RUN & DPG workshop – Torino
January 25th, 2017

ECAL Commissioning: operations and plans

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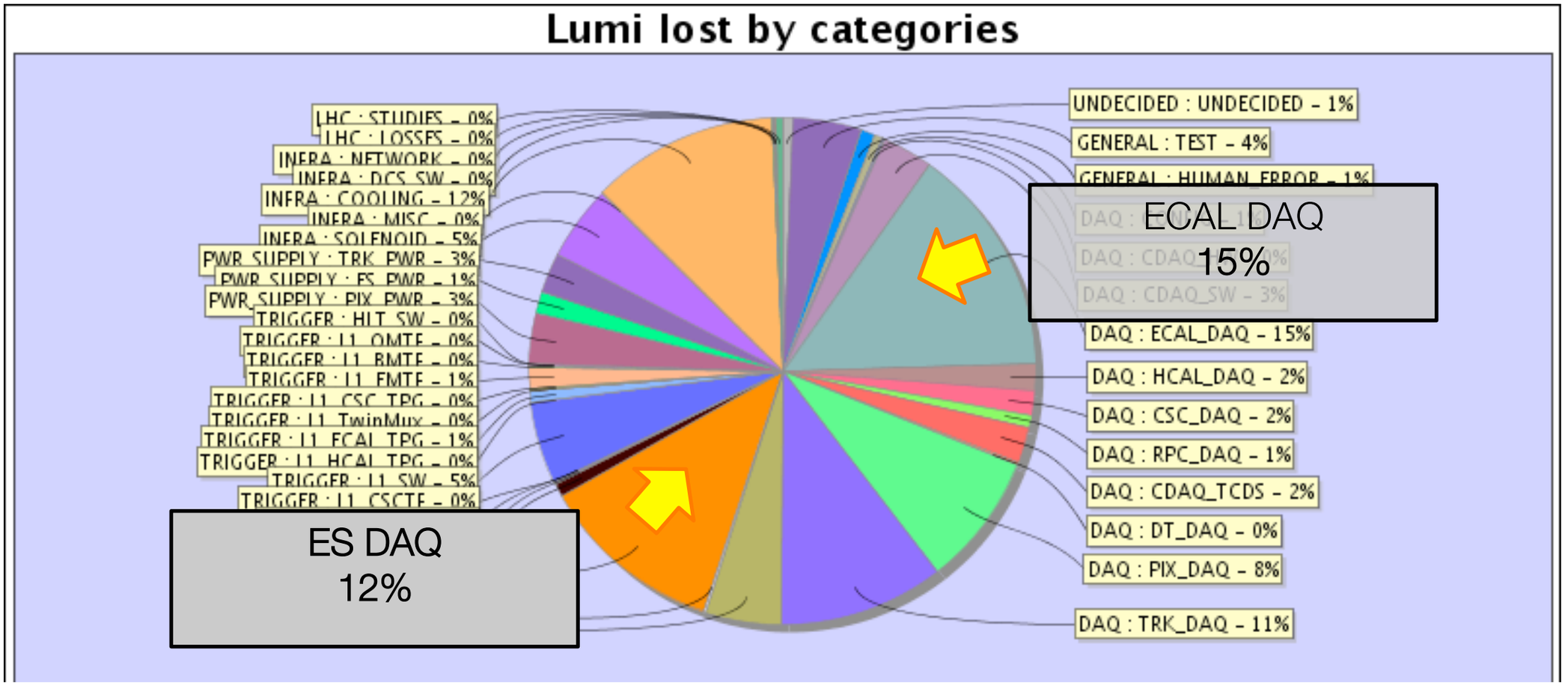
OUTLINE

- **Brief summary of 2016 data taking from ECAL perspective**
- **Infrastructure status: ongoing activities and plans**
- **ECAL DAQ and Trigger status/plans:**
  - improvements made
  - remaining issues
  - development plans for 2017 restart
- ECAL team/experts supporting P5 operations

