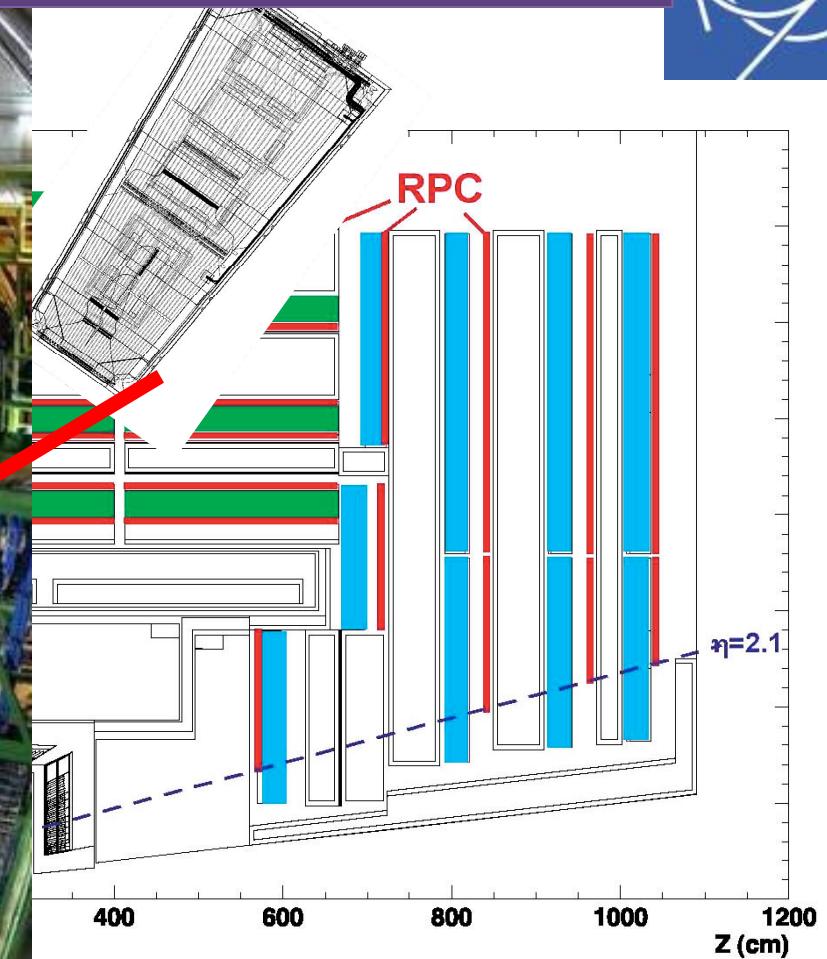
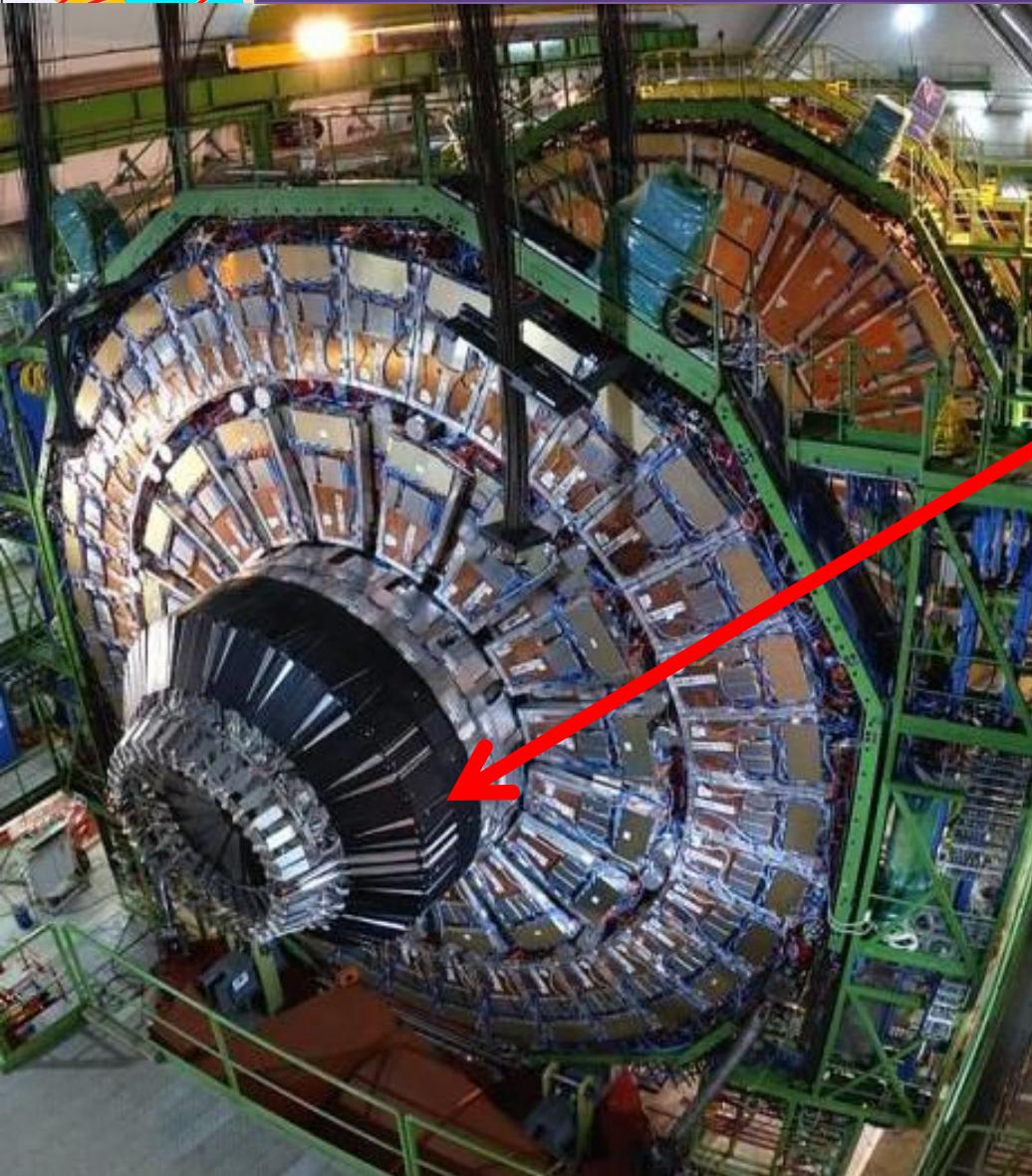
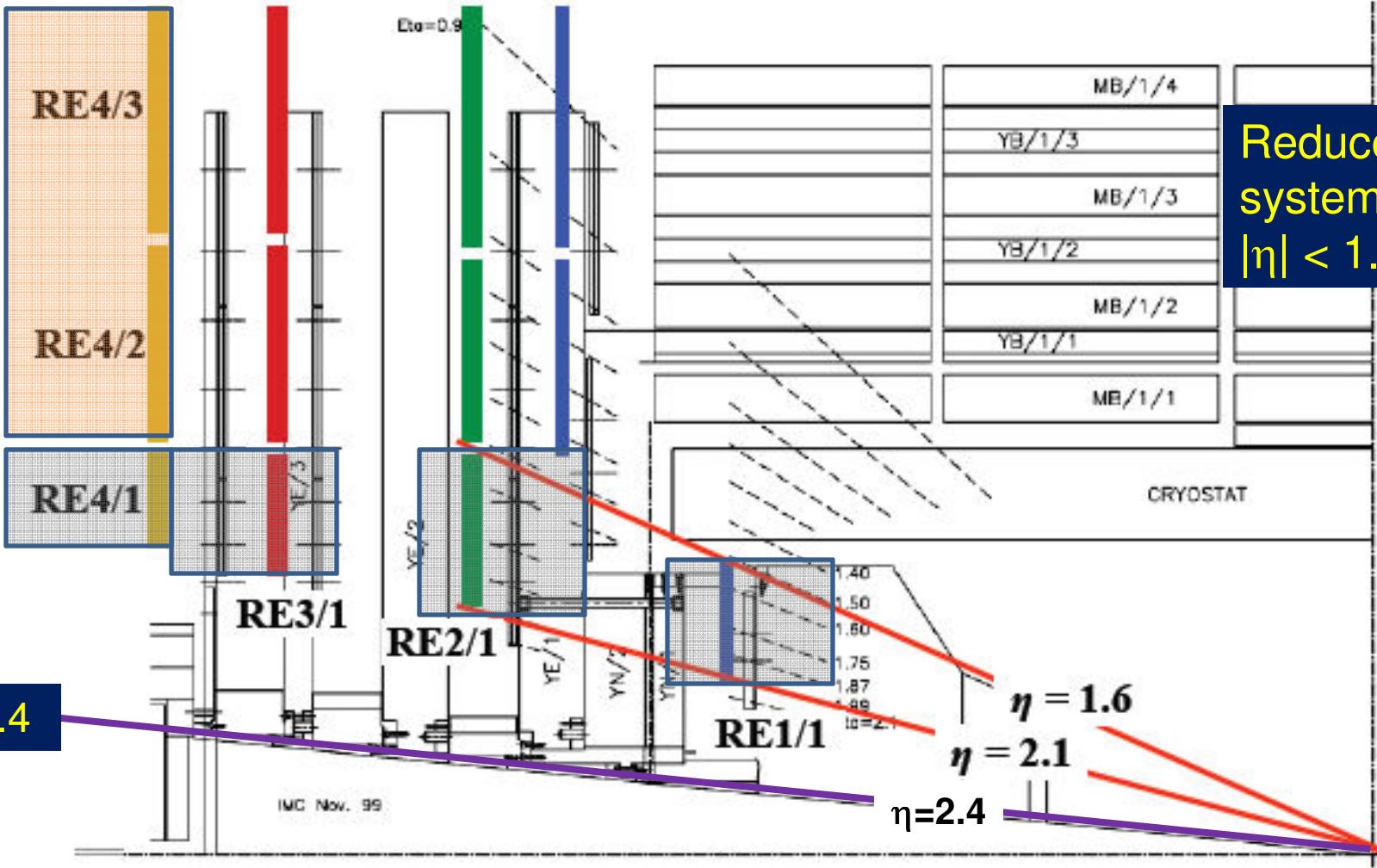


Feasibility Studies for a High Eta Forward Muon Trigger and Tracking detector for CMS



Endcap RPC:

