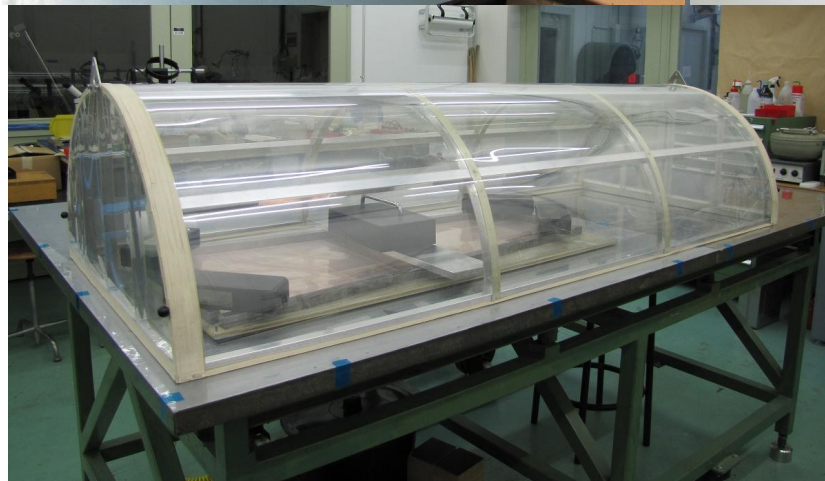
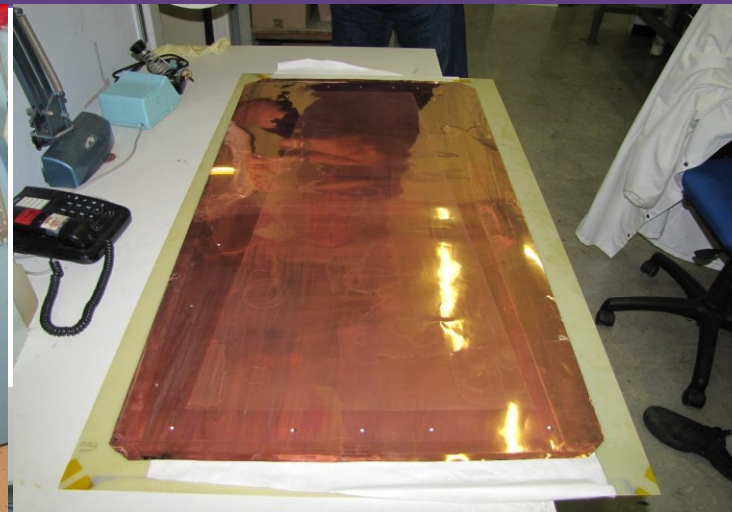


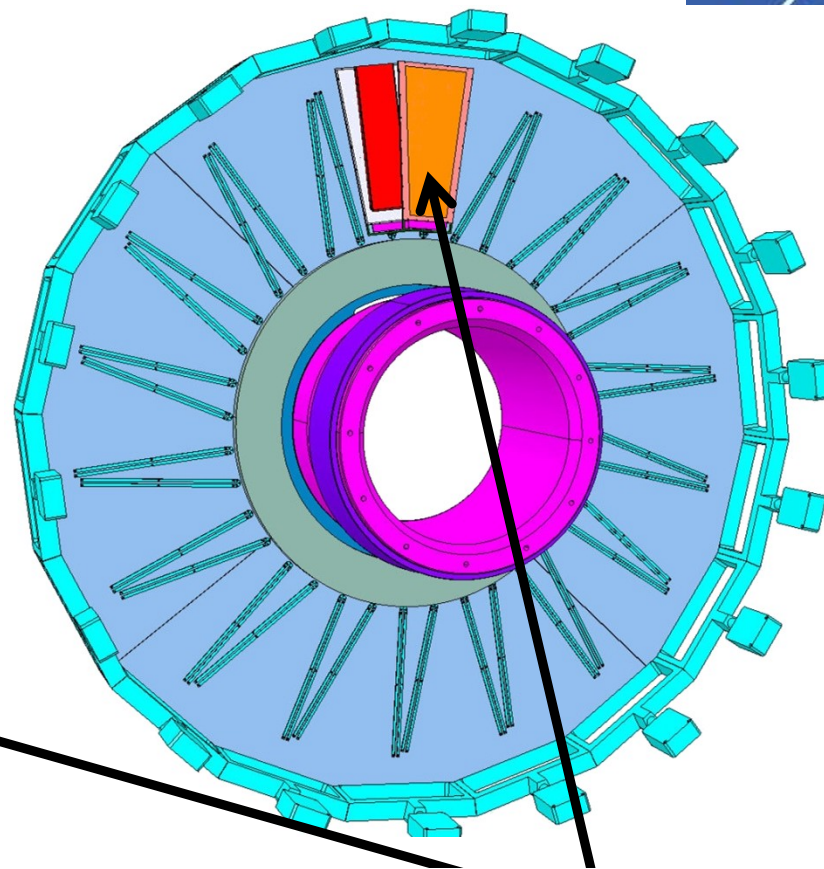


A High Eta Forward Muon Trigger & Tracking detector for CMS STATUS – UPDATE for Large Size Prototype



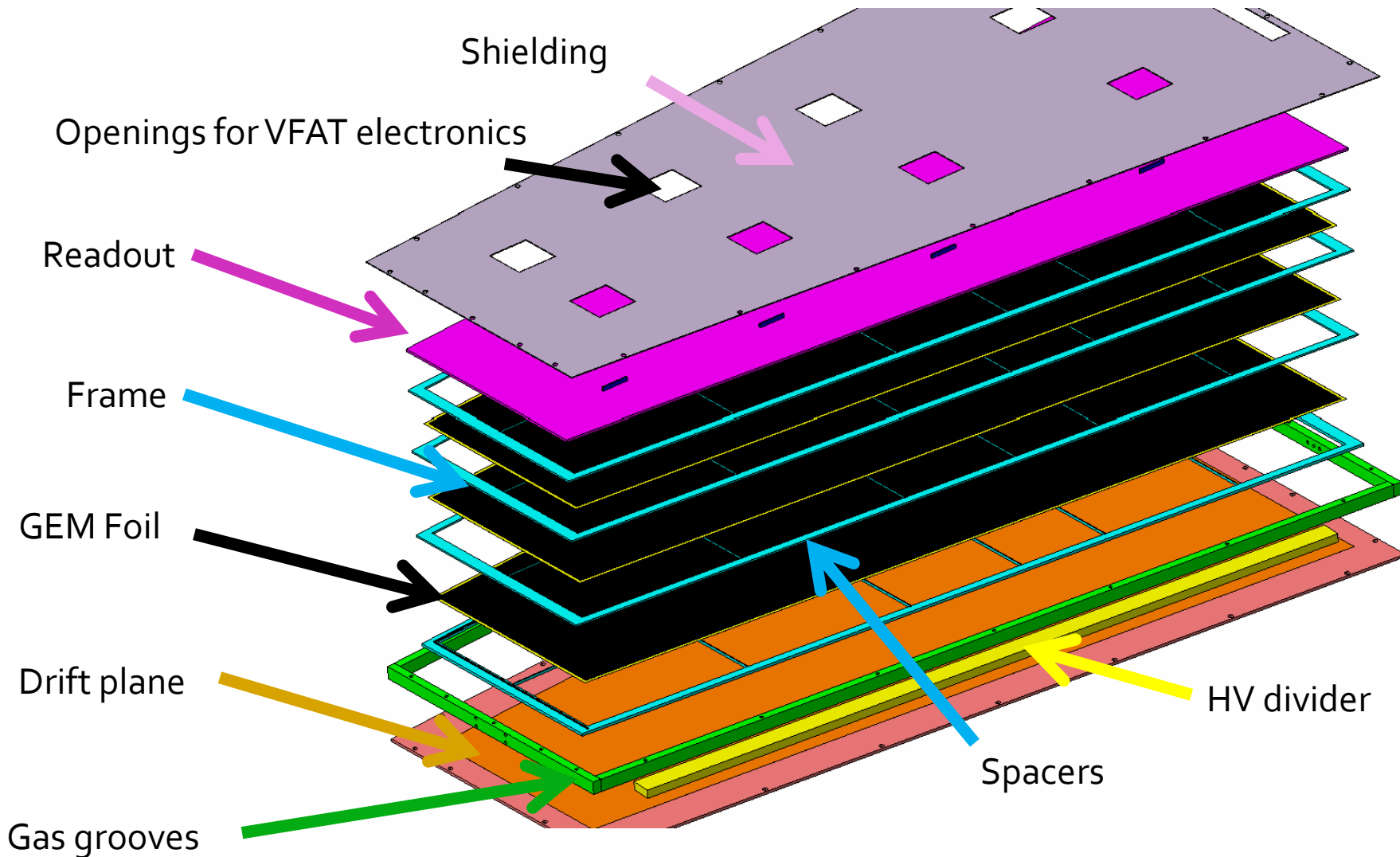
Archana Sharma
For CMS High Eta Upgrade
Team
(CMS, GDD and RD51)

CMS GE1/1 Introduction



CMS GE1/1
 $1.6 > \eta > 2.1$

CMS GE1/1 prototype description I

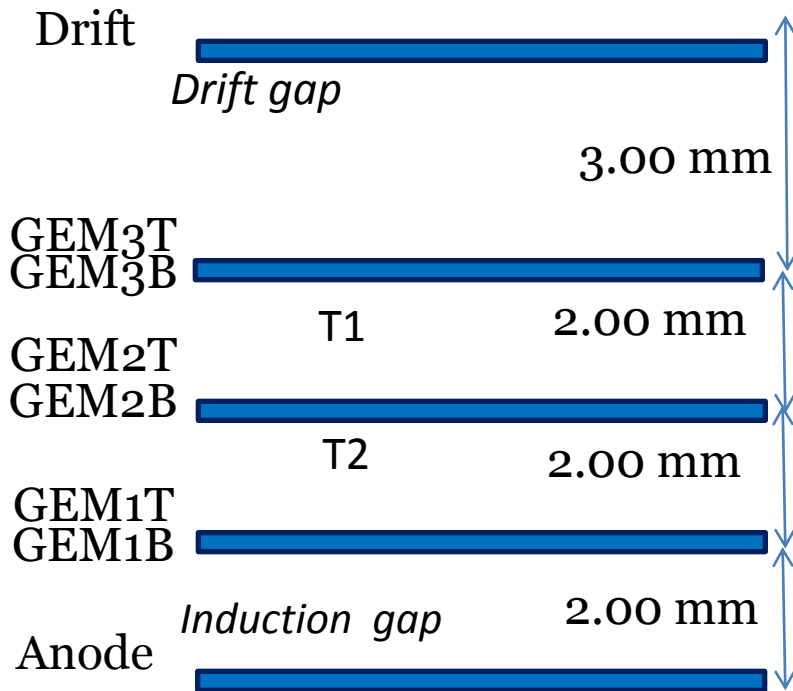




CMS

GE1/1 prototype description II

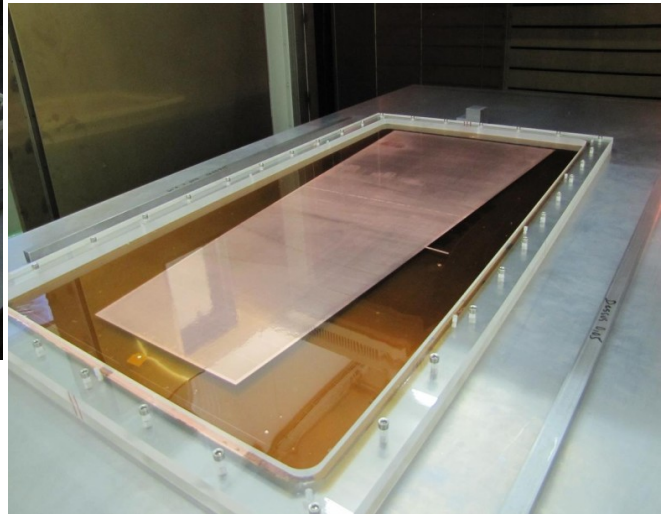
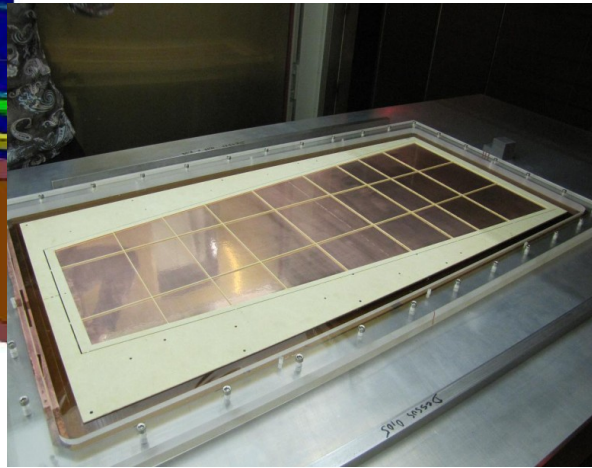
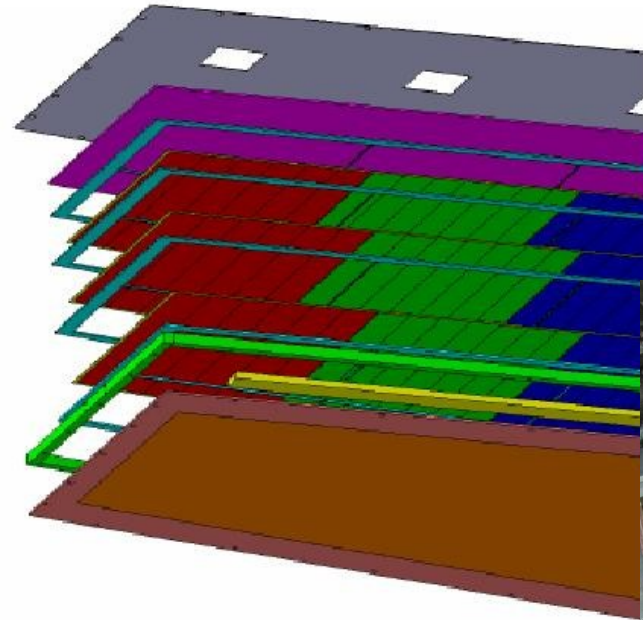
Detector Active area: 990 x (220- 445) mm



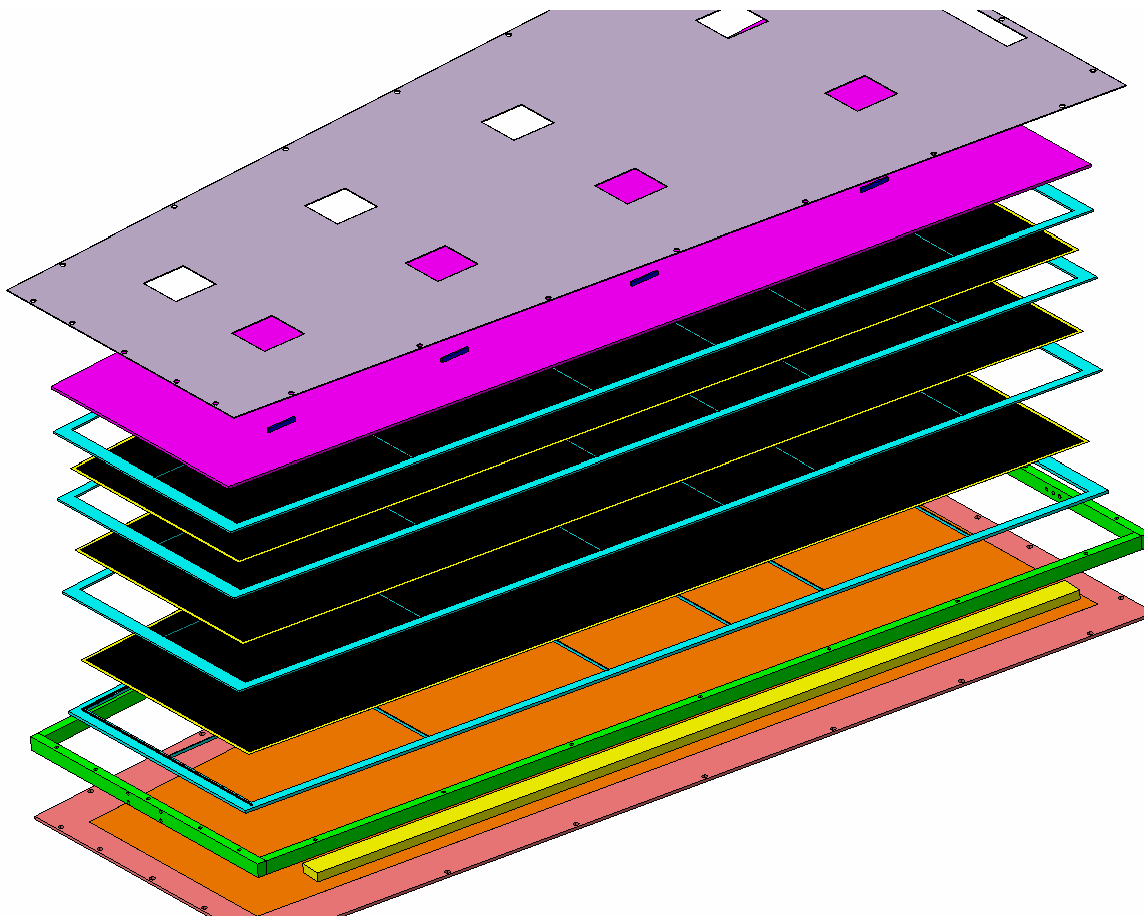
- Single mask GEM technology
- 1D readout
- Gas mixture: Ar/CO₂ (70/30)
- Gas flow: ~ 5 l/h

Single Mask technology will be used for large size detector and mass production!