Downtime Analysis: from Runlogger

CMS data taking inefficiency: 4% downtime



ECAL contribution to CMS downtime: 29%

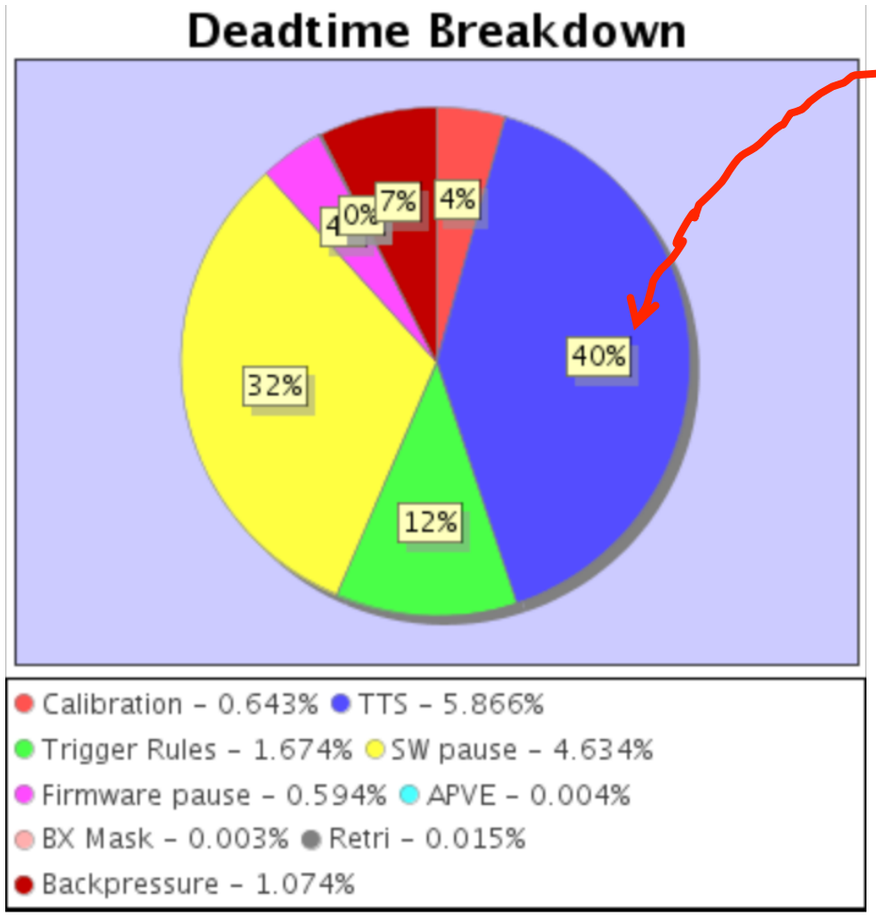
- dominated by DAQ errors (ECAL DAQ: 15%, ES DAQ: 12%) causing stop/start or red-recycle.

  → Several fixes made in 2016 to reduce frequency of these errors

- other contributions small (ES PWR ~1%, ECAL TPG ~1%)

Downtime Analysis: Deadtime

CMS data taking inefficiency: 4% deadtime



ECAL contribution to TTS deadtime:

