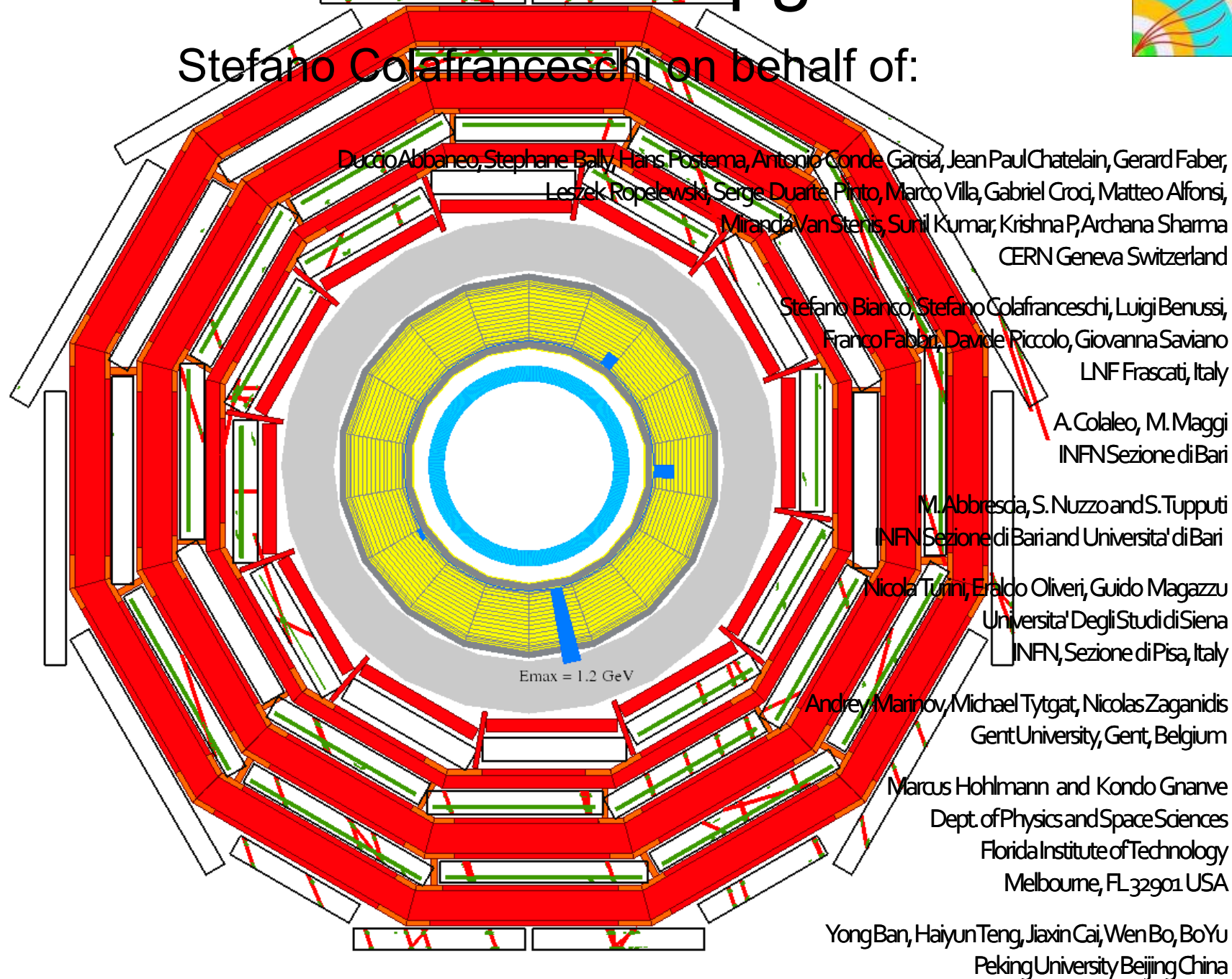




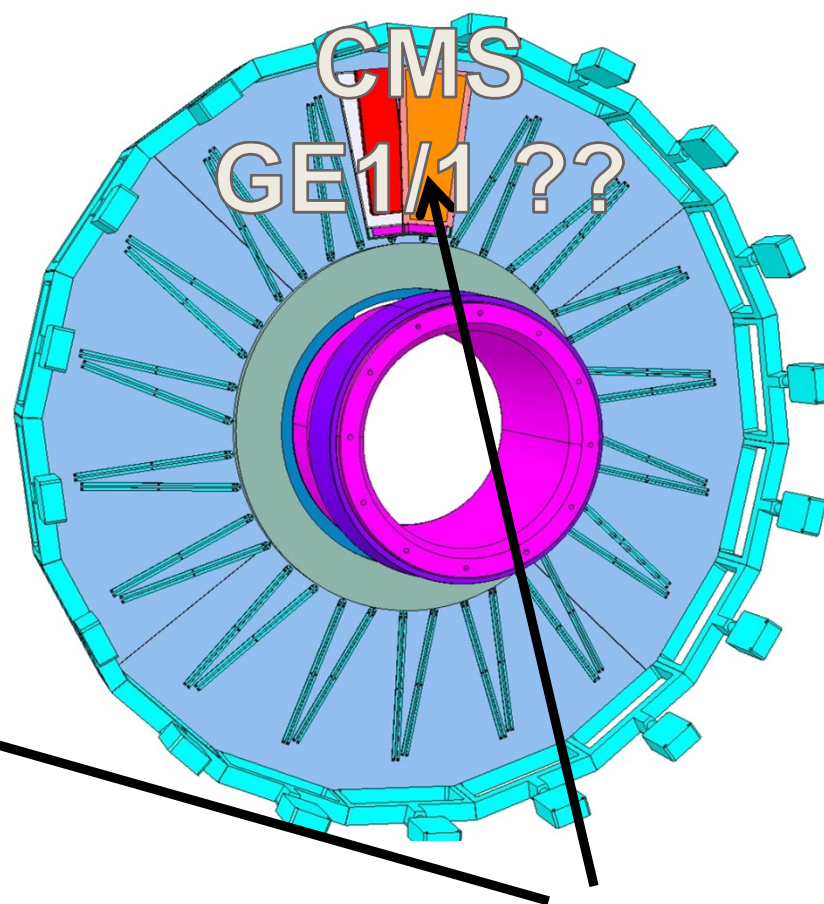
MPGD for CMS upgrade



Stefano Colafranceschi on behalf of:

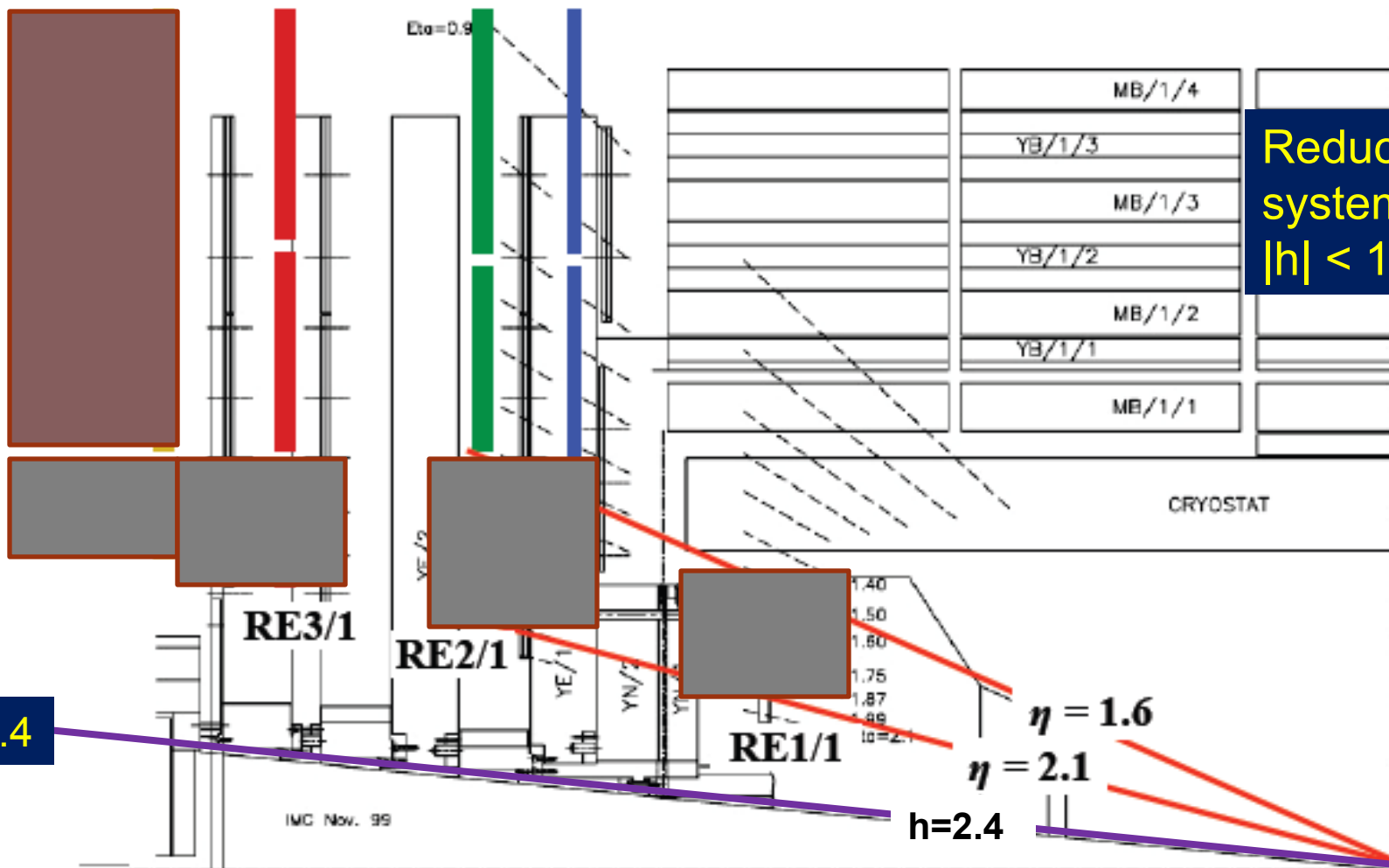


CMS GE1/1: Introduction 1/2



The Forward Muon RPC trigger system is equipped with detectors at $\eta < 1.6$, then high η region of CMS is presently vacant and presents an opportunity to instrument it with a detector technology that could sustain the environment and be suitable for operation at the LHC and its future upgrades.

