
CMS
and its upgrades
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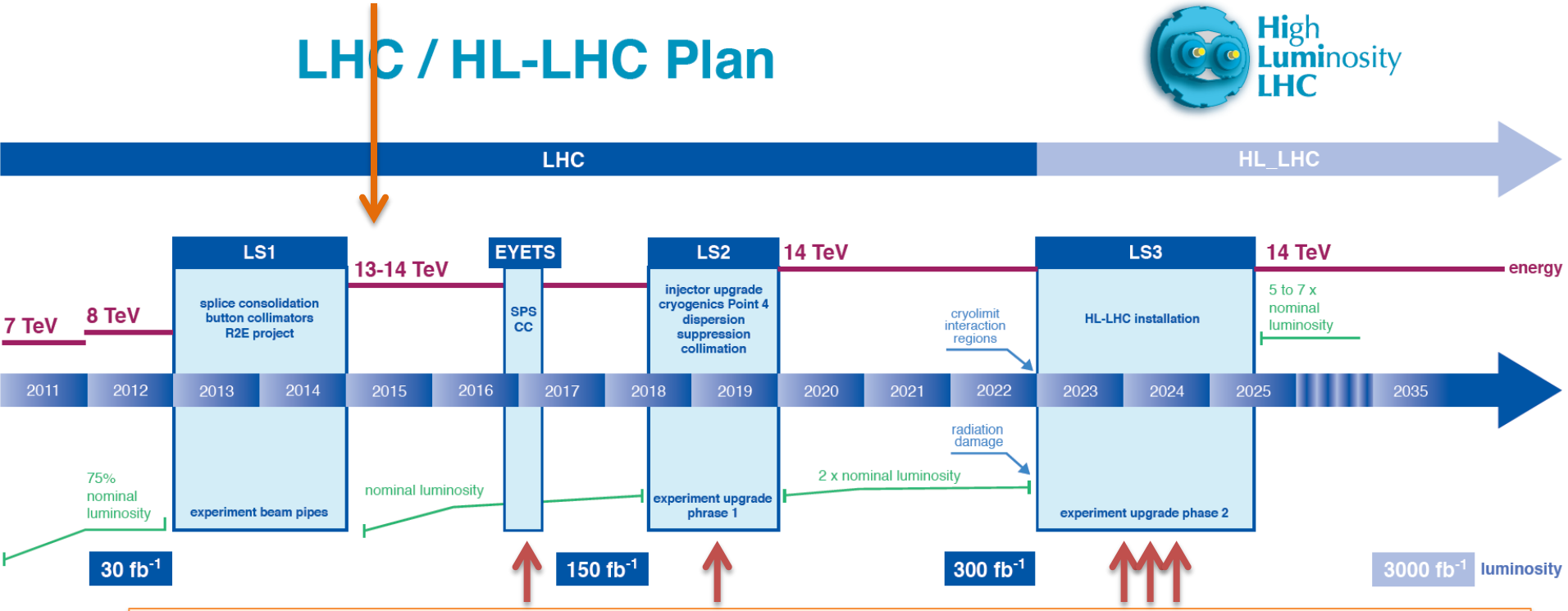
Imminent: take data at the highest energy ever reached in a collider!

Make sure that the detector is optimized, reconstruction algorithms are ready and well tested….



