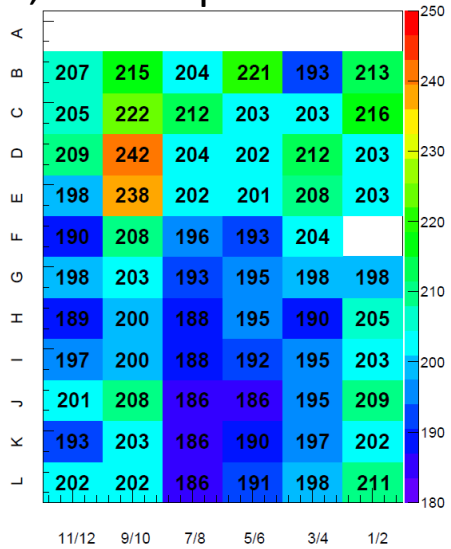


Ar/CO_2 (70:30);
Pre-amplifier + Amplifier
+ MCA; ^{55}Fe



Uniformity gain, ***E*** res. spectra





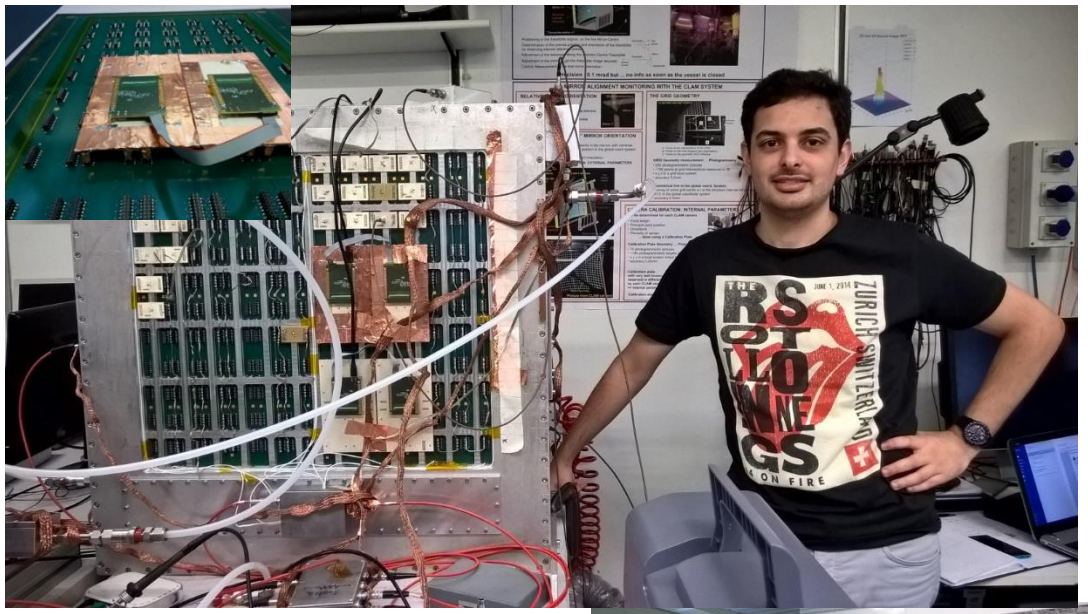
^{55}Fe positioning → Corresponding connector selection → Spectra collection

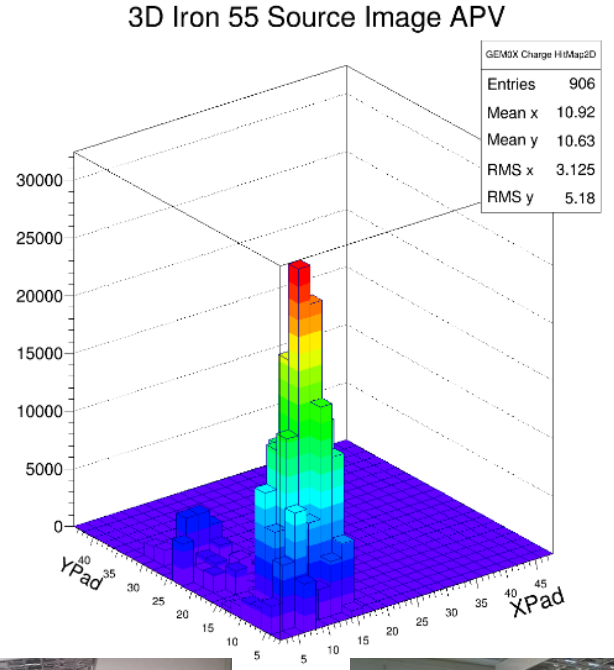
Operation is time consuming, and affected by gain variation due to the ***P,T*** gas/environmental changes

