

# Overview of GEM DPG Reco / Monitoring / Validation

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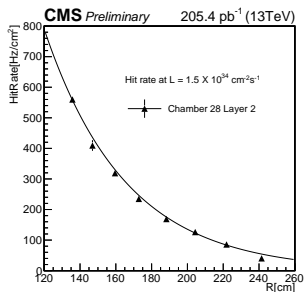
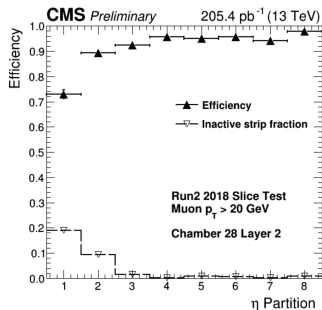
GEM Workshop  
October 2, 2019



**KRF** KOREA RESEARCH FELLOWSHIP  
해외 우수신진연구자 유치사업

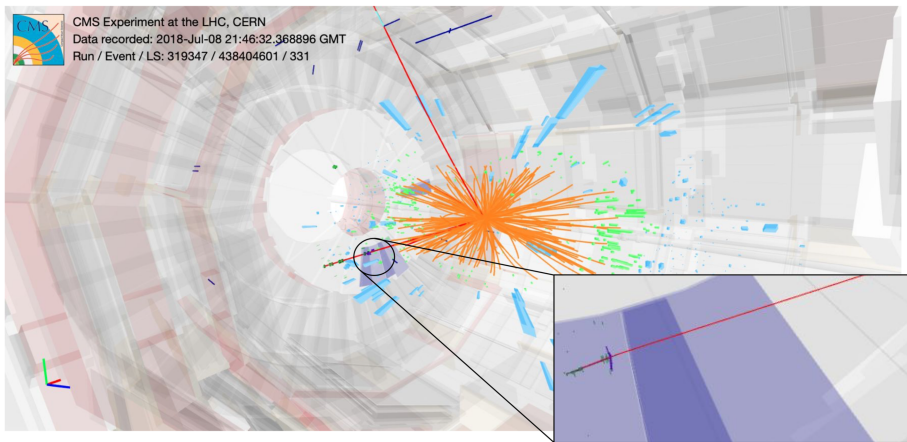


# Slice test measurements



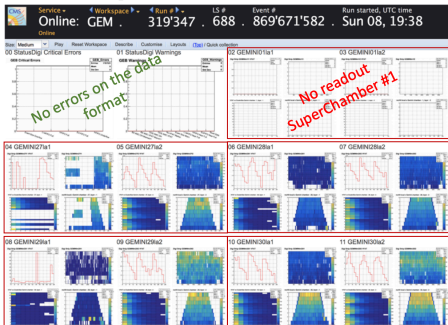
- I'll present an overview of recent topics in GEM DPG Reco/Validation/Monitoring, the work of many people
- Slice test was essential for testing the reconstruction and DQM chain
  - Full chain RAW -> Unpacker -> Digi -> Reco -> DQM successful
  - Revealed and debugged issues in electronics map
- Efficiency of GEM hits to be found when a tight muon is passing through a GEM slice test chamber
  - Some vfats were not reporting data, indicated with the open triangles
- Background rate for GE1/1 measured in-situ

# Event Display

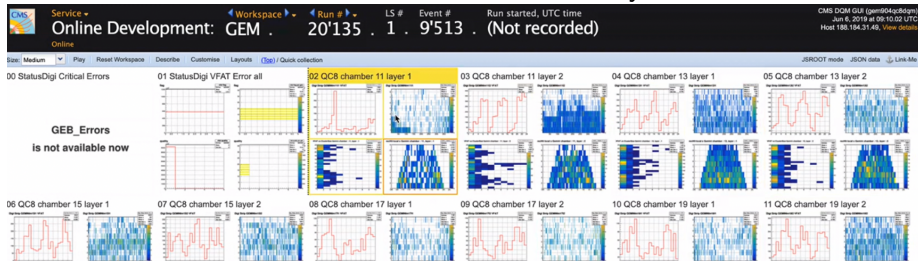


- Incorporated GEM into the iSPY event display
- Event from slice test data with muon candidate passing through GEM

