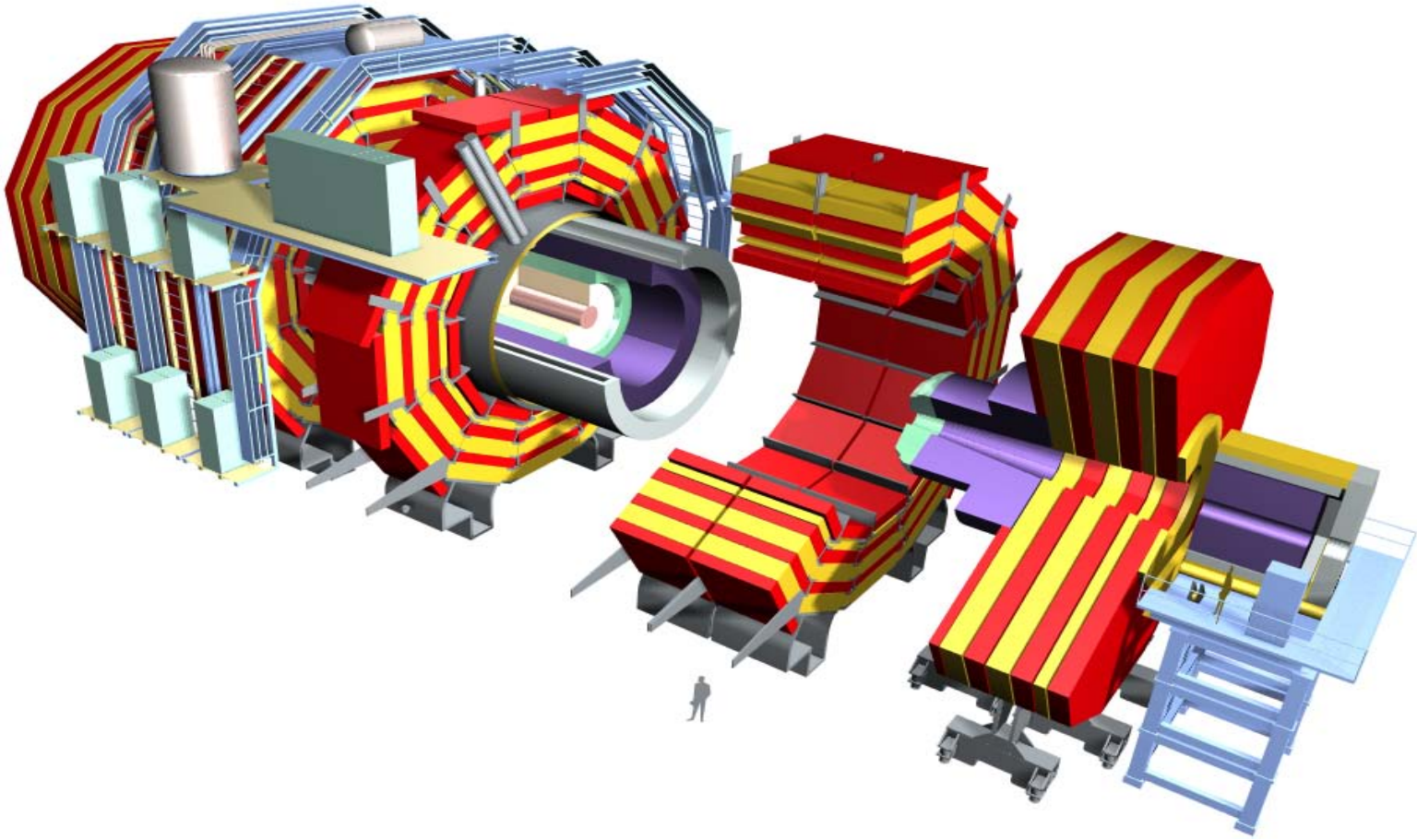
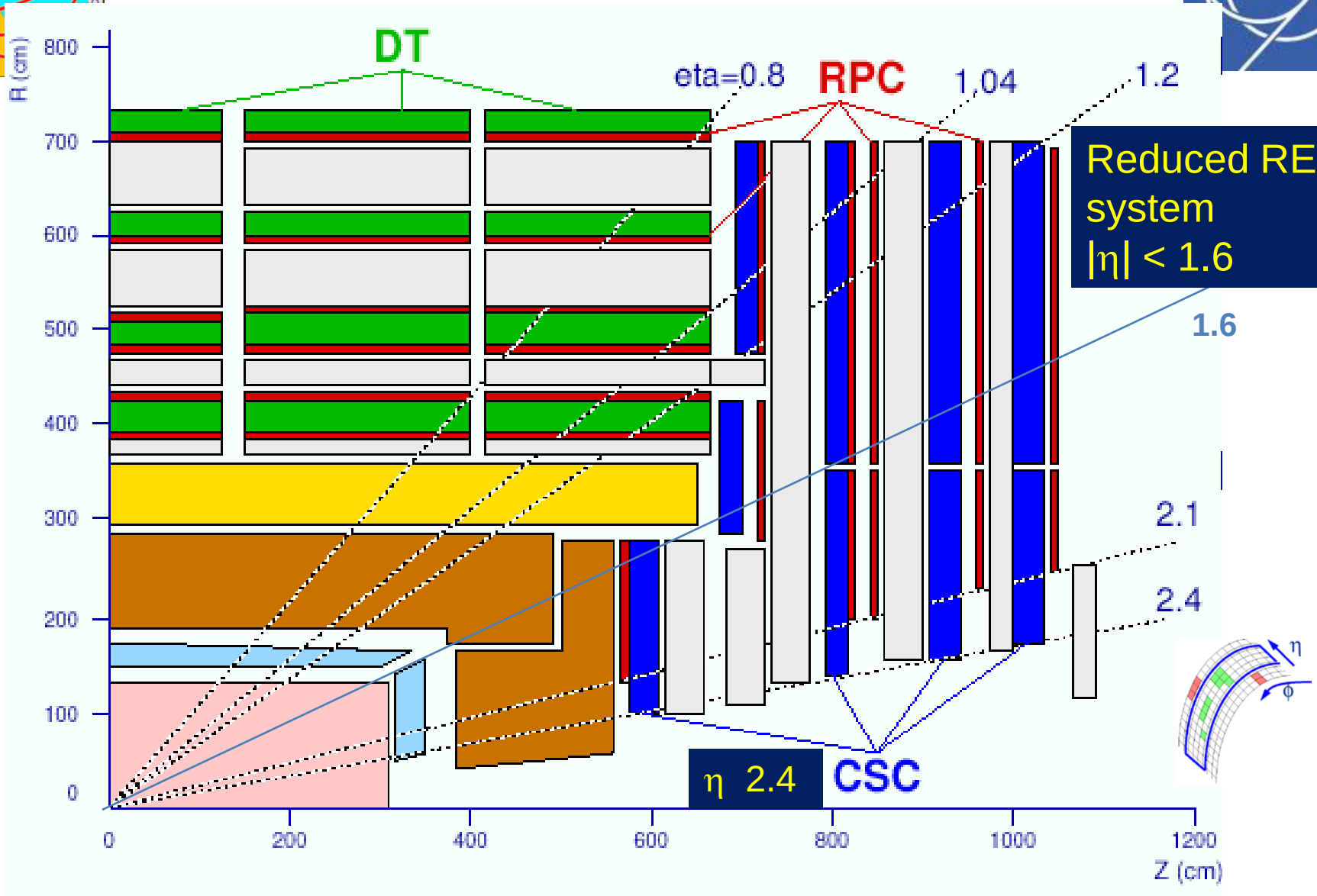
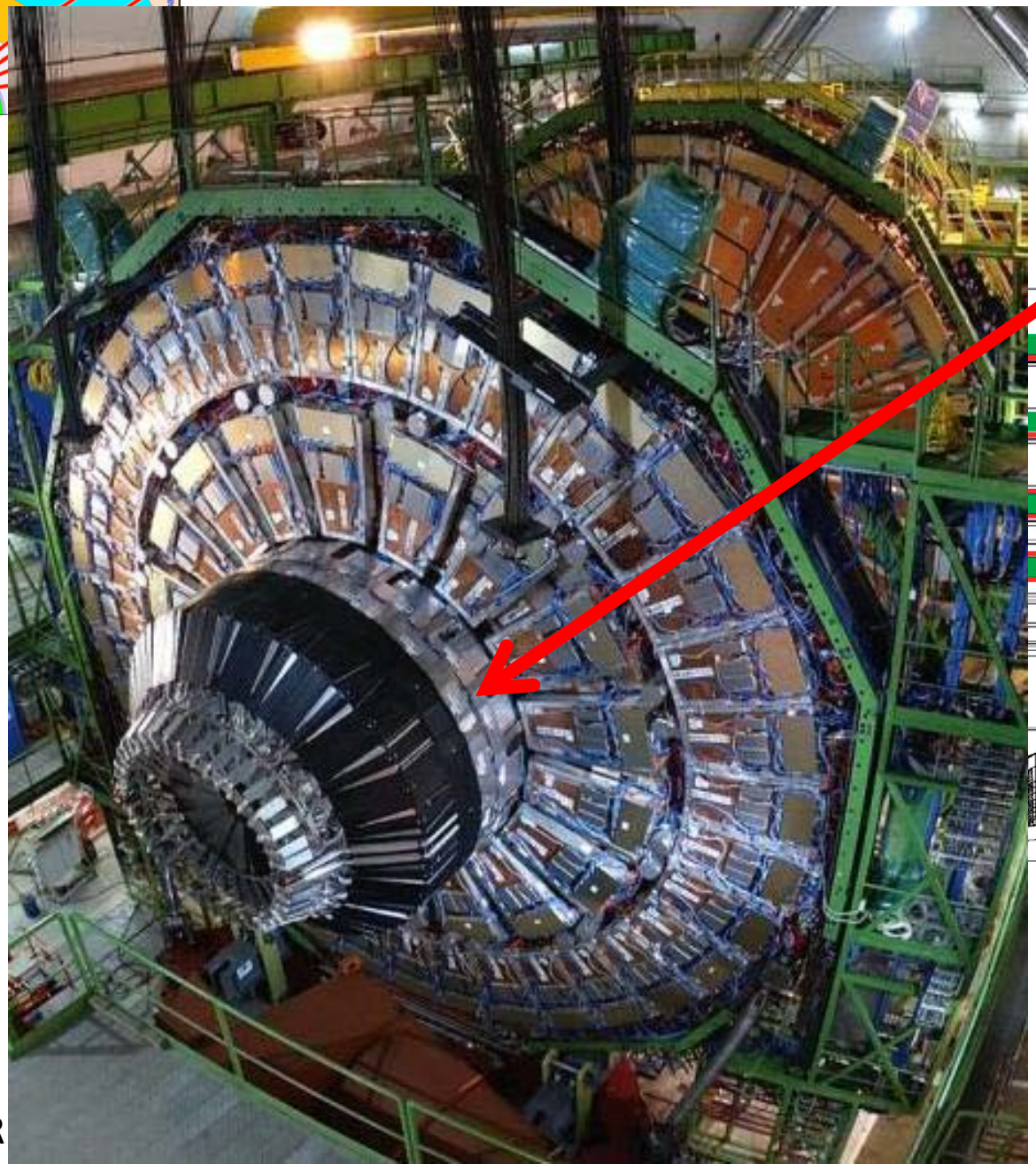
High Eta Forward Muon Trigger and Tracking detector for CMS

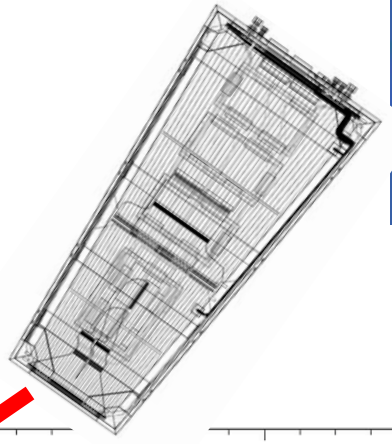


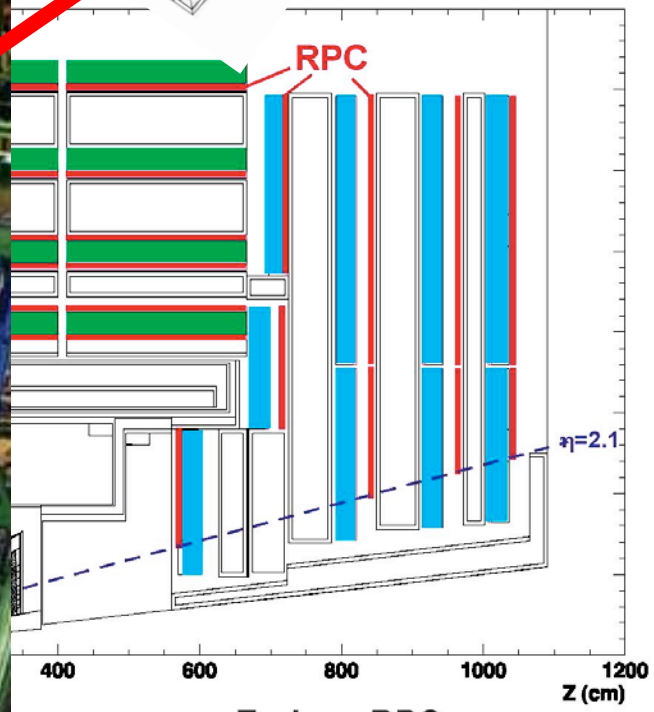
High η imperative for improving trigger efficiency



