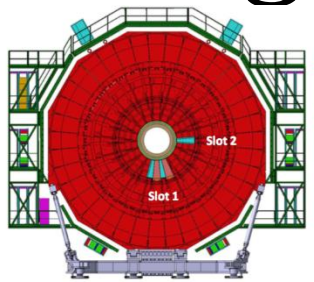
GEM Demonstrator Performance & Commissioning Plans



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For GEM Group

Run and DPG Coordination Workshop in Turin

Jan. 24-26, 2017

https://agenda.infn.it/confRegistrationFormDisplay.py?confId=12412

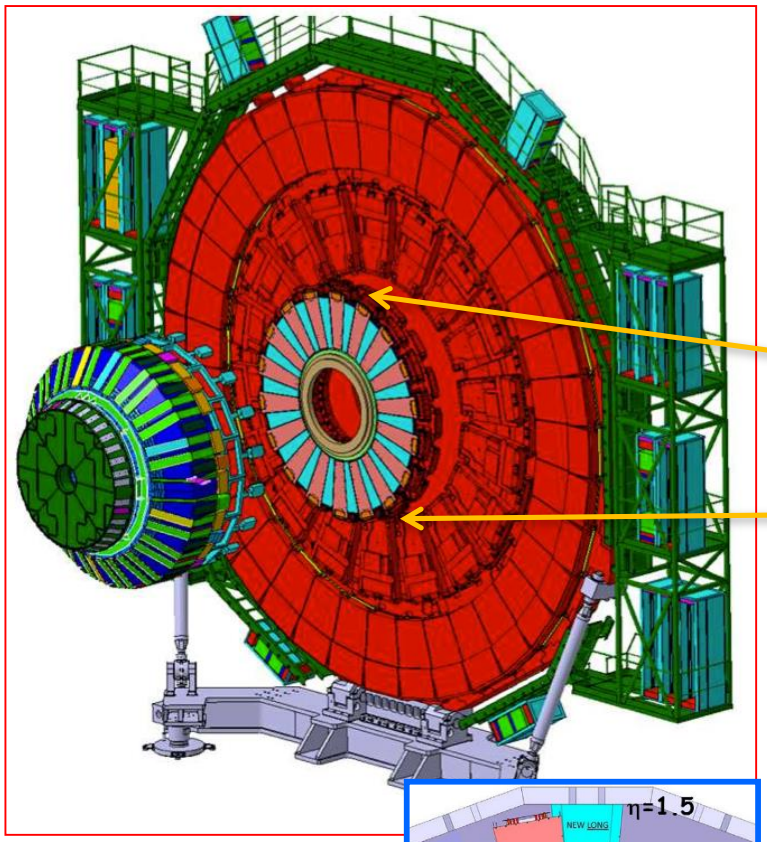
OUTLINE

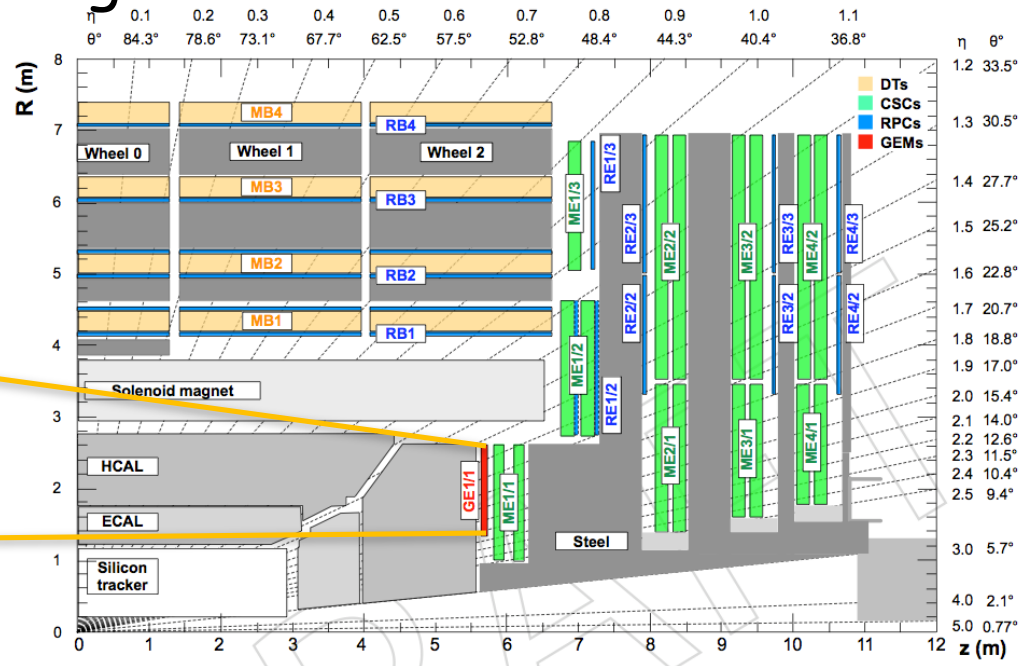
I. Topics on GEM demonstrator (aka Slice Test) from hardware team, online team, TC team, DB team and DPG team (geometry, readiness for offline software).
   - ❖ Status of the GEM demonstrator installation.
   - ❖ Status and plans on the online software system
   - ❖ Definition of the full commissioning and calibration process including
     - Module testing
     - System integration
     - Commissioning in P5 without beam
     - Commissioning with LHC

II. One key message: the GEM commissioning will not be synchronizing with the regular commissioning.

FORWARD MUON UPGRDAE GE1/1

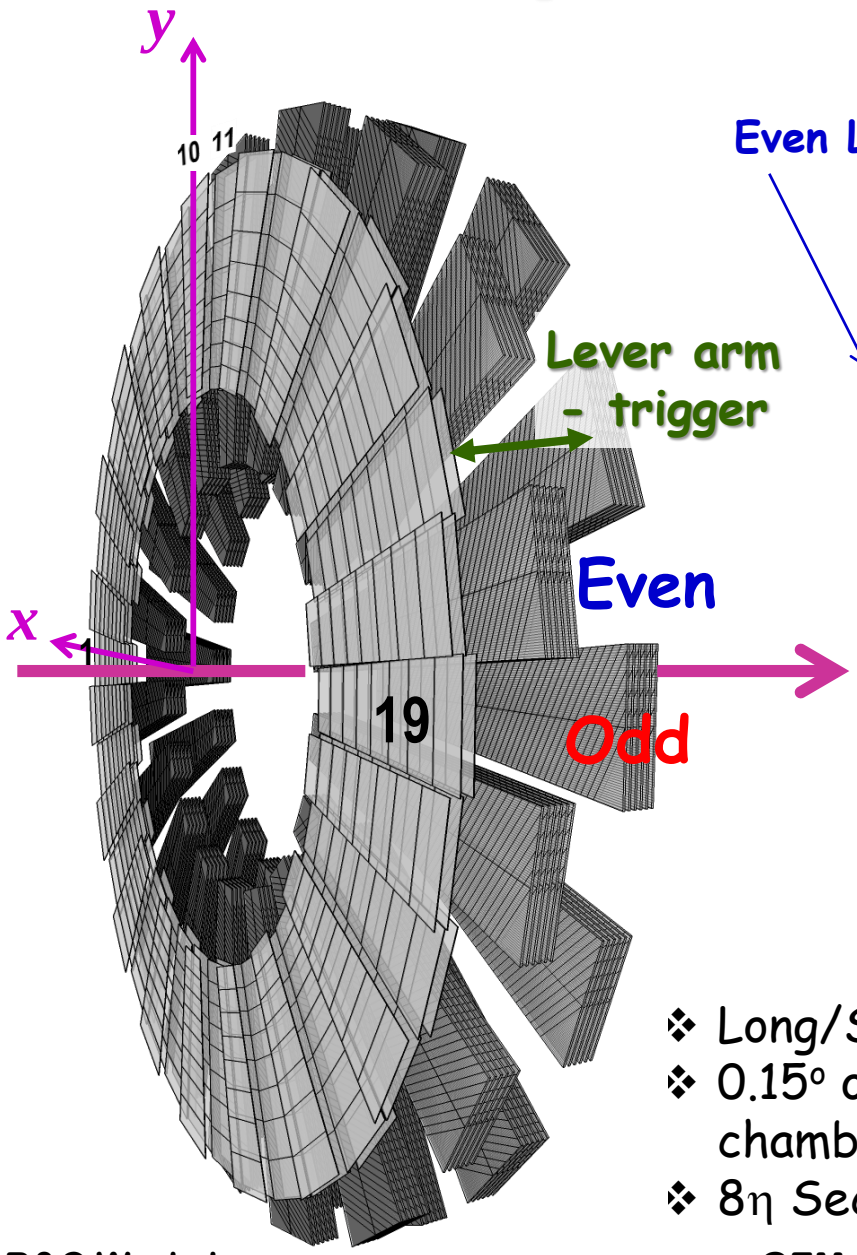
Two layers of triple-GEM chambers in the presently vacant positions in front ME1/1 during LS2