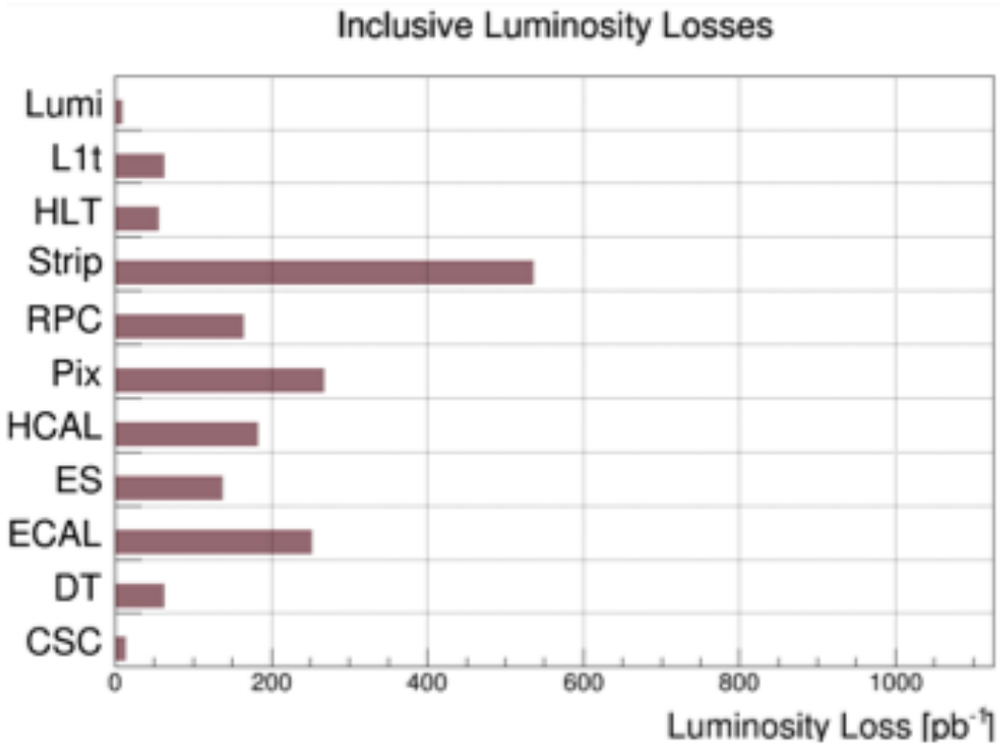
- **calibration sequence**: was 1%, substantially reduced (to ~0.1%) after TS2. The ECAL calibration sequence has been modified (suppressing test pulse events) to allow the removal of the orbit mask after the calibration events
- **backpressure from DCC** increased at the end of the year: large event size from EB FEDs generated few % of deadtime at the beginning of high lumi (1.4e34) fills @ 100 kHz

Actions for 2017:

- **retune zero suppression/selective readout thresholds**
- **increase the size of the SLINK Sender Card buffer** (see later)

Summary of Data Certification

LHC delivered: 41.5 fb^{-1}; CMS recorded: 38.6 fb^{-1}; CMS validated: 36.9 fb^{-1}



Exclusive losses

- **ECAL: 172.8 pb^{-1}**
- **ES: 73.7 pb^{-1}**

learning from these cases to improve the online monitoring

- **Main causes:**
  - **EE HV failure (first since run I) - ~100 pb**
  - Various FED powering issues (FEDs out due to VME crate/cooling problems)
  - ES excluded from several runs (cooling, bad ES configuration after TCDS timing problem)
  - Data corruption in EB/EE FEDs: firmware timing issues, mitigated by firmware and unpacker updates. The latter allowed ~30pb^{-1} to be recovered in rereco

Ongoing Activities on Hardware/Infrastructure

On ECAL LV:

•MARATON Power Supplies rework* to add **two externally readable temperature sensors on all MARATON units**, disable the ON/OFF switch on the power unit front panel, **upgrade the firmware**.

- **It requires transportation of the MARATONS in the underground control room, opening, gluing the sensors, firmware testing in S2 test bench, re-installation.**

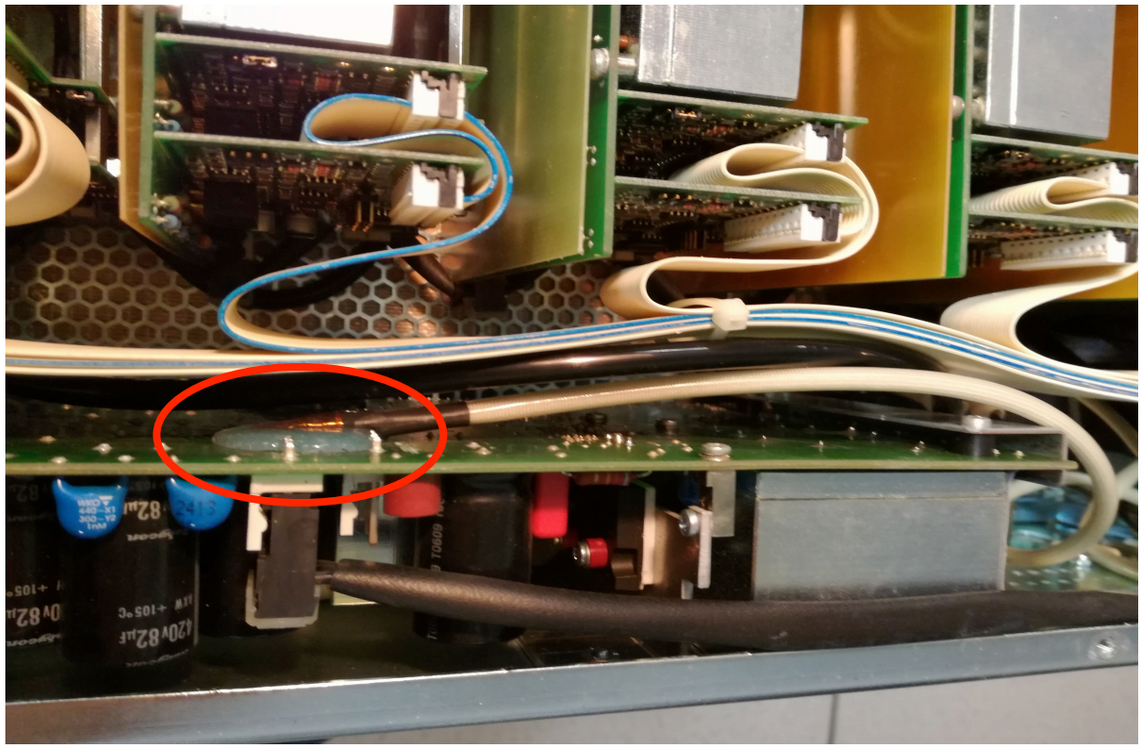
* **Actions from mitigation strategy following-up on:**