CMS Forward RPCs





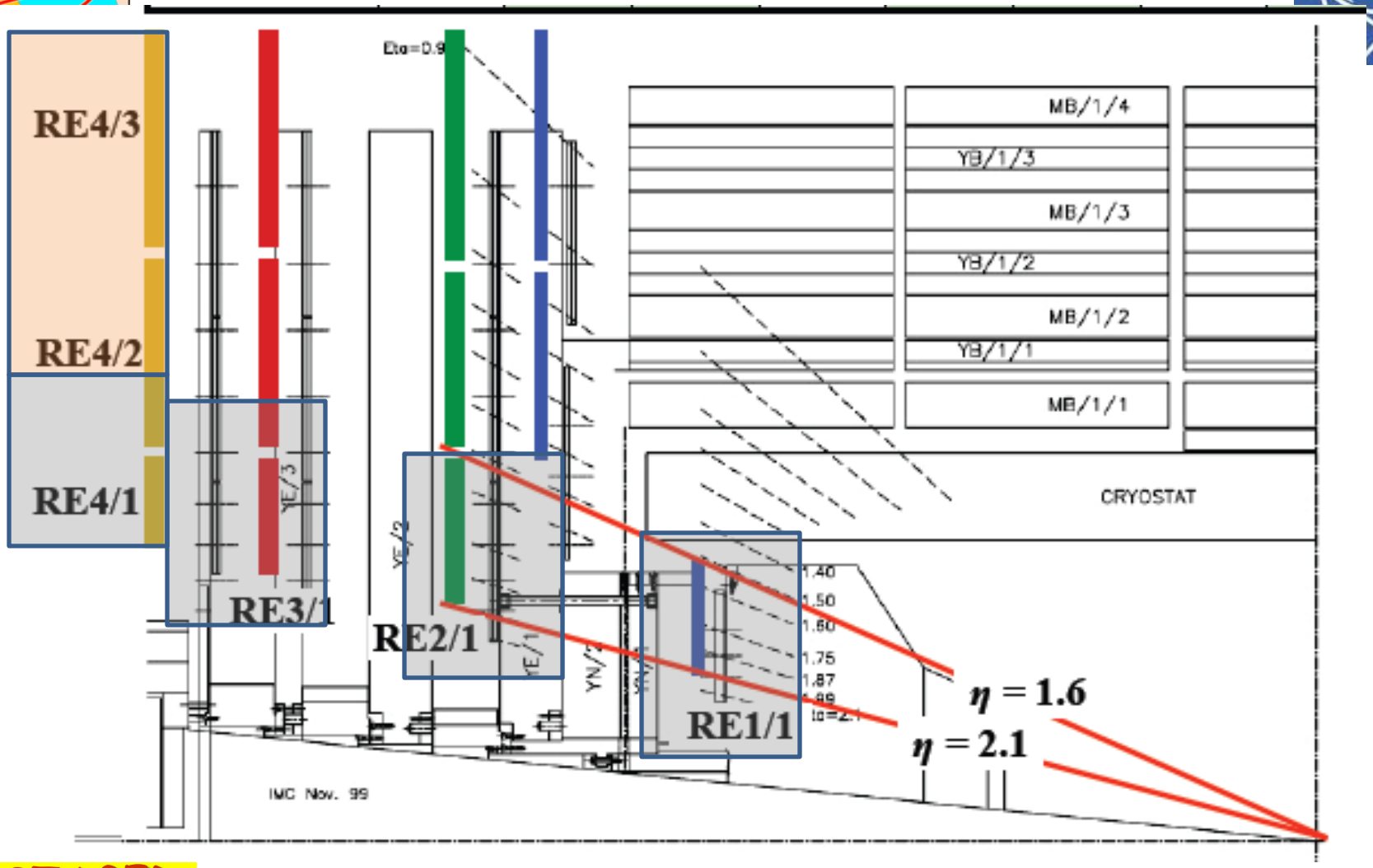


Endcap RPC:

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

R

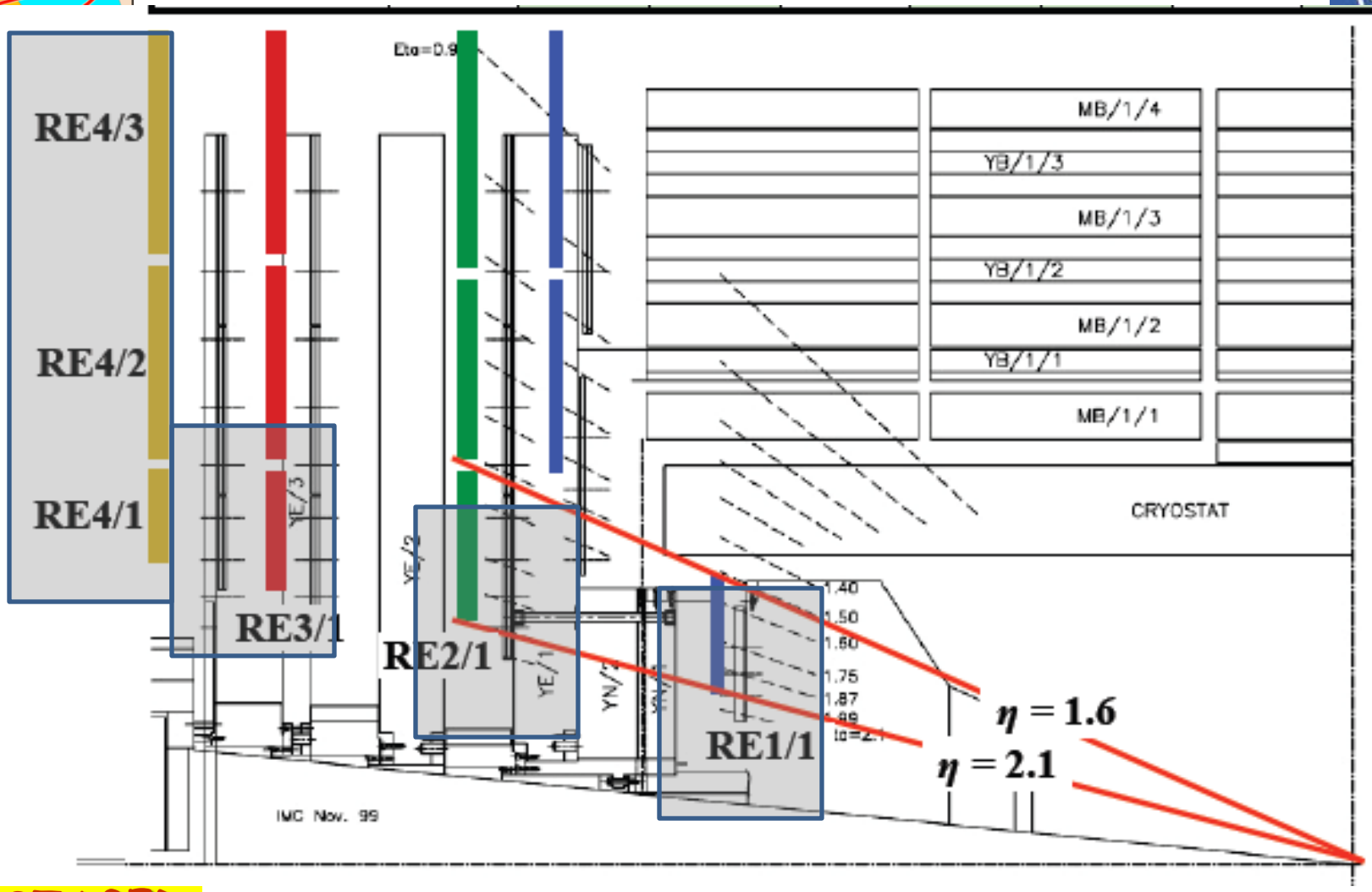
Initial RE system –tailored to budget



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	18*2	36*2	36*

High η imperative for improving trigger efficiency



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	18*2	36*2	36*2

Increase Trigger Efficiency by adding
- 4th layer
-High eta

Simulations
To be continued..

NIM A 609 2009 (825-829)
A. Sharma and S. Beri

Guesstimated Particle rates in CMS

RPC Region	Rates Hz/cm^2 LHC (10^{34} cm^2/s)	High Luminosity LHC 2.3 x LHC	(10^{35}cm^2/s) Phase II SLHC ??
RB	30	Few 100	kHz (tbc)
RE 1, 2, 3,4 $\eta < 1.6$	30	Few 100	**kHz (tbc)**
Expected Charge in 10 years	0.05 C/cm^2	0.15 C/cm^2	~ C/cm^2
RE 1,2,3,4 $\eta > 1.6$	**kHz**	**Few kHz**	**Few 10s kHz**
Total Expected Charge in 10 years	~ C/cm^2	few C/cm^2	Few 10s C/cm^2

Dose expected at LHC at low eta (0.8– 1.6)

Rate: **30 Hz/cm^2**
Average total charge: **30 pC**
Effective operation time: **5x10^7 s (10 LHC years)**
The total expected charge is **5 10^{-2} C/cm^2**

Punch through Rates, Neutrons, Gammas, Low Energy Protons, Non uniform Magnetic Field ..

Dose expected at LHC, High Lumi and Phase II at high eta (1.6 – 2.1)

To be evaluated:

p-p

Beam losses

Cosmics

Material thickness

Punch through hadronic showers

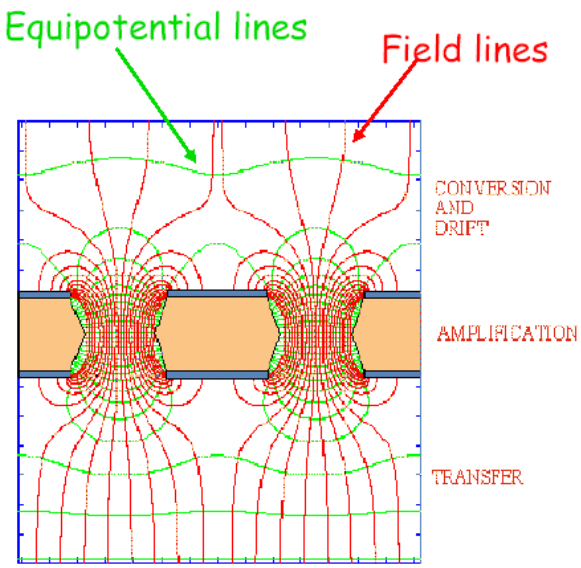
… Need more information, simulations and measurements at LHC

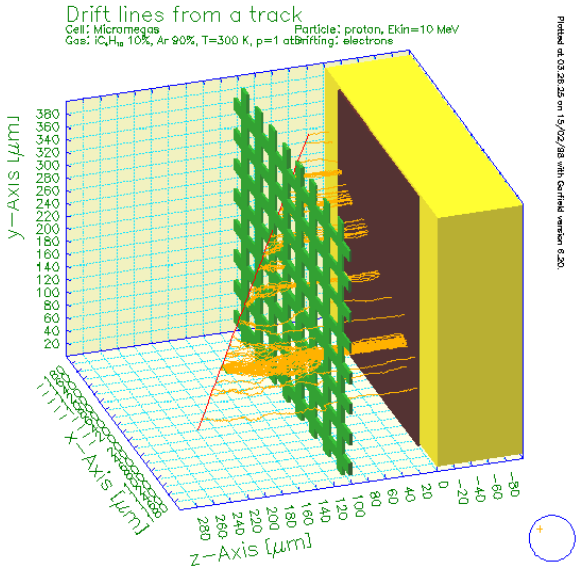
MPGDs as candidate technology

Improve contribution to Muon Trigger Efficiency

Combine triggering and tracking functions?

