CMS GE1/1 update

Alejandro Puig Barañac on behalf of the CMS GEM collaboration

Summary

- Introduction to GE1/1 detector
- Gain uniformity test
- Aging study
- Quality control stages
- Slice test

- Need to add a redundant muon detector system in CMS for the high η region. In the present day we only rely in CSC.

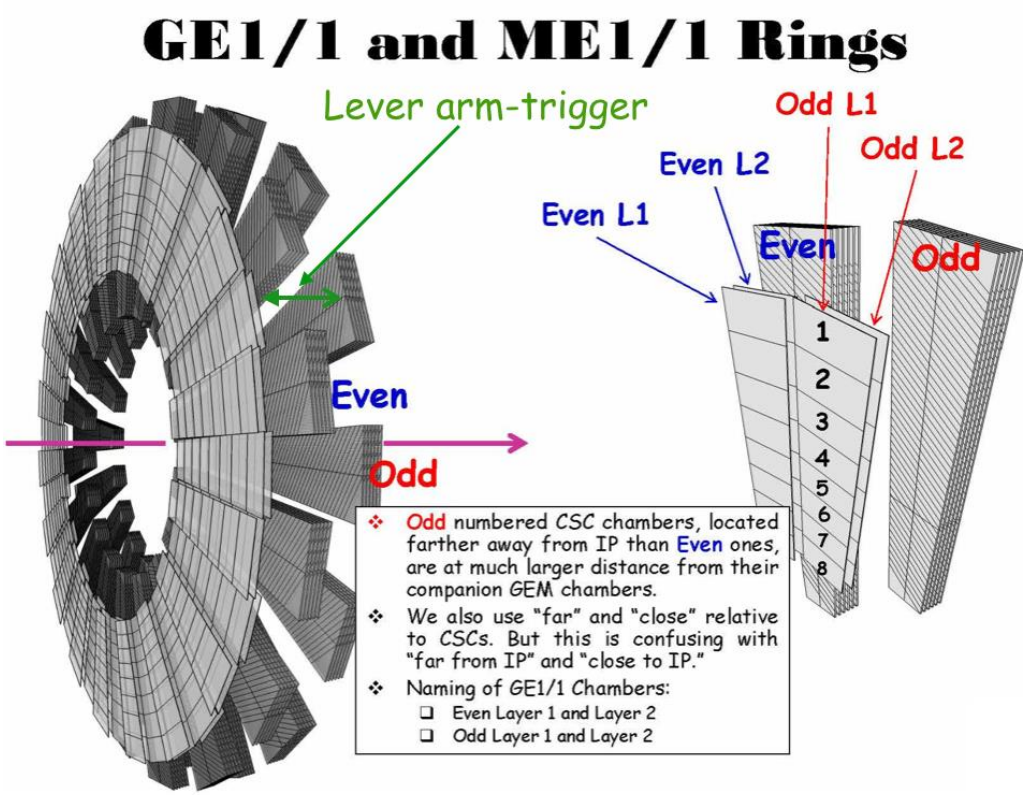
- For the HL-LHC the CSC will not be enough

- GE1/1 has recently been approved by LHCC

- Advantages of GE1/1:
  - Relative low cost
  - High rate capability
  - It has been proven to be radiation hard. No gain loss for doses up to 11 mC/cm^2
  - Spatial resolution of ~100µm and time resolution of ~4-5ns.
  - Efficient (98%)
  - Gas mixture is Ar CO2 CF4 45:15:40 which is non flammable