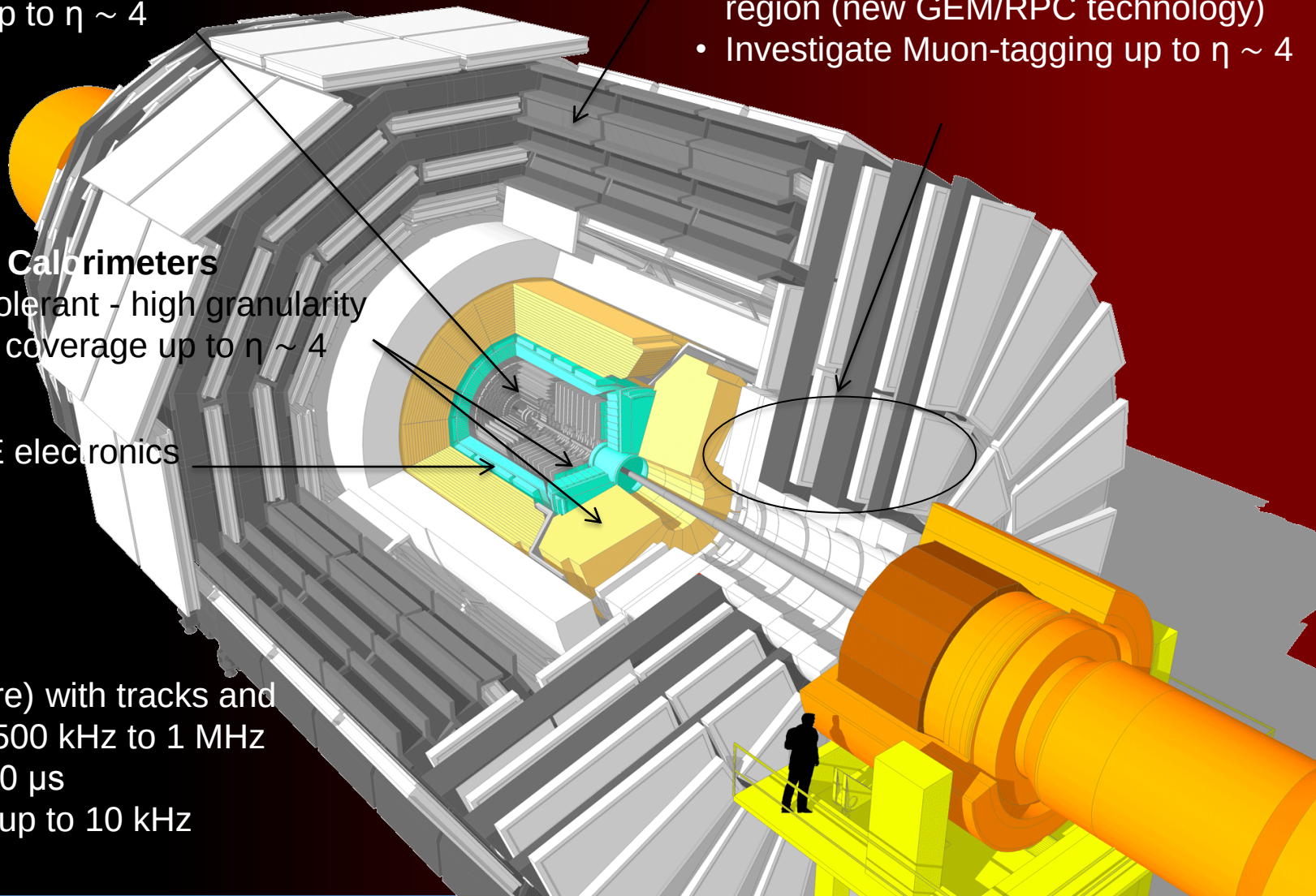
At the same time: prepare for the future!

Eventually more than 5x design luminosity: most of the present detector unable to operate!
Design and build new subdetectors to ***upgrade*** CMS for the ***high luminosity***.
Take advantage of state-of-the-art technology!

CMS Upgrades for the High Luminosity

New Tracker
- Radiation tolerant - high granularity - less material
- Tracks in hardware trigger (L1)
- Coverage up to η ~ 4

Muons
- Replace DT FE electronics
- Complete RPC coverage in forward region (new GEM/RPC technology)
- Investigate Muon-tagging up to η ~ 4



New Endcap Calorimeters
- Radiation tolerant - high granularity
- Investigate coverage up to η ~ 4

Barrel ECAL
- Replace FE electronics

Trigger/DAQ
- L1 (hardware) with tracks and rate up ~ 500 kHz to 1 MHz
- Latency ≥ 10 μs
- HLT output up to 10 kHz

Evaluating the benefits of the CMS ECAL Endcap LED stability pulser

- The CMS Electromagnetic calorimeter (ECAL) is a highly granular crystal calorimeter that precisely measures the energies of electrons and photons produced in LHC collisions.
- Light from the crystals in the ECAL Endcap regions is detected using Vacuum PhotoTriodes (VPTs, see photo) which provide high radiation tolerance in the harsh radiation environment of the LHC.
- Sudden large changes in radiation levels can affect the response of the VPTs. Laboratory measurements (see plot) indicate that these changes in response can be significantly reduced if the VPTs are continuously pulsed with a low rate of blue light provided by a LED monitoring system.
- **It is important to minimise any response fluctuations in the ECAL to provide the best possible energy resolution. This project will use CMS data to evaluate the benefits of applying LED stability light to the VPTs during LHC operation.**

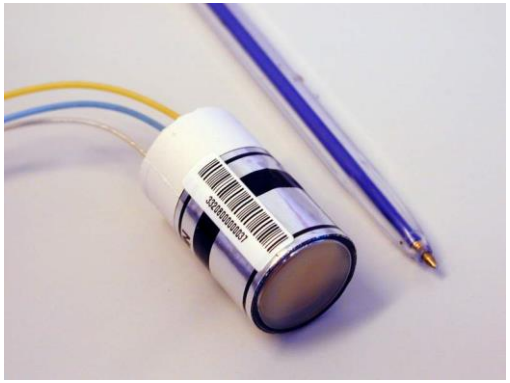
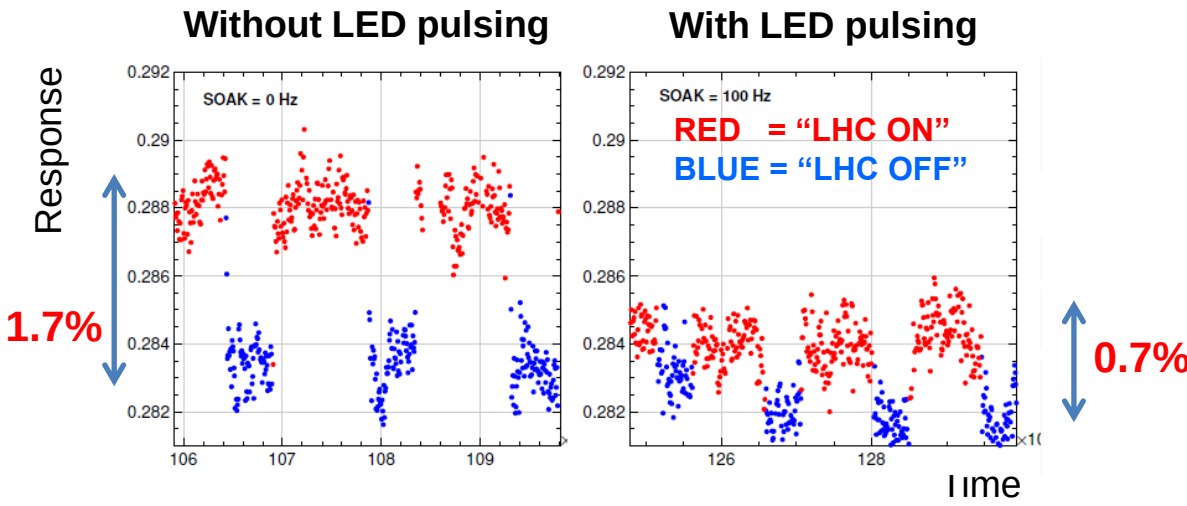