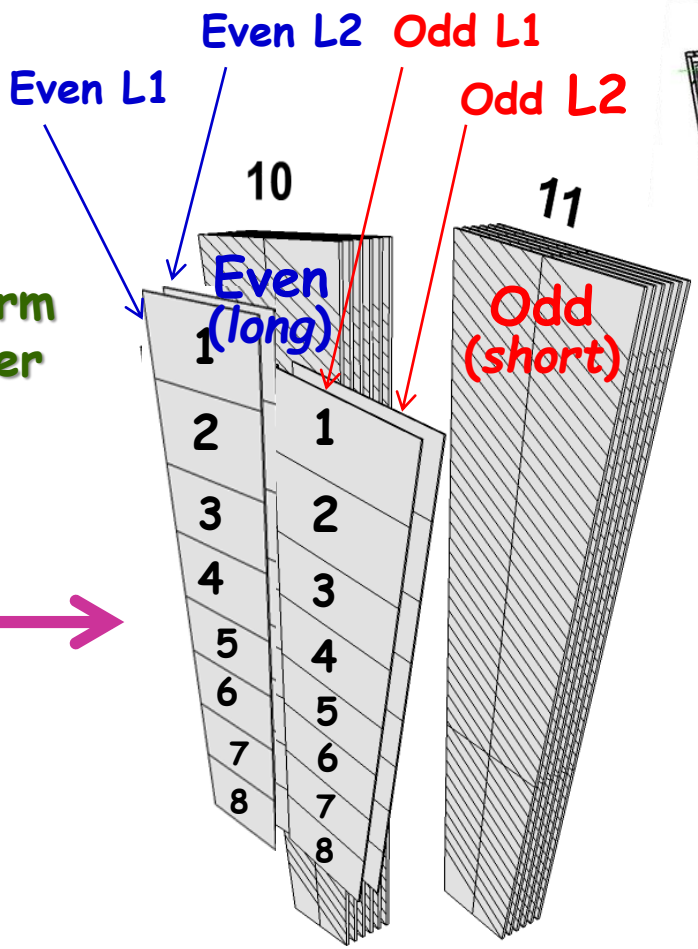


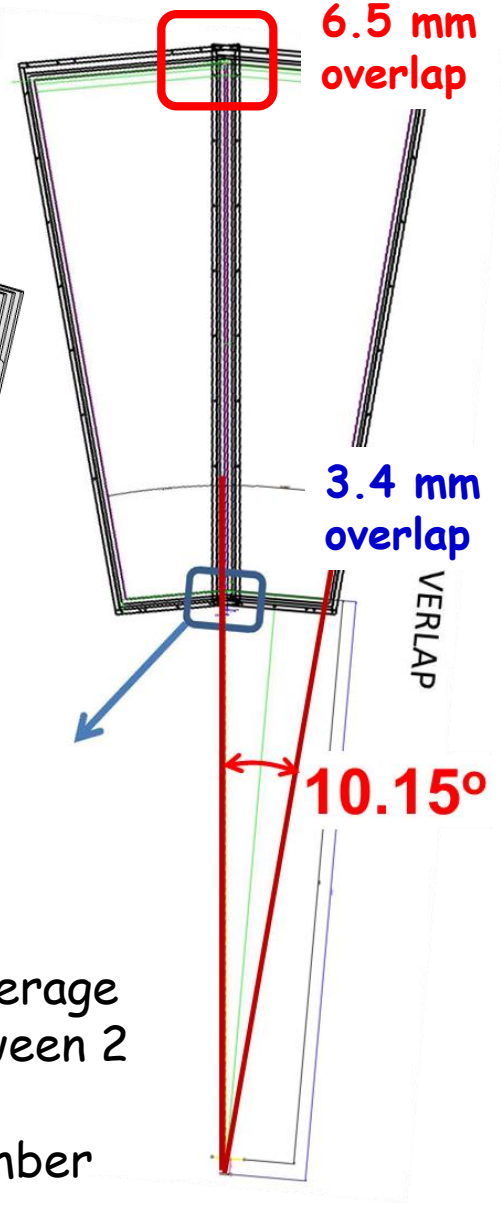


- One super-chamber is made of two triple-GEM chambers, each covering $\Delta\varphi = 10°$.
- 36 staggered super-chambers in one station per endcap.
- Short and long super-chambers for maximum coverage.

