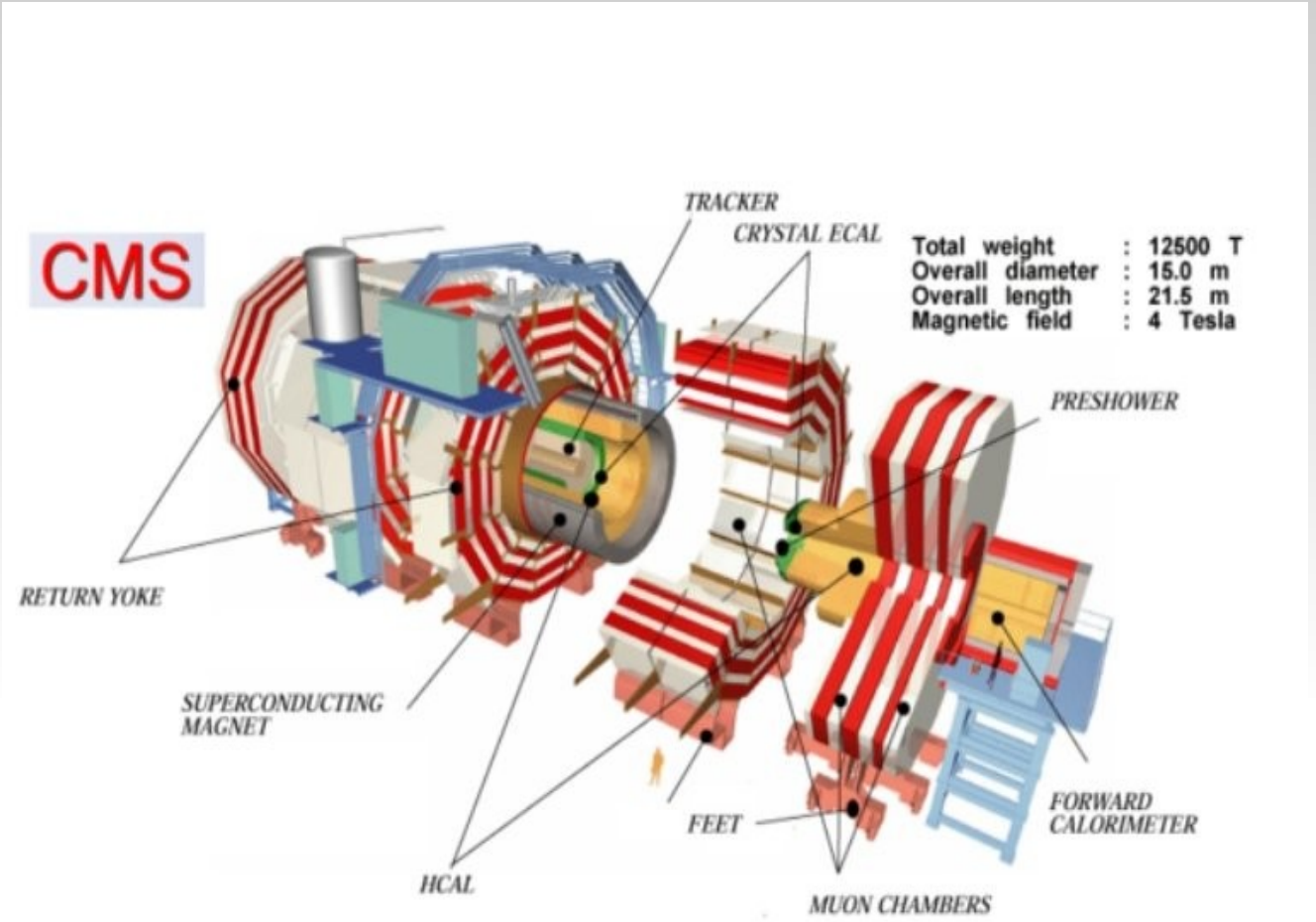
CERN SUMMER

GLOBAL RUNS AND L1 TRIGGER AT CMS SUMMER 2007

Muon system



Muon system:

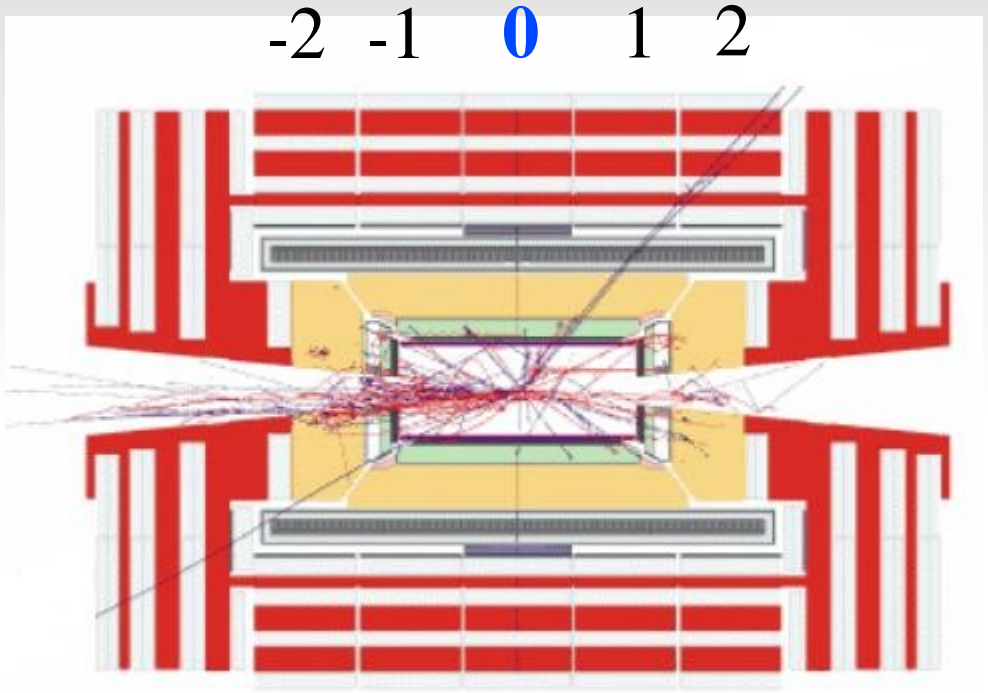
Barrel:

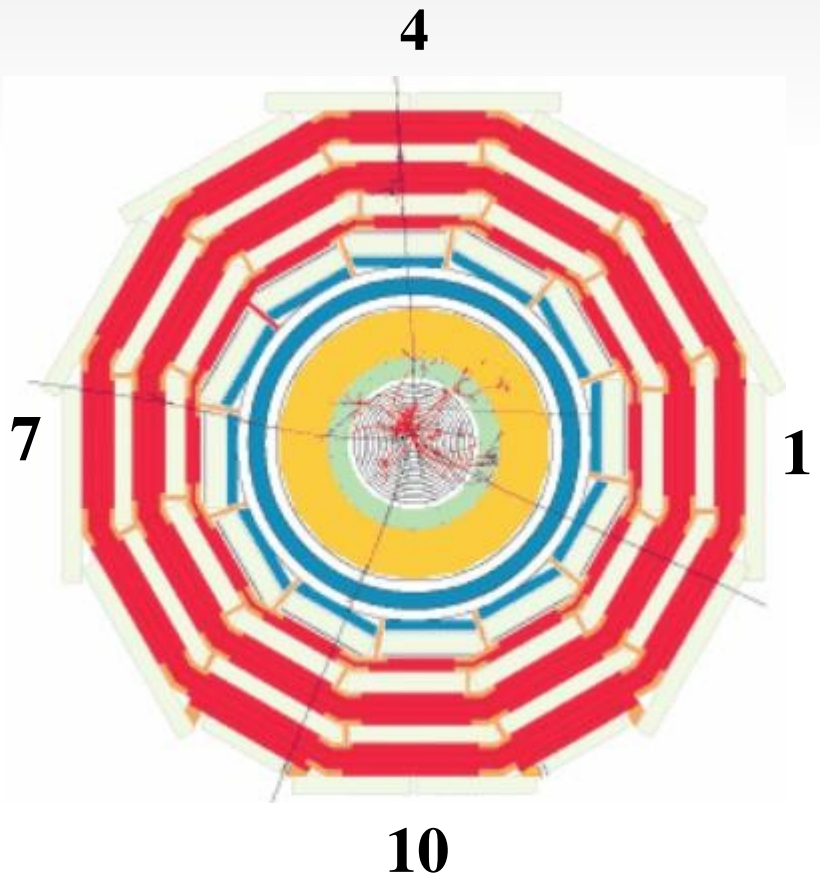
- **5 wheels. 12 sectors.**
- **Drift Tubes (DT) and Resistive Plate Chambers (RPC).**

Endcaps:

- **RPC's and Cathode Strip Chambers (CSC).**

CMS wheels and sectors

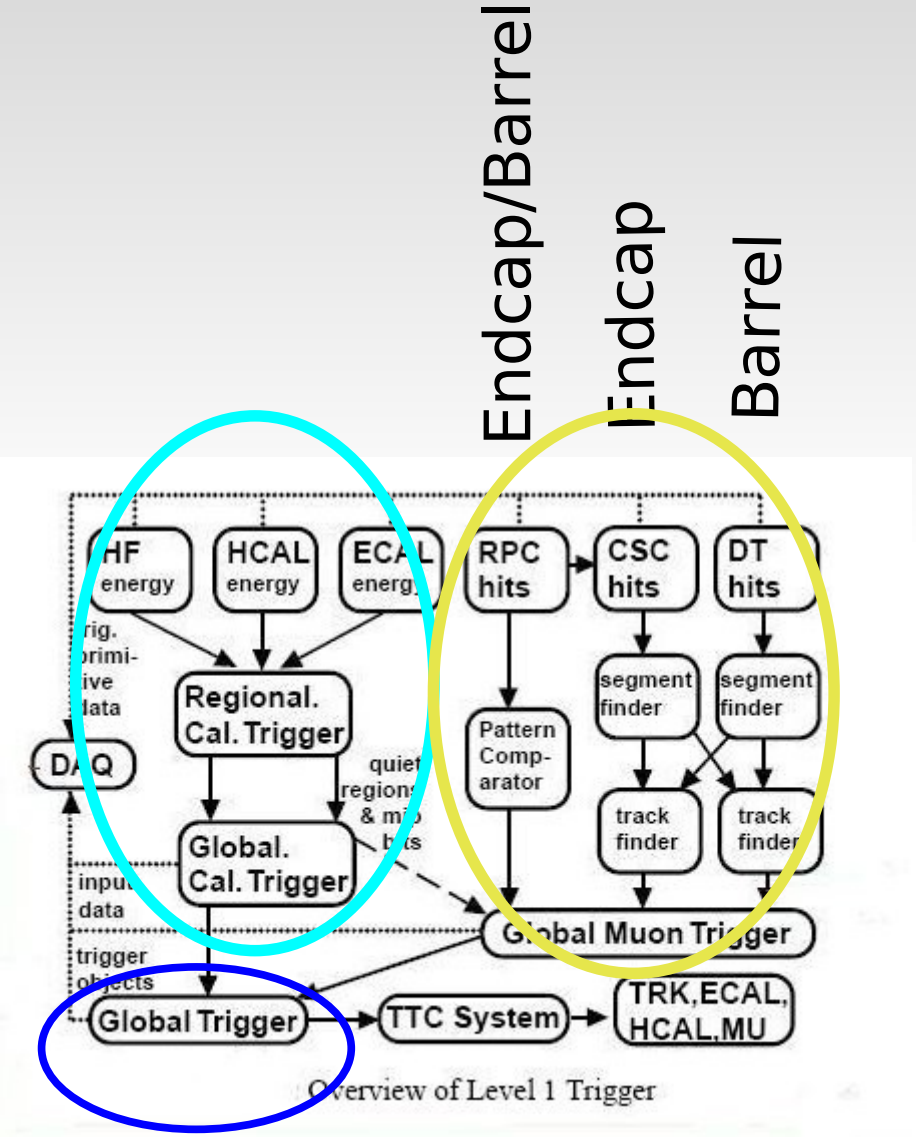




Global Runs

- **Purpose** of the Global Runs:
  - A first test of how the various subsystems work together, both hardware and software. Detectors integrated with Central Trigger & DAQ system in Global Runs. Also some monitoring. A “mini” rehearsal of the real data taking.
  - Hardware and software included as they are ready.
- Use **cosmic muons** for triggering events in the muon system.
  - Very low rate ~ 7Hz. ->Easy to handle and the only “physics” signal available at the moment for commissioning.
  - The trigger components themselves produce data:
    - receive coarse input data, do their trigger task, and send trigger data to the DAQ (when triggered).
    - **This trigger data is studied in my analysis.**

L1 Trigger

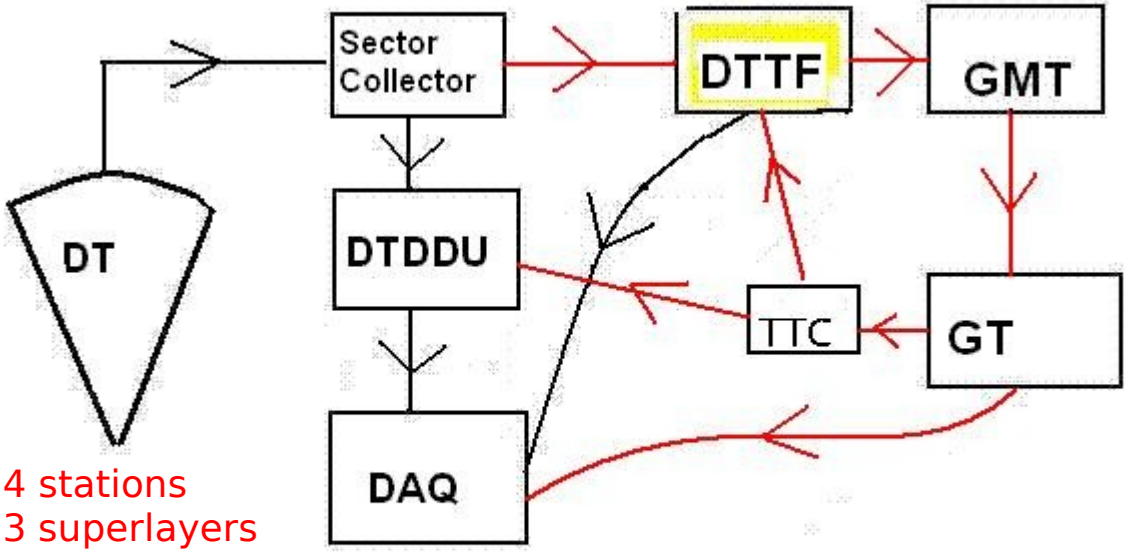


- L1 Trigger consist of 3 major subsystems:
  - L1 **Calorimeter** Trigger
  - L1 **Muon** Trigger
  - L1 **Global** Trigger

L1 DT Trigger Chain

- The data from each bunchcrossing goes to the Sector Collector/ Readout Server (ROS).
- The full event data goes to the DT Detector Dependent Unit (DT DDU).
- The coarse trigger data goes to the Drift Tube Track Finder (DTTF) joining segments in tracks, and calculating direction and transverse momentum.
- The output of the DTTF follows the trigger chain to the Global Muon Trigger (GMT) and then to the Global Trigger (GT).
- The trigger decision is sent via the Timing Trigger and Control System (TTC) to the detector front ends and to the Trigger electronics for discard/keep of the data.
- When L1 accept (L1A) the data goes to the High Level Trigger (HLT) and Data Aquisition (DAQ)

SIMPLIFIED SCETCH OF DATAFLOW



4 stations
3 superlayers
4 layers

Trigger chain in red

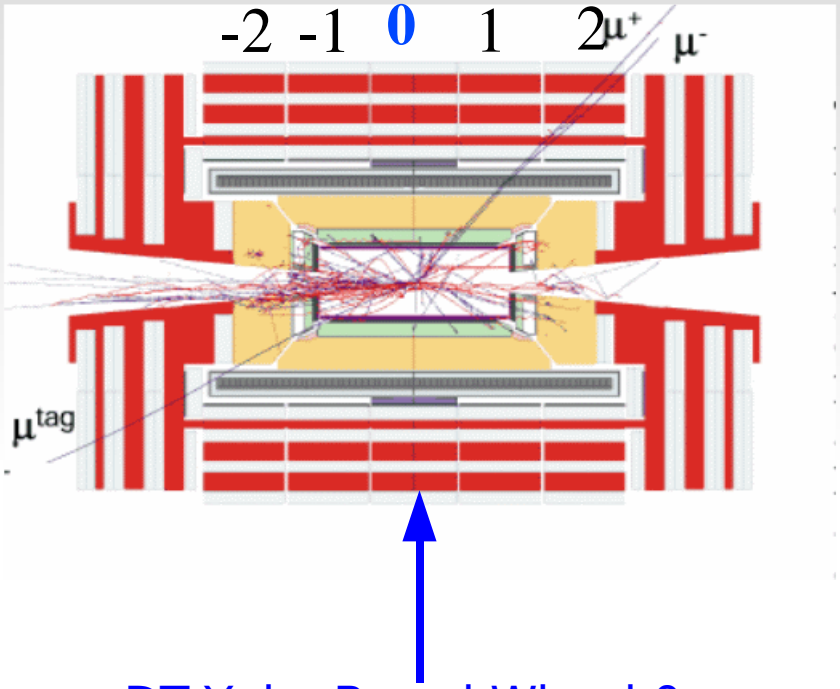
Physical Location of Trigger Electronics

- Trigger electronics located in underground interaction hall and underground counting house.
- Optical fibers for connection. Minimize length of fibers as much as possible.
- L1 Calorimeter trigger: counting room.
- DT, RPCs and CSCs form track segments. These systems are mounted on the chambers and in racks outside the detector. Segments are transmitted via optical fibers to the DTTF electronics in counting room .
- GT is placed in the counting room close to the other L1 Trigger Components.

L1 LATENCY

- L1 decision made at fixed time and transmitted through the Trigger Throttle System (TTS) to the TTC and then to the detector frond-ends for readout. Optical fibers used for this.
- Data stored in a pipeline for a maximum of 3.2microseconds.
- L1 trigger calculations must be made in less than 1 microseconds.
- L1 decision is transmitted every 25ns.
- If L1 transmits an accept (L1A), the data is moved to a buffer for readout and processing by the High Level Triggers.
- The event data waiting in pipelines on the detector, and the trigger data in the pipelines of the trigger electronics that are placed in the counting room is then read out.

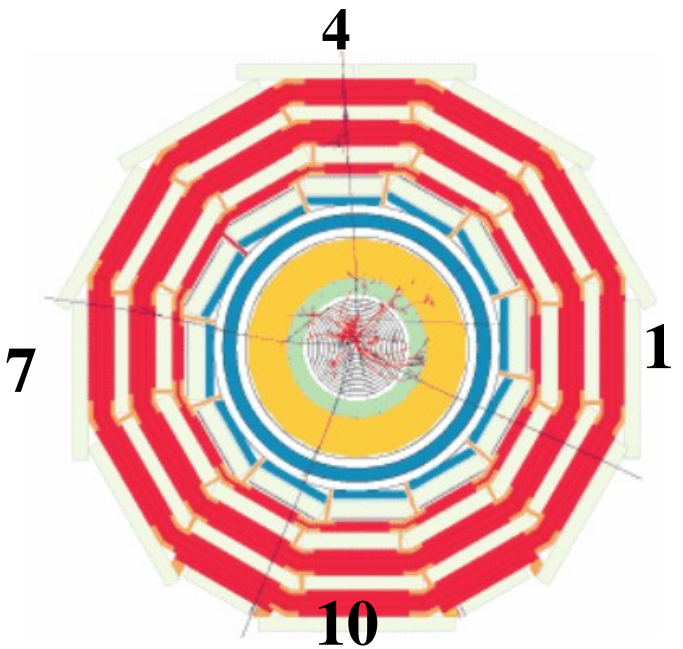
Sectors in Global Runs



DT Yoke Barrel Wheel 0

- **June GR:**
  - DT sector 4.
  - L1trigger comp: DTTF GMT GT.
- **August GR:**
  - DT sector 10.
  - L1trigger comp: DTTF GMT GT, CSCTF, GTFE
- **July GR:**
  - DT sector
  - L1trigger comp: DTTF GMT GT GCT, HCAL, Tracker

Small part of the detector included but: **Full vertical chain/slize**.



Global Runs

- Simple Trigger requirements used:
  - If there are muon segments in 2 or more stations we trigger.
  - Only reason for not triggering would be if the above requirement is not fulfilled or trigger is prohibited by trigger rules.
  - Trigger Rules: Only allows a certain number of events in a given timeperiod:

    1) No more than 1 Level 1 Accept per 75 ns (minimum 2 bx between L1A), dead time 5.10-3.

    2) No more than 2 Level 1 Accepts per 625 ns (25 bx), dead time 1.3.10-3.

    3) No more than 3 Level 1 Accepts per 2.5 μs (100 bx), dead time 1.2.10-3.