Photo of a CMS ECAL VPT



Laboratory measurement of the response of a CMS VPT versus time for simulated LHC on/off cycles

Evaluating the benefits of the CMS ECAL Endcap LED stability pulser

Goals

- **Perform a detailed evaluation of the available data in CMS to search for definitive evidence of response variations in the VPTs due to LHC on/off cycles.**
  - Compare the magnitude of these variations with and without the LED stability pulser active.
  - Compute the magnitude of these variations as a function of LHC beam intensity
  - Compare the results obtained in CMS to existing laboratory measurements
- **Evaluate the effect of these variations on ECAL performance**
  - Compute the impact on the ECAL response corrections used for energy measurement.
  - Compare the ECAL energy resolution for Z→ee decays, using electrons that are located in regions with/without the stability pulser active.
- **Produce a final report documenting the findings**

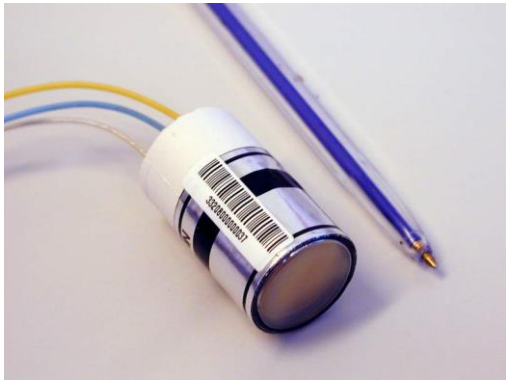
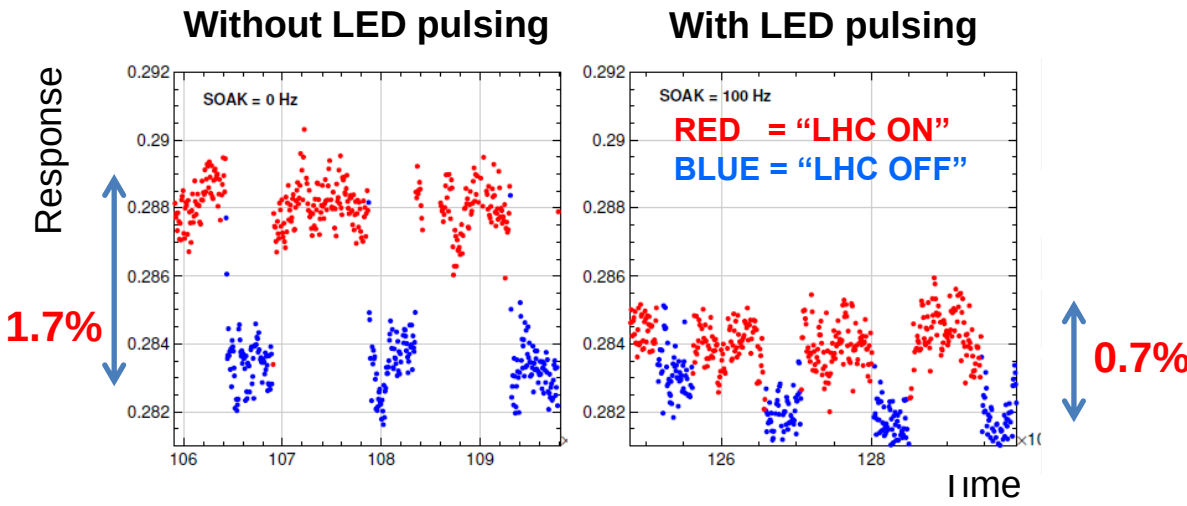