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

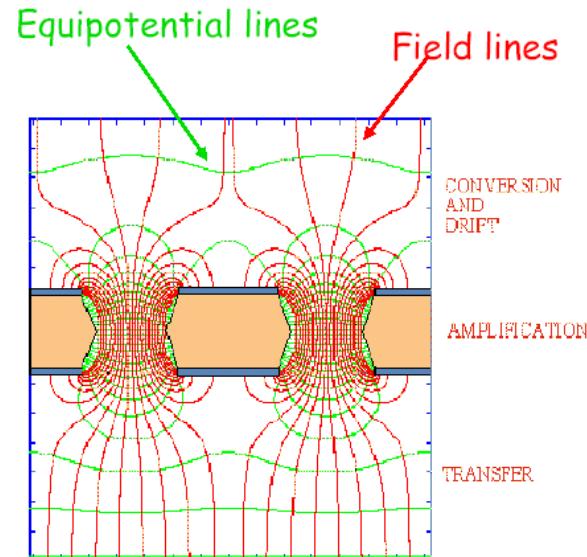
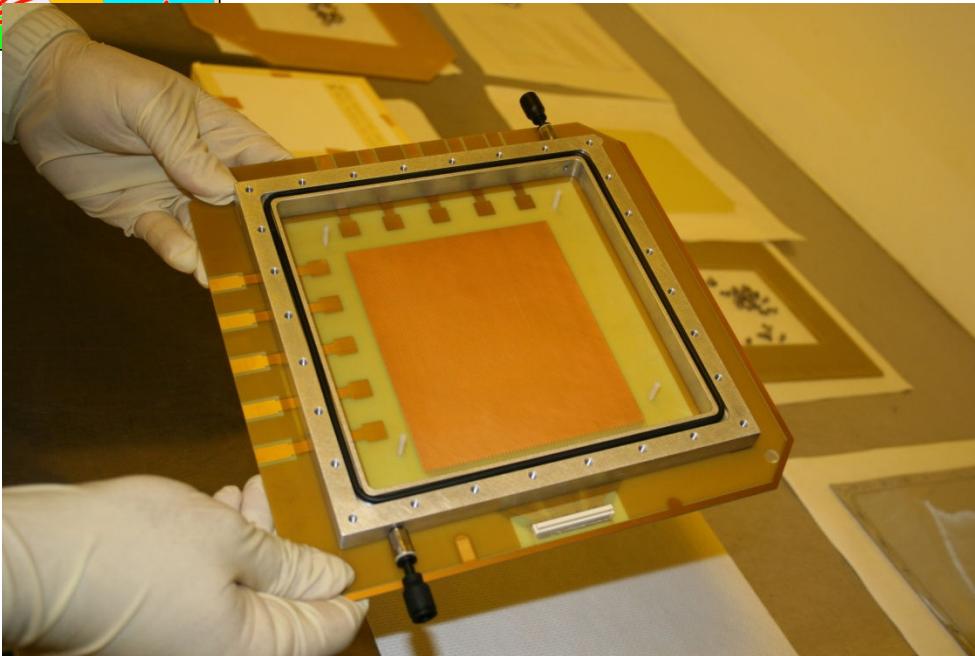


Reduced RE
system
 $|\eta| < 1.6$

STAGED

	RE 1/1	RE 1/2	RE 1/3	RE 2/1	RE 2/2	RE 2/3	RE 3/1	RE 3/2	RE 3/3	RE 4/1	RE 4/2	RE 4/3
No. of chambers	36*2	36*2	36*2	18*2	36*2	36*2	18*2	36*2	36*2	36*2	36*2	36*

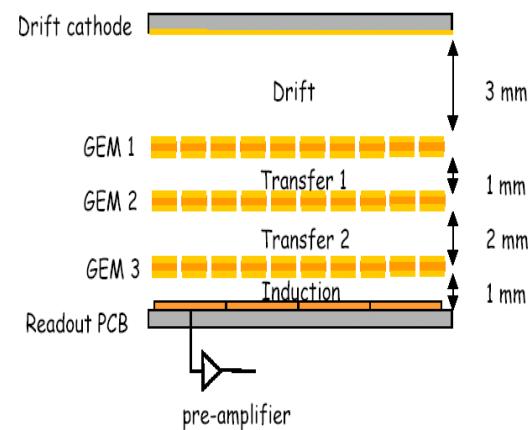
MPGDs as candidate technology



Enhance and optimize the readout ($\eta-\phi$) granularity by improved rate capability

Rate capability – $10^4/\text{mm}^2$

- Spatial resolution $\sim 100 \mu\text{m}$ ($\Theta_{\text{track}} < 45^\circ$)
- Time resolution $\sim 5 \text{ ns}$ (Gas!)
- Efficiency $> 98\%$
- Rate capability $> 5 \text{ kHz/cm}^2$
- Argon CO₂ (non flammable mixture - big plus)



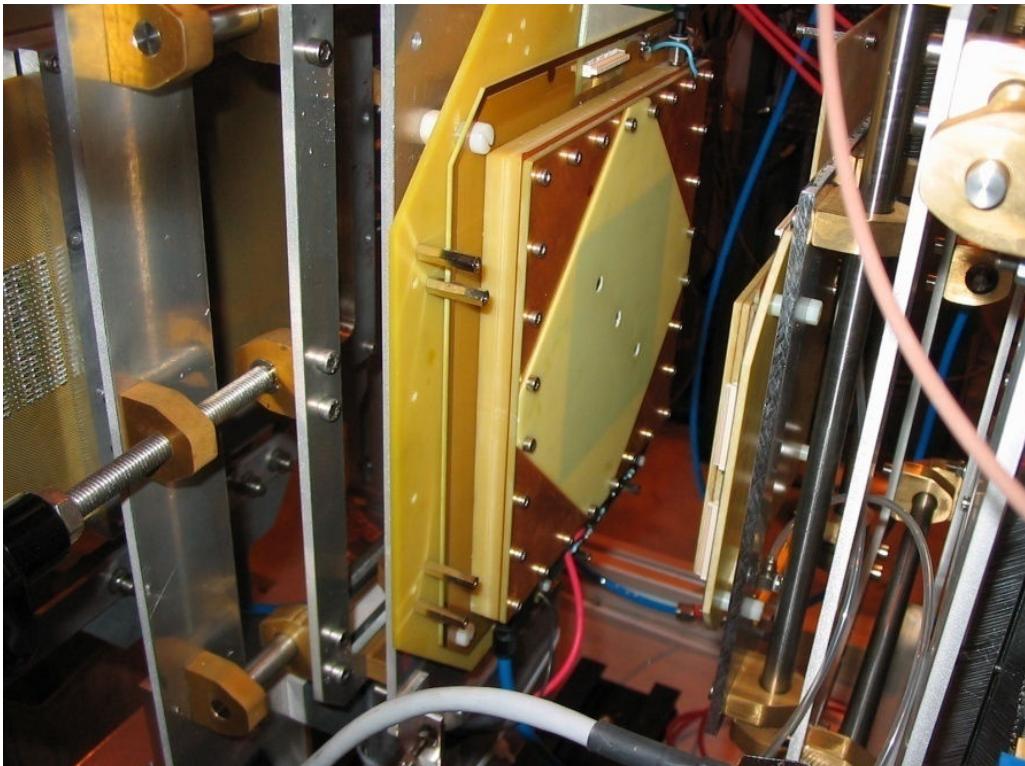


ONGOING Activities:

1. Prototype tests in lab and beam, data analysis
2. Detail mechanical design
3. Definition of the readout electronics and it's mechanical support
4. Services and routing: HV, Gas, LV, Cooling
5. Mockup realization of the detector
6. Production of the prototype

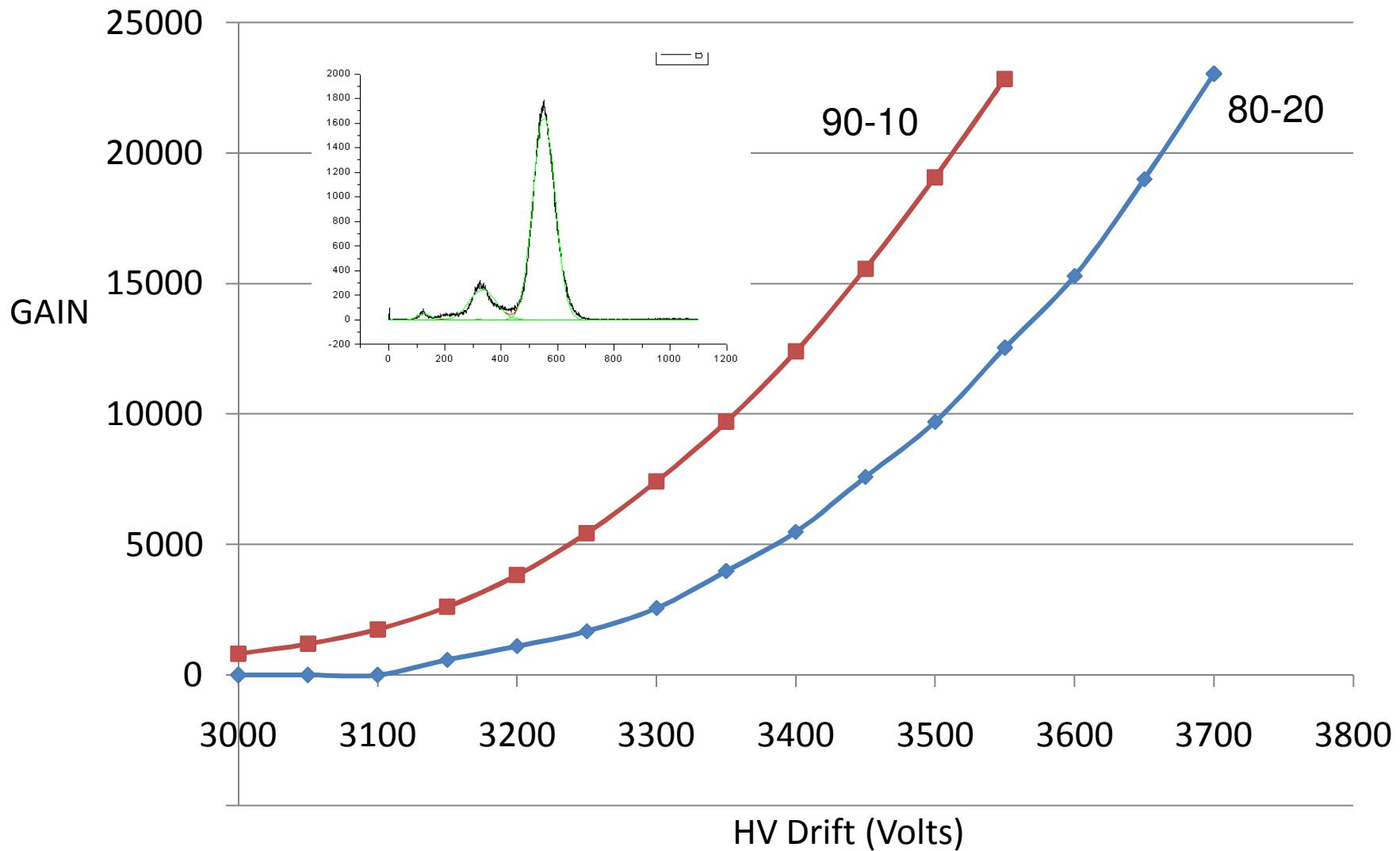
ONGOING Activities: Small Prototype

- Triple GEM Detector
- 10x10 cm² active area
- Gas Mixtures used: Ar/C0₂ 90%/10% and 70%/30%
- 1D Readout Strip (X-direction) and 1 VFAT connected to the only one connector
- Strip pitch = 0.8 mm;
1 connector → 128 strips