- one “near miss” incident occurred during SM cooling intervention: **MARATON did not respect cooling interlock;**
- some instances of a 380V input unit **overcurrent – not detected by the protection system**.
- Causes have been identified. **A modified ESS deployed during TS2 → further revision during EYETS**

Ongoing Activities on Hardware/Infrastructure

On ECAL LV:

- 150 units in total (-9 already done during the YETS 15-16)
- 4 weeks of work scheduled. Started on Monday 9
- **The work is progressing well, with half of the units being already refurbished and tested during the first 2 weeks.**
- Expected to end in the second week of February



Ongoing Activities on Hardware/Infrastructure

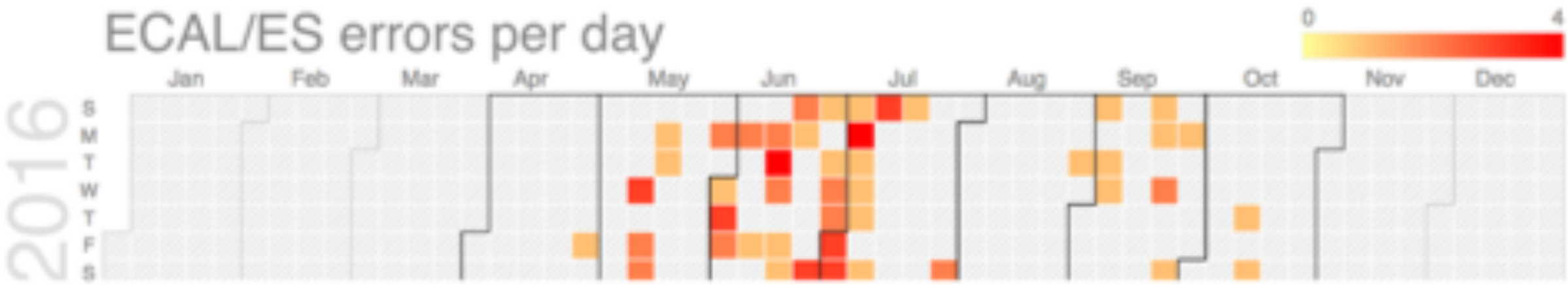
On ECAL HV

- calibration of the HV boards ongoing in USC
- no issues observed with EB HV during 2016 (few channels replaced)
- one (rare) failure of EE CAEN power supply

Otherwise no other issues (and interventions) to be noted for ES LV and the Light Monitoring System hardware

DAQ: Summary of 2016 Data Taking

- ECAL DAQ underwent **regular modifications and improvements** during 2016 **to cope with changing running conditions and solve recurring errors** (main contributor of downtime: ECAL DAQ 15%, ES DAQ 12%)
- Two main causes of error solved in 2016:
  - **DCC "synch lost"** error solved by DCC f/w update in May
    - secondary error "stuck in busy" mitigated by new f/w deployed in Oct
  - **ES DCC "ready for red recycle"** error solved by ES DCC supervisor code update in June