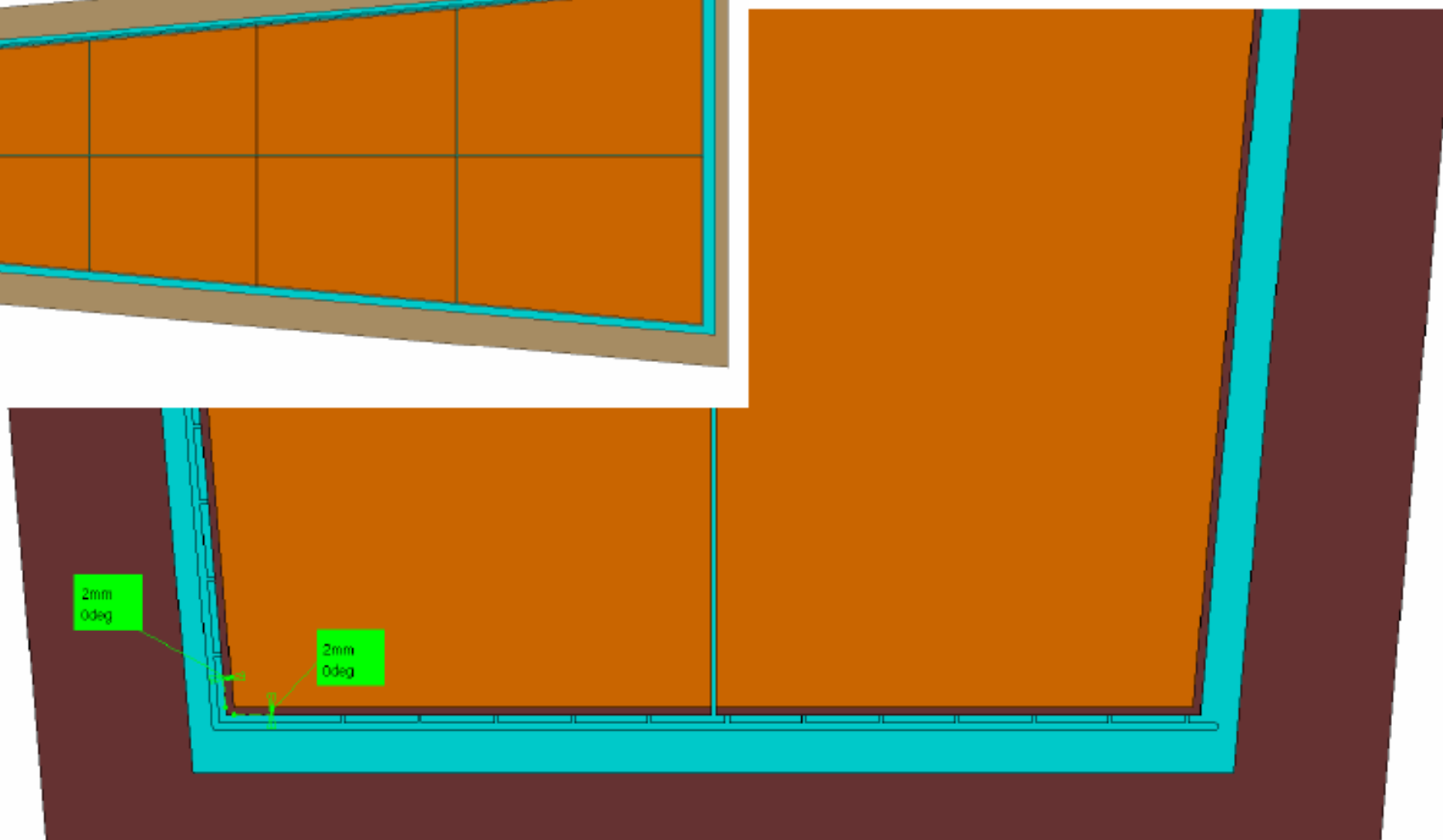
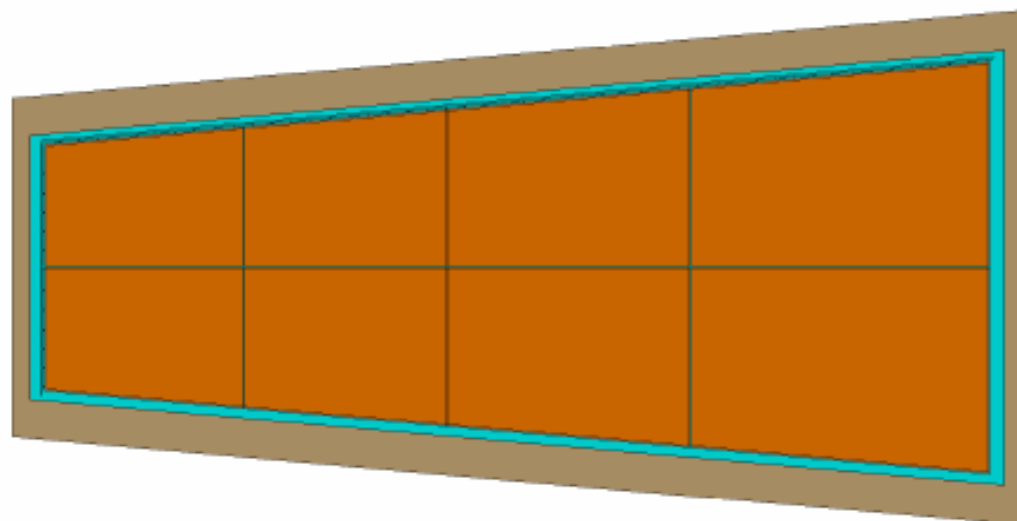
CONSTRUCTION OF THE LARGE PROTOTYPE - CMS GE1/1



CMS Prototype GEM - Stack

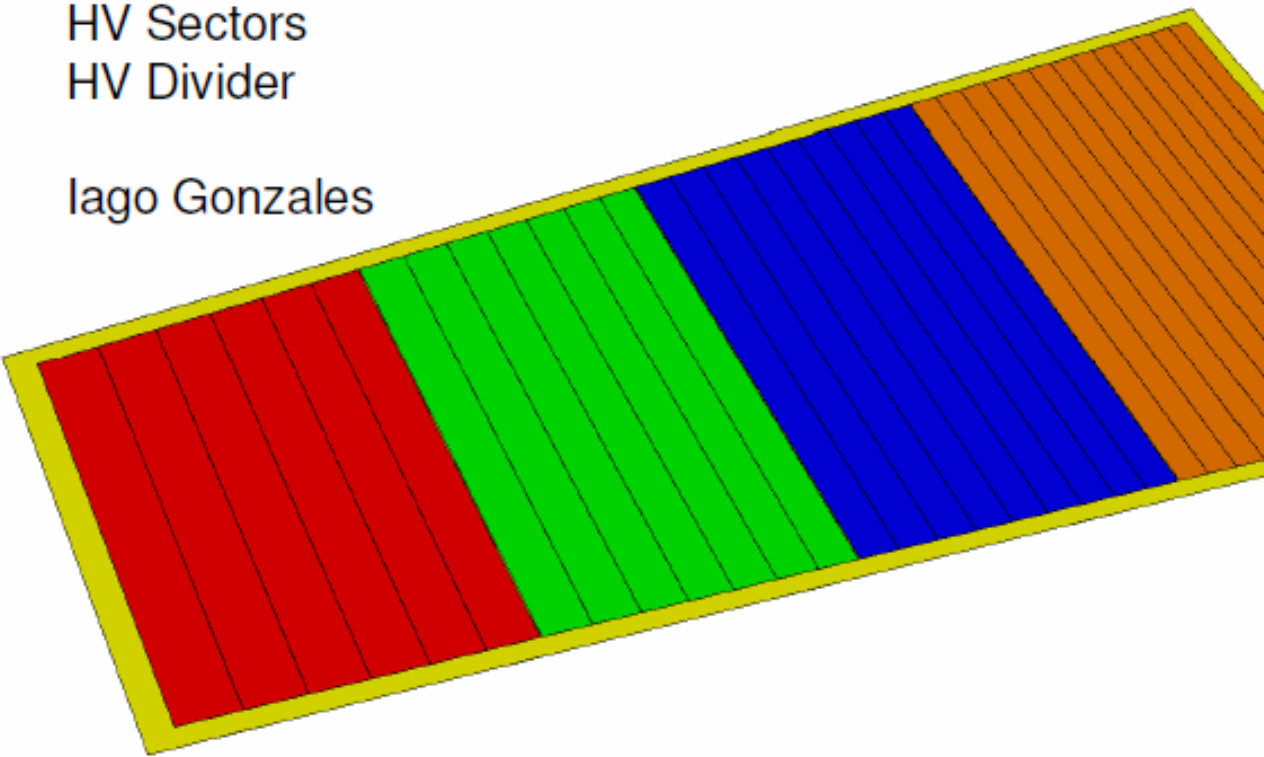


Frames, spacers and grooves for gas



HV Sectors
HV Divider

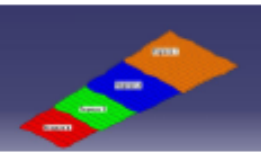
Iago Gonzales



DIMENSION OF THE TRAPEZES

Trapez 1

	a (mm)	A (mm/2)	b (mm)	h (mm)
1.000	418.054	9200.300	416.080	22.000
2.000	418.057	9200.300	417.180	22.210
3.000	418.140	9200.300	408.220	22.420
4.000	408.183	9200.300	404.330	22.630
5.000	404.200	9200.300	400.500	22.840
6.000	400.174	9200.300	396.130	23.050
7.000	396.105	9200.300	392.020	23.260
8.000	392.094	9200.300	387.860	23.470
9.000	387.830	9200.300	383.660	23.680
10.000	383.645	9200.300	379.430	23.890
11.000	379.364	9200.300	375.170	24.100
12.000	375.100	9200.300	370.790	24.310
13.000	370.758	9200.300	366.340	24.520



Trapez 2

	a (mm)	A (mm/2)	b (mm)	h (mm)
1.000	305.180	9200.300	307.600	26.100
2.000	301.275	9200.300	306.040	26.440
3.000	295.021	9200.300	301.230	26.780
4.000	285.209	9200.300	297.890	27.190
5.000	281.020	9200.300	294.020	27.520
6.000	276.488	9200.300	287.690	27.830
7.000	271.637	9200.300	281.710	28.140
8.000	267.086	9200.300	277.650	28.470
9.000	262.625	9200.300	273.680	28.800



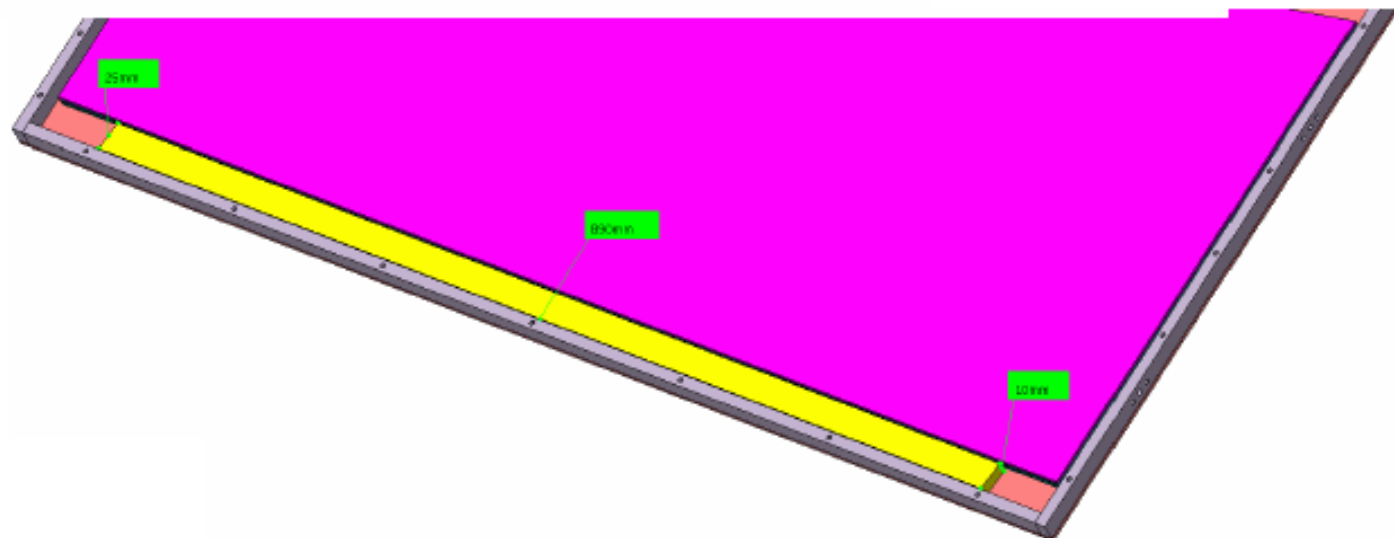
Trapez 3

	a (mm)	A (mm/2)	b (mm)	h (mm)
1.000	312.500	9200.300	317.570	28.100
2.000	312.548	9200.300	311.530	28.840
3.000	312.595	9200.300	305.490	29.580
4.000	307.388	9200.300	300.230	30.410
5.000	307.181	9200.300	296.030	30.730
6.000	295.883	9200.300	291.510	30.670
7.000	291.480	9200.300	286.000	31.330