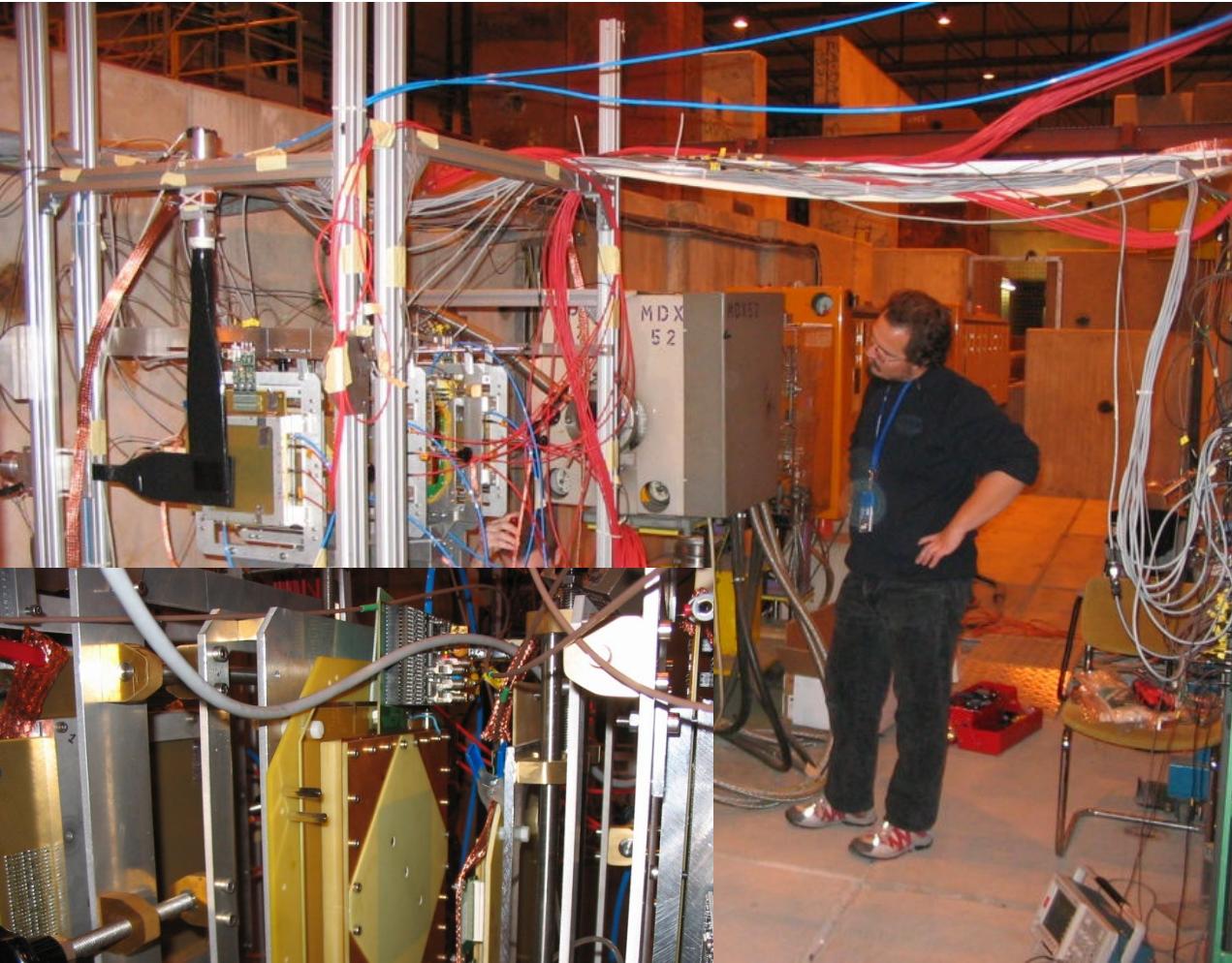


GAIN STUDIES WITH TRIPLE GEM ARGON CO2 CURRENT WITH Cu X-Rays





ONGOING Activities: BEAM TEST DATA ANALYSIS



- During Beam Test and later in the lab the CMS GEM has been working fine, data has been taken.
- Unfortunately, lots of discharges have been observed during beam in the CMS μ Megas prototype

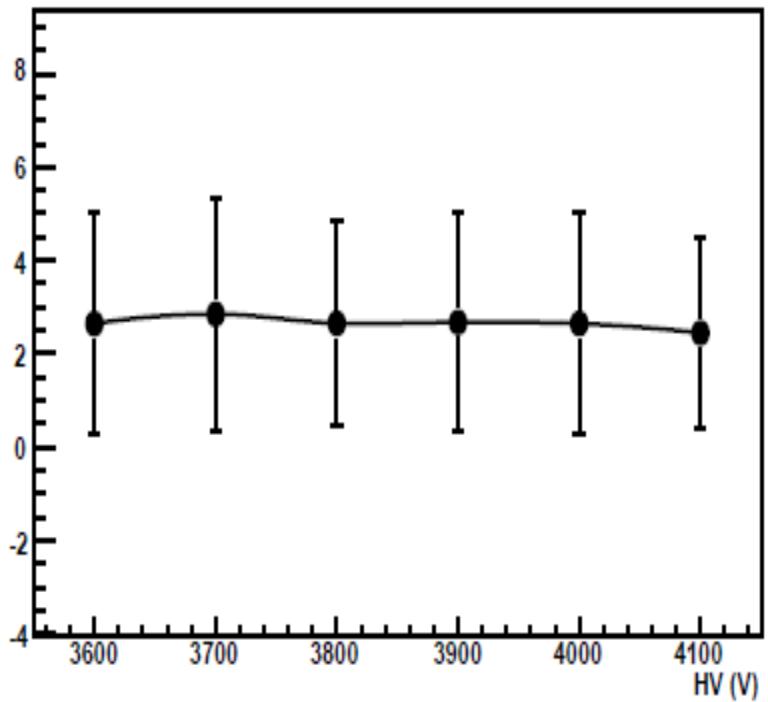
BACK IN THE LAB

- Read the CMS GEM with VFAT electronics and play with Gas mixture.
- Understand the timing performance of the detector.

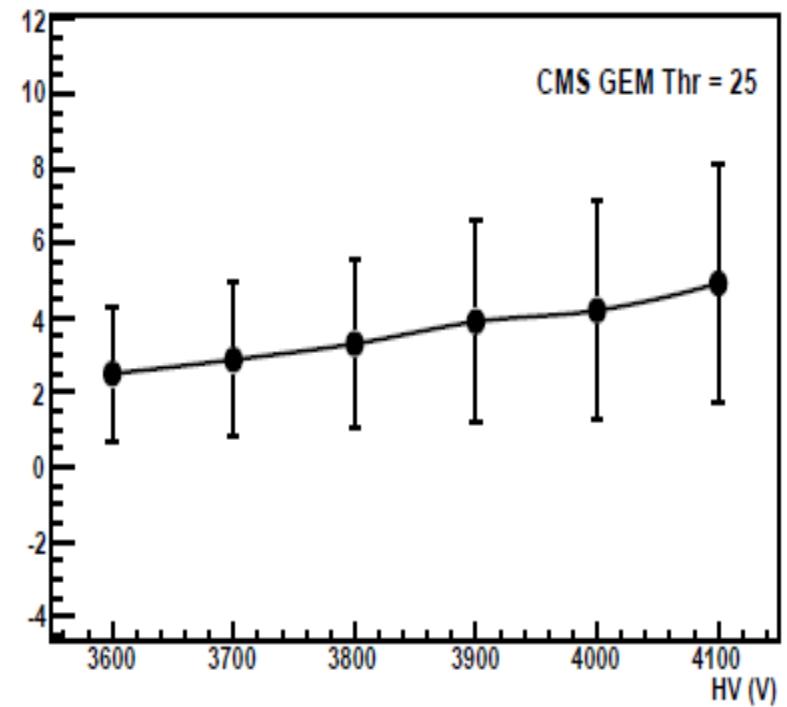


CLUSTER SIZE & CLUSTER MULTIPLICITY

Cluster multiplicity



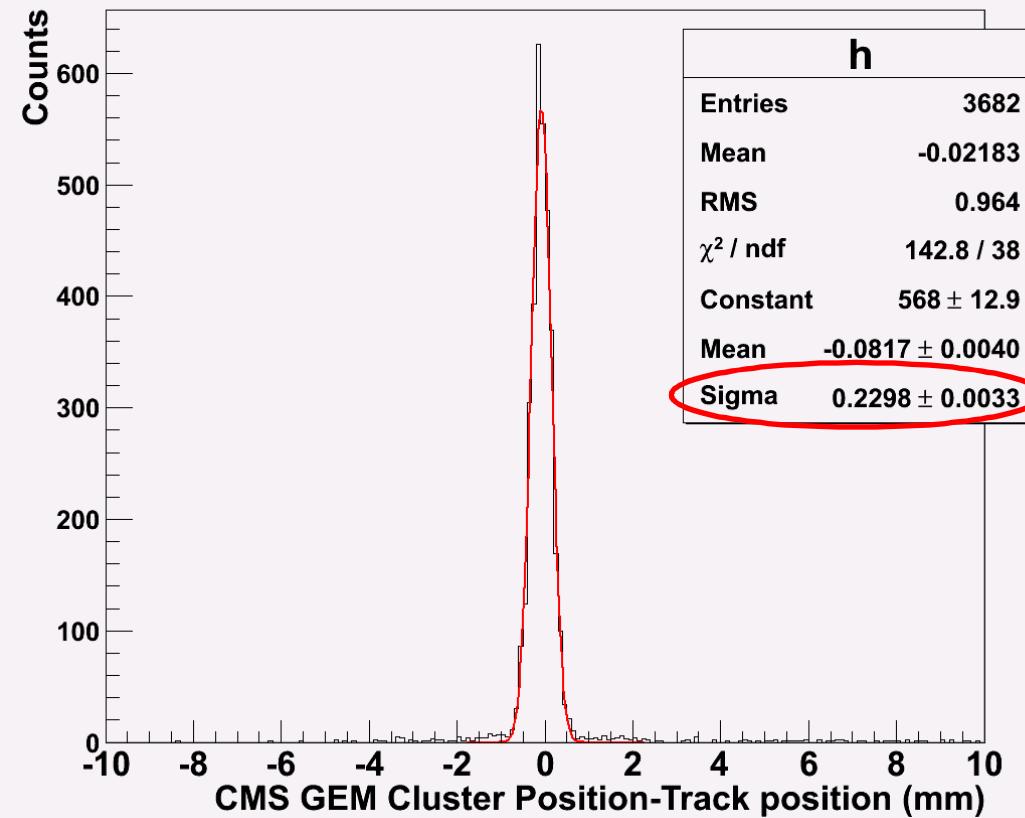
Cluster size (#channels)



