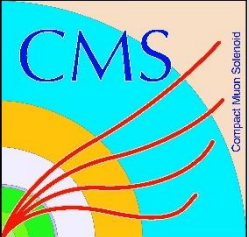


CMS GE1/1 update



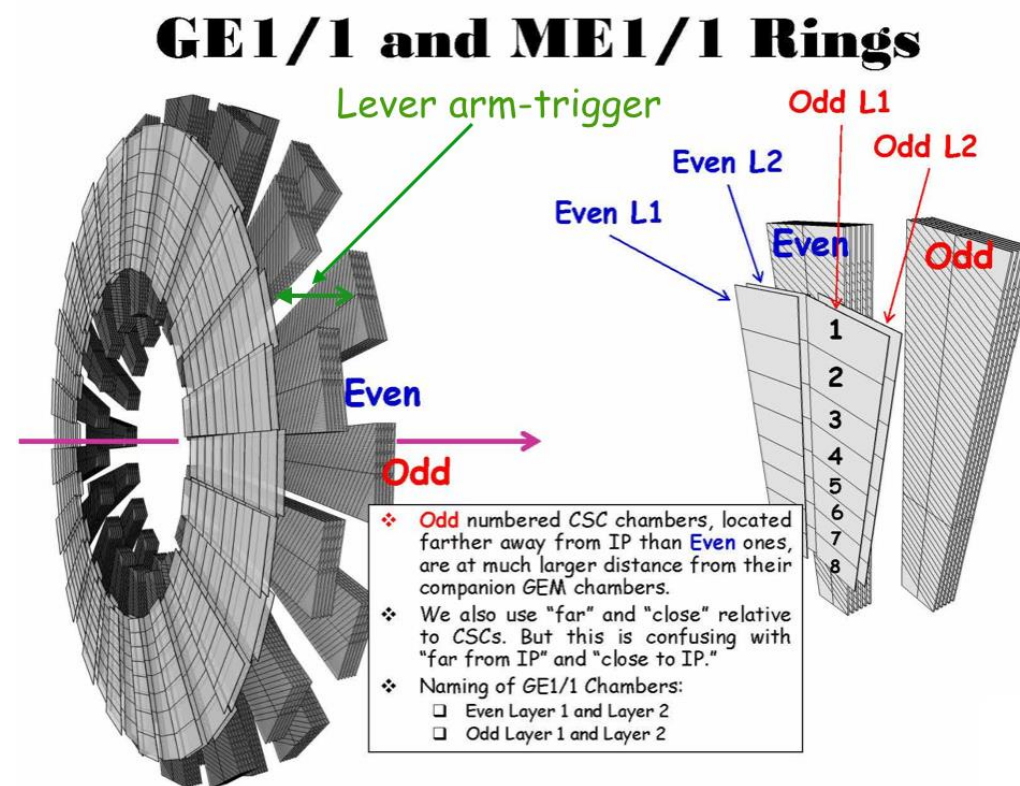
Summary



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

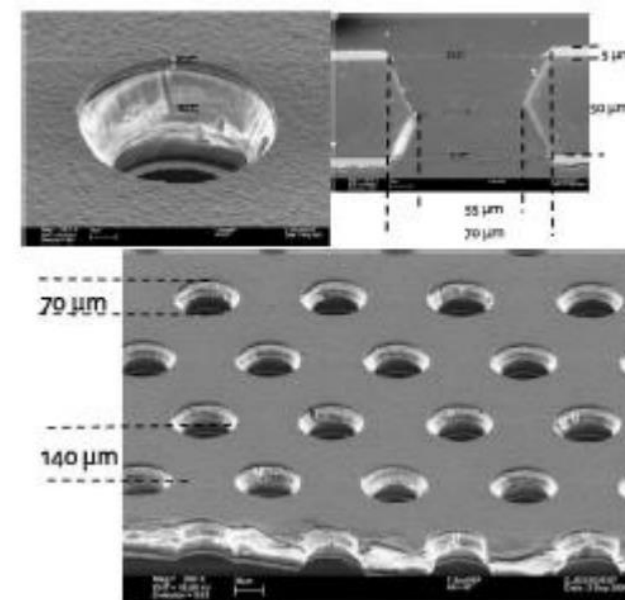
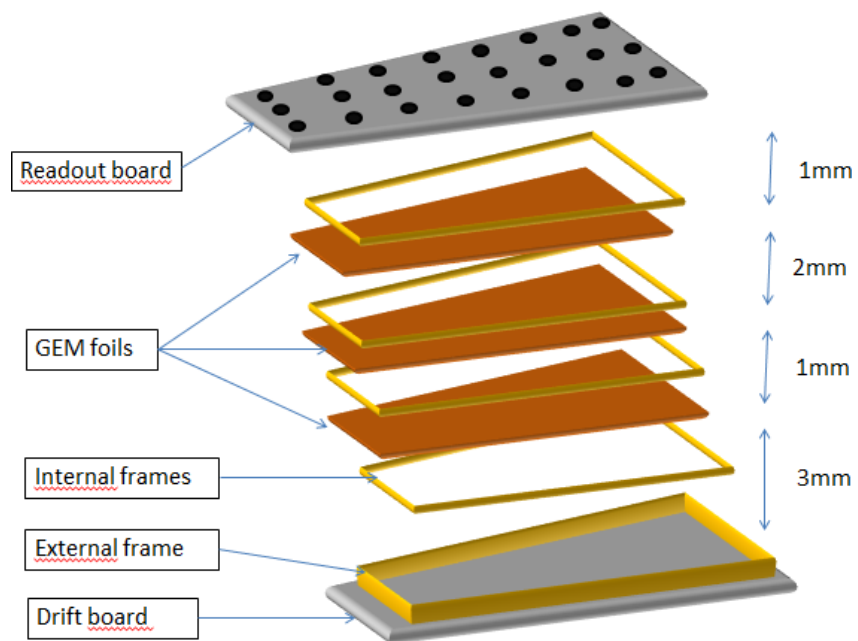
- Need to add a redundant muon detector system in CMS for the high η region. In the present day we only rely in CSC.
- For the HL-LHC the CSC will not be enough
- GE1/1 has recently been approved by LHCC
- Advantages of GE1/1:
 - Relative low cost
 - High rate capability
 - It has been proven to be radiation hard. No gain loss for doses up to 11 mC/cm^2
 - Spatial resolution of $\sim 100\mu\text{m}$ and time resolution of $\sim 4\text{-}5\text{ns}$.
 - Efficient (98%)
 - Gas mixture is Ar CO₂ CF₄ 45:15:40 which is non flammable

- What is GE1/1?
 - Triple GEM detector that will be applied in the endcaps of CMS for the $1.55 < |\eta| < 2.18$ 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.

