A High Eta Forward Muon Trigger & Tracking detector for CMS

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for

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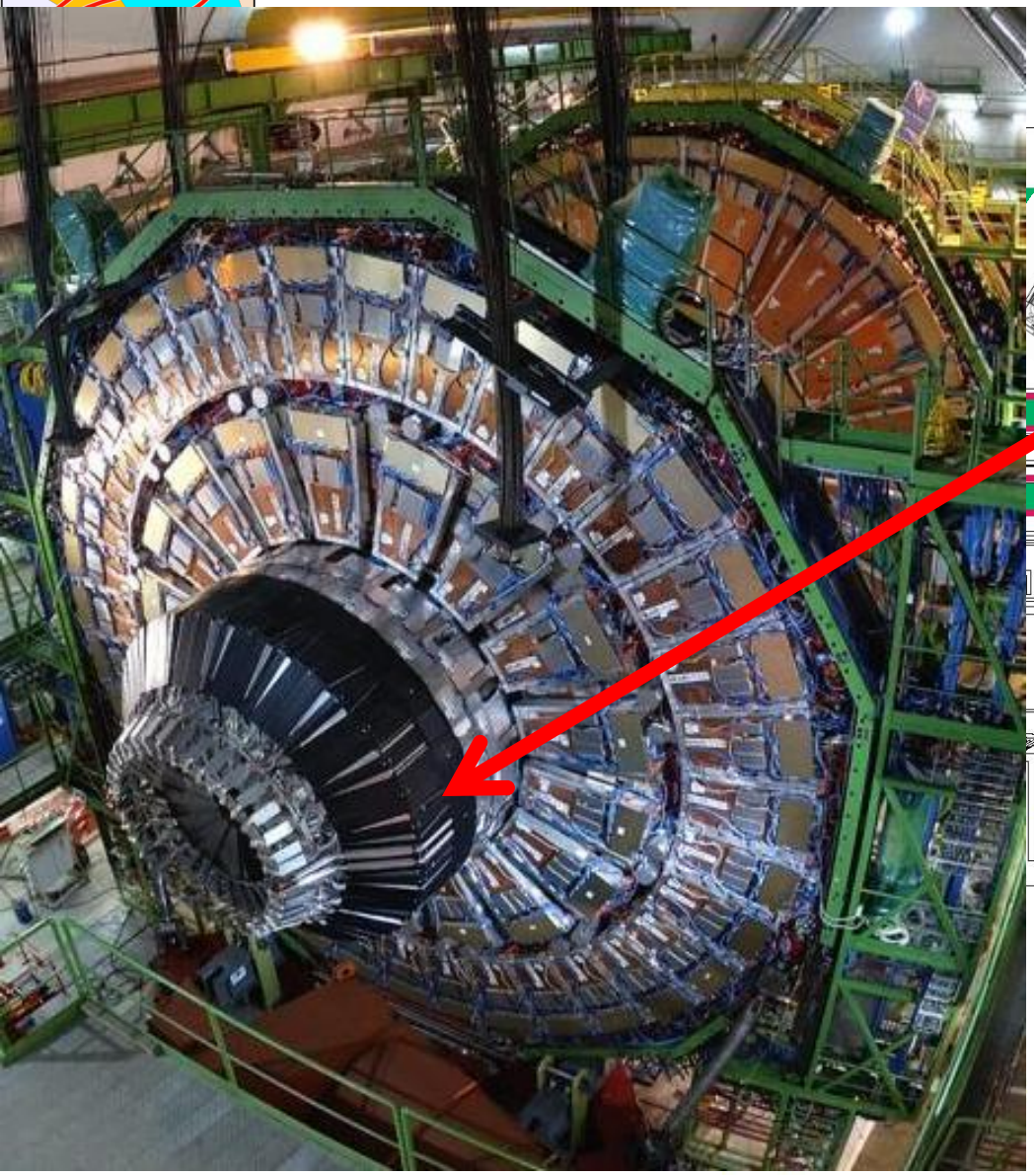
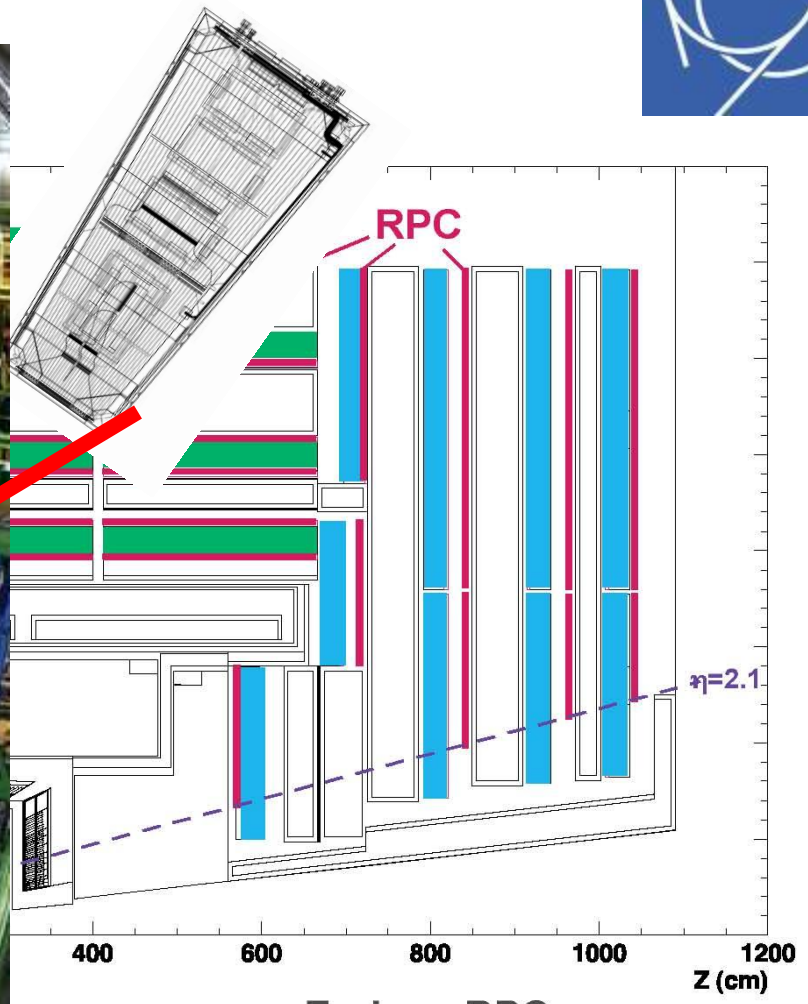
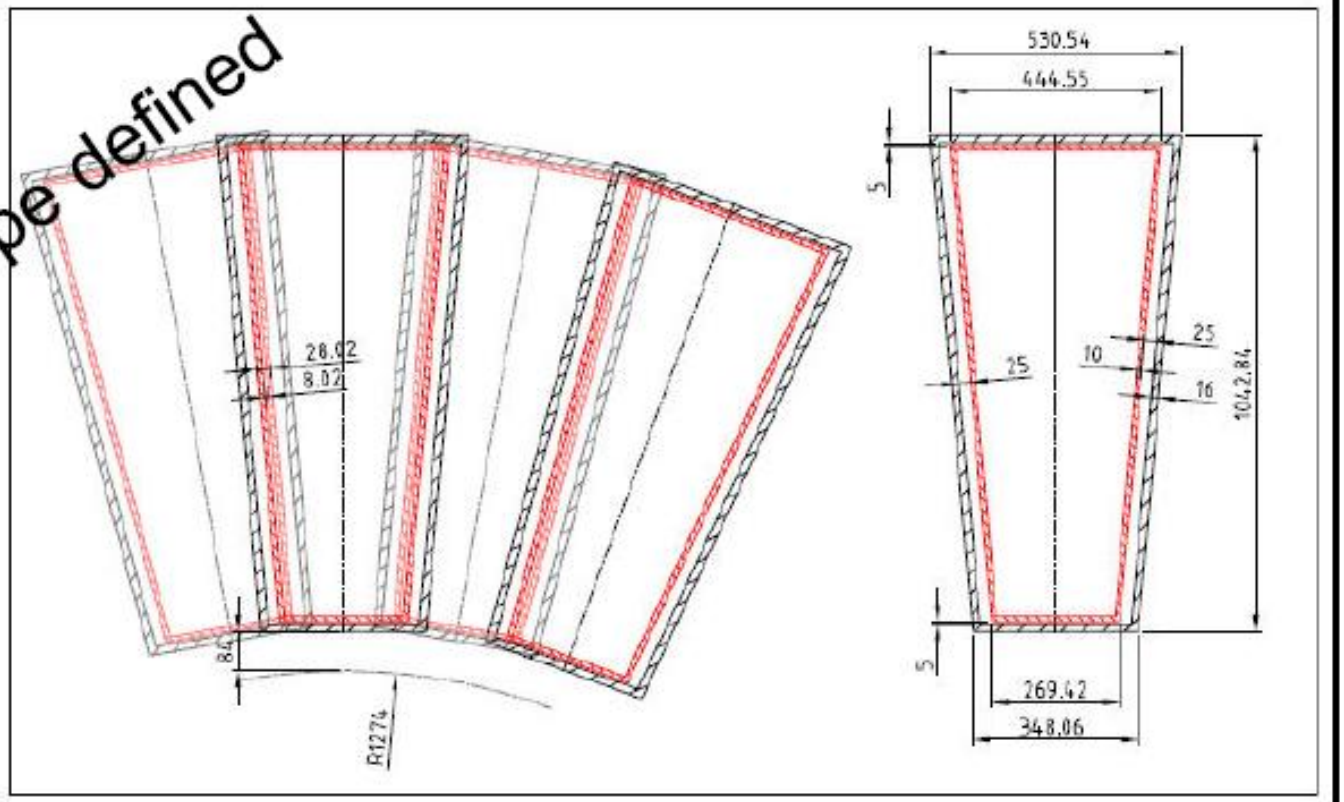




Endcap RPC:

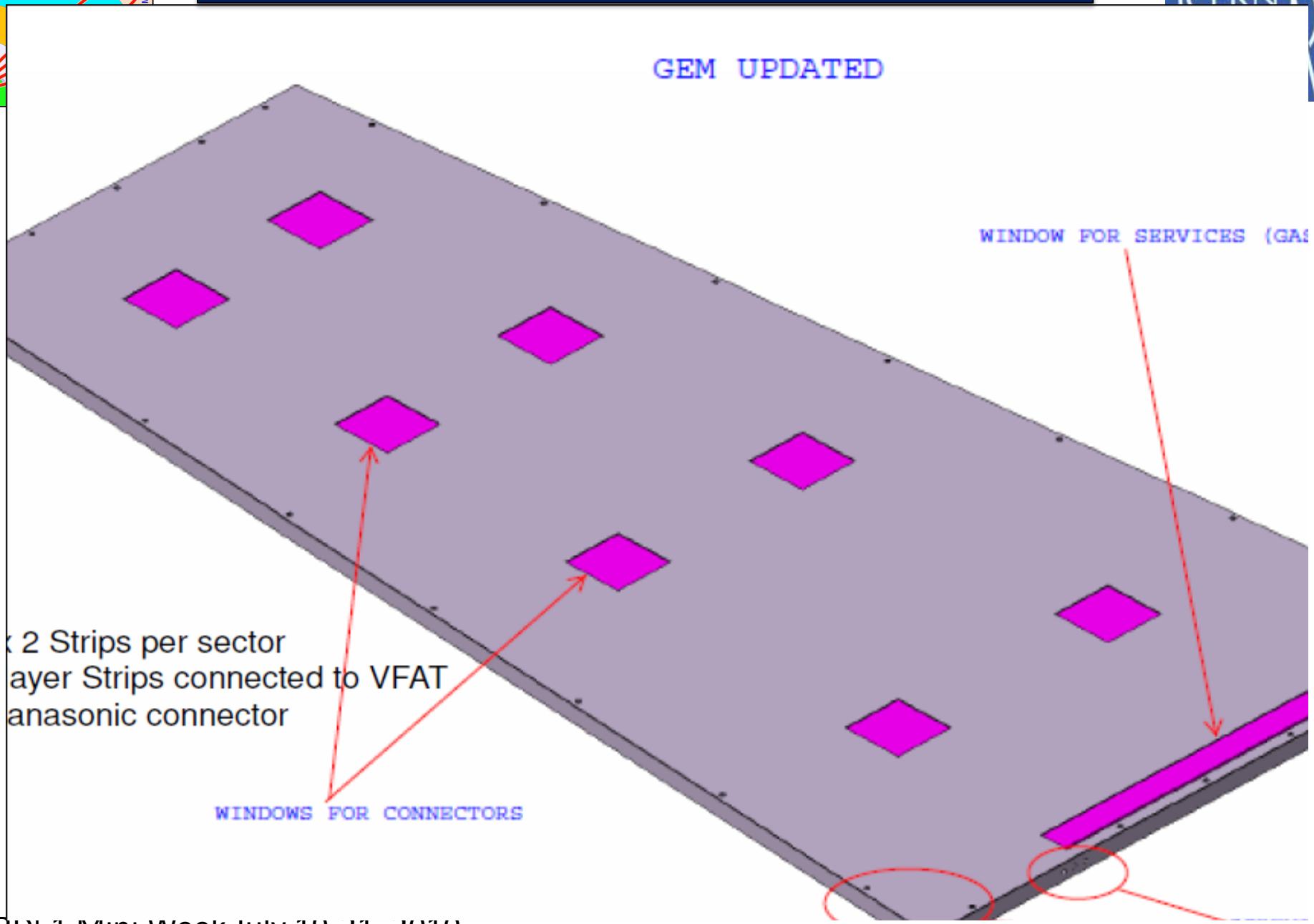
- RE 1,2,3,4 = 1 layers
- 540 trapezoidal chambers
- 80 000 radial strips

Is it possible to increase the eta coverage from 2.1 to > 2.2 ?
There are mechanical (and installation) constraints to be understood.