Instrument the non-instrumented zone in CMS (1.6 >η>2.1) - and increase up to 2.4



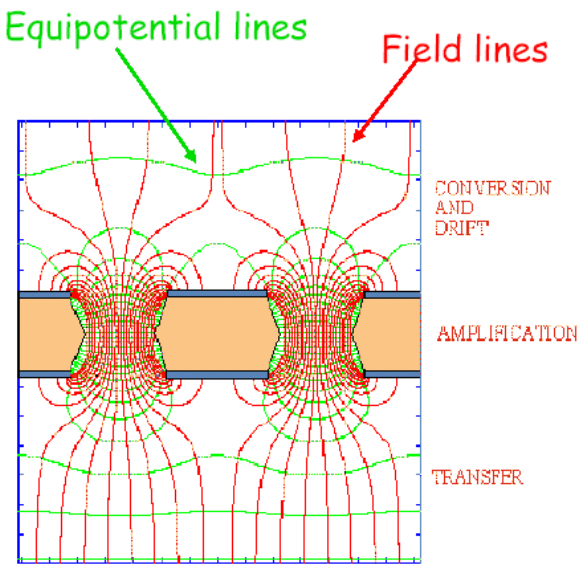


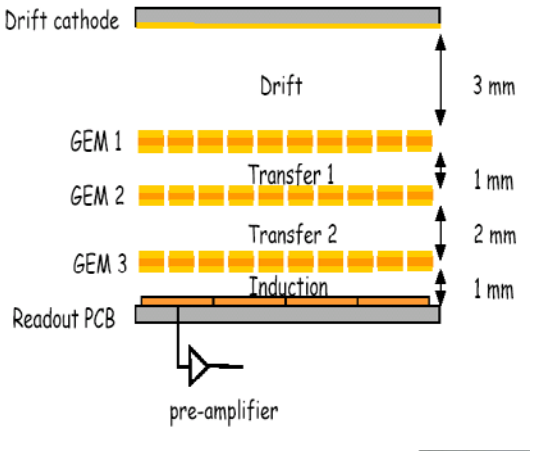
MPGDs as candidate technology

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

- Rate capability – $10^4/mm^2$
  - Spatial resolution ~ 100 μm ($\Theta_{track} < 45°$)
  - Good double track resolution
  - Time resolution ~ 2-3 ns (Gas!)
  - Efficiency > 98%
  - Rate capability > 5 kHz/cm^2

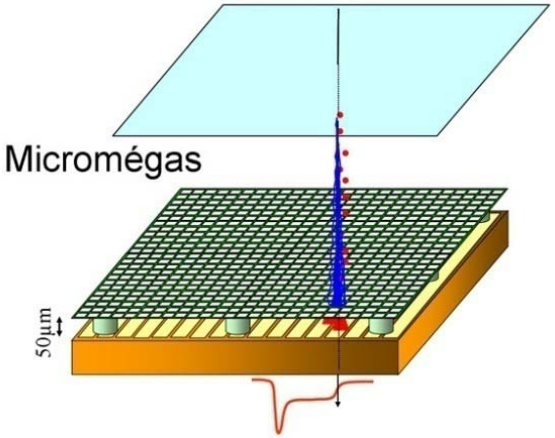
- Argon CO2 (non flammable mixture - big plus)

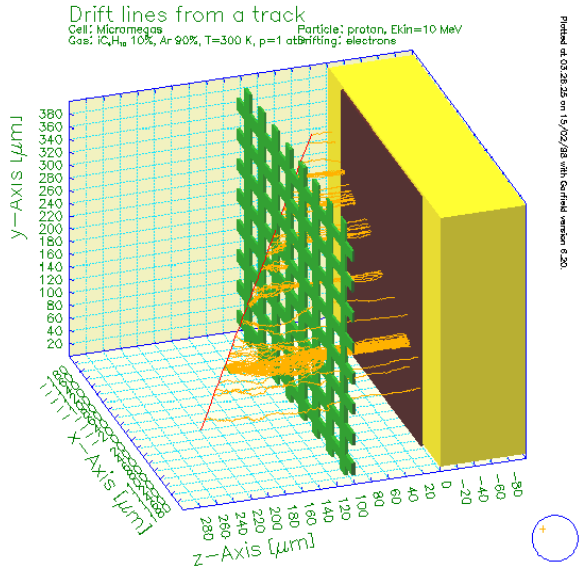




MPGDs as candidate technology?

- Potential for going to large areas ~ 1m x 2m with industrial processes (cost effective)
- Long term operation experience in Compass
- Negligible Discharge probability with no consequence
- **Implemented for LHCb first muon station ($4m^2$)**
- **Proposed for ATLAS Muon upgrade ($1000m^2$)**





CMS MPGD
Activities in last three months:

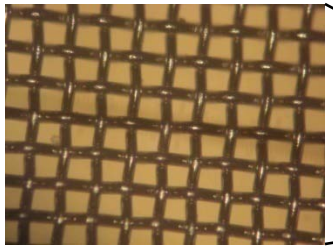
1. Assembly and test of two small MPGD prototypes
   - Micromegas
   - Triple Gem

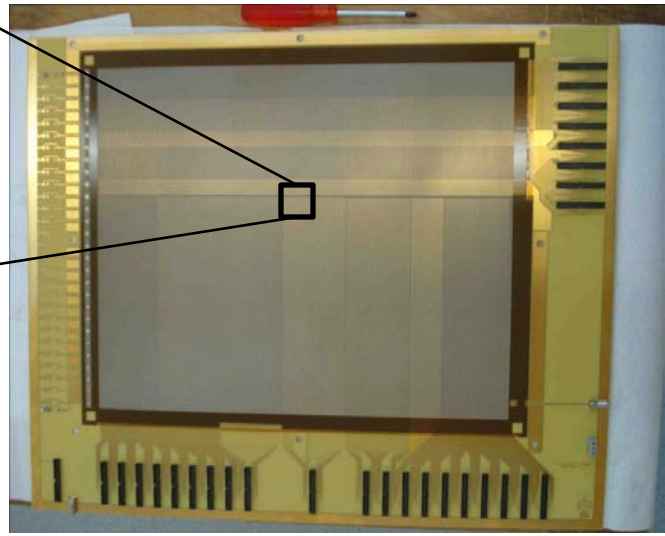
2. Planning for mock up of large prototype
   - Size and envelope limitations
   - Drawings

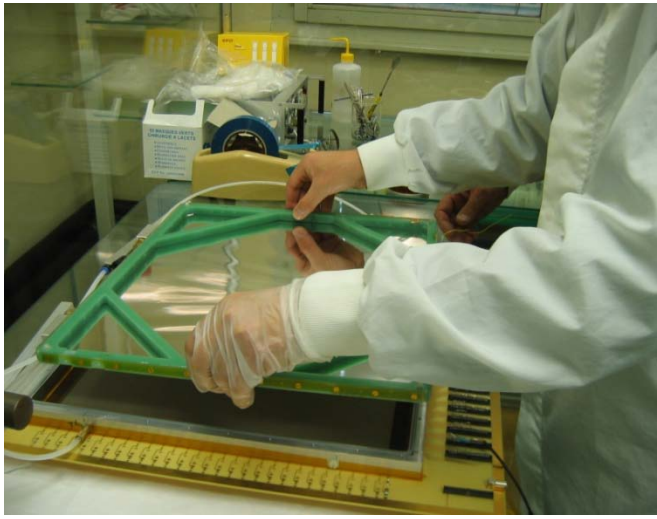
3. Beam test preparation
   - Mechanics and gas lines
   - Readout electronics(?)
   - DAQ

Small proto-CMS-MM-01

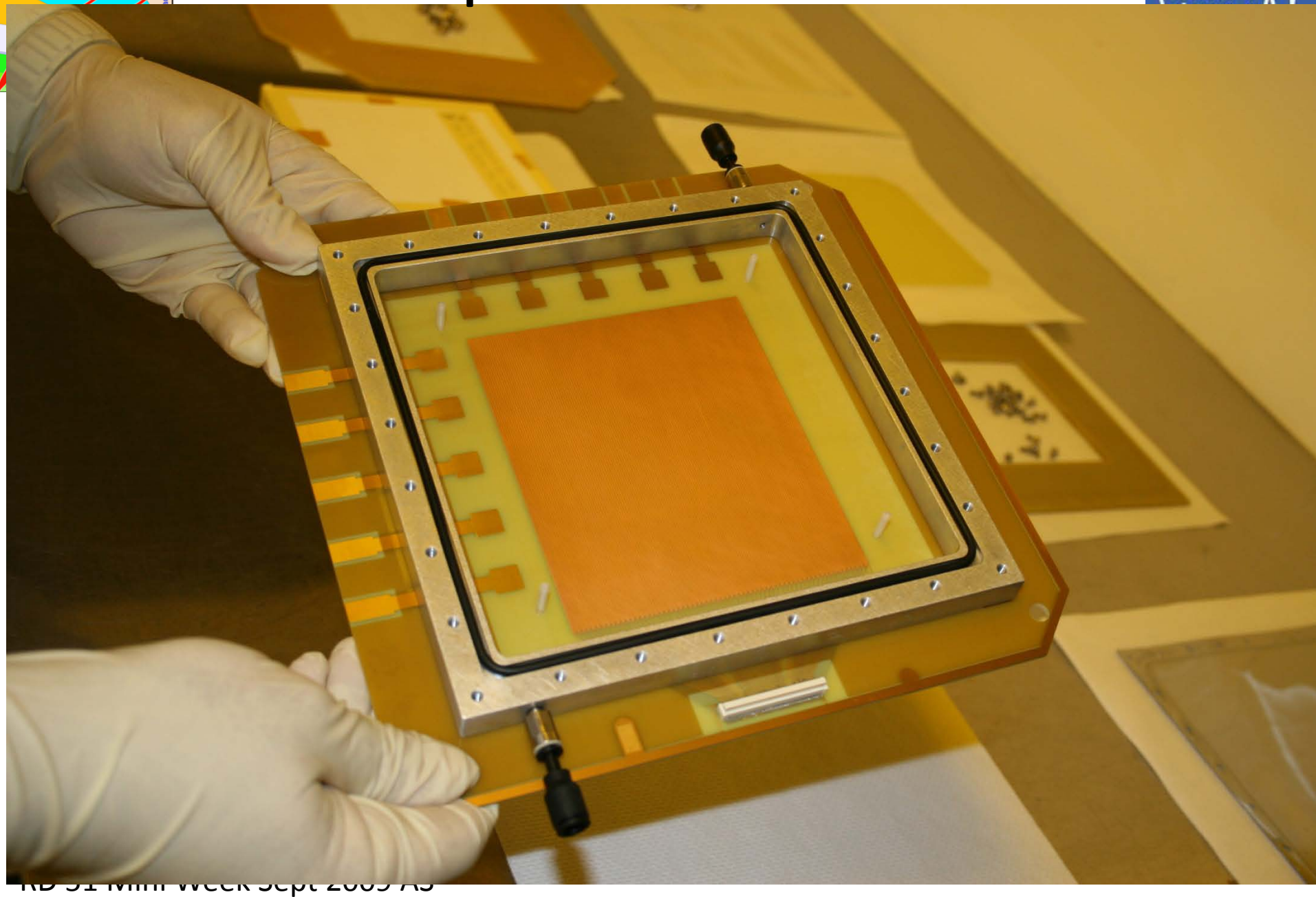
- Standard bulk micromegas fabricated at CERN-TS/DEM
- Homogeneous stainless steel mesh
- Wire diameter ~25 μm
- Amplification gap = 250 μm
- 100mm x 100mm active area
- Strip patterns (128 strips in 100mm ~ 0.700 μm)
- Drift gap: 3 mm