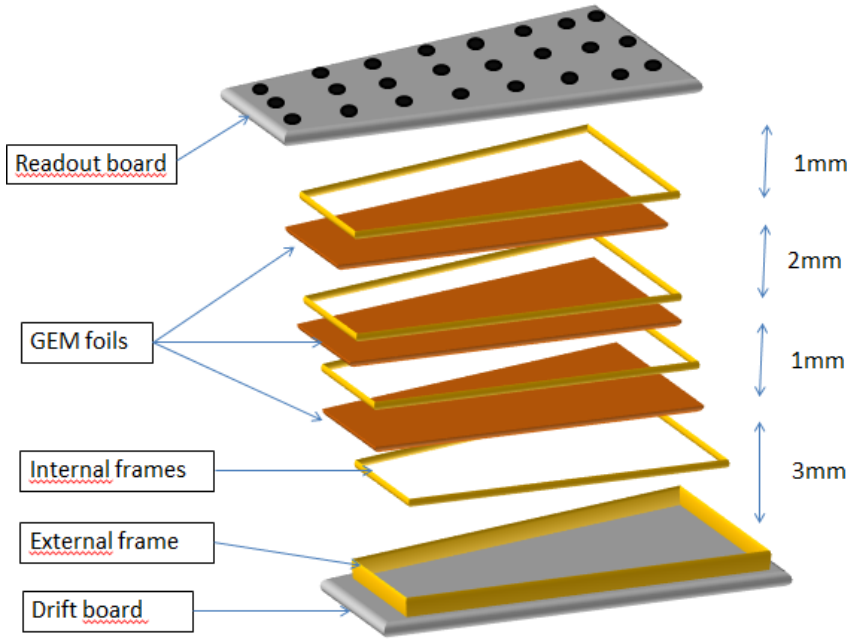
Introduction to GE1/1

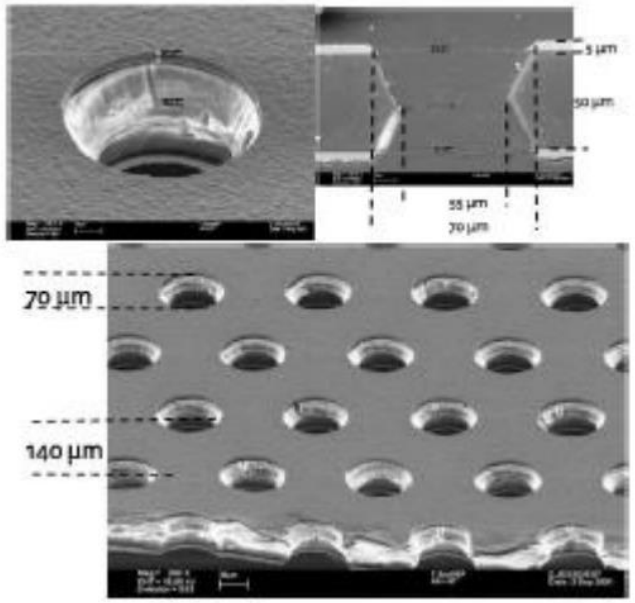
- What is GE1/1?
  - Triple GEM detector that will be applied in the endcaps of CMS for the 1.55 < |η| < 2.18 region
  - A total of 144 chambers placed in couples in superchambers
  - Each superchamber will host 2 chambers a long version and a short version
  - After several prototypes we are currently testing the 6th generation of GE1/1 chambers. To the present day we only have 2 long version prototypes, the short version prototypes are still under construction.



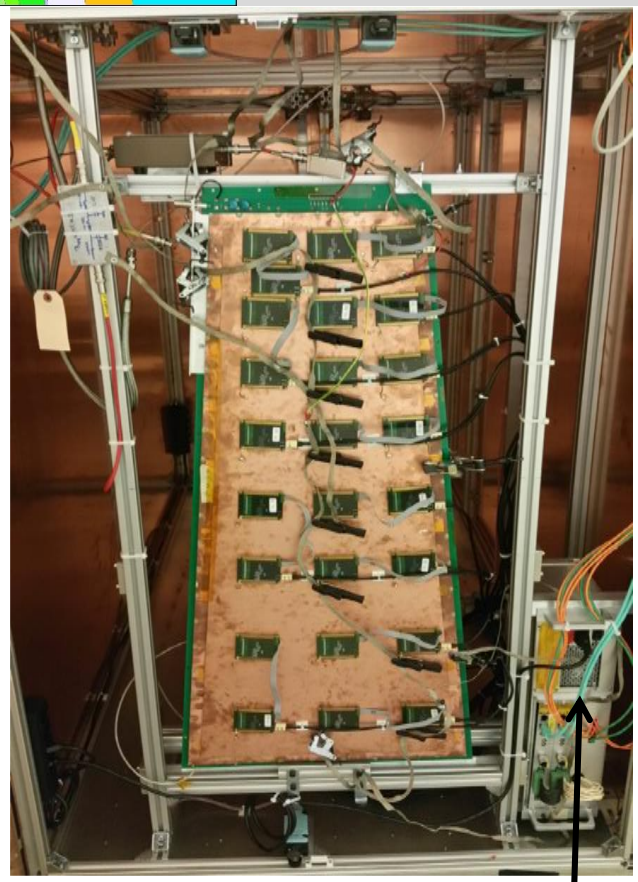
Introdction to GE1/1

- GE1/1 uses GEM foils made of 5:50:5µm for Cu:Kapton:Cu with single mask technology
- Holes geometry is 70µm with a pitch between holes of 140 µm
- Gap configuration between drift and foils is 3/1/2/1 (mm)

