Muon Data Quality Monitoring Training

Siyuan Sun March 26th, 2015

Table of Contents

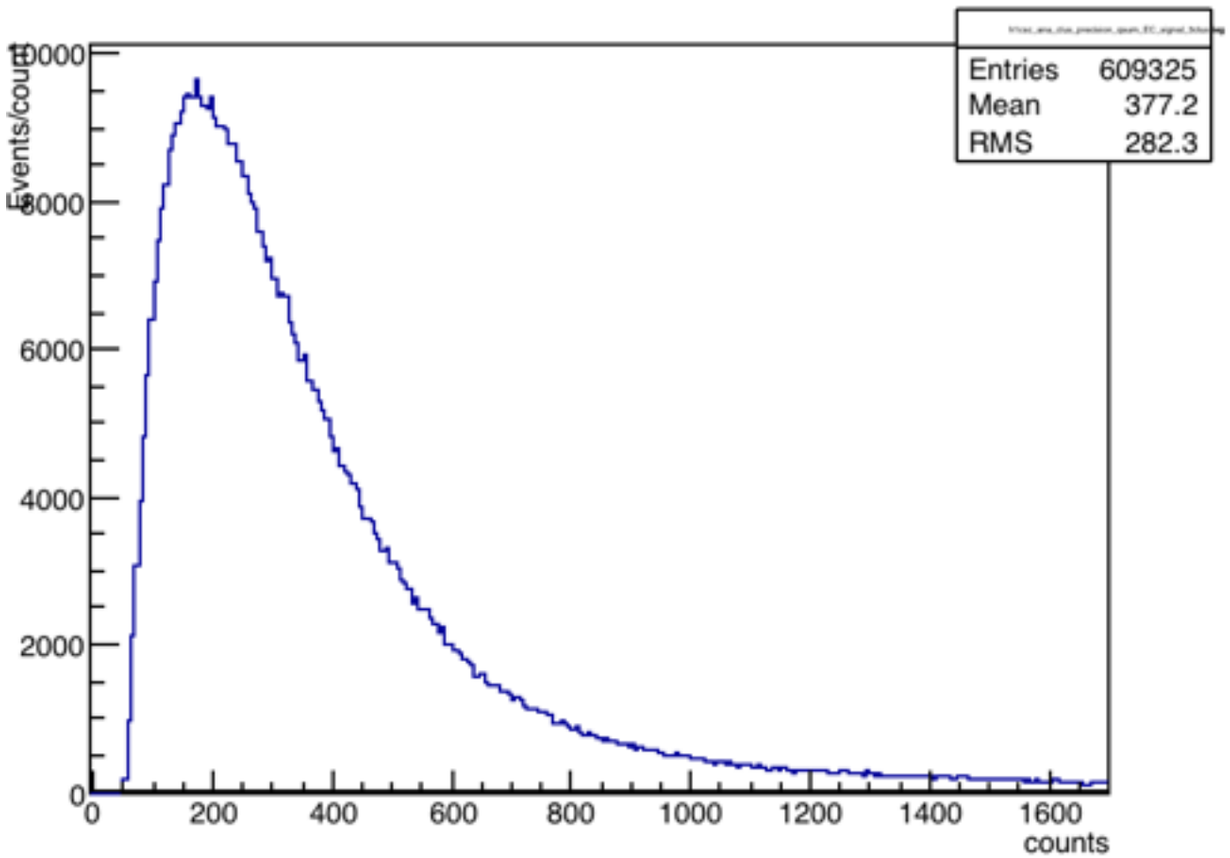
Overview

- Data quality monitoring (DQM) allows shifters to look directly at samples of data recorded by ATLAS
- Used to detect and diagnose any problems with the detector
- Run in parallel with the DCS FSM.
    - The FSM controls the ATLAS detector (turns on/off high voltage, temperature sensors, etc).
    - The DQM only monitors the detector's output but doesn't control anything.
- During physics runs, shifters are expected to check data quality histograms at least once an hour and call experts if any part of detector is flagged as bad.
- During cosmic runs, shifters are expected to check only a select subset of histograms and only document the bad histograms.

What We Monitor

- CSC, MDT (Precision Tracking)
  - Charge Deposited, Timing, How many hits we're getting (occupancy), Electronics errors
- RPC, TGC (Triggering)
  - Timing, Occupancy, Electronics errors, and the electronics clock.
  - Clocks must be synchronized or else you're triggering on the wrong collision

CSC Charge Distribution



Distribution is Landau

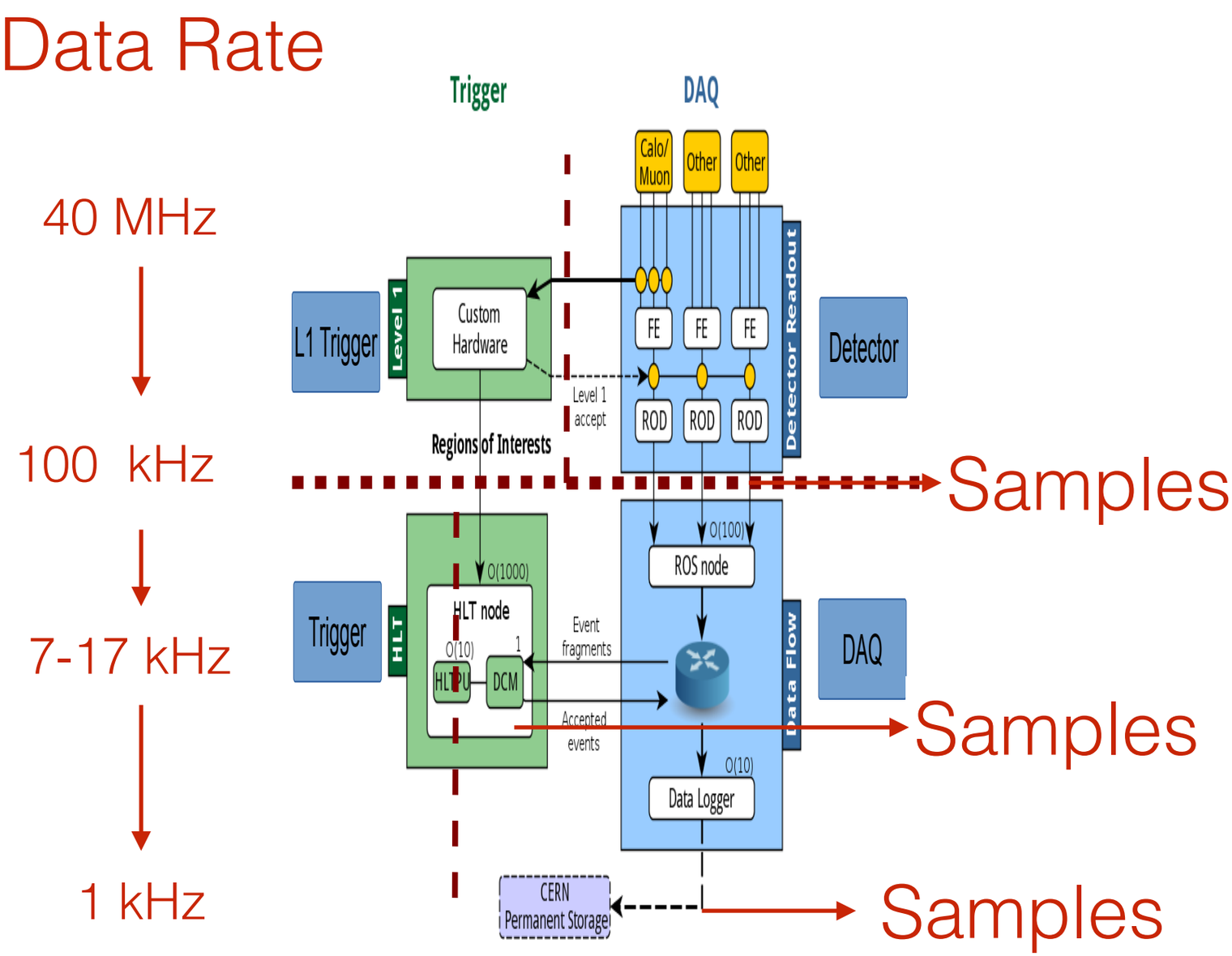
Tools of Muon Data Monitoring

- Gnam
  - produces histograms from samples of data
- Other athena packages that also produces histograms
- Programs that present and organize the histograms
  - Data Quality Monitoring Framework (DQMF) } Checked Regularly by shifter
  - Online Histogram Presenter (OHP)
  - Other visualization tools normally used by experts