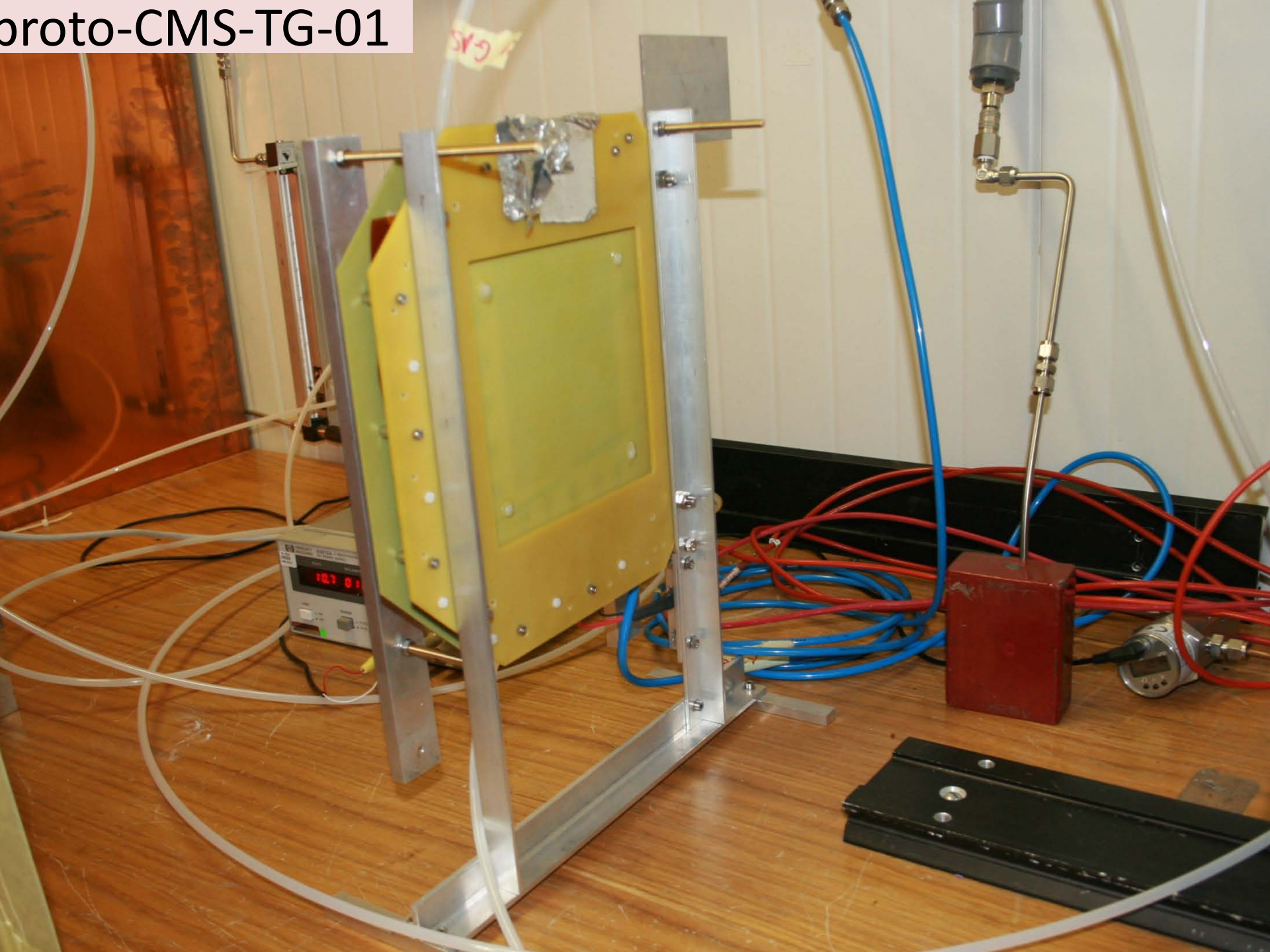




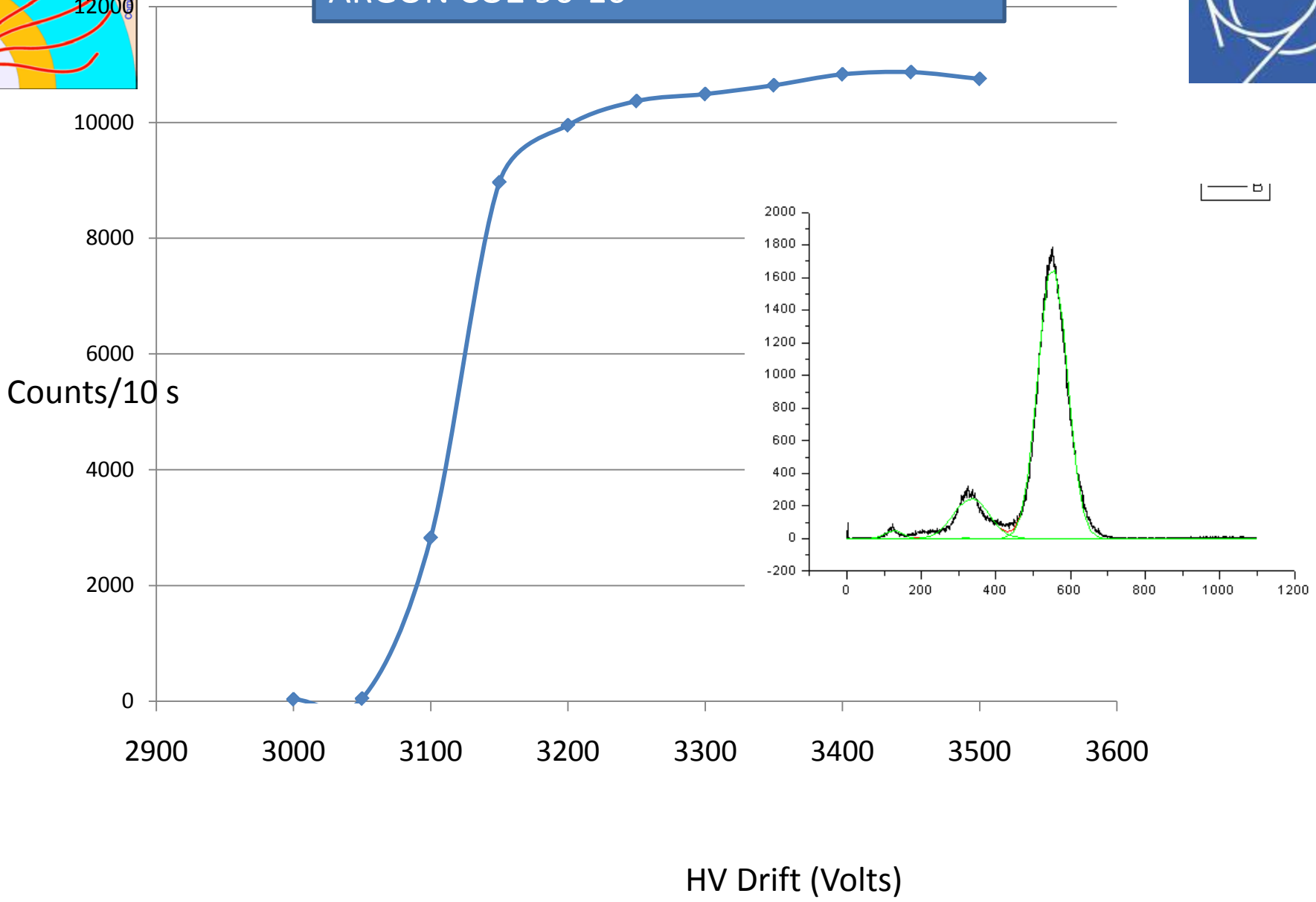


Small proto-CMS-TG-01

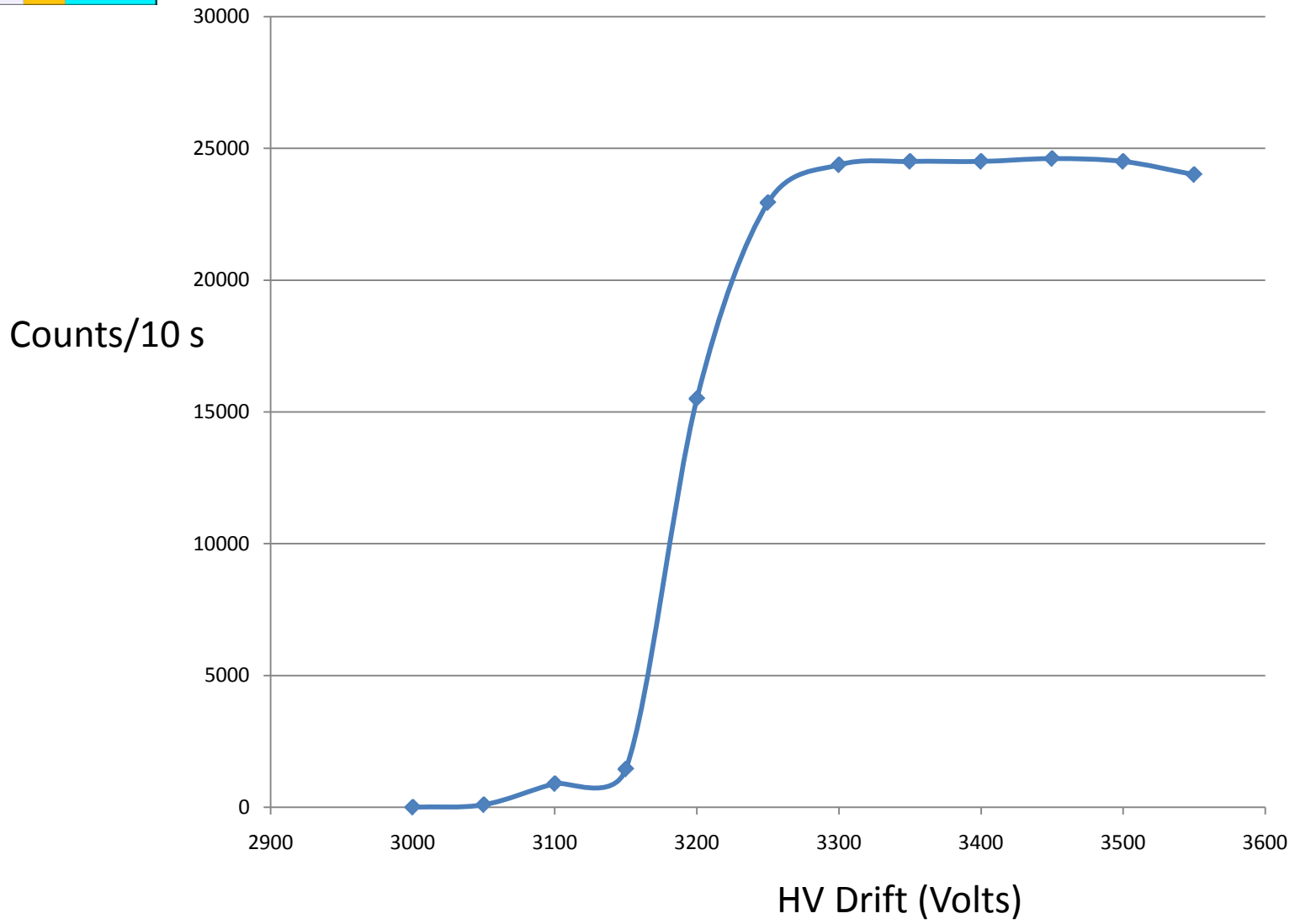



proto-CMS-TG-01

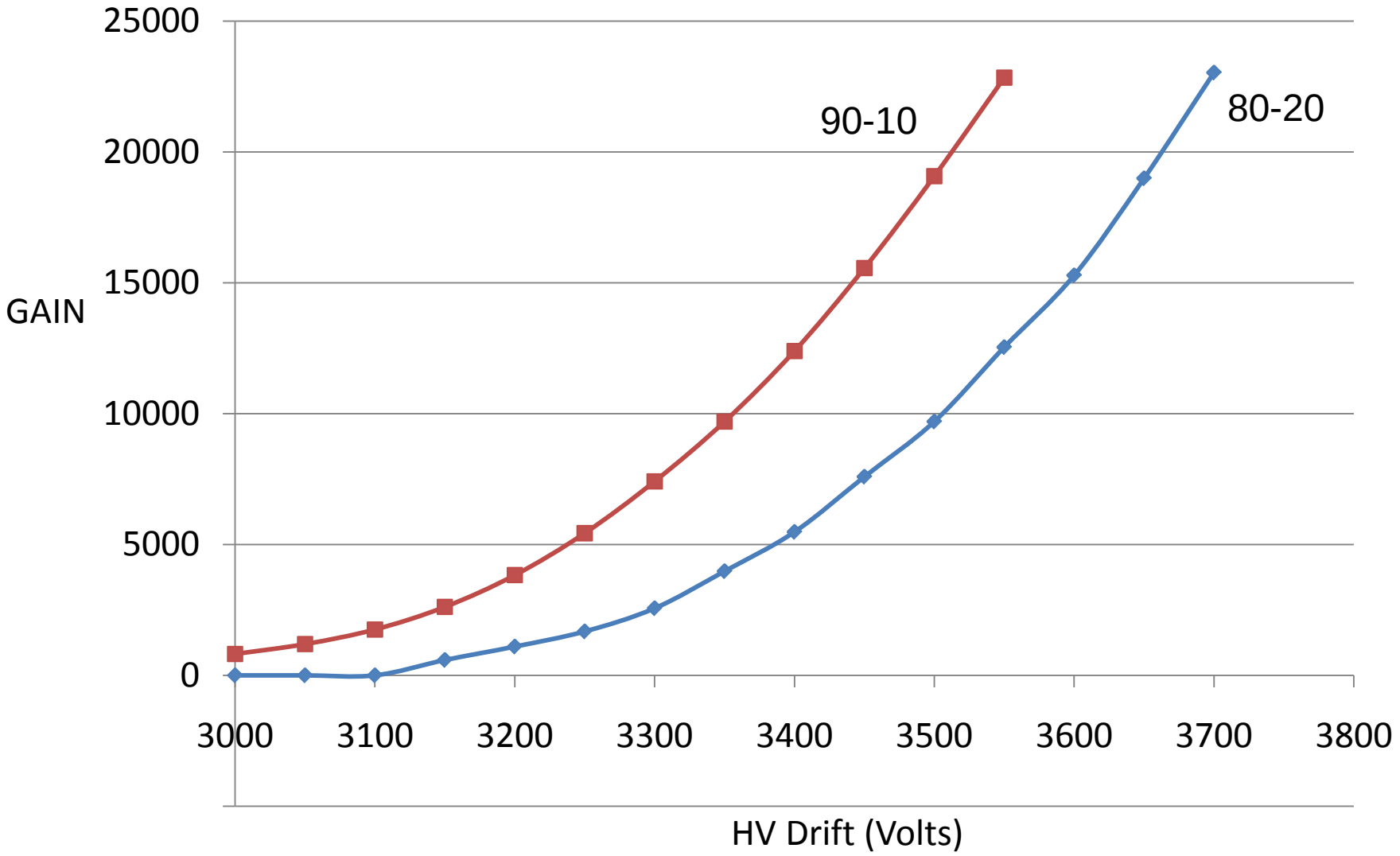
EFFIICIENCY STUDIES WITH TRIPLE GEM ARGON CO2 90-10