Photo of a CMS ECAL VPT

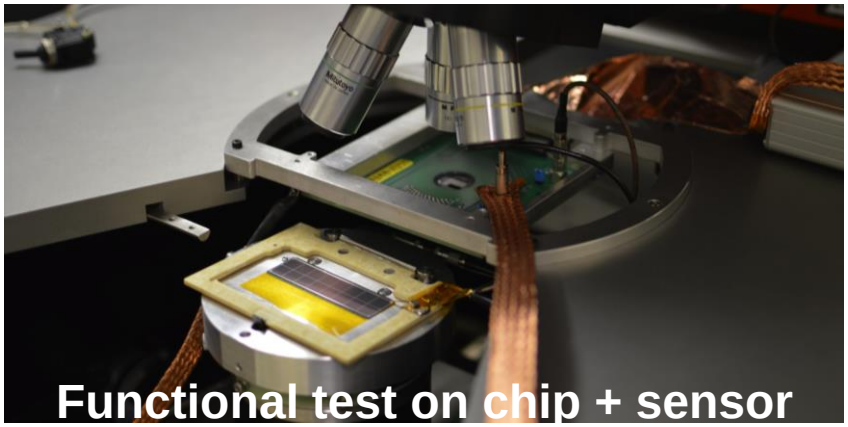


Laboratory measurement of the response of a CMS VPT versus time for simulated LHC on/off cycles

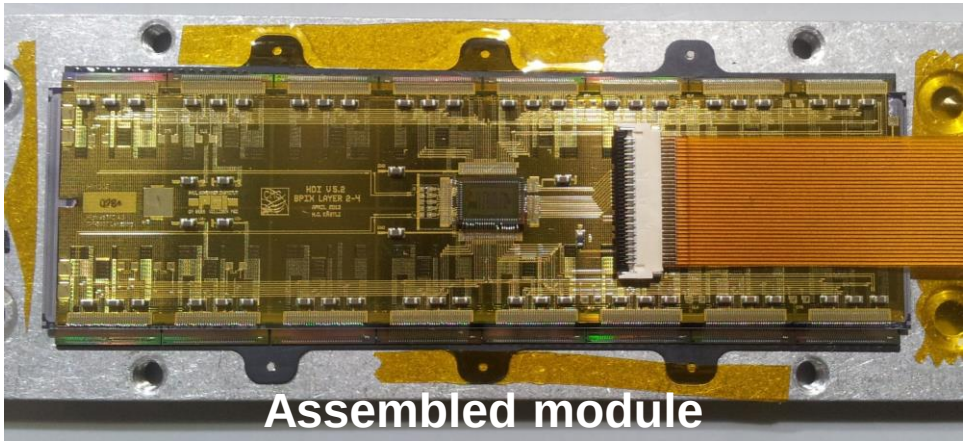
First Pixel Upgrade

(to be installed in 2016)

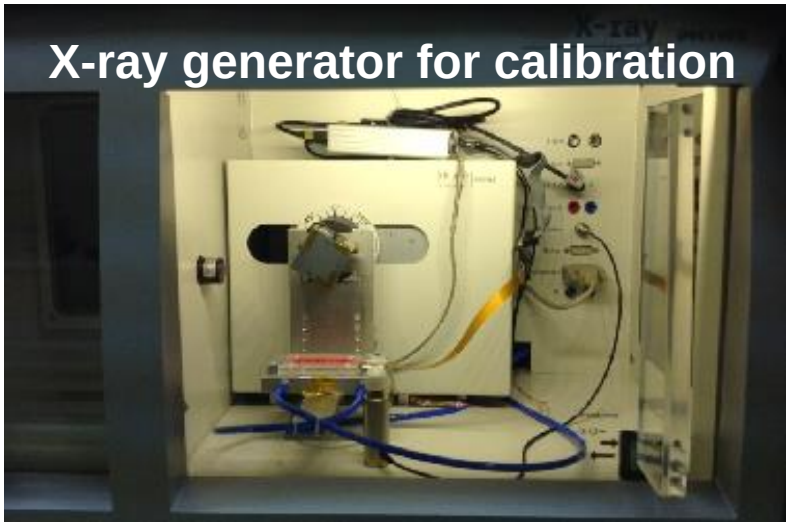
•Production will start ~ March: Definition of Quality Control procedures (traceability, mechanical alignment, handling), performing tests on first production items (chip functional test, burn-in through thermal cycles, calibration with x-rays), test automation/analysis