CMS GE1/1: Introduction 2/2



$h = 2.4$

STAGED

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

CMS GE1/1: The environment

RPC Region	Rates Hz/cm ² LHC (10 ³⁴ cm ² /s)	High Luminosity LHC	SLHC ?? (10 ³⁵ cm ² /s)?
RB	30	Few 100	kHz
RE 1, 2, 3,4 $\eta < 1.6$	30	Few 100	kHz
Expected Charge in 10 years	0.05 C/cm ²	0.15 C/cm ²	~ C/cm ²
RE 1,2,3,4 $\eta > 1.6$	500Hz ~ kHz	Few kHz	Few 10s kHz
Total Expected Charge in 10 years	(0.05- 1) C/cm ²	few C/cm ²	Few 10s C/cm ²

CMS GE1/1: Motivations

- ⌘ Improve contribution to Muon Trigger Efficiency instrumenting the vacant RE i/1 zone
- ⌘ Combining triggering and tracking functions
- ⌘ Enhance and optimize the readout (η - ϕ) granularity by improved rate capability:

Rate capability : $10^4/\text{mm}^2$

Spatial/Time resolution: $\sim 100 \mu\text{m} / \sim 4\text{-}5 \text{ ns}$

Efficiency > 98%

Gas Mixture: Argon CO₂ (non flammable mixture - big plus)

(* *RPC time-res dependent on rate; bakelite resistivity, Wire chambers typically fail – kHz/mm²*)

- ⌘ Potential for going to large areas $\sim 1\text{m} \times 2\text{m}$ with industrial processes (cost effective)
- ⌘ Long term (10 years) operation experience in Compass and LHCb
- ⌘ Large margins of operation at full efficiency
- ⌘ Negligible Discharge probability with no consequen

Feasibility study for CMS: question of time..

GE1/1

The very first idea.

Meetings

Starting weekly meeting with strong support from DT, RD51 collaboration.

Several feasibilities studies

Integration studies, gas flow, mechanics, electronics, detector performance...

TestBeam 2

At the RD51 setup we performed further studies with small single mask prototype.

TestBeam 3

The GE1/1 is being successfully tested!

GE1/1 proto II

Design is ready, Material ready, ...building it...



Interests

Few groups expressed interest.

Lab tests

Setup preparations in the lab.

TestBeam 1

At the RD51 setup we tested timing performance of small prototype.

Detector is ready!

The construction of the first GE1/1 is finished.

World's record!

GE1/1 proto II

Started working on the second prototype.

- ◆ The detector GE1/1_proto_I has been designed, built and successfully tested in only 1 year!
- ◆ The detector GE1/1_proto_II has ben designed, building is ongoing, let's try to be faster than GE1/1_proto_I
- ◆ Intense interest about electronics and CMS integration.
- ◆ Exciting beam periods are just near.

Feasibility study for CMS: activities

1. Assembly and tests of small MPGD prototypes

2. Beam tests 2009, 2010 (small prototypes studies)

Characterization of GEM Detectors for Application in the CMS Muon Detection System,
D. Abbaneo et al. <http://arxiv.org/abs/1012.3675v1>

3. Mock ups of large prototype

- Size and envelope limitations
- 3D Model / Drawings
- Services and routing: HV, Gas, LV, Cooling
- Electronics, HV Divider

4. Production and tests of full scale prototype

Construction of the first full-size GEM-based prototype for the CMS high-eta muon system,
D. Abbaneo et al. <http://arxiv.org/abs/1012.1524>

5. Data-taking at Beam-Test with the full-size detector

6. Designing a new full-size prototype with enhanced performance

7. Thinking a further development in the detector construction

Feasibility study for CMS: making detectors!

CMS_timing_GEM: Double mask 10x10cm² 1D readout (3/2/2/2);

Ok!

256 channels

CMS_Proto_I: Single mask FULL_SIZE 1D readout (3/2/2/2);

Ok!

1024 channels

CMS_Proto_II: Single mask FULL_SIZE 1D readout (3/1/2/1);

ongoing

8192channels

CMS_Proto_III: Single Mask 10x10cm² [N2] (3/1/2/1);

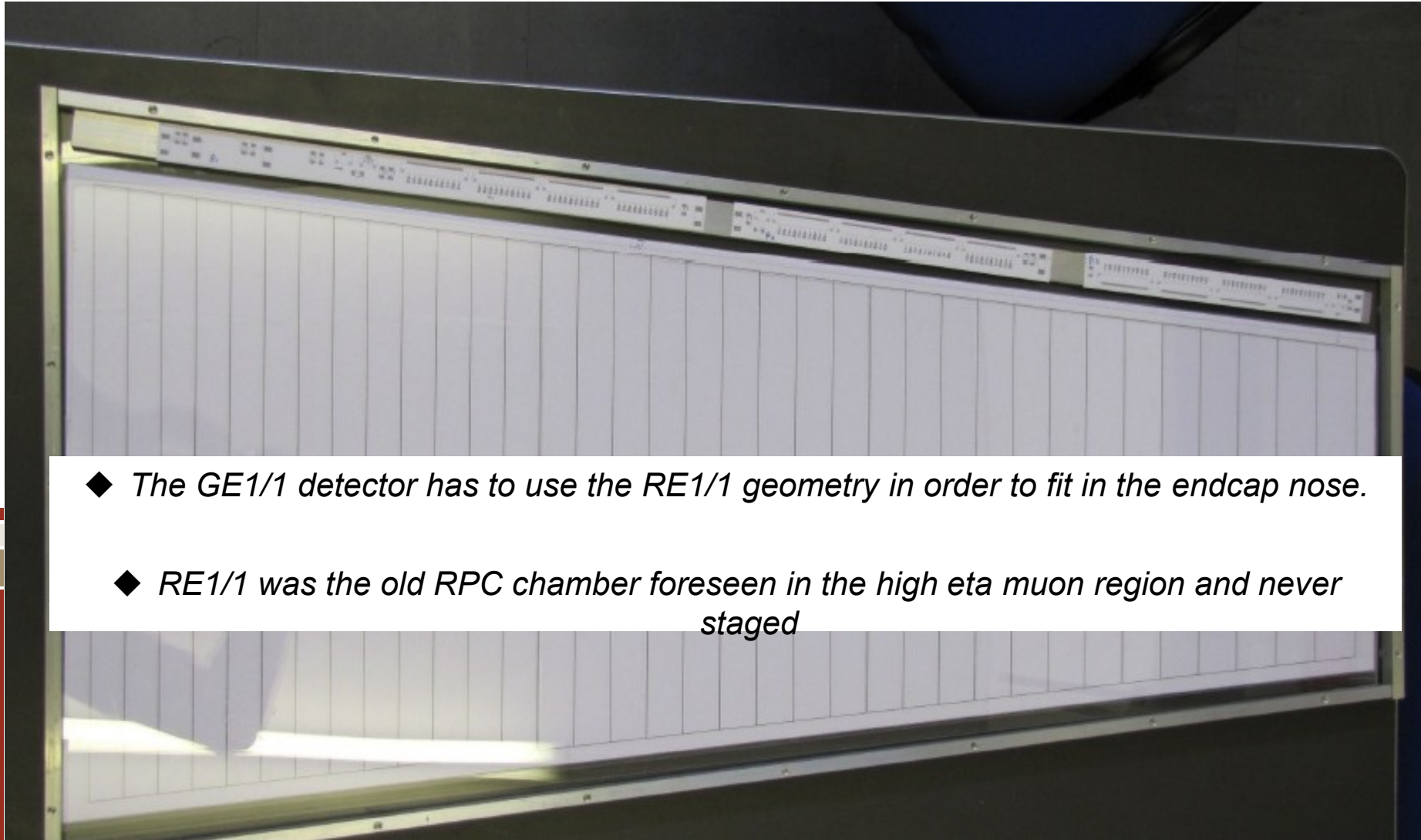
Ok!