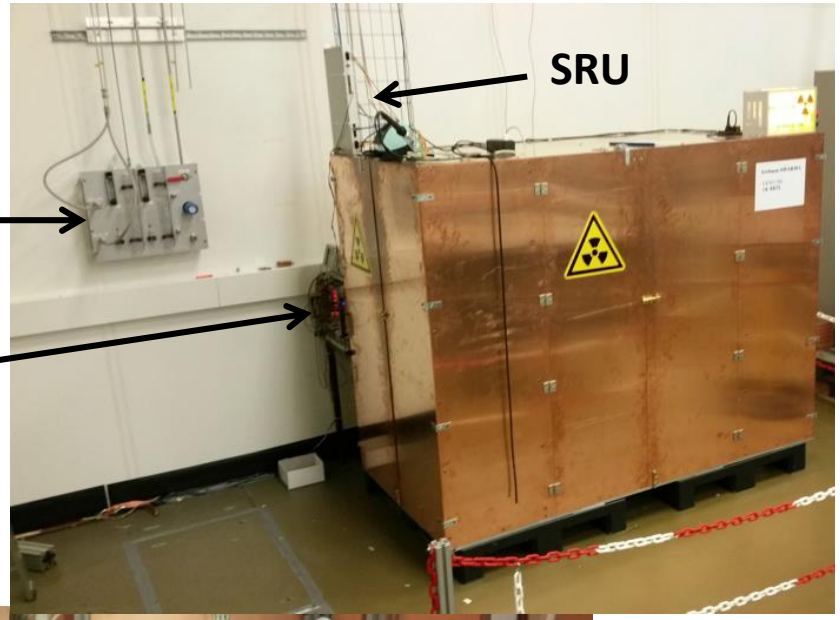




Gain uniformity test



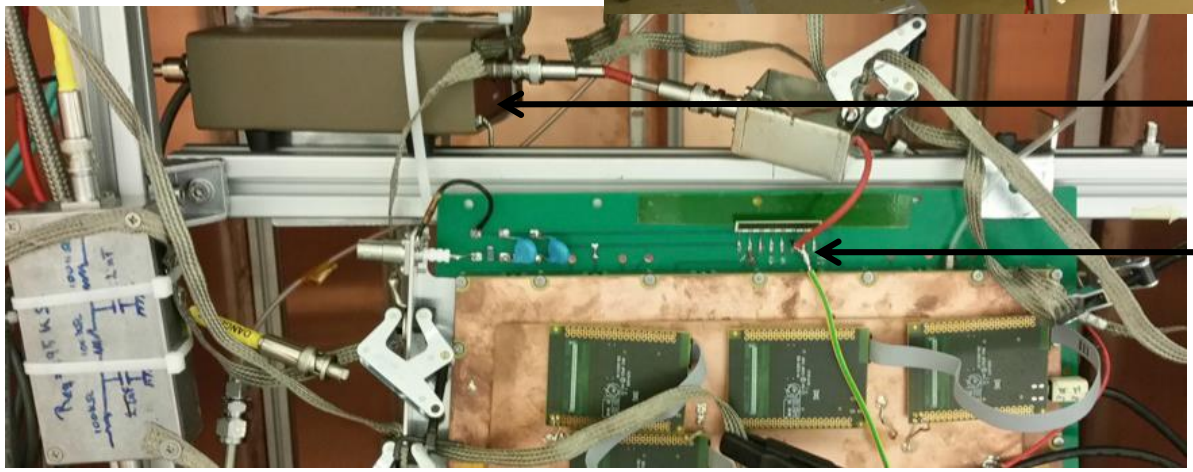
SRS



SRU

GAS IN/OUT

NIM (trigger) electronics

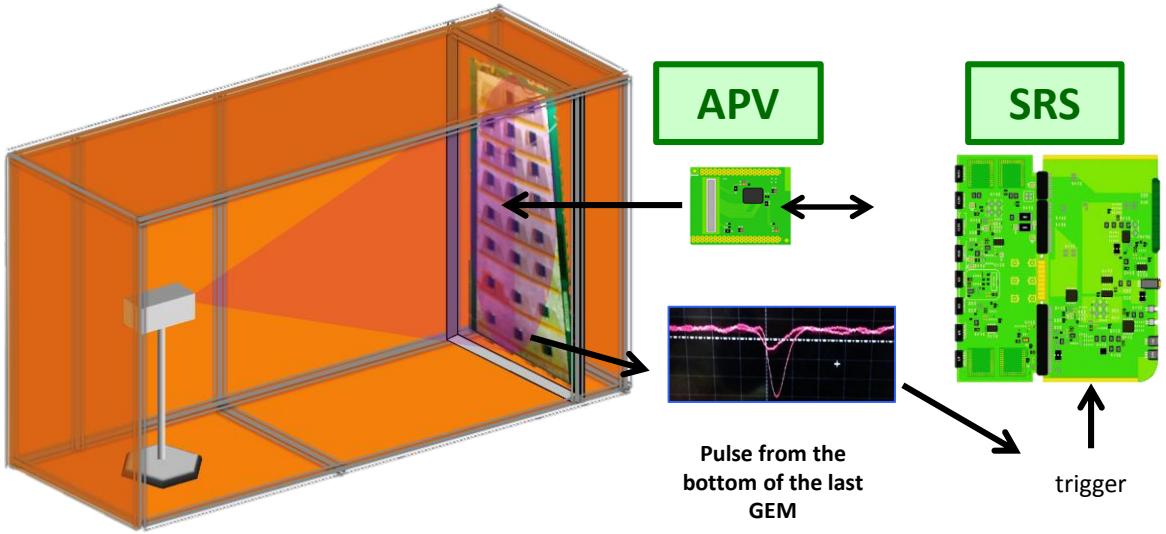


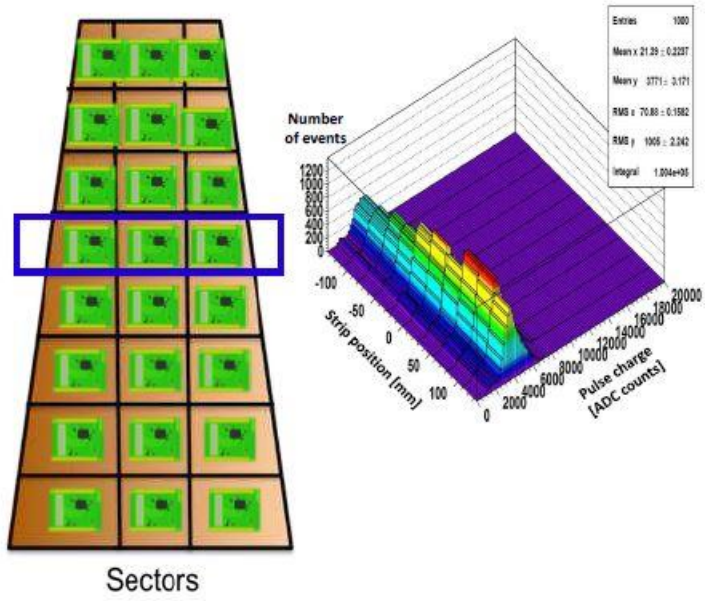
Preamplifier

Preamplifier connected to the bottom of GEM 3

Gain uniformity test

- **DAQ: DATE software**
  - **Minimum 1’000’000 events (100Gb): multiple files**
  - **Rate limitation while saving data = 50 Hz. This means it takes 5 to 6 hours**