DAQ: Summary of 2016 Data Taking

- **Remaining errors mostly in ES DAQ:**
  - SEU-like error in ES FE crashing the run
  - ES token ring errors blocking configuration

➢ Investigated, fixes under implementation, part of the EYETS plans:

➢ apply ECAL SEU-like recovery to ES CCS code

➢ add automatic re-initialisation of TTCrx/QPLLs during red-recycle

DAQ: Plans for 2017 – improvements/error handling

ES CODE improvements:

- **Configuration from database**: the code is available and tested with success. Need to add the functionality to rapidly change the configuration in case of unexpected hardware problem.
- **Pedestals from database**: Not urgent but advisable (better/faster handling of different pedestals sets)
- **ECAL/ES code synchronization**: the Front-End control code has to be aligned to the ECAL one. Very important to stabilize the data taking:
  - possibility to **automatically bypass a problematic FE** electronic during the configuration phase (as it is in ECAL).
  - **automatic correction of FE errors** during a run.
  - **reduction of the area of detector excluded** from the data taking in case of problems.

DAQ: Plans for 2017 – maintenance/tools

Miscellaneous/important:

- **ECAL/ES CODE:**
  - Migration of DAQ code to the new OS CC7 and the new framework XDAQ14

- **LOCAL RUNS:**
  - not available since a while. **Now fully revived**. Fine adjustments still required. We'll be able to use LOCAL RUNS to record pedestals and other types of calibration runs

- **904 test bench status:**
  - Working to put it back to life: **904 test bench is operational again**! it can be used for f/w development/test + board programming.
  - Input data can come from a FE box with 4 real TTs.
  - There is also a SM simulator: electronic board to recreate any kind of signal coming from a SM. Need to work retrieve lost knowledge on how to use it.

DAQ Developments for Higher Lumi in 2017

DCC designed with this specs: 2kB/FED/evt at 100 kHz

Some changes are needed to DCC f/w and configuration in 2017 to allow ECAL to run at 100 kHz with minimal deadtime.

Main lines of attack for the short term are:

- **the tuning the Zero Suppression (ZS) and Selective Readout (SR) thresholds** to achieve **lower and more balanced** payloads
  - Currently retuning thresholds using high PU fill as input
  - DCC has finite buffer size: retune SR thresholds to avoid **too many consecutive full readout requests**
- **running with a larger output buffer in the SLINK card**

Also, possibility to work on the DCC firmware to allow **zero suppression to laser calibration data** (gain 0.3-0.4% in deadtime)

ECAL read out with a new SLINK Card

The plan is to read out the DCC (ECAL FED) with a new SLINK Sender Card

see F.Meijers talk

- Standard SLINK Sender card has a small output buffer (2 kB), LVDS copper cable with a 400 MB/s throughput (50 MHz clock).
- SLINK v2, with a slightly bigger buffer (8 kB), has been tested quickly in October on three FEDs
  - **sign of improvements on ECAL deadtime**

- A new SLINK Sender card has been designed by the DAQ team [**SLINKXpress_v1**]:
  - **buffer of 1 MB**
  - **transmit the data over optical fibers**: two possible outputs, at **5 Gb/s** and **10 Gb/s** (current is 3.2 Gb/s)

ECAL read out with a new SLINK Card

Status of the project (update from D. Gigi)

- **design is complete** - no prototype step will be done
- request for offers sent on the 16th
- cards (PCB) should be delivered in a month (mid/end of february)
- two will be populated and **tested** (one for D. Gigi and one for Jose) - **mid/end of march**
  - DCC clock phase adjustment at this time
- if everything goes well and no major problems are found, the whole production will be done.
- **April will be used to populate/test and install the cards in ECAL.**