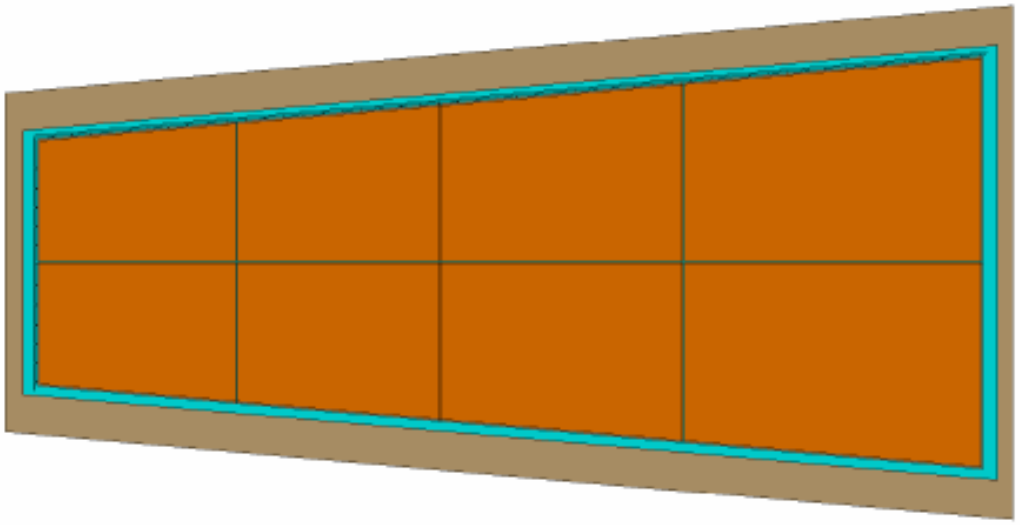


Hans Postema, Stephane Bally, Antonio Conde, Gerard Faber, Jean-Paul Chatelain

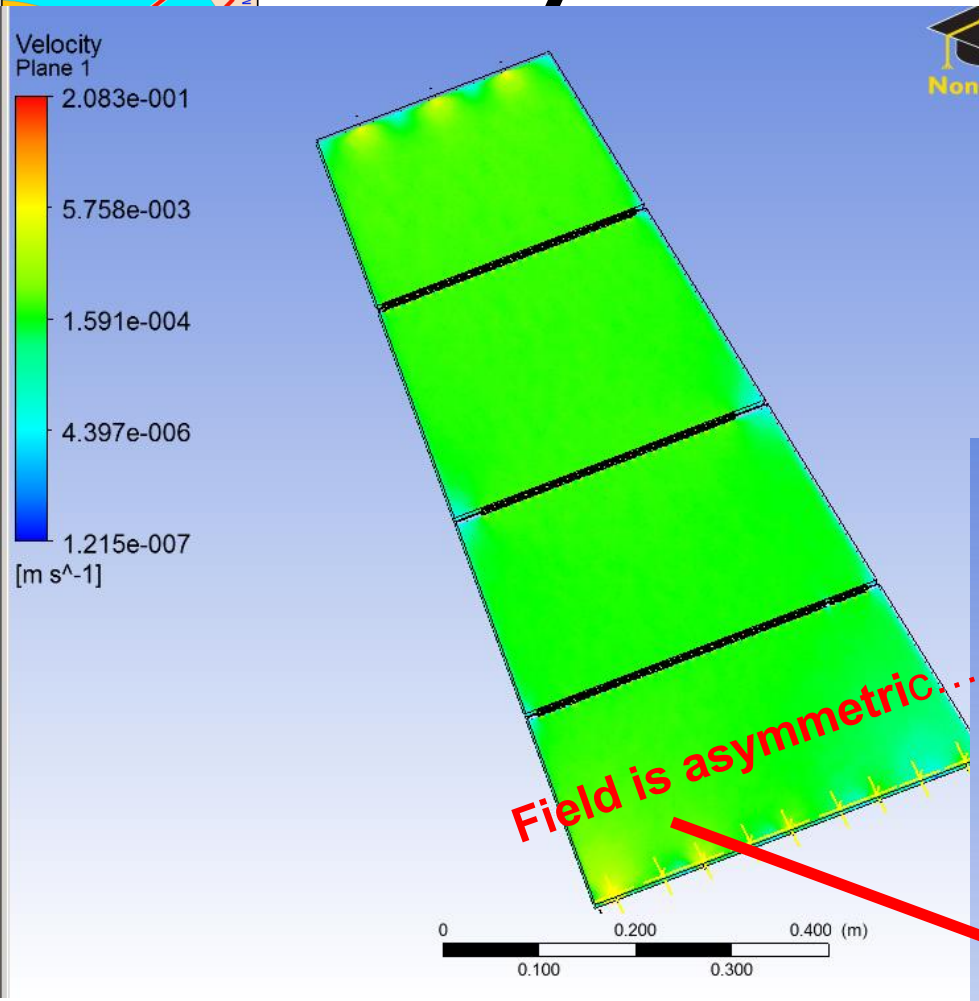
CONSTRUCTION OF LARGE PROTOTYPE



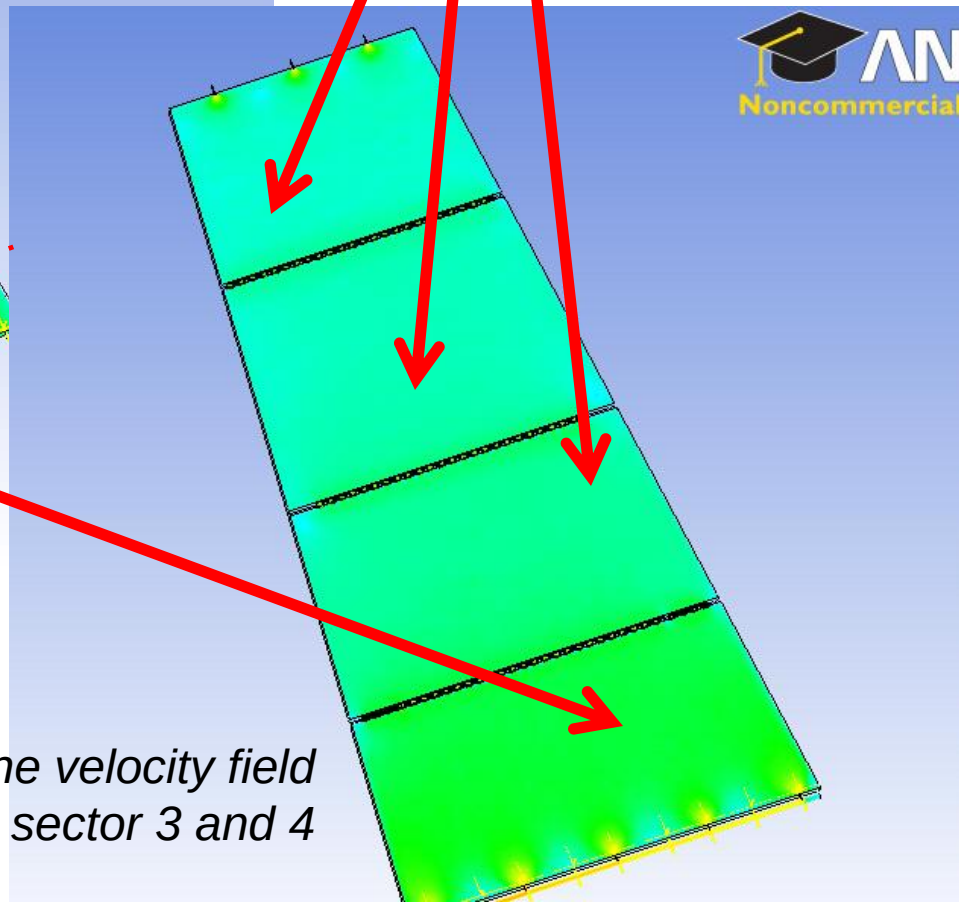
Frames, spacers and grooves for gas



Velocity field

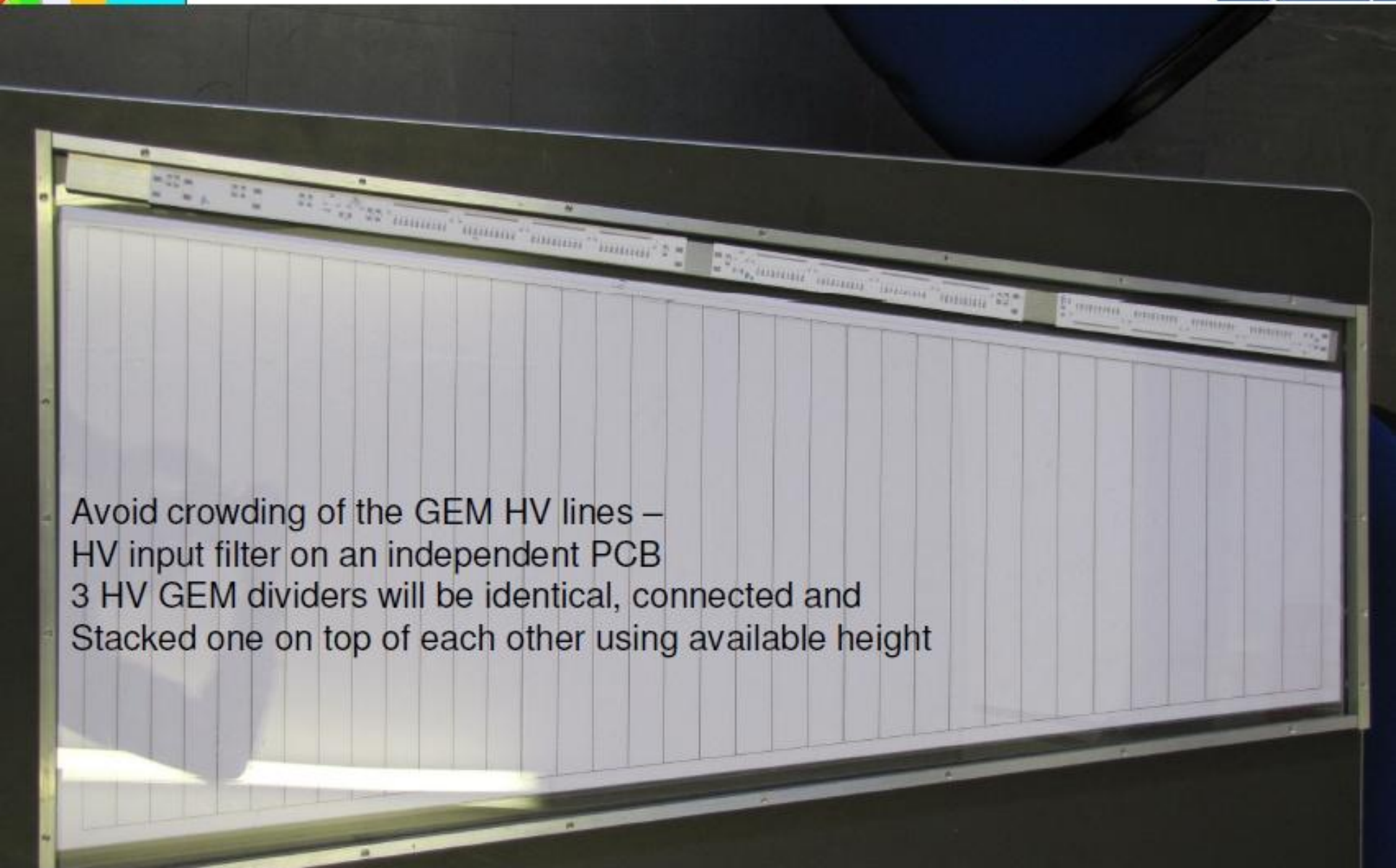


PROBLEMS..



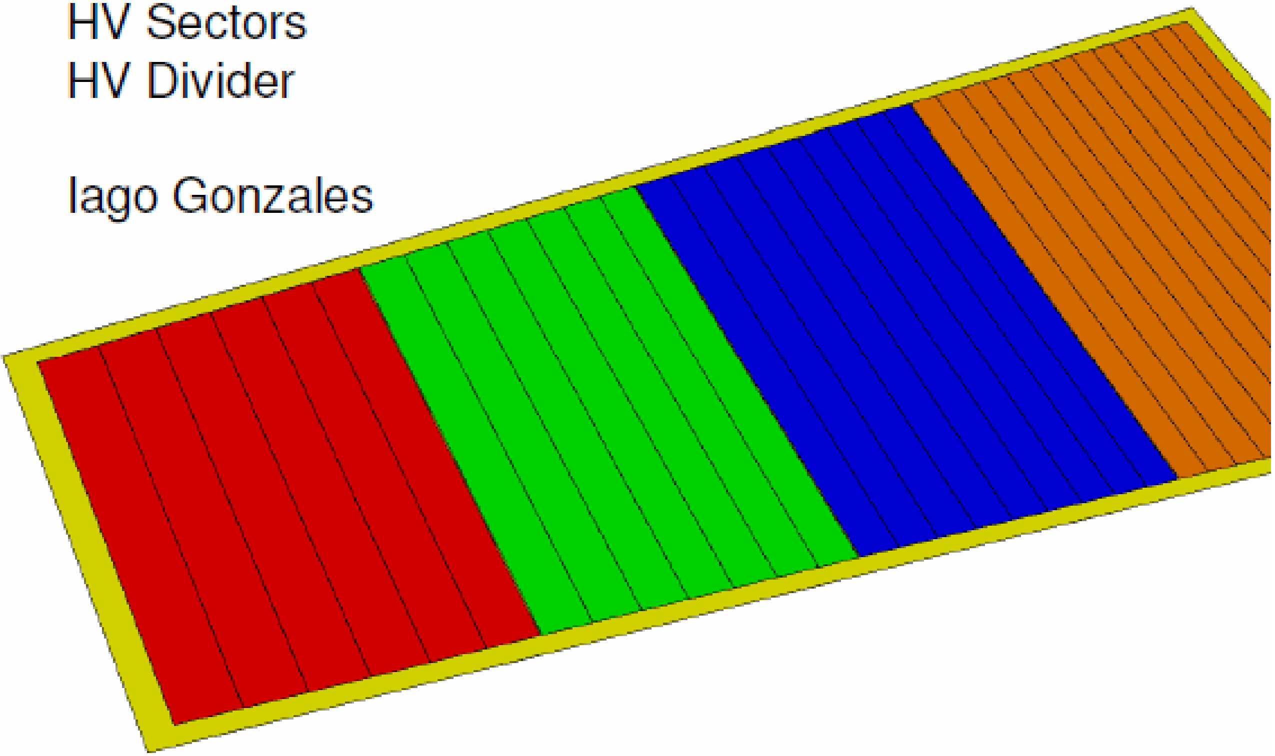
Reducing inlets diameters (1mm) the velocity field is more uniform but slower in the sector 3 and 4

CMS GE1/1 Mock up



HV Sectors
HV Divider

Iago Gonzales

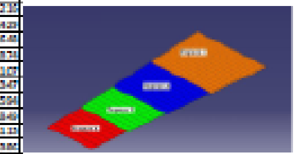


(THANKS TO IAGO GONZALEZ FOR CALCULATING STRIPS)

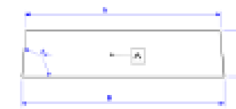
DIMENSION OF THE TRAPEZES

Trapeze 1

	l (mm)	A (mm^2)	b (mm)	h (mm)
1.000	419.534	9200.000	416.080	22.009
2.000	416.057	9200.000	411.168	22.218
3.000	412.143	9200.000	408.218	22.429
4.000	408.192	9200.000	404.238	22.648
5.000	404.203	9200.000	400.201	22.874
6.000	400.174	9200.000	396.131	23.107
7.000	396.105	9200.000	392.028	23.347
8.000	391.994	9200.000	387.865	23.594
9.000	387.839	9200.000	383.668	23.849
10.000	383.640	9200.000	379.430	24.113
11.000	379.394	9200.000	375.137	24.386
12.000	375.101	9200.000	370.784	24.668
13.000	370.758	9235.575	366.348	25.223



Trapeze 2



	l (mm)	A (mm^2)	b (mm)	h (mm)
1.000	365.169	9500.000	361.601	26.107
2.000	361.575	9500.000	356.948	26.443
3.000	356.921	9500.000	352.230	26.792
4.000	352.207	9500.000	347.455	27.156
5.000	347.429	9500.000	342.611	27.535
6.000	342.585	9500.000	337.680	27.930
7.000	337.672	9500.000	332.710	28.342
8.000	332.686	9500.000	327.659	28.773
9.000	327.635	9183.000	322.684	28.242