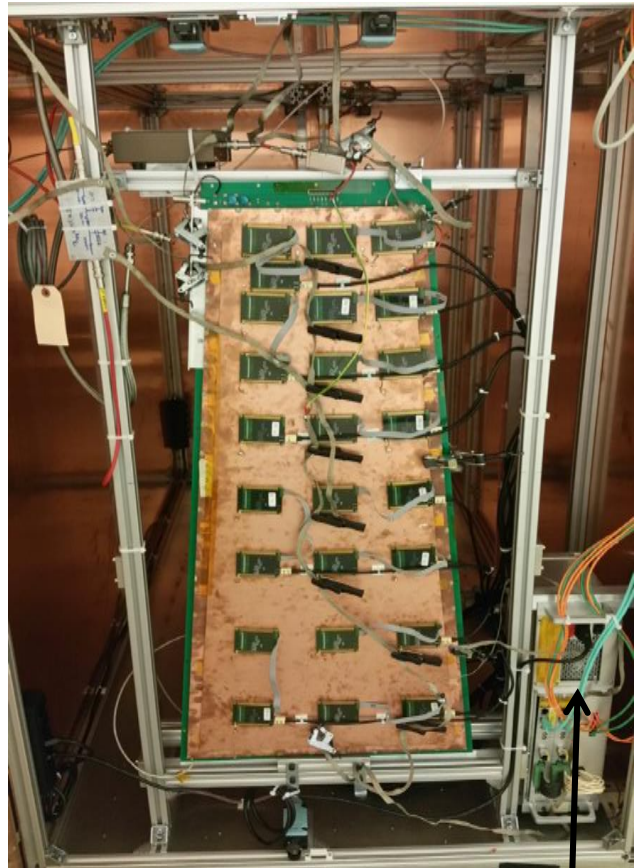


Introduction to GE1/1

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



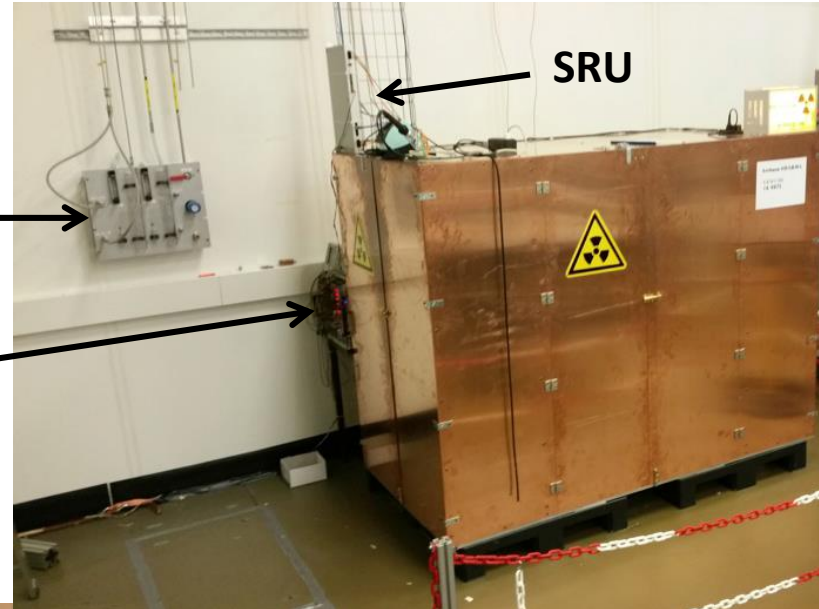