GE1/1 and ME1/1 Rings



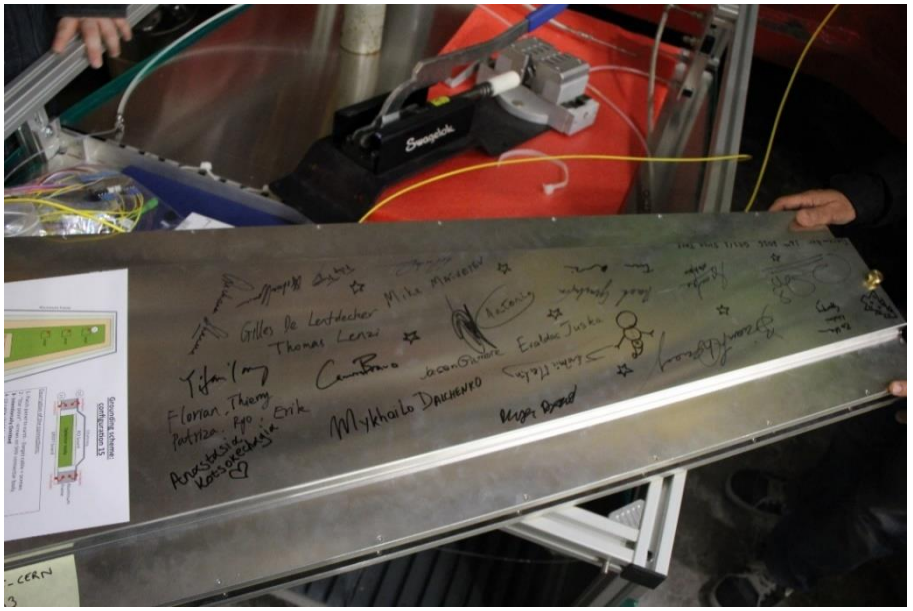




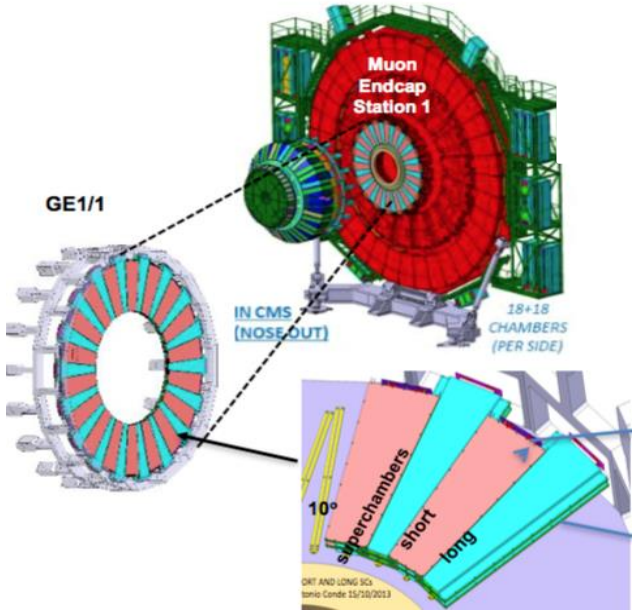
- Long/Short → maximum η coverage
- 0.15° overlap (5-6 strips) between 2 chambers → no ϕ boundary
- 8η Sectors → 24 VFATs/chamber

SLICE TEST INSTALLATION

- First active phase of Phase 2
- Three Stages:
  - [Stage 1] Mechanical Installation
  - [Stage 2] Service Installation: cooling, gas, HV, LV. No communication with chambers.
  - [Stage 3] Commissioning: pace will be very different from regular physics runs.



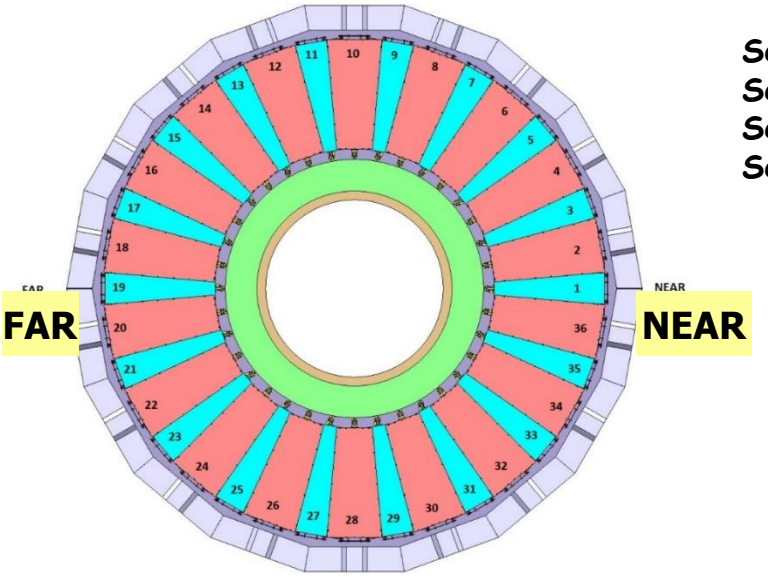
Slice Test at a Glance



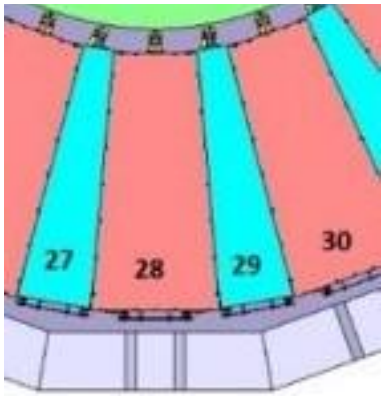
- **10 GEM chambers will be installed on YE-1**
  - Two chambers grouped into a super-chamber
  - Two slots considered:
    - Sectors 27;28;29;30 in Slot 1 covers 40° to have higher cosmic rate
    - Sector 1 in Slot 2 covers 10° to test a new GEM HV system

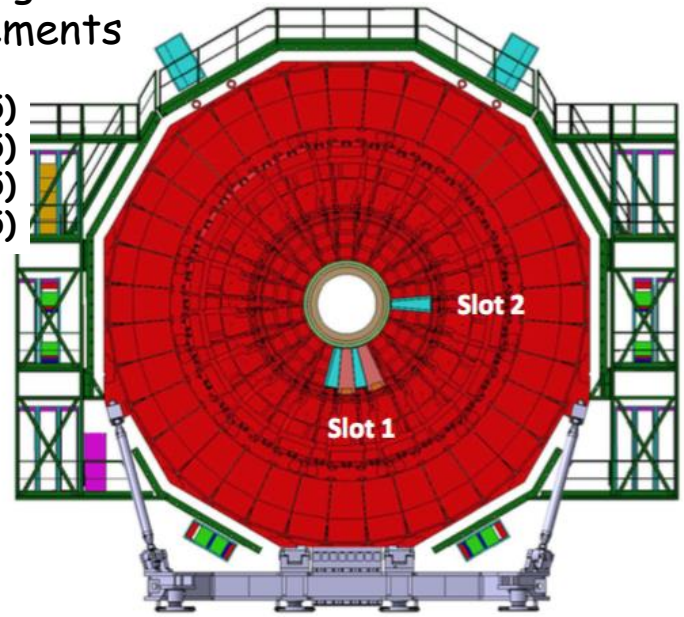
- **Main Goals of the test:**

1. Gain installation and integration experience
2. Reduce the GE1/1 commissioning period at LS2
3. Trigger commissioning
4. Background measurements



Sec 27: 260° cham (255~265)
Sec 28: 270° cham (265~275)
Sec 29: 280° cham (275~285)
Sec 30: 290° cham (285~295)