Trapeze 3

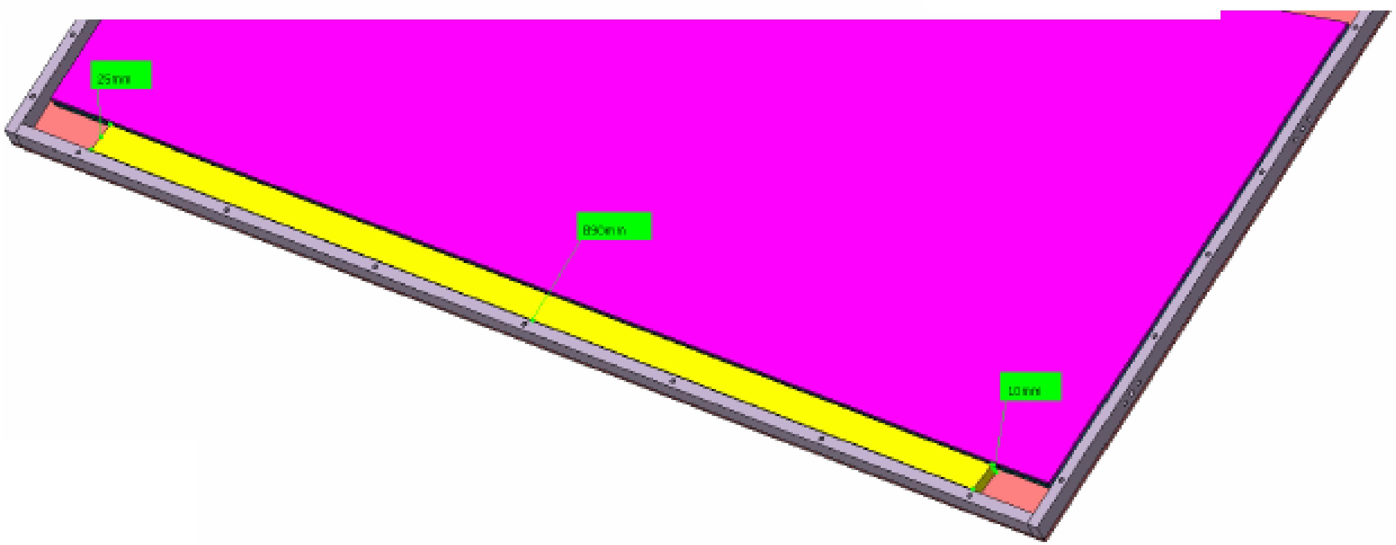
	l (mm)	A (mm^2)	b (mm)	h (mm)
1.000	322.509	9025.000	317.575	28.188
2.000	317.548	9025.000	312.536	28.647
3.000	312.510	9025.000	307.418	29.128
4.000	307.389	9025.000	302.208	29.619
5.000	302.181	9025.000	296.919	30.128
6.000	296.883	9025.000	291.516	30.678
7.000	291.489	9044.187	286.008	31.322

Trapeze 4

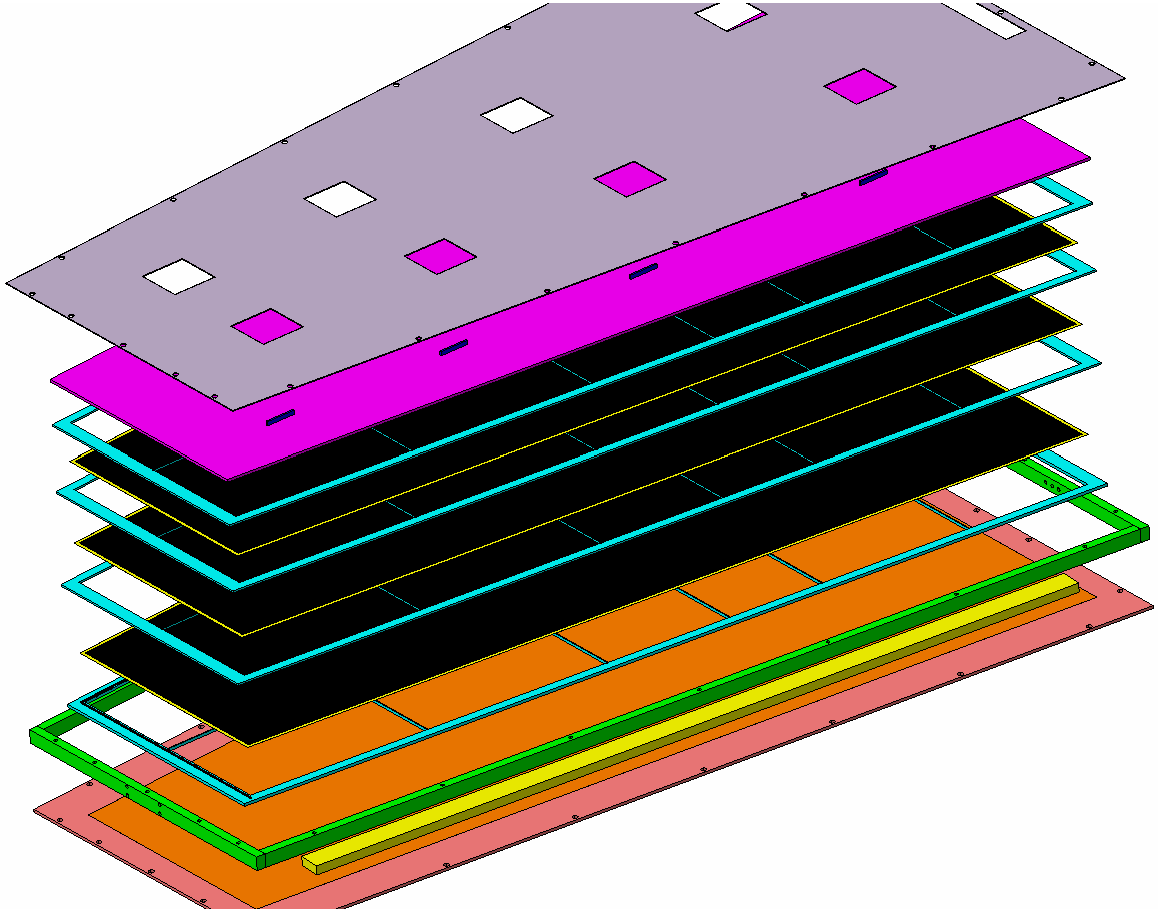
	l (mm)	A (mm^2)	b (mm)	h (mm)
1.000	285.934	9050.000	280.238	31.979
2.000	280.213	9050.000	274.504	32.628
3.000	274.477	9050.000	268.646	33.328
4.000	268.620	9050.000	262.658	34.068
5.000	262.632	9050.000	256.533	34.864
6.000	256.506	9030.578	250.278	35.640