Gain uniformity test



SRS

GAS
IN/OUT

NIM
(trigger)
electronics



SRU

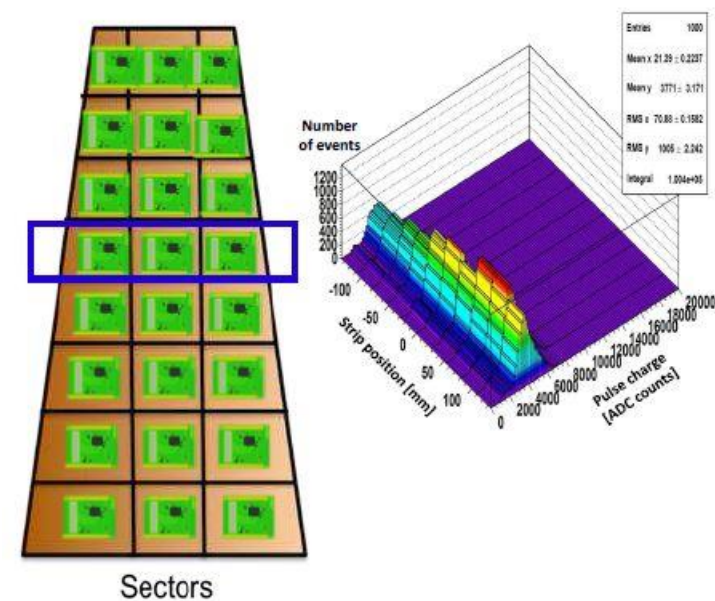
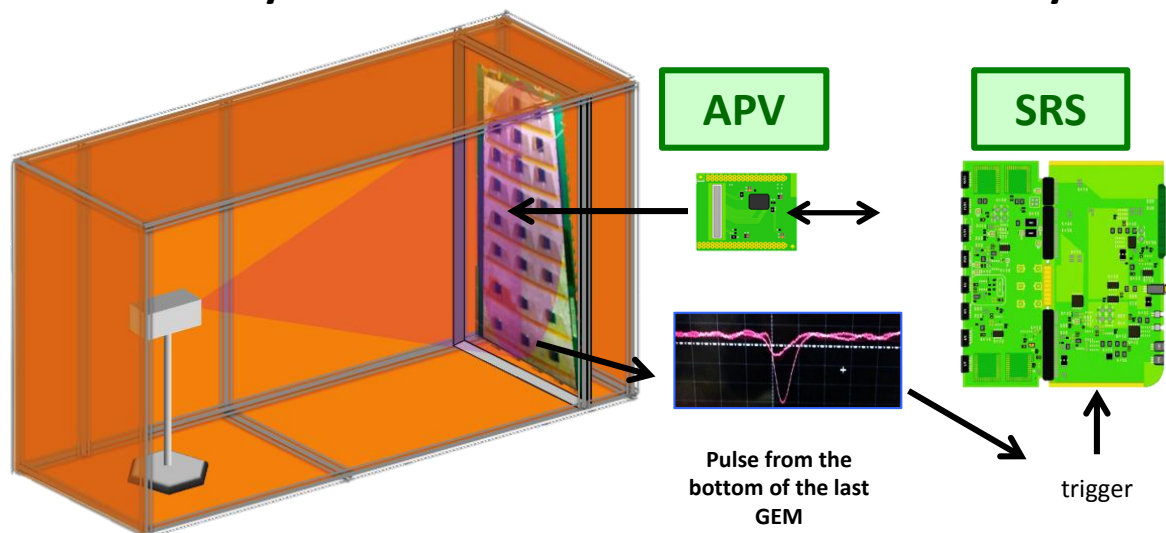