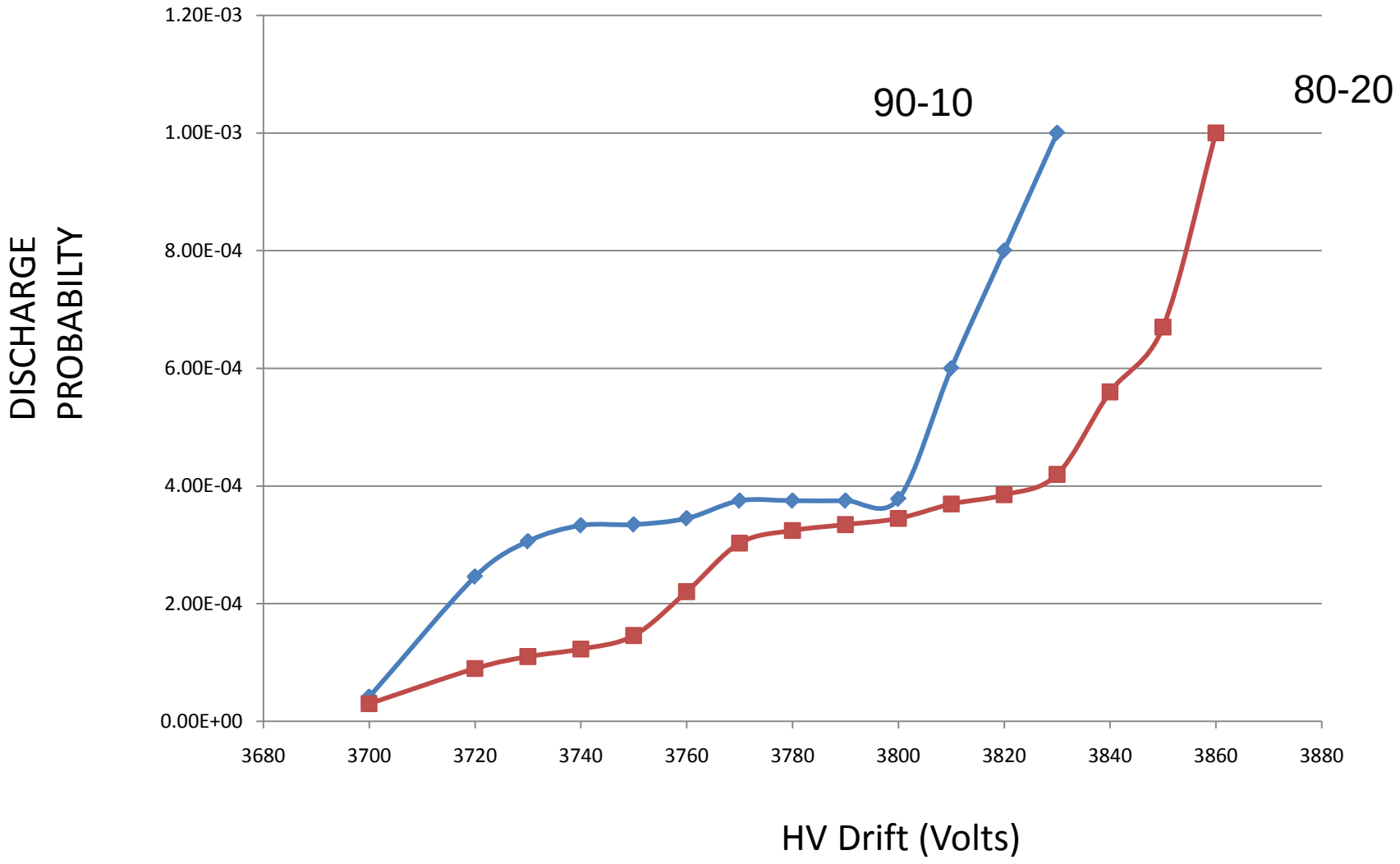
EFFIICIENCY STUDIES WITH TRIPLE GEM ARGON CO2 80-20



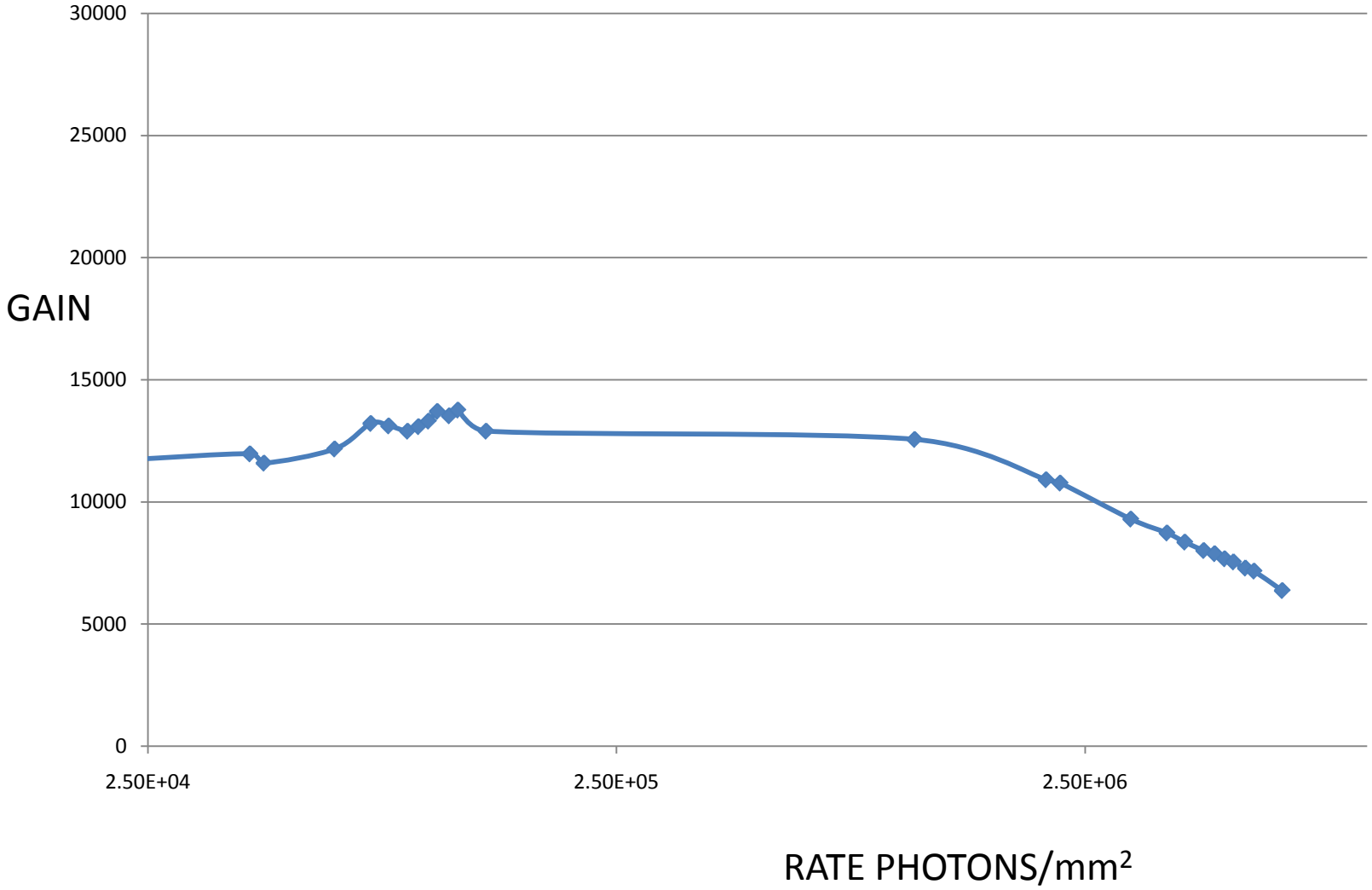
GAIN STUDIES WITH TRIPLE GEM
ARGON CO2
CURRENT WITH Cu X-Rays



DISCHARGE STUDIES WITH TRIPLE GEM ARGON CO2

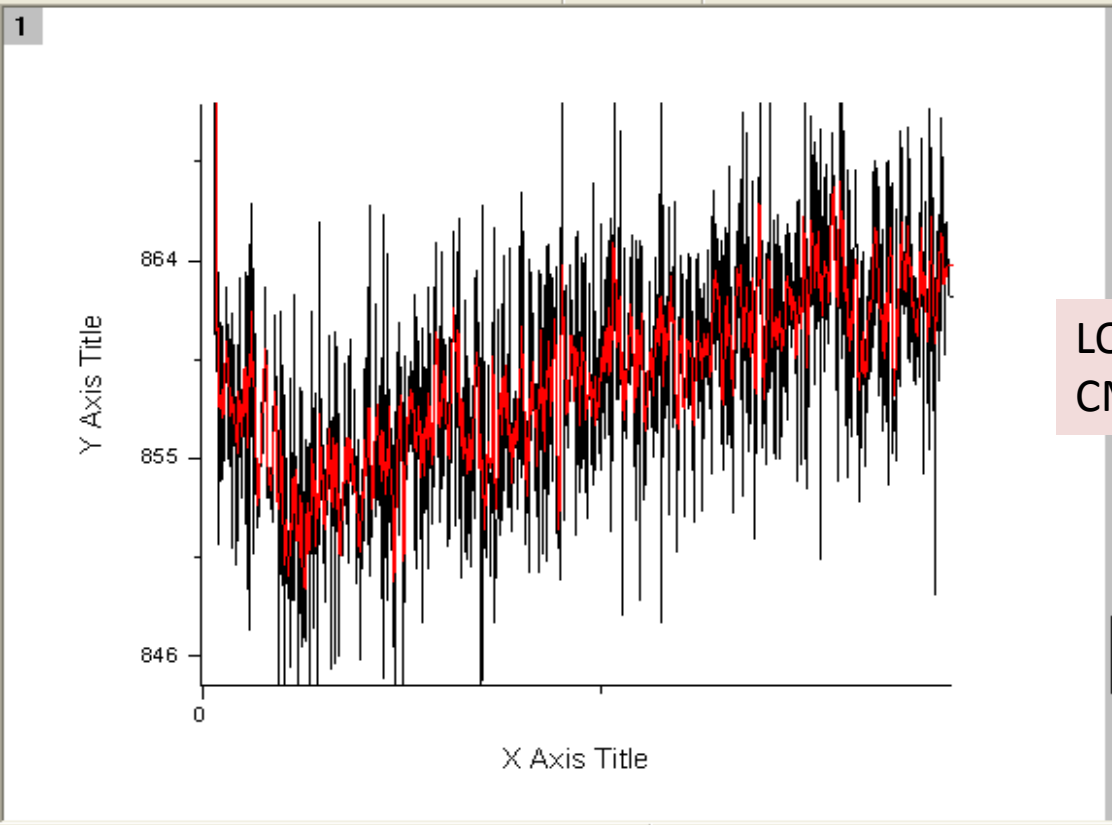


RATE CAPABILITY STUDIES WITH TRIPLE GEM
ARGON CO2 90-10



Origin 6.1 - \\cern.ch\dfs\Users\a\archana\Desktop\MPGDs-2009\Archana_SameTime - [Graph3]