- **Current status:**
  - **Qualitative analysis→ modification of new code to analyse results is ongoing**





Gain uniformity test

- Measurements:
  - GE1/1 IV (700000 events)
  - GE1/1 IV GIF (700000 events)
  - GE1/1 III (500000 events)
  - GE1/1 IV Ghent (700000 events)
  - GE1/1 VI 002 long (640000)

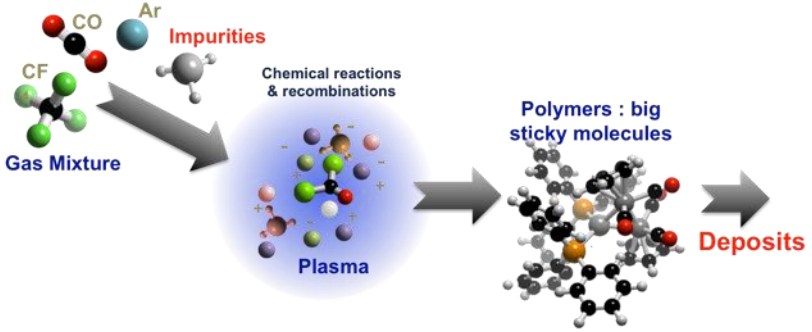
- Operation conditions:
  - Gas: Ar/CO2/CF4 45:15:40 (2l/h)
  - Gas: Ar/CO2 70:30 (2l/h)
  - Gain=2000