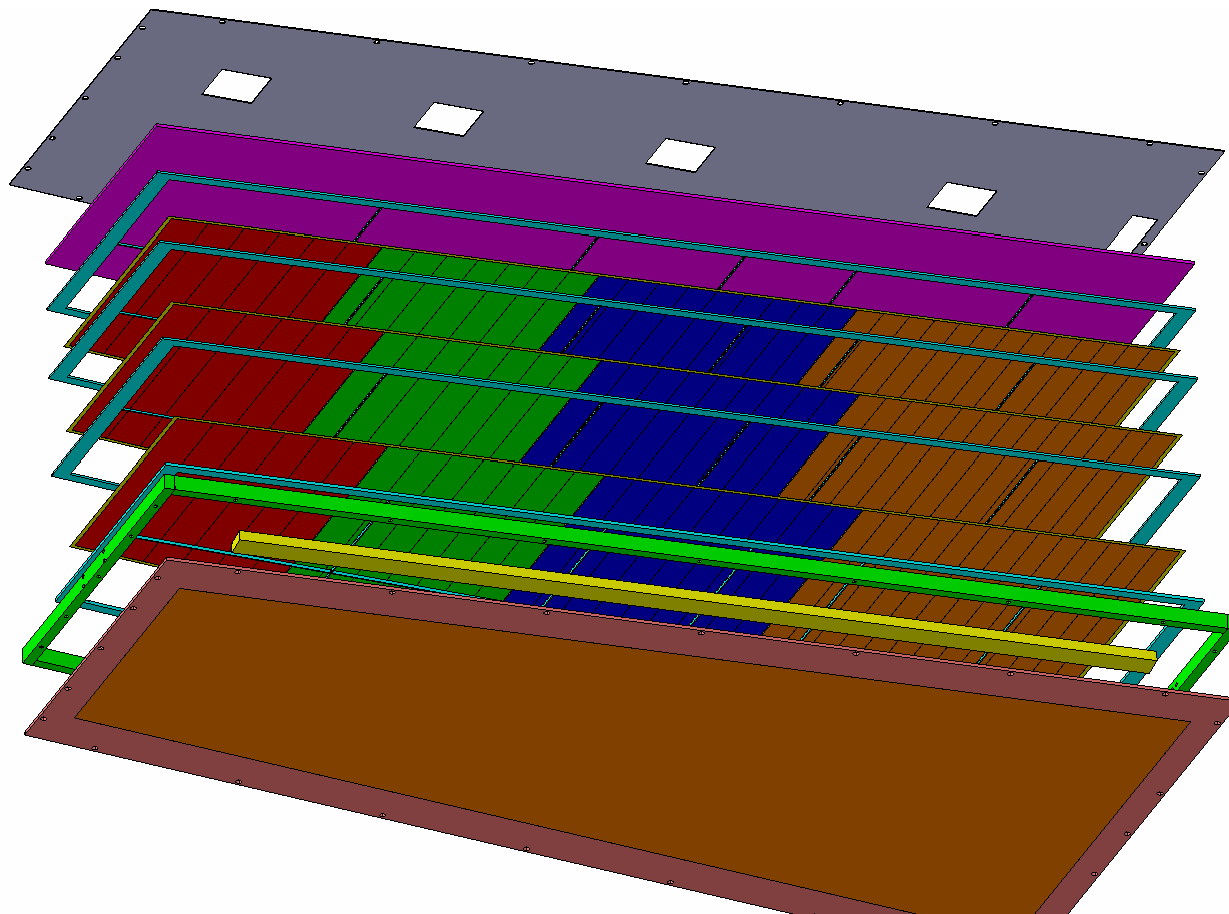
Trapez 4

	a (mm)	A (mm/2)	b (mm)	h (mm)
1.000	297.334	9200.300	298.230	31.970
2.000	298.314	9200.300	297.820	32.420
3.000	294.277	9200.300	293.640	33.130
4.000	288.620	9200.300	287.670	34.060
5.000	282.633	9200.300	284.510	34.860
6.000	285.506	9200.300	280.230	35.230

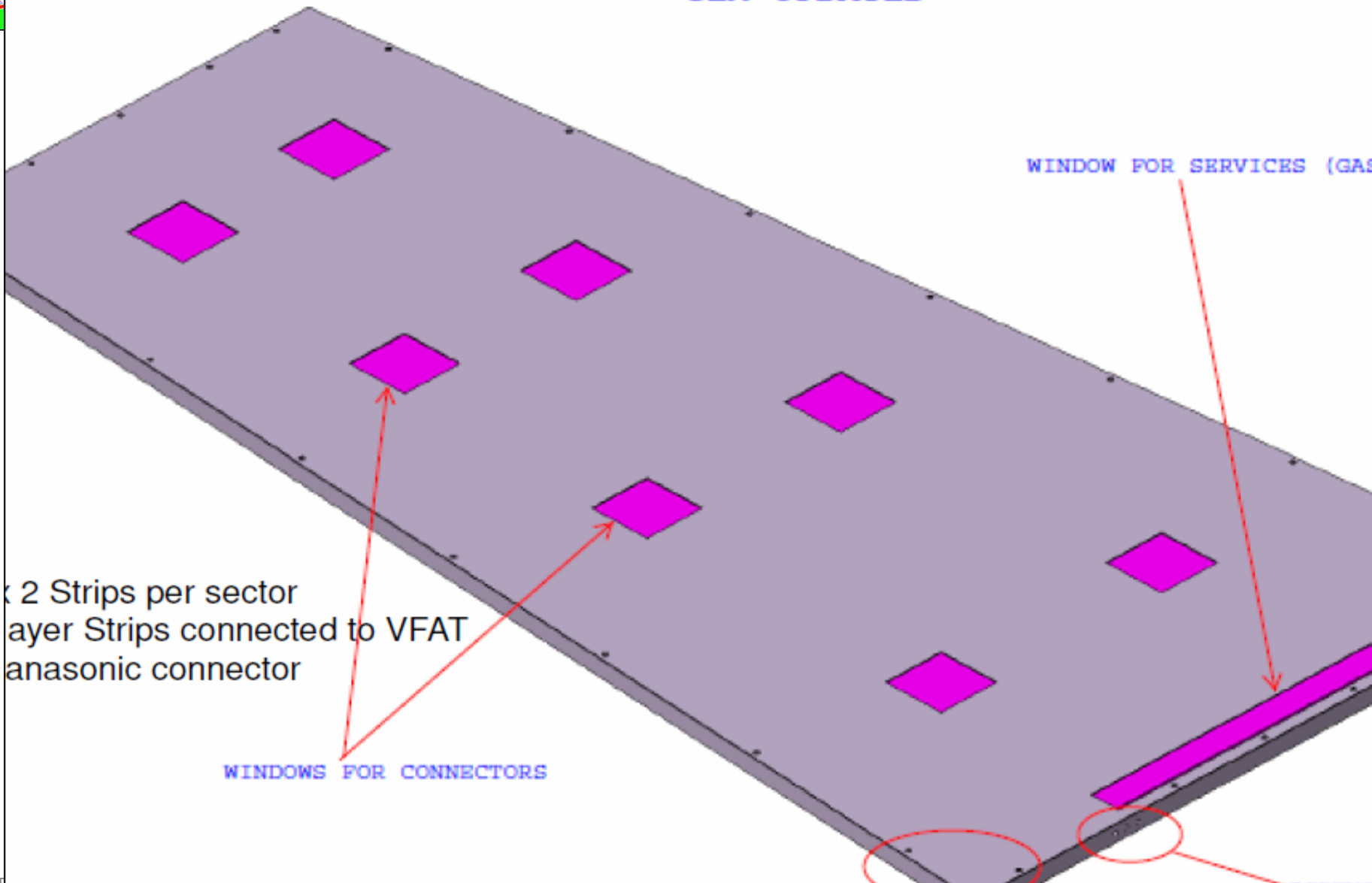
Iago Gonzales Tablero
PH-CMX-05
12/1/2010



CMS Prototype GEM - Stack



GEM UPDATED



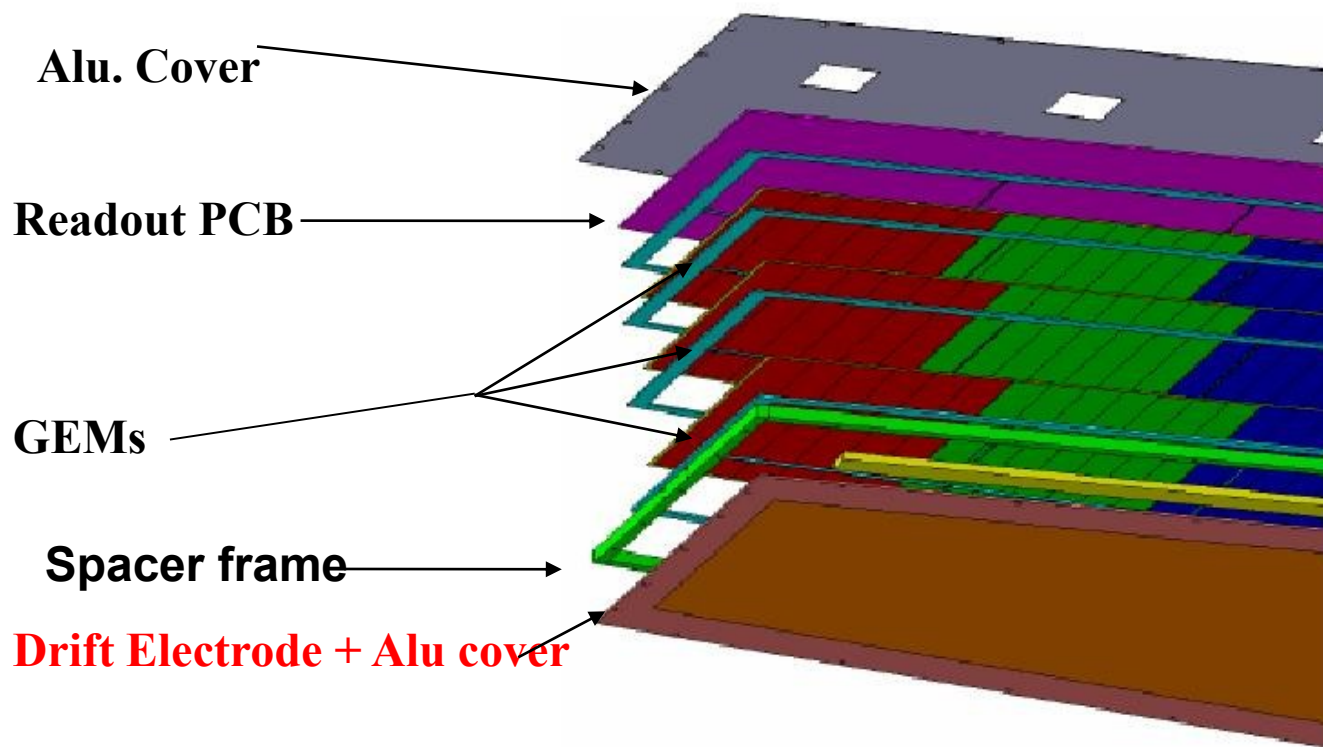
2 Strips per sector
layer Strips connected to VFAT
anasonic connector

WINDOWS FOR CONNECTORS

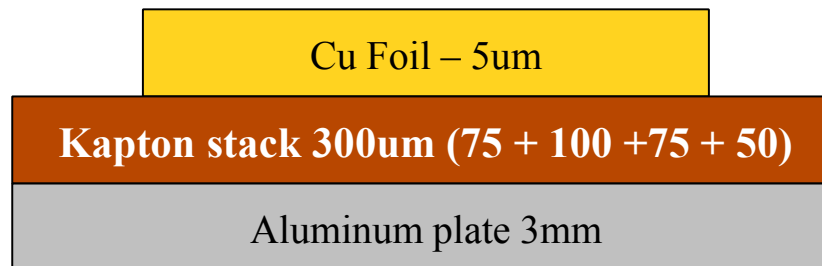
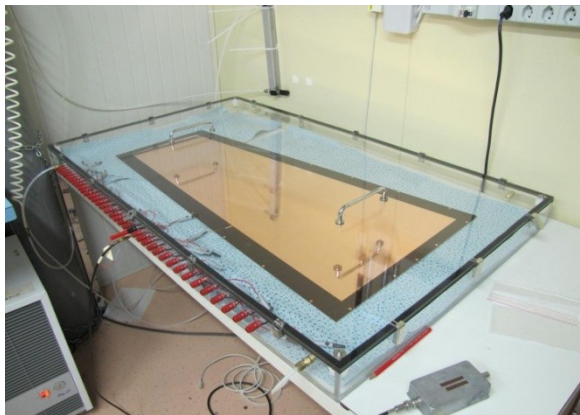
WINDOW FOR SERVICES (GAS)



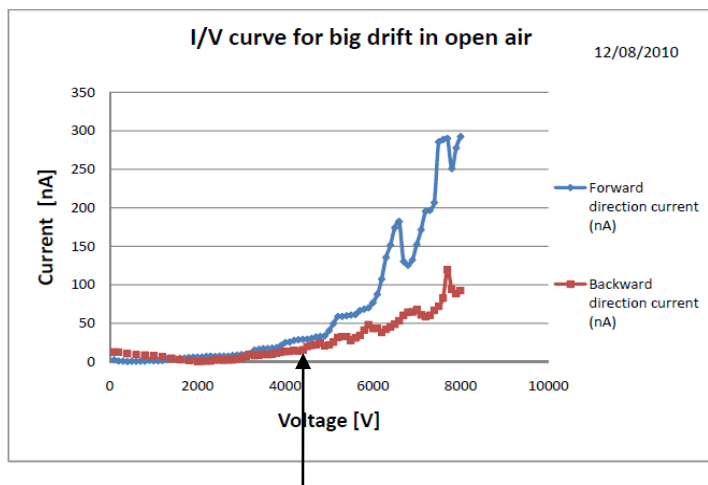
GE1/1 3D Model



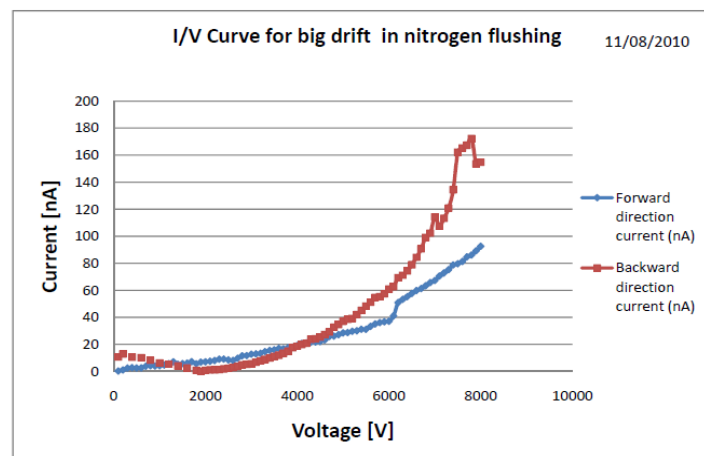
GE1/1 Drift Electrode



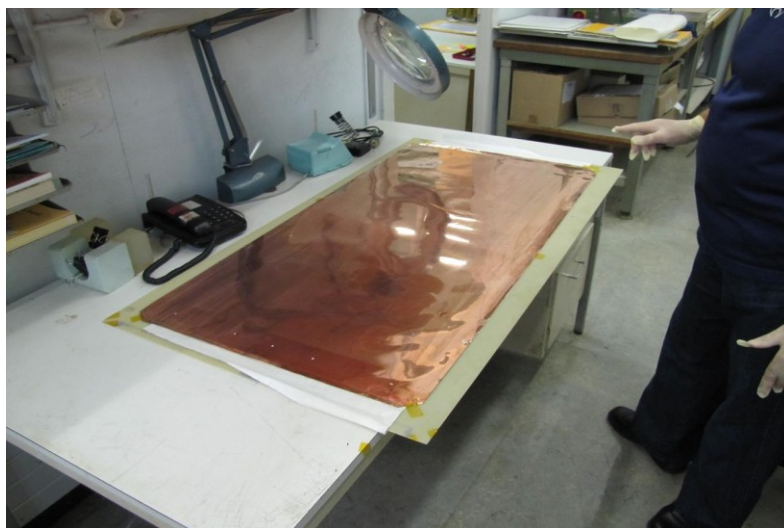
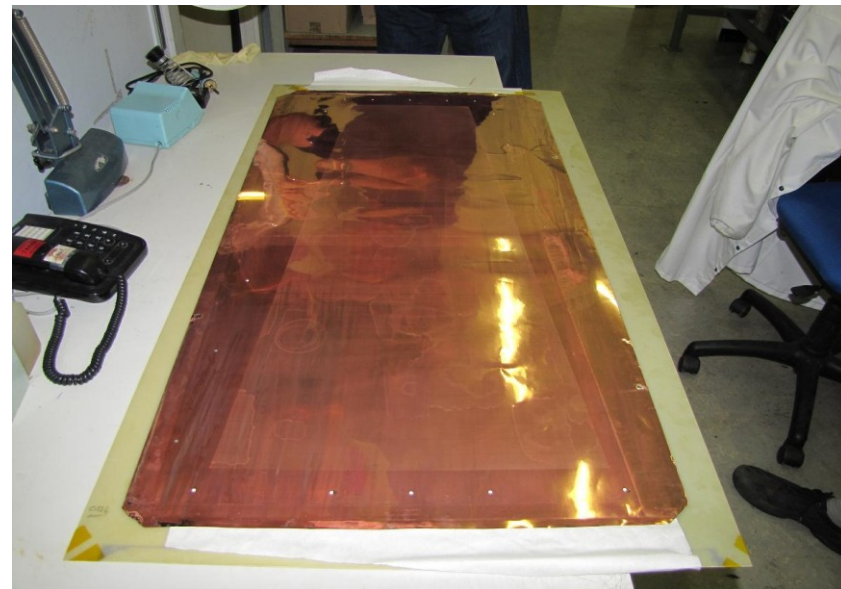
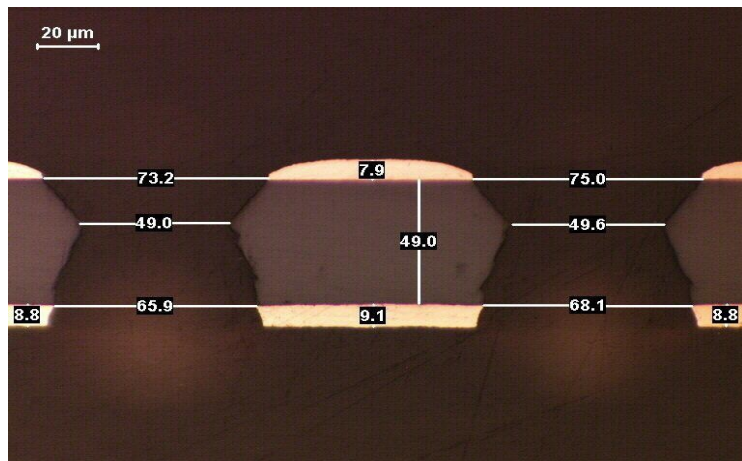
The operation voltage is 4.5kV
 The leakage current is 20nA in open air