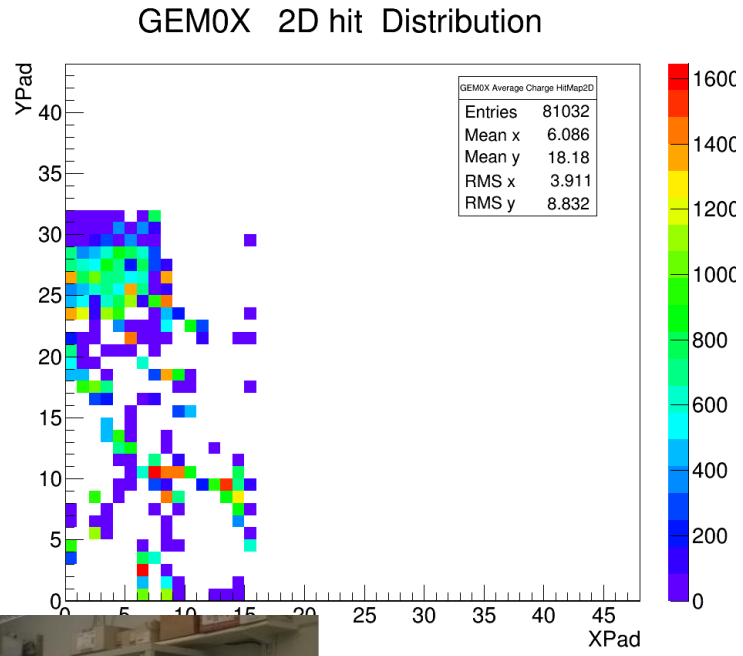
THGEM characterization

Gain Uniformity will be measured with X-Ray source (up to now ^{55}Fe), Data collected with SRS system.

Each THGEM will be fully characterized. Amore software adapted, Different Mapping Option added to have Pads: Thanks to Eraldo for borrowing us the FEC!





