HLT Commissioning/Operations and Plans

CMS Run and DPG Commissioning Workshop, Torino

Geoffrey Smith on behalf of the FOG group

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Field Operations Group

FOG group of the TSG

- https://twiki.cern.ch/twiki/bin/viewauth/CMS/FieldOperationsGroup
- Responsible for online testing and deployment of HLT menus, providing on-call HLT experts
- Close coordination with DAQ, L1
- Rate monitoring, timing, data certification tasks

Coordinators

- Geoffrey Smith
- Michele De Gruttola

2017 HLT DOCs

- DOC 1: primary HLT on-call
  - Responsible (24/7) for the HLT for data-taking
  - Answers DOC phone; responds immediately to problems as they occur
  - Tests + deploys new HLT menus and changes to existing menus. Handles (timely) requests for special menus.
  - Tests new L1 menus before they are deployed, and coordinates with L1 DOC on L1+HLT prescales.
  - Fast-track validation of conditions updates
- DOC 2: secondary HLT on-call
  - Responsible for certification of runs for HLT
  - Helps primary on-call as needed (for example with fast-track validation)
- DOC 3: validation of conditions
  - Responsible for weekly ("full") validation of conditions updates

HLT issues in 2016

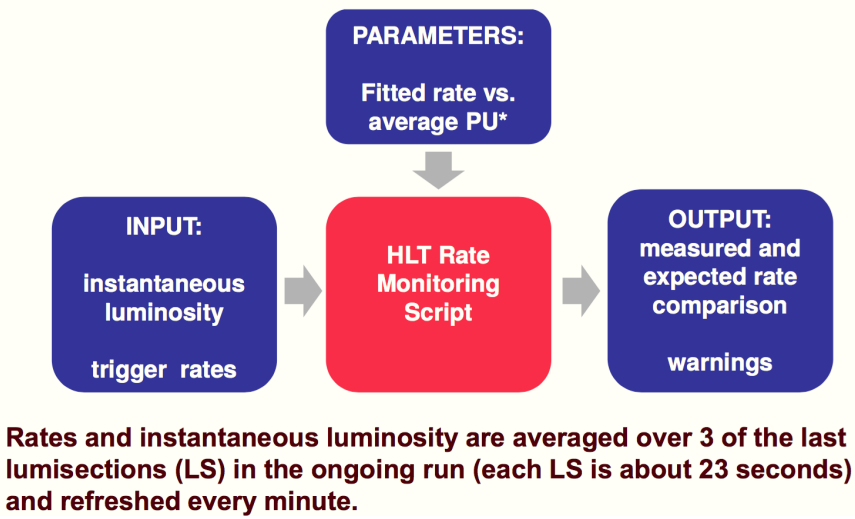
- Bugs affecting HLT over course of the year:
  - Run2016B - L1-HLT objects matching
  - HLT H/E issue: disagreement between HLT and offline mitigation of out-of-time PU for HCAL (affecting all e/γ triggers). Fixed in era H.
  - Miss-configuration of single electron trigger (no rho correction) in era F-G ("v6"), fixed in era G ("v7")
- For full details see:
  - https://indico.cern.ch/event/578112/contributions/2342005/attachments/1373168/2083746/L1HLT_Pam17November2016.pdf
  - https://twiki.cern.ch/twiki/bin/viewauth/CMS/KnownHLTIssuesOnline2016
- Number of measures in place to test new menus / changes to menus before they go online (next slides)

Hilton validation

- Full collisions menu undergoes suite of offline tests by STORM, STEAM (rates, timing)
- FOG then performs online test on hilton before deploying. Also done for cosmics and special menus prepared by FOG
- TSG policy: not just for new menus, but for all HLT menus – every time a change is made, it is tested on hilton first before deploying!
  - Automated check for necessary streams, dataset, event content
  - Consistency check with L1 menu
  - HLT menu tested by running on hilton in online-like way (with hltd)
  - Test also done for conditions updates
  - DQM can also be checked on hilton
- Changes need to be announced before being deployed, to allow FOG to validate them

HLT rate monitoring tool

- Checks rates of several key triggers (L1 and HLT) by comparing against reference rate.
- If the difference between the actual and predicted rate is too large ($> 5\sigma$ deviation from fit for 3 consecutive LS), a visual and audio warning is activated in the control room.



