Strip Performance, calibration/alignment & commissioning: plans for 2017

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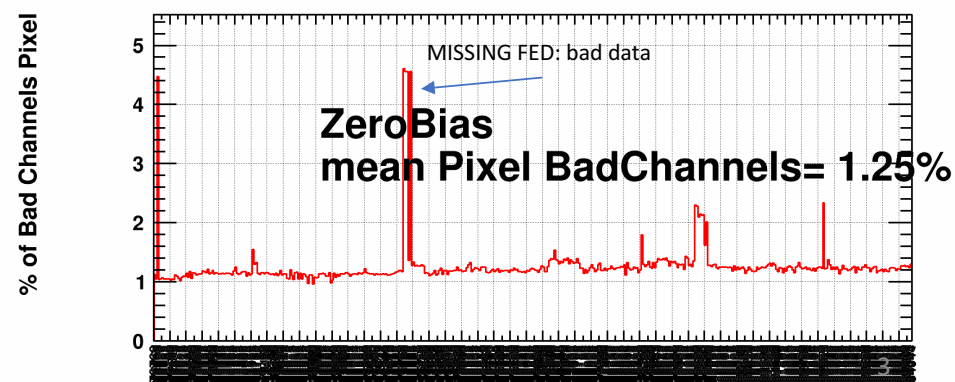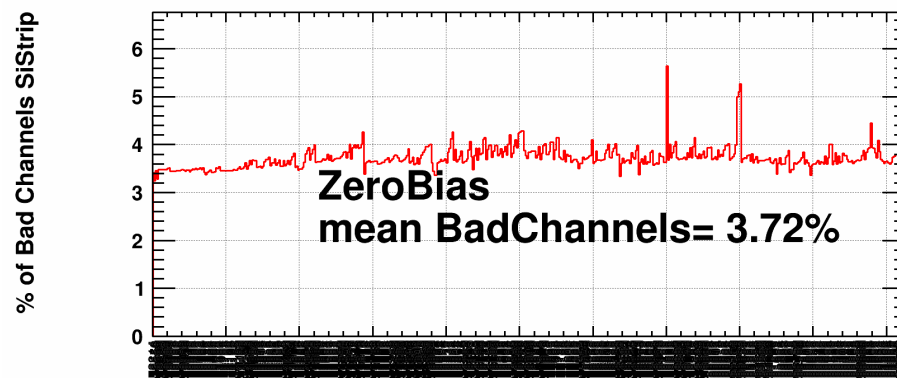
On behalf of the Tracker Project
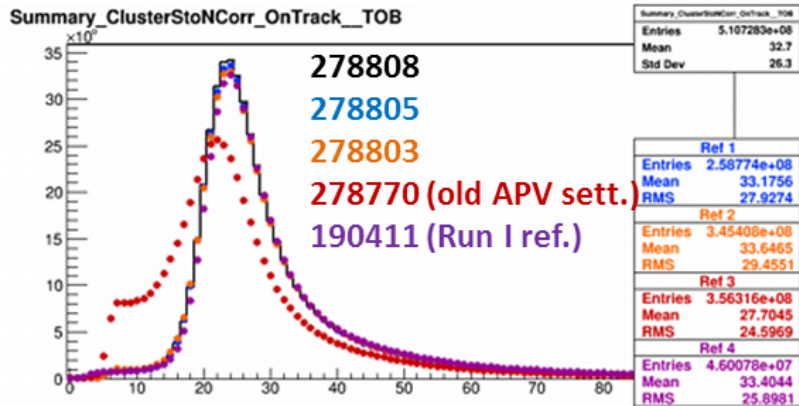
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Looking back over 2016 …

Tracker data taking efficiency (pixel + Strips)