256 channels

CMS_Proto_VI: Single Mask FULL_SIZE 1D [N2] (3/1/2/1)

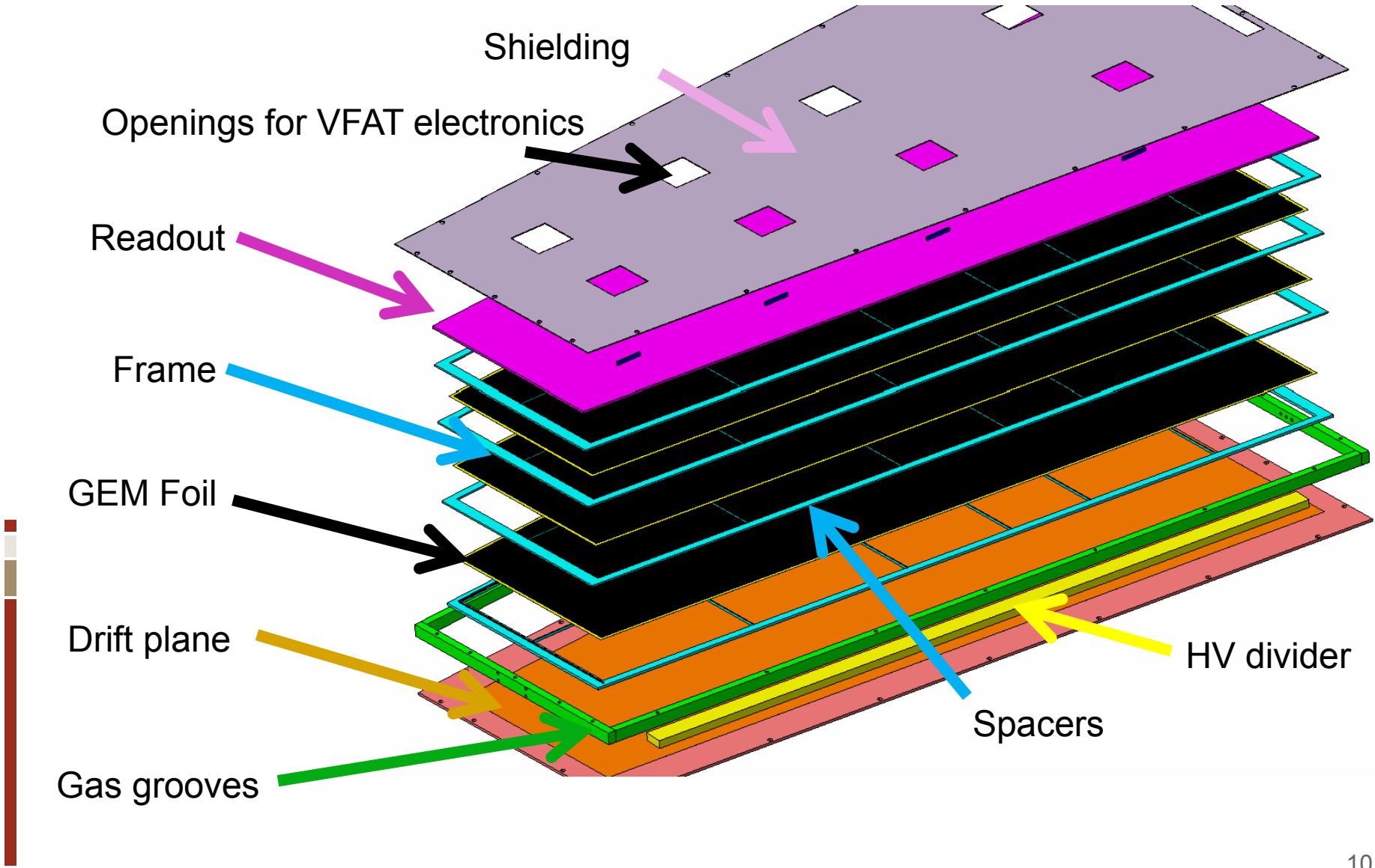
scheduled

8192 channels



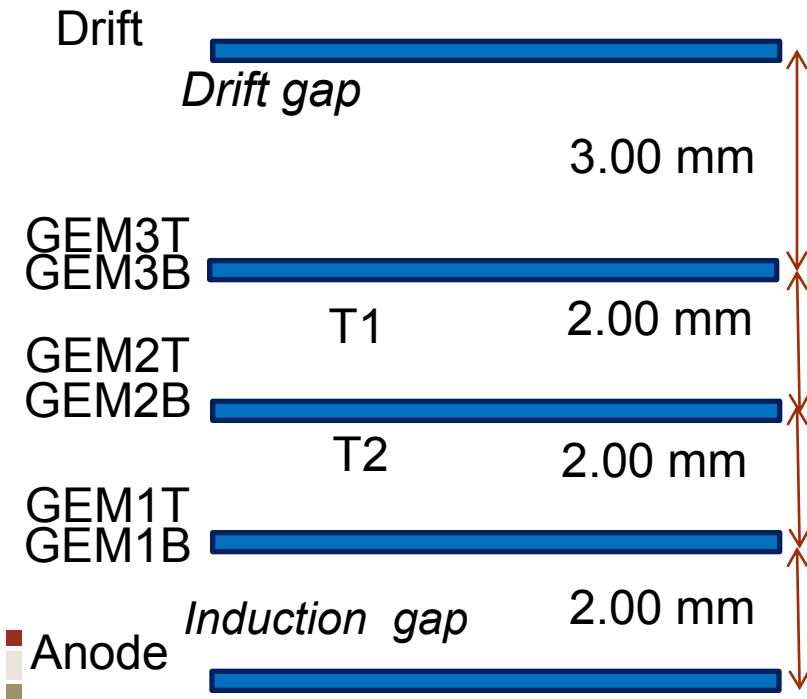
- ◆ *The GE1/1 detector has to use the RE1/1 geometry in order to fit in the endcap nose.*
- ◆ *RE1/1 was the old RPC chamber foreseen in the high eta muon region and never staged*