Gnam

- Automatically produces histograms from samples of data

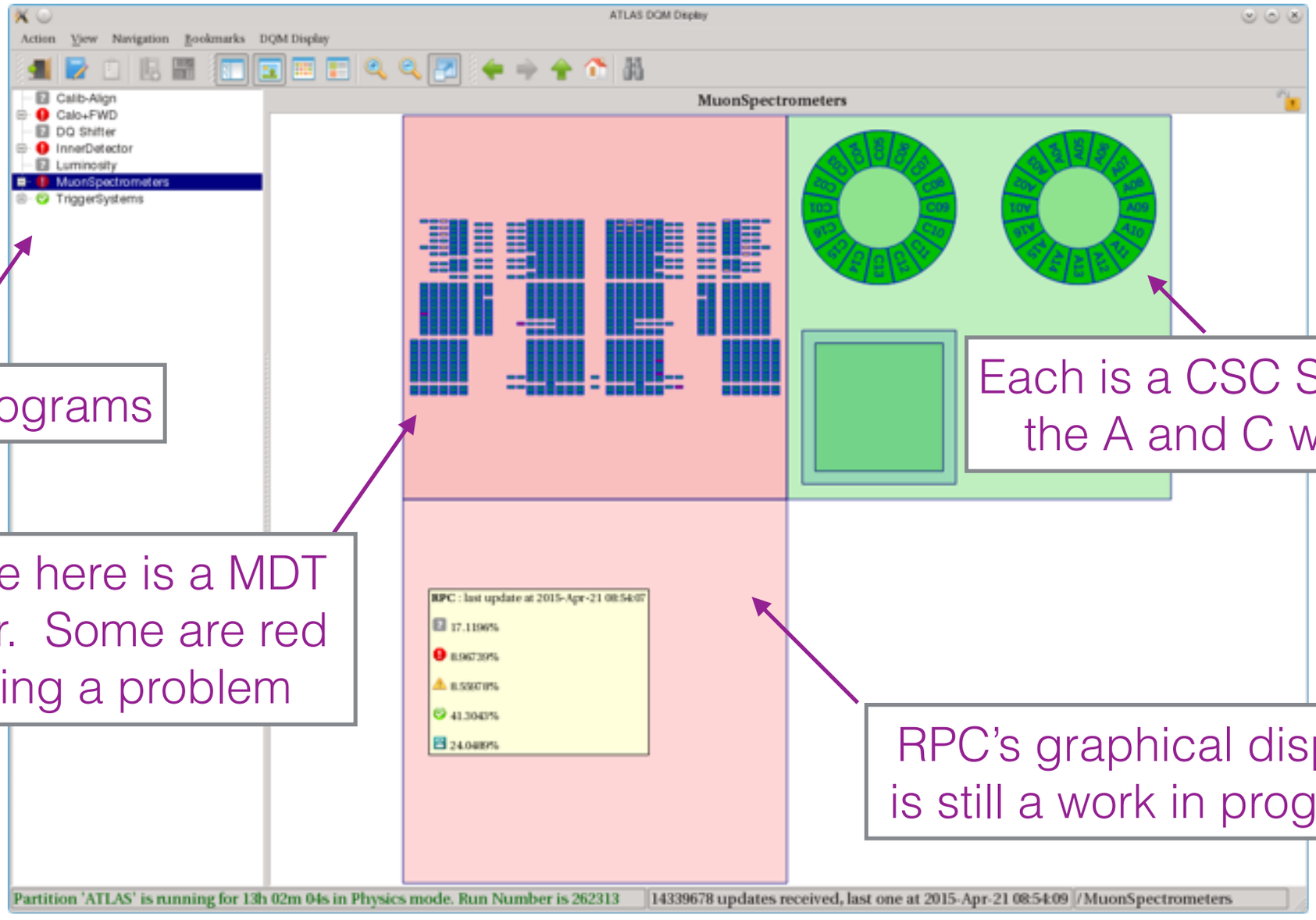
- Samples data from right after the L1 trigger, from the HLT farms, and from various data streams depending on the sub- detector.



DQMF

- Tool that will be watched by the shifter. it will be used for all sub-detectors during actual physics runs.
- Chooses a select set of histograms and tests them.
- Organizes histograms into a tree structure according to detector geometry or some other system like readout electronics.
- Each histogram is tested by an algorithm and flagged as Green/Yellow/Red. Grey = No data. Blue = Not enough statistics to tell.
- Yellow and Red flags are propagated up the tree. so problems can be spotted from the most general screen.
- Shifters should check the DQM display for any red flags at least once an hour.
    - If this was a physics run with collisions. Check muon white board to see if the chamber has a known problem. Check alarm screen to see if the chamber has any active alarms. If not phone an expert and describe the problem. Plus document in elogs and run summary.
    - For cosmic running, instructions depend on the particular histogram and subdetector.

Muon DQM Display Interface



List of all histograms

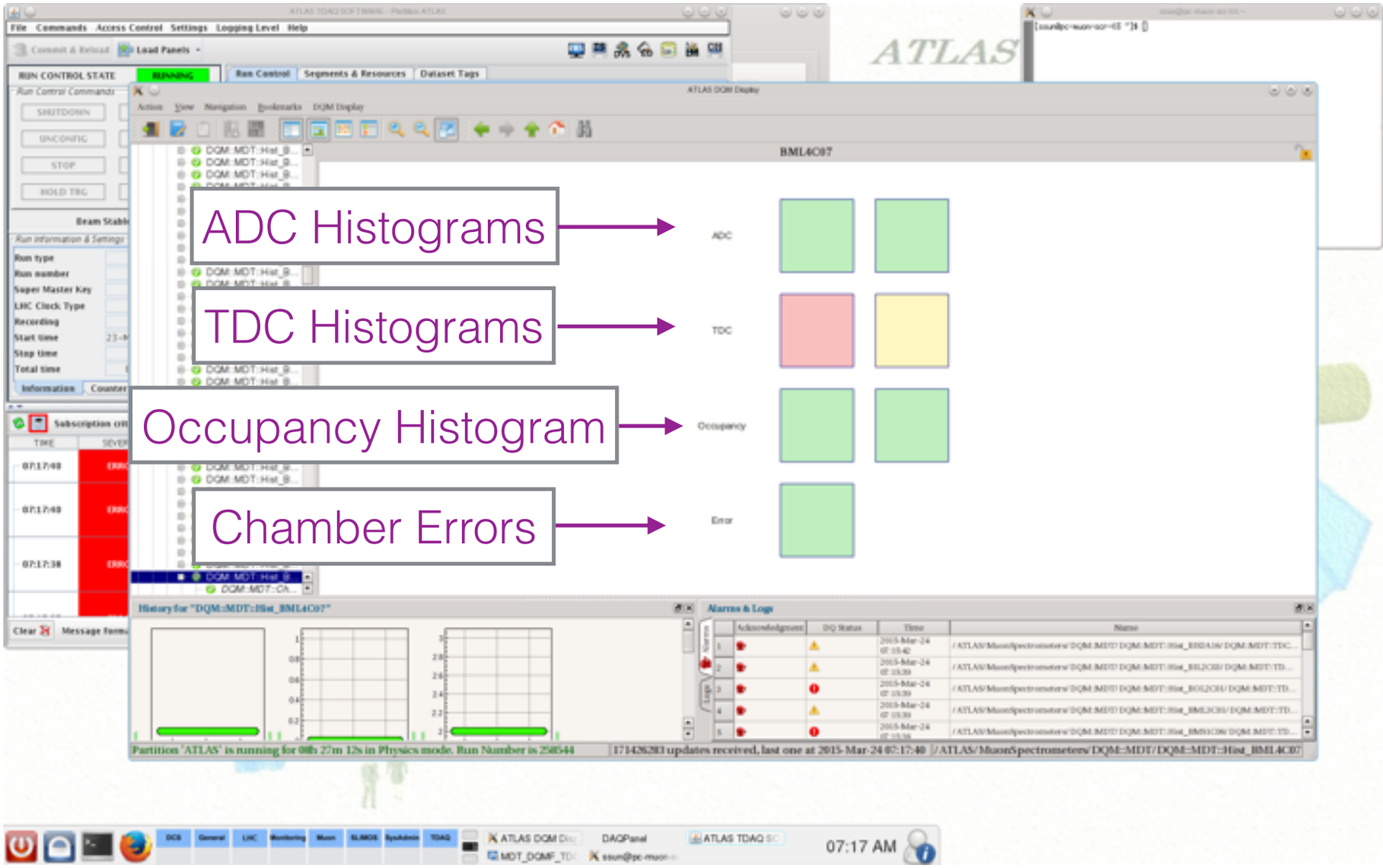
Each one here is a MDT chamber. Some are red indicating a problem

Each is a CSC Sector in the A and C wheels

RPC's graphical display is still a work in progress

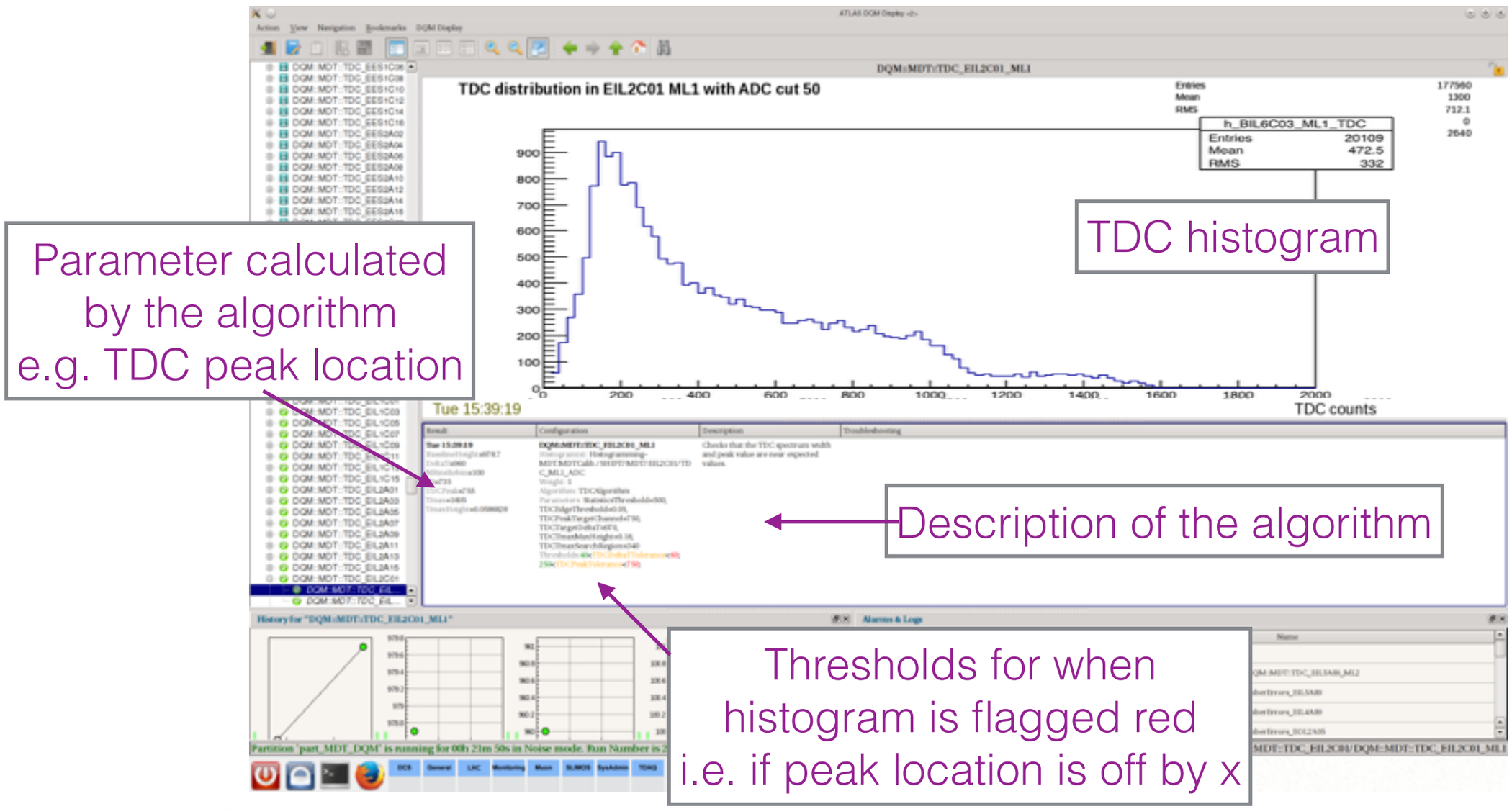
The Muon DQMF Display is organized according to each detector's geometry or electronics. You will be able to see all 4 sub-systems at once