Preamplifier

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



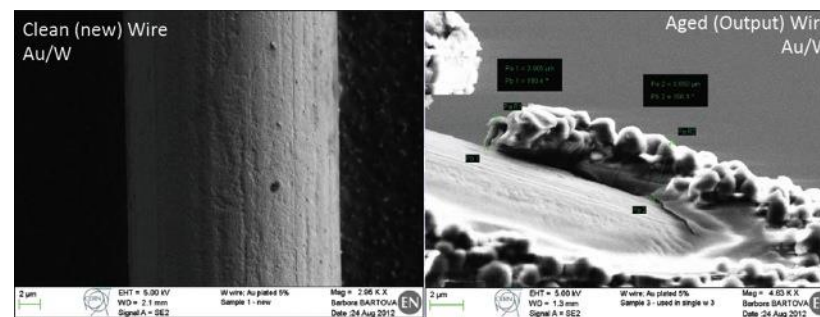
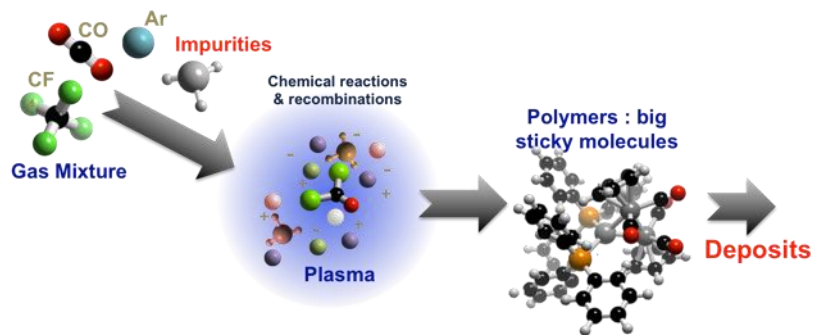
Gain uniformity test

- 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

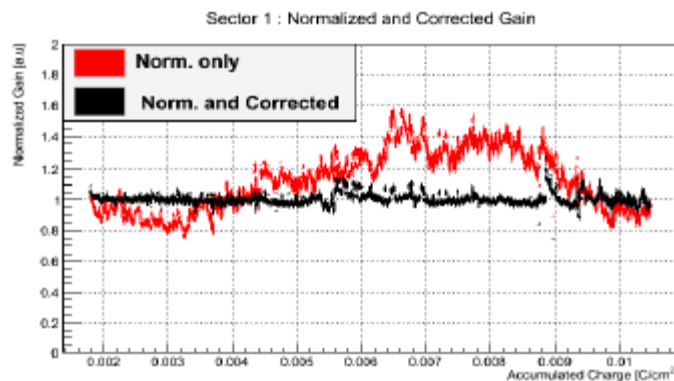
With these conditions we get no saturation, a good position of the peak and good trigger signal
- Time scale
 - One day to take measurements
 - One to treat data (zero suppression and clusterisation)
 - Data analysis is still ongoing
 - Including installation it is necessary 2 -3 days per detector.