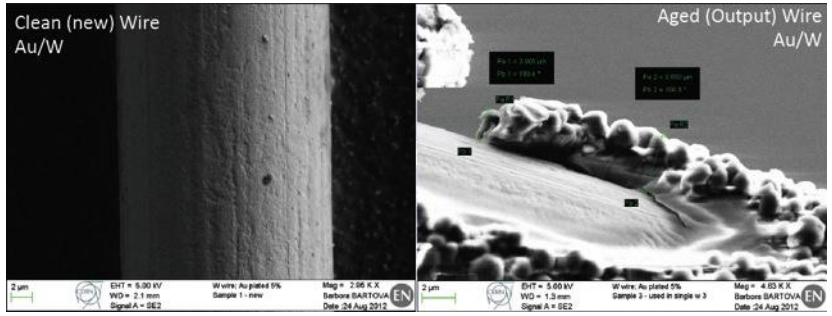
  With these conditions we get no saturation, a good position of the peak and good trigger signal

- Time scale
  - One day to take measurements
  - One to treat data (zero suppression and clusterisation)
  - Data analysis is still ongoing
  - Including installation it is necessary 2 -3 days per detector.

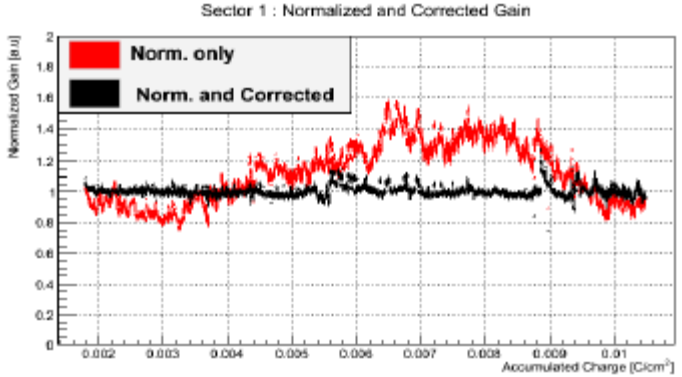
Aging study

- GE1/1 chambers must be able to perform properly for a long period of time ~ 20 years
- Classical aging due to outgassing affects the gain of the detector, its uniformity, may increase the probability of destructive discharges, degrade resolution of space/time and rate capability





- In the last 2 years 2 chambers have been tested GIF facility.
- Now one of the chambers has been moved to the new GIF ++ facility and tests started over a month ago.
- In addition to studying the performance of GE1/1 chambers materials are also tested individually in the outgassing setup placed in the TIF