    4) No more than 4 Level 1 Accepts per 6 μs (240 bx), dead time 1.4.10-3.

June G.R

- We chose to look at 4 runs: Run 12153, 12411, 12436,12443.
  - DTTF readout timed in.
  - GMT readout not timed in->no trigger data from GMT.
  - Some runs had DTDDU readout included.
- The available data allowed us to look into bunch assignment of the detected muon segments. 3 bunches are read out if L1A:
  - Triggered events are placed in bunch 0.
  - Data from previous bunch in -1, data from following bunch in 1.
    - We expect all events having segments in bunch 0, and possibly in bunch 1.
    - Segments in bunch number -1 should not fulfill trigger requirements otherwise they would have produced L1A and therefore would be placed in bunch 0.
      - Inconsistent in June G.R.
  - We also observed some noise-events.

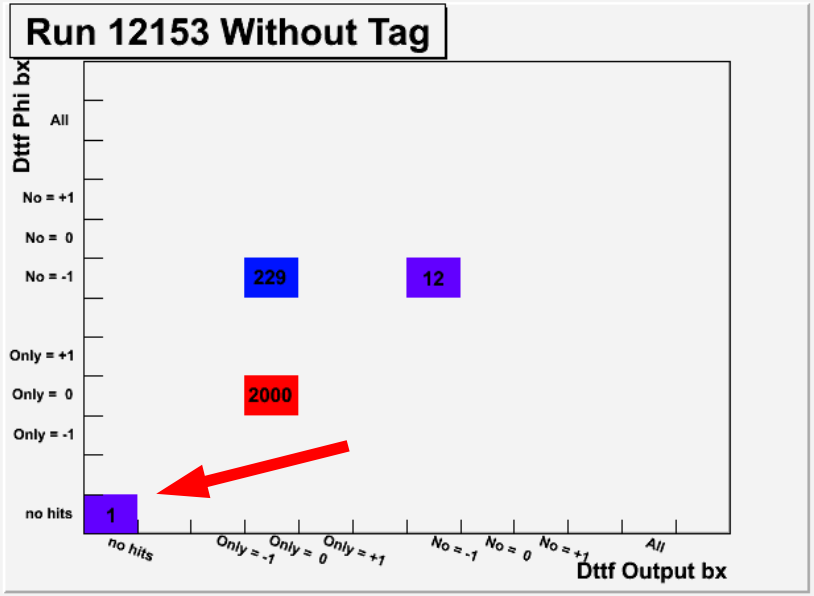
Some Results – June G.R

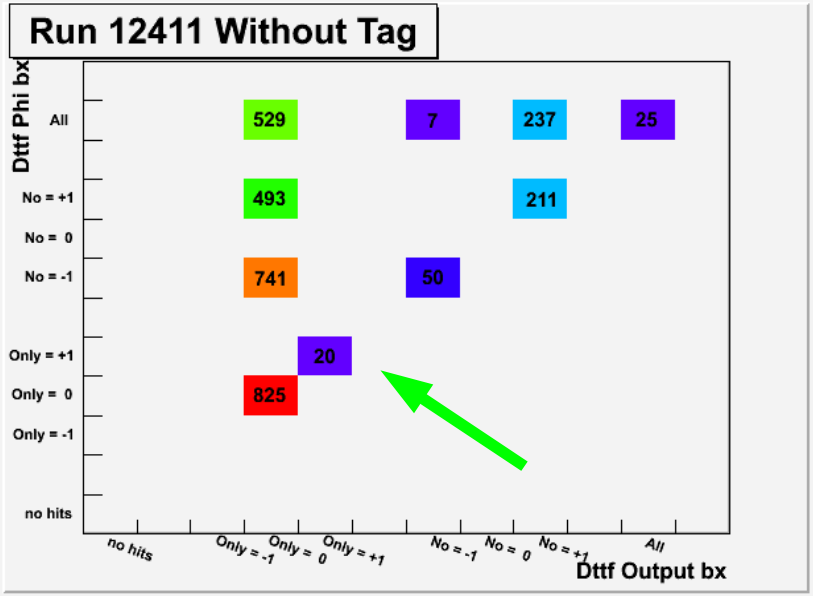
All bunches

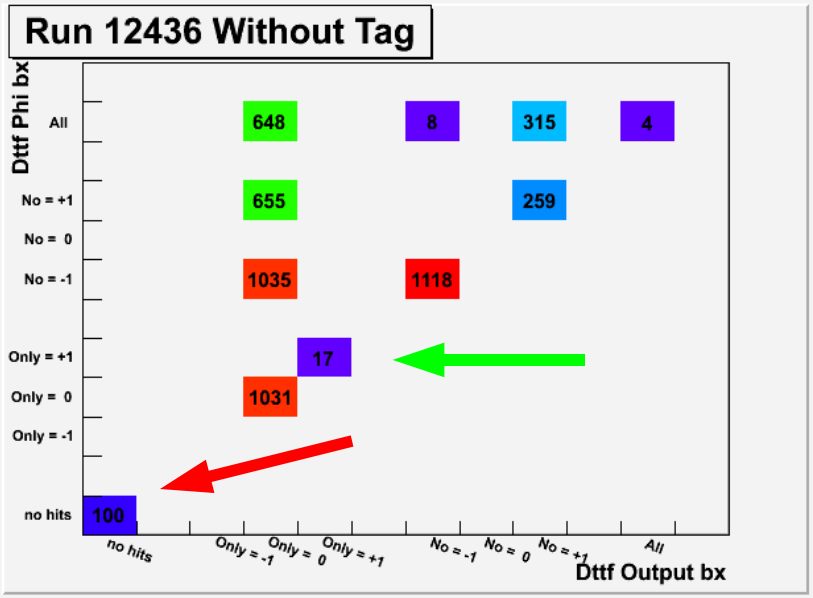
Bxes -1 and 0
Bxes -1 and 1
Bxes 1 and 0

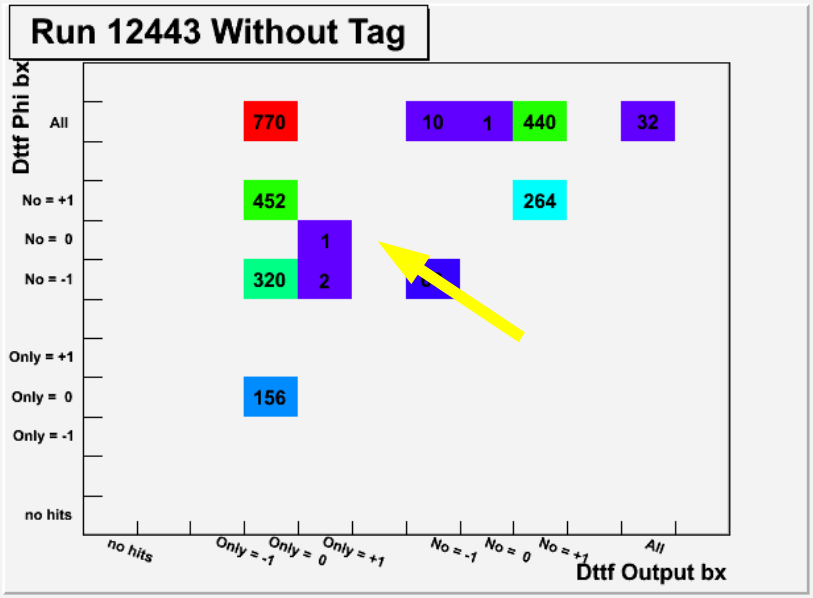
Only bunch 1
Only bunch 0
Only bunch -1

No segments









Some Results – June G.R

- Data suggested at first glance correlation between noise-events and shift in bunch assignment.
- But DTTF experts explained that there had been manual interventions with DTTF DCC (Readout board)

```
Event filled bx  0 and 1: PHI    Ltc event number:36   Jentry: 34
Event filled bx  0 and 1: PHI    Ltc event number:35   Jentry: 35
Event filled bx  0 and 1: PHI    Ltc event number:37   Jentry: 36
Event filled bx  0 and 1: PHI    Ltc event number:38   Jentry: 37
>100 Hits deltatinsec 0.0994646   deltatinbx: 3976246   ltc eventnumber: 39   jentry38
Event filled bx  0 and 1: PHI    Ltc event number:39   Jentry: 38
>100 Hits deltatinsec 5.8825e-05   deltatinbx: 8   ltc eventnumber: 40   jentry39
Event only filled bx 1: OUTPUT Ltc event number:40   Jentry: 39
deltatinsec: 11.5231
Event only filled bx 1: PHI    Ltc event number:40   Jentry: 39
>100 Hits deltatinsec 6.3375e-05   deltatinbx: 95   ltc eventnumber: 43   jentry40
Event only filled bx 1: OUTPUT Ltc event number:43   Jentry: 40
deltatinsec: 6.3375e-05
Event only filled bx 1: PHI    Ltc event number:43   Jentry: 40
>100 Hits deltatinsec 5.725e-05   deltatinbx: -75   ltc eventnumber: 42   jentry41
Event only filled bx 1: OUTPUT Ltc event number:42   Jentry: 41
deltatinsec: 5.725e-05
Event only filled bx 1: PHI    Ltc event number:42   Jentry: 41
>100 Hits deltatinsec 5.8525e-05   deltatinbx: -12   ltc eventnumber: 41   jentry42
Event only filled bx 1: OUTPUT Ltc event number:41   Jentry: 42
deltatinsec: 5.8525e-05
Event only filled bx 1: PHI    Ltc event number:41   Jentry: 42
Event only filled bx 1: OUTPUT Ltc event number:44   Jentry: 43
deltatinsec: 0.0164343
Event only filled bx 1: PHI    Ltc event number:44   Jentry: 43
Event only filled bx 1: OUTPUT Ltc event number:45   Jentry: 44
deltatinsec: 0.00260675
Event only filled bx 1: PHI    Ltc event number:45   Jentry: 44
Event only filled bx 1: OUTPUT Ltc event number:46   Jentry: 45
deltatinsec: 0.118447
Event only filled bx 1: PHI    Ltc event number:46   Jentry: 45
Event only filled bx 1: OUTPUT Ltc event number:47   Jentry: 46
deltatinsec: 0.180047
Event only filled bx 1: PHI    Ltc event number:47   Jentry: 46
Event only filled bx 1: OUTPUT Ltc event number:48   Jentry: 47
deltatinsec: 0.201042
Event only filled bx 1: PHI    Ltc event number:48   Jentry: 47
Event only filled bx 1: OUTPUT Ltc event number:49   Jentry: 48
deltatinsec: 0.193635
Event only filled bx 1: PHI    Ltc event number:49   Jentry: 48
Event only filled bx 1: OUTPUT Ltc event number:50   Jentry: 49
deltatinsec: 0.218582
Event only filled bx 1: PHI    Ltc event number:50   Jentry: 49
Event only filled bx 1: OUTPUT Ltc event number:51   Jentry: 50
```

Only bunch 1 filled

Noise

DT events with very large number of hits. Clearly not from cosmics. Correlated to external noise.