M. Tytgat



CMS GEM SPACE RESOLUTION

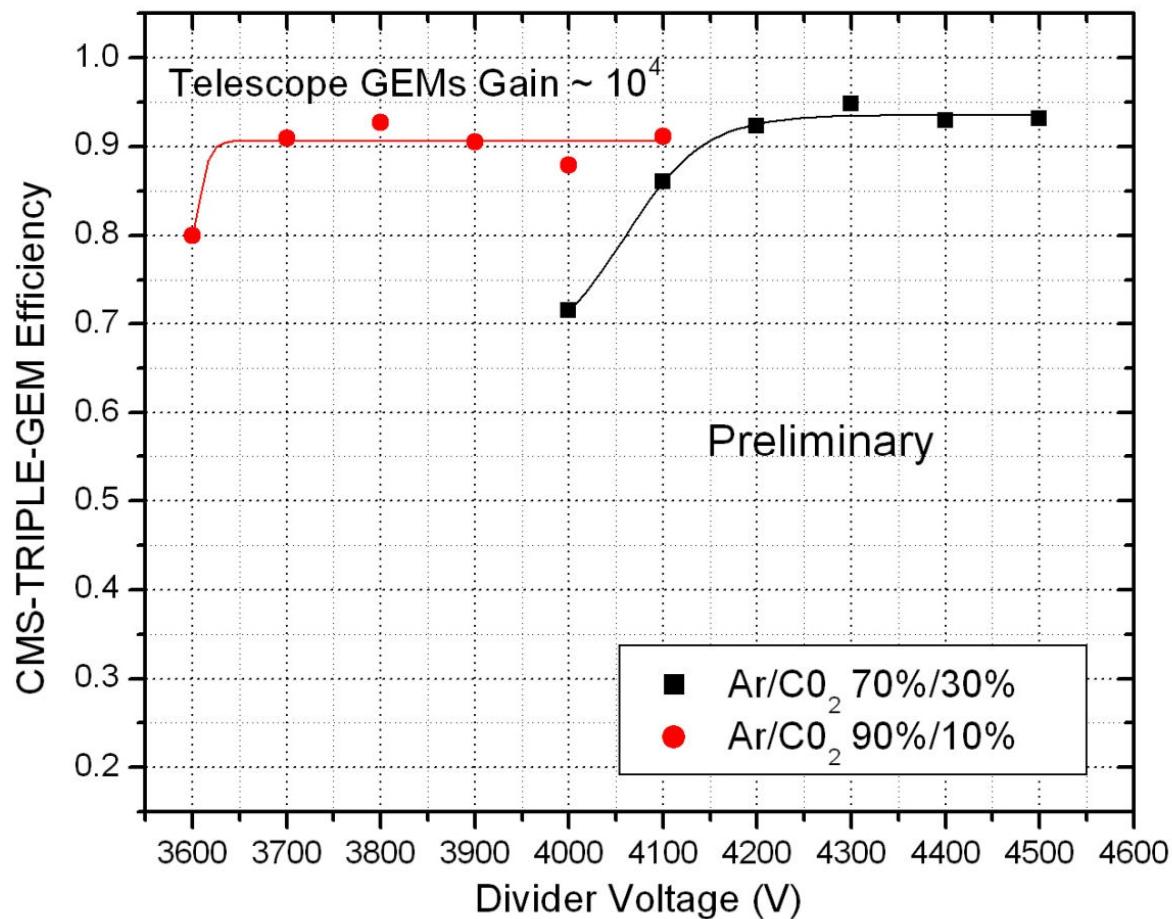


The expected resolution due to a digital readout is $\text{pitch}/\sqrt{12} = 0.8\text{mm}/\sqrt{12} = 230\text{ }\mu\text{m}$
The measured space resolution is $\sim 230\text{ }\mu\text{m}$



CMS GEM Preliminary Efficiency ..

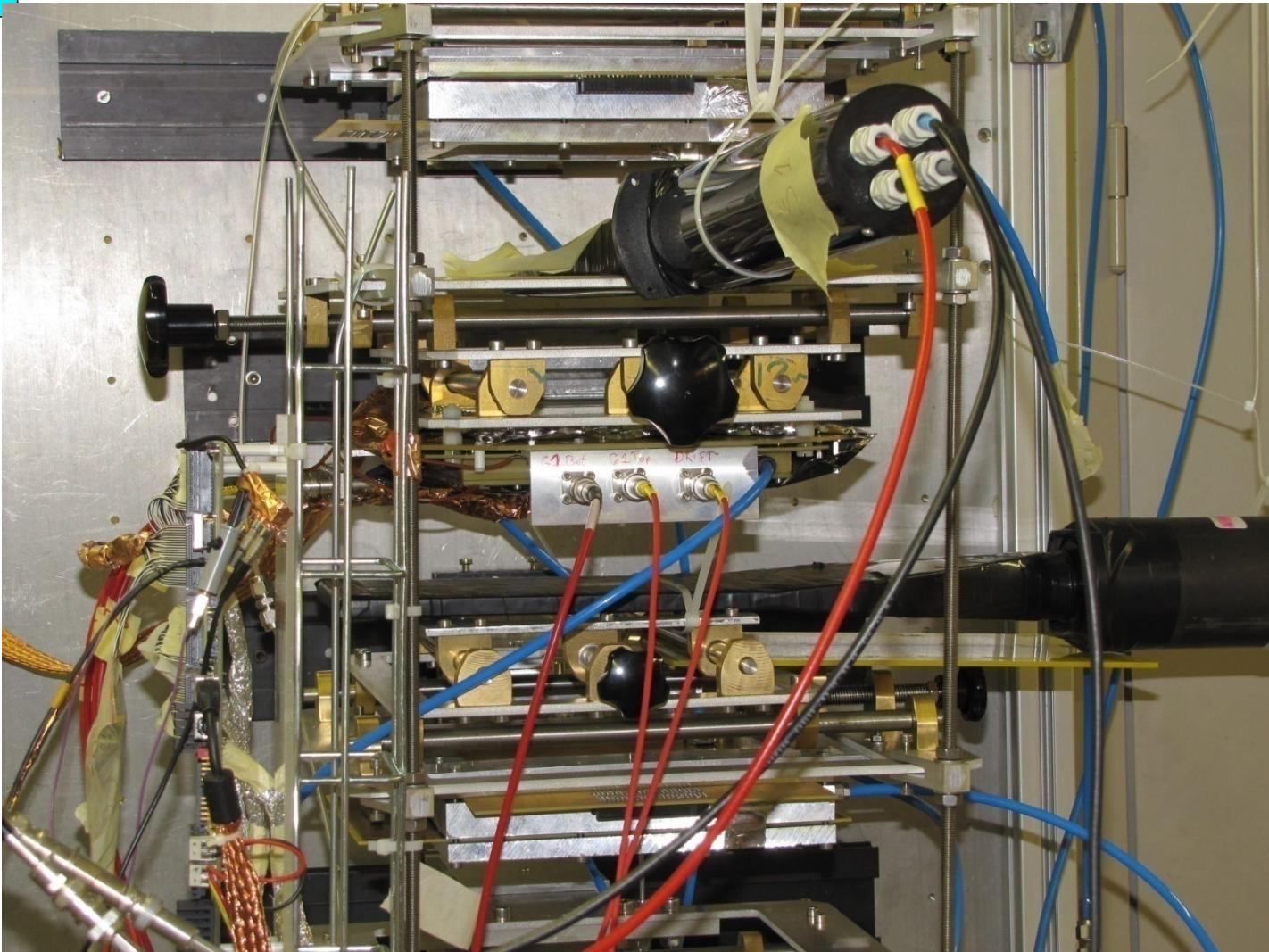
Ongoing analyses



Efficiency = Cluster in CMS GEM close to track crossing point
number of tracks

G.Croci (CERN)

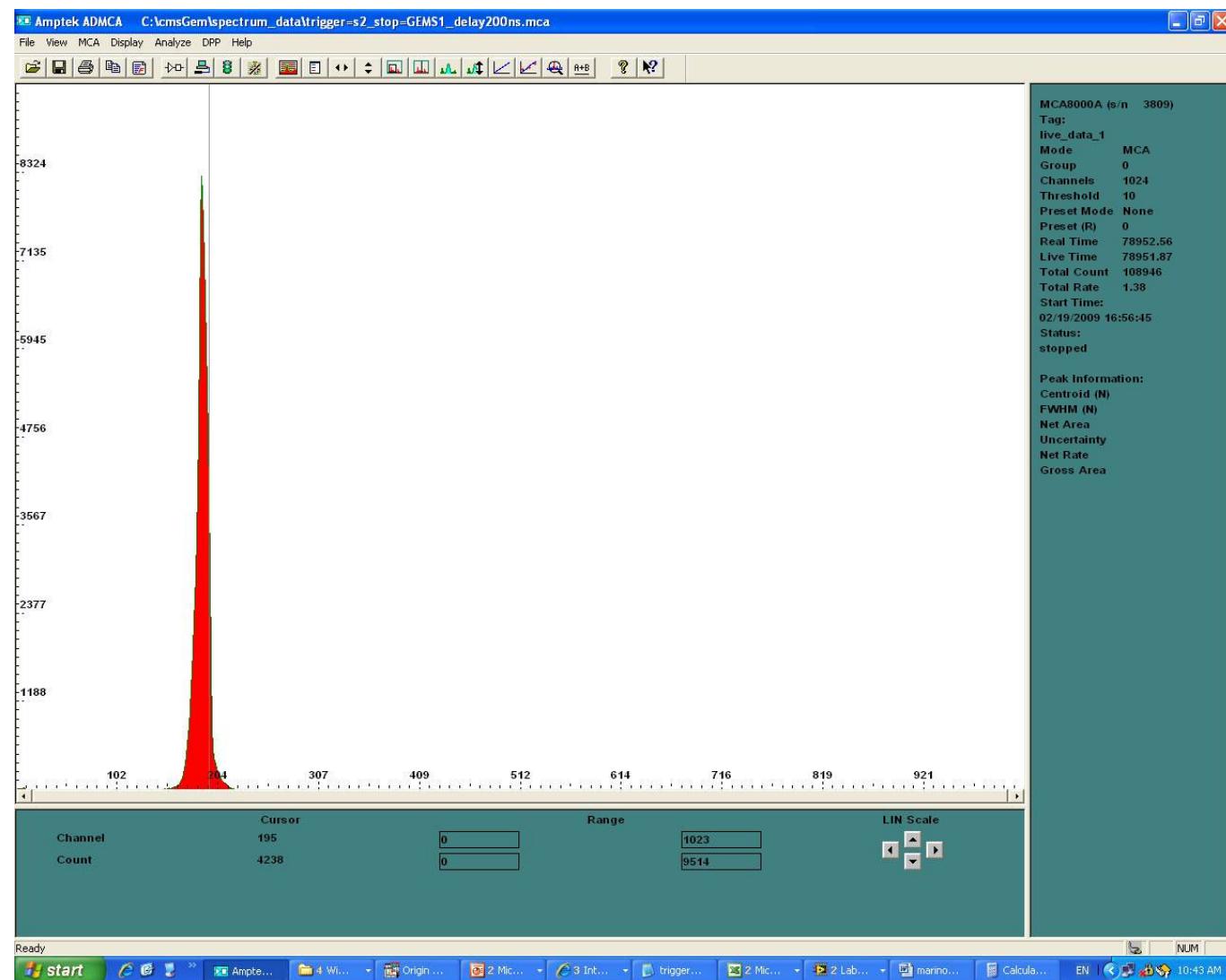
BACK IN THE LAB..Cosmic Stand



Andrey Marinov



Timing Studies..