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

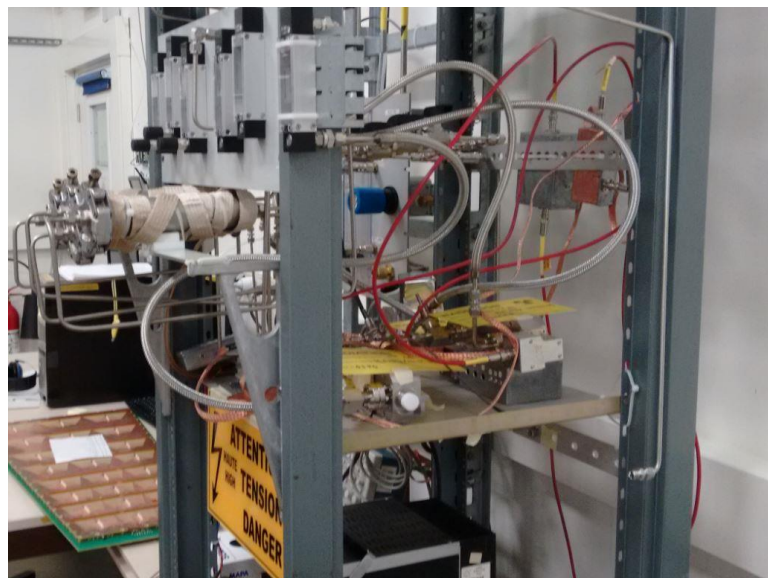
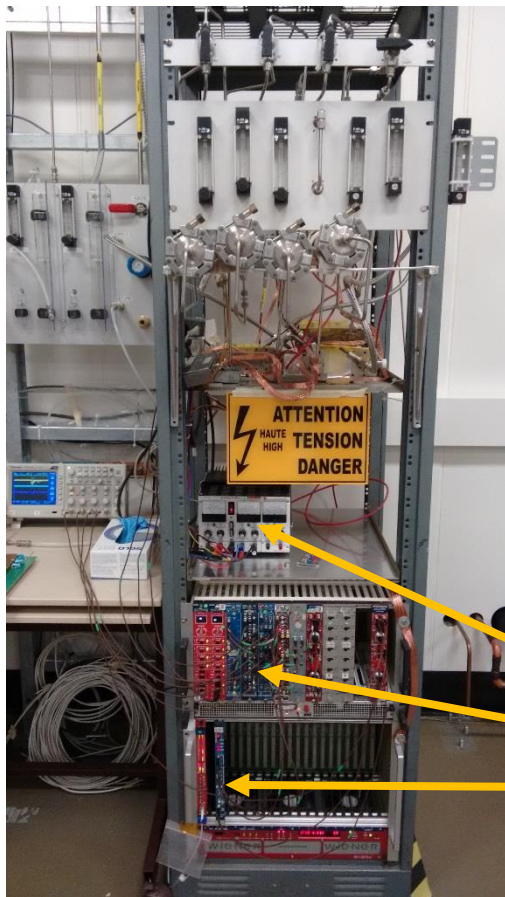


- **GE1/1-IV in operation since 23rd of April (almost 2 months)**
- **Average readout current : 450 nA**
- **Accumulated charge approx. 8mC/cm² on lower sectors (1-4)**
5.8 mC/cm² on higher sectors
- **Long term operation**
 - **1 year for GE1/1**
 - **2-3 years for ME0**