Iago Gonzalez Tabarez
PH-CMX-DS

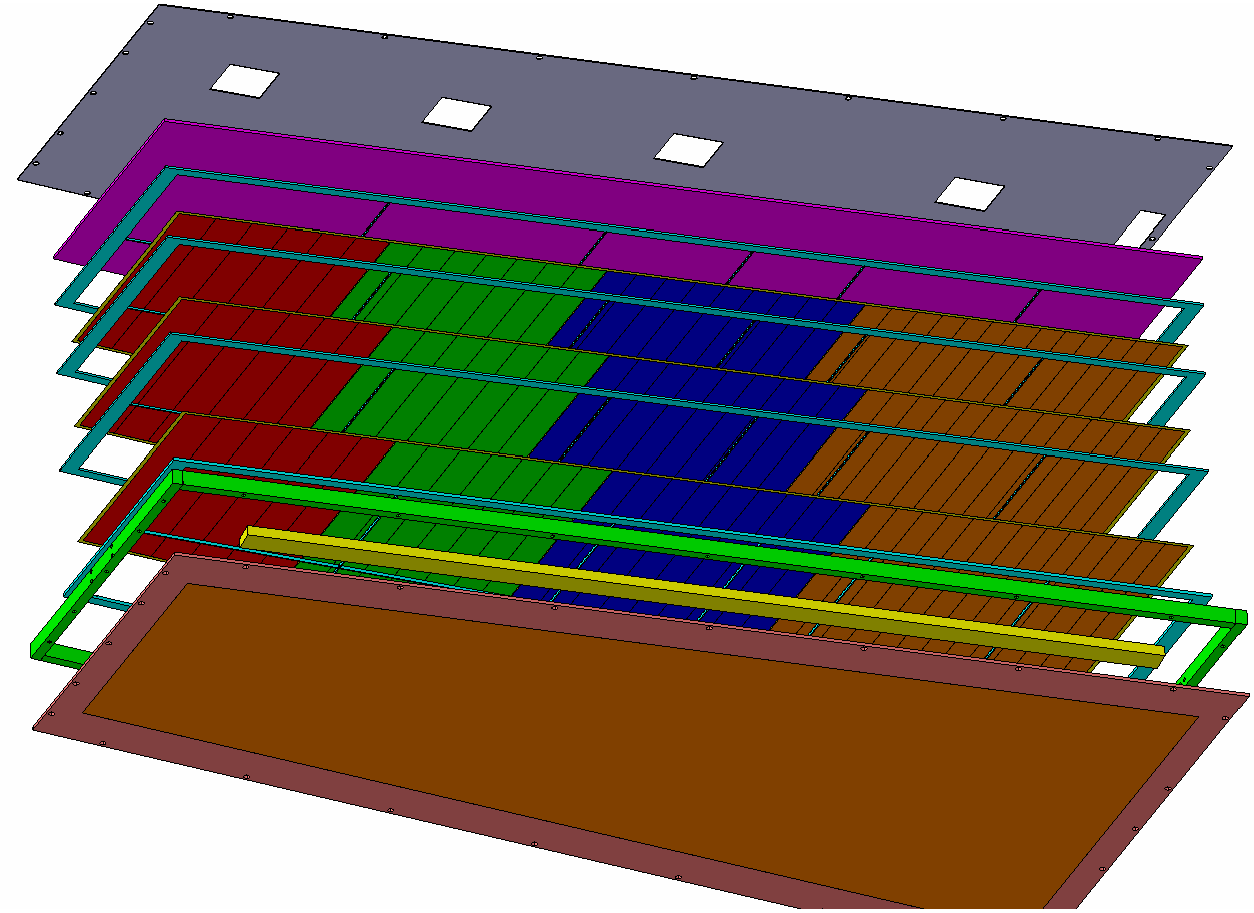
12/1/2010



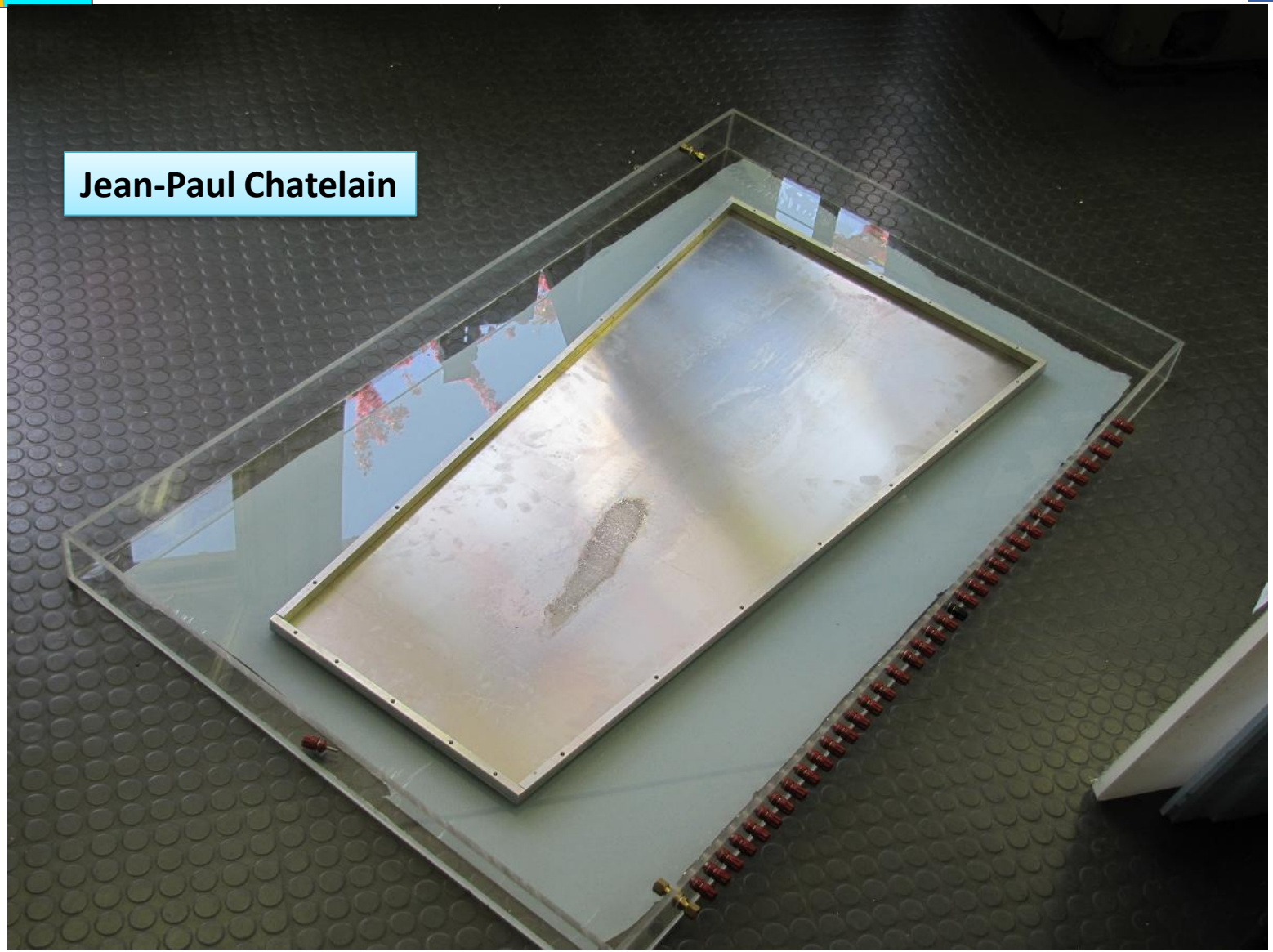
CMS Prototype GEM - Stack



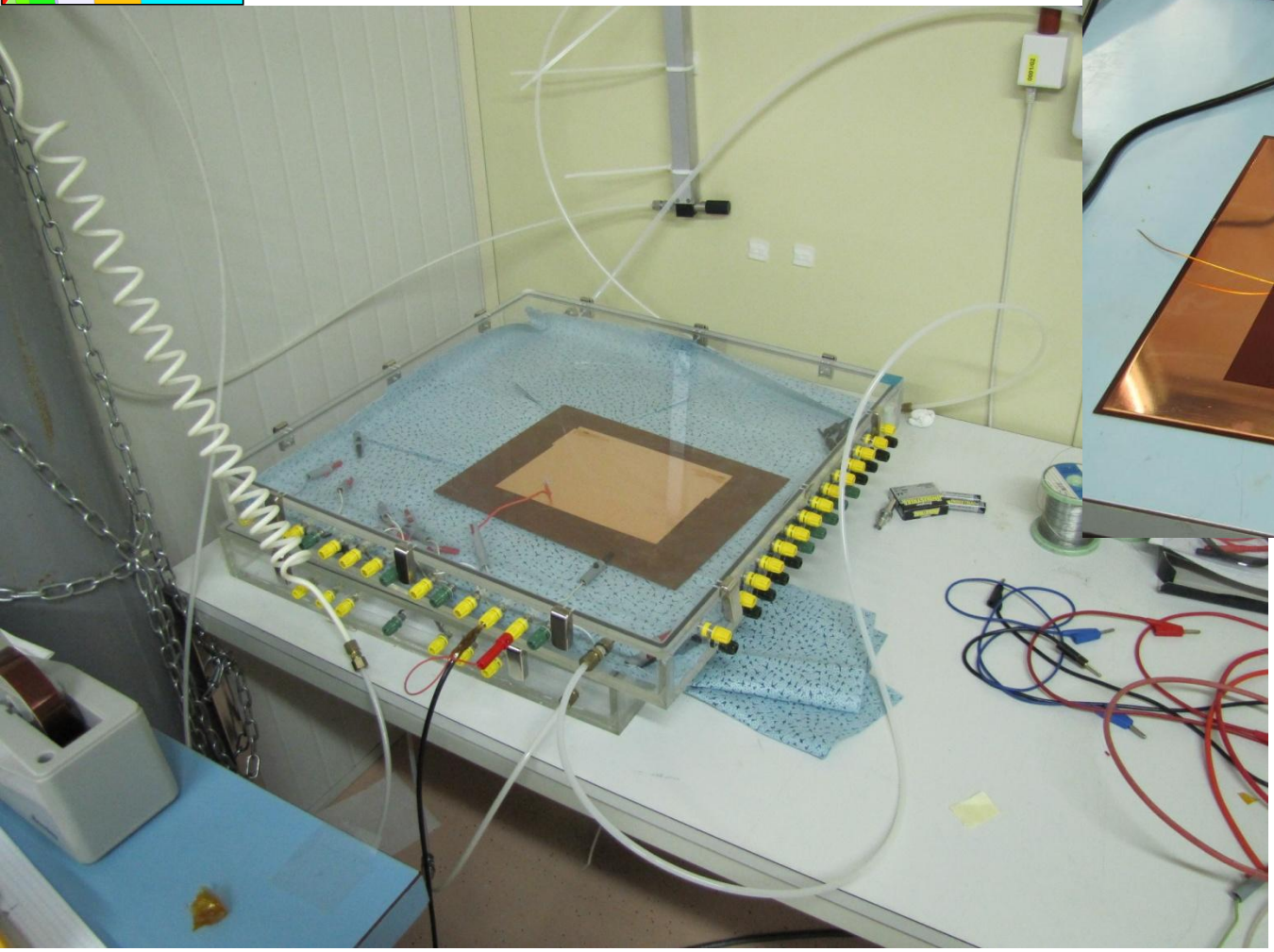
CMS Prototype GEM - Stack

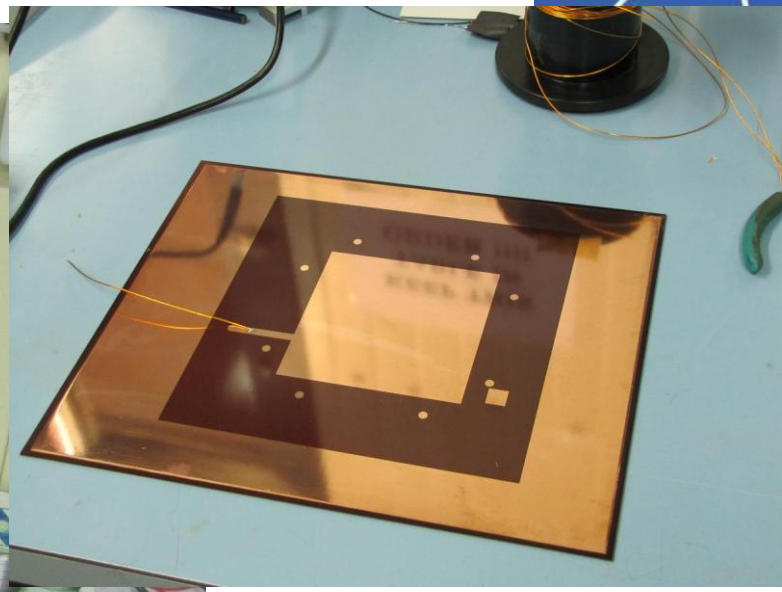


CMS Prototype GEM - Test Box
Large Drift Electrode Sample under test

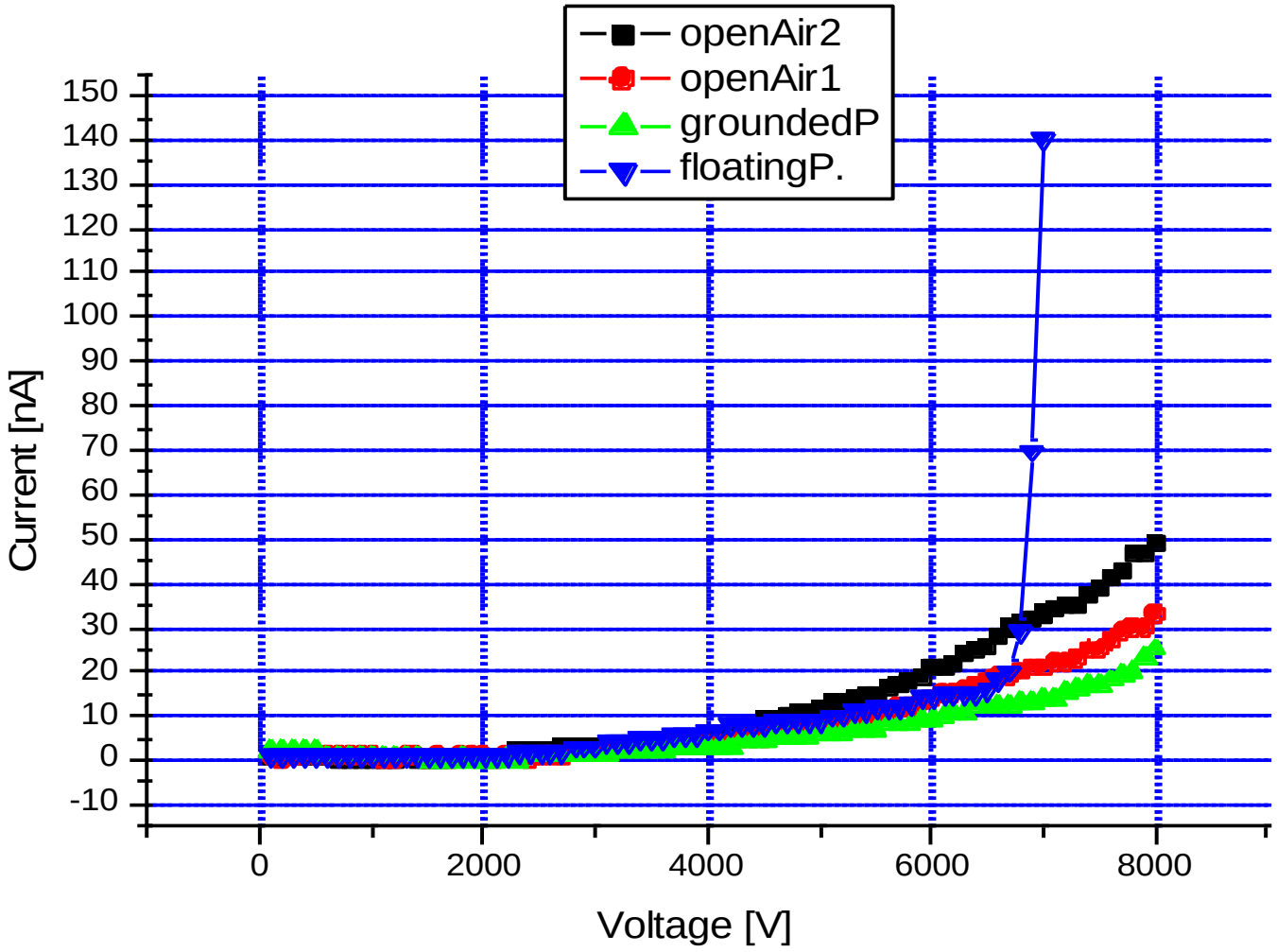


Ongoing Drift Electrode Tests

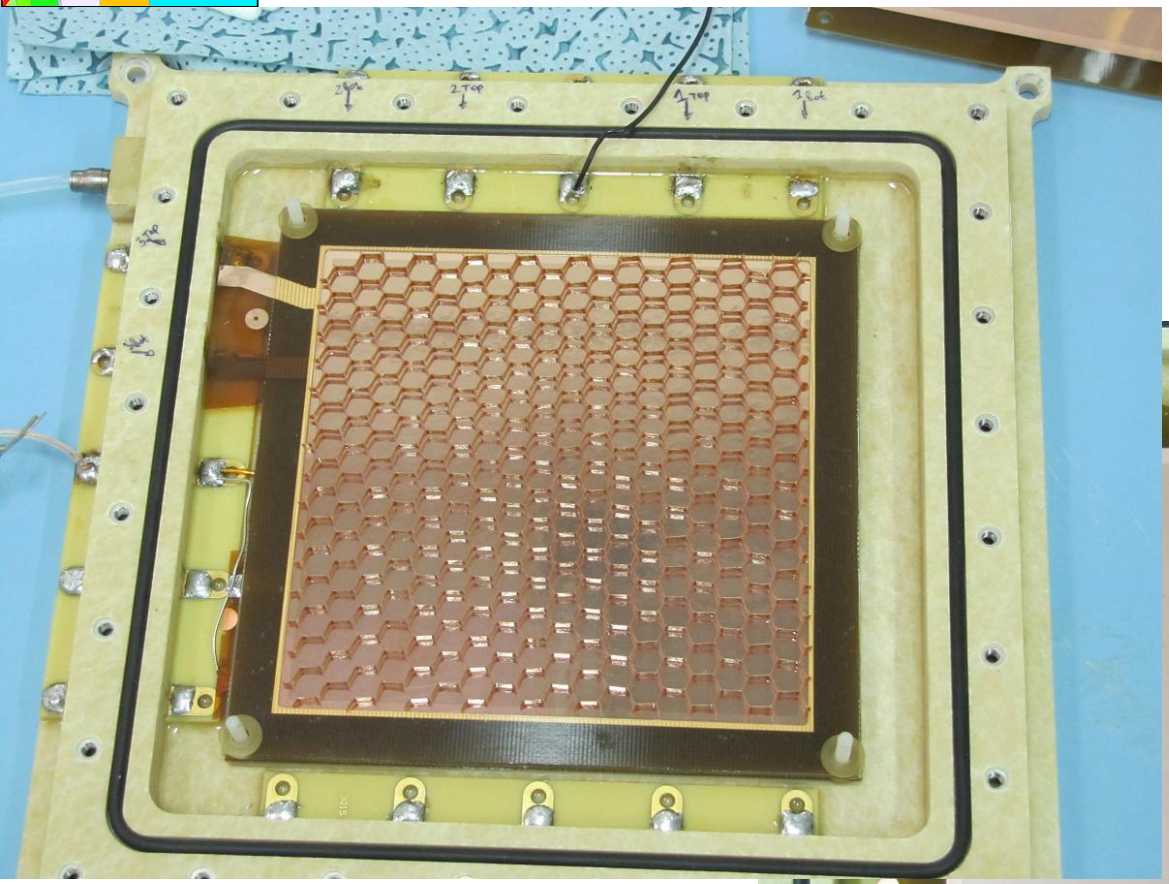


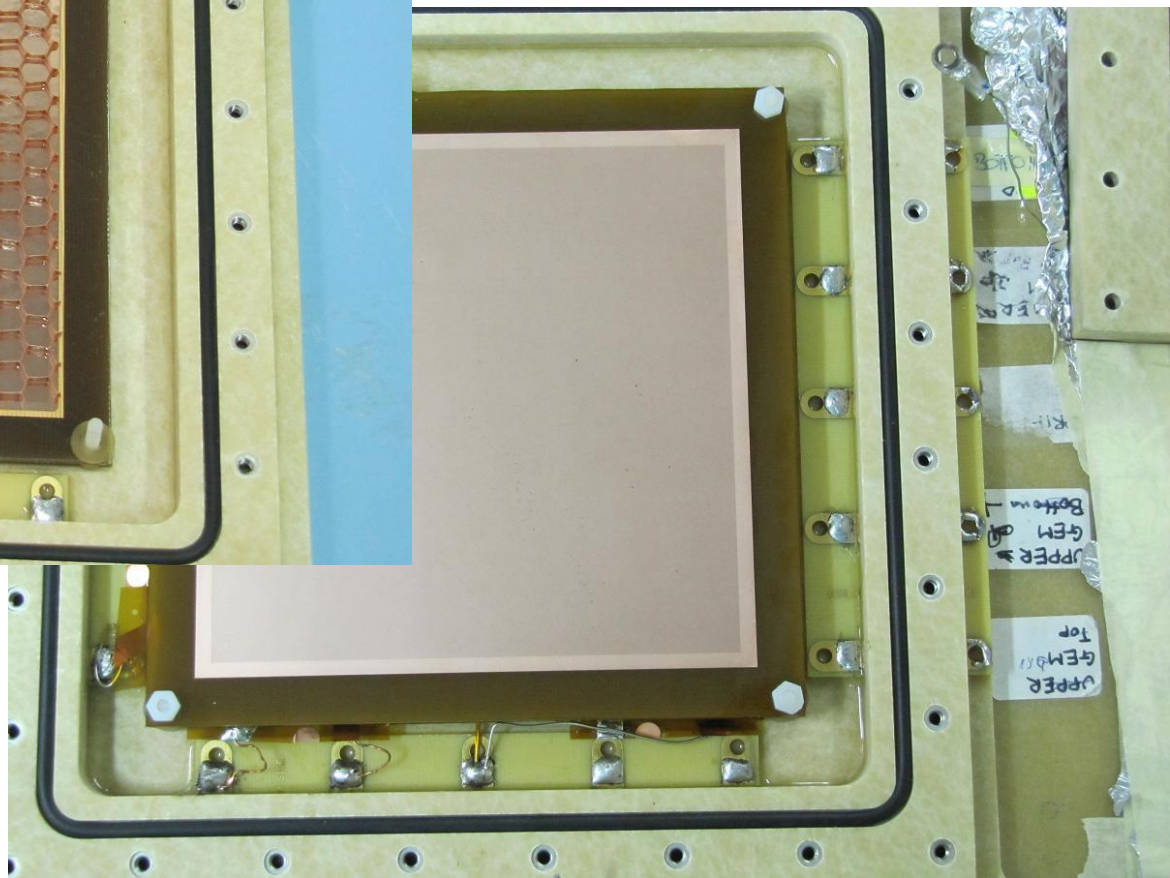


All I/V scans


openAir2
openAir1
groundedP
floatingP.
Current [nA]
Voltage [V]
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
0
2000
4000
6000
8000