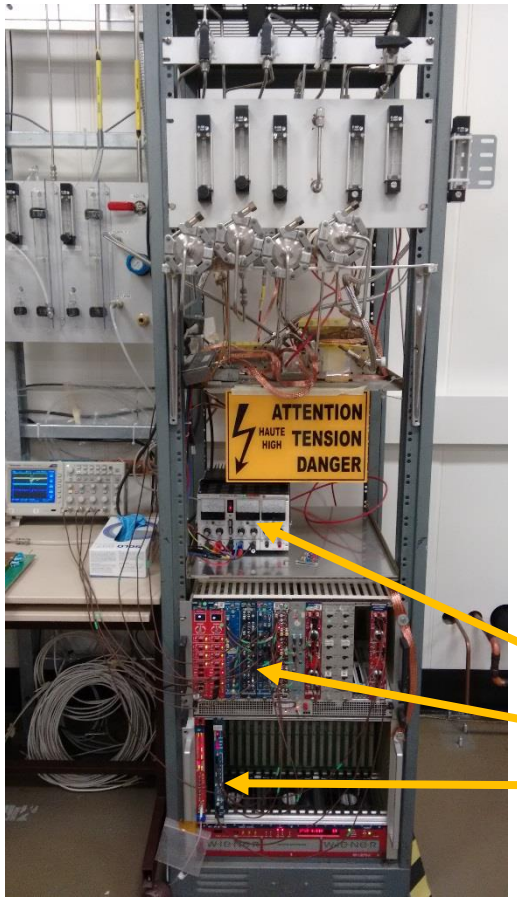
Aging study

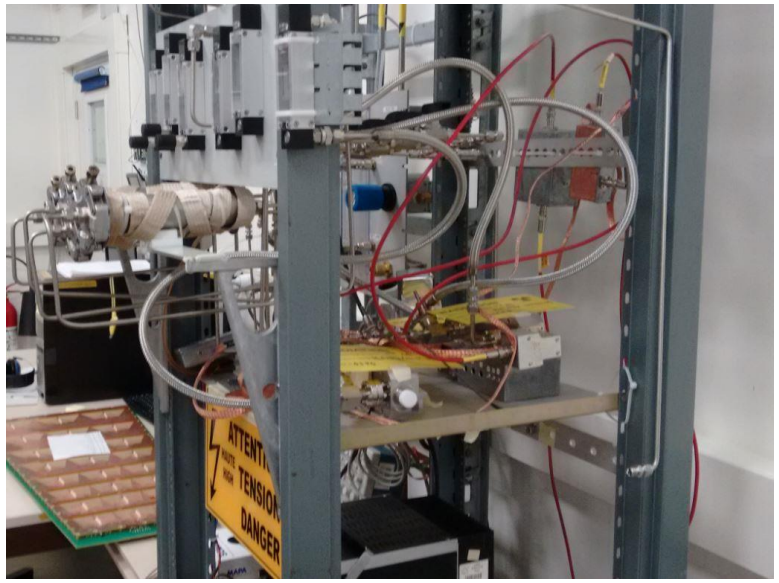
- **GE1/1-IV in operation since 23rd of April (almost 2 months)**
- **Average readout current : 450 nA**
- **Accumulated charge approx. 8mC/cm^2 on lower sectors (1-4)**
  5.8 mC/cm^2 on higher sectors
- **Long term operation**
  - **1 year for GE1/1**
  - **2-3 years for ME0**

GIF++ = 10xGIF
Expected 30xGIF
But distance+lens+gain

Aging study

Outgassing setup





Readout electronics
-Trigger Signal
-ADC (VME)

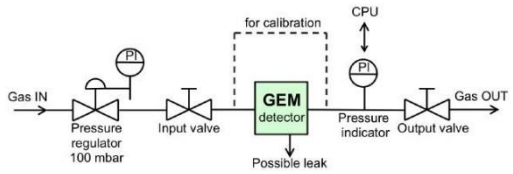
4 outgassing boxes with
The corresponding SWPC

3 materials being tested right now
PCB FR4 + Soldering mask (Elpemer 2467)
Silver Glue (MSDS_Polytec _EC)
Krempel KDF 0/25/25 HT