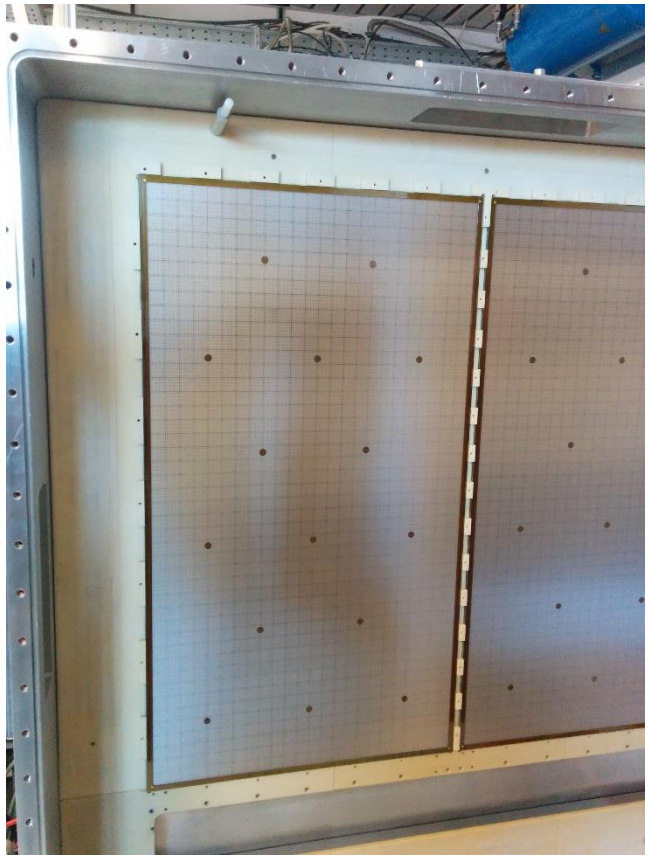


Next weeks ^{55}Fe →X-rays gun

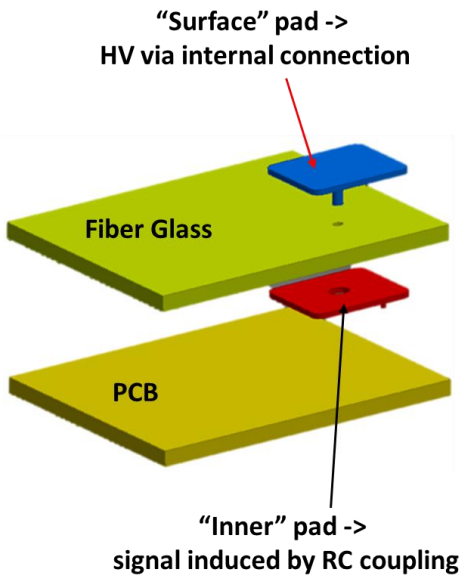
Detector Micromegas production

Final anode design to be completed in the next weeks for production at TVR company,
first delivery foreseen for half of July, they will be delivered to CERN for BULK Micromegas production (Agreed with RUI)

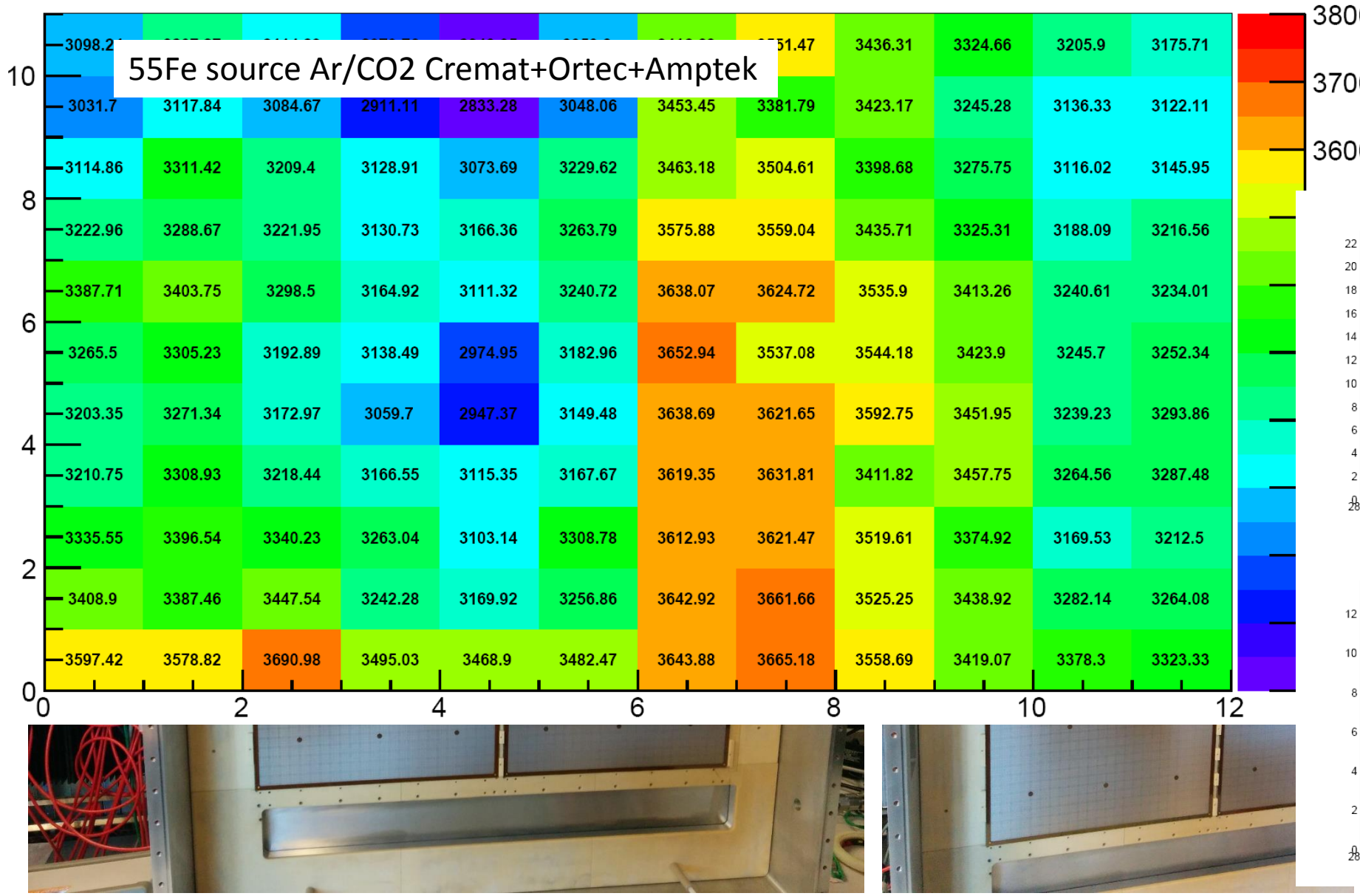
Prototypes have already been produced @ CERN with good results in terms of gain uniformity and detector stability