File Edit View Graph Data Analysis Tools Format Window Help

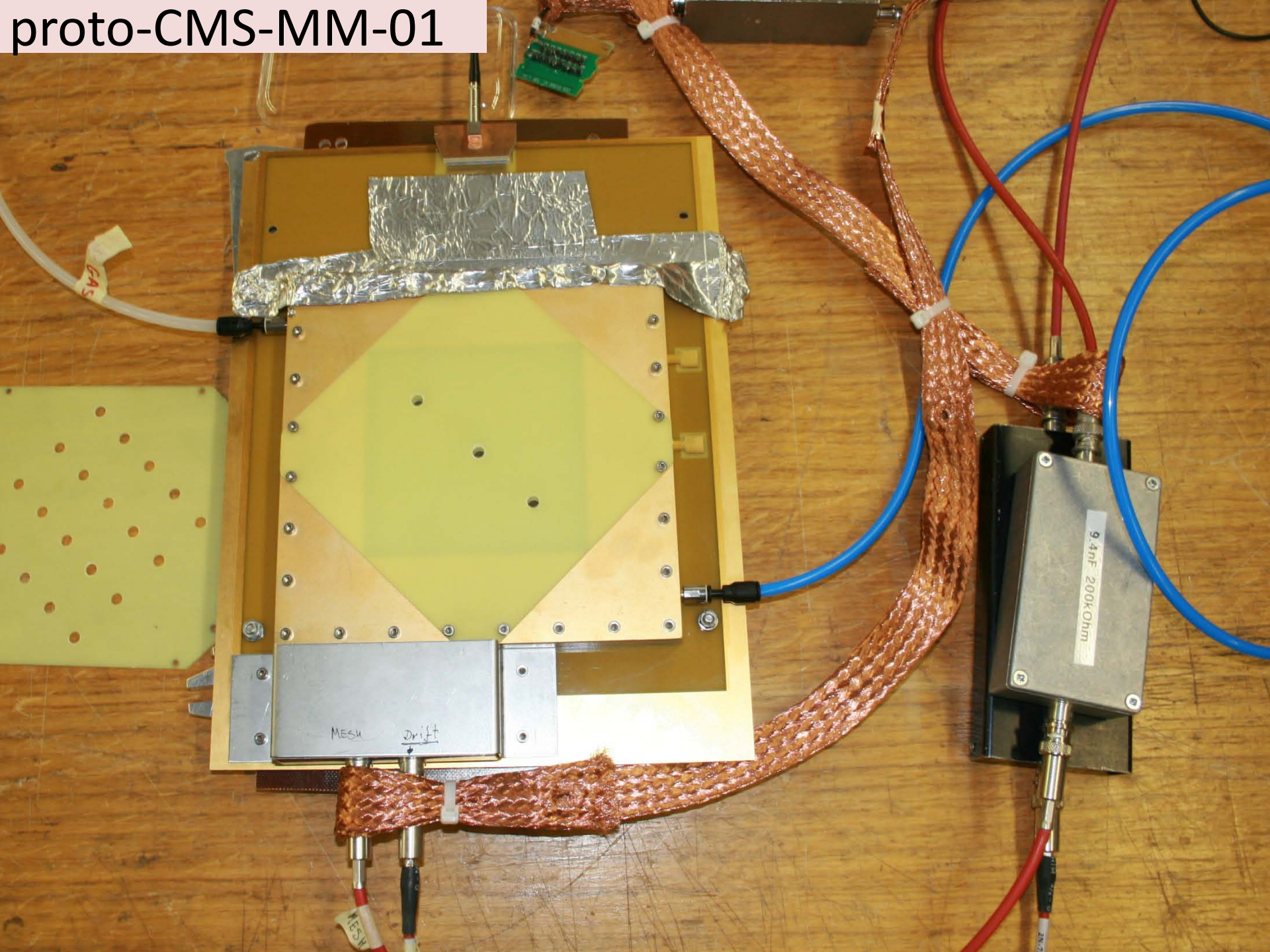


LONG TEM STABILITY (0.001%)
CMS-TG-01 OVER 20 hours

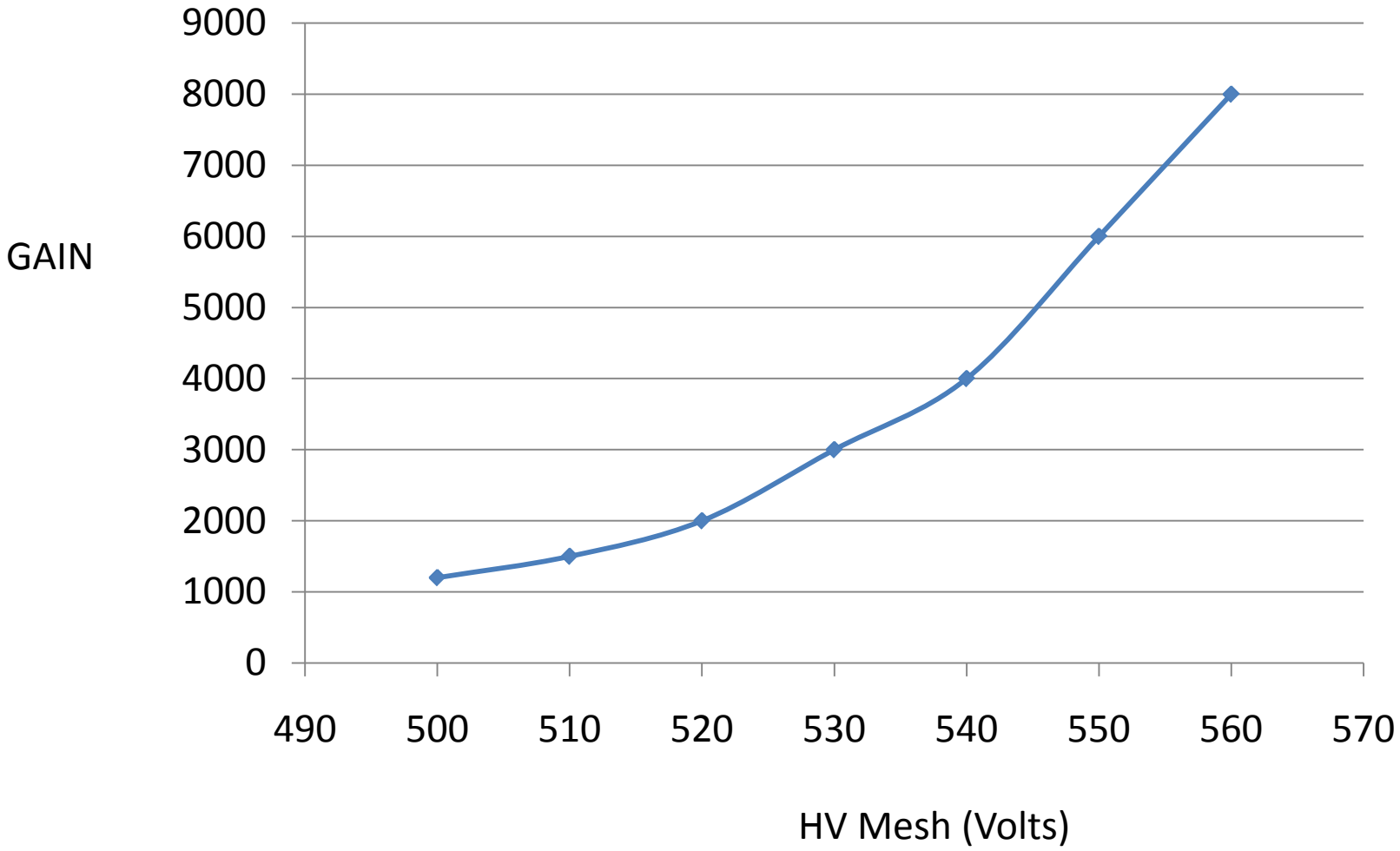
D
5 point AA Smoothing of OUTPUTTIMESCA_D

Archana_SameTime

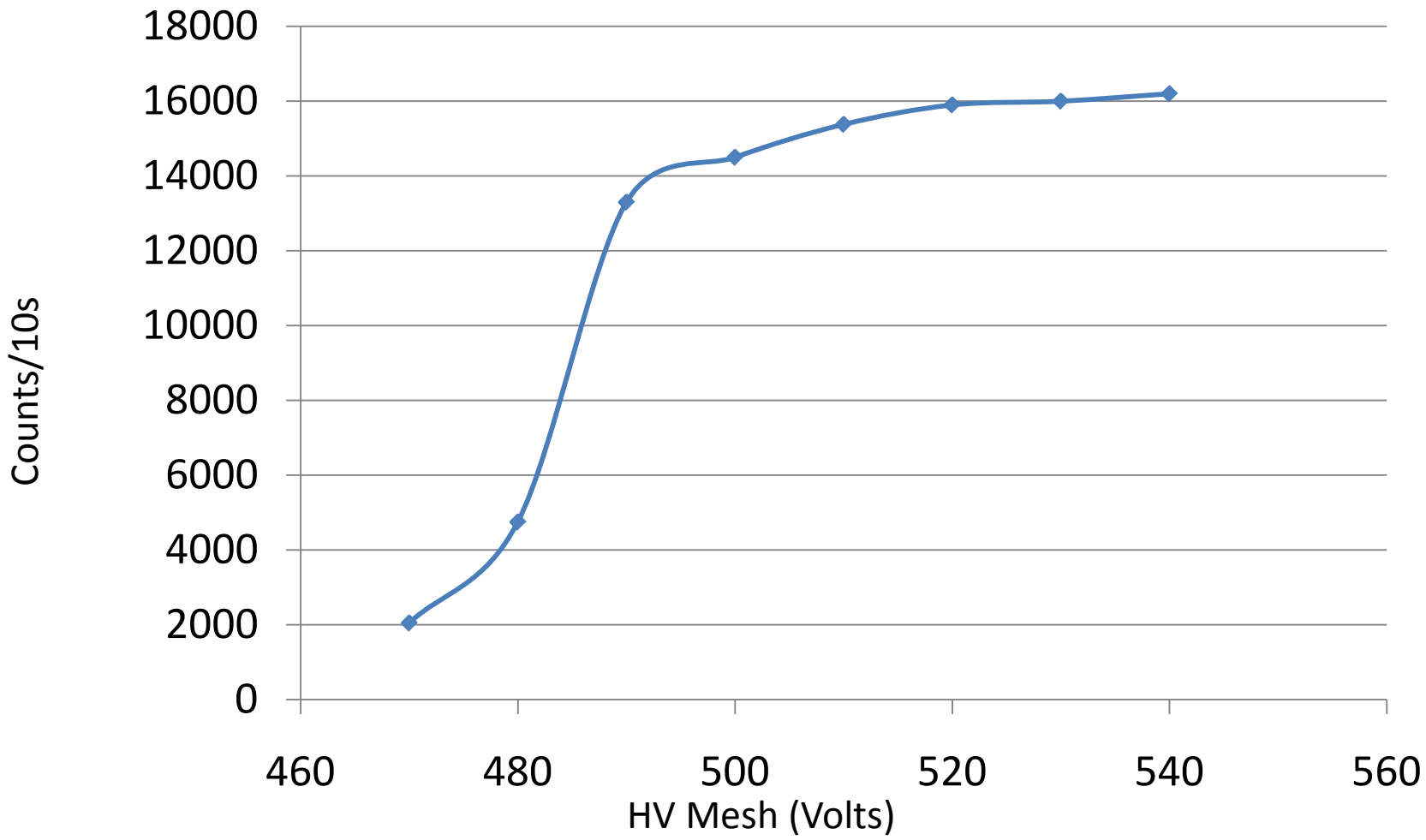
Name	Type	View	Size	Modified	Created	Dependents	Label
Graph1	Graph	Normal	19KB	9/1/2009 09:22	9/1/2009 09:22	0	
Graph2	Graph	Normal	19KB	9/1/2009 09:23	9/1/2009 09:23	0	
Graph3	Graph	Maximized	33KB	9/1/2009 09:25	9/1/2009 09:24	0	
Graph4	Graph	Hidden	20KB	9/1/2009 15:29	9/1/2009 15:29	0	
OUTPUTTIMESCA	Worksheet	Normal	57KB	9/1/2009 09:27	9/1/2009 09:21	3	C:\DOCU...
Smoothed1	Worksheet	Hidden	30KB	9/1/2009 09:25	9/1/2009 09:25	2	5 point A...


proto-CMS-MM-01
MESH
Drift
9.4nF 200kOhm

GAIN STUDIES WITH MICROMEGAS
ARGON CO2 80-20
CURRENT WITH Cu X-Rays

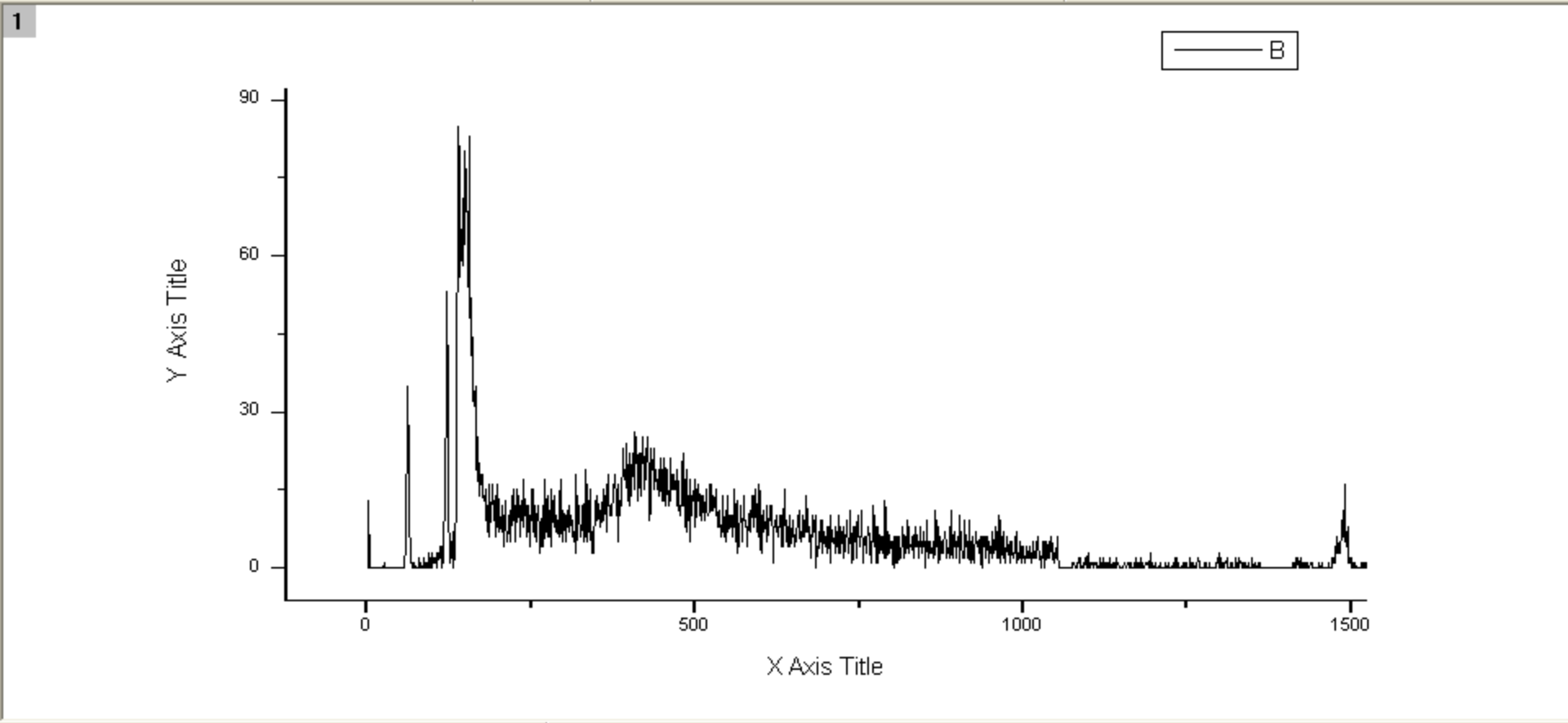


EFFICIENCY STUDIES WITH CMS-MM-01 ARGON CO2 80-20



Origin 6.1 - \\cern.ch\dfs\Users\a\archana\Desktop\MPGDs-2009\MM\MM-Alpha-Studeis - [Graph1]