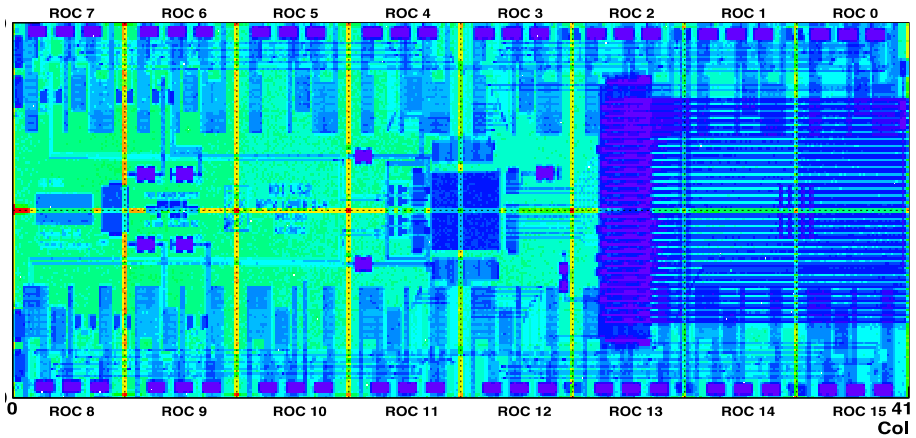


Functional test on chip + sensor



Assembled module

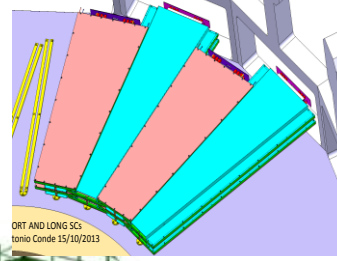


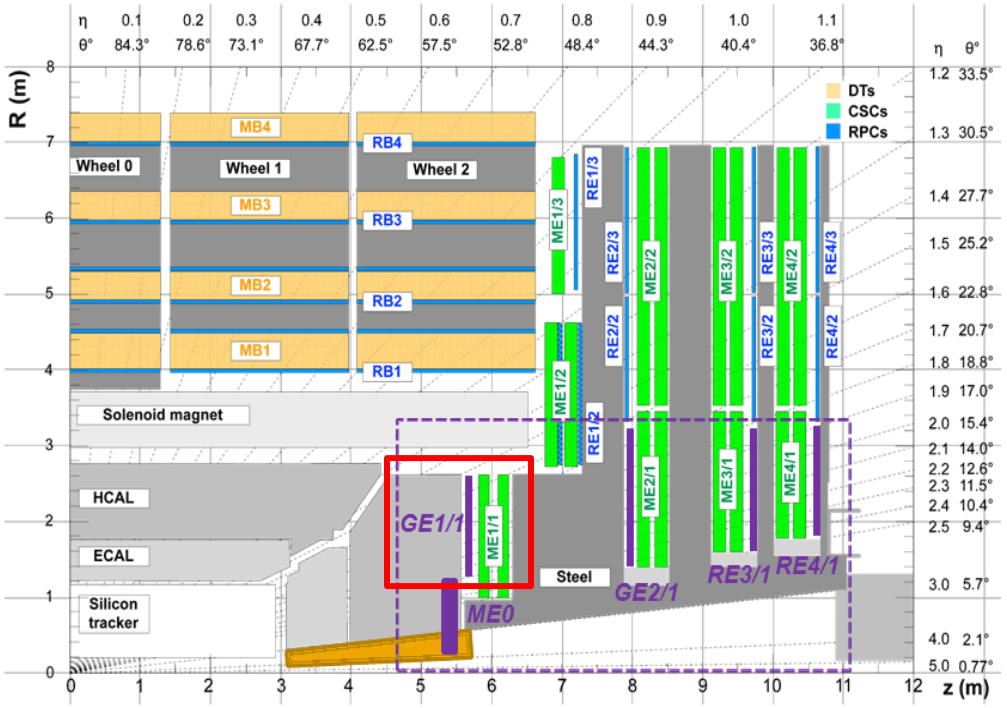


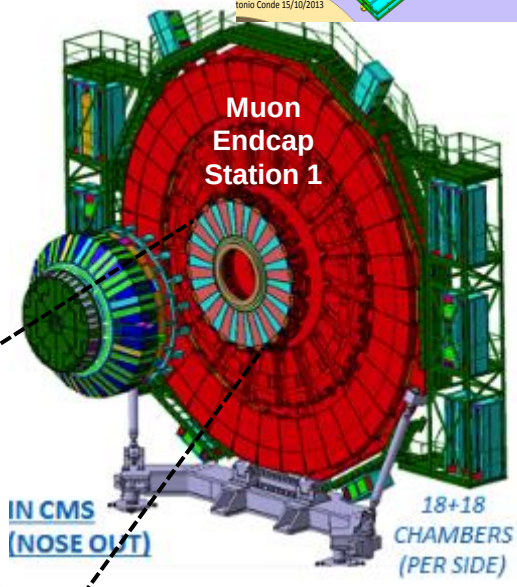
Module self-radiography

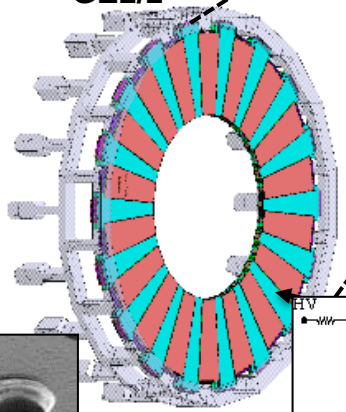
GEMs (Gas Electron Multiplier) for CMS Muon Endcap Upgrade

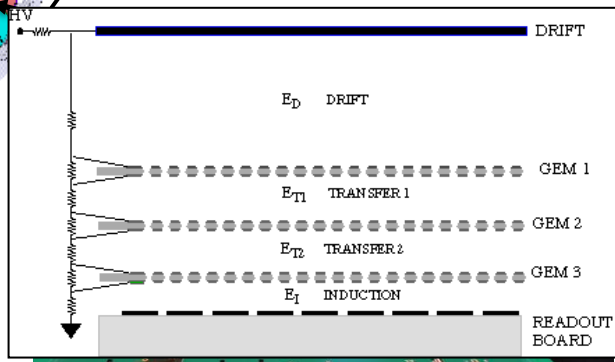
(first station to be installed in 2018)