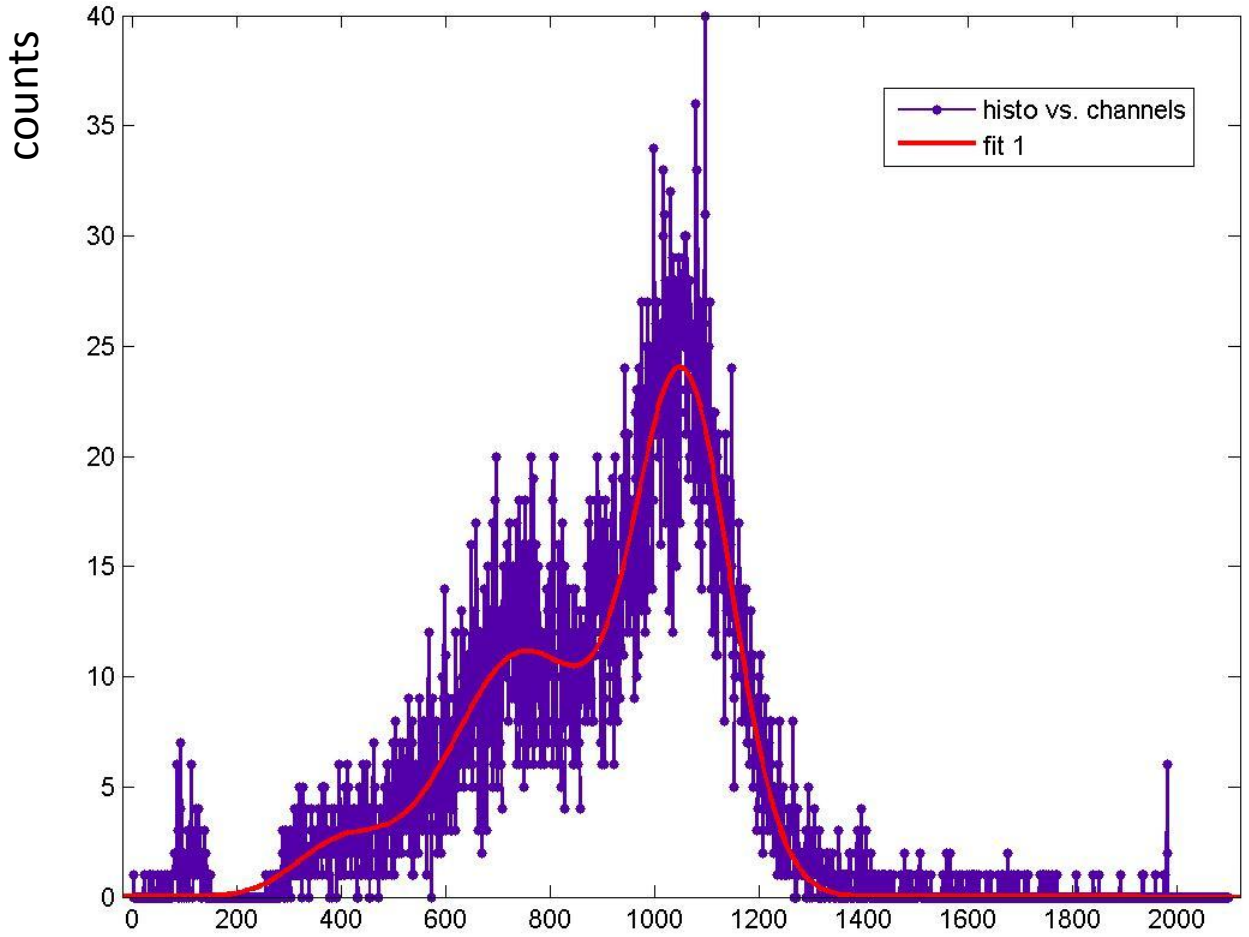
Honeycomb GEM studies

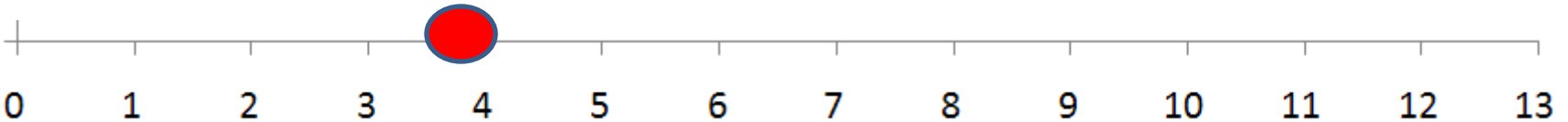




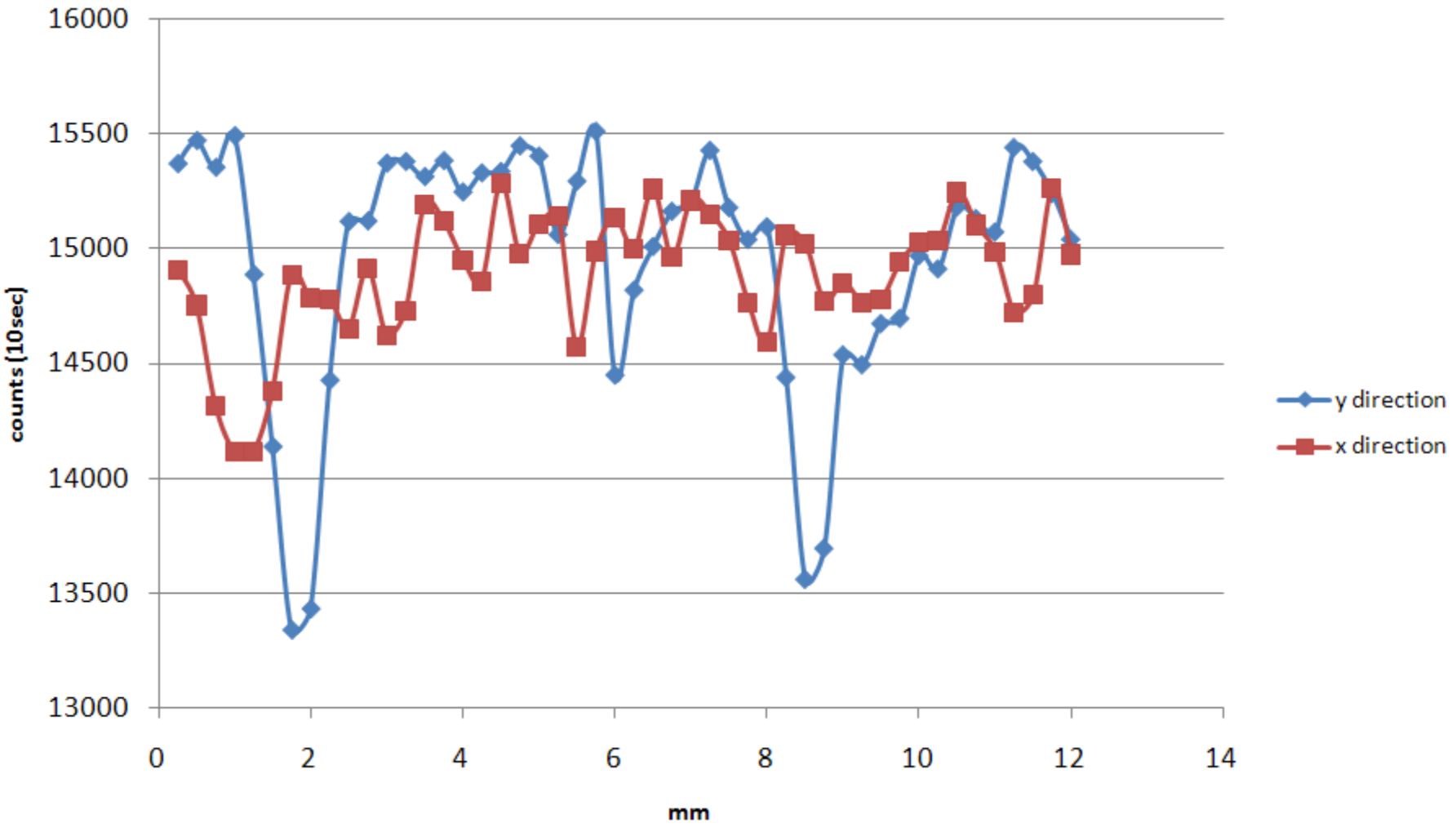
without the honeycomb
between drift and first gem

Analysis of GEM spectrum ‘X displacement’

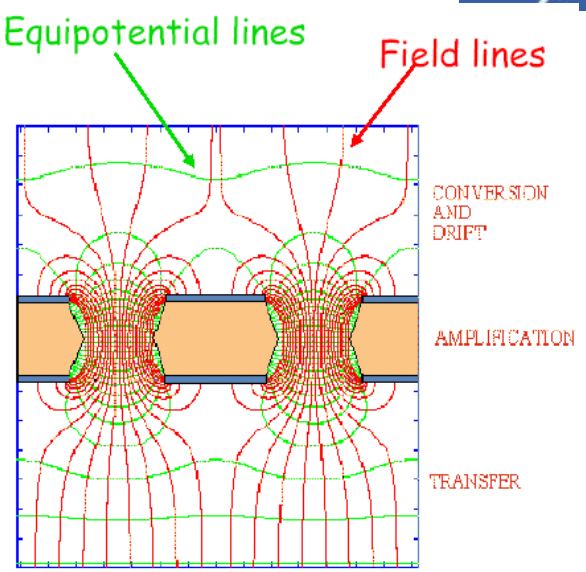




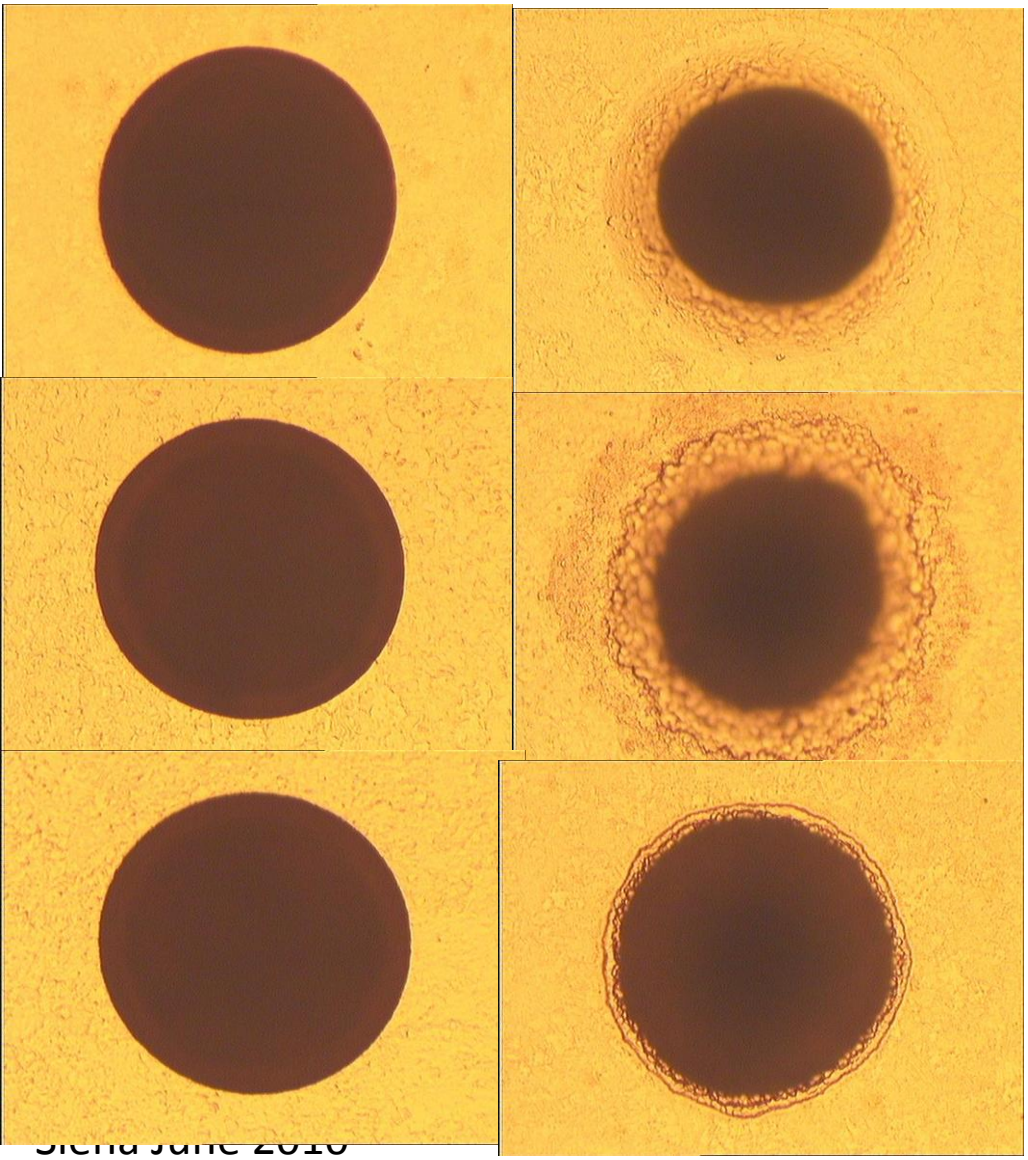
Moving the GEM (under x rays) along x,y direction with 0,25mm steps