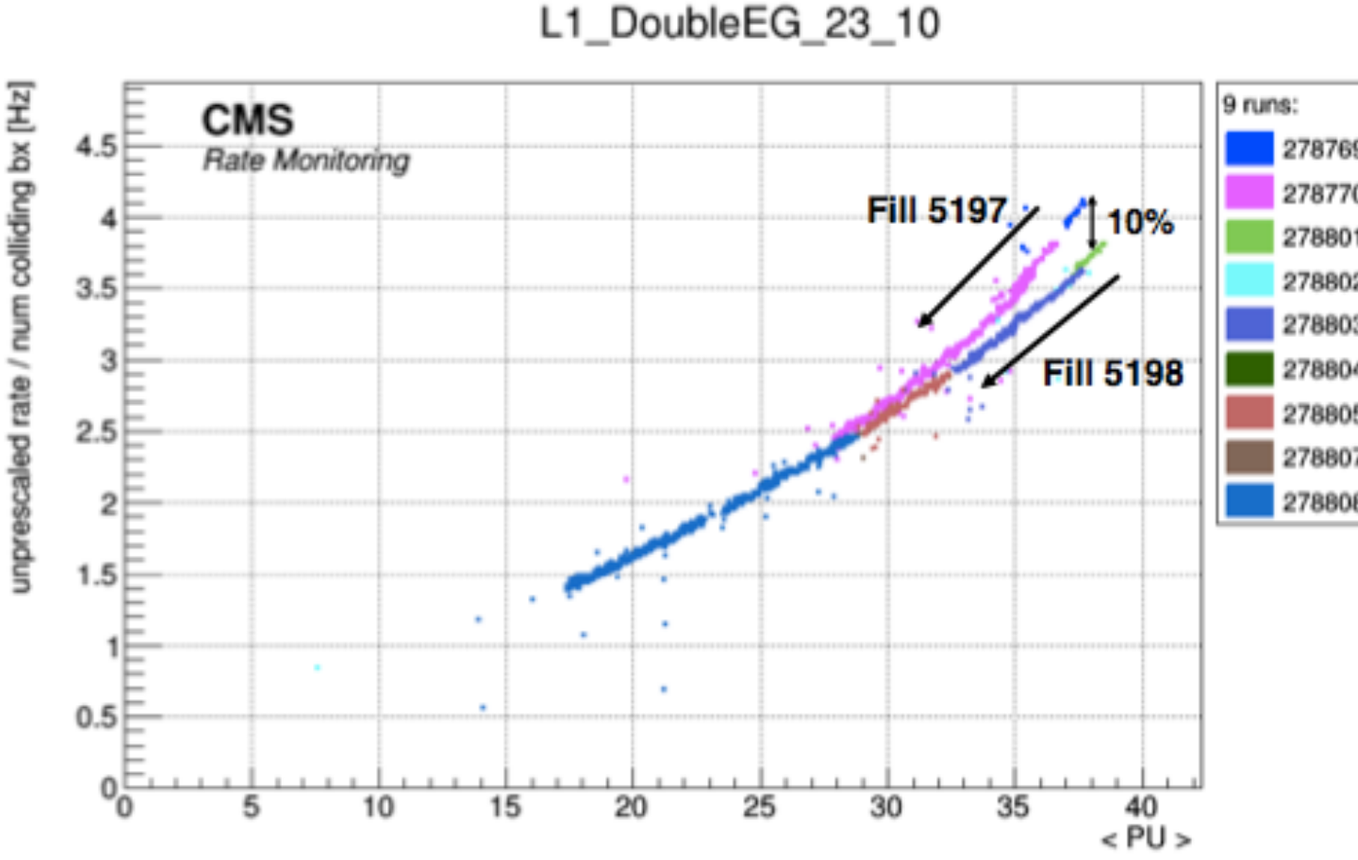
ECAL trigger in 2016

ECAL Trigger operated stably in 2016

- **minimal downtime** (1% of total), stable rates, **low masked TT fraction (0.5% in EB, 1.1% in EE)**
- smooth operation of laser calibration workflow
- the L1 Spike Killer settings (sFGVB algorithm) have been re-optimized to cope with the higher PU, reducing spike contamination of EG triggers (factor of 2)

Issue: L1 rate variations at high lumi

L1 EG rate strongly correlated with loss of transparency: its time evolution not properly followed by the correction scheme
(discussed in A. Massironi's talk)



ECAL trigger: improvements for 2017

Trigger Primitive Optimization (fake rate reduction)

- retuning of Spike Killer thresholds for PU50 and beyond: first results from high PU fill indicate that optimized setting for 2016 should be good for 2017 startup
- re-optimize Fine Grain bit for EB and introduce it for EE as well (ongoing)