Working point



Production of CMS Single Mask (SM) GEMs

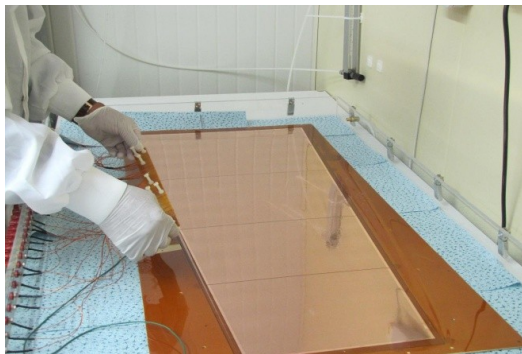


Single Mask technology
eliminates
alignment of the holes issue
Size 990/45.5/22 mm

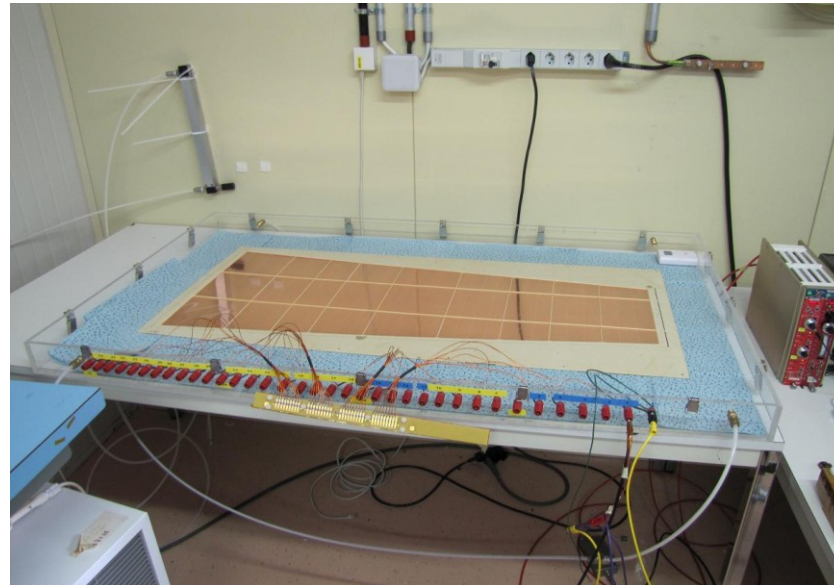
Before and after stretching and framing, the GEMs are passing QT of the GE1/1

1. Optical inspection
2. HV test before stretching
3. HV test after stretching

→ Applying up to 500V between the top sector and the bottom layer plus the 2 neighbor sectors as well.

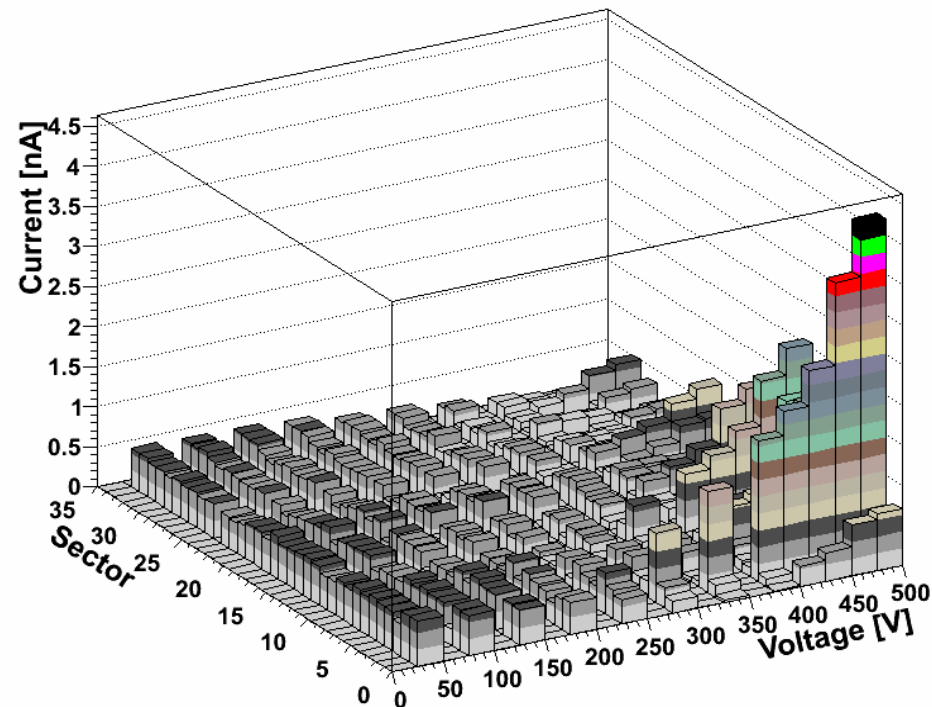
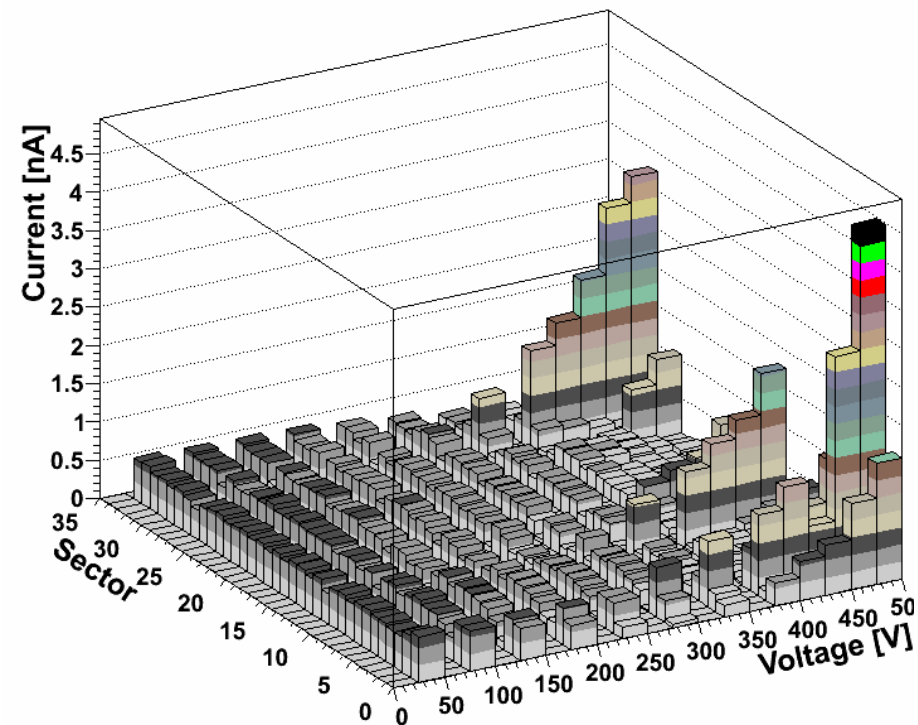


Testing sector by sector



GEM5_Foil

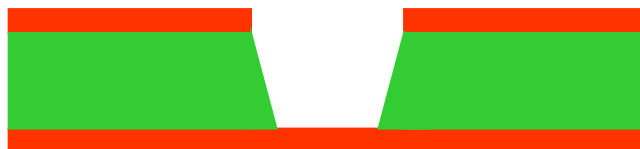
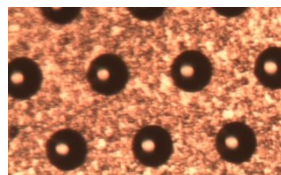
GEM5_Stretch



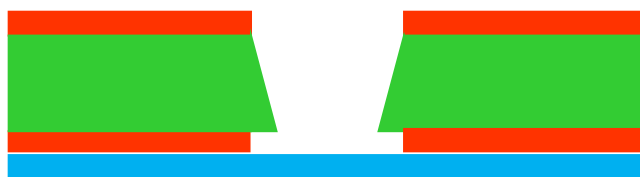
Criteria - Current less 10nA

Results of the HV test. Sectors/Voltage/Current

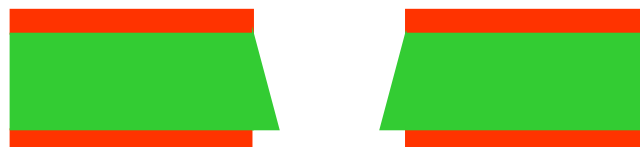
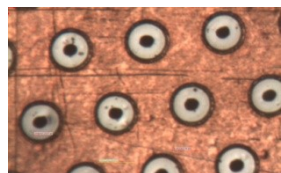
GEM single mask process



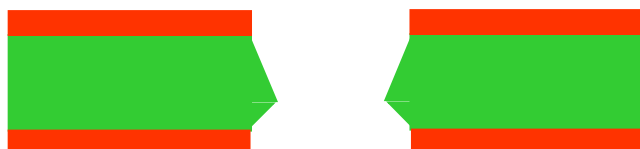
Chemical Polyimide etching



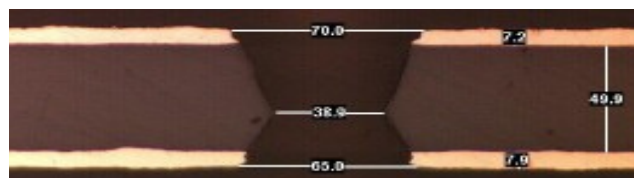
Copper electro etching



Stripping

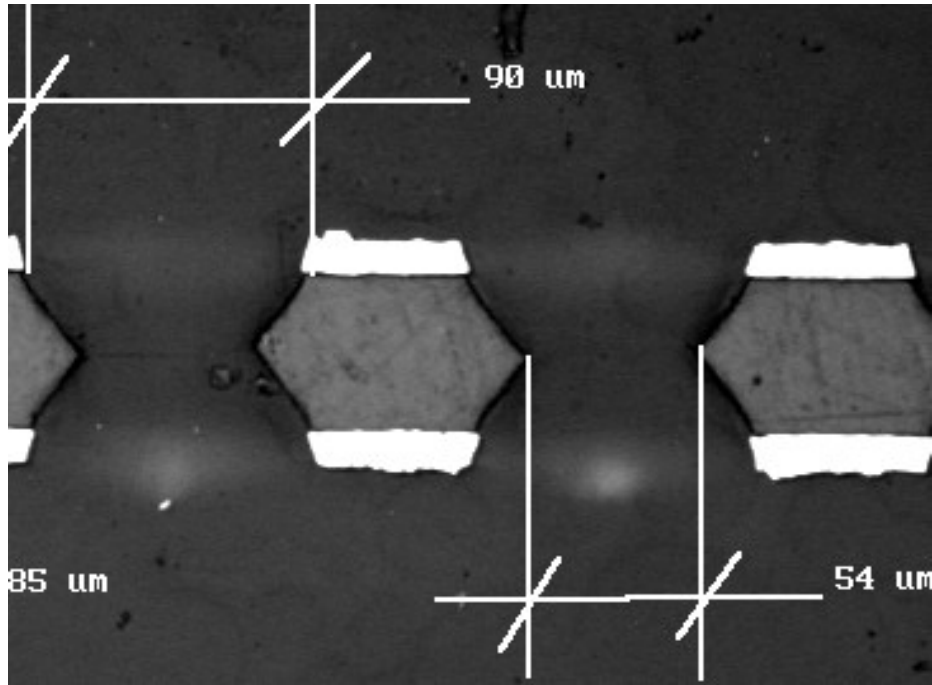
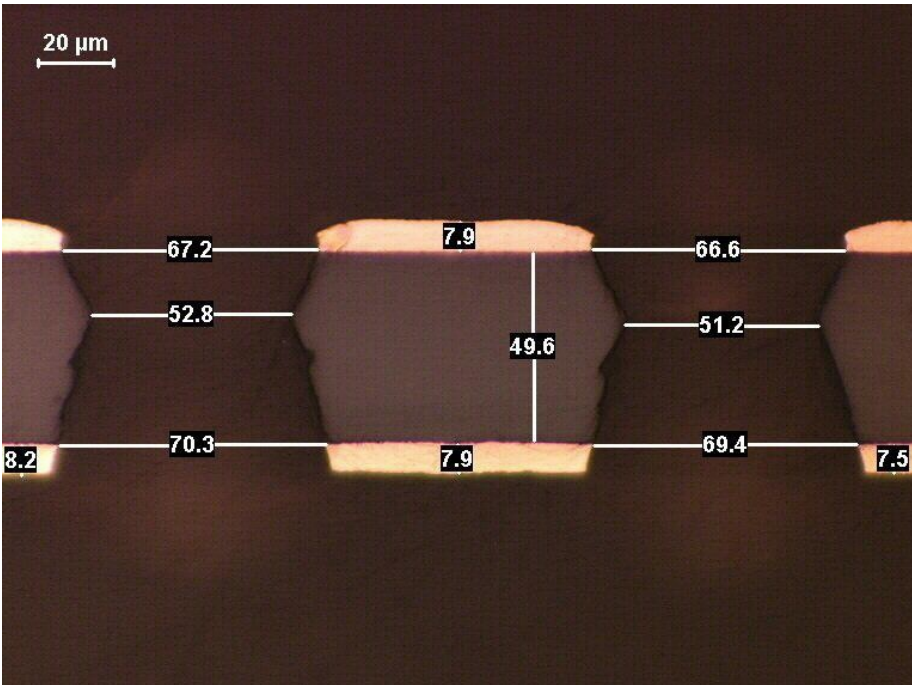


Second Polyimide etching



Reality

Comparison with *standard GEM* from external supplier



World Record !