Rates and instantaneous luminosity are averaged over 3 of the last lumisections (LS) in the ongoing run (each LS is about 23 seconds) and refreshed every minute.

- HLT rates are very sensitive to the status of the whole detector, and a deviation from the prediction can possibly be caused by a detector issue.

HLT rate monitoring tool (II)

```
INFORMATION:
Run Number: 256936
LS Range: 0 - 714
Last LHC Status: Cycling
Number of colliding bunches: 1165
Trigger Mode: l1_hlt_collisions2015/v247 (collisions)
Number of HLT Triggers: 451
Number of L1 Triggers: 116
Number of streams: 14
```

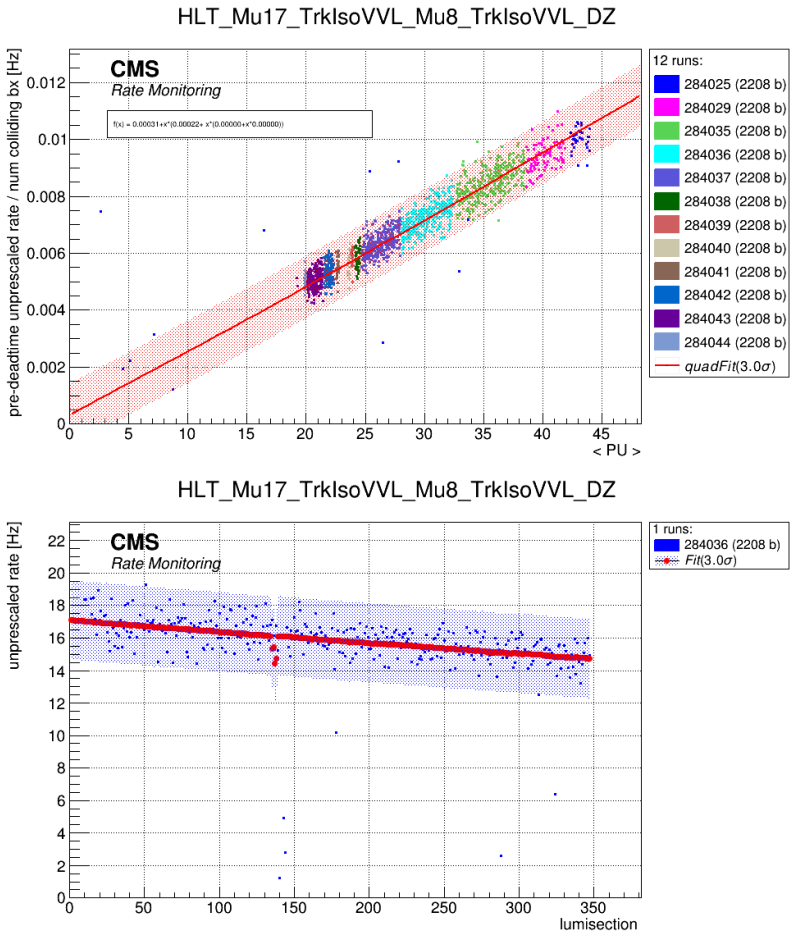
* TRIGGER NAME	* ACTUAL [Hz]	* EXPECTED	* % DIFF	* DEVIATION	* AVE PS	* COMMENTS
Predictable HLT Triggers (ones we have a fit for)						
*** HLT_PFMET120_PFMHT120_IDTight**	*** 10.73**	*** 1.63**	*** 558.98**	*** 44.84**	*** 1.00**	*****
*** HLT_PFMET170_NoiseCleaned**	*** 6.06**	*** 1.92**	*** 215.08**	*** 15.35**	*** 1.00**	*****
* HLT_Ele27_WPLoose_Gsf	* 53.62	* 58.76	* -8.76	* -2.20	* 1.00	*
* HLT_IsoMu27	* 17.62	* 19.07	* -7.59	* -1.72	* 1.00	*
* HLT_DoubleMediumIsoPFTau35_Trk1_eta2p1_Reg	* 6.15	* 6.73	* -8.62	* -1.28	* 1.00	*
* HLT_Mu45_eta2p1	* 7.68	* 8.30	* -7.38	* -1.22	* 1.00	*
* HLT_AK8DiPFJet250_200_TrimMass30_BTagCSV0p45	* 8.67	* 9.34	* -7.18	* -1.17	* 1.00	*
* HLT_Ele105_CaloIdVT_GsfTrkIdT	* 3.30	* 3.60	* -8.42	* -0.95	* 1.00	*
* HLT_DoubleEle33_CaloIdL_GsfTrkIdVL	* 2.29	* 2.48	* -7.73	* -0.77	* 1.00	*
* HLT_Mu17_TrkIsoVVL_Mu8_TrkIsoVVL_DZ	* 3.08	* 3.29	* -6.39	* -0.71	* 1.00	*
* HLT_HT650	* 16.08	* 16.58	* -3.04	* -0.64	* 1.00	*
* HLT_PFHT800	* 5.77	* 6.04	* -4.45	* -0.59	* 1.00	*
* HLT_PFJet450	* 2.26	* 2.36	* -4.23	* -0.36	* 1.00	*
* HLT_Mu23_TrkIsoVVL_Ele12_CaloIdL_TrackIdL_IsoVL	* 0.48	* 0.52	* -7.35	* -0.36	* 1.00	*
* HLT_Photon36_R9Id85_OR_CaloId24b40e_Iso50T80L_Photon22_AND_HE10_R9Id65_Eta2_Mass15	* 3.92	* 4.00	* -1.88	* -0.23	* 1.00	*
* HLT_Photon175	* 2.22	* 2.27	* -1.95	* -0.19	* 1.00	*
* HLT_CaloJet500_NoJetID	* 1.94	* 1.99	* -2.37	* -0.18	* 1.00	*
* HLT_MET250	* 2.45	* 2.40	* 2.06	* 0.17	* 1.00	*
* HLT_QuadJet45_TripleBTagCSV0p67	* 1.20	* 1.17	* 2.63	* 0.17	* 1.00	*

```
SUMMARY:
Triggers in Normal Range: 533    |    Triggers outside Normal Range: 3
Prescale column index: 5
Average inst. lumi: 2007.90734991 x 10^30 cm-2 s-1
All triggers deviating past thresholds from fit and/or L1 rate > 30000 Hz, HLT rate > 200 Hz: L1_SingleEG2_BptxAND, HLT_PFMET120_PFMHT120_IDTight, HLT_PFMET170_NoiseCleaned,
Trigger L1_SingleEG2_BptxAND has been out of line for more than 1 minutes
Trigger HLT_PFMET120_PFMHT120_IDTight has been out of line for more than 1 minutes
Trigger HLT_PFMET170_NoiseCleaned has been out of line for more than 1 minutes
```