GE1/1 Prototype in details: description 2/4

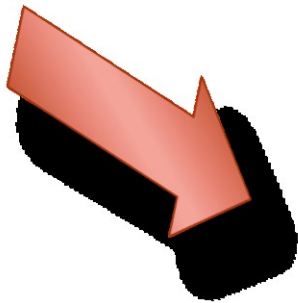


GE1/1 Prototype in details: description 3/4

Detector Configuration PROTOTYPE I



- 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



coming soon
the new
prototype...

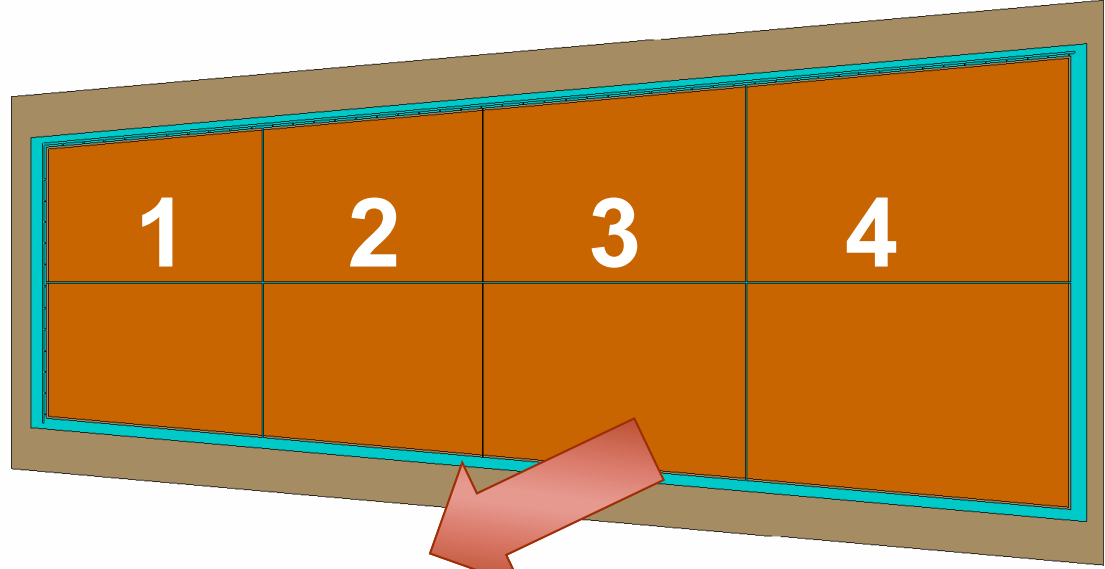
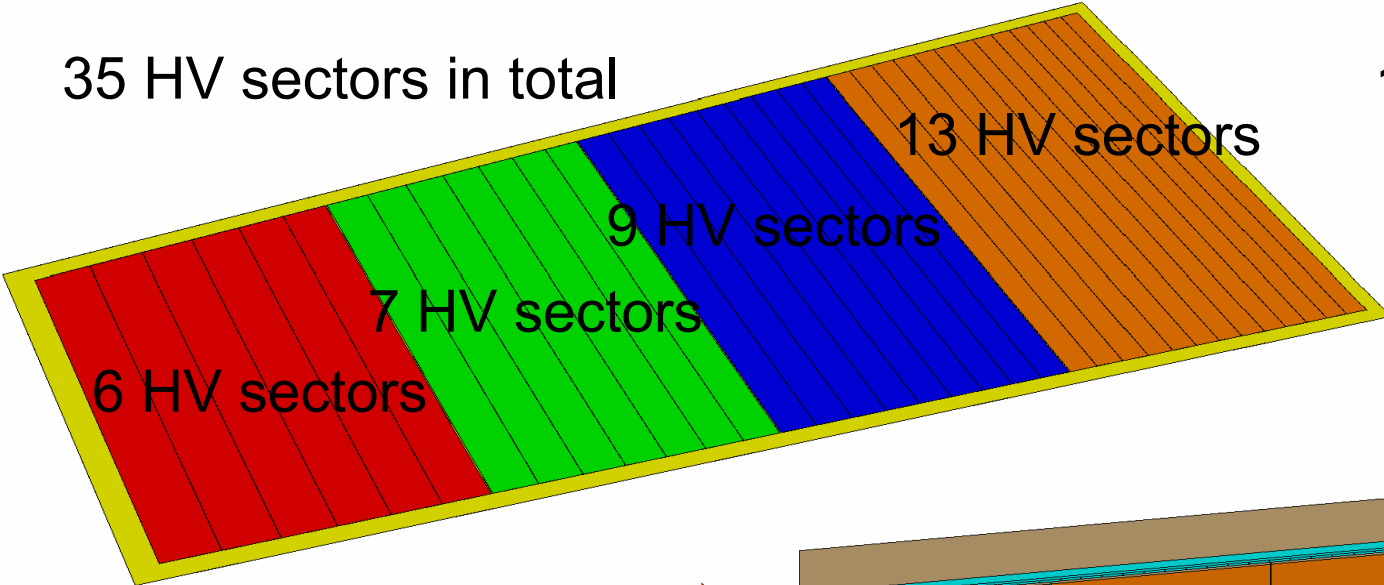