Ar-CO₂ 70-30
VFAT

Field Configuration:
Ed – 2.5 kV/cm

ET1 – 3.7 kV/cm
ET2 – 3.7 kV/cm
ET3 – 3.7 kV/cm

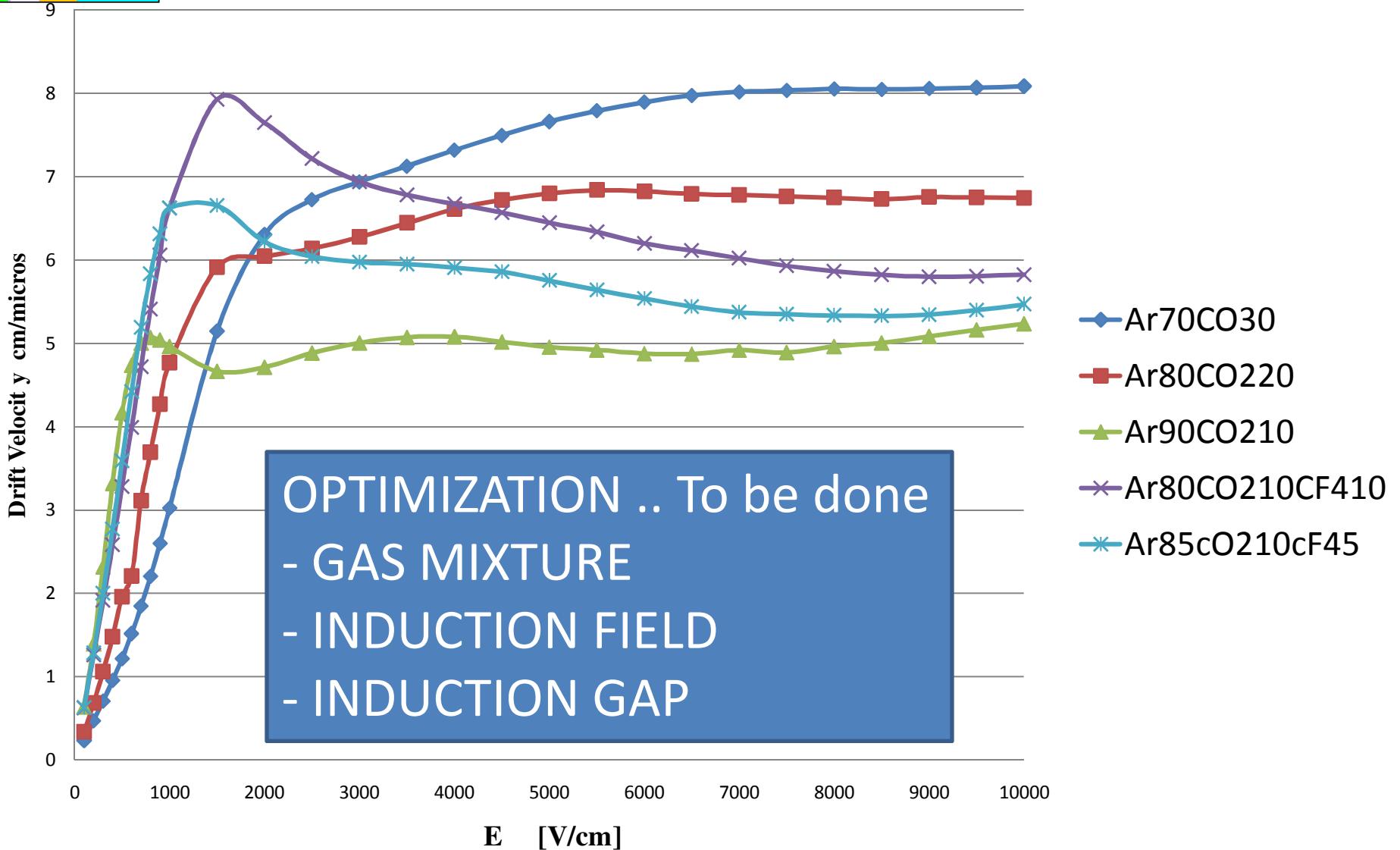
GEM1 – 416 V
GEM2 – 378 V
GEM 3 – 332 V

FWHM – 10.89 ns
RMS – 4.25 ns

Noise to be reduced

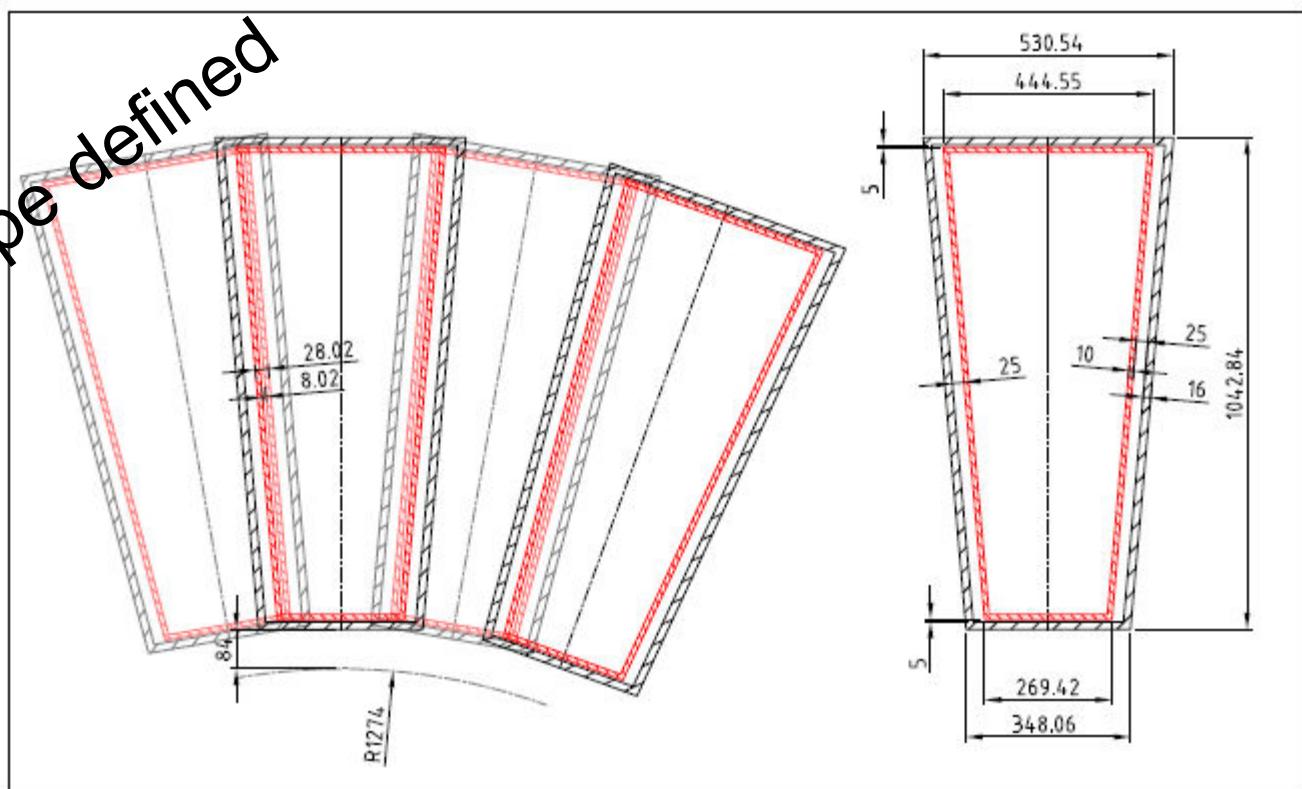


Drift Velocity



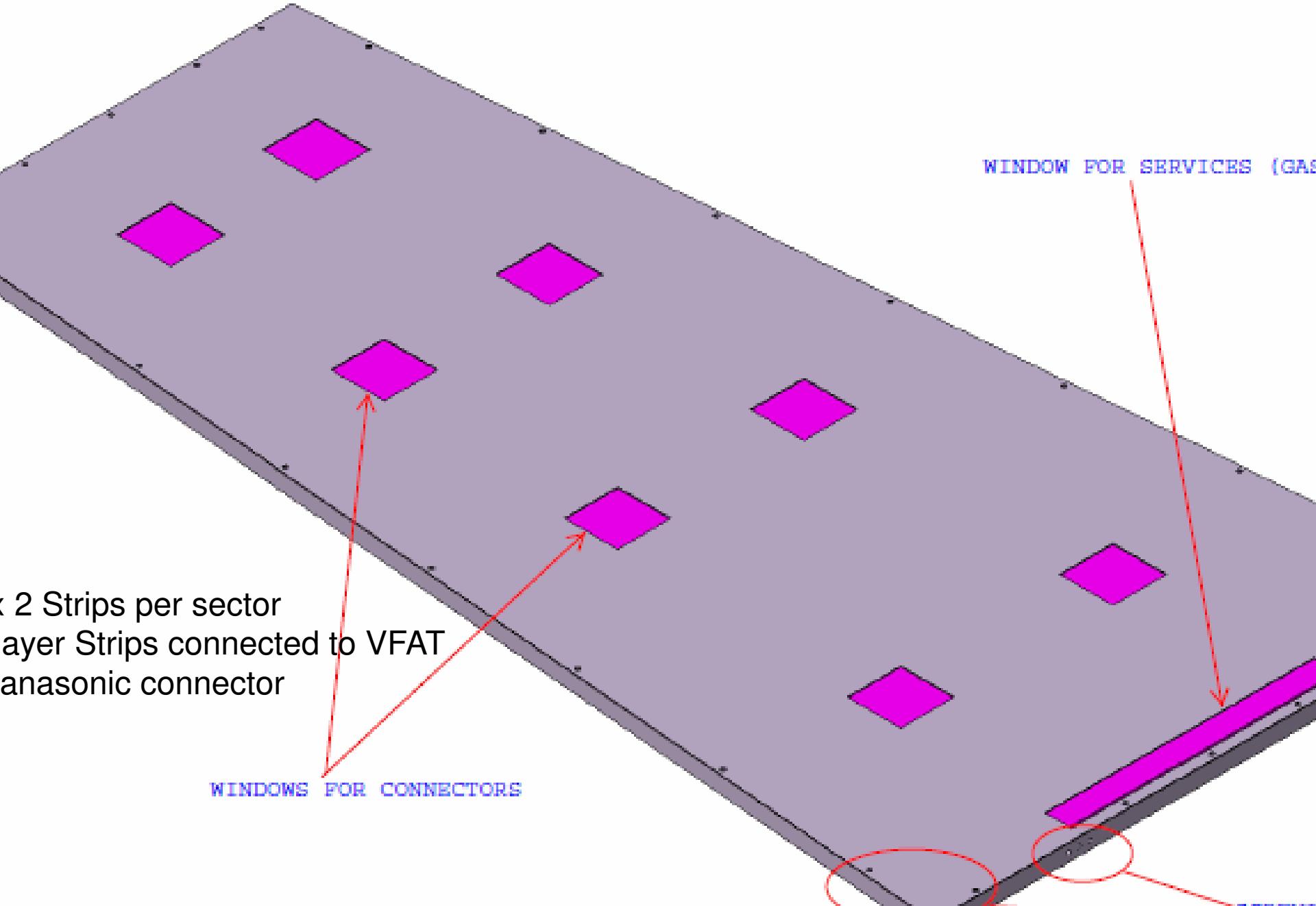
Is it possible to increase the eta coverage from 2.1 to > 2.2 ?
There are mechanical (and installation) constraints to be understood.