- Data losses due to Tracker: ~785 pb^{-1} (~2% of the luminosity)
    - Pixel data-taking inefficiencies: ~183 pb^{-1}
    - Strip data-taking inefficiencies: ~220 pb^{-1}
    - Useless Tracker data: 382 pb^{-1}
        - Mostly due to Strip (316 pb^{-1}) and Pixel (66 pb^{-1}) detectors not in global run while fixing problems
- Causes of the largest losses
    - Cooling plant valve and sensor failures
    - Pixel power supply and Strip ACDC converters (aka MAOs)
    - FED crate power supply
    - Pixel optical link baseline instabilities
    - Strip FEDs in "disconnected state"
    - Pixel stuck in "SoftErrorRecovery"

% of Bad Channels SiStrip

**ZeroBias
mean BadChannels= 3.72%**

% of Bad Channels Pixel

MISSING FED: bad data

**ZeroBias
mean Pixel BadChannels= 1.25%**

Strip Performance after the VFP change

- Hit signal restored
- Hit efficiency restored
- Track length and efficiency restored
  - Since 2016H era
  - Previous data re-reconstructed with a less demanding track reconstruction for the double sided modules and a different b-tagging track selection
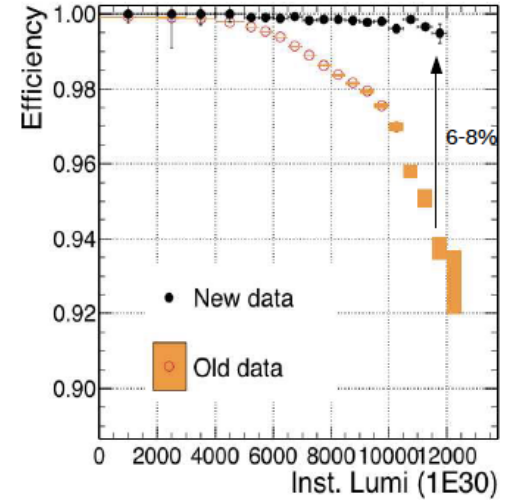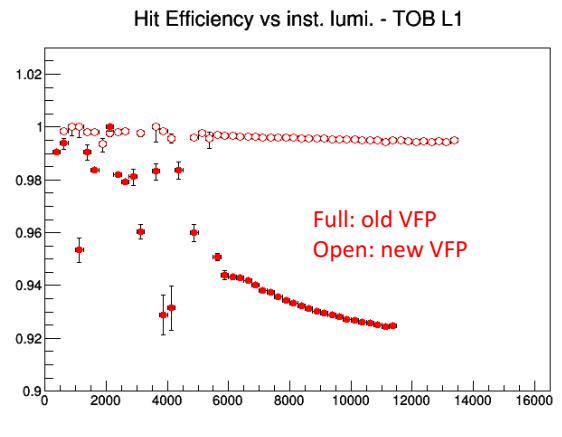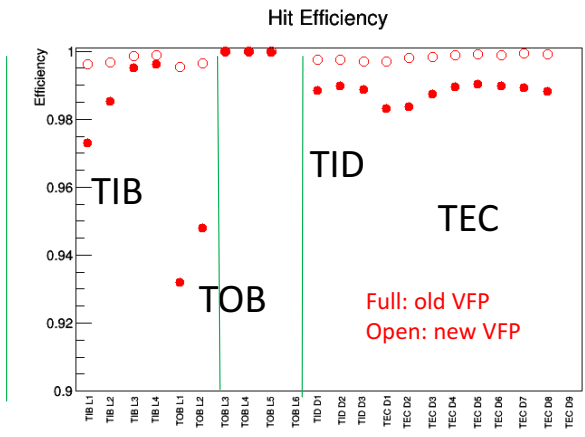
Strip Calibrations