To minimize the L1(and HLT) rate variations:

main idea, to be discussed/agreed with AlCa/TSG

- use corrections that are as close as possible in time to data taking
- put in place a “lighter” validation (automatic?)
- more frequent updates: every 2-3 days

ECAL recommissioning

Standard recommissioning procedure

- **Ecal aims to re-establish smooth operations in the first MWGR:**
  - available feds determined by Maraton rework and Barrel HV calibration work
  - need to check the status of all channels (LV rework)
  - need to take laser data to check HV calibration.
- **future MWGRs and cosmics runs will be used to test new DAQ features**
- **Splash events and first non-stable collisions: use to check readout and trigger timing, and adjust if needed.**
- **With 3.8T data:**
  - EG rate studies (including L1 spike rejection validation) and event size studies
  - Check calibration streams and collect alignment data

ECAL trigger recommissioning

- The plan is to participate in the first MWGR with the 2016 settings for sanity checks
- Following steps:
  - TCC software maintenance and code migration to more recent cmssw release
  - Check the status of all trigger optical links to L1
  - Perform a full Trigger Tower “un-masking campaign”: un-mask all disabled TT and work to recover them (if possible)
  - Perform trigger tower level timing alignment to minimize pre-firing
  - DQM: add most useful plots from offline analysis

Shifts/organization in 2017

- **No plan to change the structure and/or number of on-call experts**, as the current scheme looks satisfactory and has proven to be successful
  - Doc 1: ECAL DOC
  - Doc 2: ECAL DGL
  - Doc 3: ECAL PFG

supported by a long list of experts on call

- **Improve the instructions and the training: an evergreen/ always advisable**

In 2016:

- excellent involvement of DOC/DGL: first line of contact and continuously help improving procedures/instructions/communication
- Prompt Feedback Group/shifters have also done an impressive amount of work to provide daily feedback and data certification.

Conclusion/Outlook

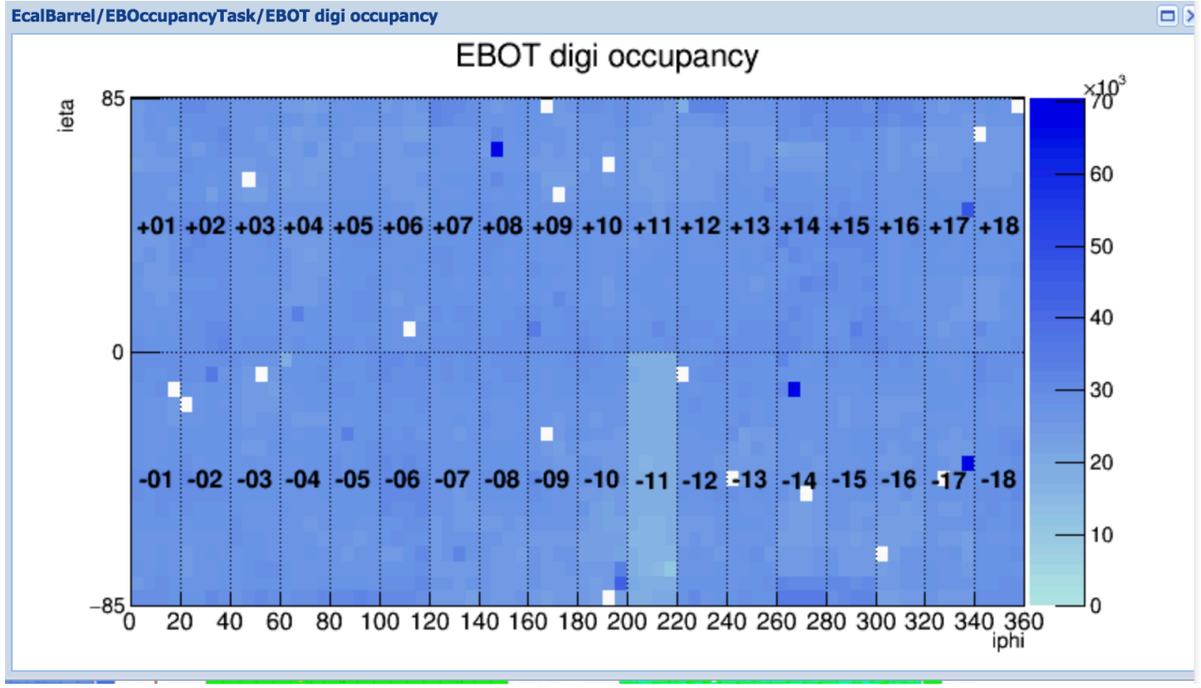
- **Main causes of downtime in 2016 being addressed**
  - DAQ improvements deployed during the year. Clear plan to address remaining errors during EYETS
- **Interventions in P5 are proceeding well, as scheduled**
- **Preparations for 2017 is underway**
  - Plan foresees the installation of the SLINKXpress cards
  - improvements to ECAL TP planned to reduce overall rate and improve rate stability
- **Getting ready for recommissioning the detector**
  - plan to participate fully in MWGRs and CRUZET/CRAFT