Single Mask technology will be used for large size detector and mass production!

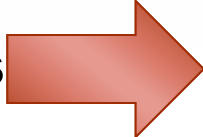
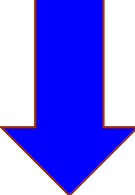
GE1/1 Prototype in details: description 4/4

35 HV sectors in total

1 HV GEM sector = 100cm²



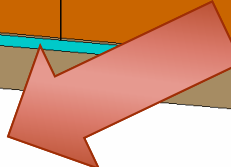
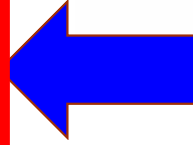
4 partitions



16 partitions
8192 channels!

*Coming soon
the new
prototype...*

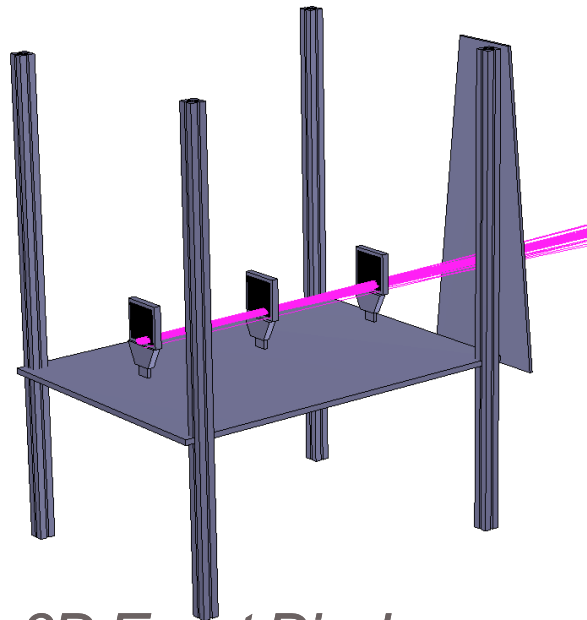
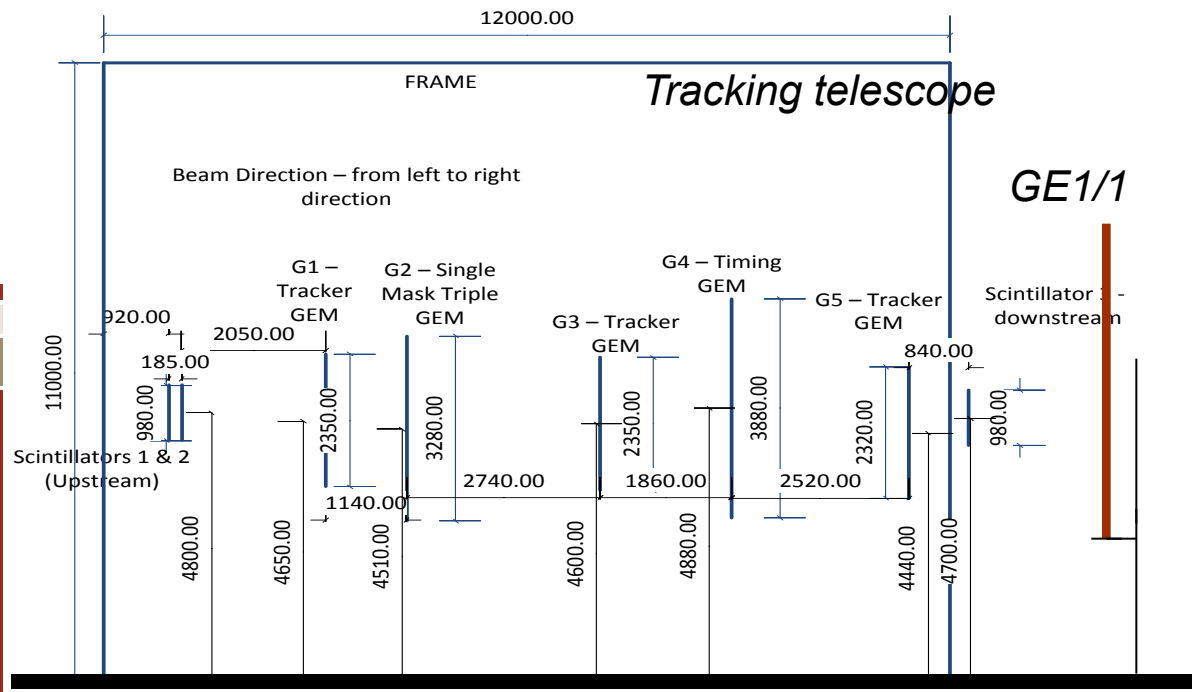
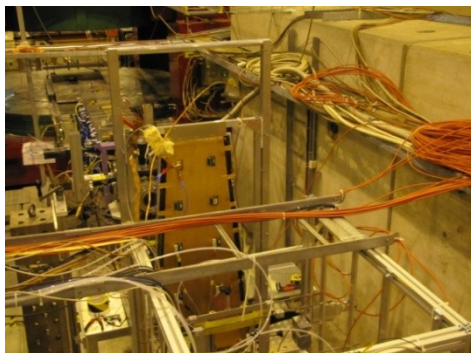
1024 channels
(8 VFAT chips)