Histograms for a Single MDT Chamber



Each chamber has multiple histograms associated with it. If any histogram is tagged red, it is then propagated up the chain

DQM Display: Single Histogram



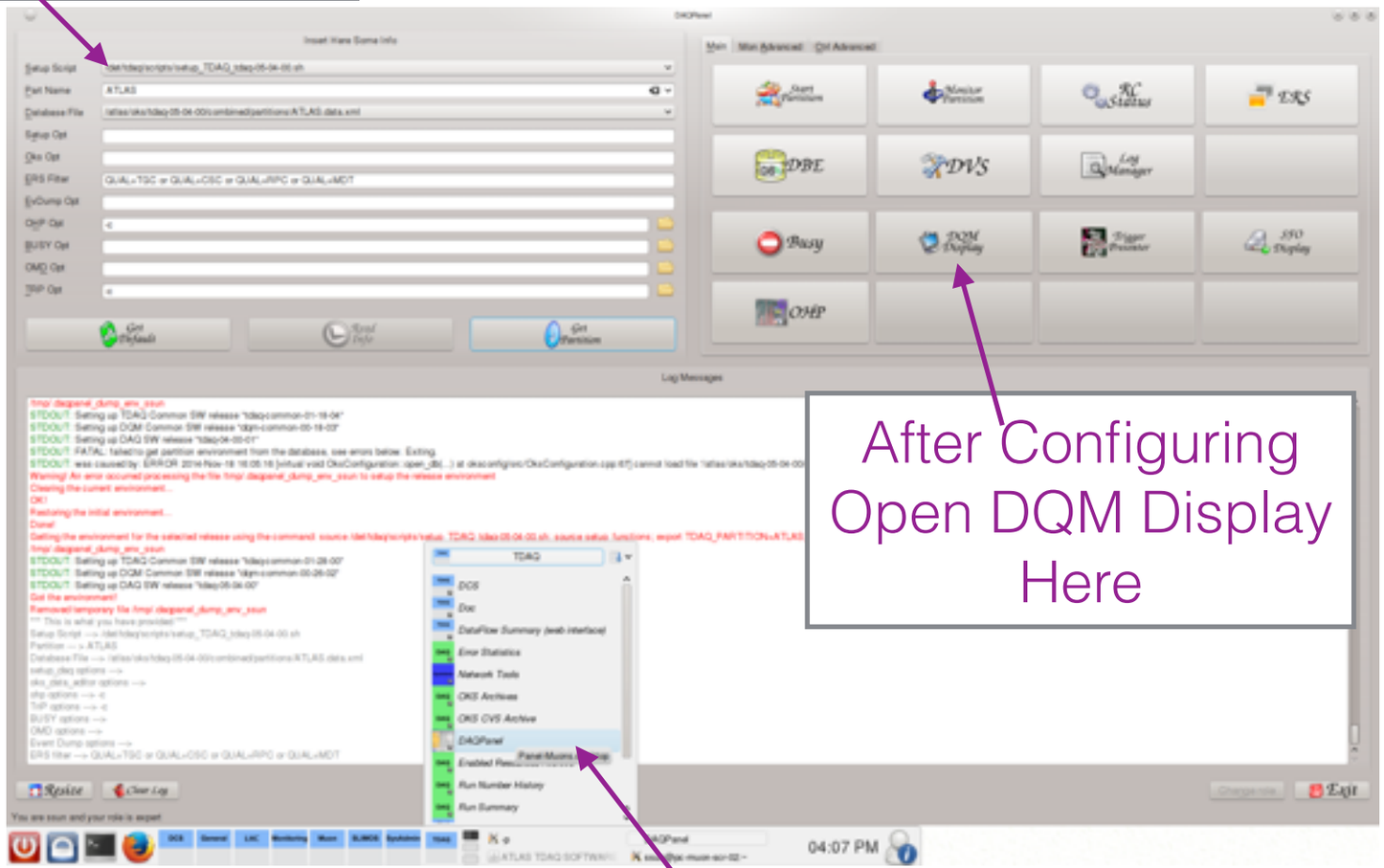
At the lowest level we see the actual histogram. Here's an example of a normal MDT TDC (timing) distribution. Things like additional spikes or TDC plateau extending out to 1500s will be tagged red.

Starting DQM Display

- DQM Display is opened with the DAQ panel
- The DAQ panel must be configured with the correct setup script and partition depending on whether the run is combined or standalone
- The current setup script for a combined run is:
  - /det/tdaq/scripts/ setup_TDAQ_tdaq-05-05-00.sh
- The combined ATLAS partition is:
  - /atlas/oks/tdaq-05-05-00/combined/ partitions/ATLAS.data.xml
- click “get partition” and then “read info” to setup
- Click DQM Display to open DQMF
- Details on setting up a combined or standalone run can be found here: https://atlasop.cern.ch/twiki/bin/view/Main/MuonOperationManualShifter#Taking_or_Monitoring_a_Run

Configure with the correct setup script and partition

DAQ Panel

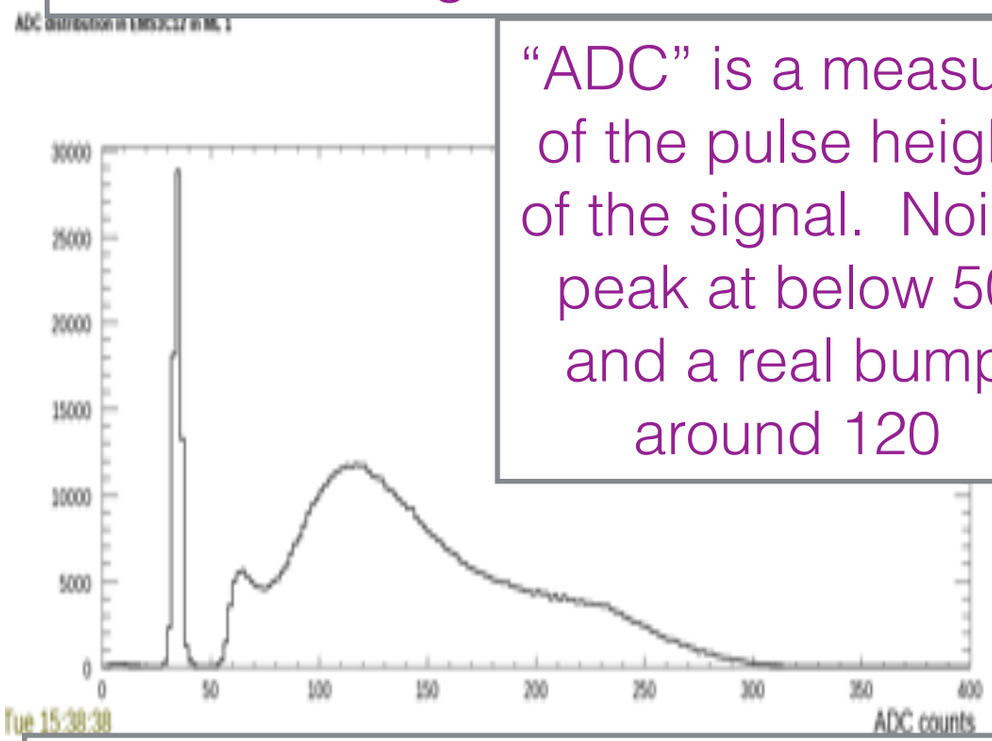


Monitoring Precision Trackers

- For precision trackers (MDT, CSC) we need to monitor the amount of charge deposited and the timing of the hits.
    - We need to make sure the quality of the hits are good and the drift time of the drift chambers are correct.
- We also have an basic occupancy plot to make sure we are getting hits at any point in time.
- Lastly we have a detector error plot to see if the readout electronics are working properly (if the data is corrupted or if the buffer is full etc).