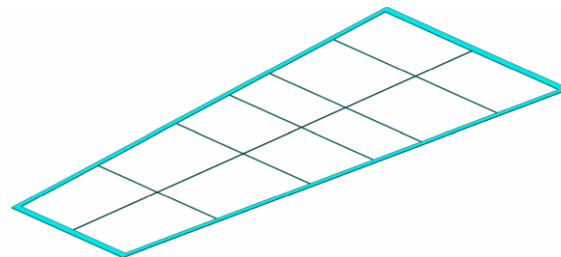
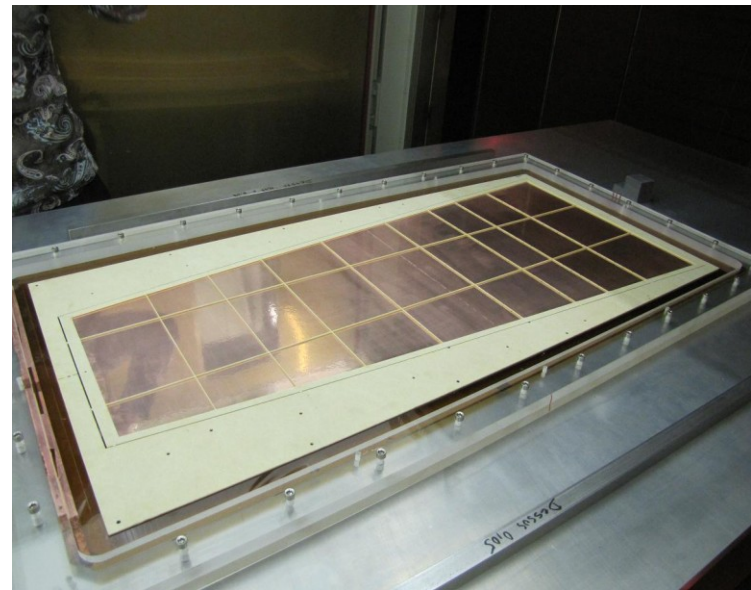
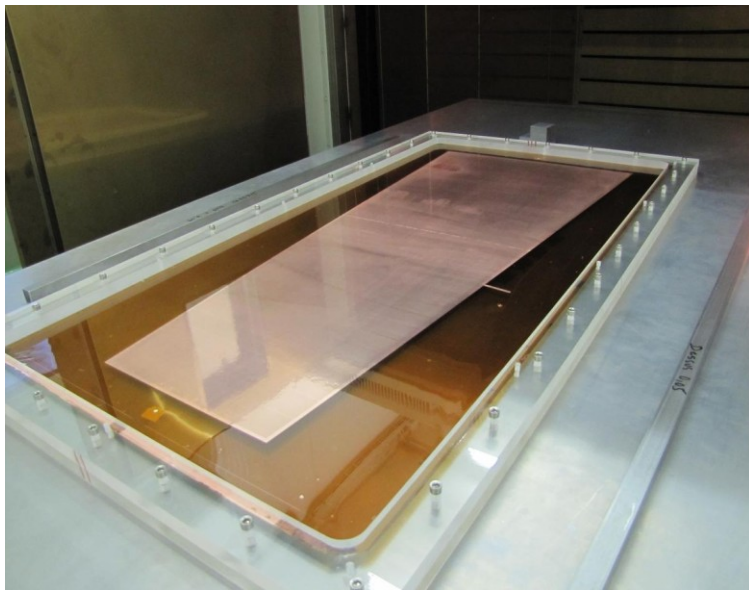
Rui's Workshop
builds
Largest
Single Mask GEMs



**CMS:
990 cm x 45.5cm x22 cm
(6 pieces)**

Stretching and Framing Procedure for GE1/1 GEMs

- Gluing the spacer frame on the GEM foil.





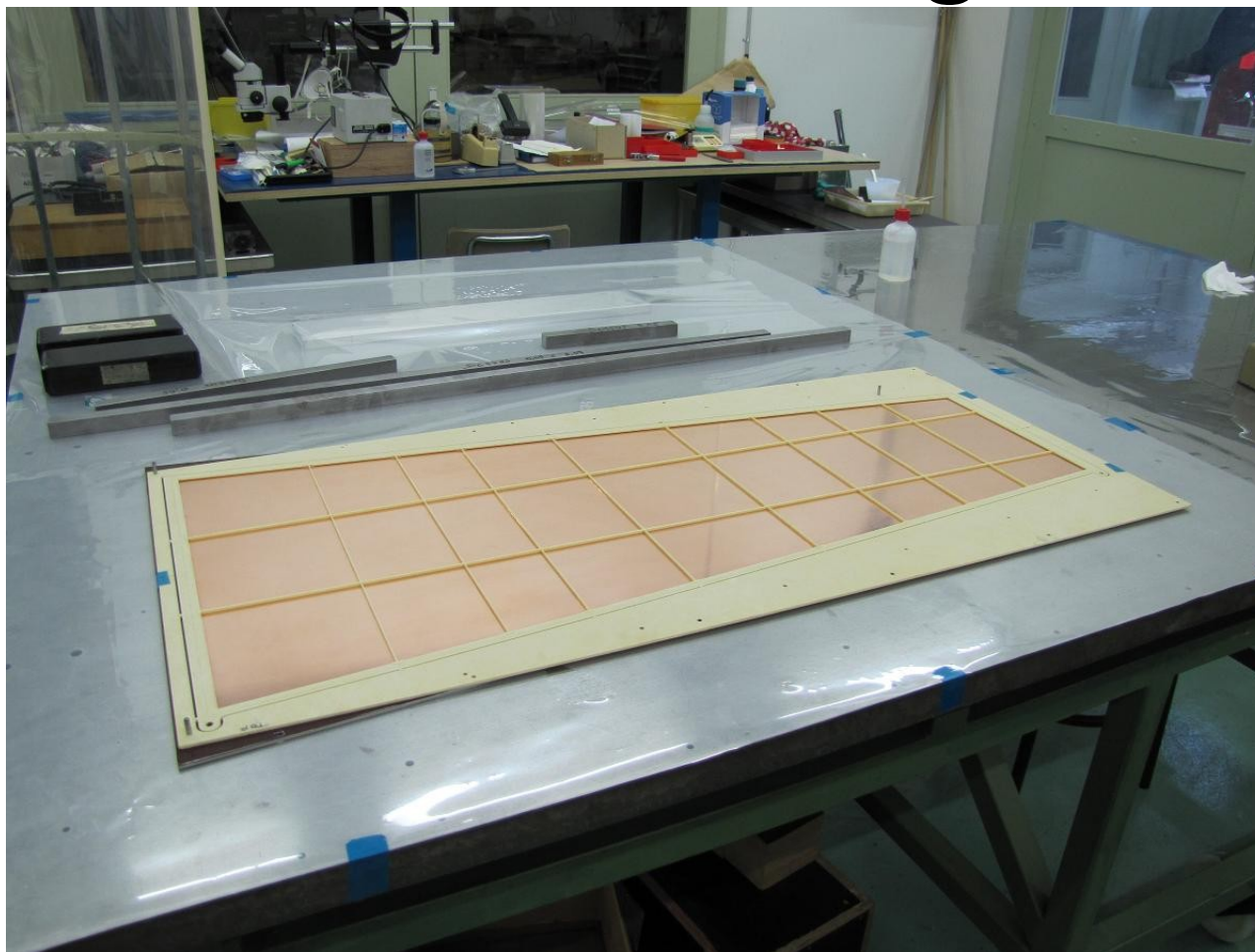
Stretching and Framing Procedure for GE1/1 GEMs



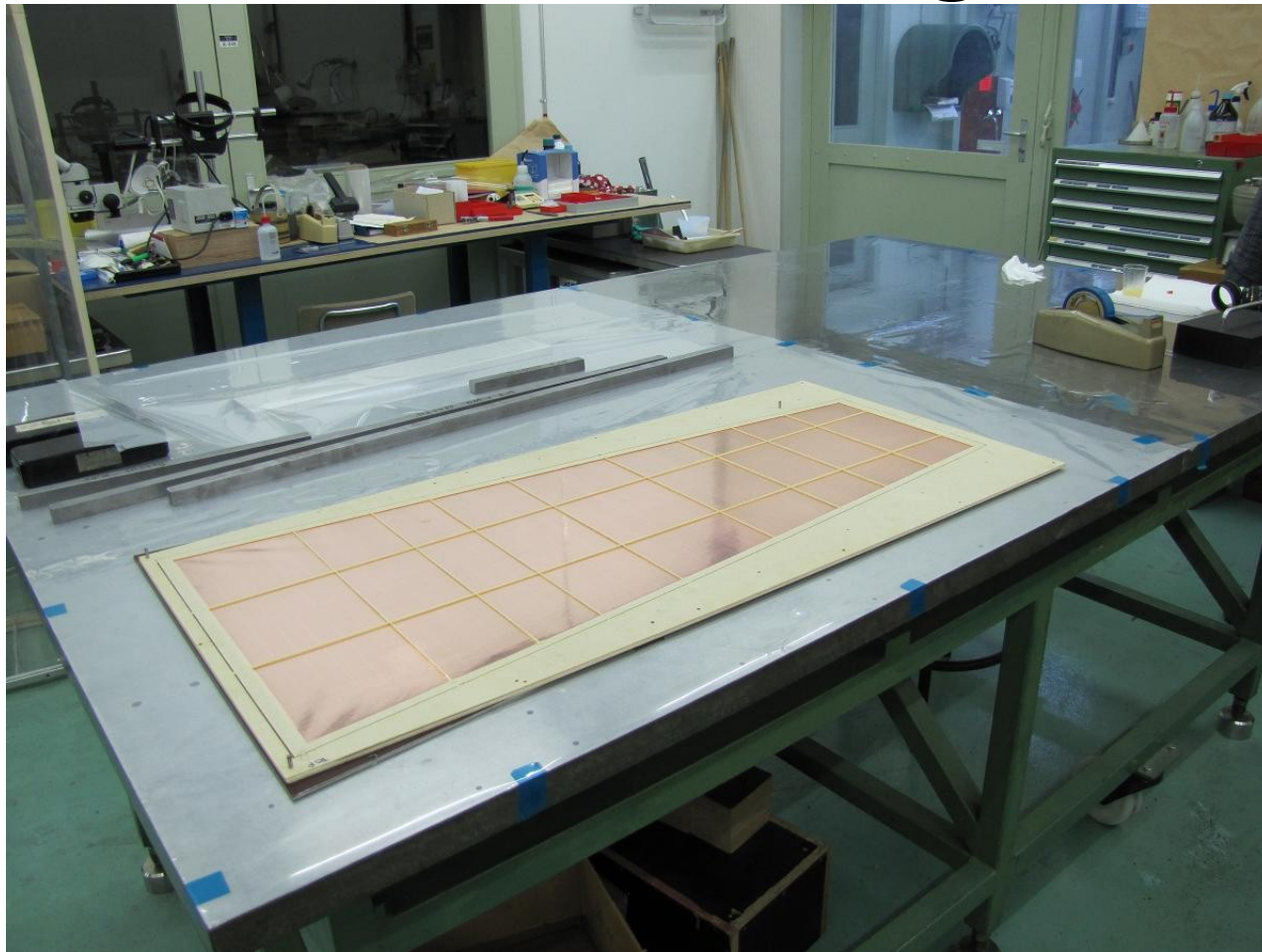
- The GEM foil, with glued frame, stays in the oven heated up to 37°C over 24 hours.