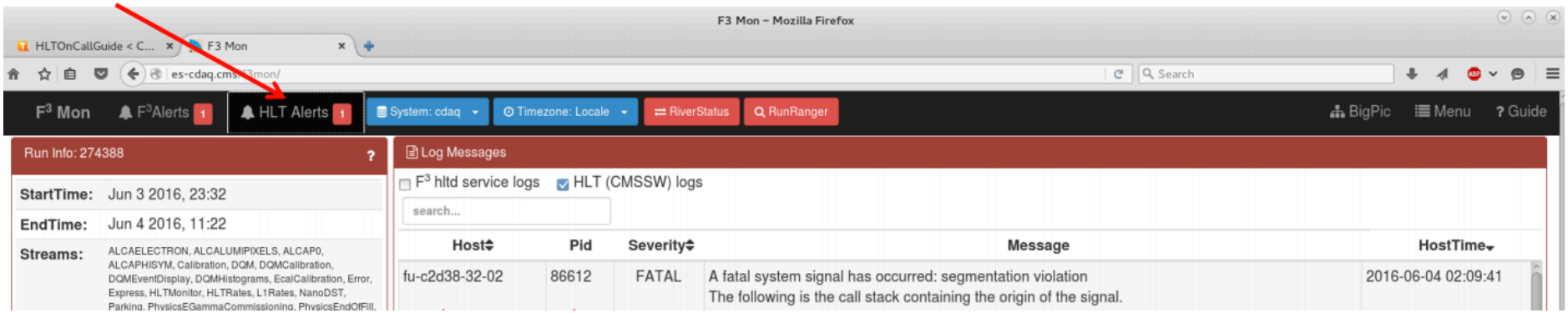
- In this example the PFMET triggers are raising an alarm due to larger than expected rate. Indeed there was a problem in the HF occupancy.
- This screen monitored by trigger shifter
- Visual warning (yellow line), audio alarm at p5, and email sent to FOG.