File Edit View Graph Data Analysis Tools Format Window Help



MM-Alpha-Studeis

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ALFA2	Worksheet	Normal	47KB	9/3/2009 15:58	9/3/2009 15:58	1	A:\ALFA...
Data1	Worksheet	Normal	6KB	9/3/2009 15:57	9/3/2009 15:57	0	
Graph1	Graph	Maximized	27KB	9/3/2009 15:58	9/3/2009 15:58	0	

TEST Beam Plan:

Oct 09

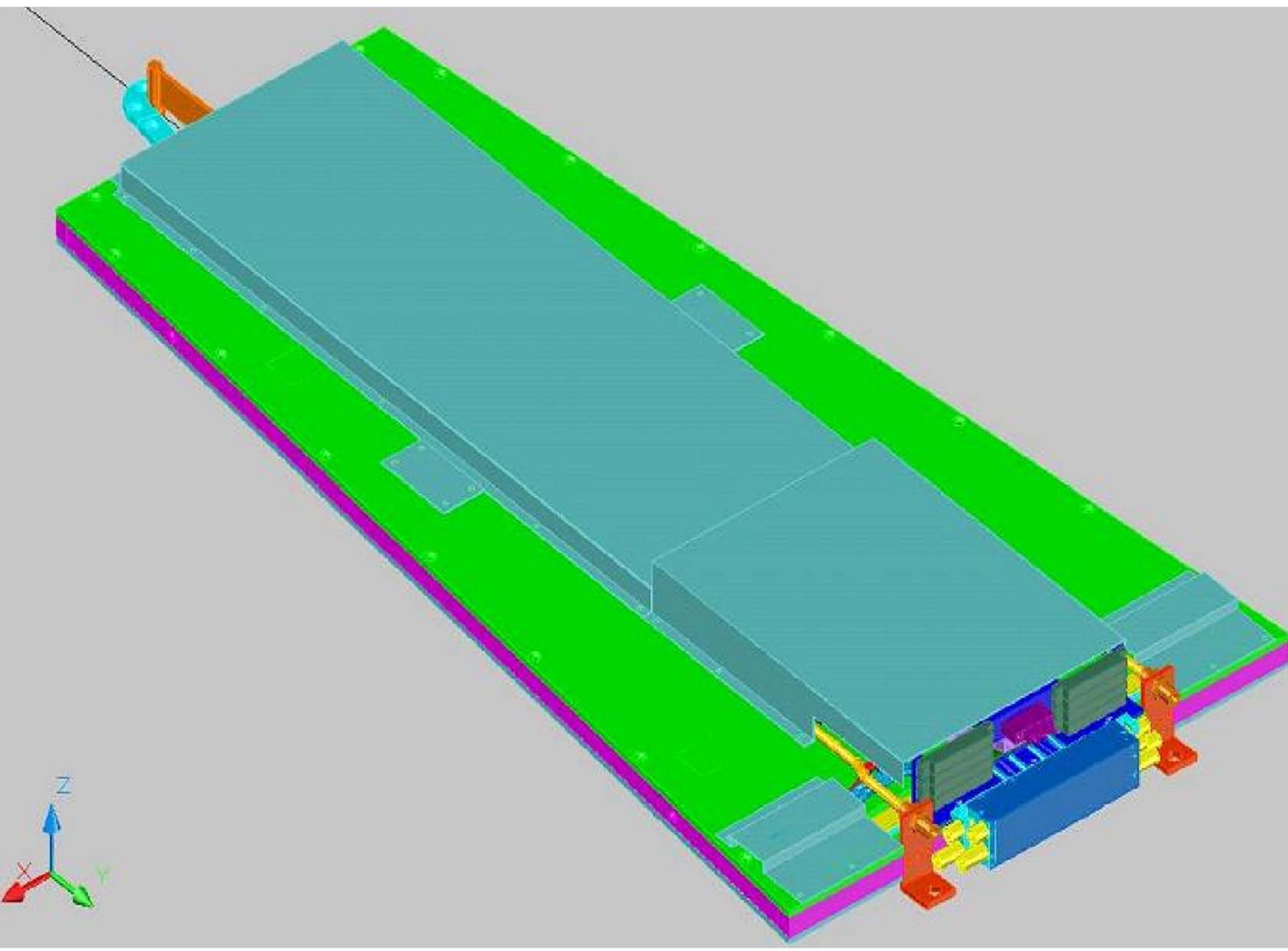
1. Gas Studies (two separate lines for premix)
2. Tests with Front End electronics for mips
3. Measure Efficiency for perpendicular tracks
4. Measure Efficiency for inclined tracks with tracking

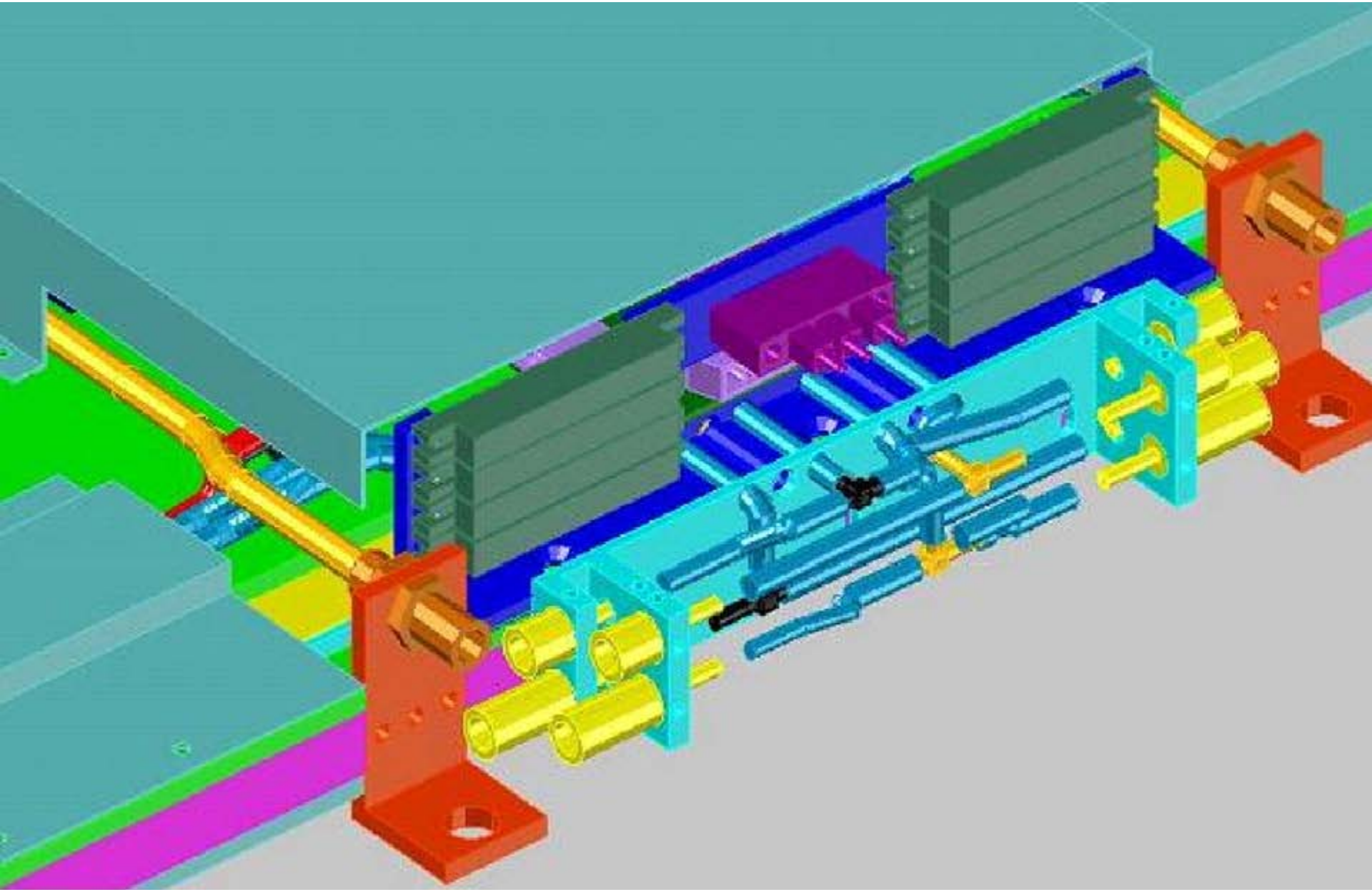
Next Year

1. Time resolution
2. Space resolution with present strip size
3. Magnetic Field Operation
4. Large Prototype

PROTOTYPE Plan:

1. Detail mechanical design
2. Definition of the readout electronics and it's mechanical support
3. Services
4. Mockup realization of the detector
5. Production of the prototype


Z
X
Y



MPGD Meeting 02

Friday 04 September 2009

Next Meeting 20th November 2009

14:30 Introduction and discussion (20')

14:50 New Physics Potential and Detector Requirements - Albert (de Roeck) (40')

15:30 MPGD Experience and Expression of Interest from Frascati - Stefano Bianco / Benussi / Fabbri (20')

15:50 Current MPGD studies, CSC alignment work within CMS and interest in the high-eta MPGD upgrade from Florida (20') (Slides)

16:10 Current Experience, Expression of interest and (preliminary preparation for Simulations of Trigger Efficiency) - Arun K
(Slides ; document)

16:30 Update on small prototype tests at CERN - Archana (20')

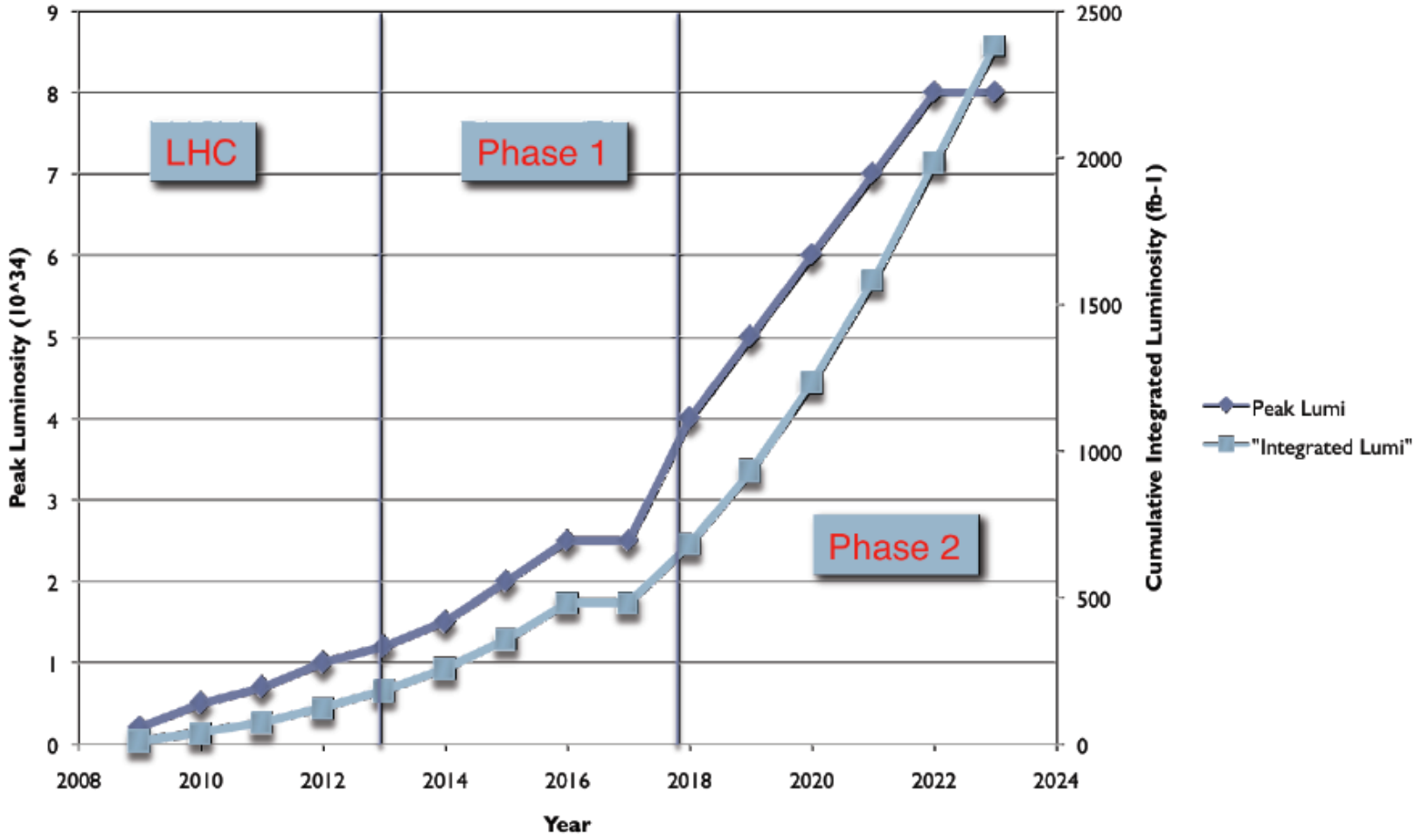
16:50 Preparation towards large prototype(s) - Andrey / Serguei /Serge (20') (Slides)

17:10 Update on Front End Readout - Nicola Turini (20') (VFAT - Details)

Next Steps..