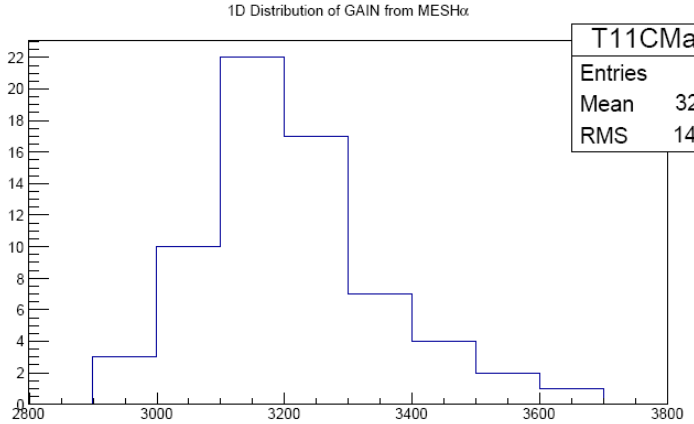
Start of production
of BULK MM (final pieces)
at the end of July
Then 2 pieces for month

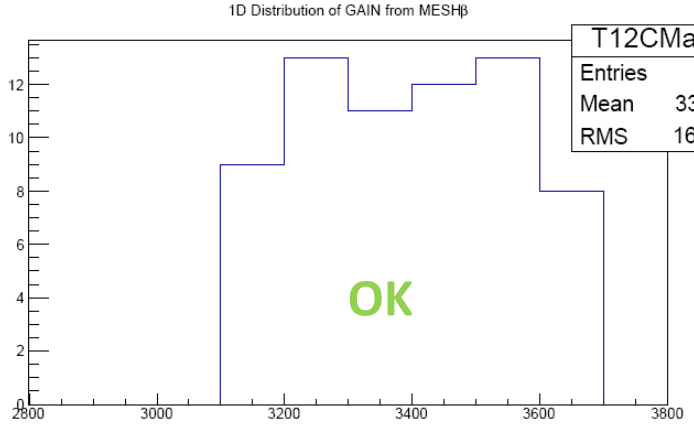


Detector Micromegas production



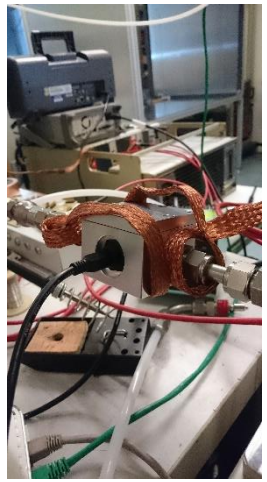
uction (Agreed with RUI)