HLT rate monitoring tool (III)

- In addition to script run by trigger shifter, rate monitoring code contains suite of tools for offline use by experts / HLT DOC
- Cron job once every hour during data-taking that makes plots of rate vs. PU, uploads to web area.
  - gesmith.web.cern.ch/gesmith/HLT/RateVsPU/
  - Rates of every HLT and L1 trigger, as well as stream rates; organized by fill, era
  - Working to integrate into WBM
- The secondary HLT doc also uses the tool to plot rate vs. LS to examine performance during individual runs for data certification
- For more info see: twiki.cern.ch/twiki/bin/viewauth/CMS/RateMonitoringScriptWithReferenceComparison



HLT error stream events



- "Error stream events:" events that cause crashes in the HLT
- When a crash happens, DAQ produces log files locally, as well as in elastic search that are propagated to HLT experts together with stack traces.
- Data files saved in error area are copied to Hilton test stand for further analysis
- An automated process communicates to HLT experts that error data is available

HLT "prompt monitoring"

- To improve on our ability to spot issues during data taking in order to promptly react with the proper fixes, this year we will require an improved trigger monitoring strategy before a path will be included in the HLT menu.
- Rely on "multirun harvesting" to collect enough statistics to monitor low rate triggers or differential quantities
- In order to reach this goal, trigger developers / TSG are in the process of identifying (for each path):
  - The list of monitored quantities (if any) in the offline DQM, and their reliability/usefulness on providing proper monitoring of the trigger
  - The observables used for the trigger performance studies in offline analyses
  - The strategy and the corresponding events used for such analyses
  - The typical statistics used for trigger performance studies in offline analyses, and the minimum statistics needed for getting reasonable results online.
  - The typical latency for analyzing/monitoring/checking performance, and if not done promptly (i.e. within a week of the data being collected), what is the main source for the delay
  - What would be required to implement an (even simple) analysis in the online and/or offline DQM.

Upcoming MWGRs

MWGR 1 (8-10 Feb)

- Migrate cosmic and other FOG menus to 81X template
- Run HLT online in 810 (with 530 scram arch)
- Possible update to CC7

MWGR 2 & 3 (March)

- Migrate cosmic and other FOG menus to 90X template
- Run HLT online in 900

CRUZET/CRAFT (March-May)

- Take cosmic data
- (Cosmic menu should already be made available during the MWGRs)
- Special requests? (Possible early alignment of strip detector)

Special menus for commissioning period

- Magnet on April 29
- First beams May 1, first stable beams June 12
  - Dedicated menus for splashes, quiet beams
- Alignment/calibration needs for first collisions: see dedicated talks this workshop
- Further discussion at upcoming AlCa-DB workshop (indico.cern.ch/event/592618/)

Need to align the new pixel detector as quickly as possible during the first days of collision + magnet

- Will need high rate of ZeroBias + MinimumBias during first collisions; possibly also high-pt jet or HT triggers. On the order of 20 kHz (L1 rate) of L1_ZeroBias for calibration paths.
- Express stream content under discussion

Expectation for large structure misalignment?

- I.e., pixels wrt Strips and whole tracking wrt Ecal
- Would affect some variables we cut on, for example for electron triggers

Plans for collisions menu

April-May

- Deadline for trigger proposals around April 20th
- Finalize collisions menu by the end of April
- Beginning of May: aim to have the L1 and HLT menus available
- Full offline + online validation
- For details see Mia's talk

June

- Online deployment of collisions menu.

Note on beam spot monitoring

Reminder:

- Online beam spot measurement software is not maintained by anyone at the moment (the person in charge in 2016 is no longer working on this)
- CMS needs to find a person who can take care of the task and adapt the code and workflow to work with the new pixel geometry/tracking.
- Of interest to CMS that a person is found as soon as possible.

Summary

- Tools/procedures in place to catch potential problems and understand behavior of HLT before going online, as well as tools to monitor HLT during data taking
- Work ongoing to:
  - Improve online DQM
  - Implement "prompt monitoring"
  - Move rate monitoring plots to WBM
- Plan for commissioning period: FOG provides menus for MWGRs, CRAFT/CRUZET, first beams
  - Reminder to all detectors: we expect specific requests well in advance (at least one week before) to prepare dedicated menus

Reminder: we will need a working online beam spot