- Strip gain calibration
  - Stability of the cluster charge distribution needed because of the "cluster charge cut" used to reduce the out of time pileup
    - Reduced fake rate, faster reco
  - Scale factors computed from opto-link gain measurements and with collision data (G1 and G2)
    - Virtually impossible to calibrate with collision data with the old VFP setting!!
    - Everything OK with VFP=0
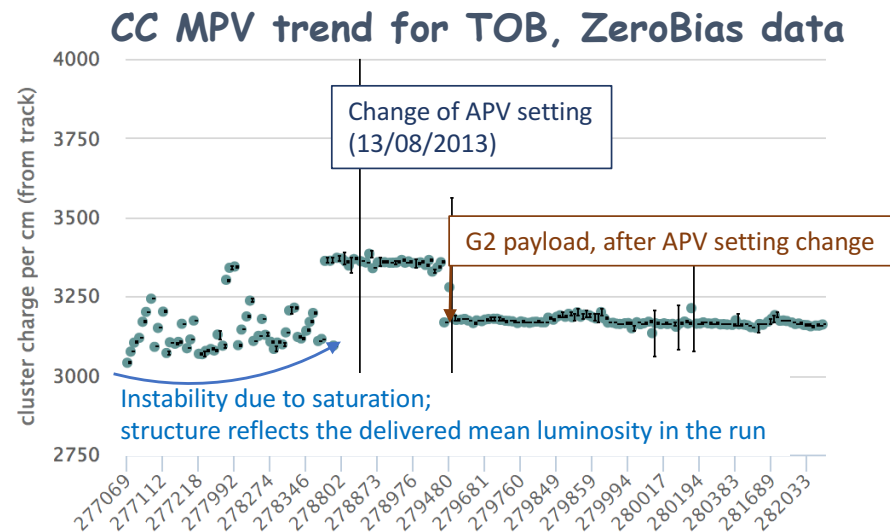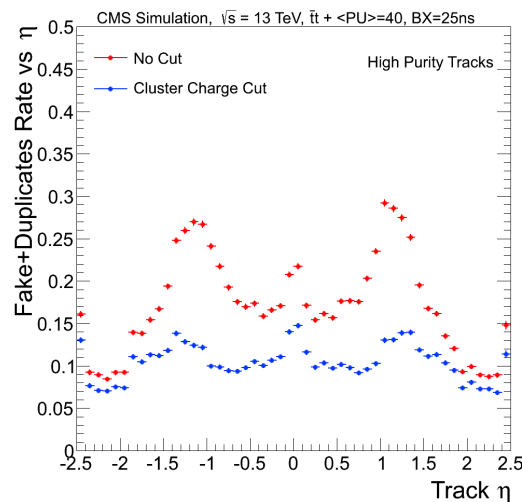
Looking forward 2017…

Plans for 2017 – Strips Detector Calibration

- Smooth running ☺

- Recalibrate detector **before data taking**
  - *Laser Gain*
  - *FED thresholds*
  - *APV baseline*
  - *APV pulse shape*
  - *Pedestal and noise*

- Recalibrations **over the year**:
  - *Pedestal and noise thresholds*
    → will try to move to 1x month (was 4/year)
  - *Laser Gains + FED thresholds (need to be done together): 3x in 2016*
    → need to increase frequency to cope smoothly with radiation effects
  - *In addition: FED threshold measurement intimately related to G1 gain*
    → aim to move this into an O2O procedure to have detector conditions and offline reconstruction in sync by construction.
    - See next slide

Gain calibration: G1 factor

G1 gain factor: status of the tools and operations in 2016

- Single CMSSW analyzer that produces the G1 payload from the online tickmark run data;
  - tickmark data retrieved through WBM interface;
  - analysis of signal height versus noise: identification of problematic channels
- Run manually when notified by the online crew that new tickmark runs are available and processed.
- Full Alca Validation of the payload required
  - → in short : a lot of manual and human interventions (including central teams) , we would like to improve and reduce the load

- **2017 : Milestones for G1 improvements:**
  - access online validation infos to identify faulty channels
  - Transfer the measurements using the "O2O" procedure
  - define set of DQM histograms to be checked by shifters;
  - Goal is to set this workflow in production by end of April