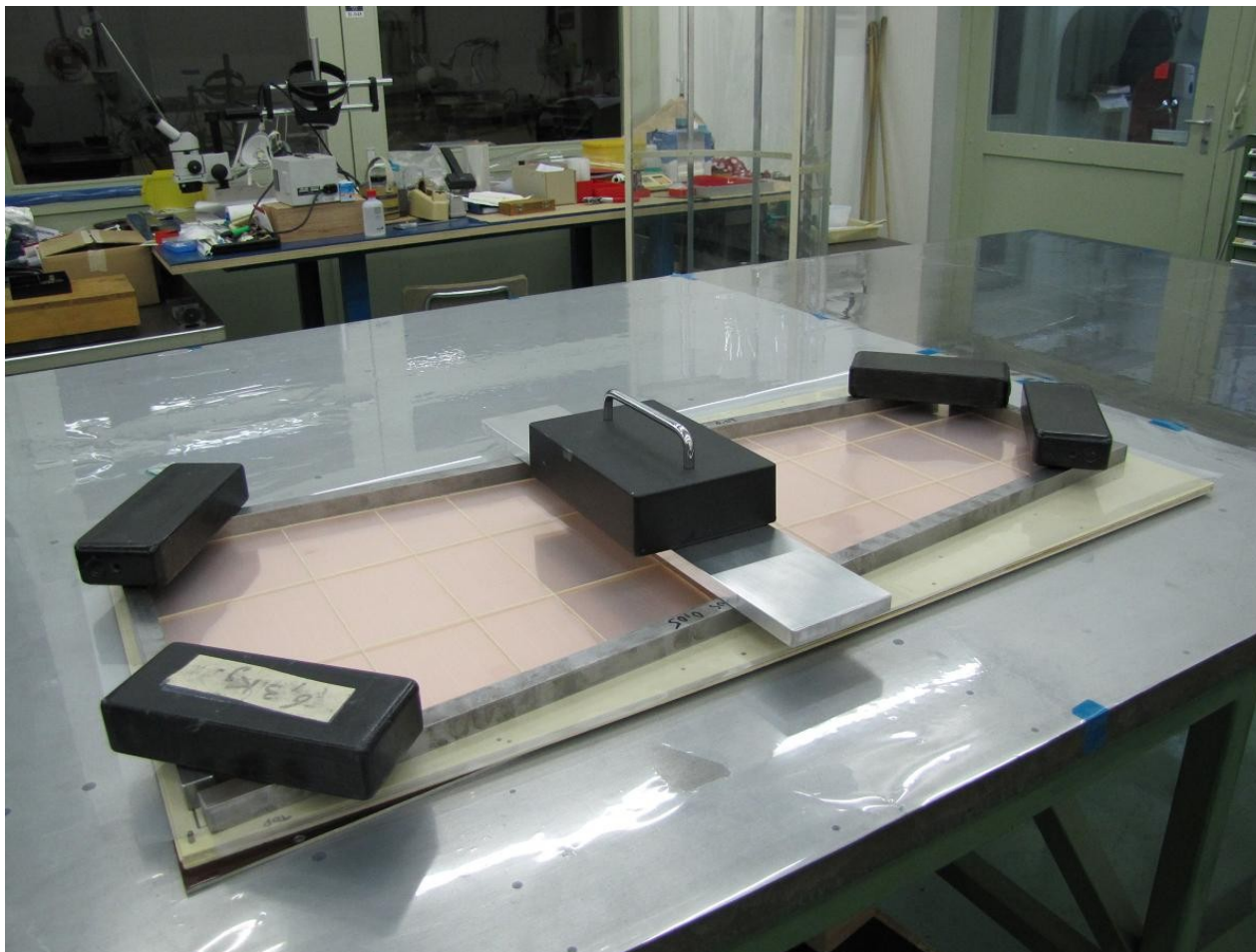
Glued drift and 3 gems



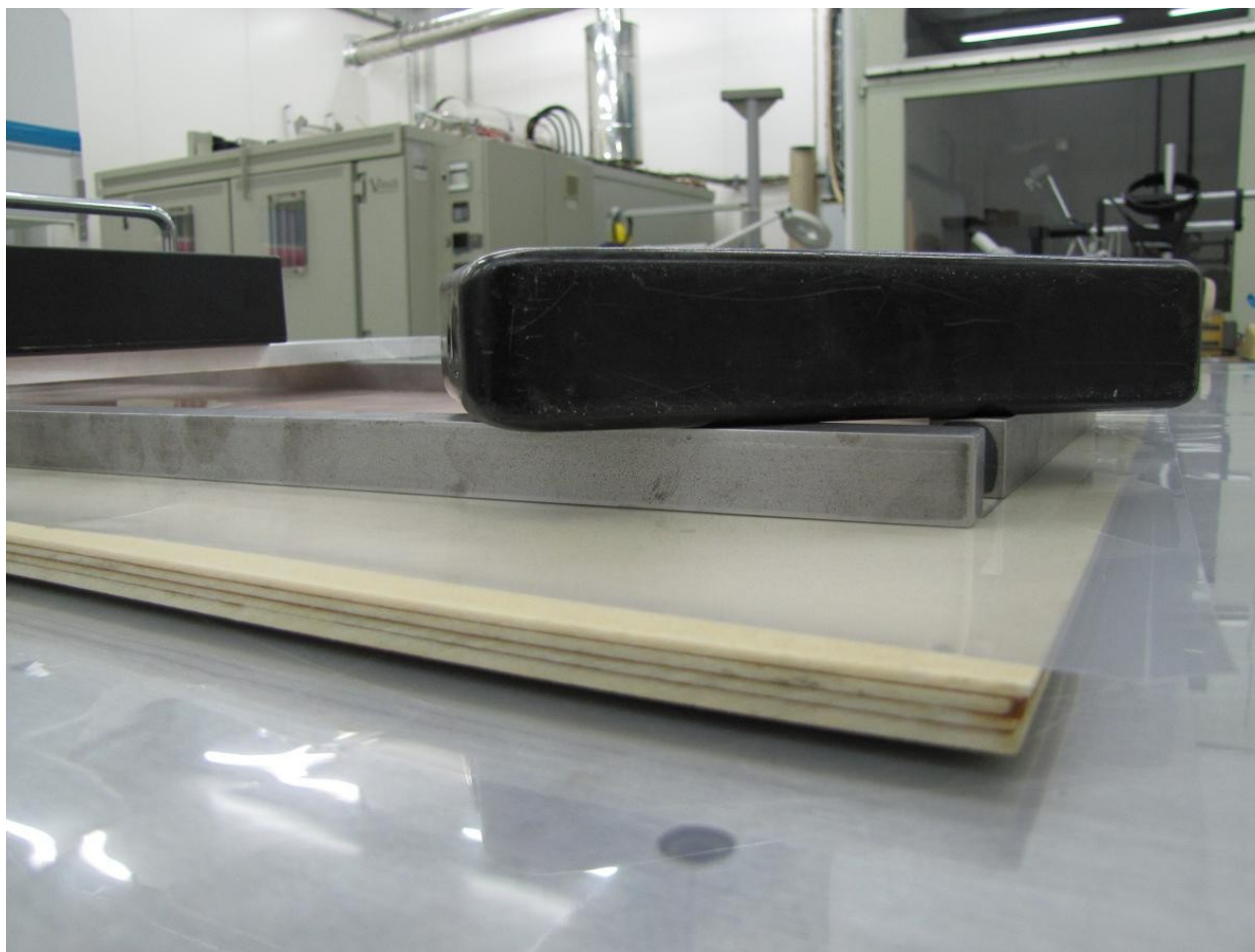
Glued drift and 3 gems



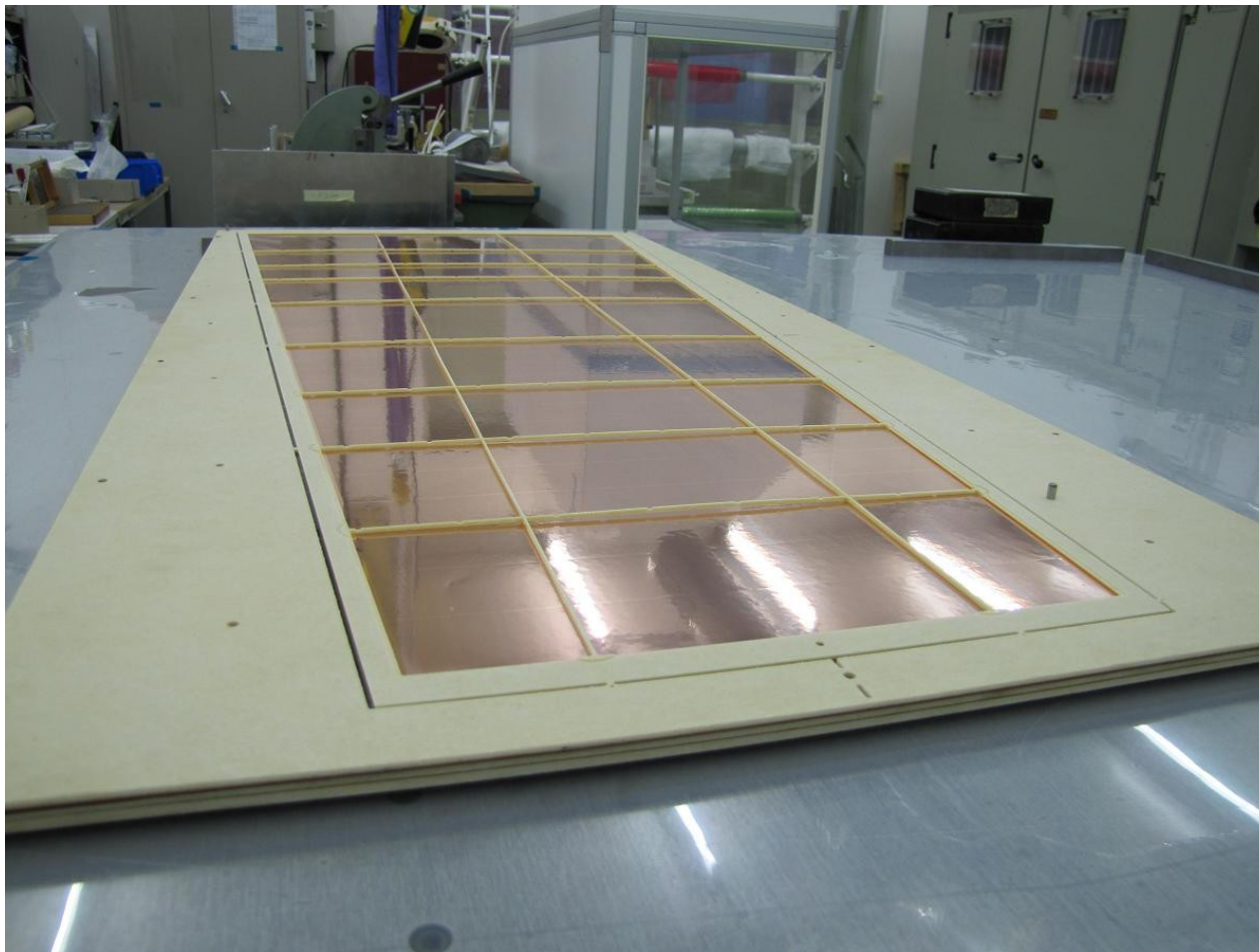
Weights on top



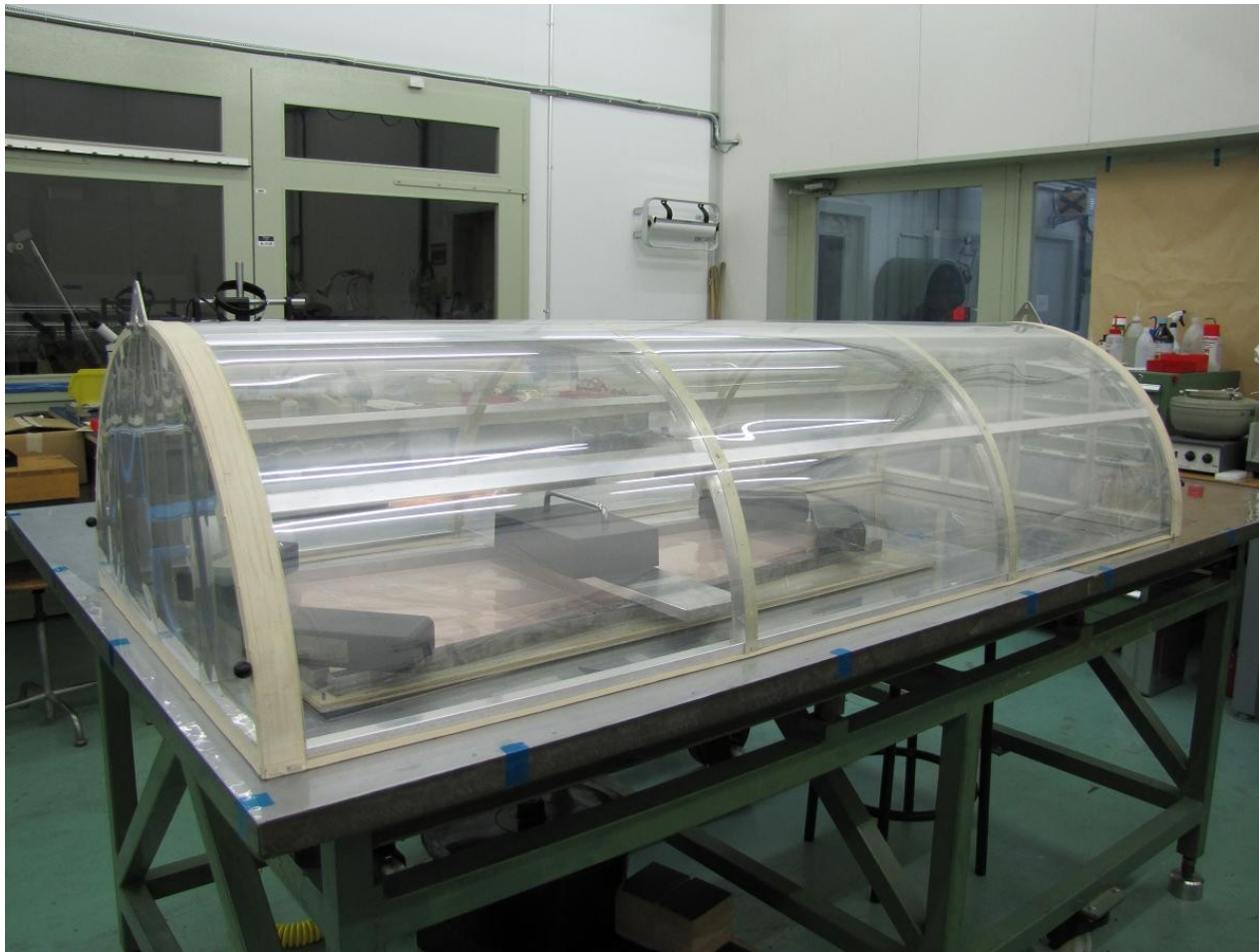
Corners



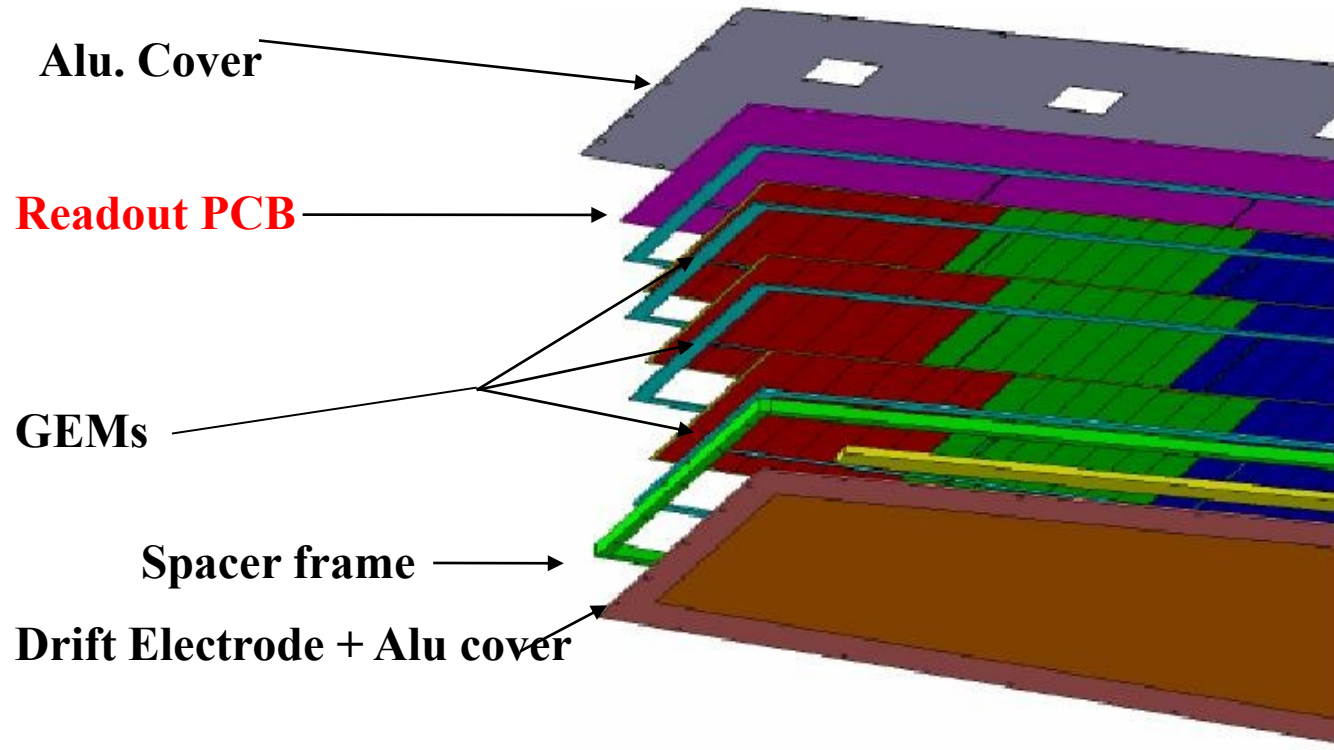
Without weights



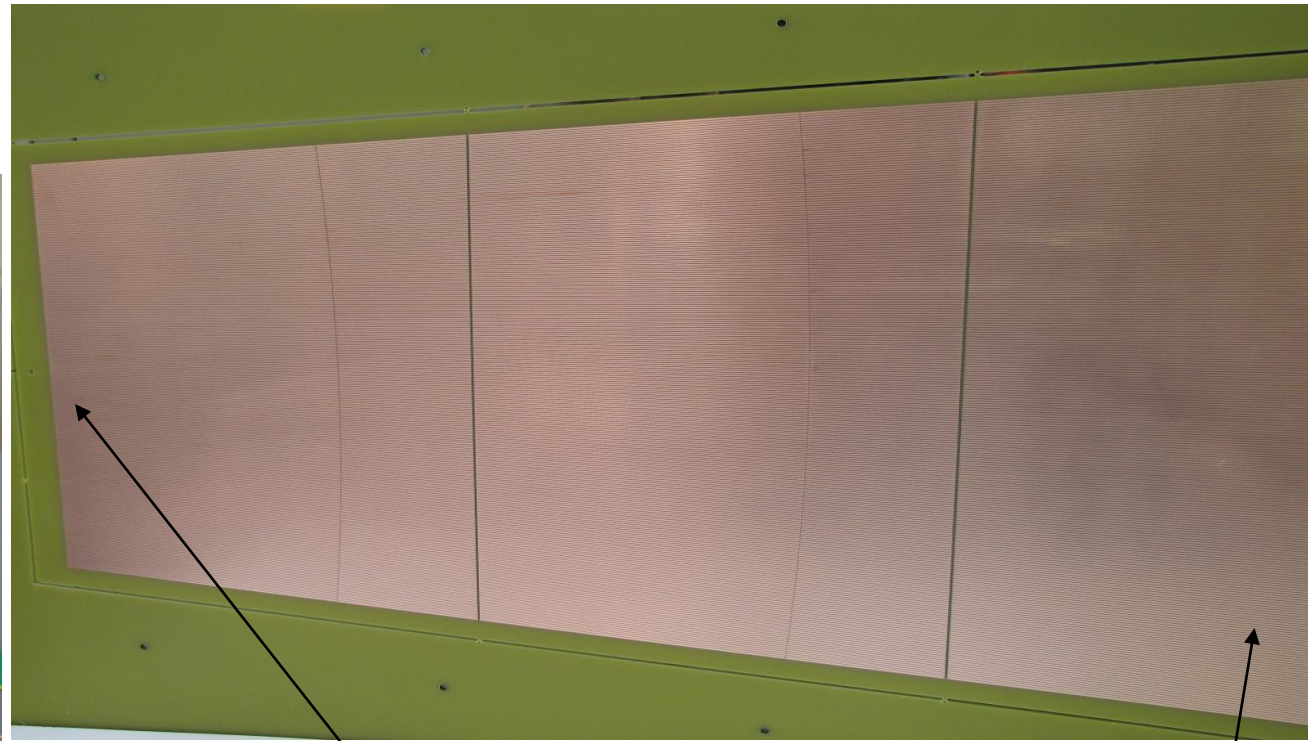
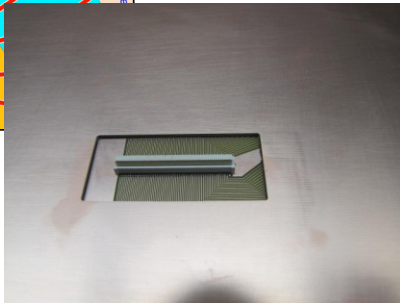
Waiting for the readout in safe