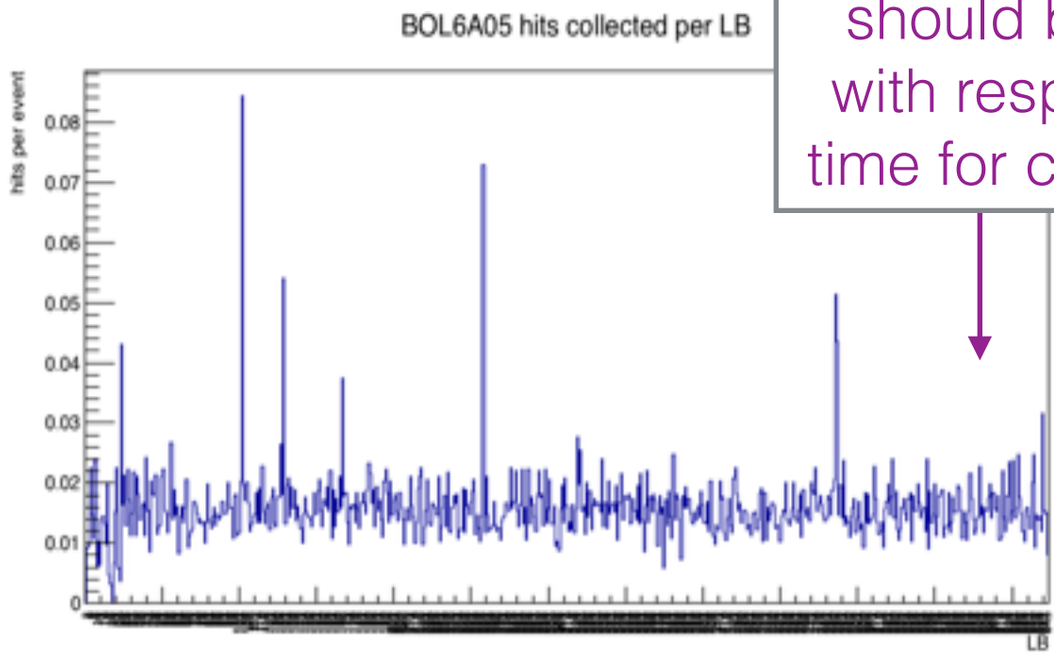
MDT Histograms

Charge Distribution



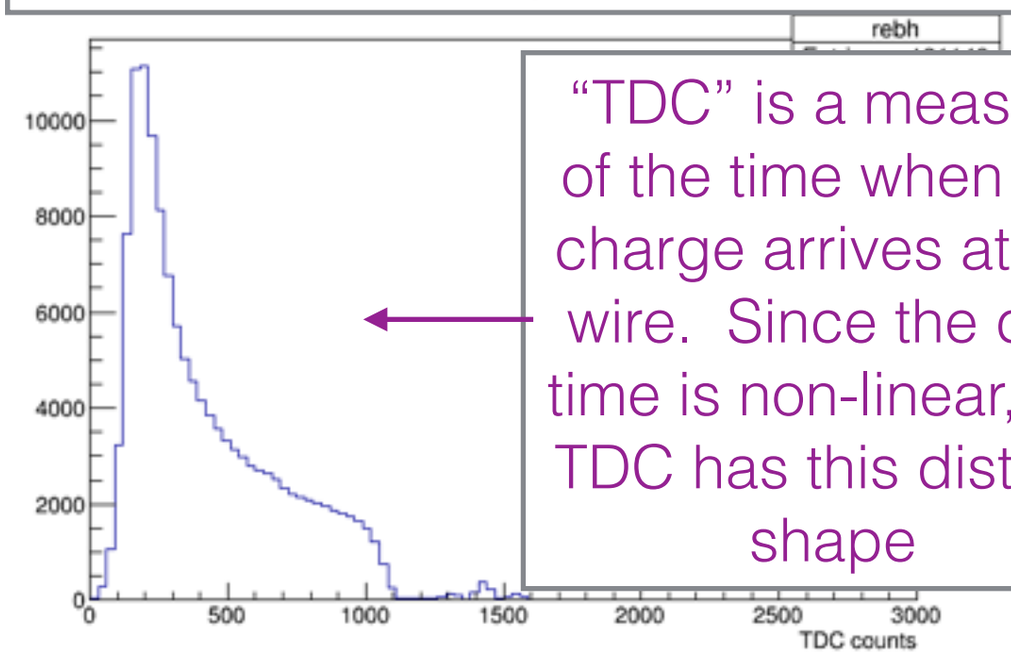
"ADC" is a measure of the pulse height of the signal. Noise peak at below 50 and a real bump around 120

Occupancy Plot



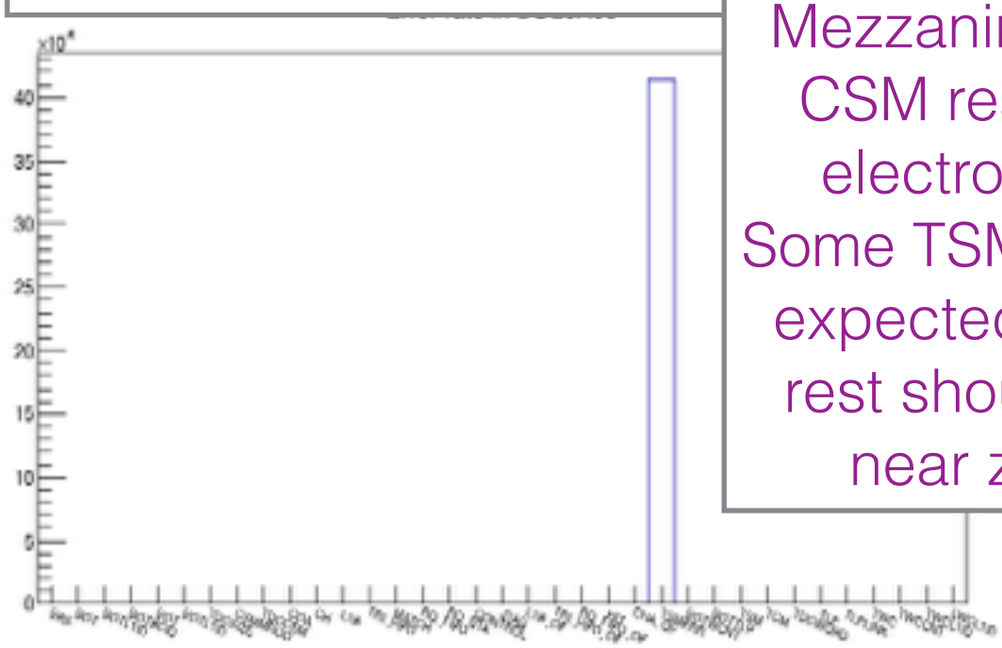
Hits per Event should be flat with respect to time for cosmics

Timing Plot



"TDC" is a measure of the time when the charge arrives at the wire. Since the drift time is non-linear, the TDC has this distinct shape

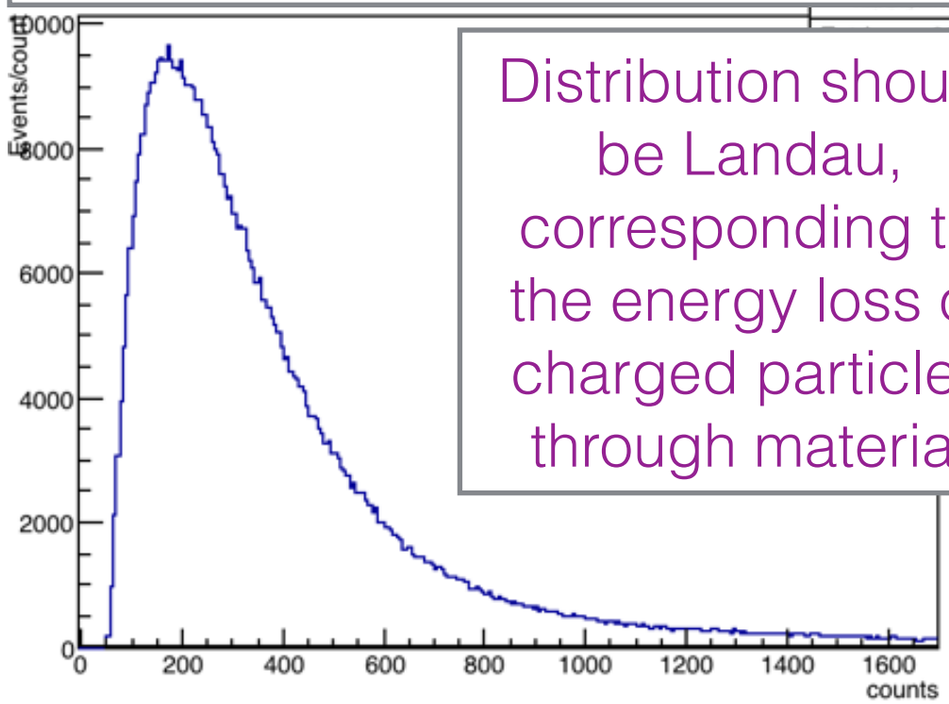
Error Rate



Errors from Mezzanine and CSM readout electronics. Some TSMERR is expected. The rest should be near zero

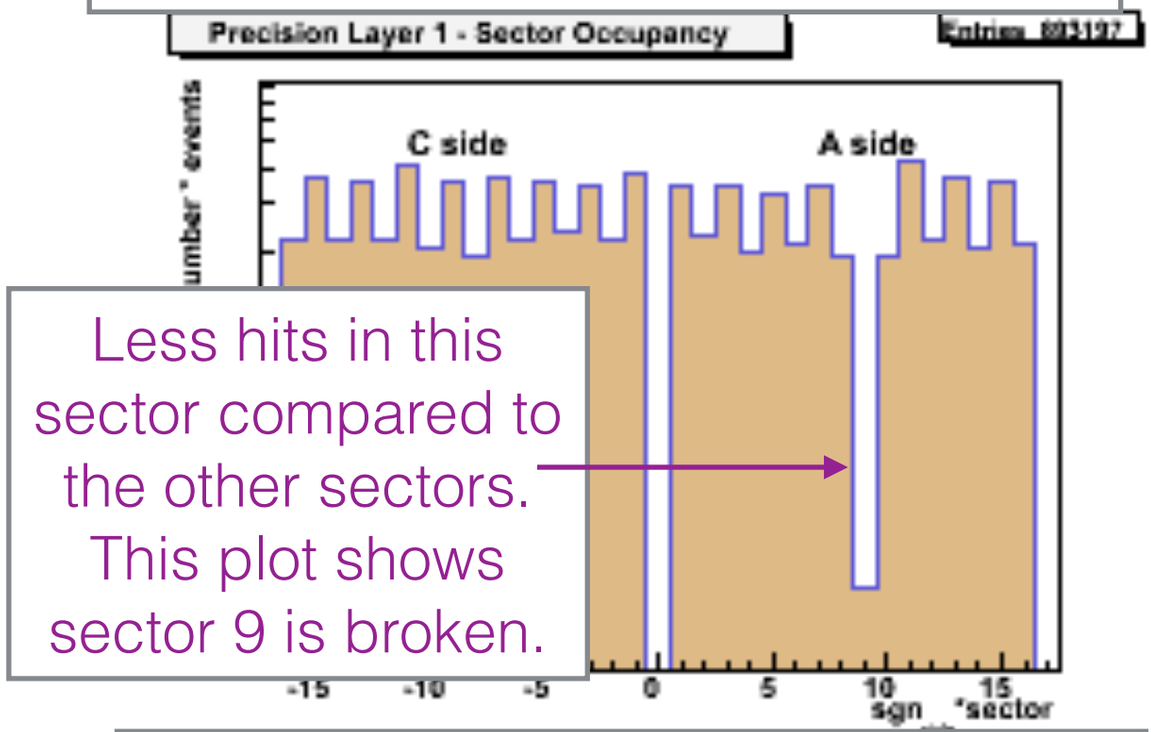
CSC Histograms

Charge Distribution



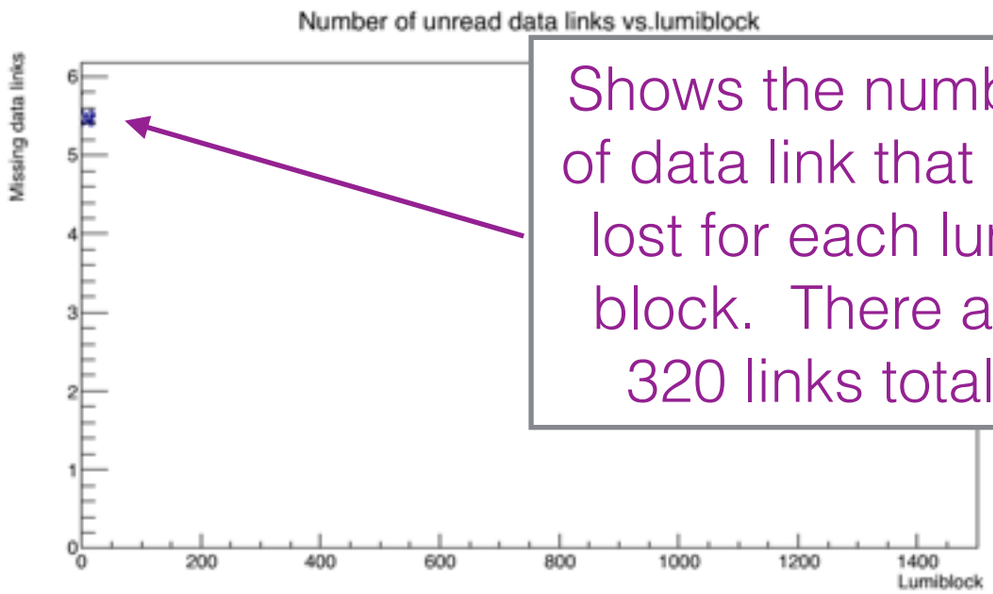
Distribution should be Landau, corresponding to the energy loss of charged particles through material