Plans for 2017 – special runs with beam

- **Timing scan early in the year for validation**
  - 3-5 hours with beam
  - Pixels in the run and efficient
  - >~ 1 kHz of ZeroBias on disk
- **Bias voltage scans**
  - *Full scans 2x per year*
    - 1.5 – 2 hours
    - Pixels in the run and efficient
    - >~ 1 kHz of ZeroBias on disk
  - *Small scan 1x month (during physics)*

APVE emulator and latency

- The APVe fulfills three main functions
  - Emulation of the APV pipeline to prevent buffer overflow in the APVs
  - Transmission of read out pipeline address for L1As to tracker FEDs via b-channel data for data integrity checks
  - Blocking of triggers in certain positions in the APV readout cycle as large noise is induced in certain pipeline locations

- The full APVe functionality was moved from a separate electronic board to TCDS after LS1

- Veto mask was recommissioned and correctly placed in the TCDS CPM in 2016

- **With the APVe in the CPM,** there is no transmission and decoding delay when the APVe asserts busy to prevent buffer overflow

- → With the APVe in the CPM, busy threshold could maybe be lowered
  - This by itself will mainly benefit deadtime
  - Measurements were made at the end of run 1 to see what maximum latency we can tolerate without too much increase in deadtime
    - → with APVe in CPM these measurements could be revisited

- -> Could mean that latency of APVs MIGHT be shifted IF necessary for L1 trigger upgrade
  - Has to be done with a lot of care
    - If the APV buffer overflows, data will be garbage until next resync

Event Size in the Strip Tracker

- No problem with input data rate into FEDs
    - Non-sparsified data from APV chips
    → data rate = constant

- Strip tracker event size expected to increase ~linearly with pile-up
    - No problem with output rate from FED point of view → output rate up to 640 MB/s

- Some problems observed in 2016 with increased event size in TID
    - Caused increase in dead time because of backpressure from DAQ

- Total event size for scenarios under consideration by high lumi WG (estimates based on #PV not PU)

	1.8E34 (PU 52)	2.0E34 (PU 60)	2.25E34 (PU 70)
Min-Max per FED	0.6-2.2kB/ev/FED	0.7-2.5kB/ev/FED	0.75-2.9kB/ev/FED
Total	~850 kB	~960 kB	~1090 kB

Shift Operation

- Strips DOC remains single point of contact for strips operations as before
  - Reports in daily run meetings
  - Reports in strips operations meetings
  - Performs (shared with pixels) comprehensive monitoring of system
  - check list (DAQ, DCS, DQM) at start of physics fill (extended working hours)

  - Will see if taking of calibration runs can be integrated into DOC duties during 2017
- Offline Shift Crew and PFG
  - Check the data quality during operation and follow up closely on any unexpected feature observed in data
  - Responsible to provide a "daily summary" on data quality to RunCoordination
    - Daily coordination meeting at 9:00 AM betwwen Offline shifters and TkDOCs
  - Documentation deeply revised in 2015 and 2016
  - Offline Shift leaders are reporting DPG meetings and attending-/reporting to online strips meeting
  - Ofline Shifts : A fraction of Offline shifts already assigned to qualified remote centers

  - DQM on call is the contact for any features observed by Online CMS DQM crew at P5 and ensure expertise for the tracker Offline crew

- The Offline Shift Crew take care also of the certification of Prompt-Reco data (and Reprocessing if needed)

Offline PFG

- Plans for 2017:
  - improve collaboration/communication with online
  - make the feedback more frequent and effective
  - post slides with a set of relevant plots (to be reviewed for 2017) each 12 hours (twice as 2016)
- Improve the training of shifters:
  - introduce a tutorial for expert shifters (SL and on-call)
- make the on-call role more effective:
  - report at the DQM meeting (Friday), work more on documentation and shift training