3D Model of GE1/1



Readout PCB



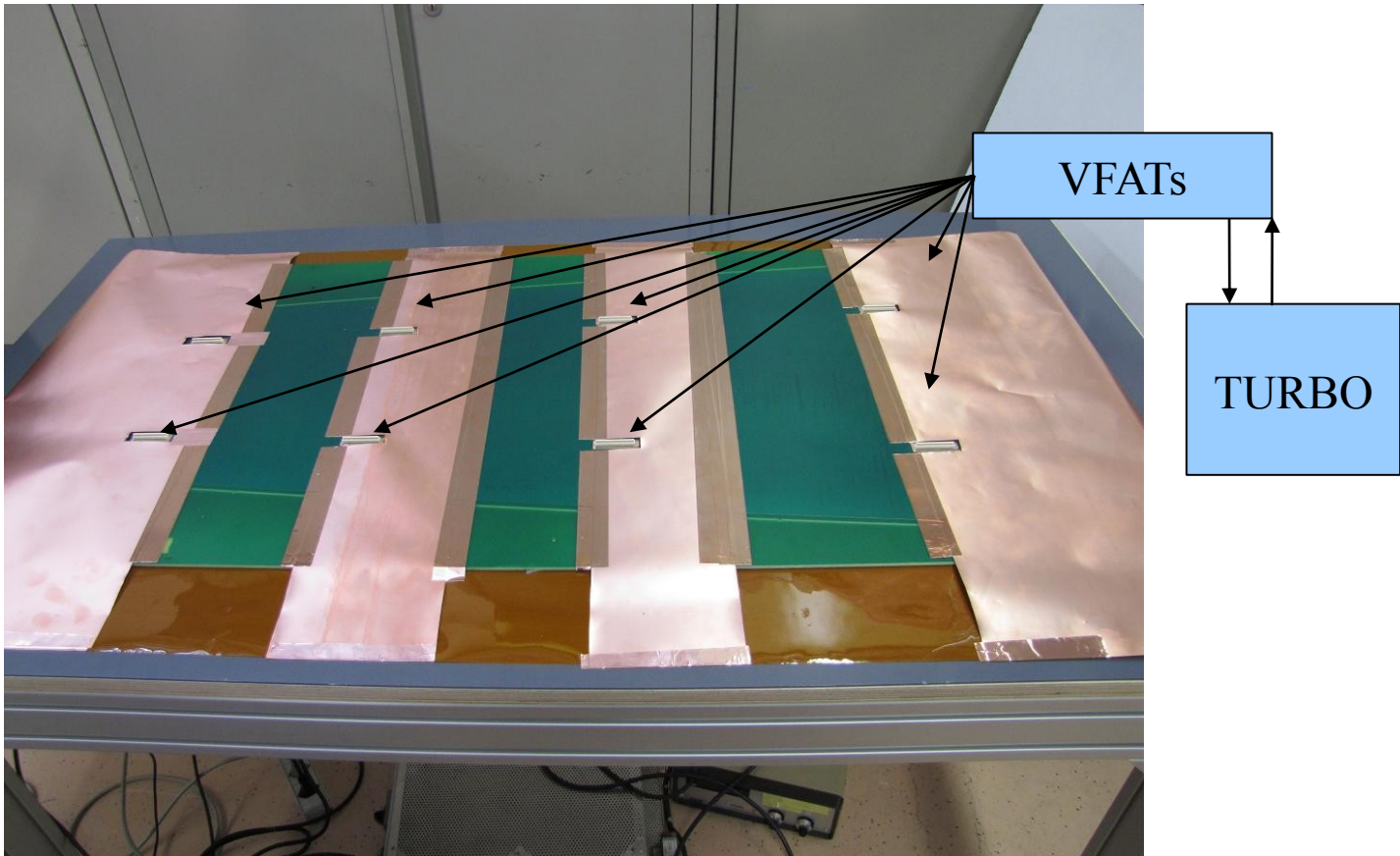
128 channels per connector
256 strips for each eta partition

0.8mm pitch

1.6mm pitch

PCB thickness = 3mm

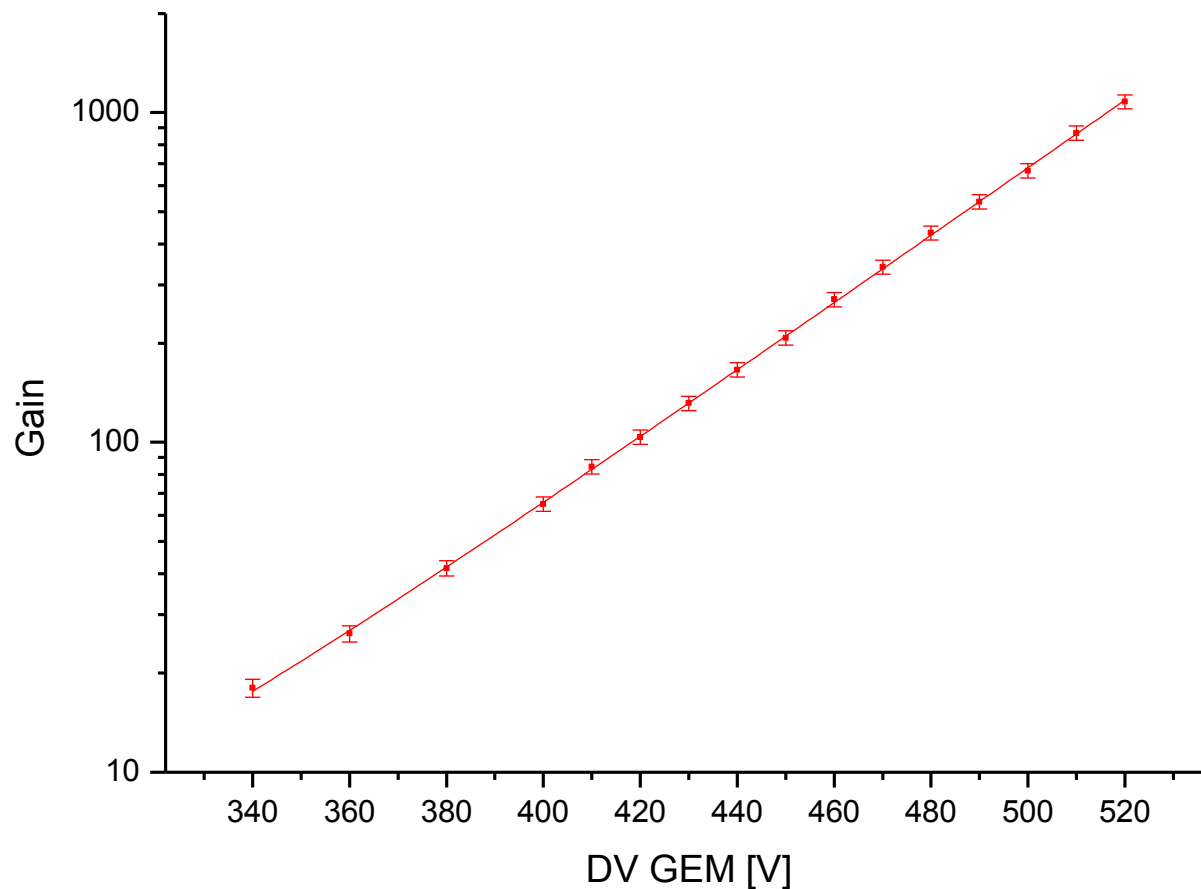
Readout Board Noise Test



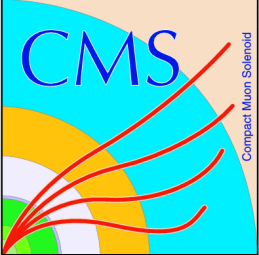
Noise test is with the VFAT electronics.



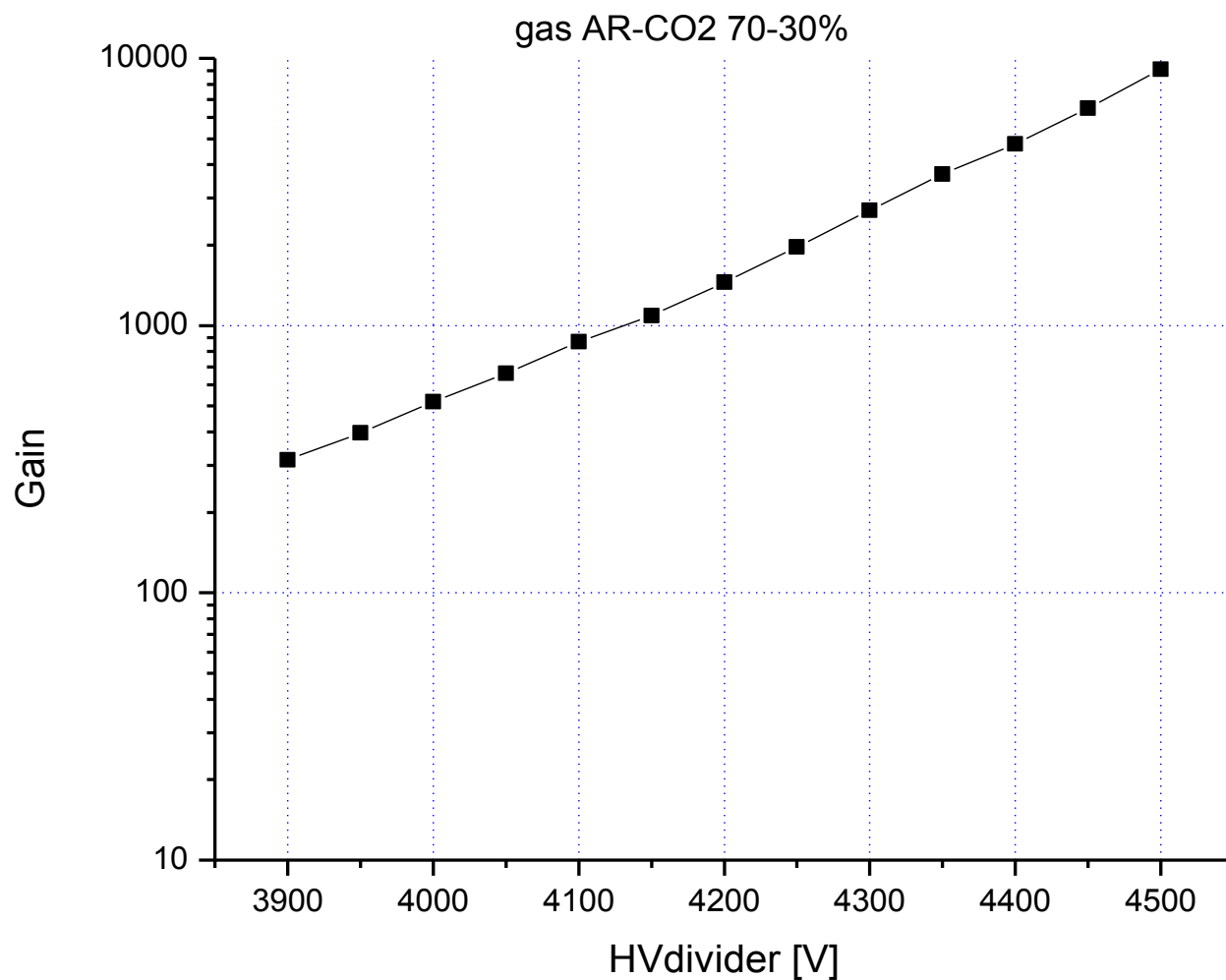
GAIN: SM 10 cm x 10 cm Single GEM



- $E_d = 2$ kV/cm
- $E_i = 3$ kV/cm
- Rate ~ 180 kHz/mm²
- Spark voltage ~ 530 V
- Max gain ~ 1080

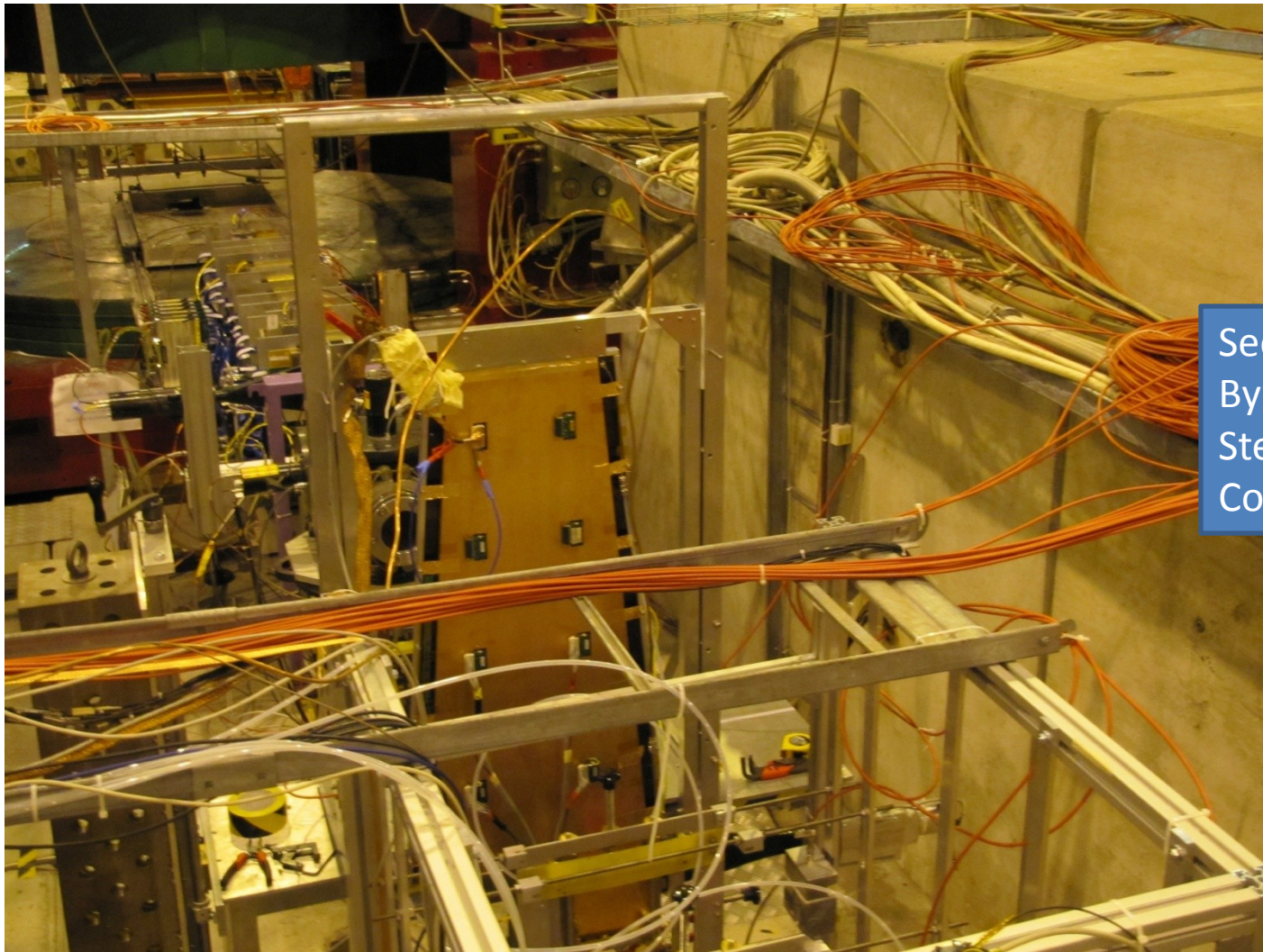


Gain: Triple GEM GE1/1 Proto



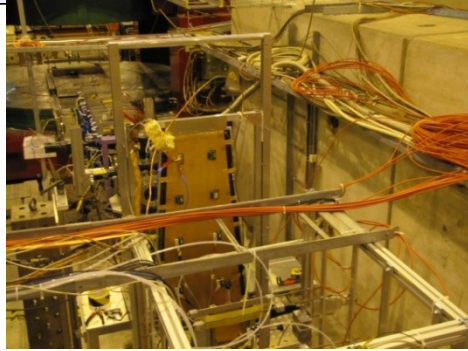
See talk
By
Andrey Marinov
&
Michal Zientek