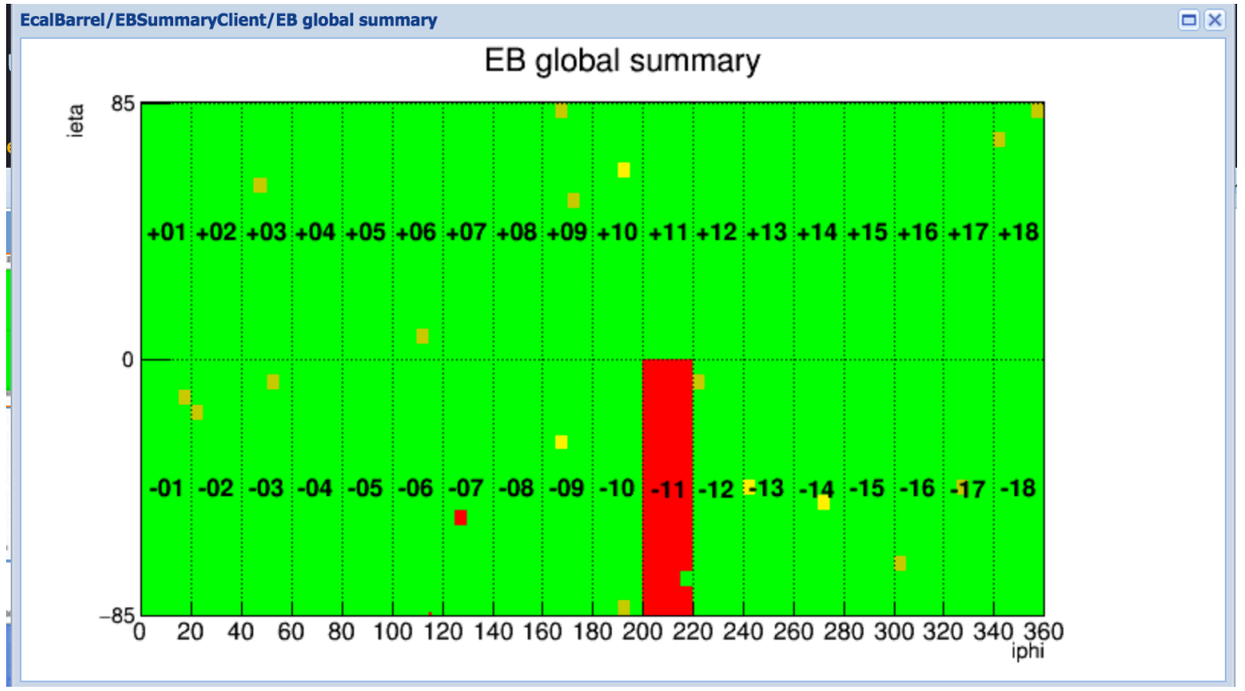
SPARES

Online Errors Detection: DQM improvements

The online DQM plays a fundamental role in the prompt identification of problems. Improved error detection deployed during the year:

- added “zero occupancy” alarms
- added per-LS plots to better monitor evolution of errors with time
- full review of data quality issues, alarm and requirements ongoing





Example of FED error during the run and manifestation in top-level DQM
Left: before; Right: after DQM improvement

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Issue: L1 rate variations at high lumi

Typical correction scheme: new constants based on "week N-1 average" are deployed on ~ Weds of week N.
Sometimes this delay introduces a difference of few % between the correction needed and the applied, especially following periods of recovery