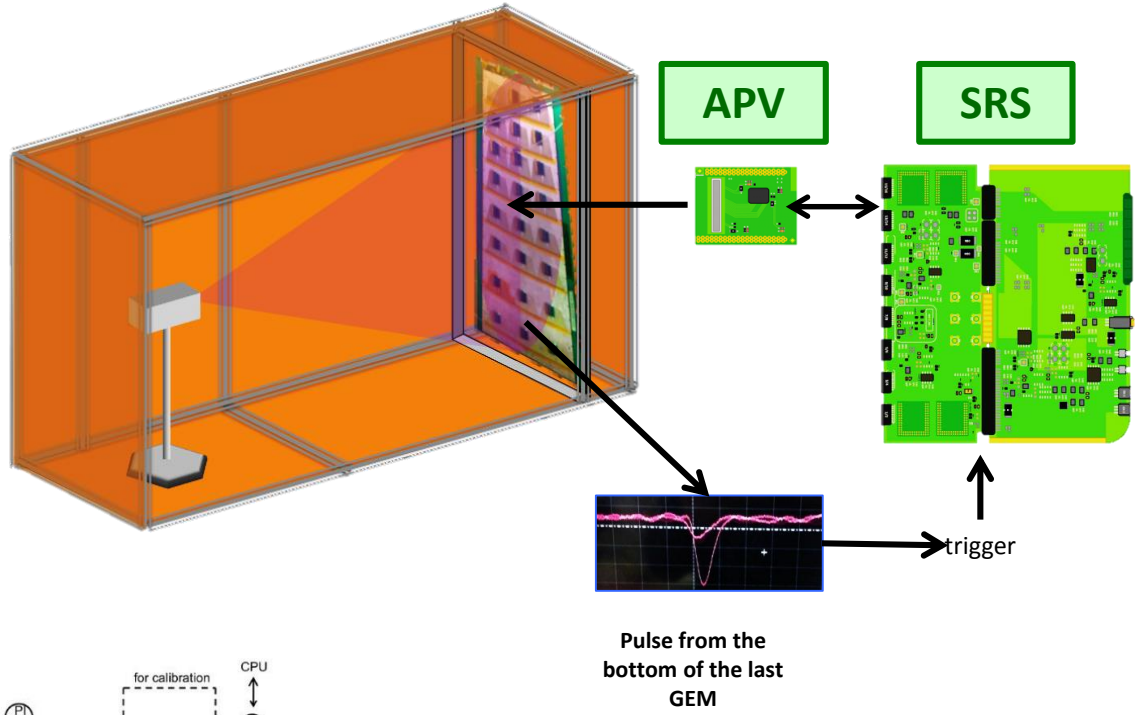
Quality control stages

- In order to qualify every chamber that will go to CMS it must pass a series of quality control stages:
  - Leakage current and stability of foils
  - Gas leakage test
  - High voltage test
  - Gain calibration and gain uniformity tests
  - Assembly of super chambers in the aluminium frame
  - Efficiency characterisation of superchambers in CS

Cosmic Stand



Gas leakage preliminary setup



Gain uniformity setup

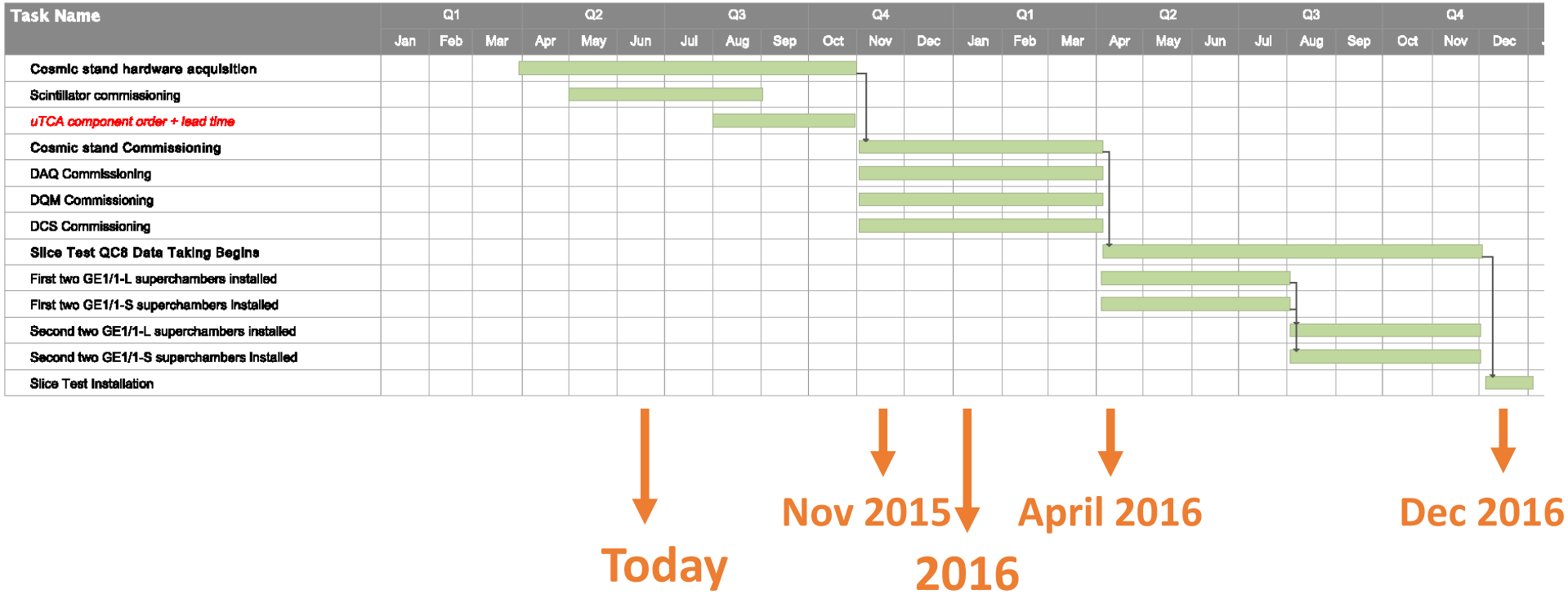
Quality control stages

- The CMS GEM collaboration has 6 production sites
- All QC stages will be done in all the different sites except for the superchamber assembly and testing the superchambers in the cosmic stand. These 2 last stages will take place only here at CERN.
- It is critical to establish a standardised QC procedure that can be transferred to every production site.