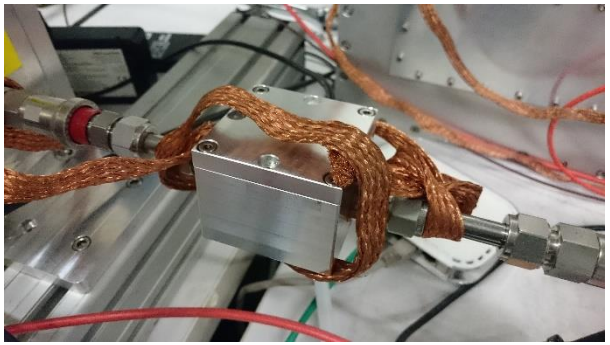




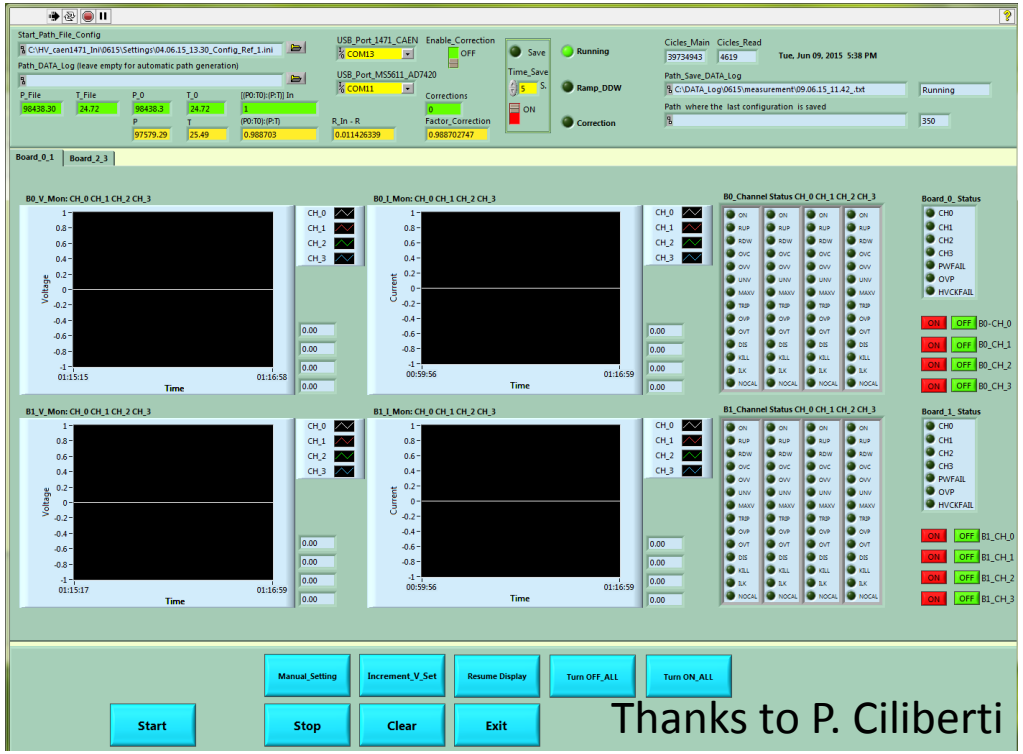
Full detector characterization: Gain Uniformity, HV monitoring, PT variation

Caen HV 1471 A



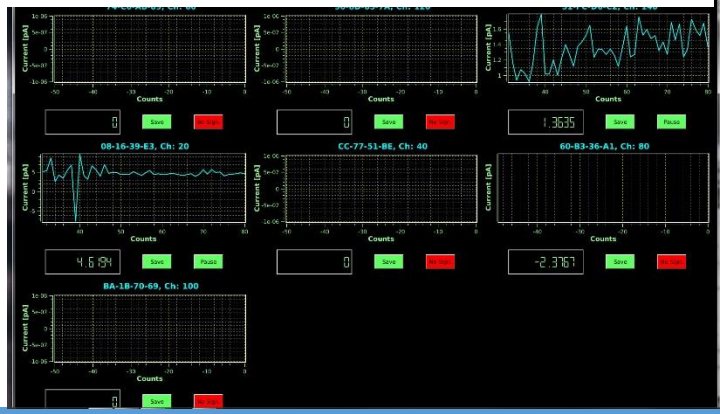


Correction of Voltage $f(P,T)$
according to linearized exponential law
System fully automated + logging
LabVIEW based



Thanks to P. Ciliberti

wireless PicoAmmeter + automated logging Linux SW QT-based



The correction under study but encouraging results!

Hybrid prototype 2 THGEMs + Micromegas
w/o PT correction **± 20%** gain variation during the day
with PT correction **± 5%**.

Thanks for your attention!