Envelope defined



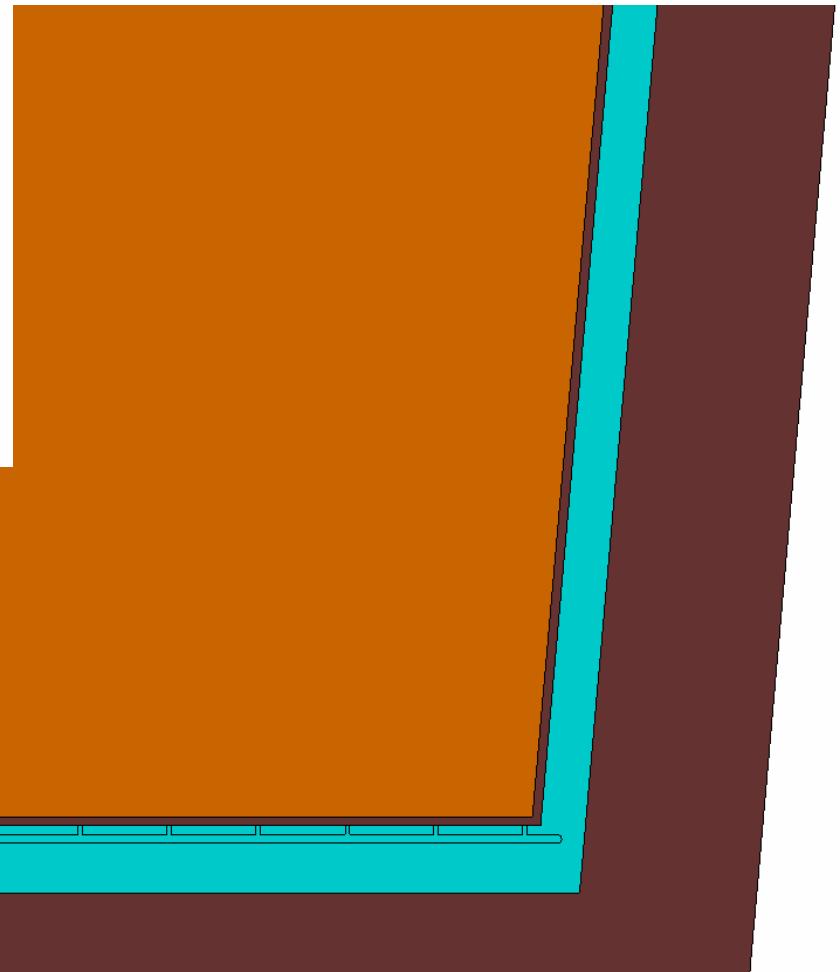
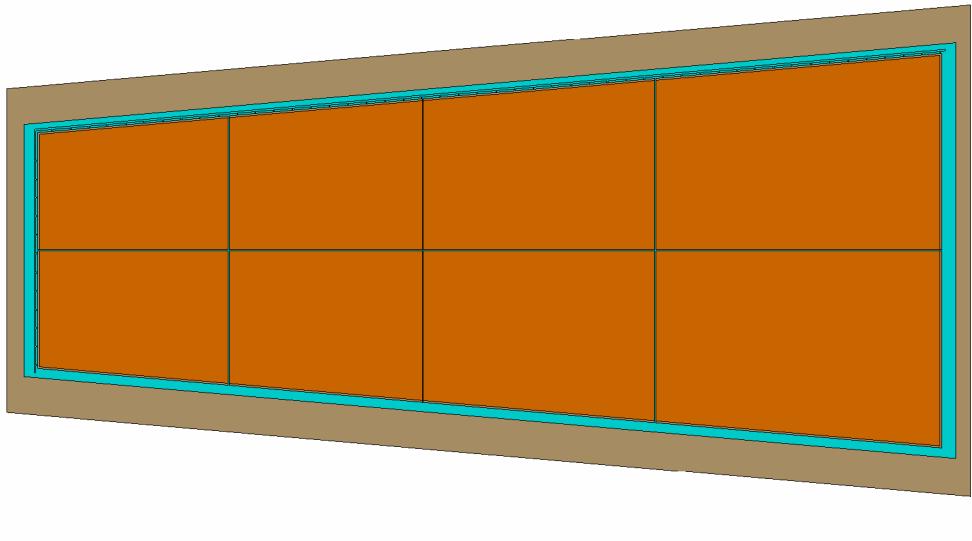
Hans Postema, Stephane Bally, Antonio Conde, Gerard Faber, Jean-Paul Chatelain

GEM UPDATED



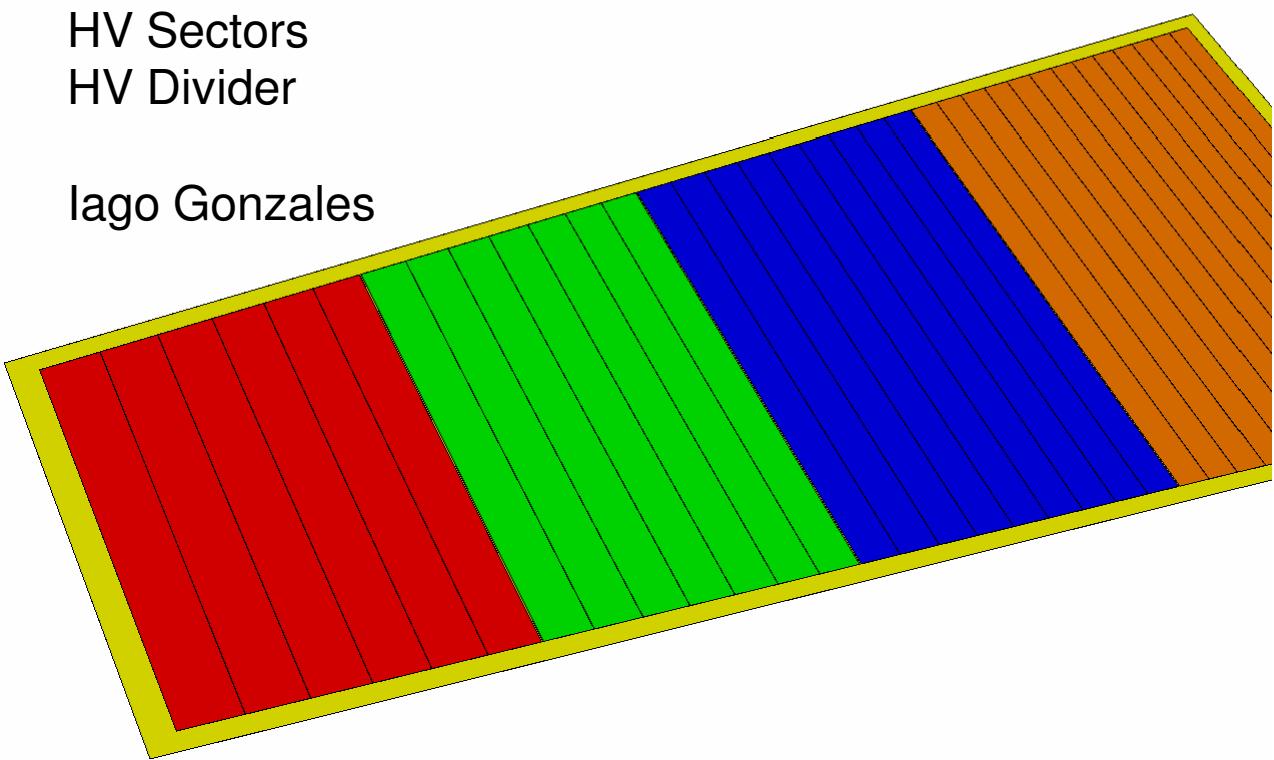


Frames, spacers and grooves for gas



HV Sectors
HV Divider

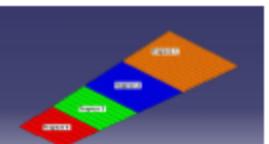
Iago Gonzales



DIMENSION OF THE TRAPEZES

Trapeze 1

B (mm)	A (mm²)	b (mm)	h (mm)
1.000	419.934	9200.000	416.083
2.000	412.057	9200.000	412.168
3.000	412.143	9200.000	408.218
4.000	408.192	9200.000	404.239
5.000	404.250	9200.000	400.201
6.000	400.174	9200.000	396.131
7.000	396.105	9200.000	392.026
8.000	391.994	9200.000	387.865
9.000	387.839	9200.000	383.666
10.000	383.640	9200.000	379.420
11.000	379.394	9200.000	375.127
12.000	375.101	9200.000	370.784
13.000	370.758	9295.573	366.345



Trapeze 2

B (mm)	A (mm²)	b (mm)	h (mm)
1.000	366.169	9500.000	361.001
2.000	361.575	9500.000	356.248
3.000	356.921	9500.000	352.233
4.000	352.207	9500.000	347.455
5.000	347.429	9500.000	342.811
6.000	342.585	9500.000	337.698
7.000	337.672	9500.000	332.712
8.000	332.696	9500.000	327.651
9.000	327.625	9183.000	322.684



Trapeze 3

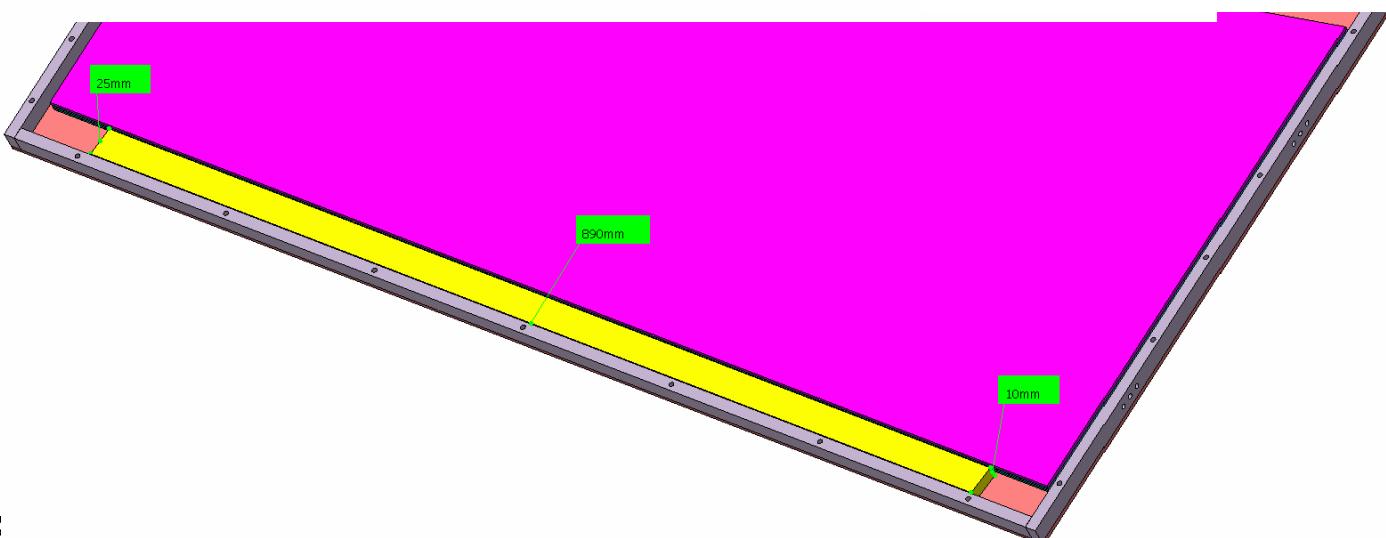
B (mm)	A (mm²)	b (mm)	h (mm)
1.000	322.520	9025.000	317.775
2.000	317.548	9025.000	312.536
3.000	312.510	9025.000	307.415
4.000	307.389	9025.000	302.208
5.000	302.181	9025.000	296.930
6.000	296.883	9025.000	291.516
7.000	291.489	9044.187	286.009

Trapeze 4

B (mm)	A (mm²)	b (mm)	h (mm)
1.000	285.834	9050.000	280.239
2.000	280.213	9050.000	274.504
3.000	274.477	9050.000	268.646
4.000	268.620	9050.000	262.659
5.000	262.632	9050.000	256.533
6.000	256.506	9030.678	250.270