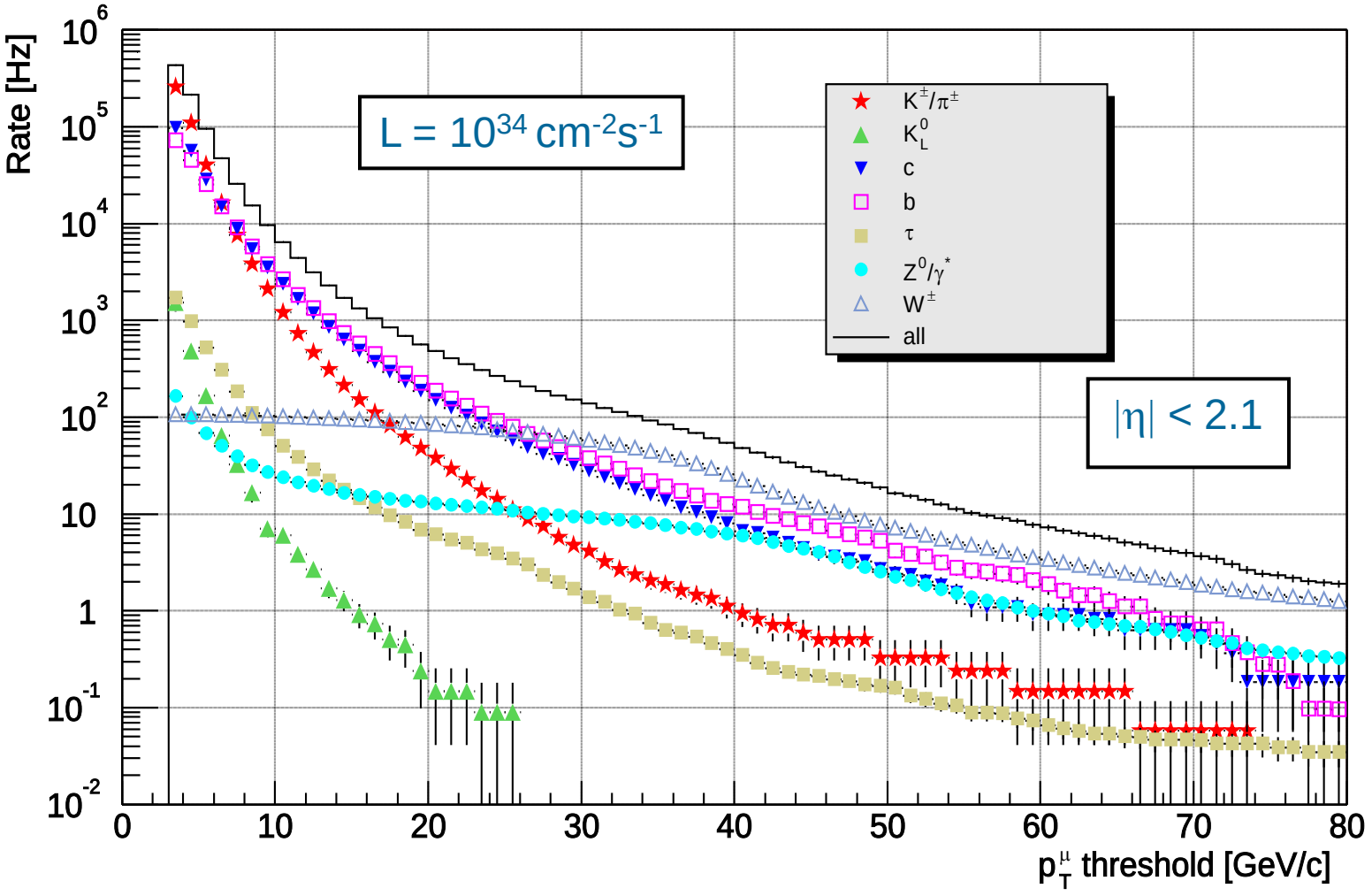
1. Participate in beam test
2. Build large size mock up to understand services
3. Build large size prototype to understand performance
4. Calculate rates as a function of eta-phi
5. Background simulations, measurements and calculations
6. Study muon road ~10 GeV, as a function of trigger sectors
7. Stagger / Layer the detector for avoiding fake hits
8. Engineering Design up to eta 2.4
9. **Evaluate the improvement in trigger and tracking efficiency**

SPARE SLIDES

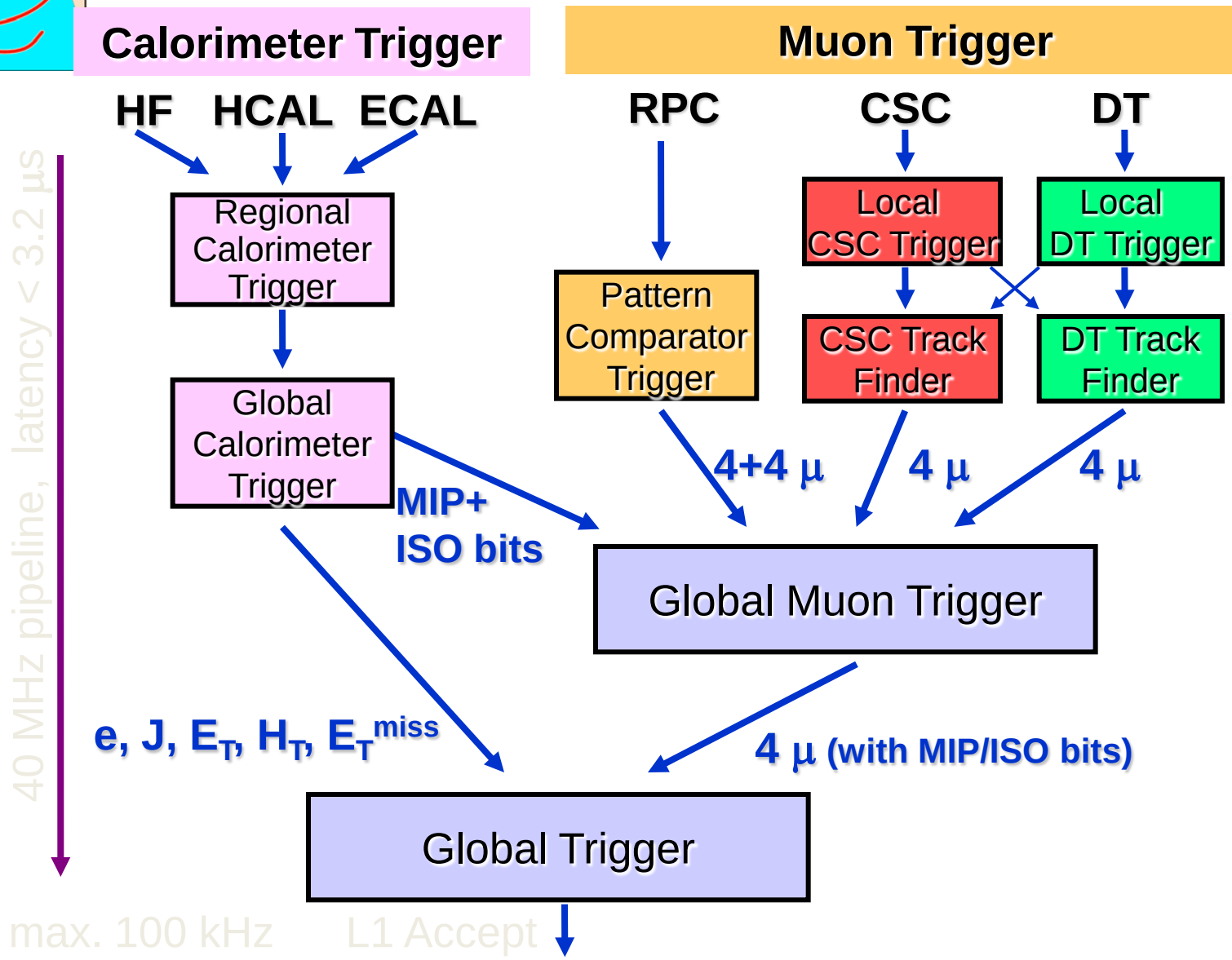

LHC
Phase 1
Phase 2
Peak Luminosity (10^34)
Cumulative Integrated Luminosity (fb-1)
Year
Peak Lumi
"Integrated Lumi"
0
1
2
3
4
5
6
7
8
9
0
500
1000
1500
2000
2500
2008
2010
2012
2014
2016
2018
2020
2022
2024

Muons at LHC

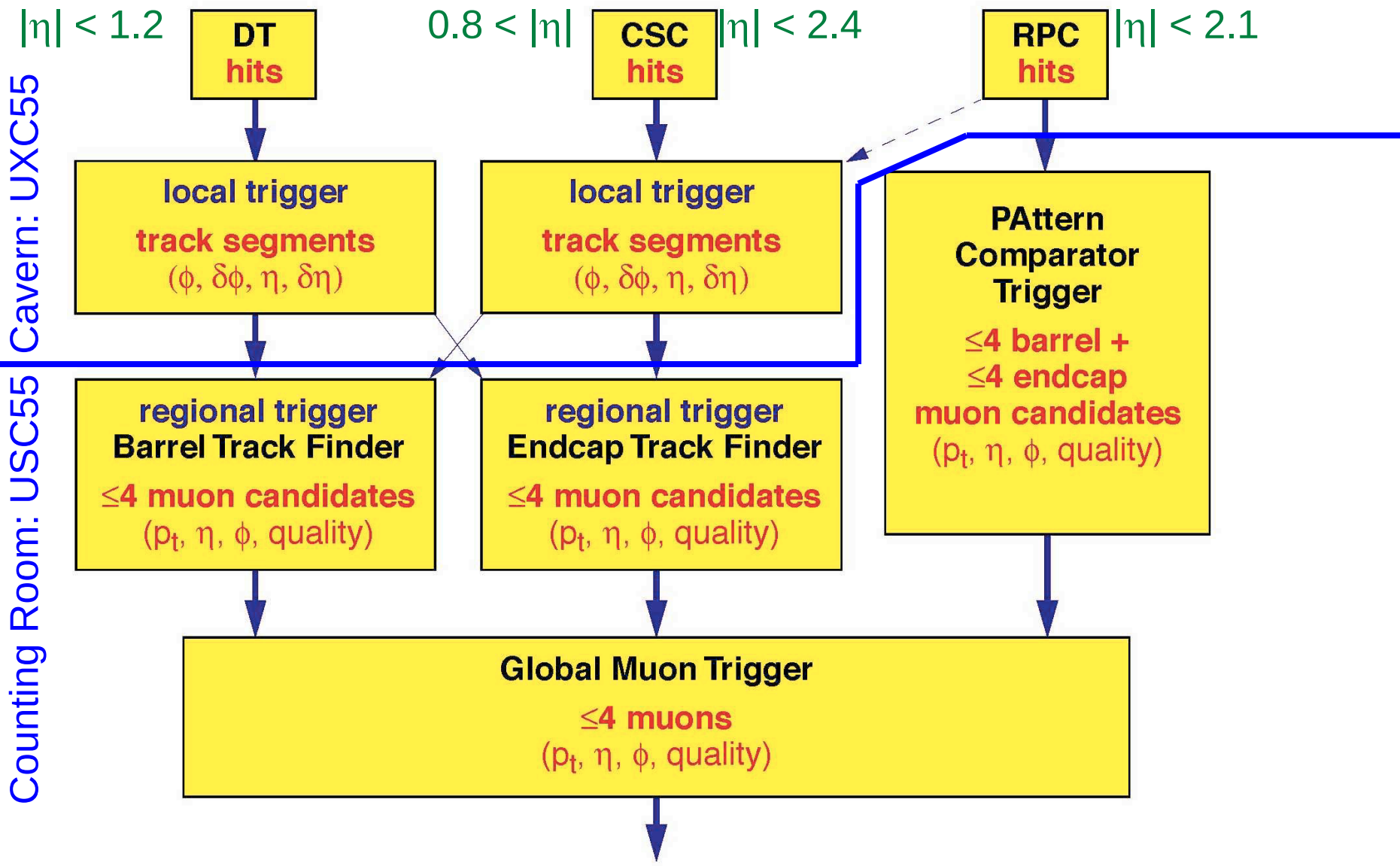
- Issue is p_T measurement of real muons



Level-1 Trigger Dataflow



L1 Muon Trigger Overview



CMS-M-01, CMS-TG-01 Test Beam

1. Measure Efficiency for perpendicular tracks
1. Measure Efficiency for inclined tracks with tracking
2. Time resolution
3. Tests with Front End electronics for mips
4. Space resolution with present strip size
5. Gas Studies
6. Magnetic Field Operation
7. Large Prototype preparation

Preparing for Test beam Oct 21-Nov 2