Occupancy Plot



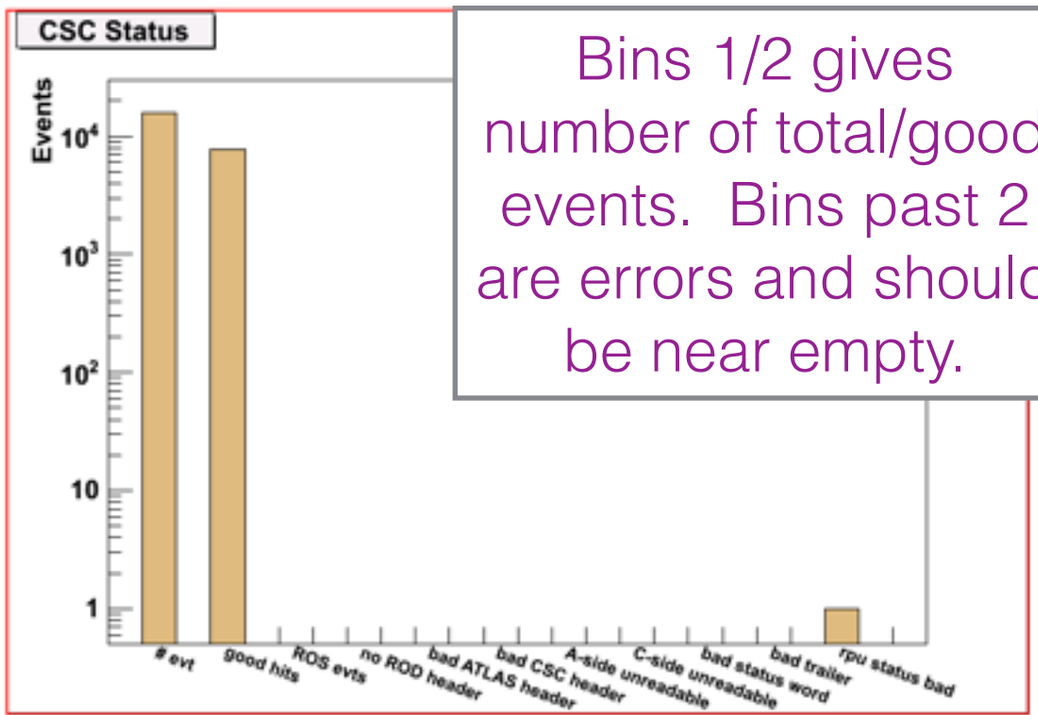
Less hits in this sector compared to the other sectors. This plot shows sector 9 is broken.

Occupancy Plot vs Time



Shows the number of data link that are lost for each lumi block. There are 320 links total.

Error Plot



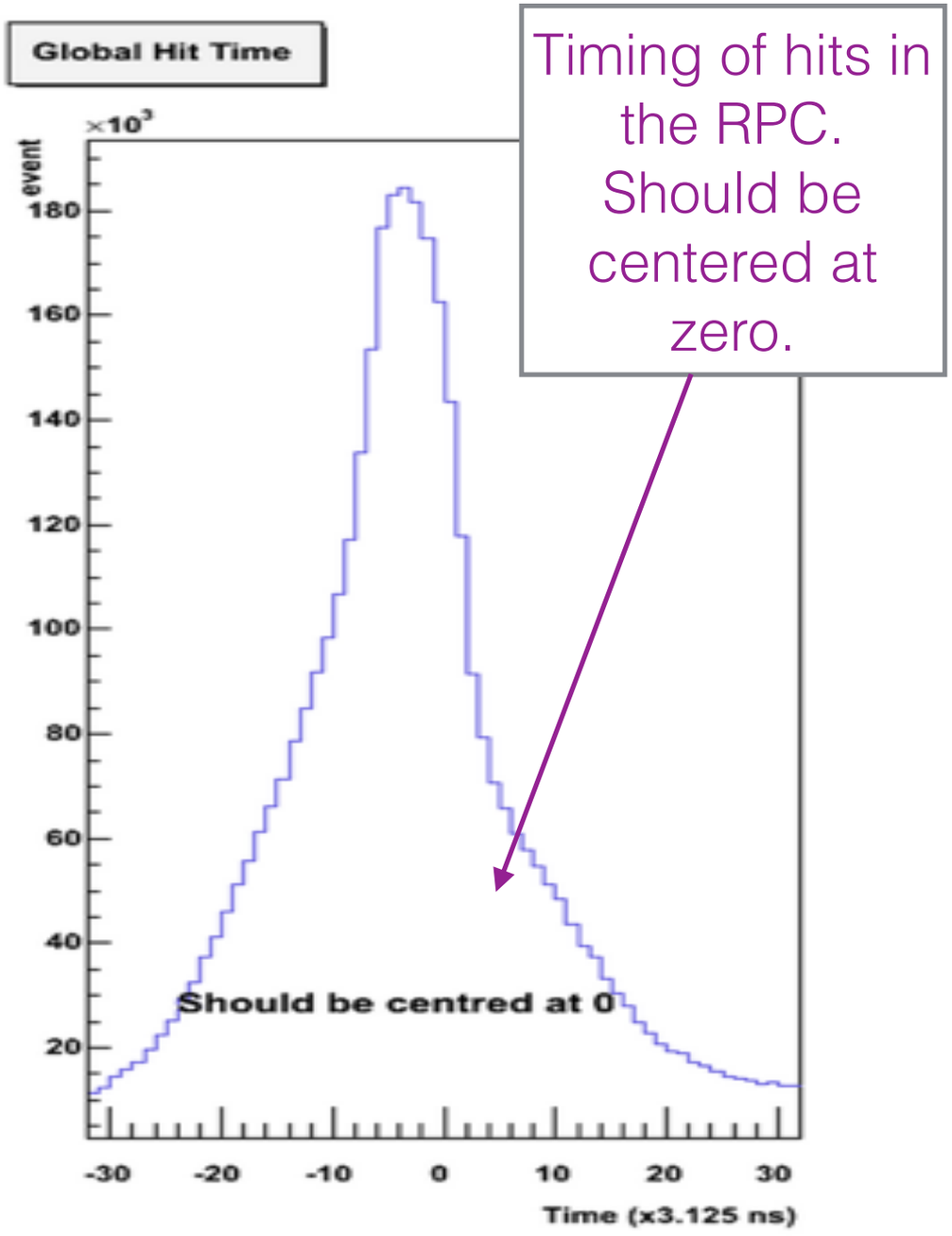
Bins 1/2 gives number of total/good events. Bins past 2 are errors and should be near empty.

Monitoring Trigger Chambers

- For trigger chambers we need to monitor only the timing of the hits.
    - We only need precision in time and not space. They are not drift chambers and don't care about the precise amount of energy deposited.
- We also have an basic occupancy plot to make sure we are getting hits at any point in time.
- We have a detector error plot to see if the readout electronics are working properly (if the data is corrupted or if the buffer is full etc).
- We need to make sure that the clock of the electronics is in sync with each other and with the LHC clock.
    - Otherwise, we'd be triggering on the wrong event. We'll still get events and out histograms will still fill with data but it is not the one that actually created the muon.