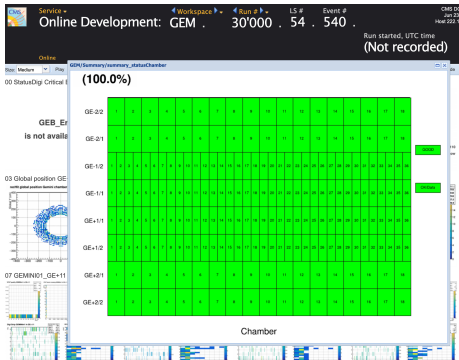
# GEM Online DQM GUI



- GEM Online DQM GUI deployed and ran at P5 for slice test
  - HW Status: AMC, GEB, VFat
  - GEMDigi monitoring: occupancy per chamber, occ. of vfat (vfat vs no. strips)
  - GEM ReHit monitoring: occupancy / chamber, cluster size, occ. of vfat
- Currently in use at QC8

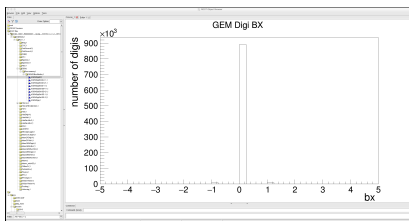
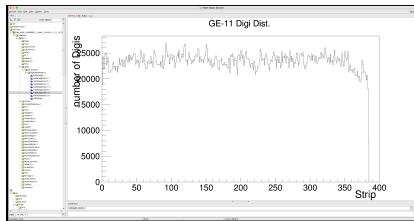


# GEM Online DQM (Full Detector)

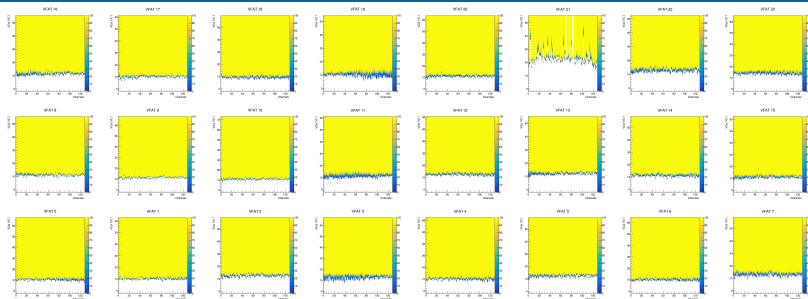


- Summary plot: monitoring whole detector in ONE plot
  - All chamber status represented in 1 pixel/bin
    - Green: all OK
    - Red: HW issues
    - Yellow: digi or rechit issues
  - Combines HW status flags and digi/rechit distributions
    - HW status flags: any chamber with bad flags marked
    - digi/rechit: non uniform occupancy, bx majority non-zero, large cluster sizes to be marked

- Certification of GEM Data
- Monitoring detector performance
  - Efficiency of GEM RecHits (using global muons)
  - Residuals
  - Background rates
  - Offline analysis takes  $\sim 2$  days (with crab)
    - Automation with integration into offline DQM
    - Port to offline DQM in progress



# Prompt Feedback Analysis



- Utilises the 3 tools: online DQM, offline DQM, and GEM online software
- Daily s-calibration plots to detect any anomaly.
- Monitoring of the %active channels as well as hot channels: time trend
- Analysis of collision (or cosmic) data to provide:
  - strip multiplicity of GEM hit cluster
  - Occupancy check for each eta sector
  - Efficiency with muon matching to GEM hit cluster
- Manpower: 1 DOC, 1 prompt feedback expert, 1 DQM dev from DPG

## MuonGEMRecHitsV

### Summary

76 COMPARISONS:

- SUCCESS: 90.8% (69)
- FAIL: 9.2% (7)

[To the DQM GUI...](#)