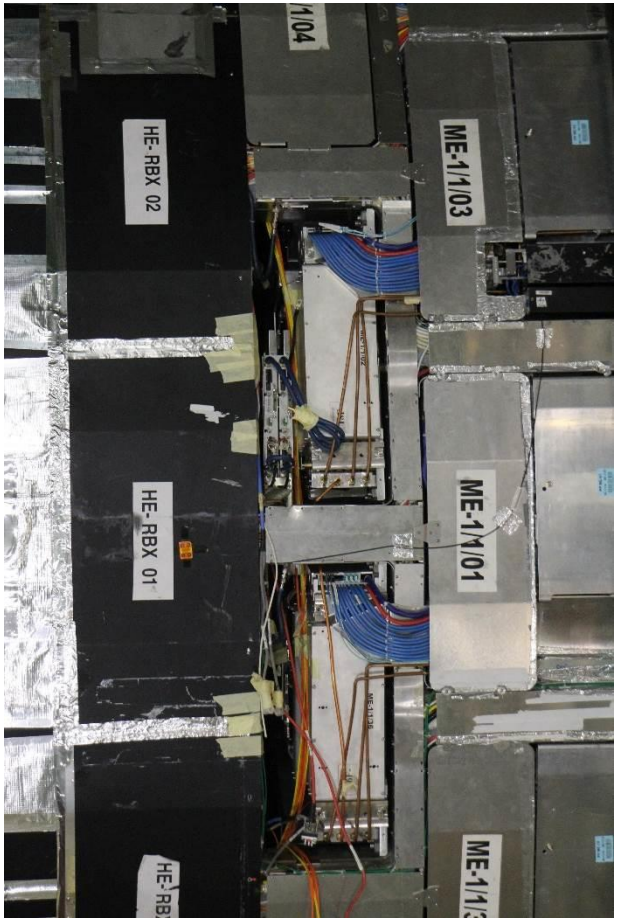




Installation: 27, 28, 29, 30 & 01

https://drive.google.com/drive/folders/0B15Nnedk0wGuQlU5VFo1TkN0RDg

GE1/1/01



- Five GE1/1 super-chambers are installed in the YE-1. See pictures on the link above.
- Cooling interconnections between the super-chambers is connected.
- Gas bypass U-shape pipes have been introduced in the gas loops.
- Gas is available and ongoing trough the pipes with flow about 7 L/hr. DCS software is operational to measure this. The procedure to change the gas flow is well understood.
- Alignment sensors are connected and recording data since the beginning.
- Difficulties and potential changes for LS2 in the mechanics have been identified and discussed between the TC and the detector team at CERN.

16-23rd Jannuary

- Priorities from 16 to 23rd of January is to install services:
  - Multiconductor HV cable from the rack in USC to the YE-1 X1 near side HV patch panel
  - Fiber Optics from USC rack S2E01 to the UXC X2V33 rack will go in parallel by the EN-EL group at CERN
  - *Monday* … the cooling "leak test" for five super-chambers.
  - Hopefully the cooling pipes up to the YE-1 manifold will be installed and connected - i.e., Ready for cooling
  - Gas connected to our chambers

The Week after 23-30th January

- Connectors mounting on the HV cables and commissioning – including the DCS
- LV cables – Andreson power pole connectors on the LV rack and commissioning including the DCS
- Fiber commissioning
- HDMI commissioning

Hopefully at the end of the week we can be ready to power the detectors

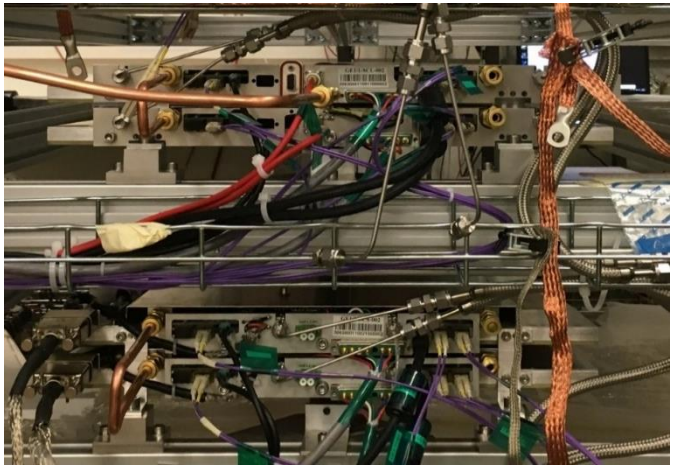
- Very aggressive schedule and lots of work to be done. But, so far all goes well.
- The program is changing almost every day. GEM TC is following the 8:30am meeting at P5.

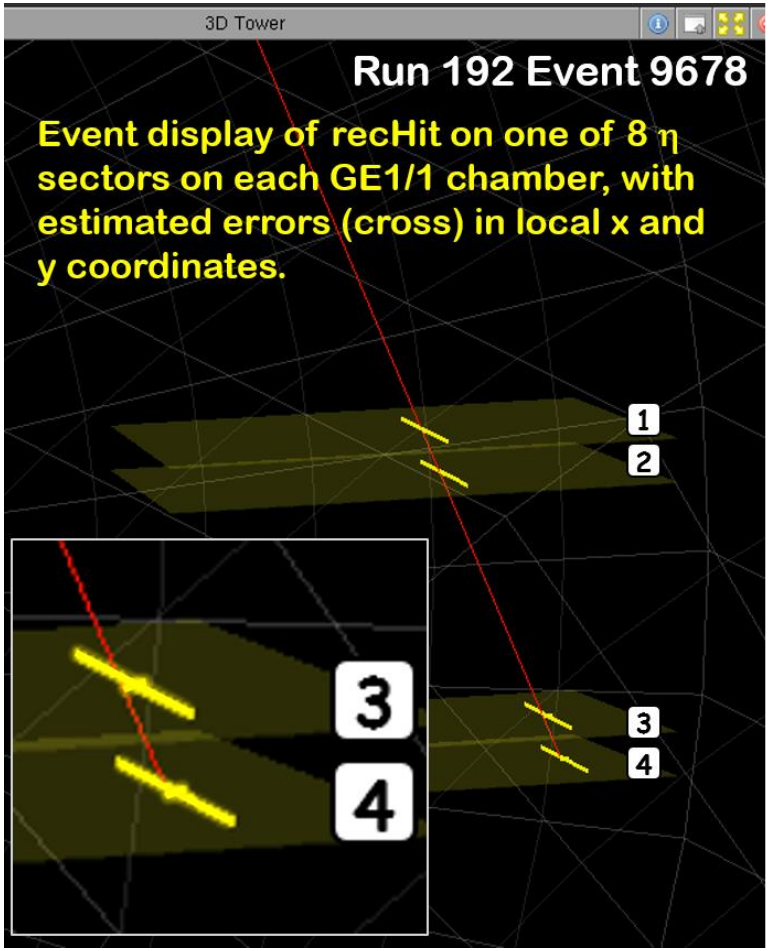
Run Coordination Issues

- **We are gaining an operation experience.**
- Quality control database information:
  - QC2 leakage current
  - QC3 gas leak test
  - QC4 HV test
  - QC5 response uniformity
  - QC8 cosmic ray stand
- The first integration phase is QC8
- We do have installed chambers waiting for Local Commission
- We need to move towards central CMS operation for Global Commission

Cosmic Ray Muon Test Stand at TIF

- **Cosmic Ray Muon Test** (Deliverable: Efficiency per η sector): Detector hardware group, Online DAQ (LightDQM, Unpacker) team; Database team, DPG prompt feedback analysis team.. Instruction twiki: https://twiki.cern.ch/twiki/bin/viewauth/CMS/GEMCosmicRayAnalysis





The Slice Test QC8

- It demonstrated the need for a team to be able to tackle different aspects of the system.
- Many aspects covered by the Detector Production team: shifts, procedures, write-ups
- Need to integrate a wide range of information out of QCs, event data and non event data