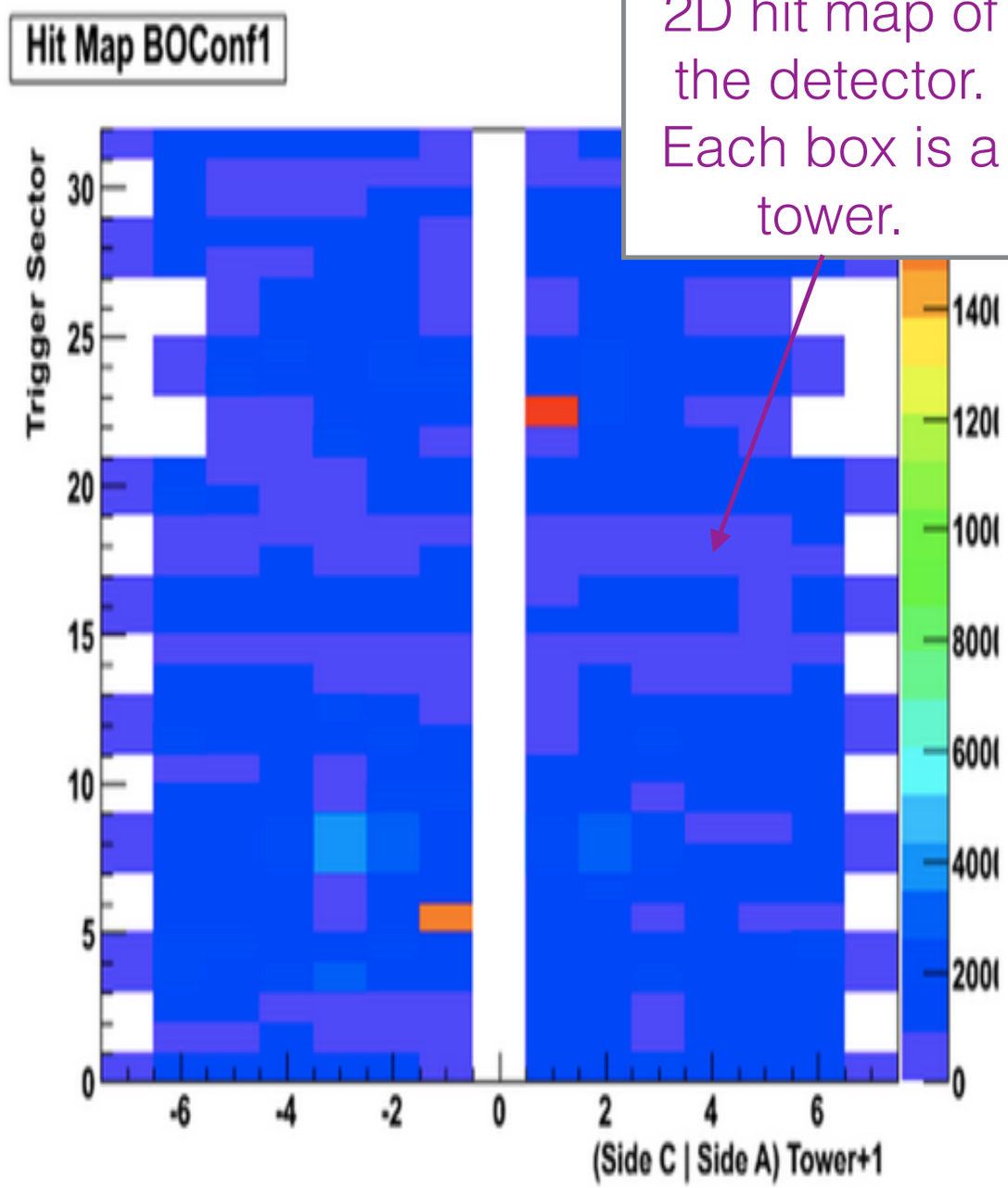
RPC Detector Histograms

Timing Plot



Timing of hits in the RPC. Should be centered at zero.

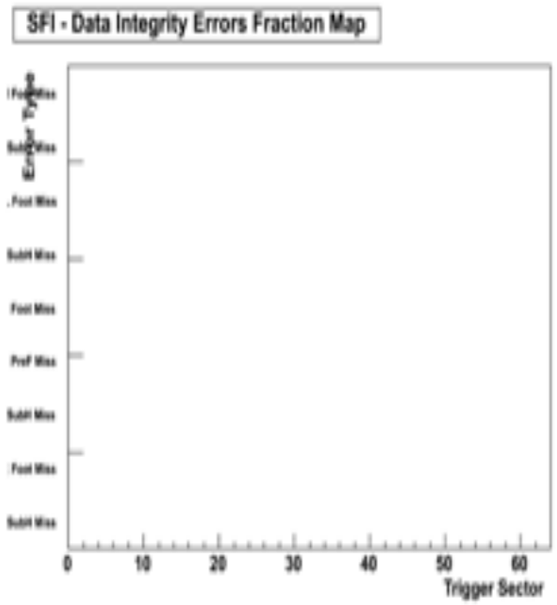
Occupancy Plot

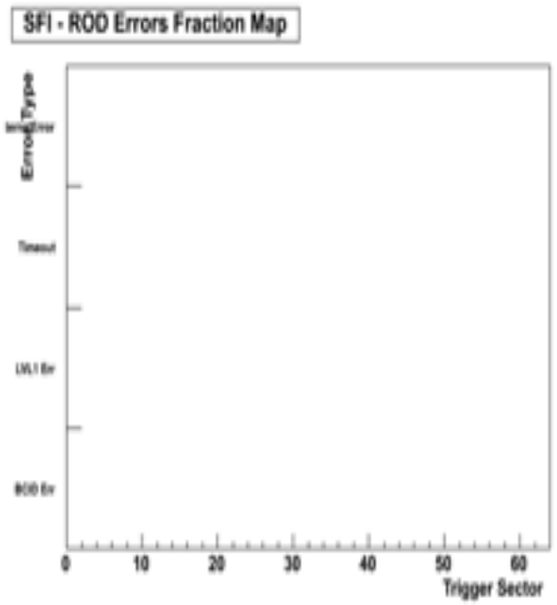


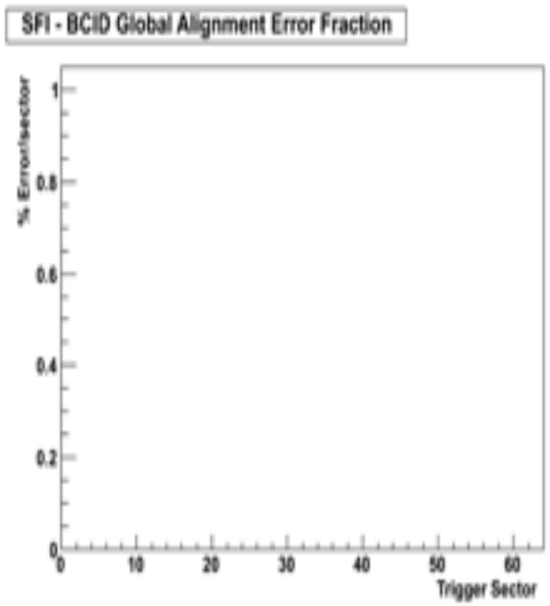
2D hit map of the detector. Each box is a tower.