Some Results – June G.R

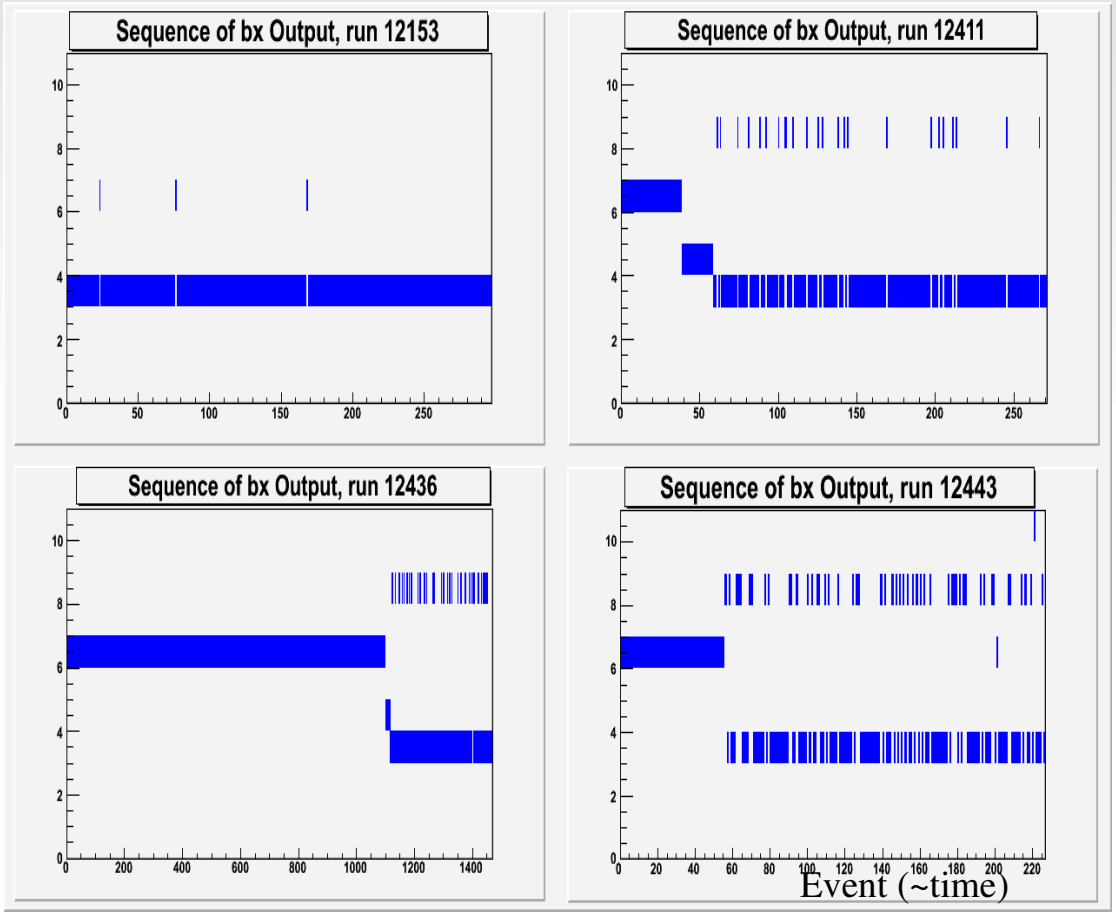
- These manual interventions seem to explain our observations for the jumps in start-up of the runs.
- The case where there are no data has not been explained.