CMS single mask GEM1



Single GEM Electrodes



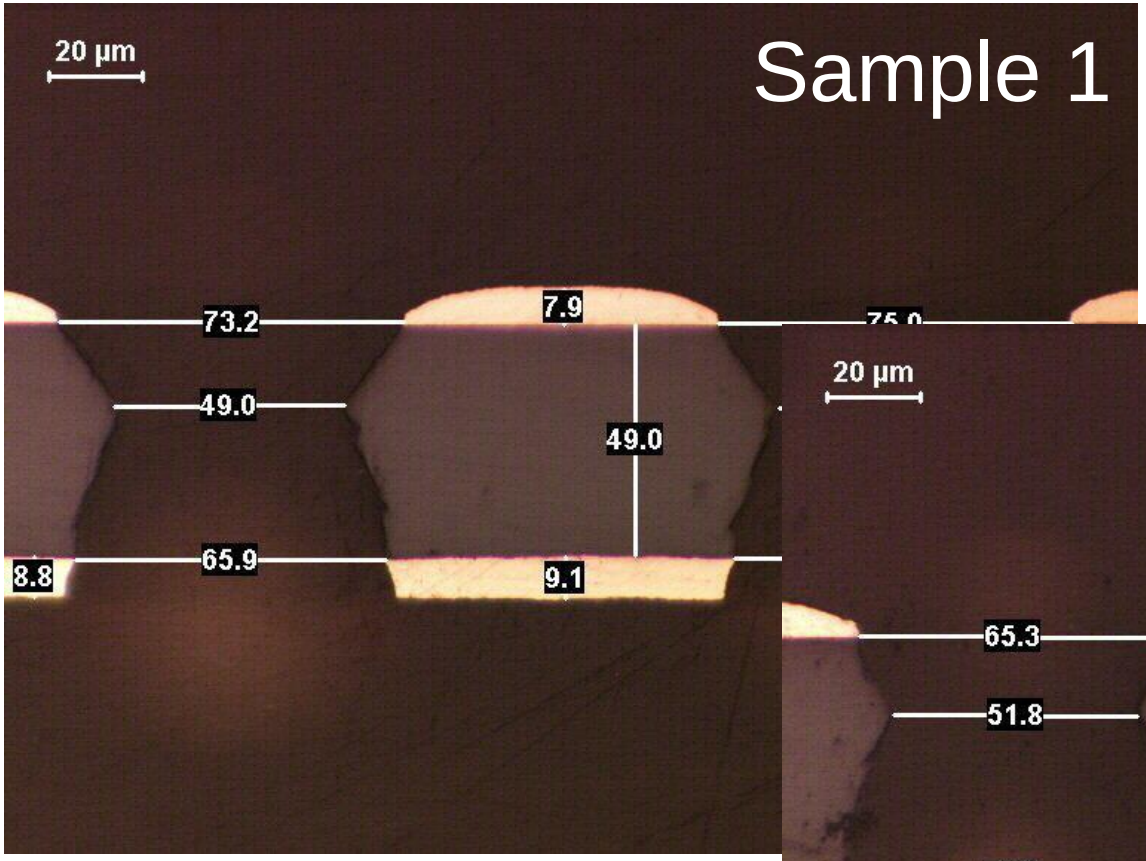
GEM 1

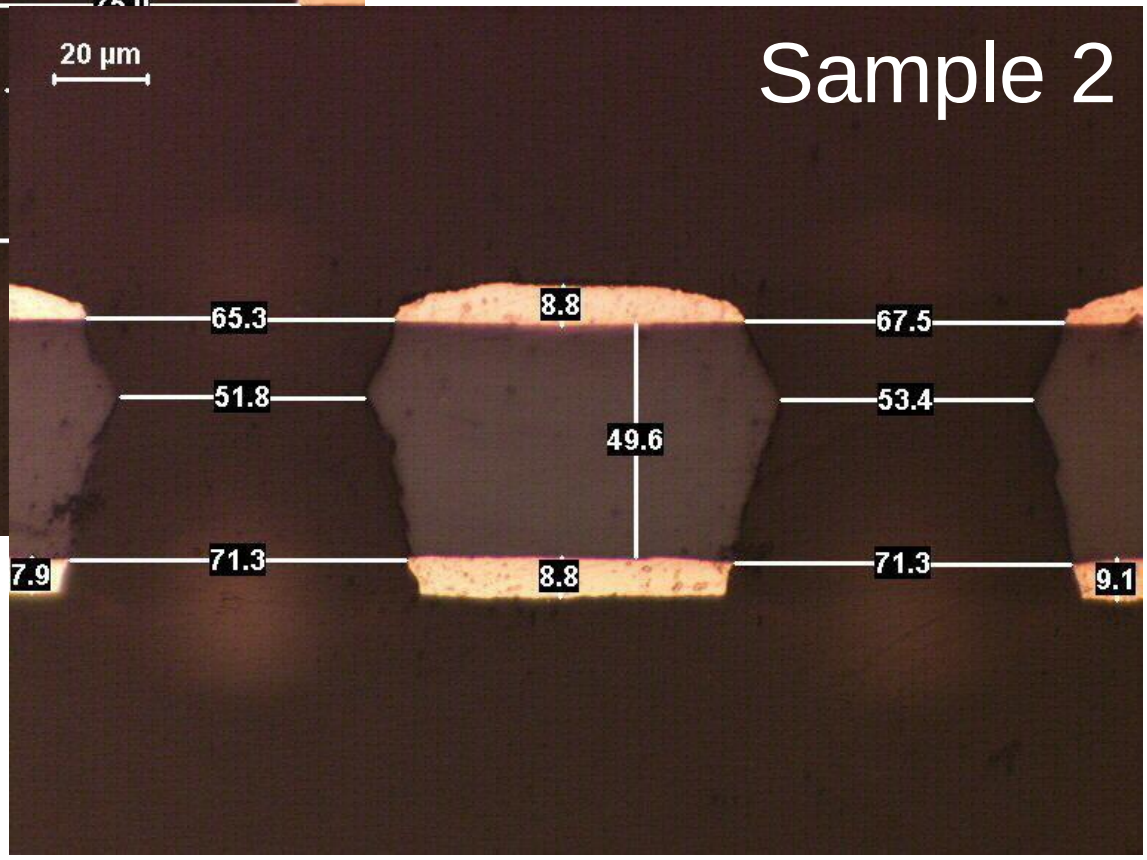
GEM 2

GEM 3

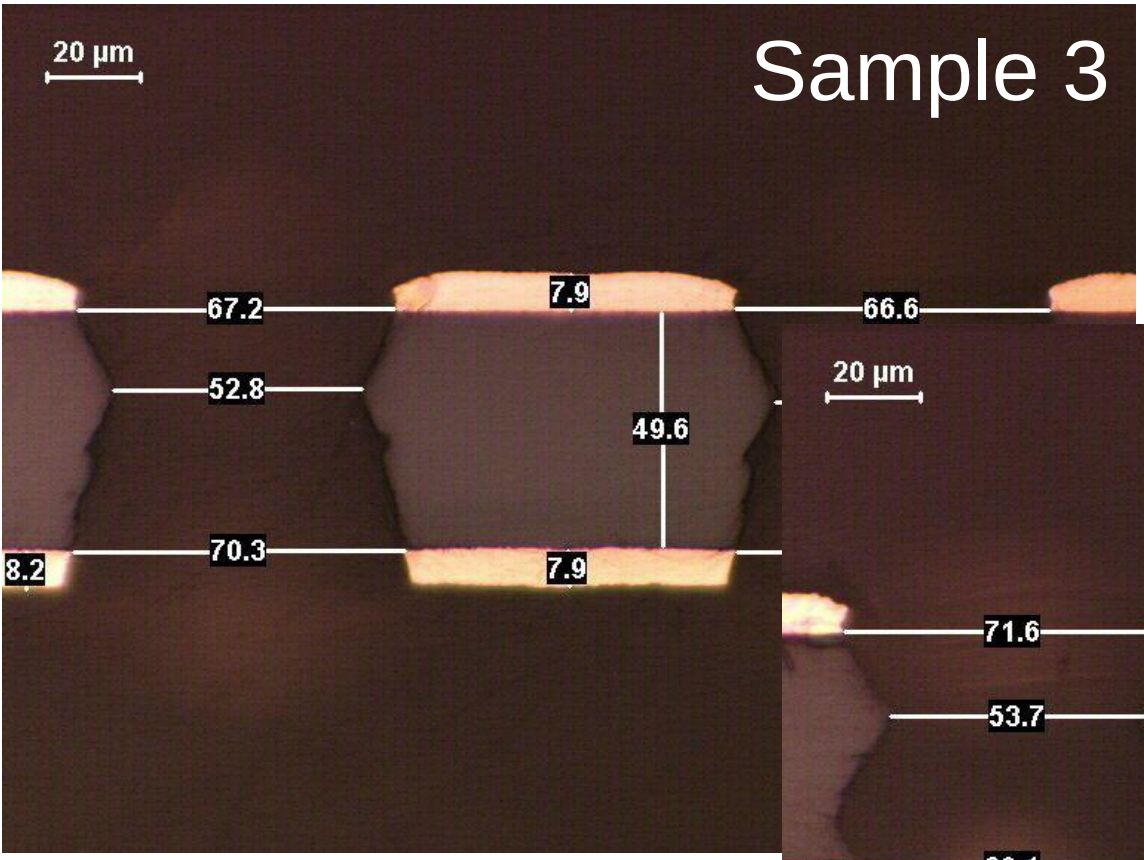
Top – Left
Bottom - Right

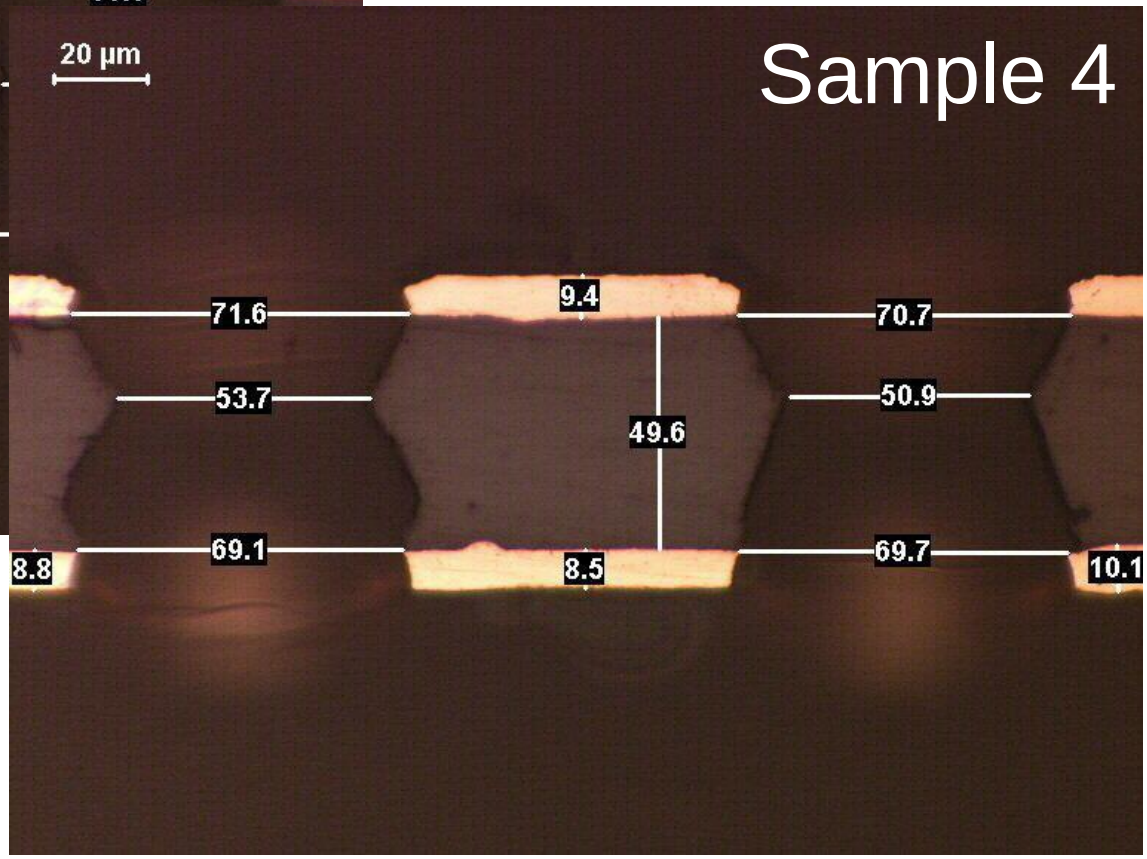
…and cross section pictures (1)



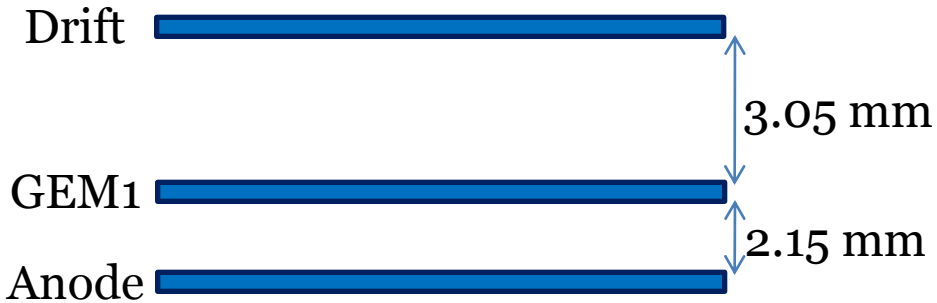


…and cross section pictures (2)

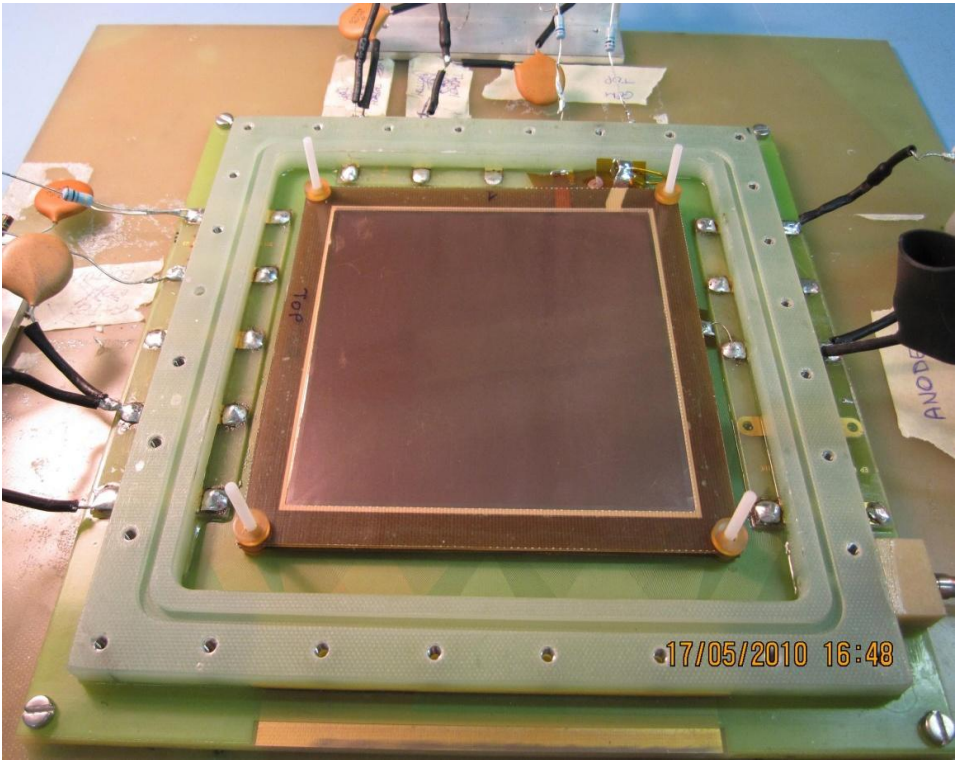


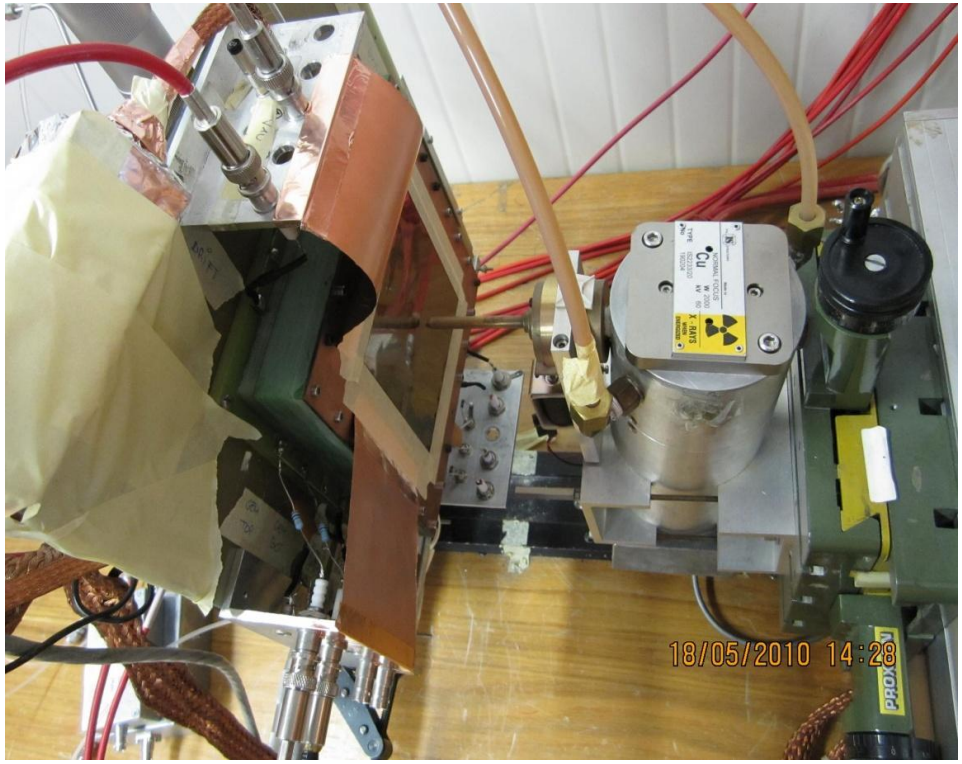


Preparing the experimental setup

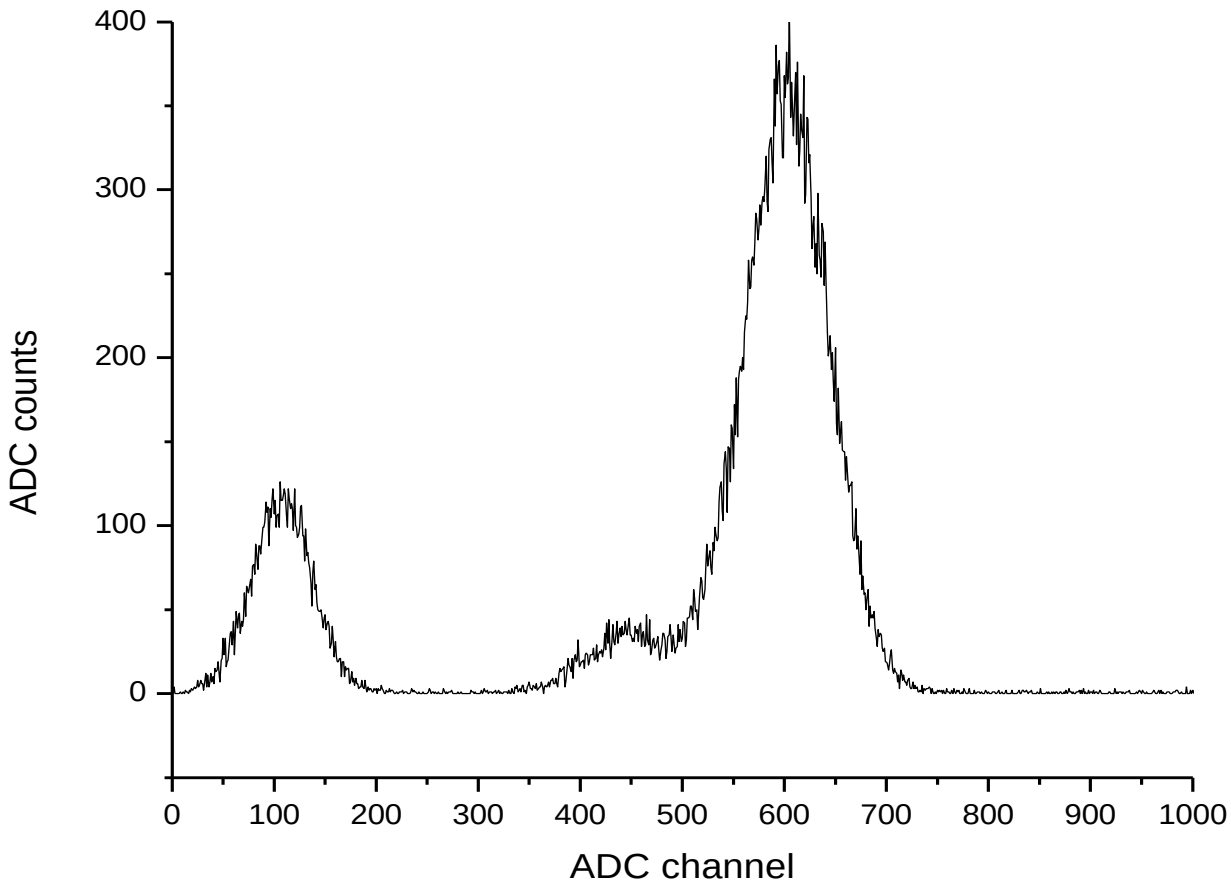


- GEM active area: 10 x 10 cm²
- Gas mixture: Ar/CO_2 70/30
- Gas flow: ~ 5 l/h
- Water content: ~ 100 ppm H_2O
- Radiation source: Cu X–ray tube