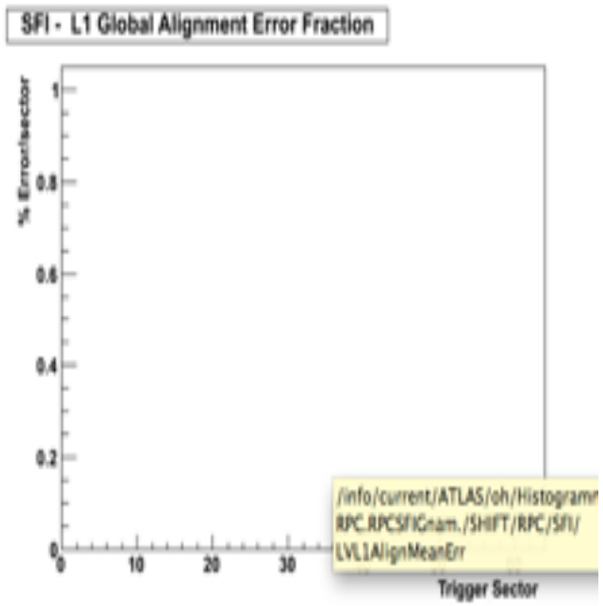
RPC Electronics Histograms

Error Plot



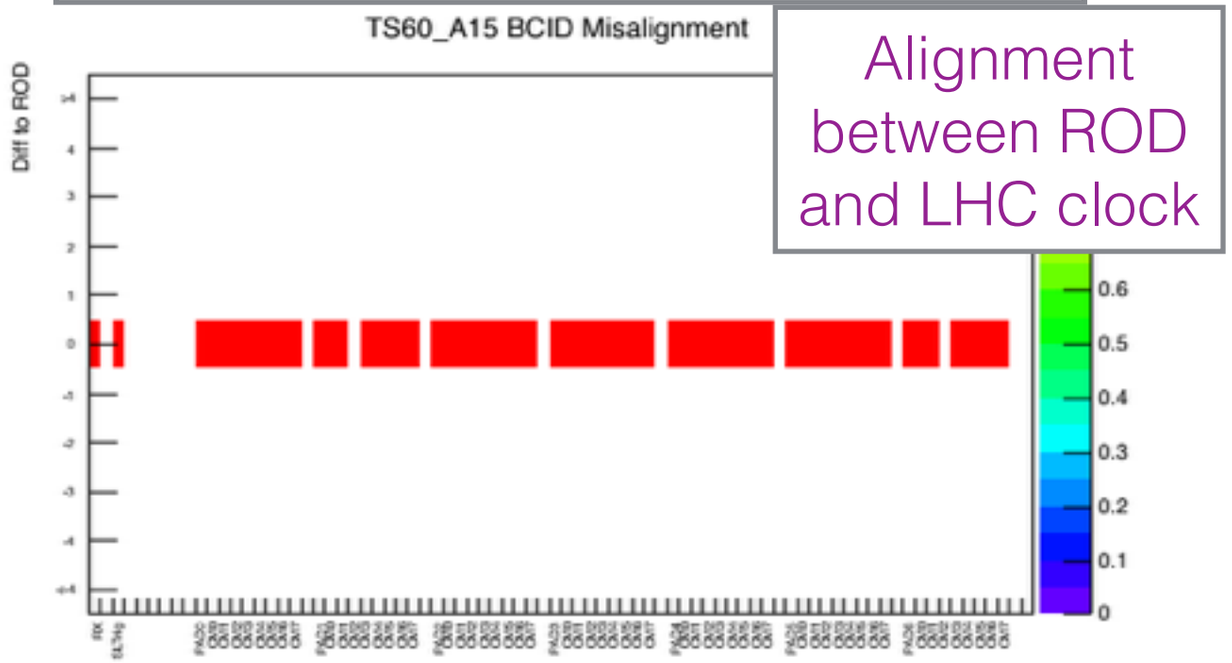




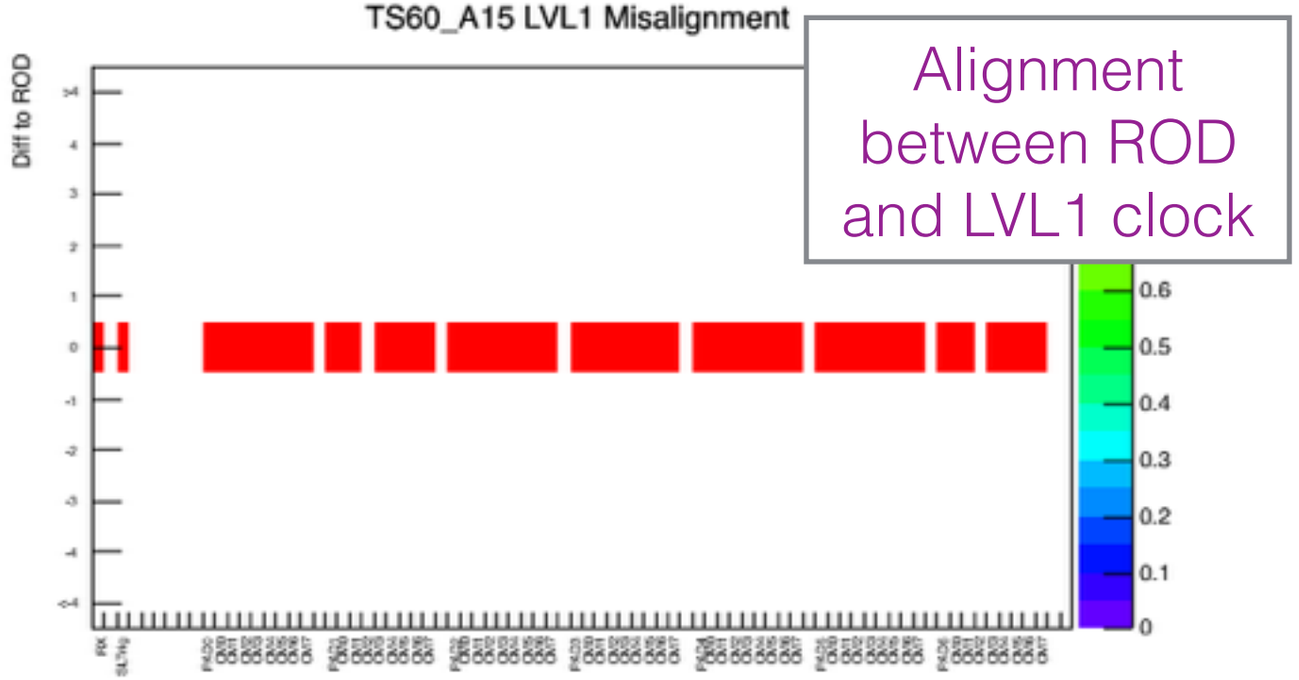


Four error plots, all should be empty

Timing Alignment Plot



Alignment between ROD and LHC clock



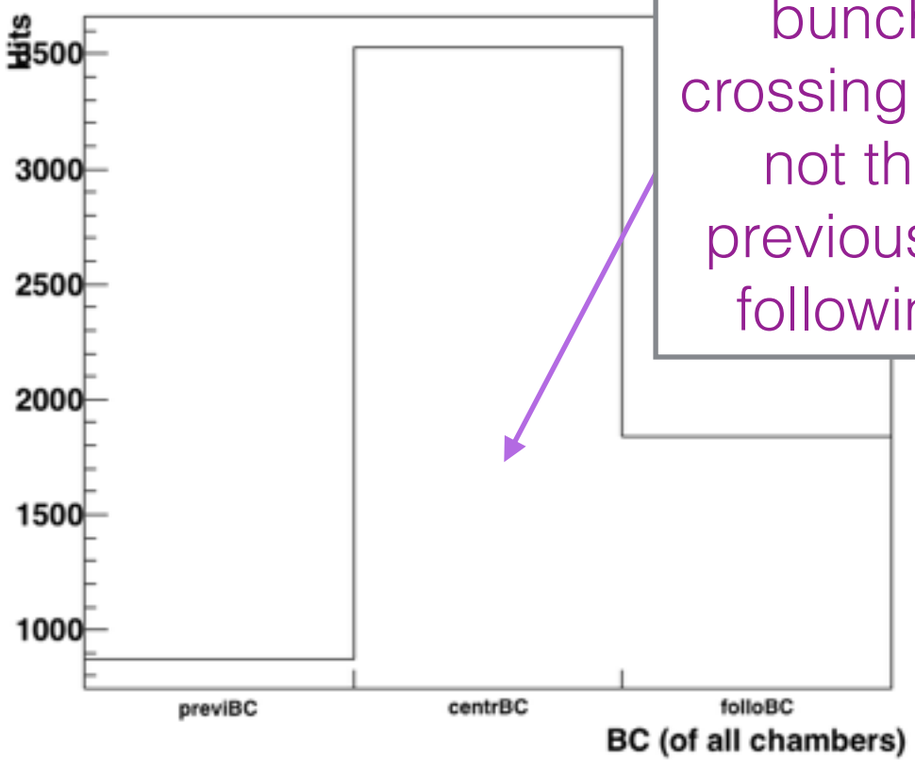
Alignment between ROD and LVL1 clock

Any time mis-alignment and we're taking data from the wrong collision

TGC Detector Histograms

Hit Timing Plo

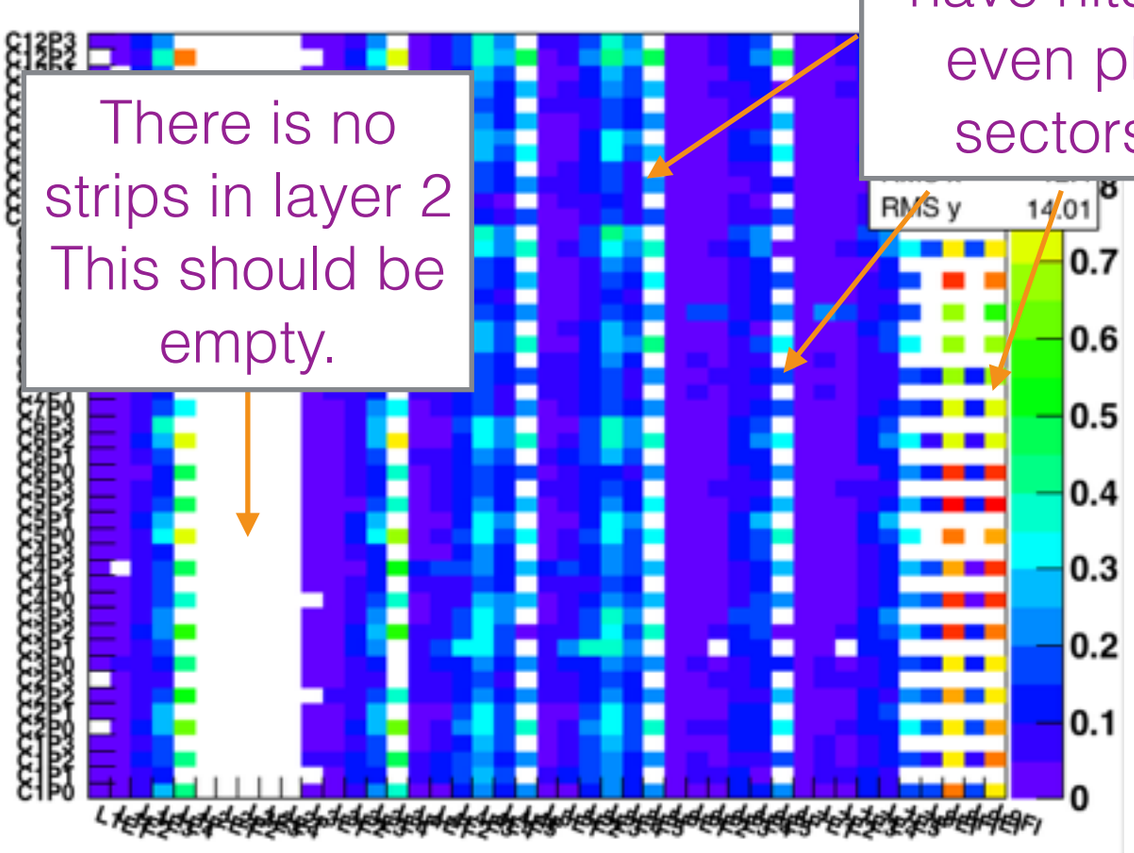
Most hits should be in the current bunch crossing and not the previous or following



Occupancy Plot

F chambers and layers 8 and 9 only have hits in even phi sectors.

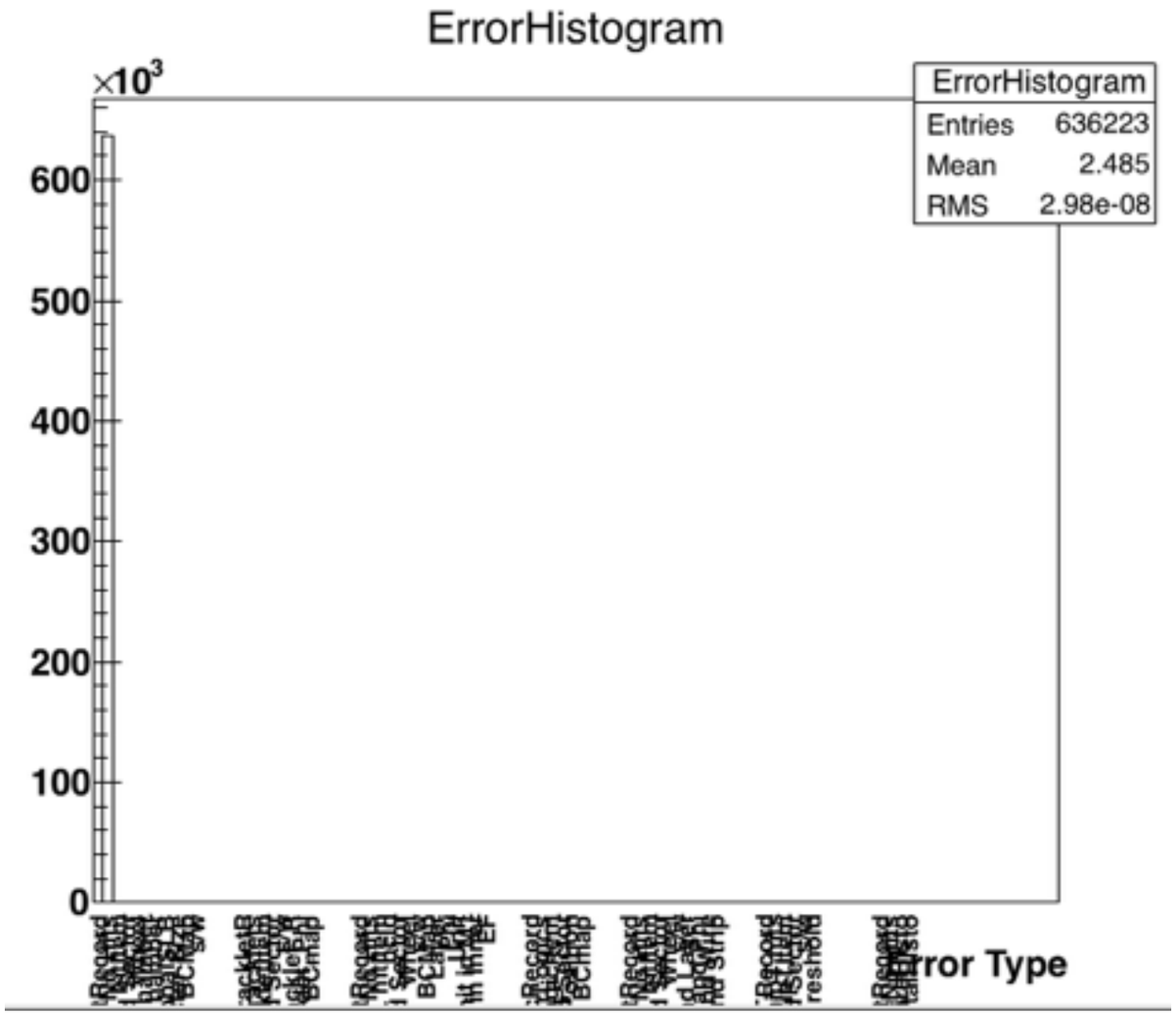
There is no strips in layer 2 This should be empty.



x-axis corresponding to layer and eta name, and the y-axis corresponding to the phi name of the chamber. For example, L1_E1 corresponds to layer 1 (first layer of the triplet M1), and eta station E1 (innermost endcap). A01phi0 corresponds to side A, sector 01 (max 12), and phi station 0 (max 3).