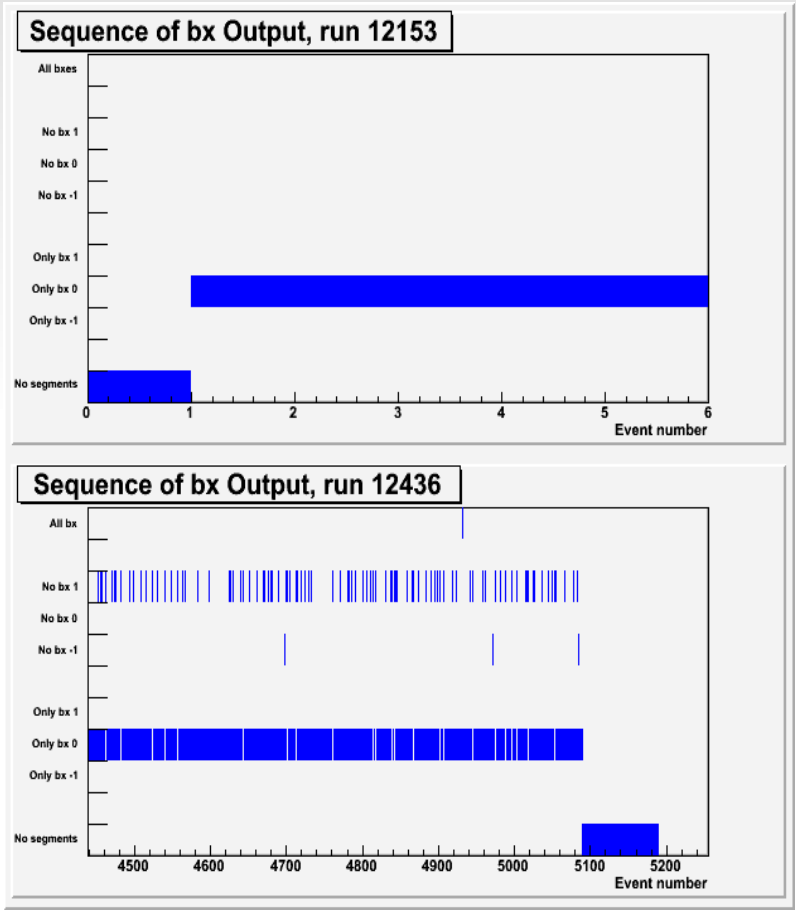
All bunches

Bxes -1 and 0
Bxes -1 and 1
Bxes 1 and 0

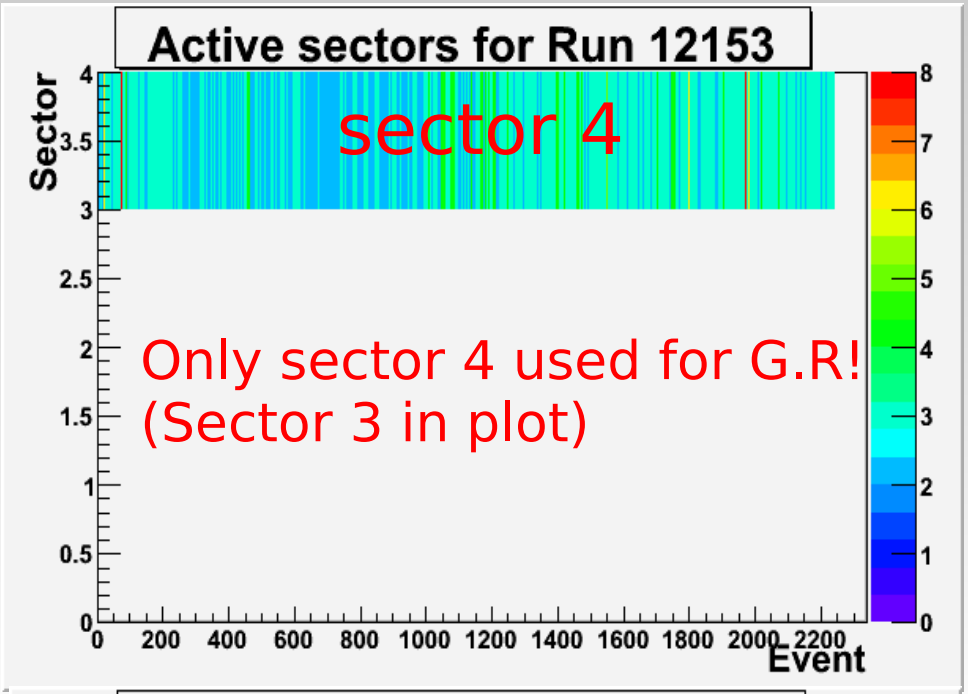
Only bunch 1
Only bunch 0
Only bunch -1

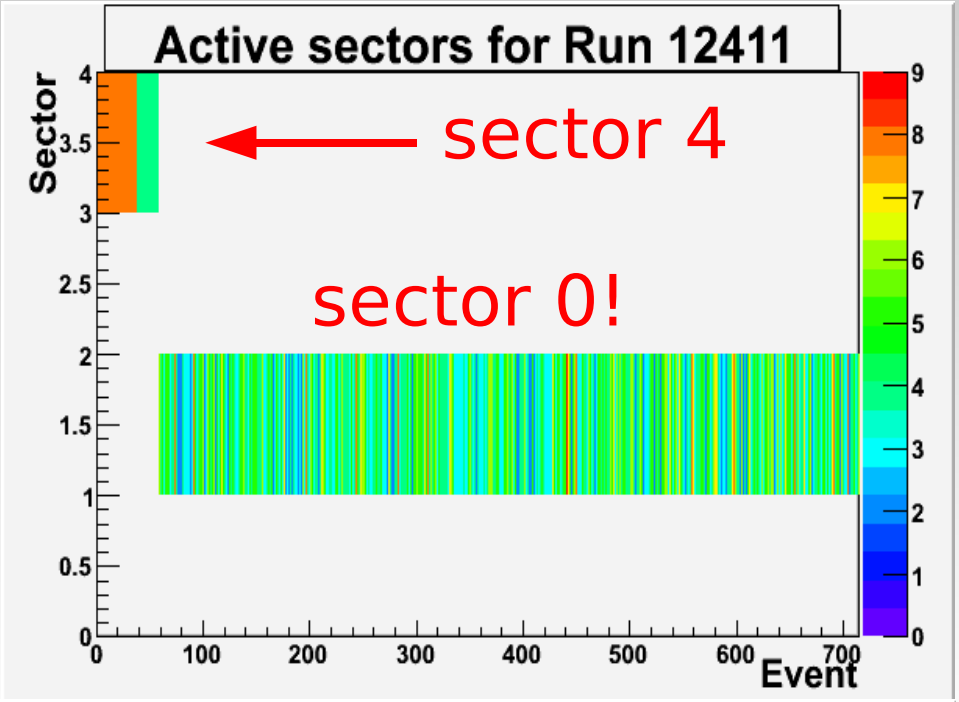
No segments

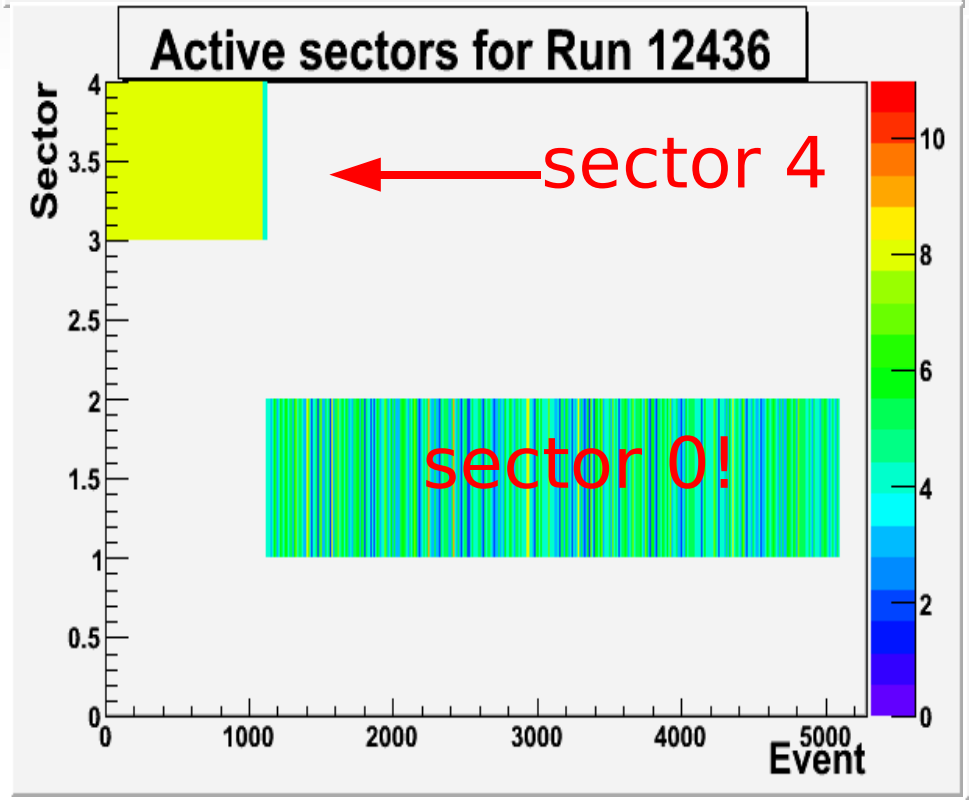


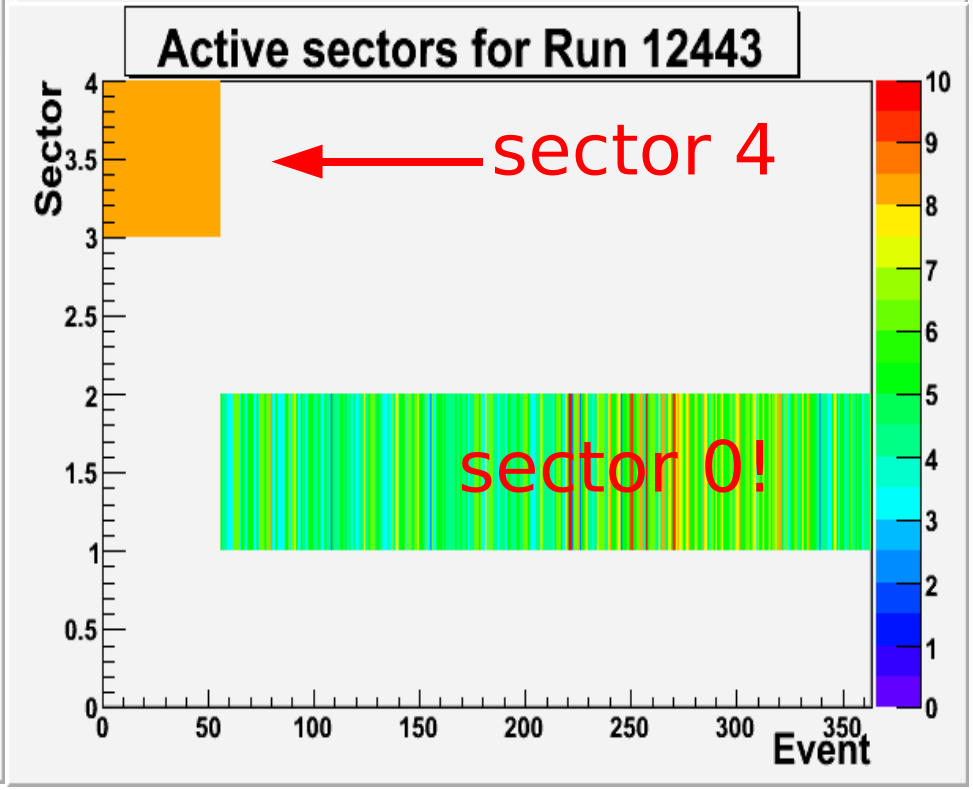


- Some bunch code plots **included in online monitoring**.


Active sectors for Run 12153
sector 4
Only sector 4 used for G.R!
(Sector 3 in plot)
Sector
Event


Active sectors for Run 12411
sector 4
sector 0!
Sector
Event


Active sectors for Run 12436
sector 4
sector 0!
Sector
Event

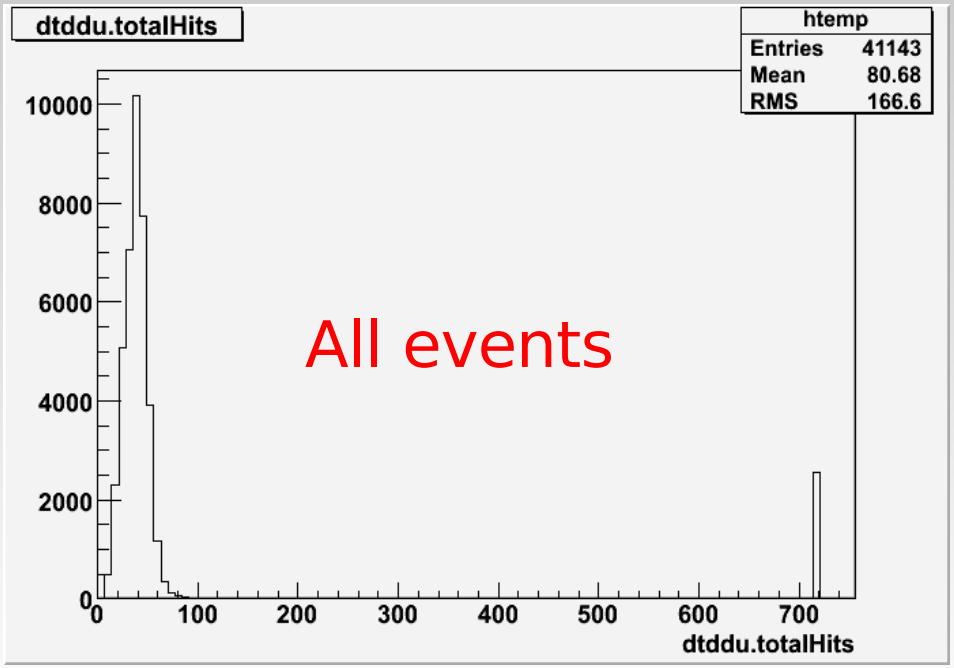

Active sectors for Run 12443
sector 4
sector 0!
Sector
Event

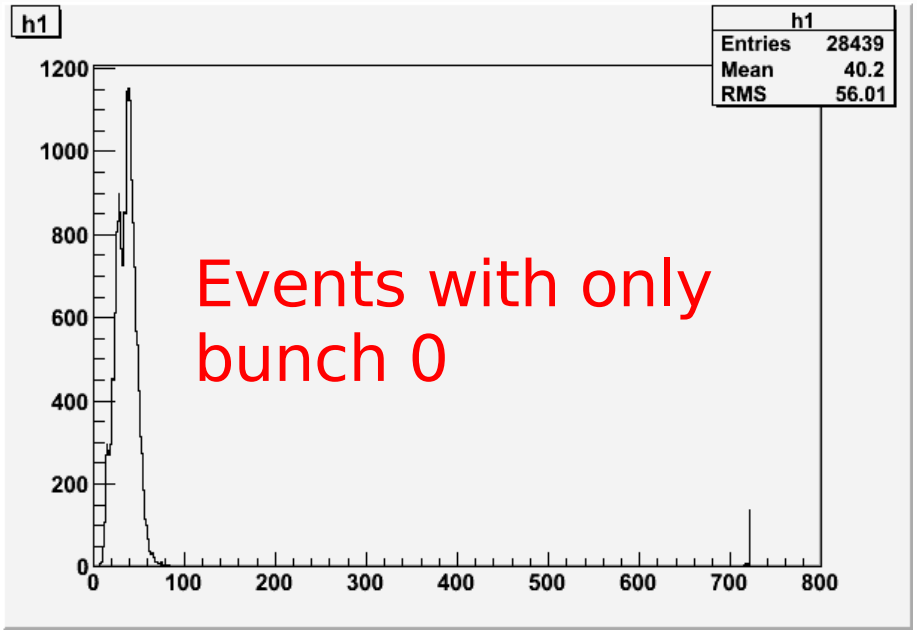
July G.R.