### Sample:

RELHLSPLACEDBSUSV\_STOPFORBOTTOM\_M\_300\_1000HW\_13

Run1 and Run2:

1 - 3

### Releases:

- CMS\_SW\_10\_6\_0\_pre4-10EX\_upgrade2018\_realistic\_v4-v1
- CMS\_SW\_10\_6\_0-10EX\_upgrade2018\_realistic\_v4-v1

### Statistical Test (Pvalue threshold):

- chi2 (1e-05)

### Sub-Directories

GEMRecHitsTask

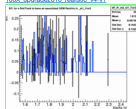
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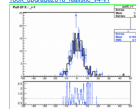
eff\_rh\_eta\_st1\_1tor2  
Chi2: 9.97E-01

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1



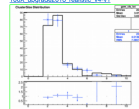
pullX\_p1  
Chi2: 5.02E-01

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1



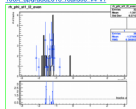
gem\_cls\_tot  
Chi2: 4.29E-02

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1



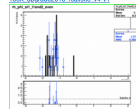
rh\_phi\_st1\_2\_even  
Chi2: 6.31E-02

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1



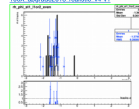
rh\_phi\_st1\_1and2\_even  
Chi2: 5.12E-02

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1



rh\_phi\_st1\_1tor2\_even  
Chi2: 5.12E-02

CMS\_SW\_10\_6\_0\_pre4-  
10EX\_upgrade2018\_realistic\_v4-v1  
CMS\_SW\_10\_6\_0-  
10EX\_upgrade2018\_realistic\_v4-v1

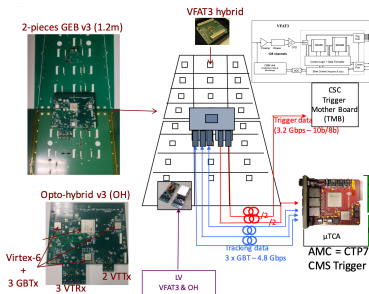


- Monitoring of simulation has been implemented
- Used in release validation and code integration



- GEM Online Software
  - P5 configurations need to be updated
  - When configurations in GEM database, takes a day to update PFA analysis
- Online DQM
  - Ready for P5
- Offline DQM
  - Porting slice test code into CMSSW DQM

# GEM packer/unpacker



- Payloads from AMC13, AMC, GEM electronics board (GEB), vfat
- Packer and unpacker for GE1/1 implemented and tested with slice test
  - simMuonGEMDigis -> FEDRAW -> muonGEMDigis
  - Supports two vfat versions (v2 and v3)
- Electronics map for slice test in DB
  - Currently using dummy maps for full GE1/1 and GE2/1
- Need to add ME0 and trigger data

- GEM RecHit clustered from adjacent Digis
  - Dead / hot strip rejection implemented, added records to DB
- GEM segments can be made from rechits from the superchamber
  - GEMCSCSegment can be built with combined GEM+CSC, can be used in muon reco anywhere CSCSegment is
- ME0 segment builder with RU algorithm has been implemented and debugged
- ME0 / GEM integration
  - The bulk of ME0 code is copy+paste of GEM code
  - In principle the operation of ME0 is the same as GEM
    - AFAIK, ME0 was planning on using non-similar tech. cf GE1/1 GE2/1, requiring separate routines
    - Currently though, the only thing code separation is doing is doubling the lines of code, and causing GEM/ME0 state to go out of sync
  - Merging ME0 and GEM code together to ease maintenance

- Online DQM
  - Basic features working since slice test
  - Full detector summary plot added
- Offline DQM
  - Automation of slice test results
- Manpower
  - Online DQM: one PhD student
  - Offline DQM: one PhD student
  - Validation: one PhD student
  - DQM with ML: one PhD student
  - Prompt feedback analysis: 2-3 people
- Reco
  - Analysis chain validated and improved in slice test
  - GEMReHit/segment use in muons possible, further work ongoing
  - Further developments in progress, such as ME0/GEM integration