Summary of Slice Test Installation

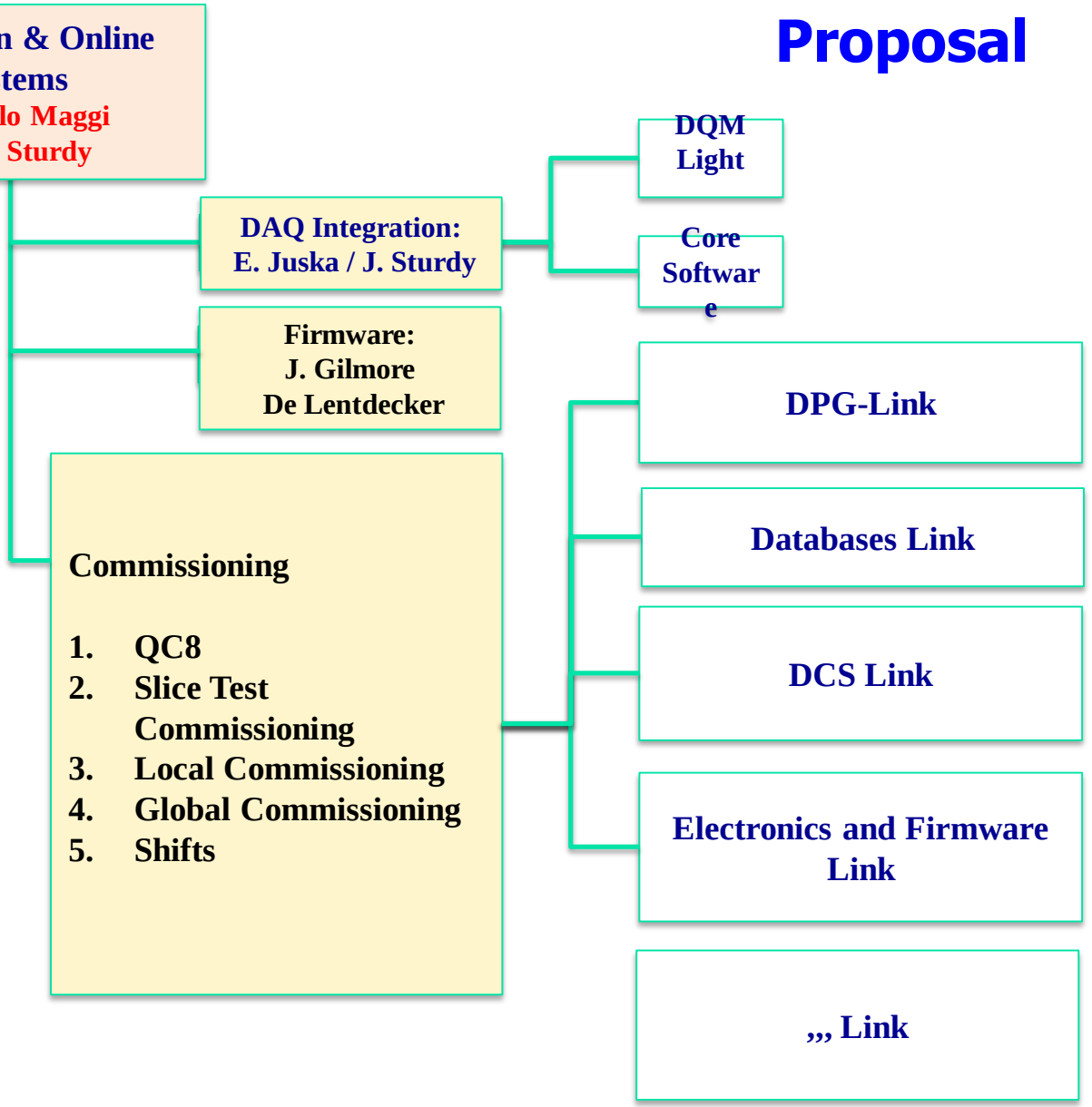
- Chambers & Services are installed.
- Full connection is foreseen for the end of January.
- Local Commissioning can start in February.

COMMISSIONING BOXES

Proposal

WTTT: Work "together" on tasks in a timely fashion:

- Task Leaders, Documentation, Shift Operation / Training
- Tight communication & coordination with teams in other areas during the integration.
- Prompt feedback during commissioning /operation.
- Proper team to follow-up a particular development
- Precise link role between members in each team.



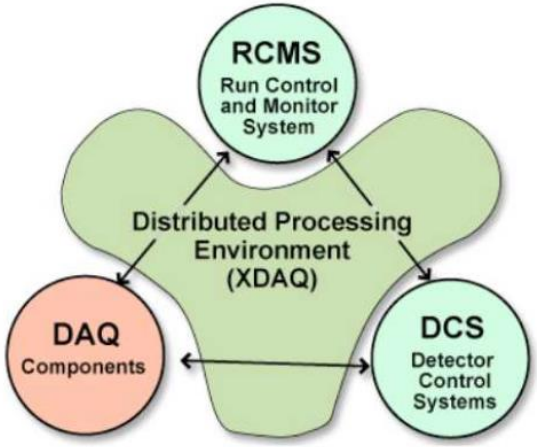
ONLINE SOFTWARE AT P5

- All development is currently happening at 904 (integration test facility). The same system is currently being installed at P5.
- [Hopefully, starting early week of Jan 23] We'll be trying to run the detectors at P5, using the same tools used in the TIF for the QC8 (which are validated versions of the tools that have been developed at 904).
- For the early commissioning (up until April/May probably), development will be happening quickly and we'll be working at both 904 and P5.
- By April/May, we will have a basic RCMS function manager (which will allow integration into cDAQ). This allows us to shake out all the links. We potentially have this possibility at 904 as well, but we may as well be taking advantage of the P5 system and infrastructure as soon as it becomes available.

Plan

- Finalize and release new version of the XDAQ software bundle fitted to work with the common CTP7-GLIB firmware.
- Improve the existing expert DAQ tools and add new features to them:
  - Implement firmware-driven calibration routines
  - Add automated channels trimming and masking
  - Add HV scanning application
  - Improve monitoring and alarming system
  - Possibly provide a common interface for expert tools

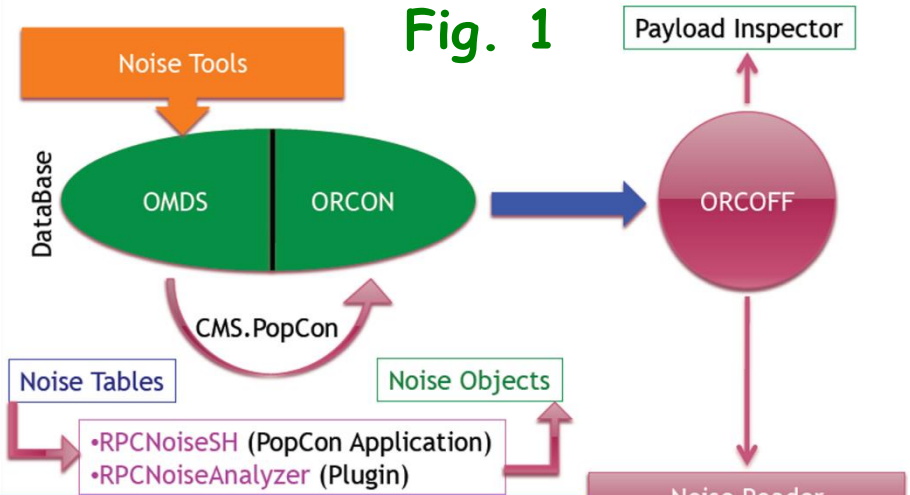
- Implement and integrate XDAQ Monitoring and Alarming System (XMAS)
- Implement and integrate RCMS