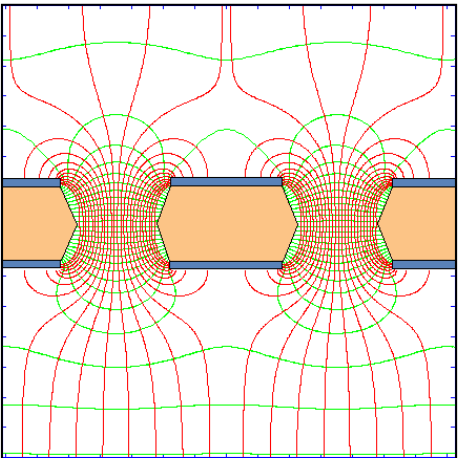


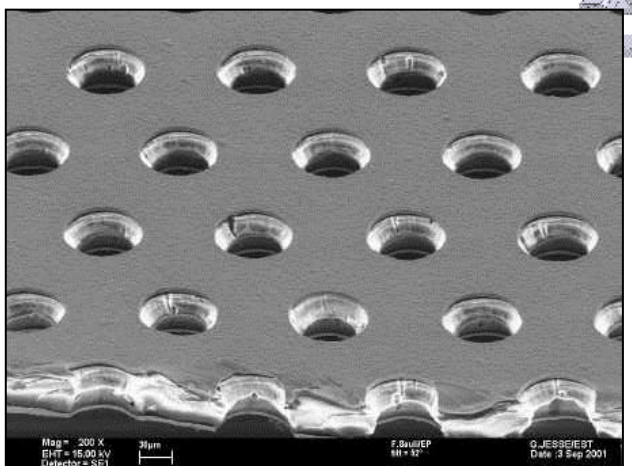




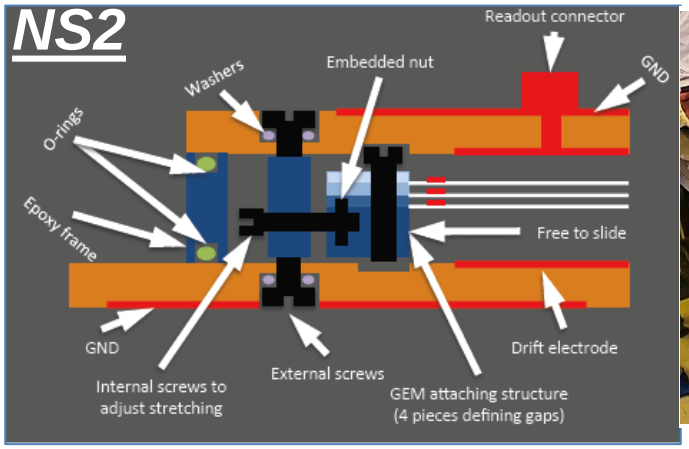


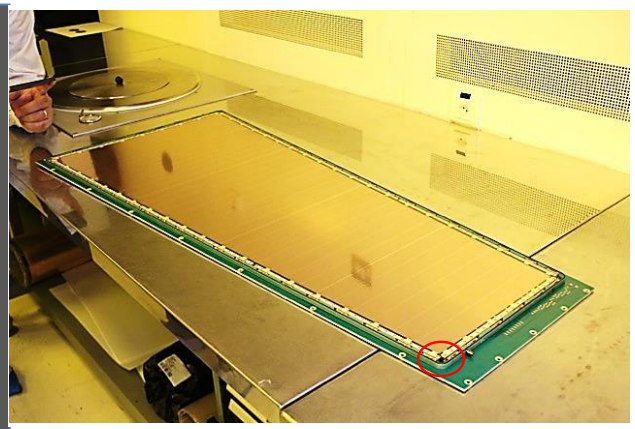


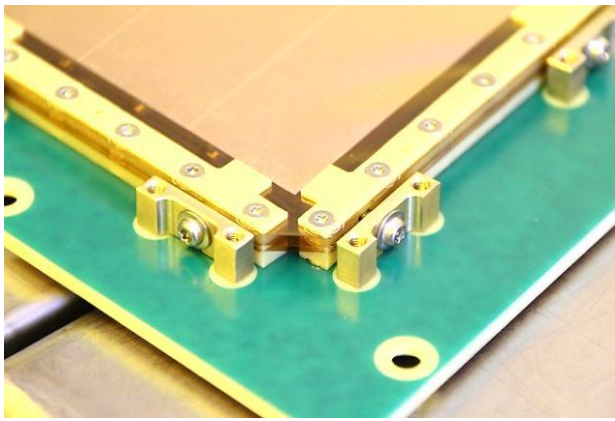


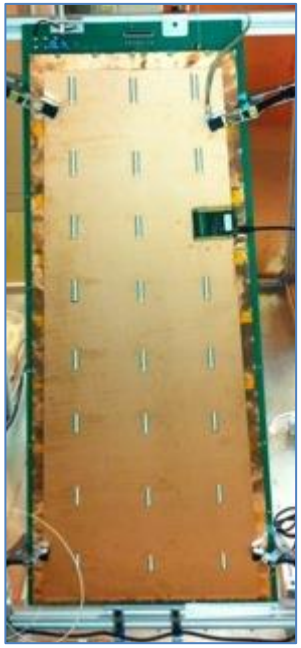


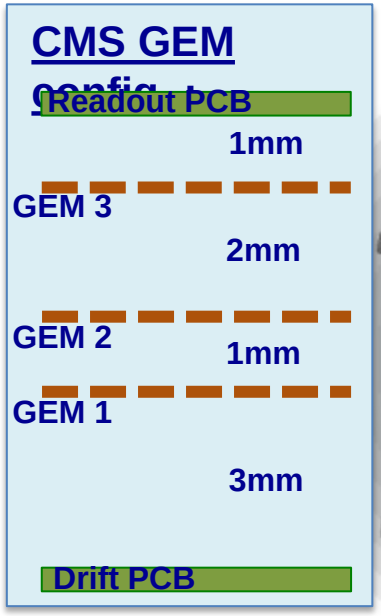
Construction and test of final prototypes