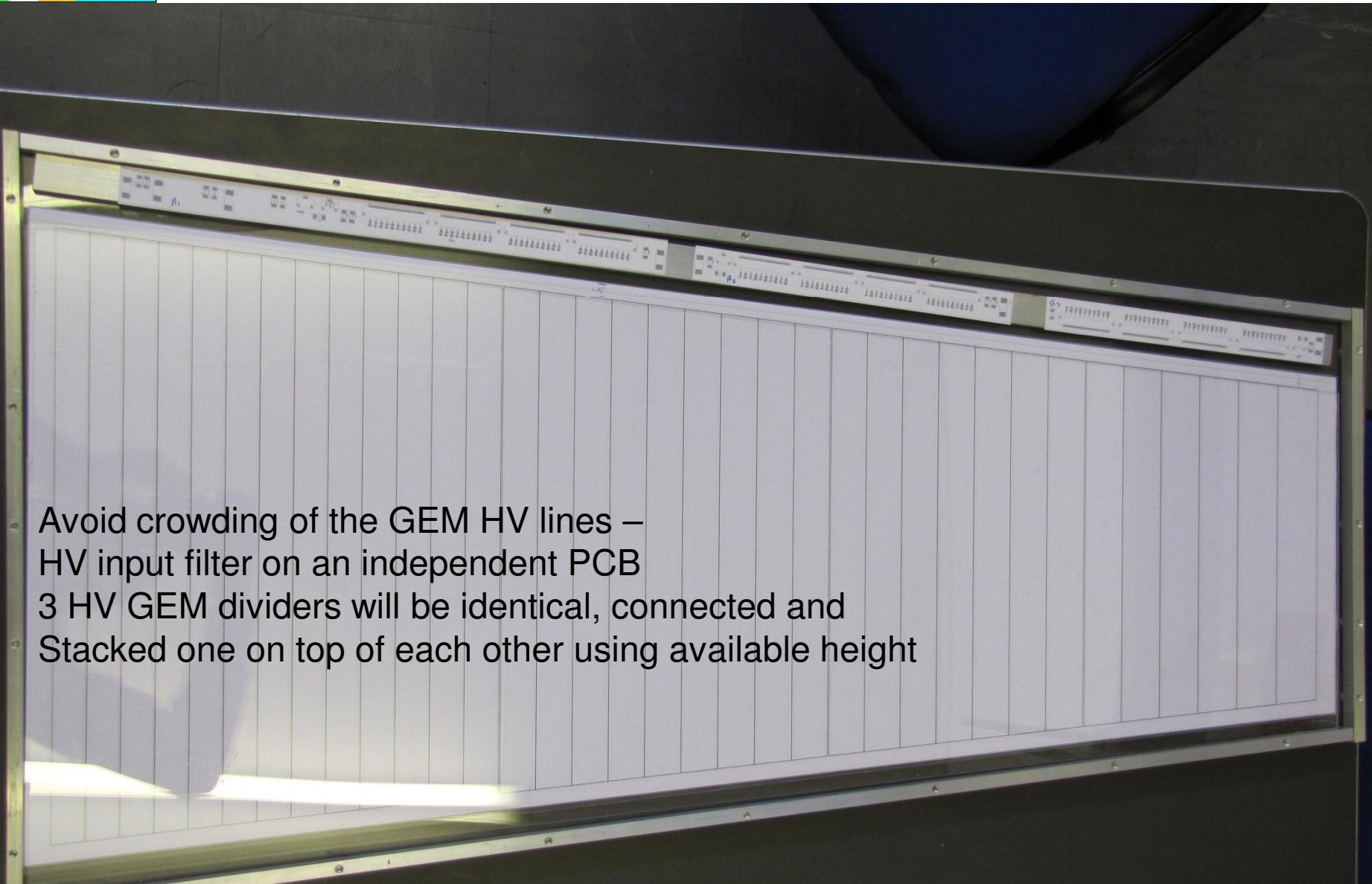
Iago González Tabares
PH-CMX-DS

12/1/2010





CMS GE1/1 Mock up

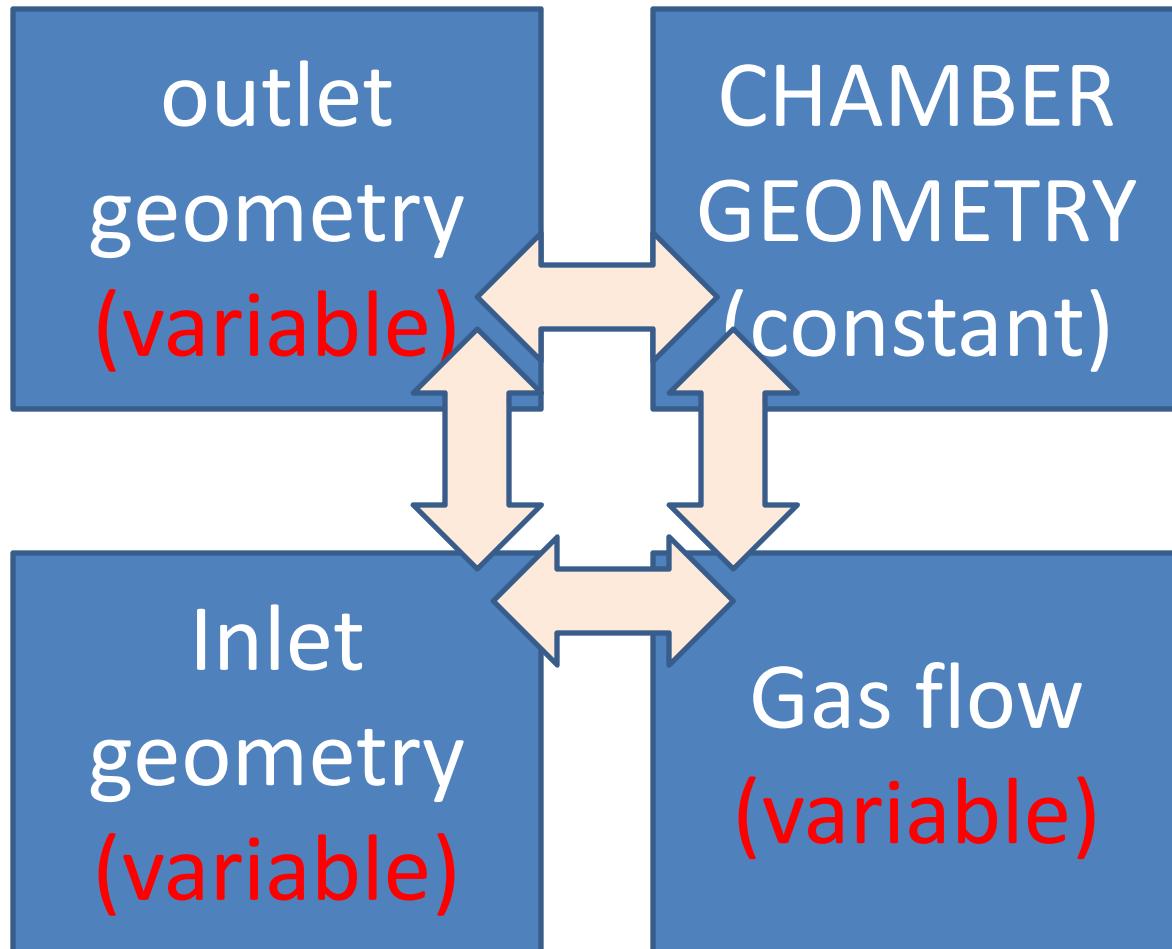


- Avoid crowding of the GEM HV lines –
HV input filter on an independent PCB
- 3 HV GEM dividers will be identical, connected and
Stacked one on top of each other using available height



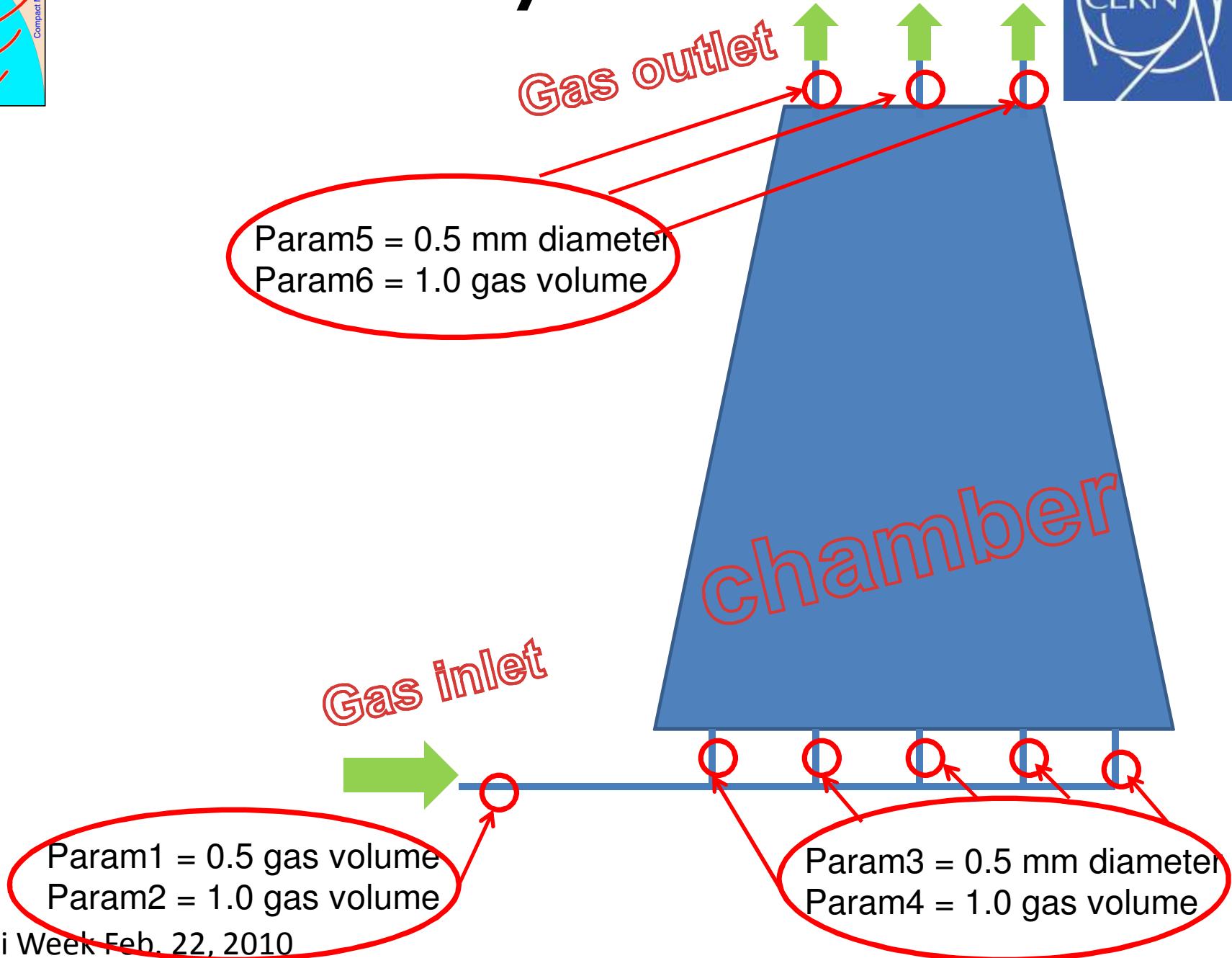
Fluid Dynamics for GEM Preliminary studies