GEM Database and Monitoring

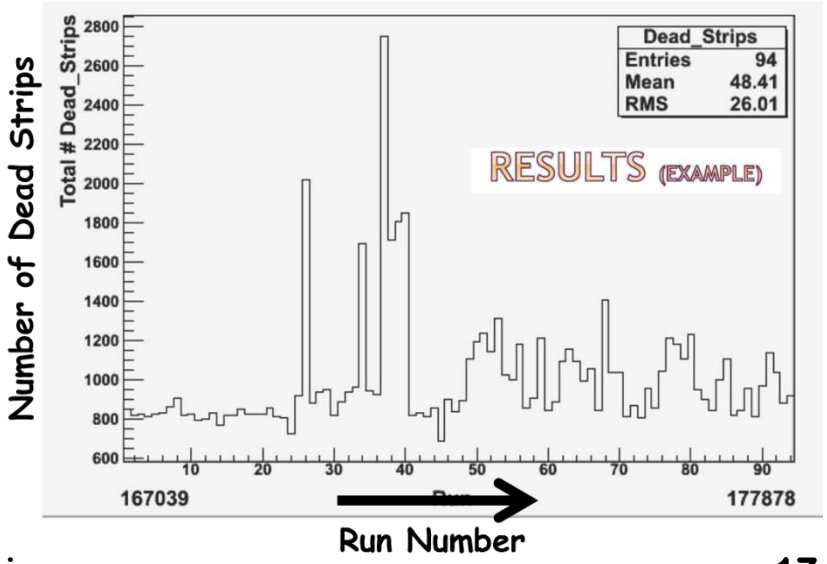
- [Big Picture] CR muon stand → Slice Test → Full System
- DB for CR muon stand to Slice Test (Fig. 1) to work on local RECO (e.g., Fig. 2) by offline/DPG. We need to access "Strip by Strip" condition by DCS and DAQ.
- Conditions:
  - DCS Map: Gas condition (pressure, temperature, flow, mixture), HV, Low Voltage, etc
  - DAQ Map: Dead strips on VFAT, etc.

Fig. 1

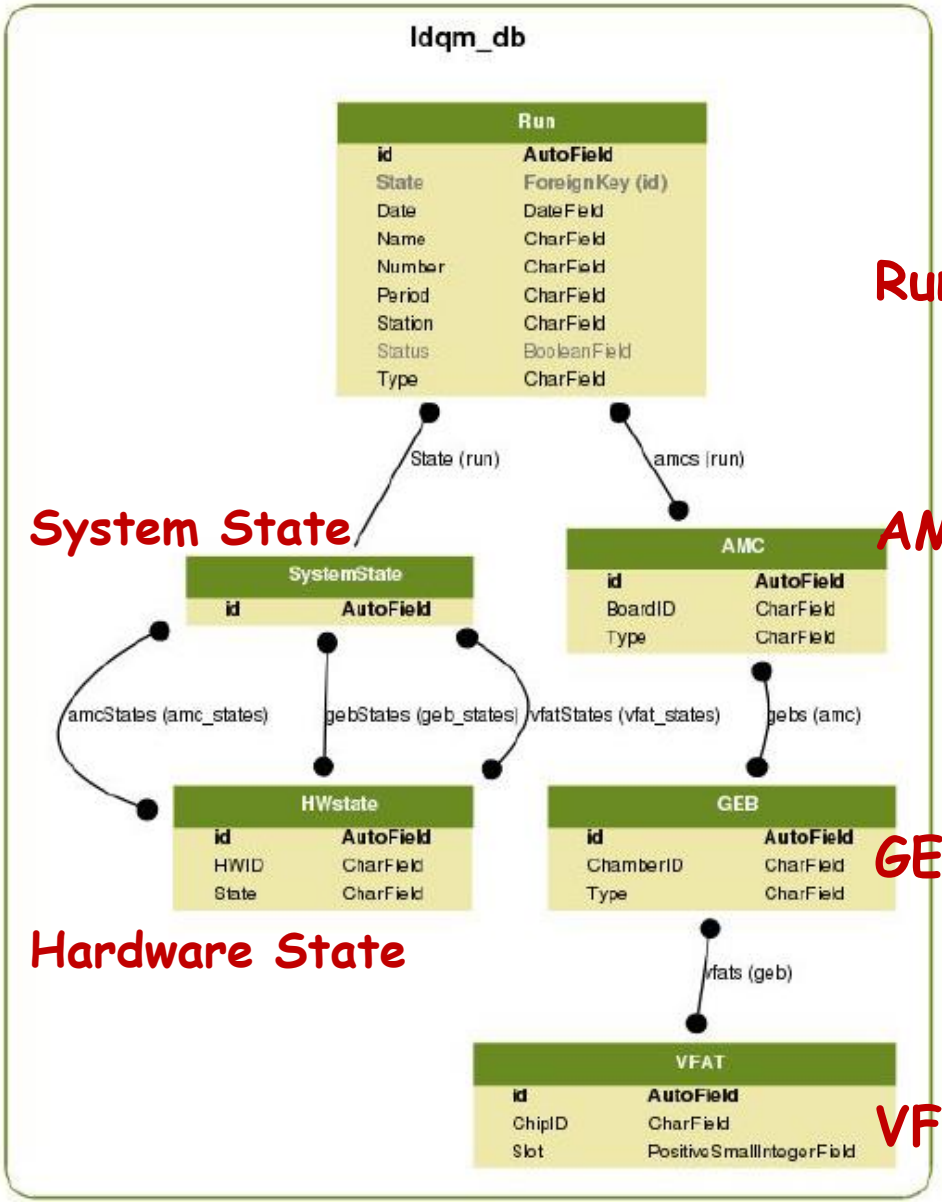


1) "Condition" DB (HV, threshold, noise, dead channels etc.), defined and filled by Hardware (TC, construction, electronics, online)
2) "Performance" DB (efficiencies, cluster sizes, etc.) by DPG