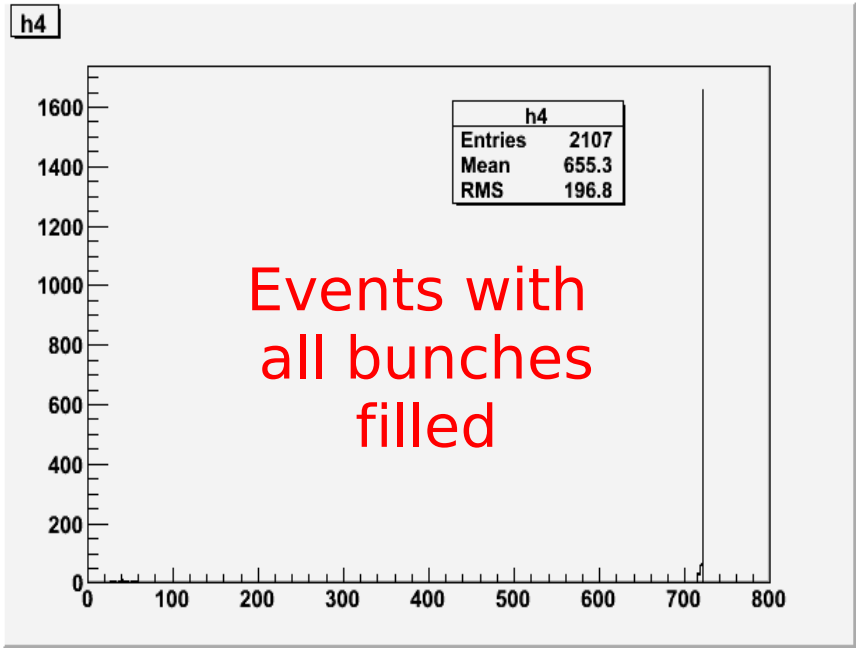
- **DTTF** readout not timed in properly.
  - ->Not any data from DTTF
- But **GMT readout** timed in.
- **GT readout** timed in, but not all GT boards included ->missing orbit number (real time).
- Some Runs with **DTDDU** data.

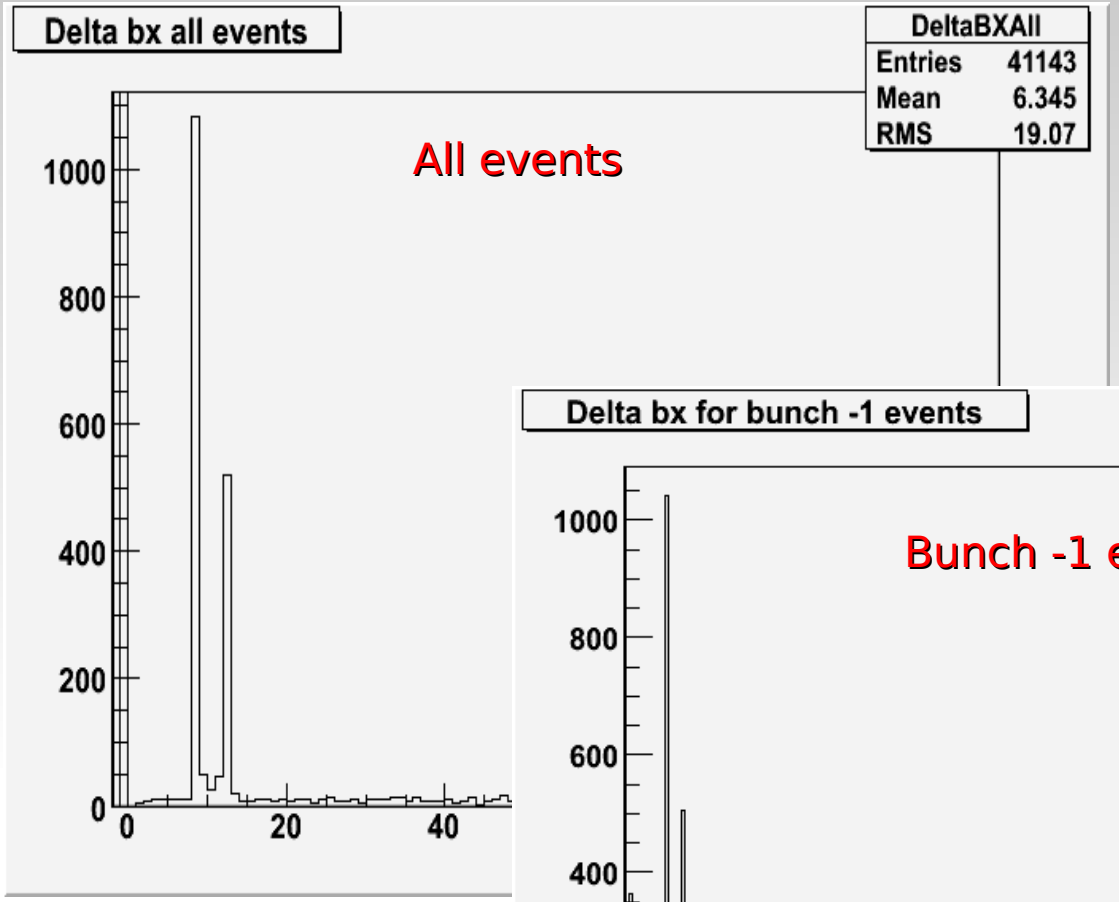
- We have looked at multiple runs.
- From the **GMT data** available:
  - We do not any longer see jumps in beginning of run.
  - Still events with muons in both bunch -1 and bunch 0. Did these not fulfill trigger requirement?
  - Also noise events in July G.R.