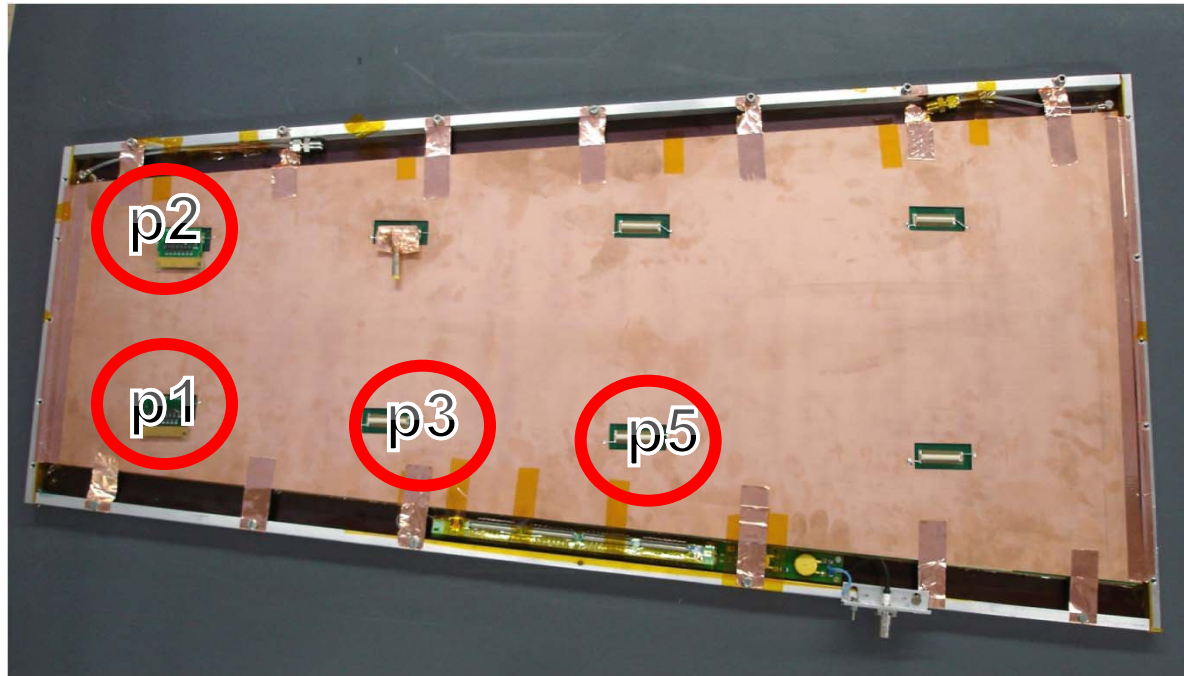


GE1/1 Prototype in details: last TB

BeamTest @ RD51 setup H4 -SPS

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





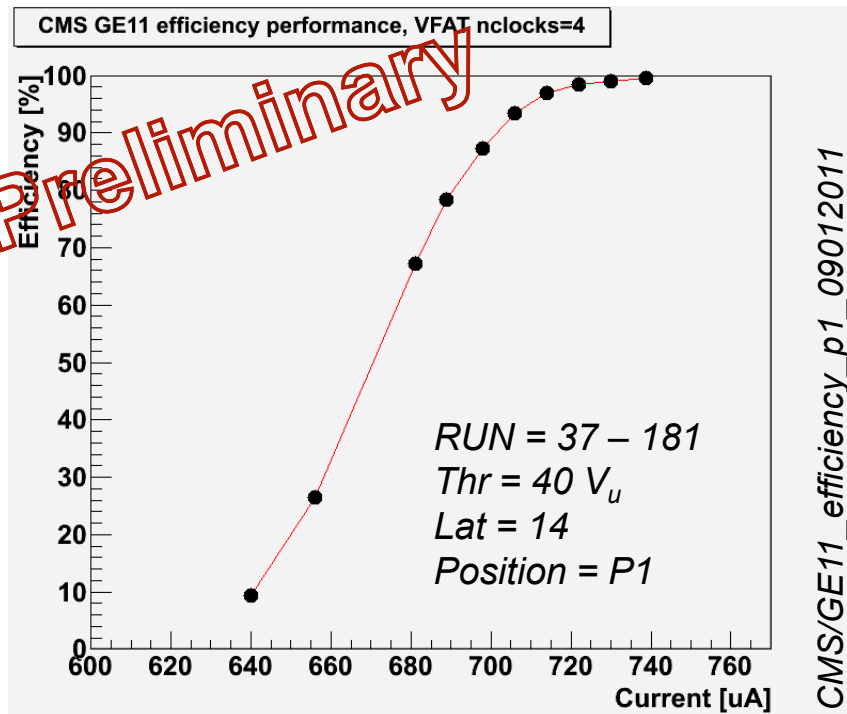
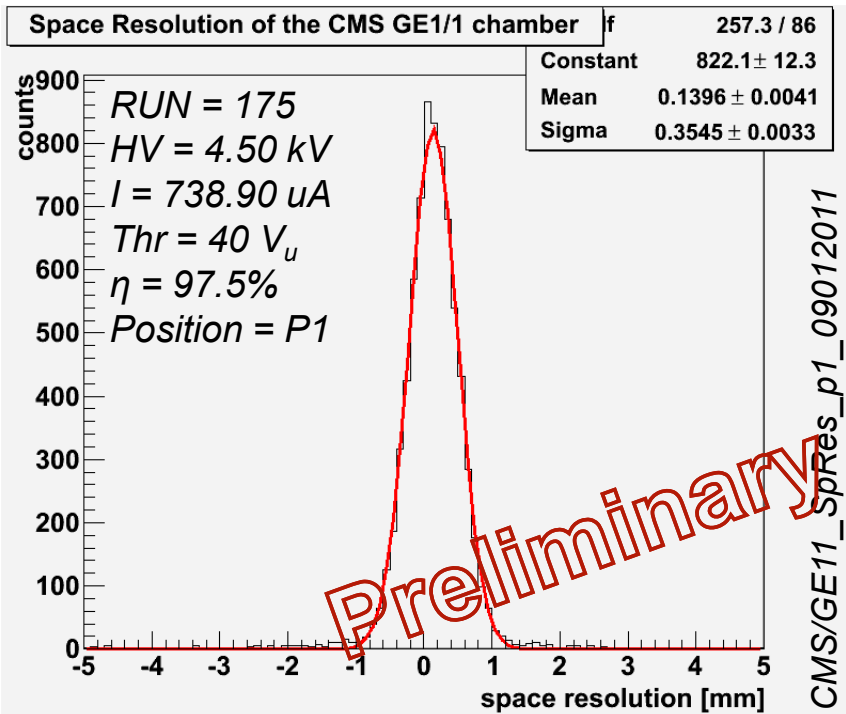
Data taking summary

- *650 Runs all over detector surface p1, p2, p3, p5*
- *Gas used: Ar:CO₂ (70:30)*
- *HV SCAN with thr/latency scan (p1-5) [3.9 to 4.5 kV]*
- *Single mask small prototype HV scan (also thr./lat.)*

Some results from October 2010 TB 2/2



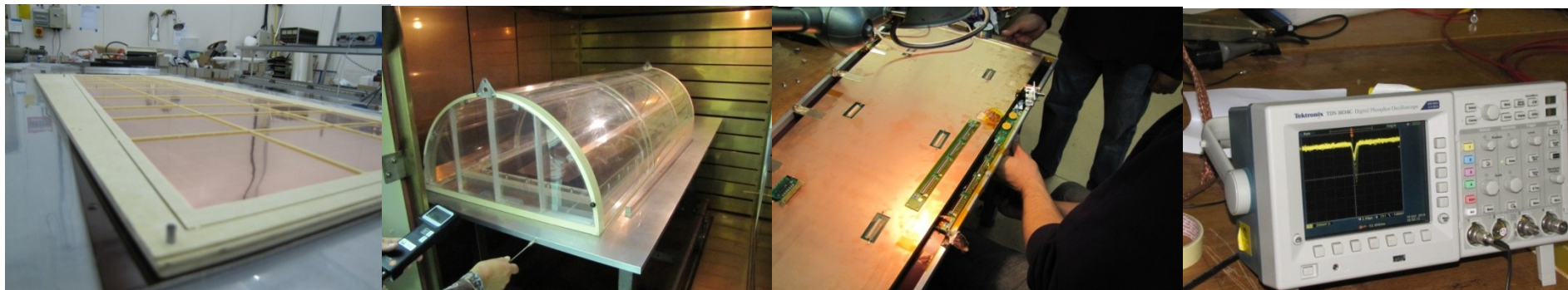
*Data-taking focused on different points along the GE1/1.
Preliminary results show good performance.*



Ongoing activities...

- ◆ Starting the construction of the new prototype II, new gap configuration and new HV divider
 - ◆ Preparation incoming beam-test
 - ◆ Simulations: GEMs in a 3T magnetic field
- ◆ Physics simulation to prove CMS trigger improvement as function of detector granularity
 - ◆ New readout with more partitions and reduced pitch
- ◆ Electronics upgrade (VFAT3??) + integration into CMS, linkboard, trigger board, PAC trigger algorithm..

Conclusions



A fully operational GEM detector 990 x (445 – 220 mm) has been designed and produced in 2010.

By the test-beams at rd51 setup with small size prototypes we demonstrated that the candidate prototype is addressing the requested requirements in terms of high efficiency and gain, stable safe and reliable operation at LHC.

The full-size detector has been tested at the RD51 setup at the H4 TestBeam in October 2010, preliminary results are very positive. Single mask (big dimension) technology behaves excellently as well as standard gems.

Designing of a new enhanced prototype already started along with test beam preparation for 2011.