Commissioning of cosmic stand
Outgassing tests on different materials

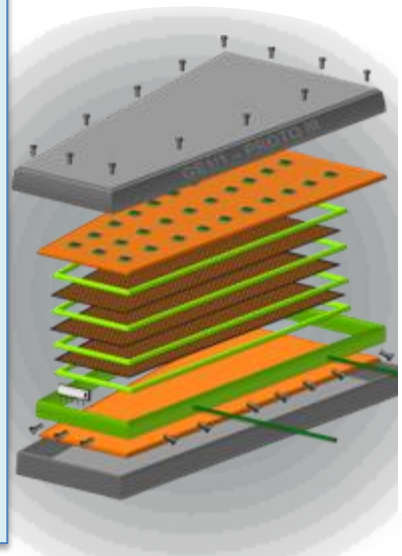


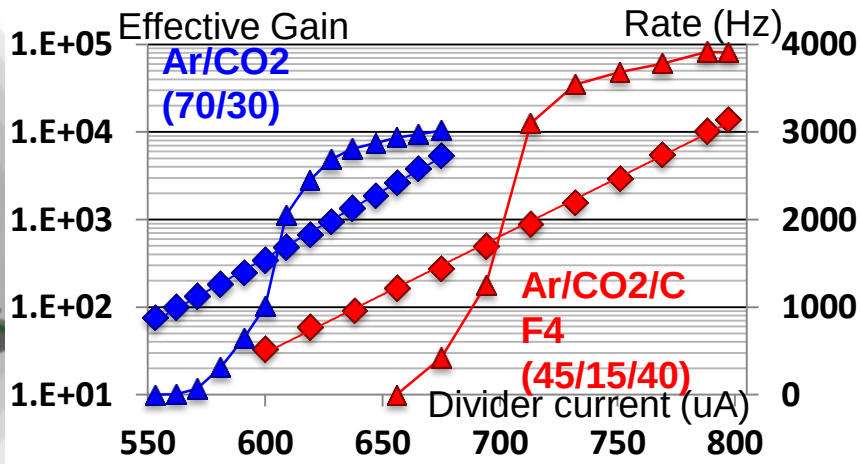










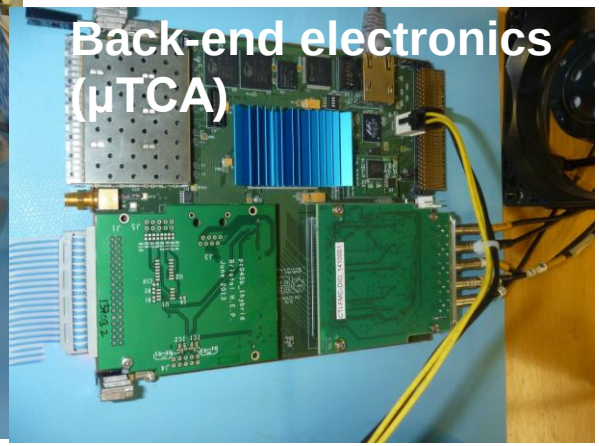


https://www.youtube.com/watch?v=Ssuqh5GAVZ4

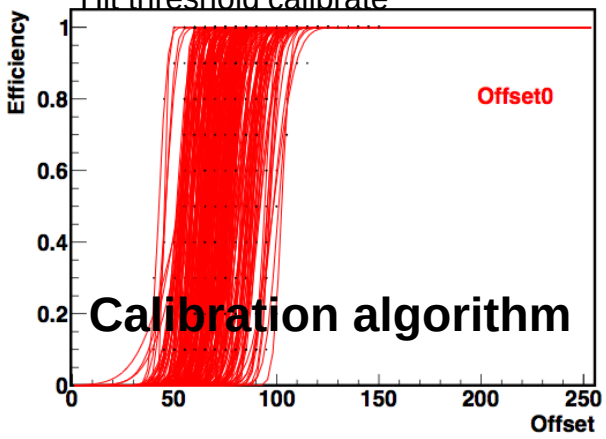
Outer Tracker Upgrade

(to be installed in 2024)