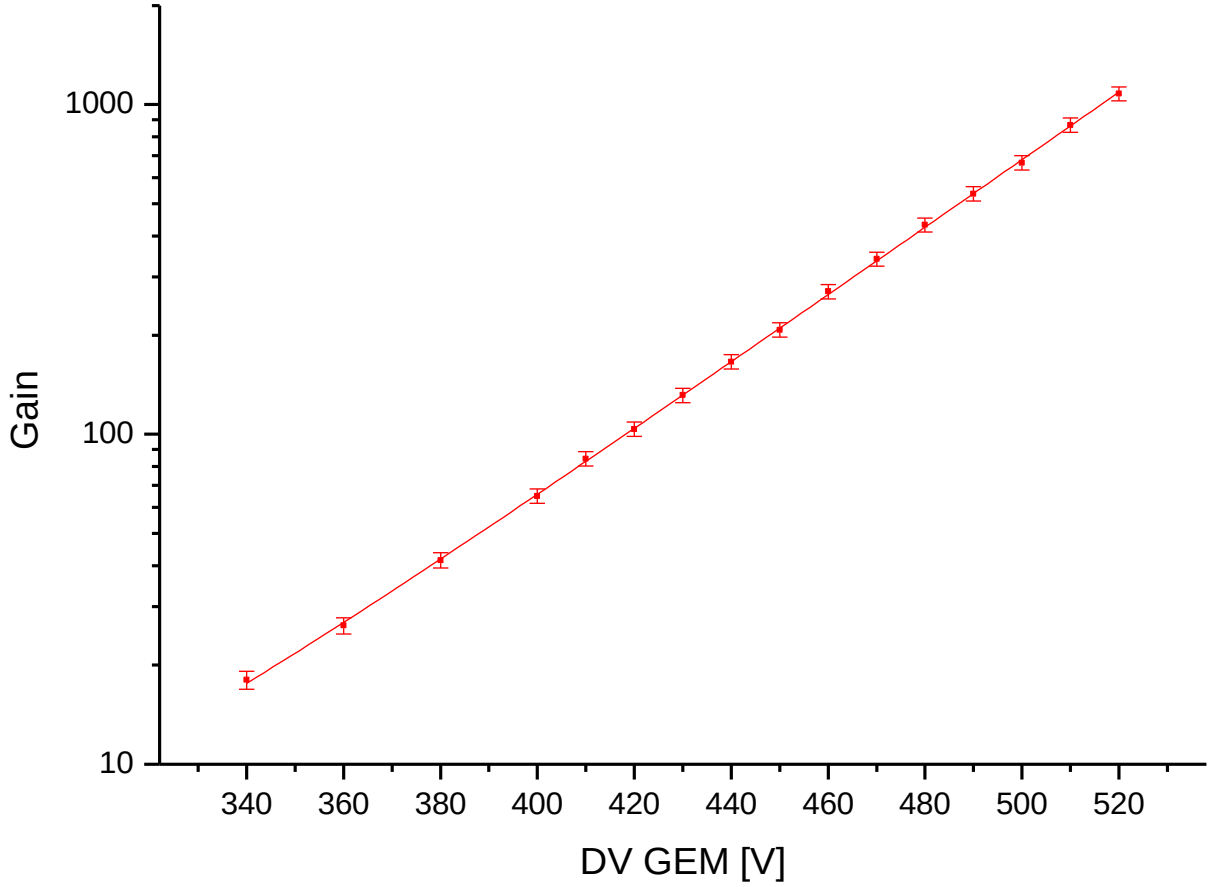


Taking spectra



- E_d = 2 kV/cm
- E_i = 3 kV/cm
- DV GEM = 480 V
- Rate ~ 32 Hz/mm^2
- Energy resolution @ 8.04 keV ~ 19.6 % FWHM/peak

Measuring the gain curve

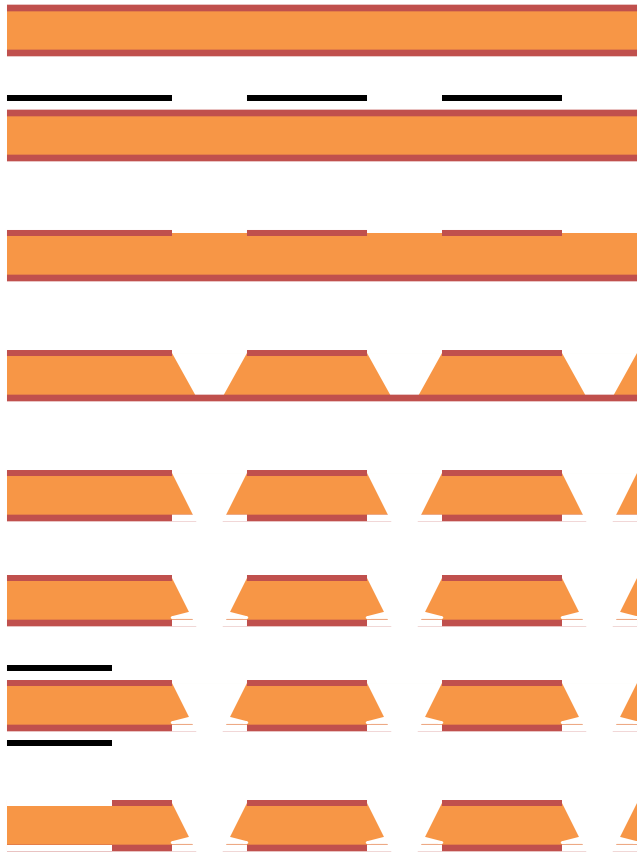


- E_d = 2 kV/cm
- E_i = 3 kV/cm
- Rate ~ 180 kHz/mm^2
- Spark voltage ~ 530 V
- Max gain ~ 1080

42cm x 990 cm

LGEM PROCESS
by single mask method

1. Base material 50 µm polyimide foil copperclad
2. Photoresist lamination, masking, exposure, development
3. Chemical etching of copper Top
4. Polyimide etching in 2 steps
5. Electrochemical etching of copper Bot + over-etched
6. Polyimide etching to transform hole geometry
7. Photoresist lamination, masking, exposure, development to define electrodes
8. Chemical etching of copper Top and Bot,
   Cleaning and electrical test



-The LGEM are actually in step 5.

CMS High Eta Upgrade Studies
Test Beam Plan 2010

Chambers for June: (SEE Stefano's talk tomorrow)

CMS Triple GEM prototype 10 x 10 cm

Honeycomb Triple GEM

Single Mask GEM

1. Measure Efficiency for perpendicular tracks
2. Measure Efficiency for inclined tracks with tracking
3. Optimization of time resolution
4. Tests with Front End electronics for mips
5. Space and time resolution

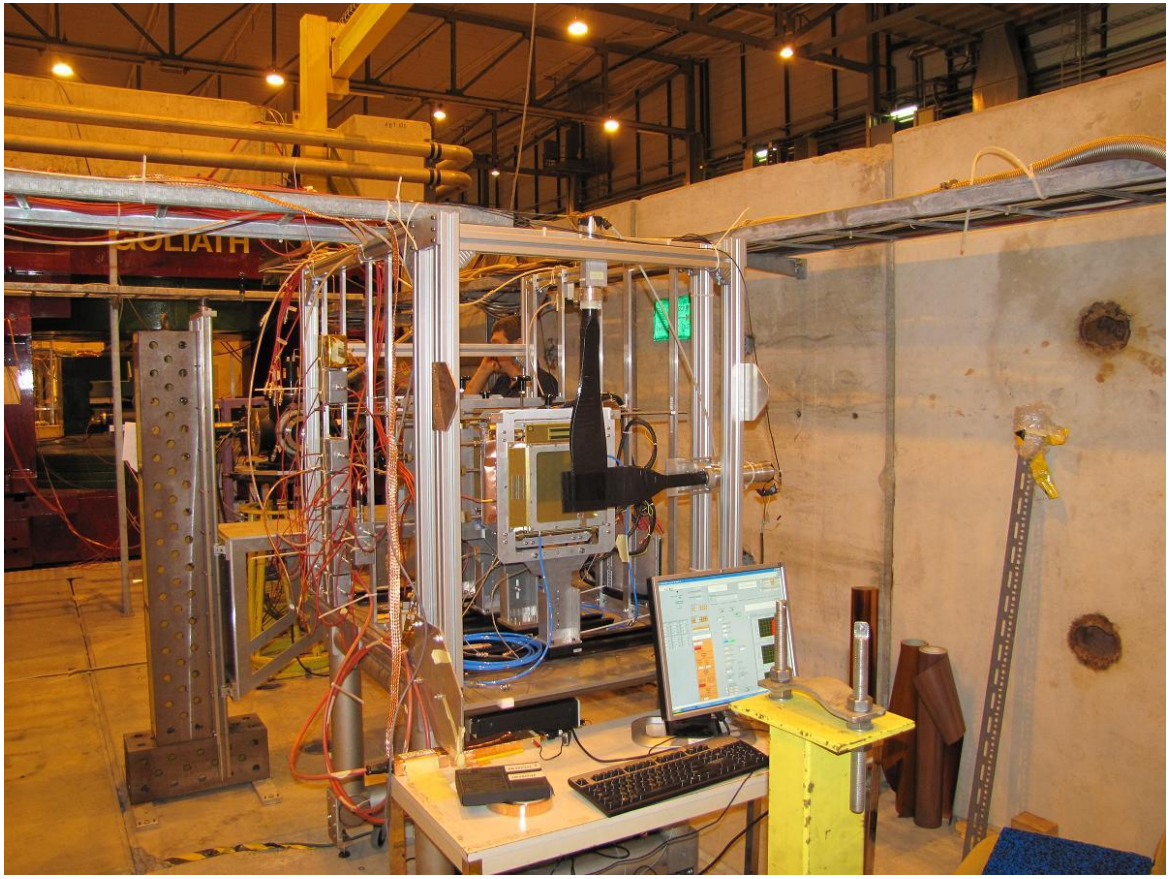
October

1. Gas Studies
2. Magnetic Field Operation
3. Large Prototype test

The setup

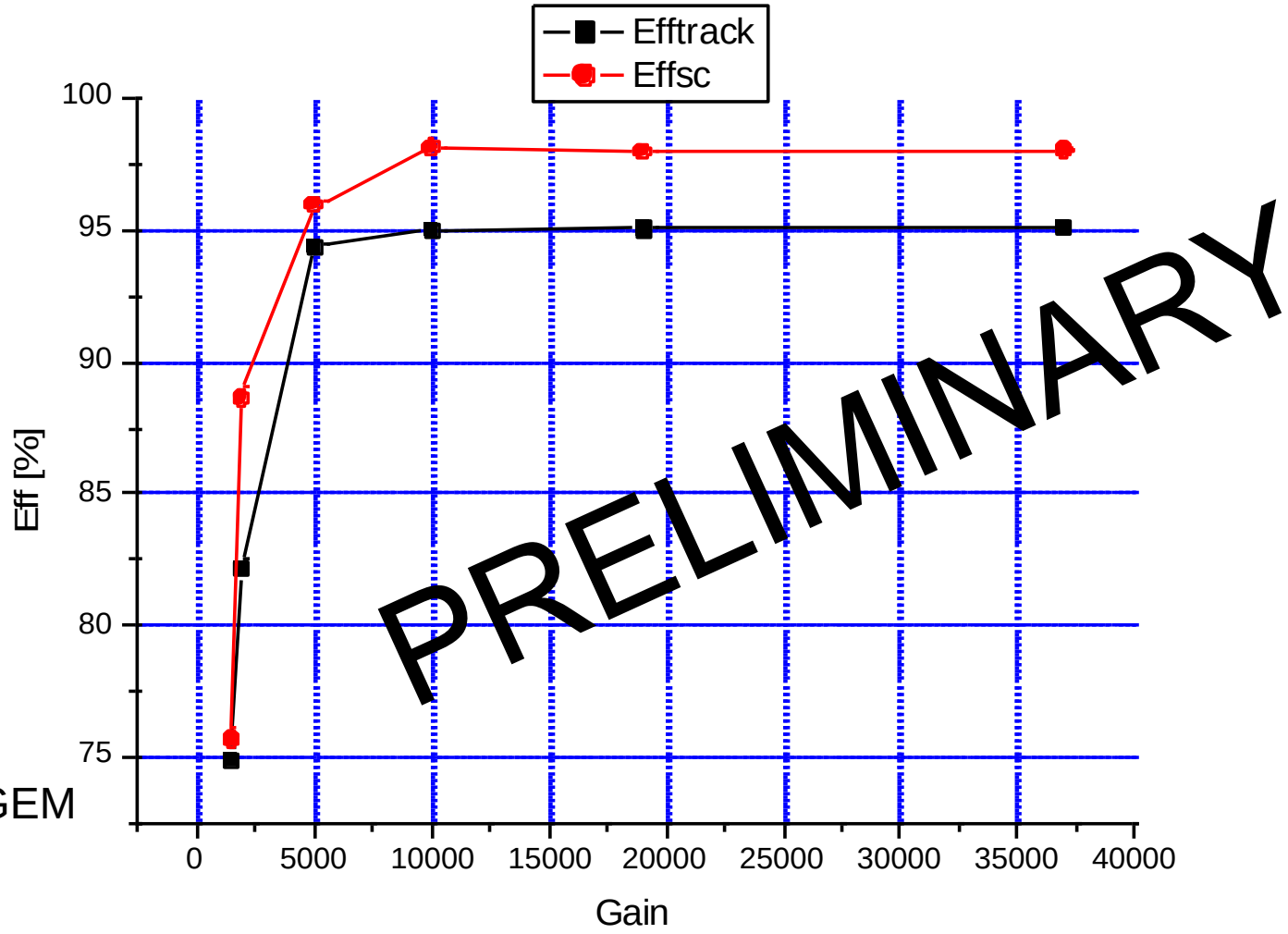
- Tracking: Standard GEMs chambers: **T1, T2, T3**
- Data-taking: GEMs chambers have been tested:
  - **"Timing chamber"**
  - **"Honeycomb chamber "**
  - **"Single mask chamber"**
- Gas mixtures used:
  1. Ar(70%) + CO2(30%)
  2. Ar(45%) + CO2(15%) + CF4(40%) *[LHCb Mixture]*