Fig. 2: Example of Performance



GEM Database - DQM



Run Table

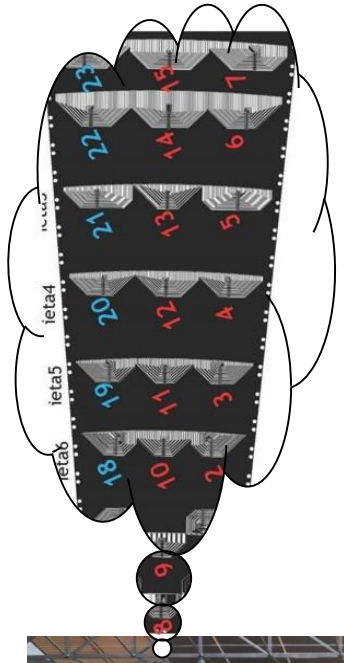
System State

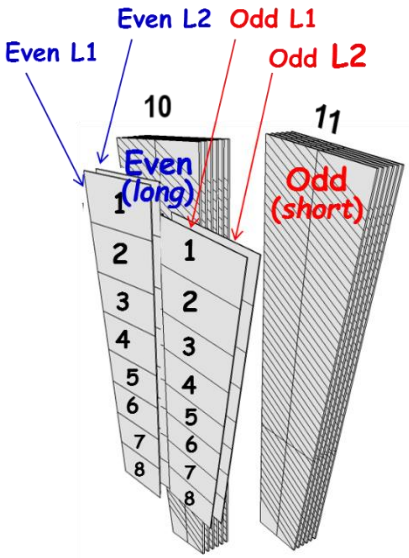
AMC

GEB

Hardware State

VFAT

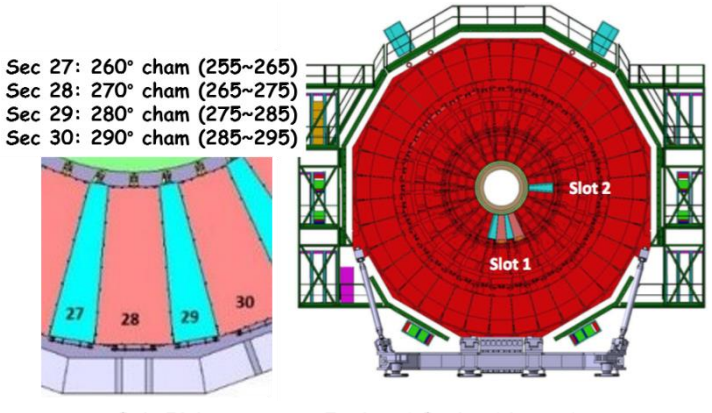


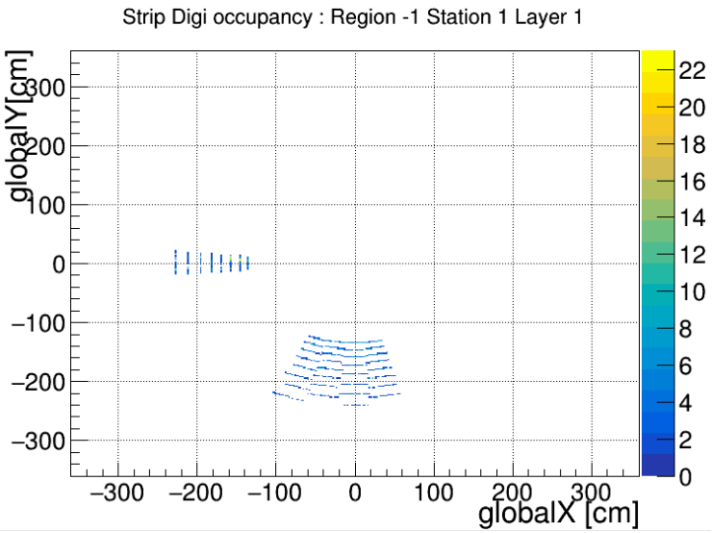


8η Sectors (1 ~ 8) &
24 VFATs per chamber (0 ~ 23)

DPG

- **Special GE1/1 geometry** for the 2017 slice test (same design but with only the chambers that are going to be installed)
  - https://github.com/cms-sw/cmssw/pull/16601
  - New scenario: **Extended2017Muon** but:
    - We are being included in the default 2017 scenario

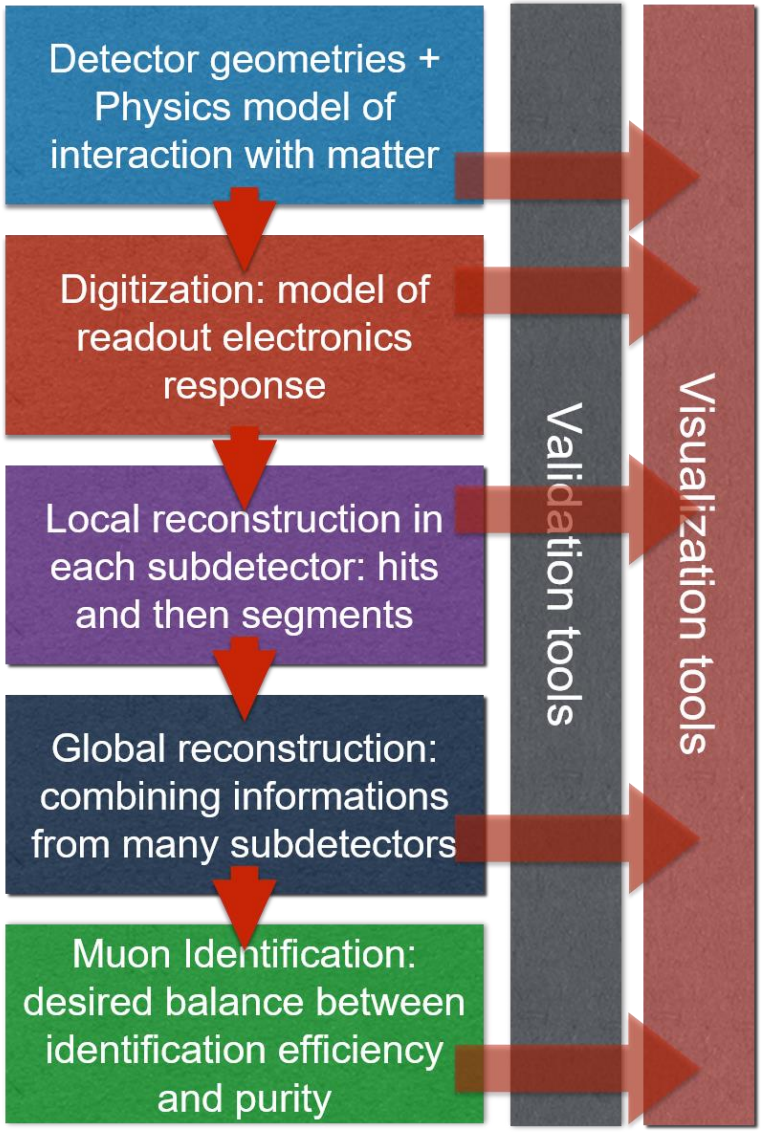




- Changes to run the the simulation + workflows with this special geometry are ready:
  - https://github.com/cms-sw/cmssw/pull/16900
  - Hopefully the PR will be merged in CMSSW_9_0_0_pre3

- **PLAN:**
  - Run the simulation or the reconstruction up to the local reconstruction (recHits) only. The RECO step will be run privately in order not to interfere with the Run2 analyses.
  - For the moment we will ask for relVal samples in pre3 and then we will ask for MC samples in March.

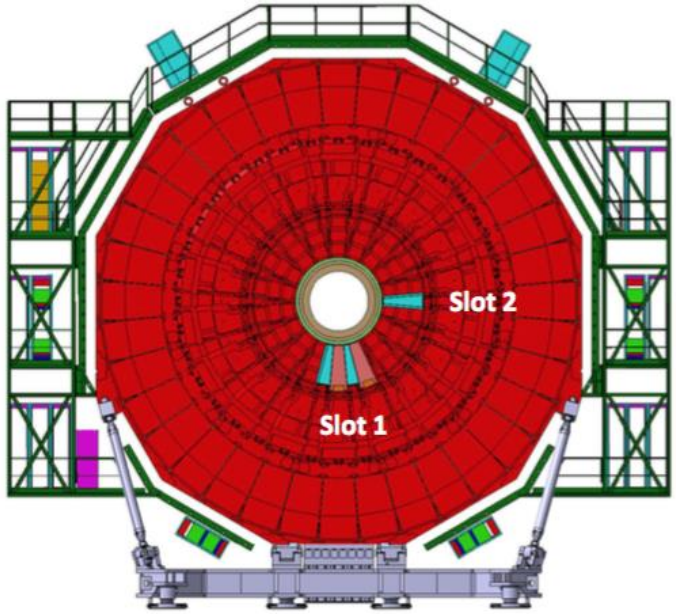
DPG Tasks using Slice Test Data



- Alignment (hardware and track-based alignments)
- Background simulation for Run 2 – Comparison of data and simulation
- Further developments of validation tools
- Standard-alone simulation to understand non-uniformity of GEM chambers due to mechanical issues, such as hole shapes, stretching holes, bending, and gap thickness.
- Validation of GEMmuon reconstruction