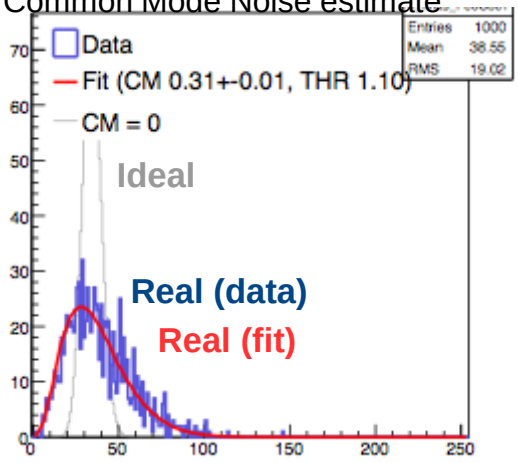
Electronic assembly (hybrid) test development – module functional test – cosmic ray stand – development of calibration procedures – beam test preparation



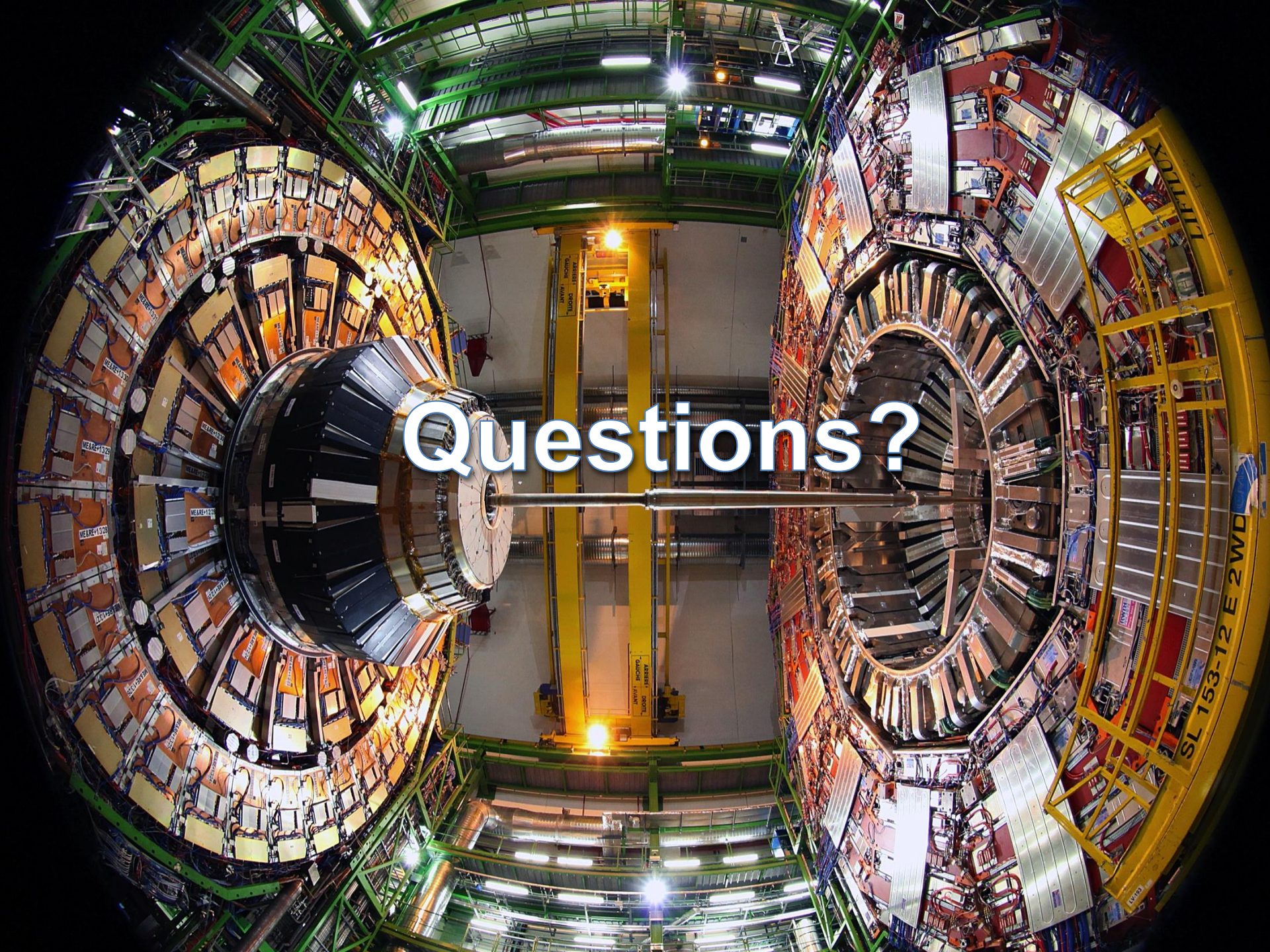
Hit threshold calibrate



Common Mode Noise estimate



Performance validation


Questions?