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

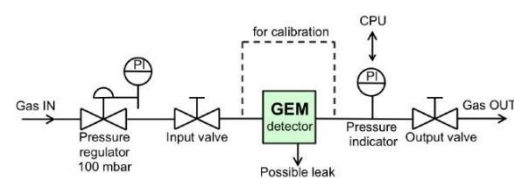
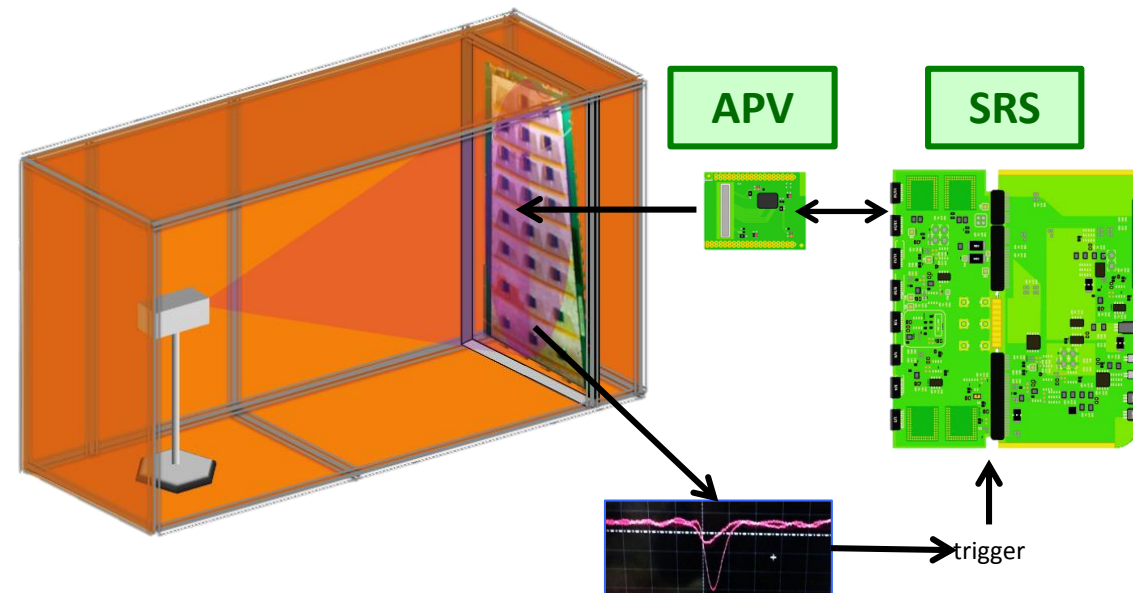
3 materials being tested right now
 PCB FR4 + Soldering mask (Elpemer 2467)
 Silver Glue (MSDS_Polytec_EC)
 Krempel KDF 0/25/25 HT

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



Pulse from the bottom of the last GEM
trigger
Gain uniformity setup

Gas leakage preliminary setup

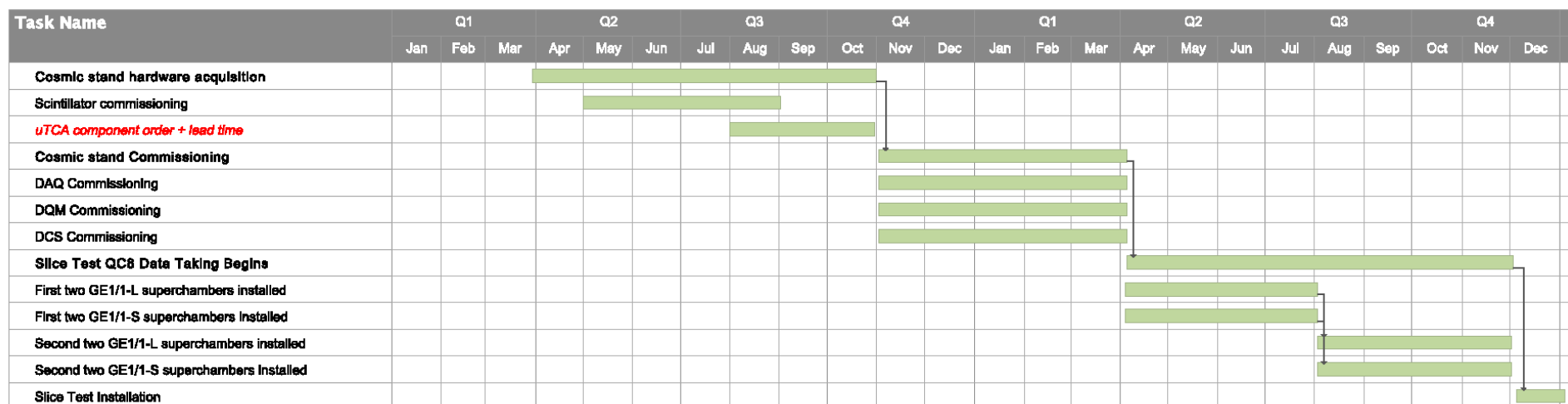
Quality control stages

- 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.