TGC Electronics Histograms

Error Plot



Should only have hits in the first "N Recorded" Column

- Plus a trigger timing histograms that monitor the clock

Instructions for physics runs.

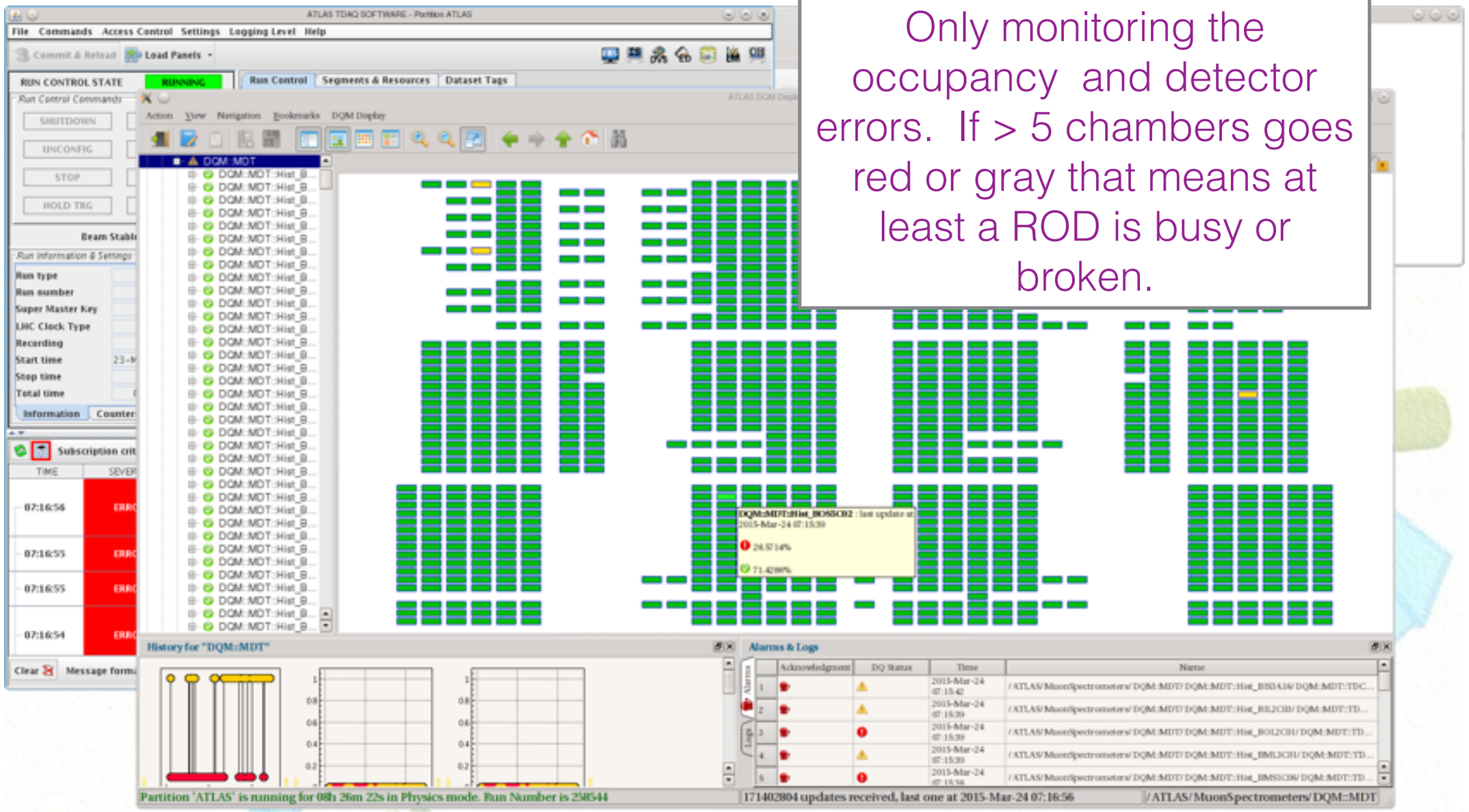
- Wait 30 mins after the start of a run and then check DQ status at least once an hour. Keep an eye on the general page for MDT, CSC, RPC, TGC overview page.
- Keep the most general screen in DQMF green for all 4 systems and free of problems. Track down each red flag and look at the problem histogram.
  - Shifter assistant will help you in this respect. All red flags will show up as an error in shifter assistant. (This is not ready for M9)
- Check the alarm screen to see if there are active alarms corresponding to the problem chamber. Follow instruction corresponding to DCS alarm if there is a DCS alarm.
- Check list of known problems on muon white board.
- Phone appropriate on call expert if there are any new problems that aren't on the muon white board.
- Document in Elogs, shift and run summary. Include screen shot if the problem cannot be easily described.

Current DQ Status and Instructions

- MDT DQMF is ready for shifters. CSC DQMF has a working version. However, the algorithm for tagging whether red/yellow/green needs more testing. RPC DQMF is ready for experts but not user friendly enough for shifters. TGC DQ is not ready and are not to be checked by shifters.

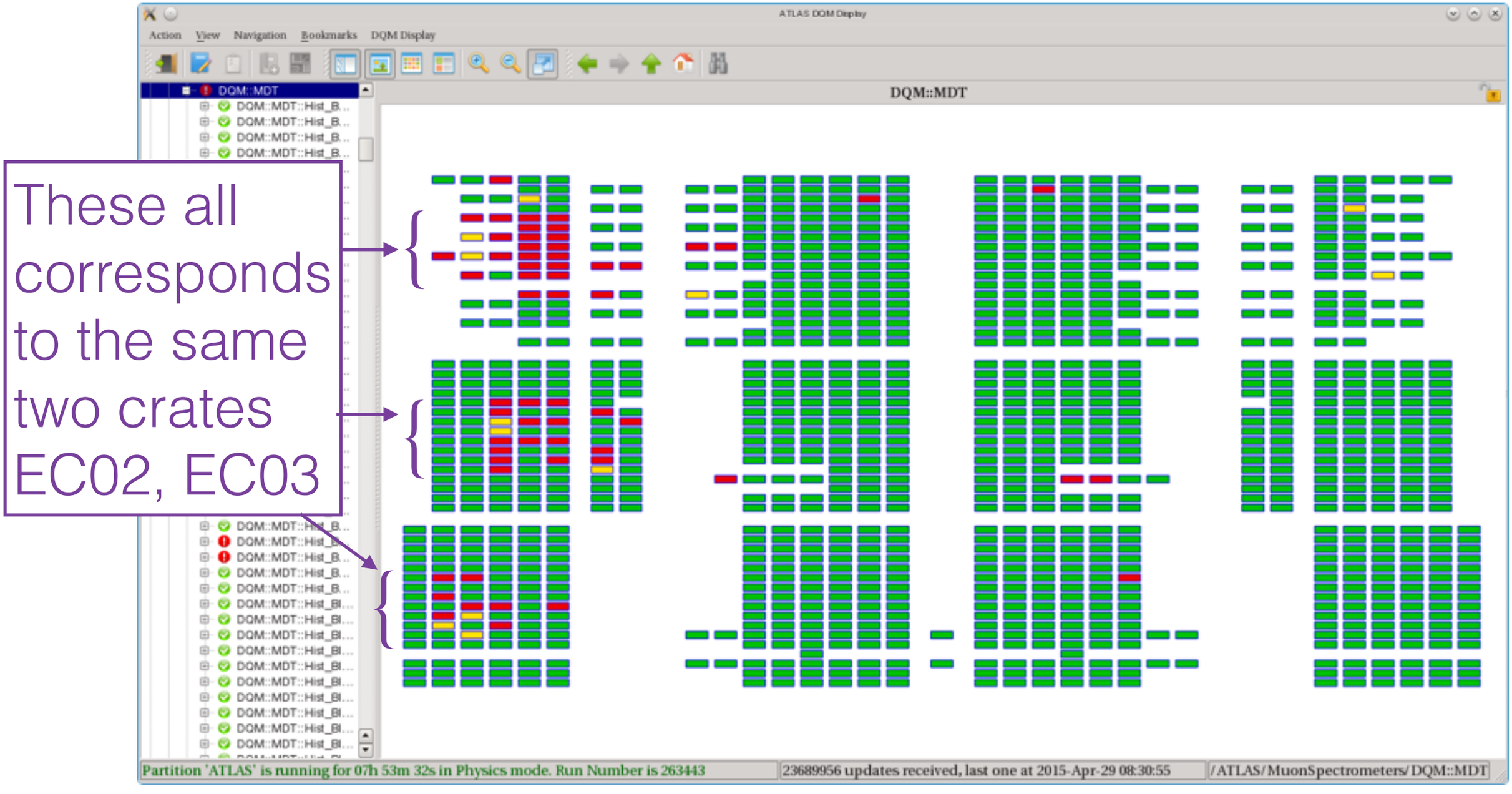
- MDT should be monitored via DQMF.

Expected MDT DQMF state for cosmic runs



Only monitoring the occupancy and detector errors. If > 5 chambers goes red or gray that means at least a ROD is busy or broken.

Example of problematic DQMF state



Suspected reason, MDT Timing Trigger Control (TTC) goes busy for a short while and then recovers