From the full event data
Number of hits per event
Hit if a wire lights up

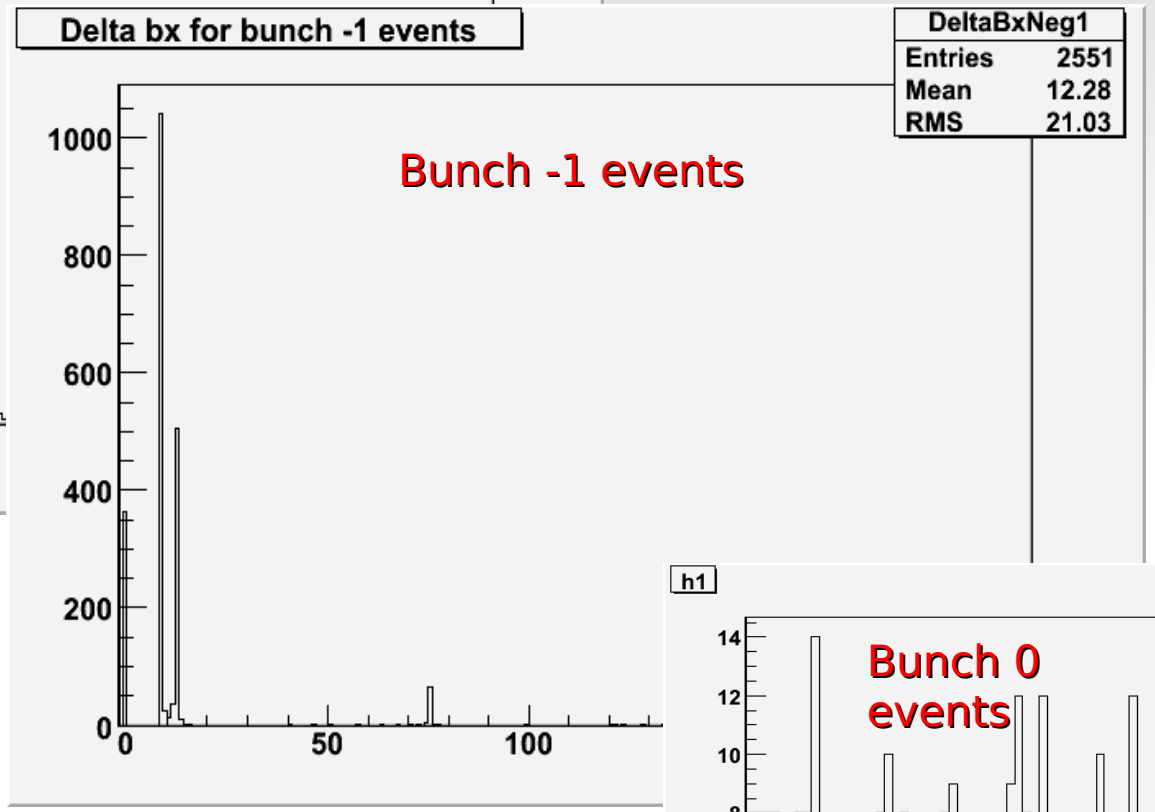


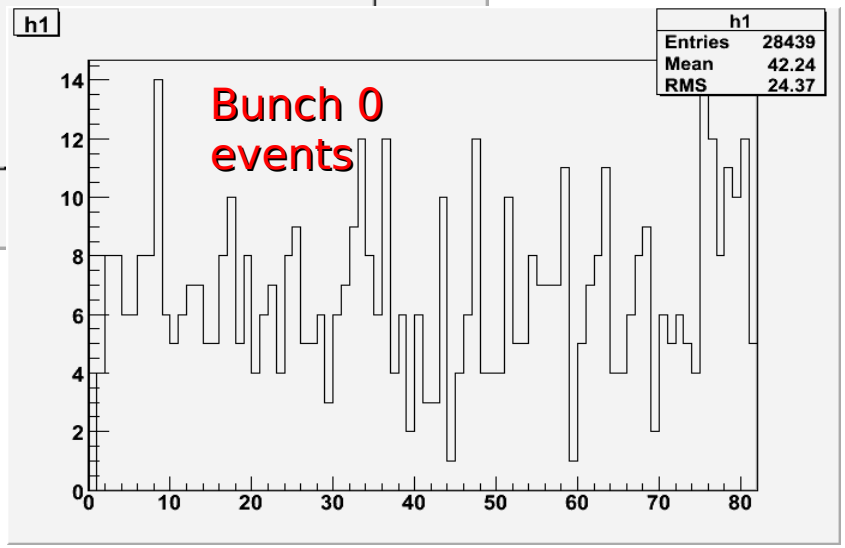




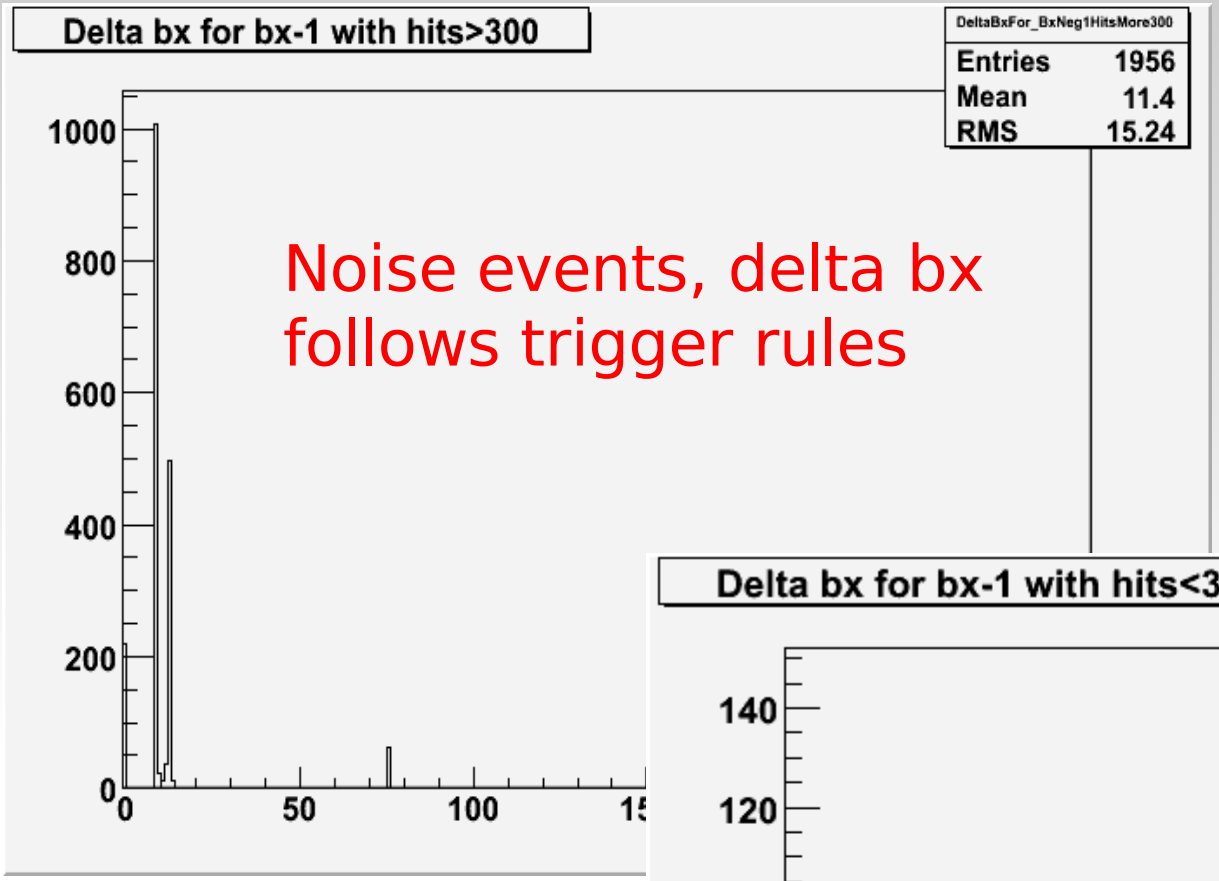


Delta bunch= Real bunch number this event - Real bunch number last event.

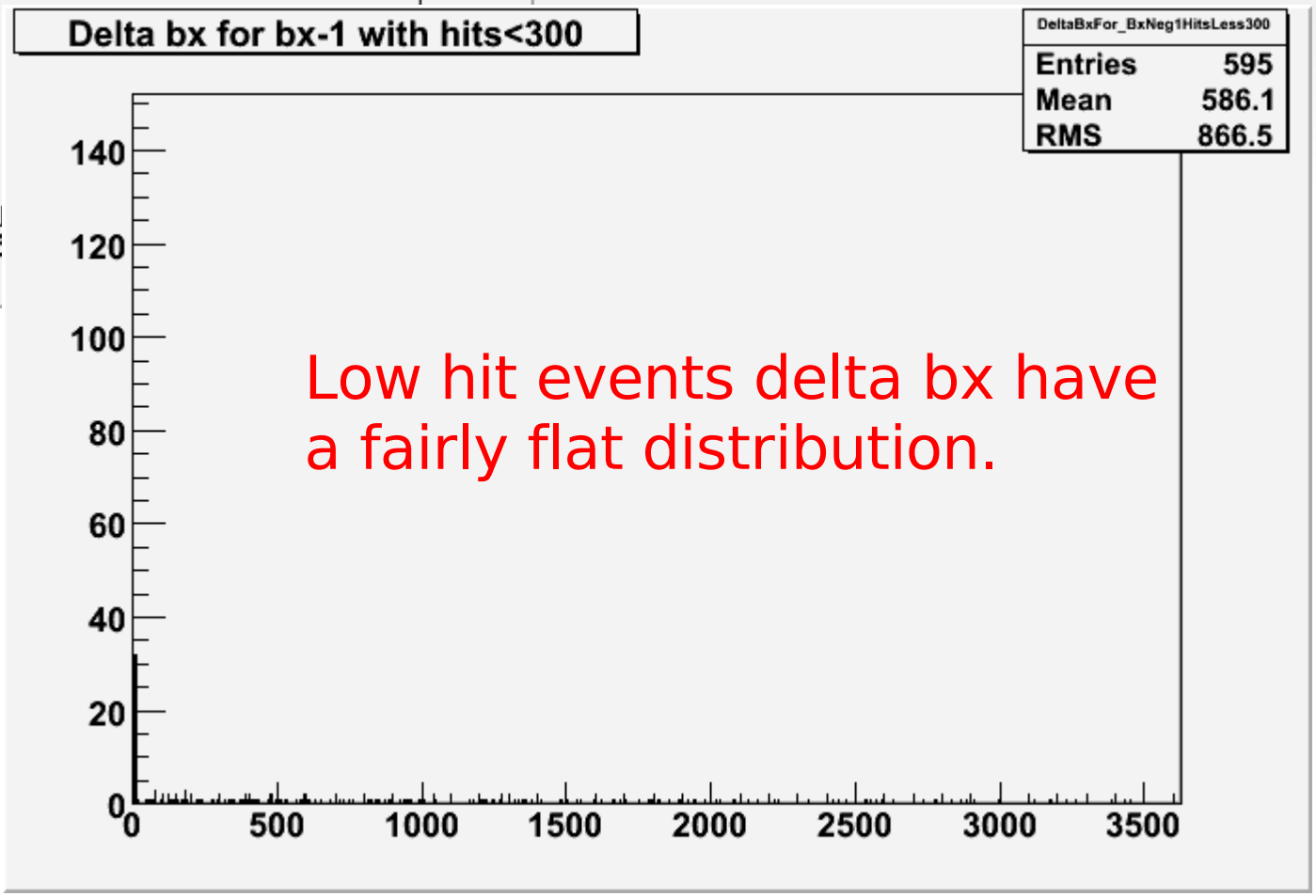




These and previous plots show correlation between noise events and bunch -1 events.

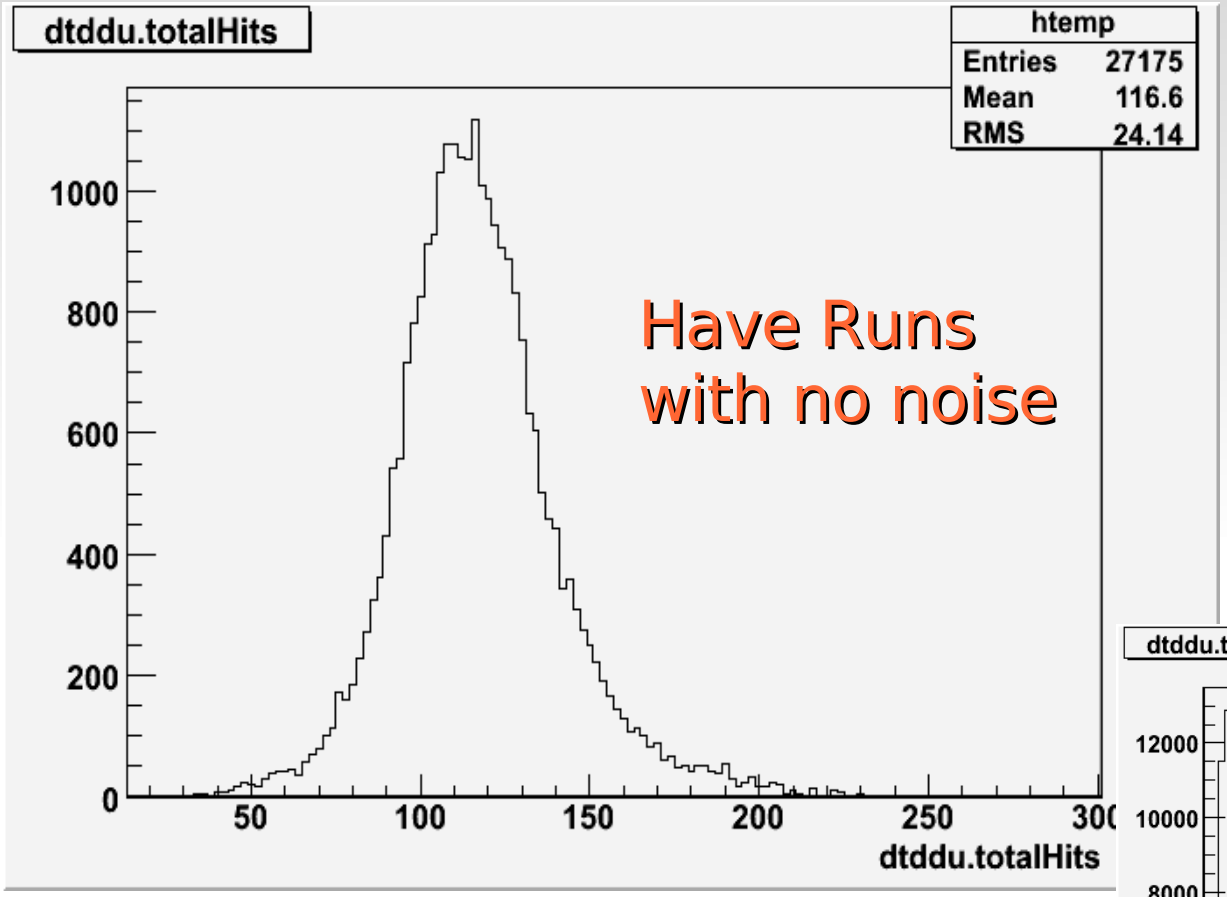


Noise events, delta bx follows trigger rules

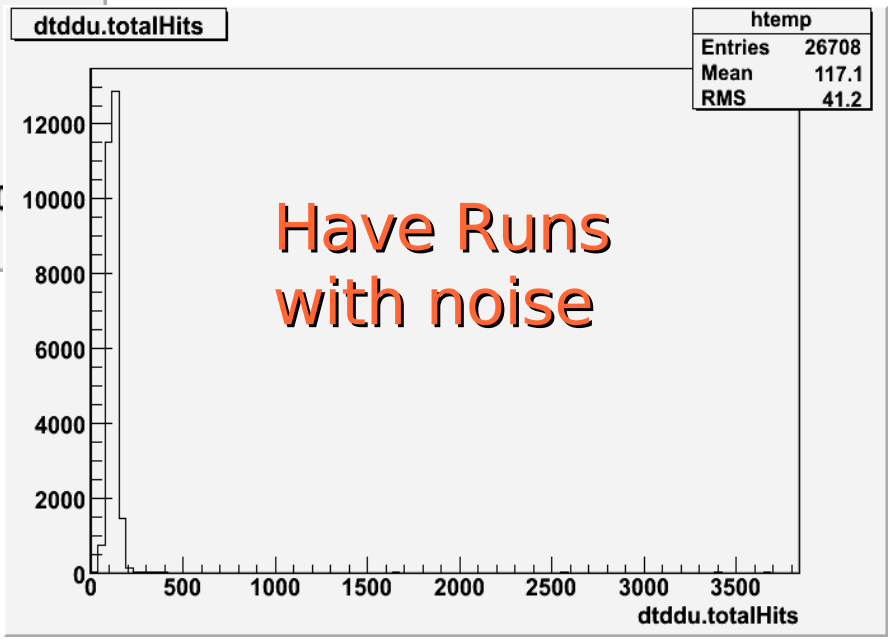


Low hit events delta bx have a fairly flat distribution.