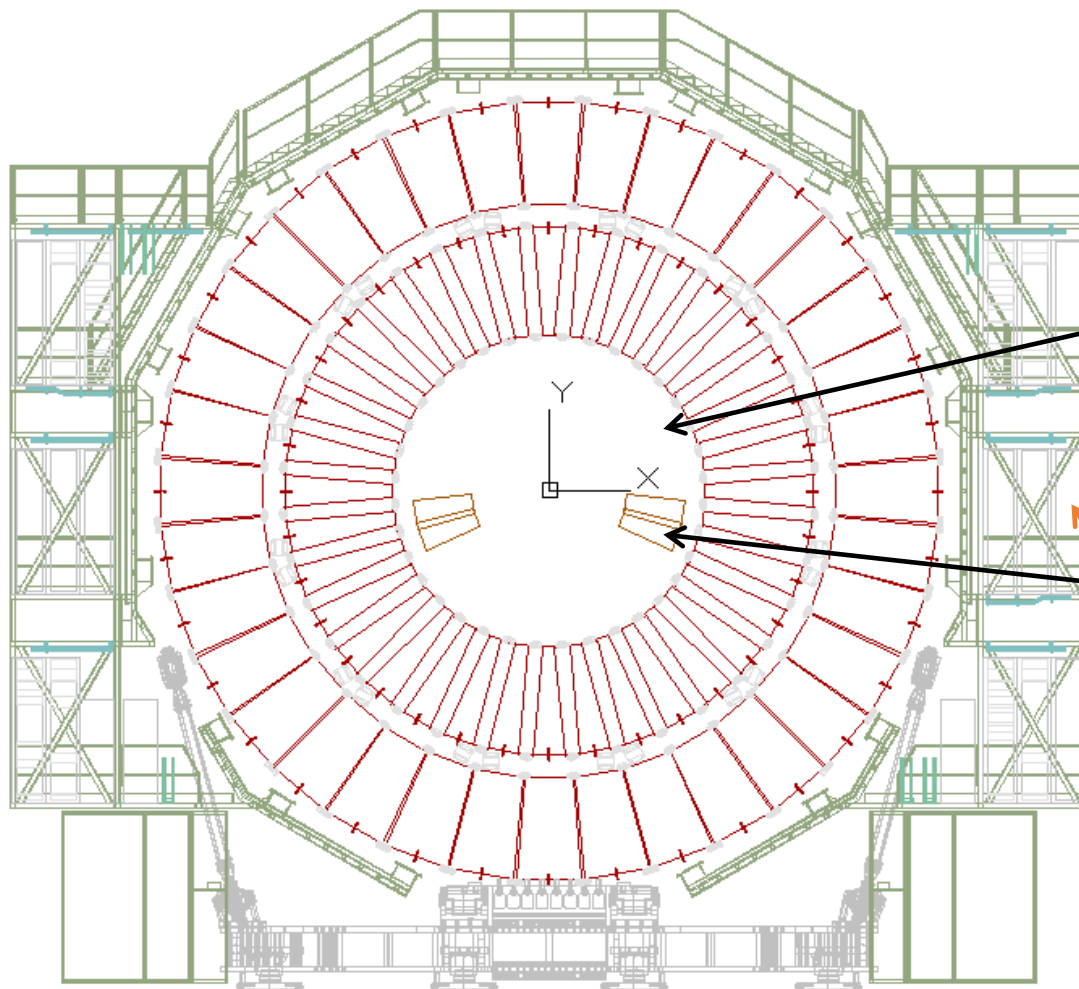
	BARC	INF-Bari	CERN	FIT	INFN-LNF	UGent
Cleanroom		X	X	X	x	
Leakage current setup		X	X	X	X	X
X-ray setup	X	X	X	X	X	X
Shipping logistics	X	X	X	X	X	X
GE1/1 assembly	X	X	X	X	X	X
Past experience	X	X	X	x	X	X

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