Beam Tests

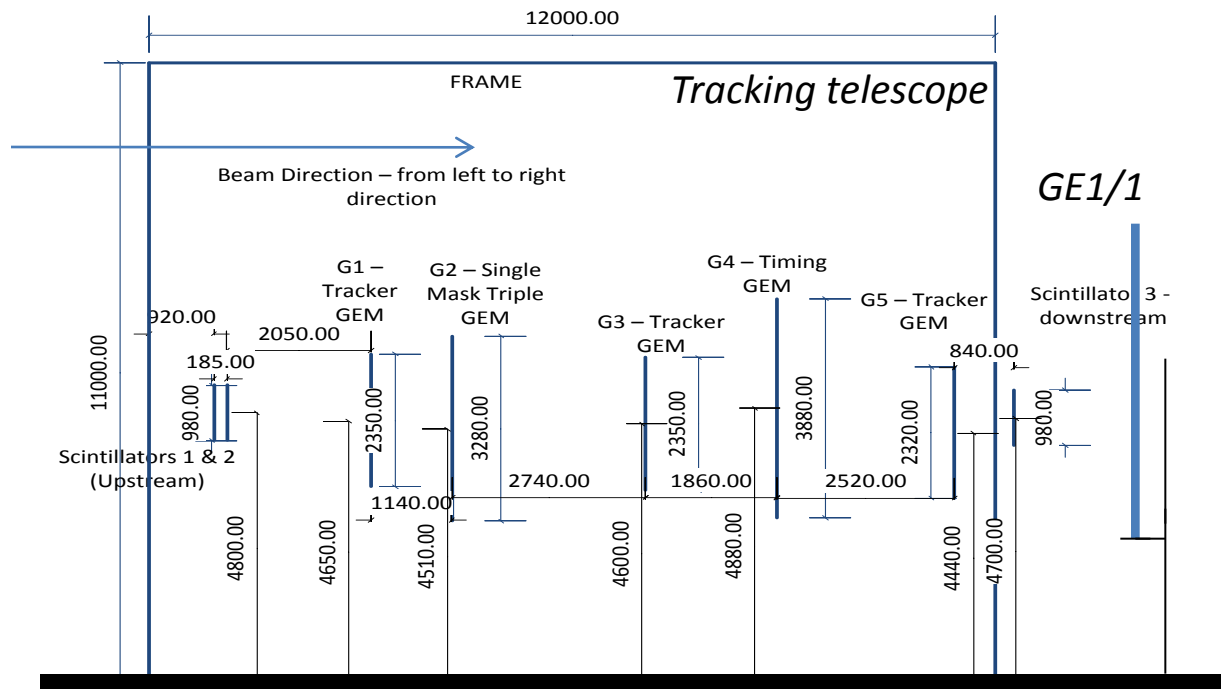
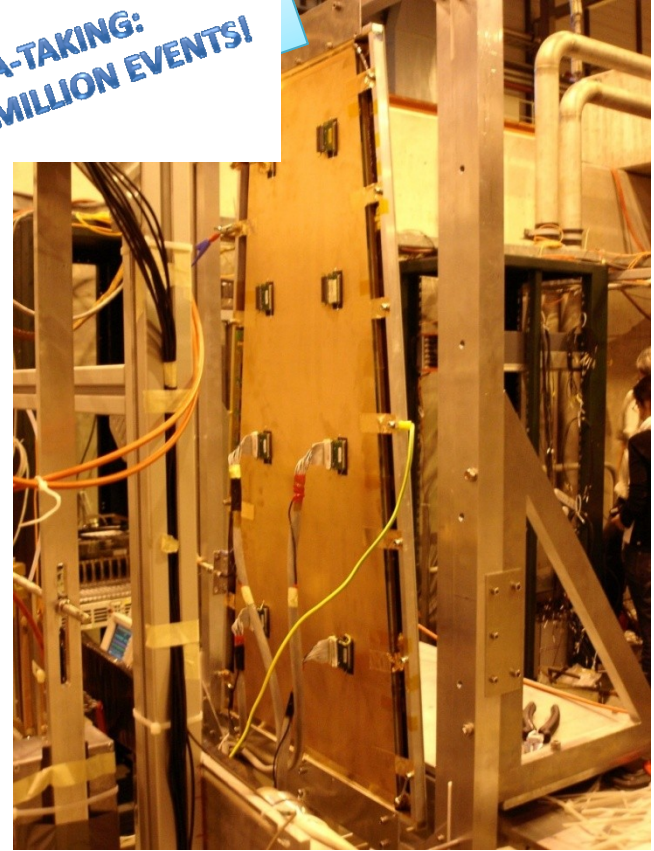


See talk
By
Stefano
Colafranceschi

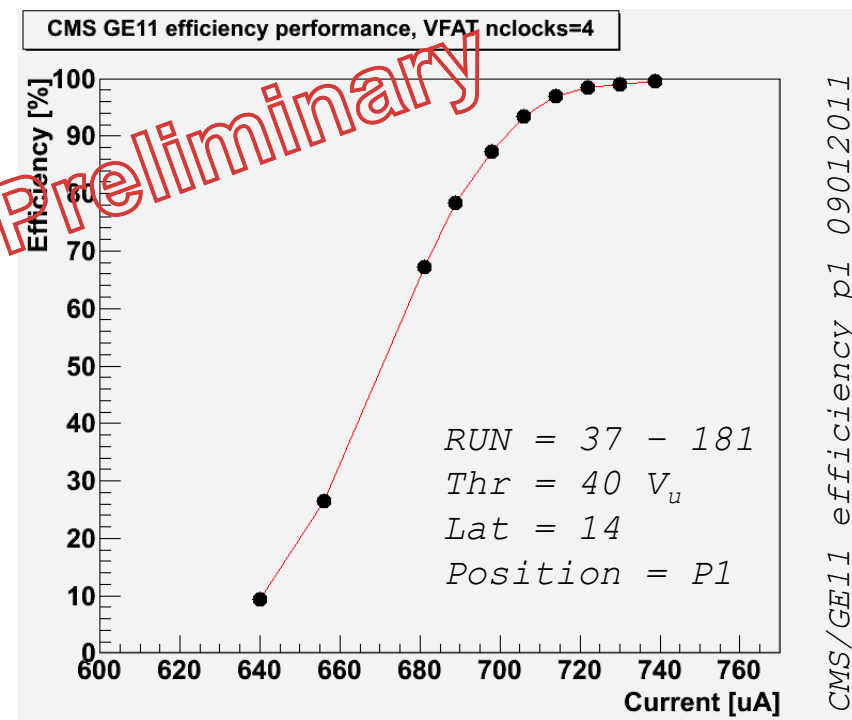
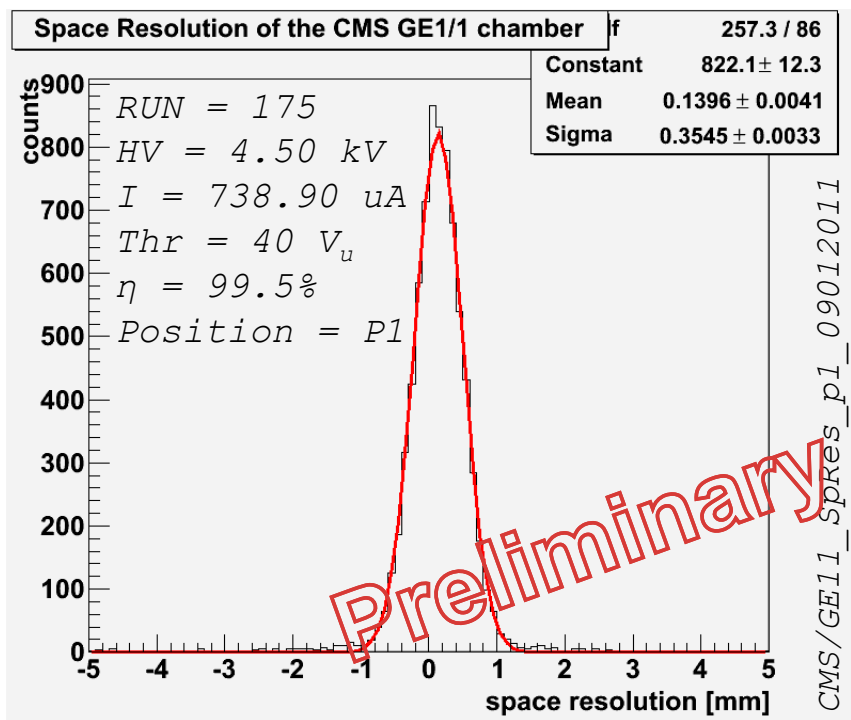
BeamTest @ RD51 setup (H4 – SPS)



**DATA-TAKING:
20 MILLION EVENTS!**



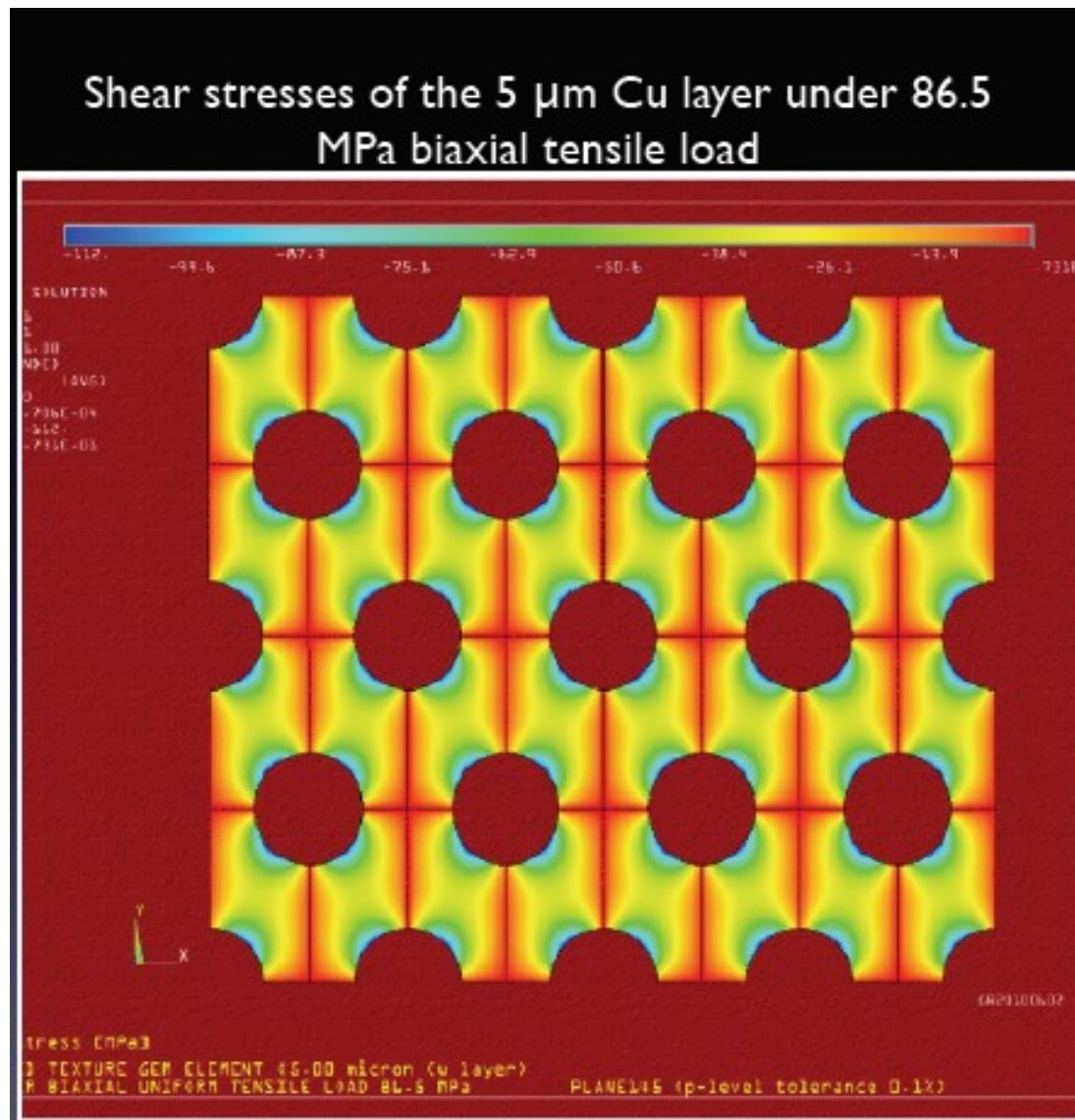
Preliminary results



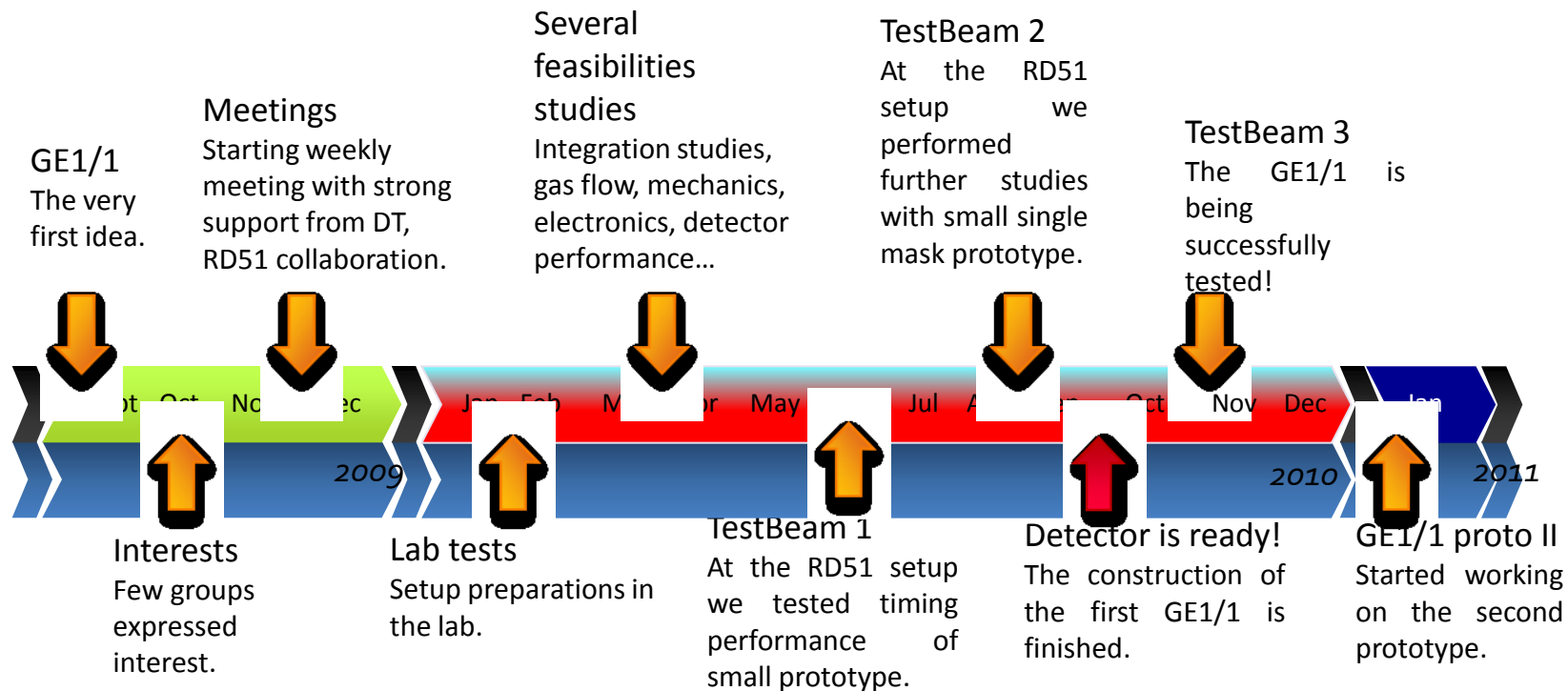
*Data-taking focused on different points along the GE1/1.
Preliminary results show good performance.*

LNF Frascati – Ongoing Simulation studies: GEM trapezoidal foils stretching

ANSYS
material stress
studies
(G. Raffone)



CMS GE1/1 - Evolution



The detector GE1/1 has been designed, built and successfully tested within a year!