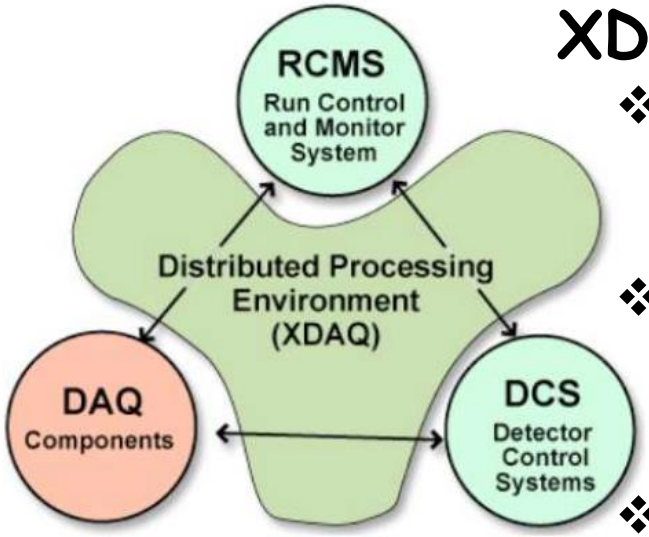
SUMMARY

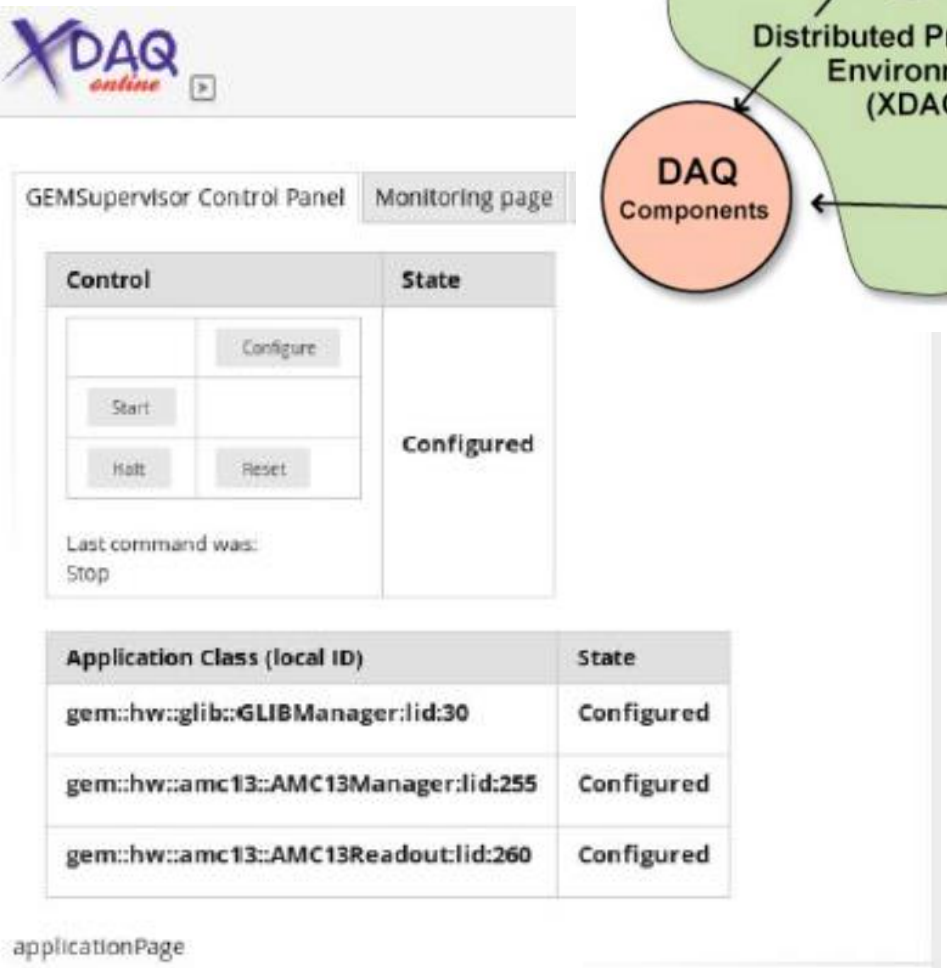
- Five super-chambers have been installed chambers waiting for Local Commission
- We are moving towards central CMS operation for Global Commission
- We gained a valuable operation experience from Slice Test QC8. Integration requires tight communication/ coordination with teams in other areas.
- **Main Goals of the Slice Test:**
  1. Gain installation and integration experience for LS2
  2. Reduce the GE1/1 commissioning period at LS2
  3. Trigger commissioning
  4. Background measurements



BACKUPs

Online Software - DAQ

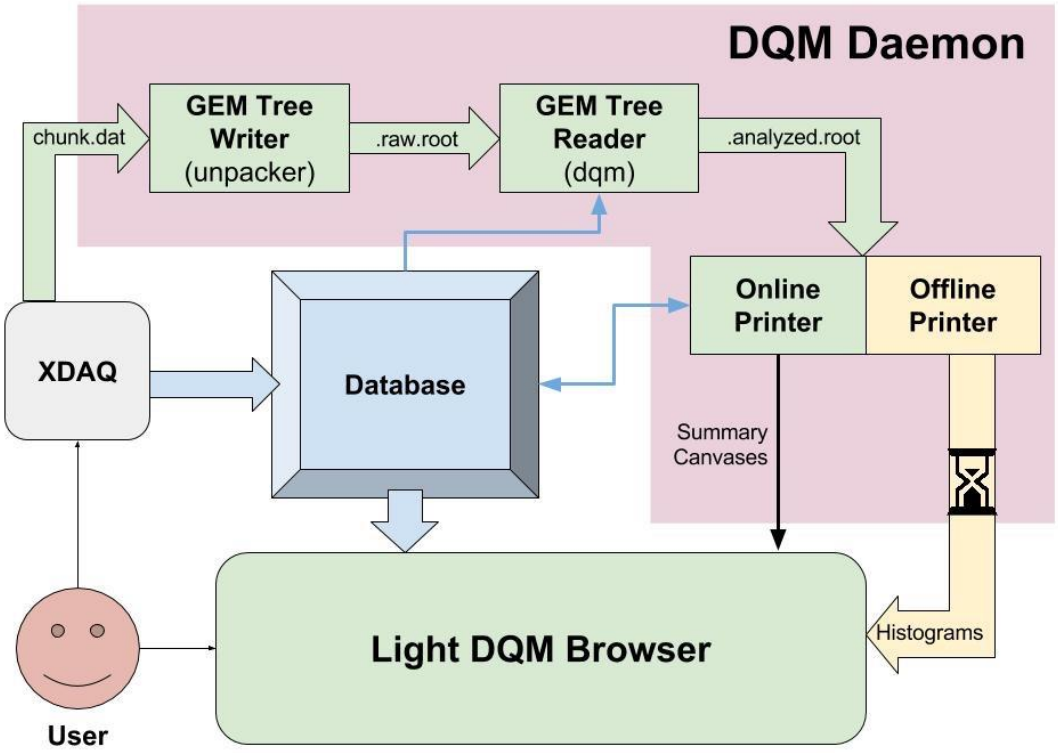




XDAQ-based software

- Implements finite state machine, allowing simple data collection
- Supports scan routines:
  - Latency
  - Threshold
- Includes hardware component managers:
  - AMC13
  - AMC
  - OptoHybrid

DQM System Overview



- DQM System provides a tool for users to identify problems with GEM data acquisition electronics and validate data taken in previous runs.
- User only interacts with DAQ software and Local DQM Browser
- Summary histograms are produced while data is being taken for online analysis