Beam Test June 2010 – Preliminary Online Results



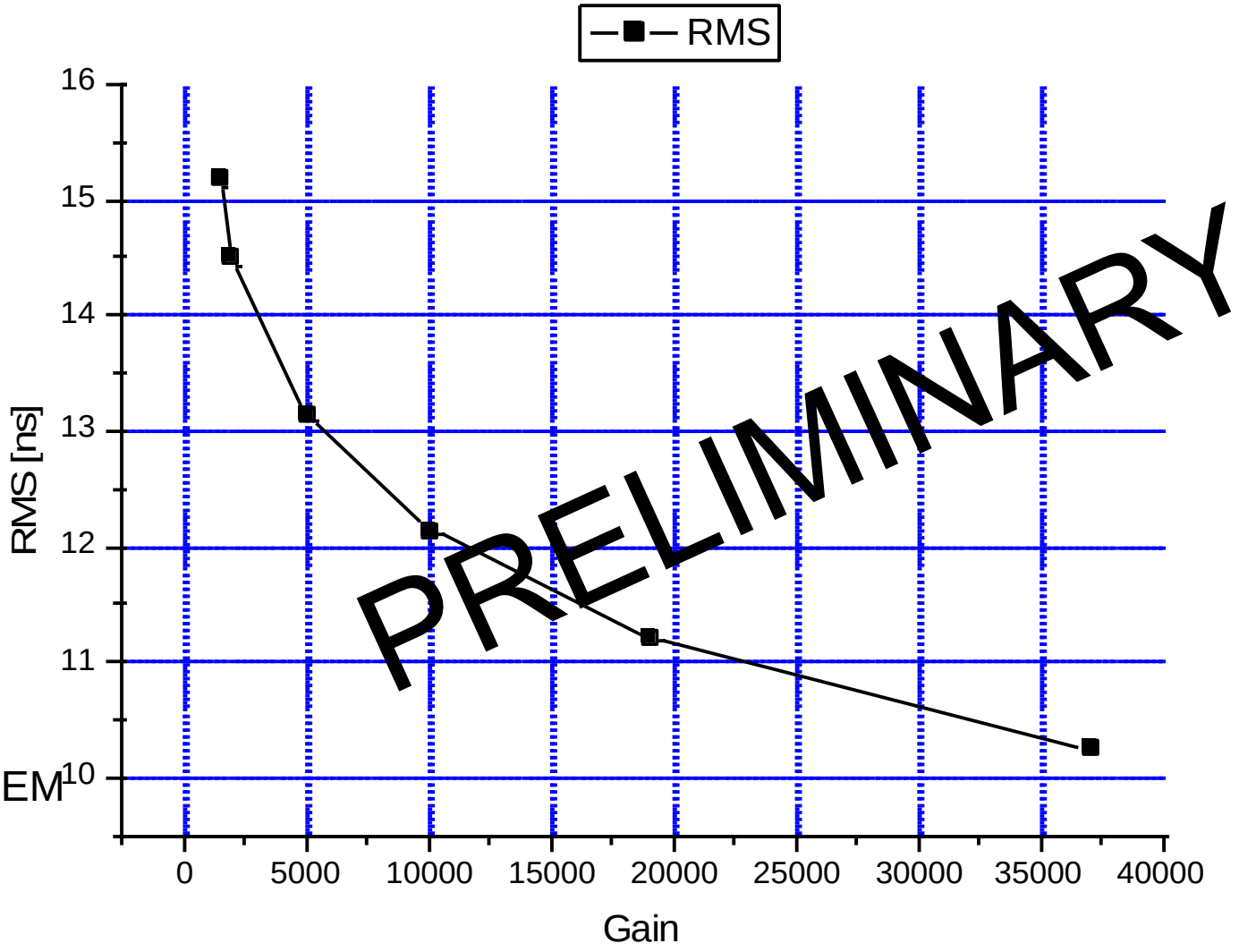
Summary

Summary Results for Ar-CO2 70-30
Efficiency scan Eff./Gain

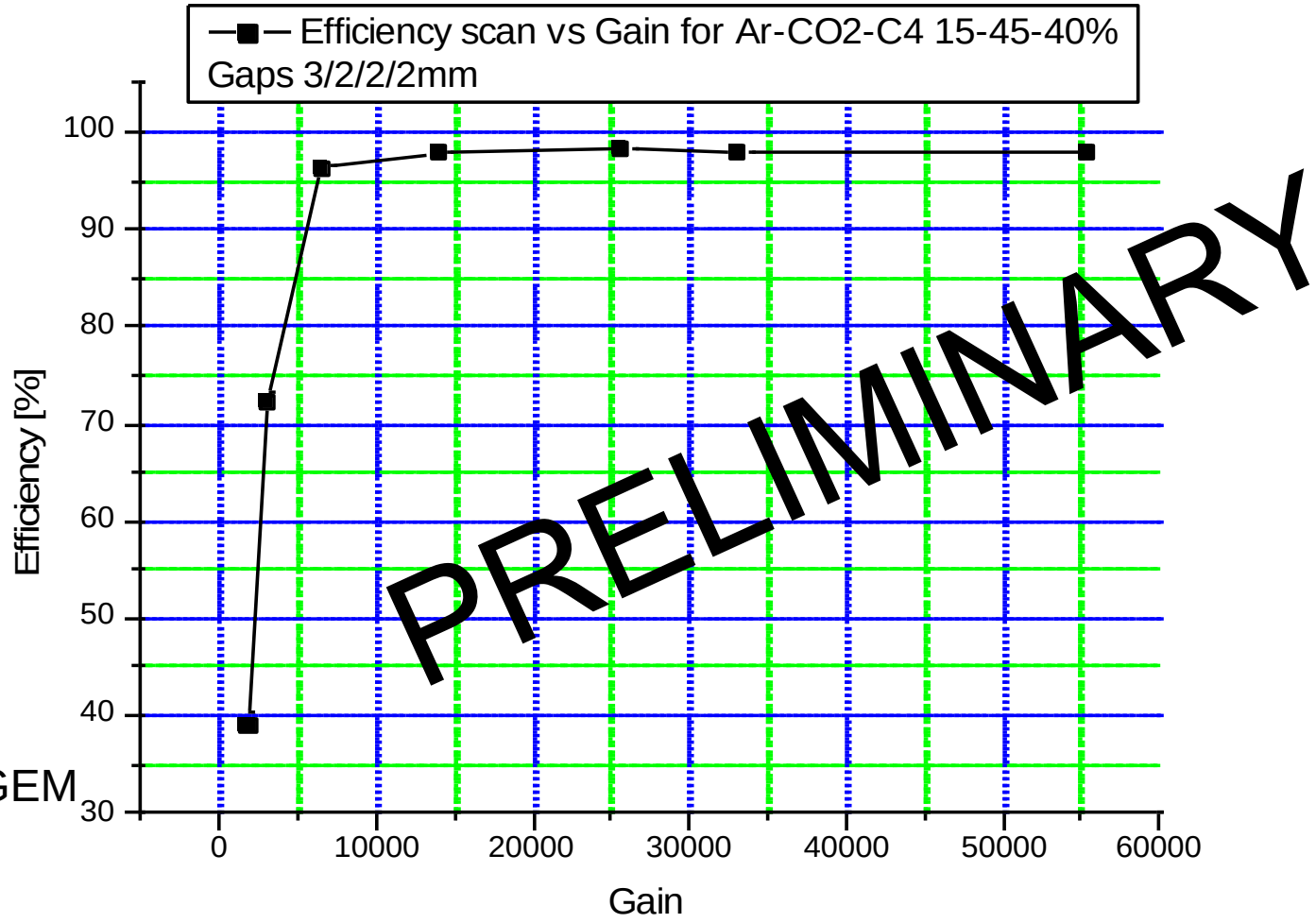


Timing GEM

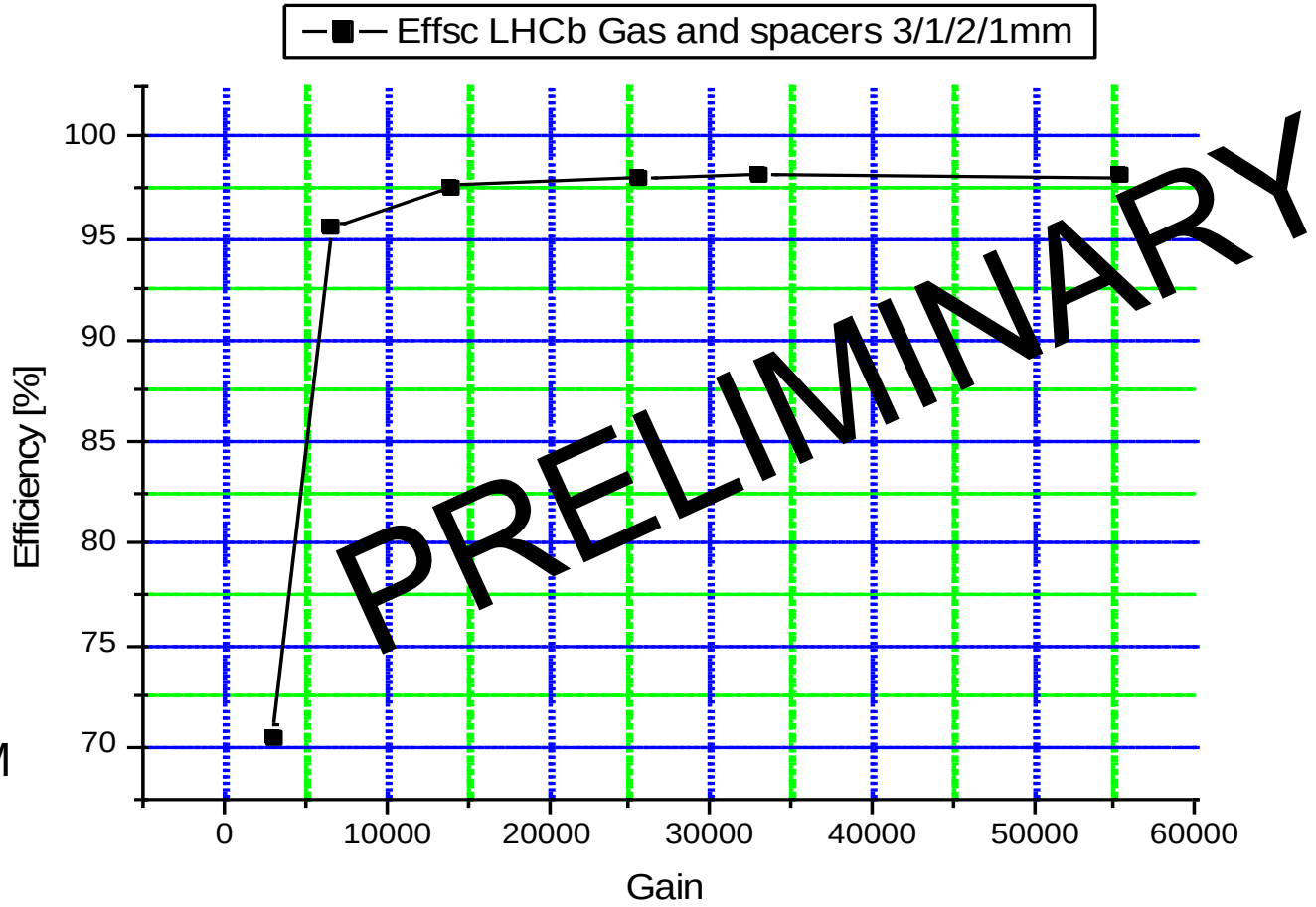
Summary Results for Ar-CO2 70-30
RMS of the arriving time vs Gain



Summary Results for Ar-CO2-CF4 15-45-40 and gaps 3/2/2/2mm Efficiency scan vs Gain

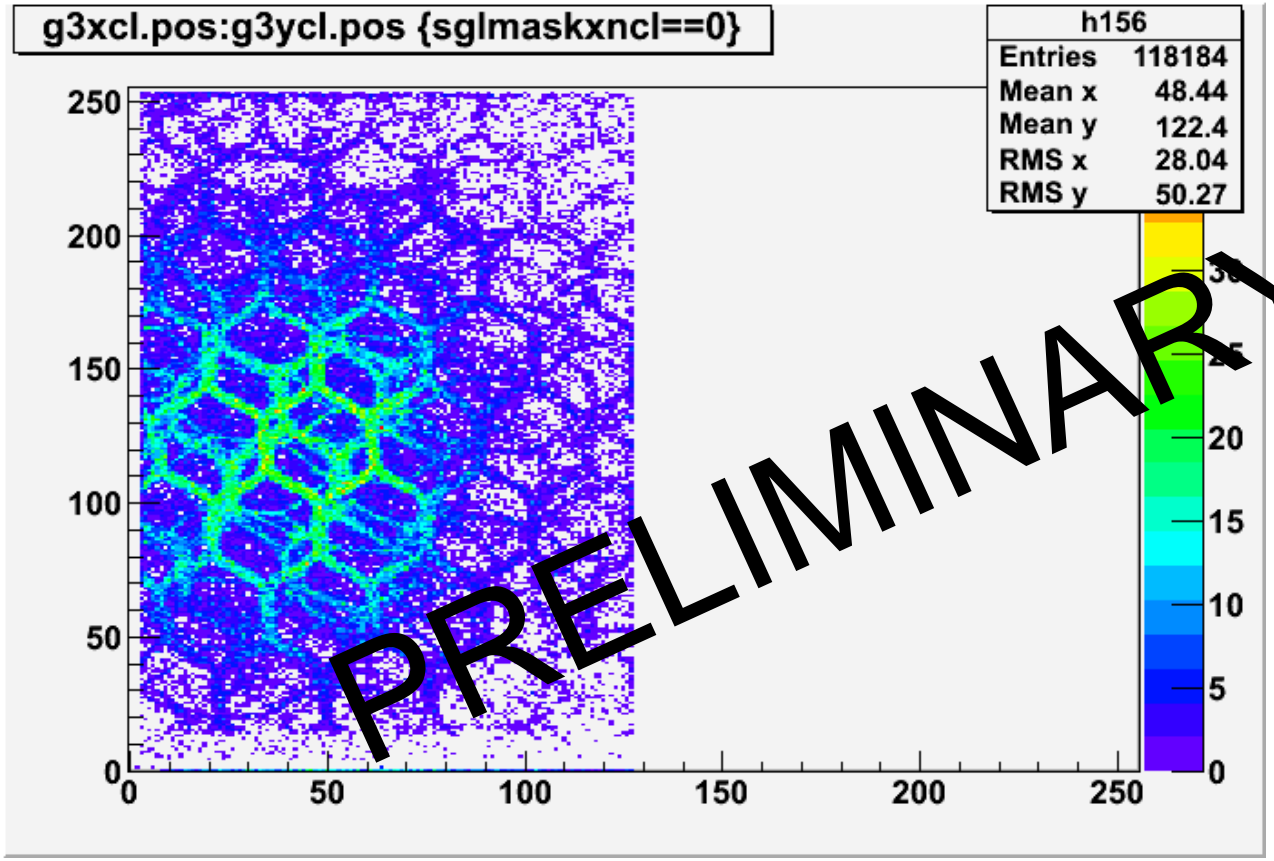


Summary for the last Eff scan with new spacers 3/1/2/1mm and LHCb gas



Timing GEM

Honeycomb GEM Data analysis continues



STATUS AND OUTLOOK

1. Prototype (standard, honeycomb, single mask) tests in lab, beam - continue
2. Beam tests and analysis 2010 – continue
3. Detail mechanical design for mock up and proto
~ final
4. Definition of readout, electronics and its mechanical support
- ongoing
Services and routing HV, Gas, LV, cooling - ongoing
5. Mockup realization of detector
Done, some details missing
6. Production of prototype
– expected to be completed by end of June
7. Tests of prototype
8. Feasibility / simulation studies of integration with CMS trigger and tracking – to be done (not yet started)