Stefano Colafranceschi



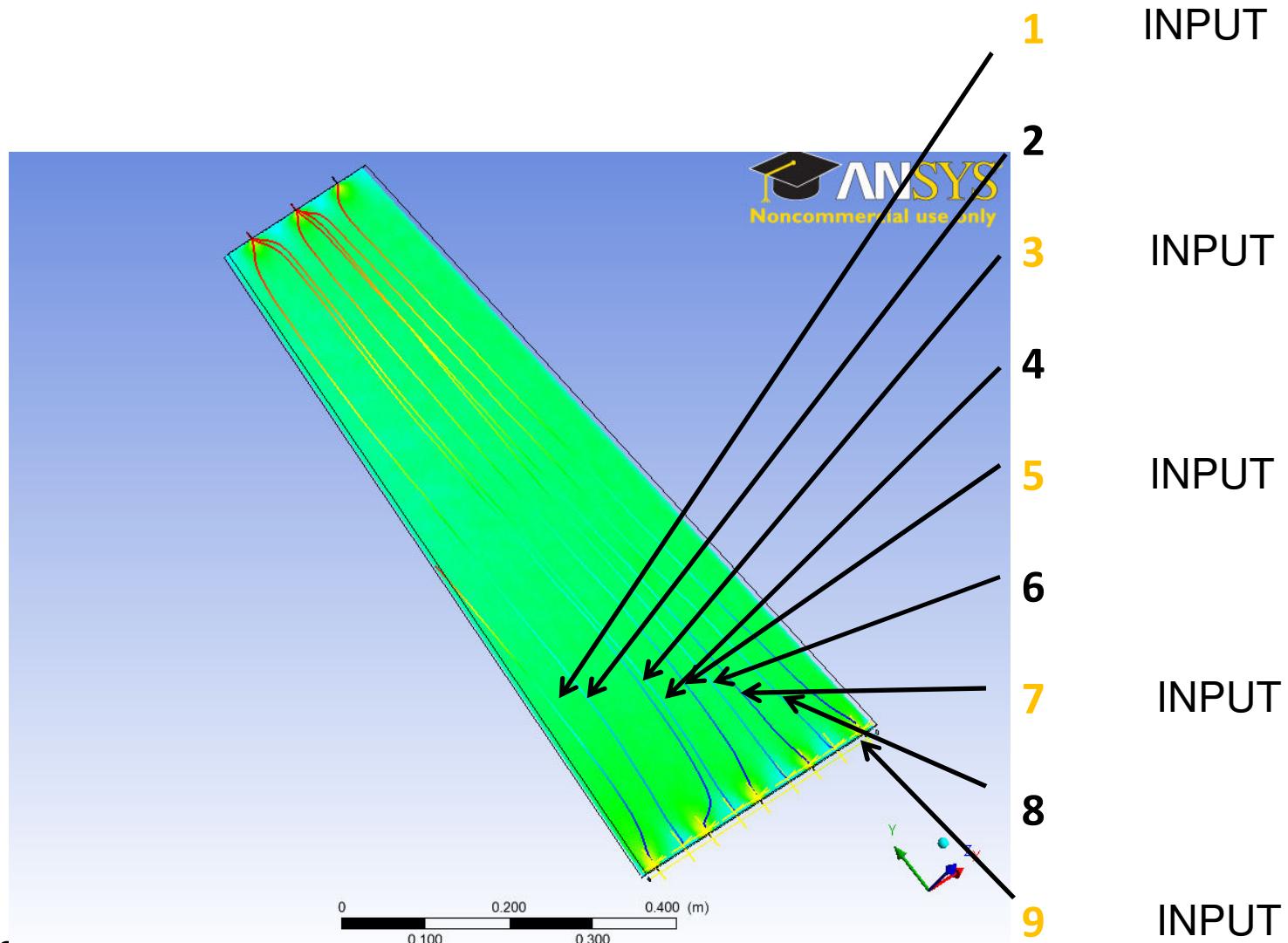


The case study



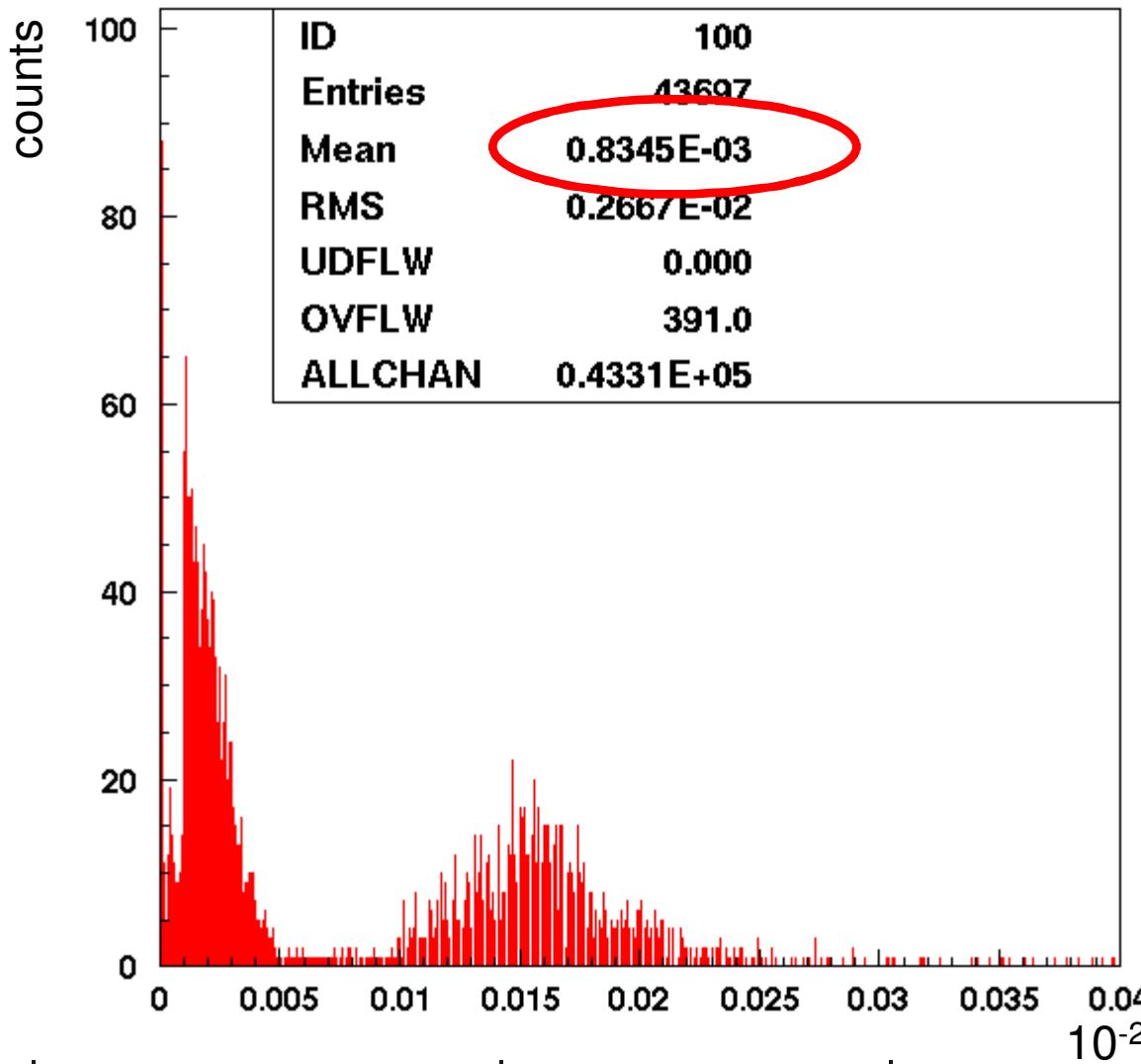
Defining the streamlines

In order to compare different tests (each one with different parameters) we defined 9 streamlines, 1,3,5,7,9 are leaving nearby 5 inlets and 2,4,6,8 are leaving in the middle between two inlets.





Histograms velocity field – CASE 5



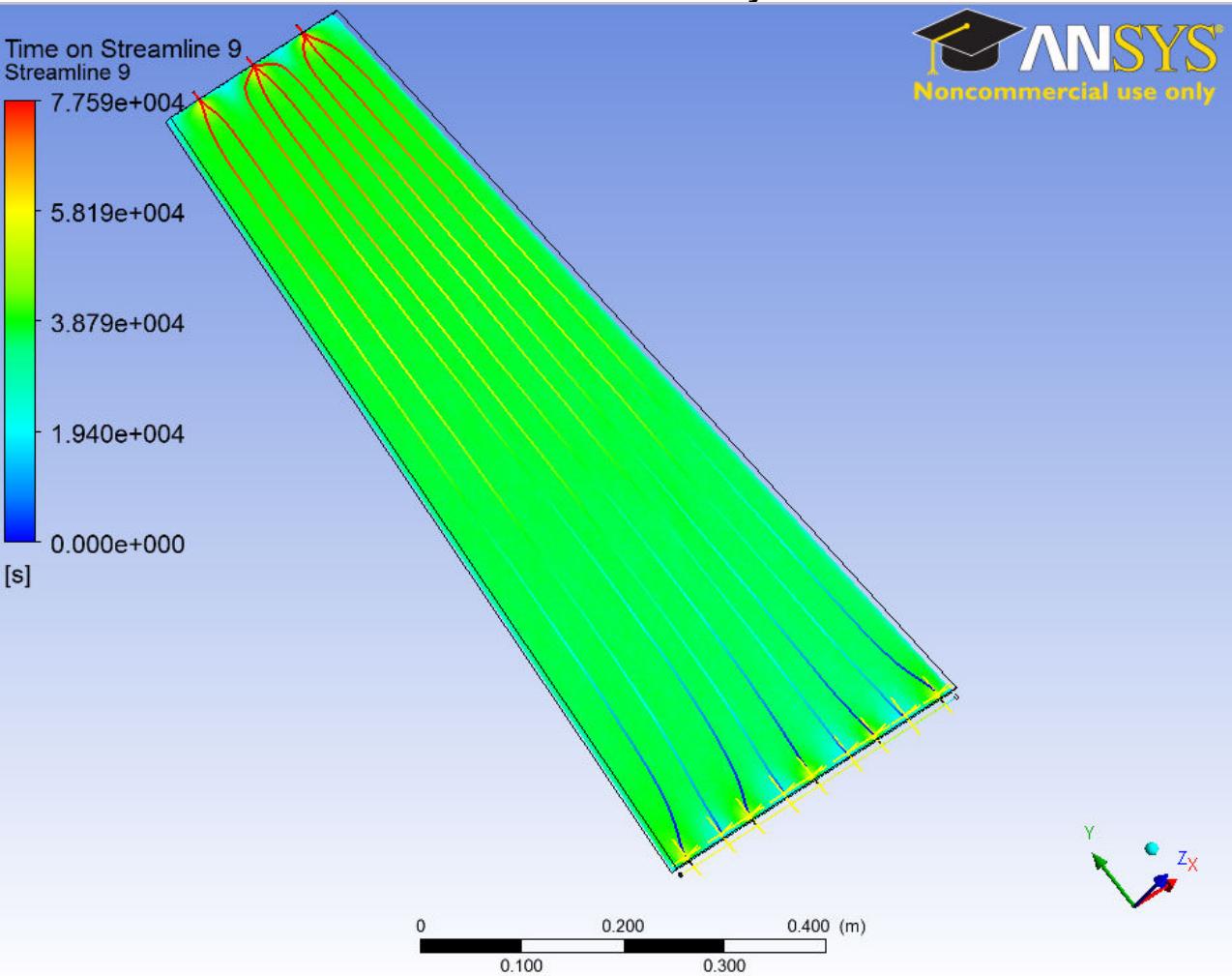
Inlet Diam. (mm)	Output Diam. (mm)	Volume Exchanged
2	2	0.5



Using the best configuration for a realistic case



CASE1 Flow = 1 Vol /day



- Geometry update with structural elements inside the chambers
- Transient analysis to evaluate time needed to completely wash the chamber



OUTLOOK

1. Prototype tests in lab and beam, data analysis
continue
2. Detail mechanical design for mock up and proto
~ final
3. Definition of the readout electronics and it's mechanical support **ongoing**
4. Services and routing: HV, Gas, LV, Cooling
ongoing
5. Mockup realization of the detector .. **Done some details missing**
6. Production of the prototype .. **To be launched in a week or so..**