August G.R.

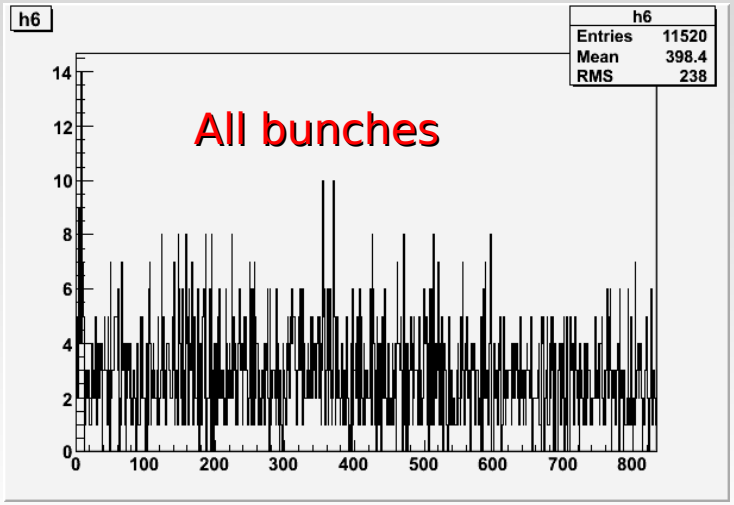


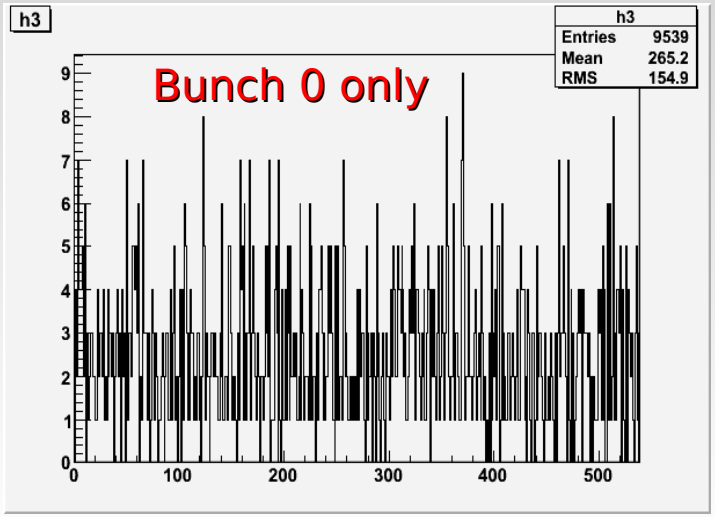
Have Runs with no noise



Have Runs with noise

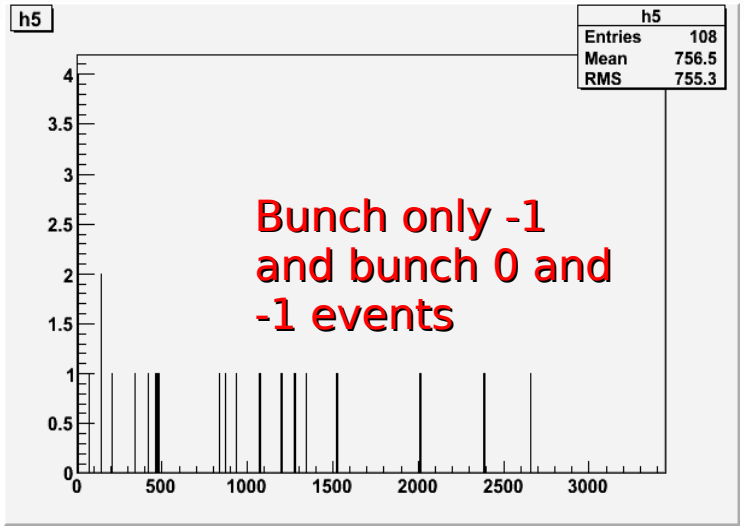
August G.R.

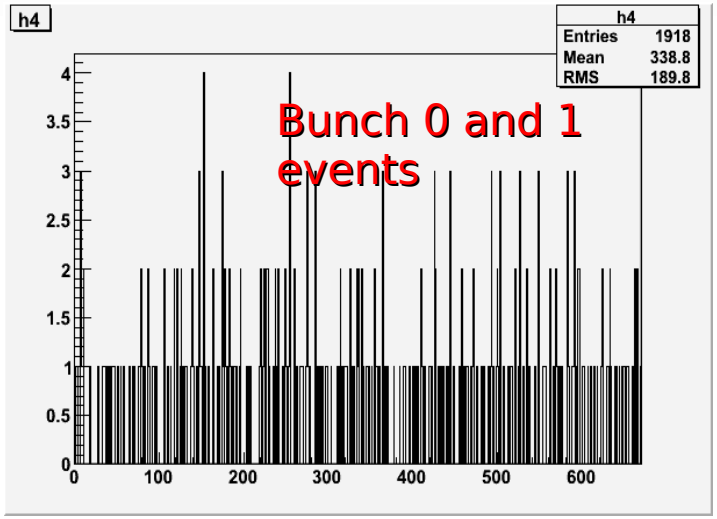




This Run has almost no noise.

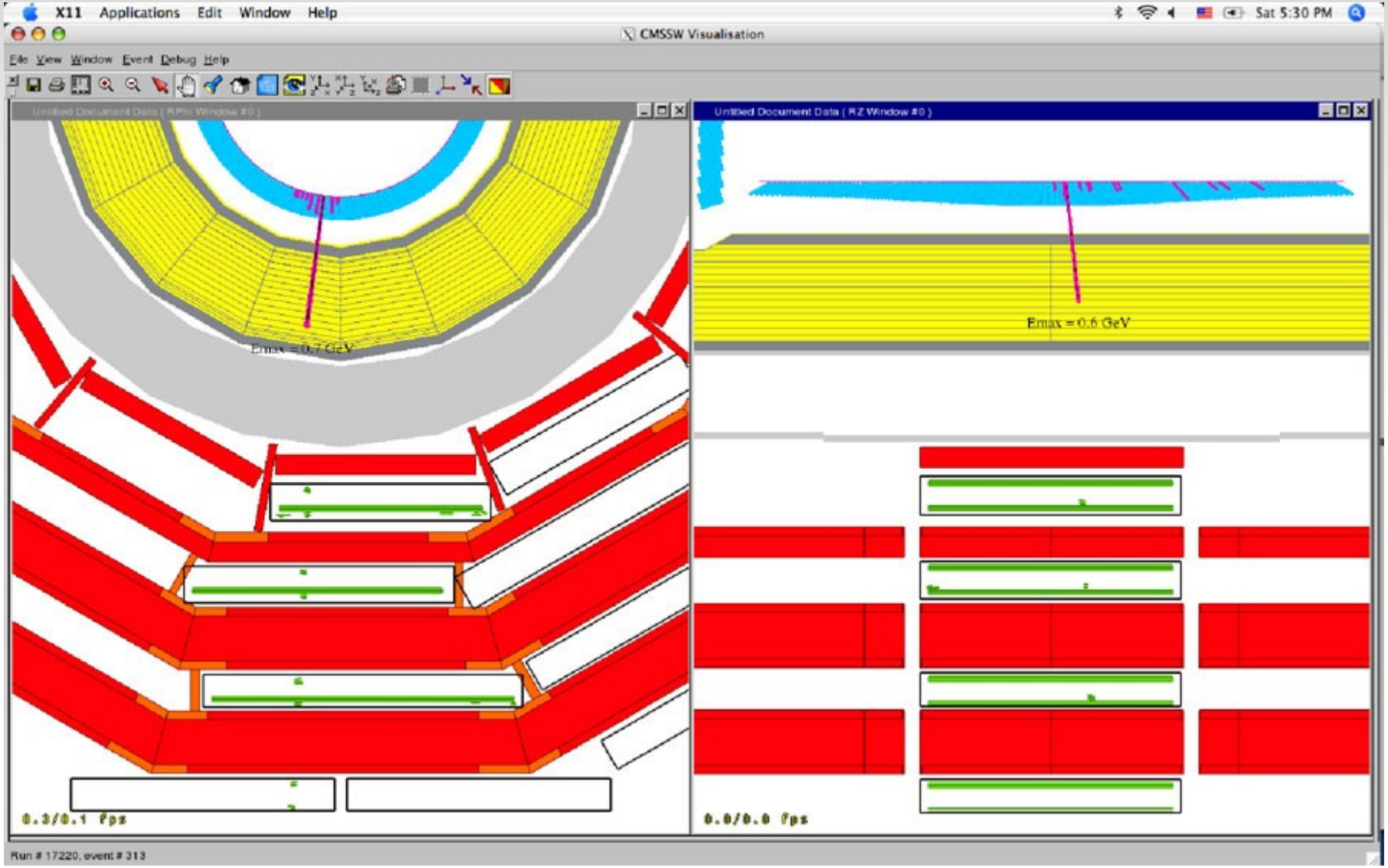
Still muons in bunch -1.





Summary

- We found a higher occurrence of noise events for the bunch -1 assignment.
- Could see that a lot of the events were truly noise with very high frequency. Trigger Rules have prohibited trigger and worked properly for these cases.
- But also events where there is no obvious correlation with noise. Why are there muons in bunch -1 in these cases? Seems that these muons should have triggered and been placed in bunch 0. Trigger latency?
  - This is an open question, and time did not allow further investigation. Have however pointed out possible problems to be checked out in more detail.


X11 Applications Edit Window Help
Sat 5:30 PM
CMSSW Visualisation
File View Window Event Debug Help
Untitled Document Data (RPhi Window #0)
Emax = 0.7 GeV
0.3/0.1 fps
Untitled Document Data (RZ Window #0)
Emax = 0.6 GeV
0.0/0.0 fps
Run # 17220, event # 313


CMSEYE_UCR1 2007-08-29 15:53:06