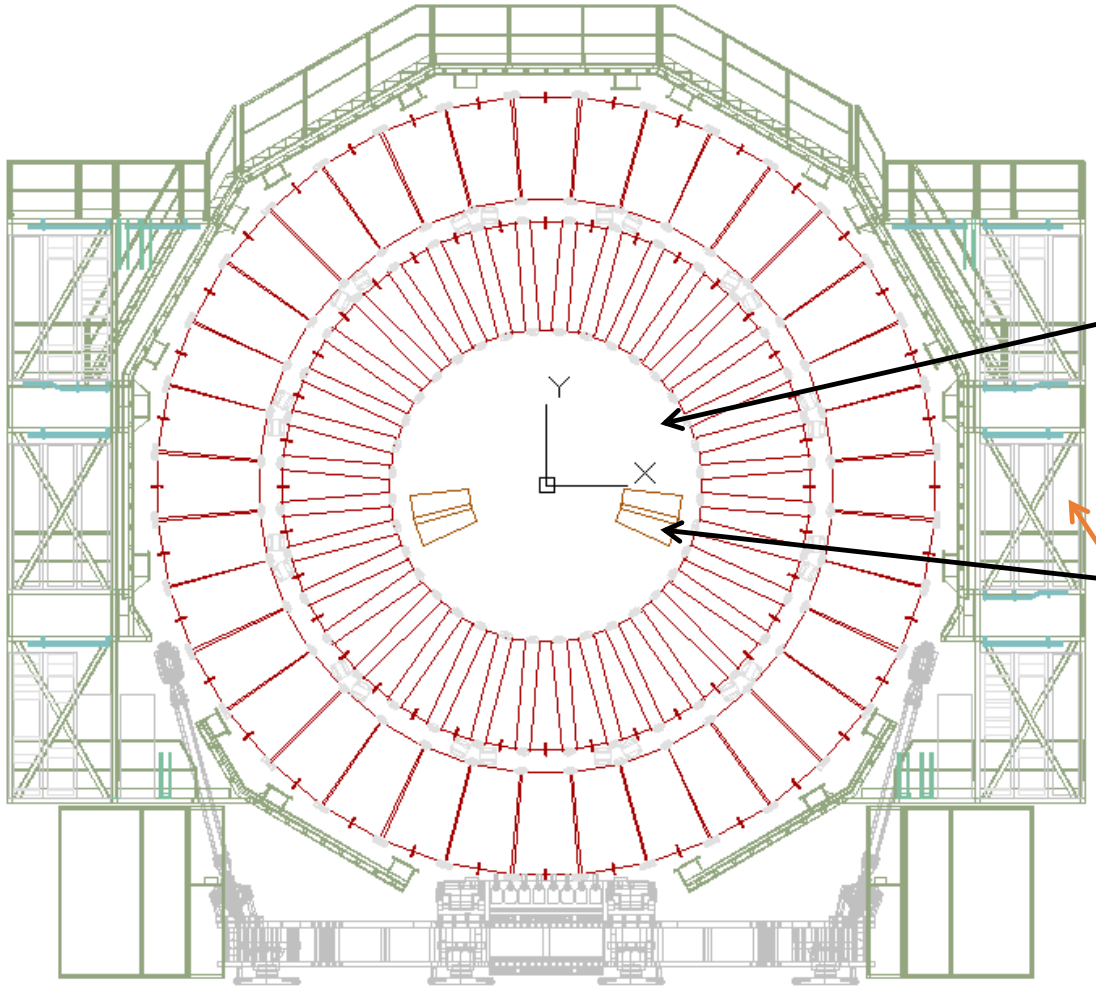
	BARC	INF-Bari	CERN	FIT	INFN-LNF	UGent
Cleanroom		X	X	X	x	
Leakage current setup		X	X	X	X	X
X-ray setup	X	X	X	X	X	X
Shipping logistics	X	X	X	X	X	X
GE1/1 assembly	X	X	X	X	X	X
Past experience	X	X	X	x	X	X

Slice test

- The slice test will be the first time GE1/1 chambers will be installed in CMS.
- A total of 4 superchambers will be installed, 2 long versions and 2 short versions.
- The slice test will take place during the 2016-2017 year end technical stop of the LHC
- We are planning to have the slice test superchambers (plus spares) manufactured by the end of 2015



Slice test



End of Year 2016 Technical Stop will be the period to install 4 super chambers in slots 1,2,35, 36 on YE-1

Rack foreseen for the LV powering X2V33