- Shifts during MWGRs will mostly focus on setting up , testing procedures and tools
  - Tracker virtual machines, new release area for shifters, test of the scripts, revision of instructions

Some operation items to be pursued in 2017

- **Main goal : make our life easier , be faster when reaction is needed , better diagnose, reduce the load on experts**

- Revive the script to send SMS to experts in case the Tracker is not giving data
- HistoricDQM :
    - has to be made faster, more "user-friendly", and more effective:
    - possibility to select the plots to be shown , improve the selection of axis limits, visualize fill bundaries, lenght of runs
- TkCommissioner : tool developed for online and has proven to be very useful for offline PFG crew too
    - Understanding feature of data taking , already in place but still needs some developments to allow prompt offline feedback

- Over the past (~10) years, a dedicated package in CMSSW is available , containing many macros, analyzers
    - Plan is to continue to document those tools (DPGAnalysis/SiStriTools package) in a more "shifter-friendly" way .
    - Give a set of "ready-to-use" cfg and examples of use cases on the basis of 2016 experience (APV shot studies, TID/TEC noise in cosmics, ...)
- Improve the tools for the monitoring of bad components and the robutness of the algorithm

- Exploit information from spy data runs

Strip Offline Gain Calibration (also known as G2 calibration)

Main goal for 2017: exploit the multi run harvesting procedure at PCL

- Reduce the time delay to deliver updates;

- Reduce the workload of the experts
  - Exploit automatic machinery that doesn't need support from manual intervention;
  - Gradually involve the offline shifters for feedback after any updates

- The multirun harvesting is being validated
  - Thanks to PPD teams (in particular Piotr) for the great help and the framework development!
  - Payloads produced 'manually' have been shown recently to be the same as the ones from this new technique

Simulation plans

- Introducing a realistic simulation of the APV behavior and saturation effect depending on APV settings
  - Require major rework on our simulation code

- Data – MC comparisons should be pursued and simulation should be (fine) tuned
  - Example: Ensuring the out of time PU is correctly modeled with the increase of PU at LHC

Failure Scenarios

- Idea: Identify some realistic failure scenarios and study their impact on reconstruction and physics analysis to ease for the future the decision on how to react in case of

- We prepared a list of them based on the operation experience over the past years and prepared the corresponding payloads
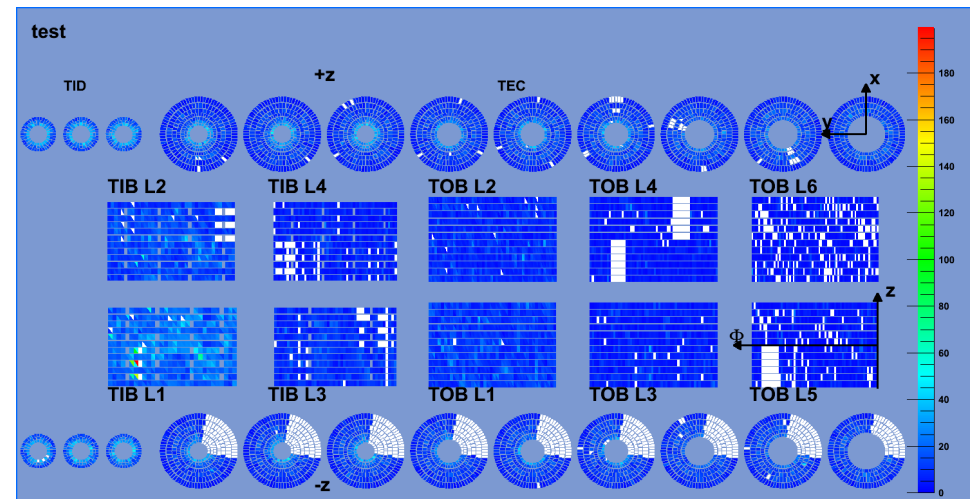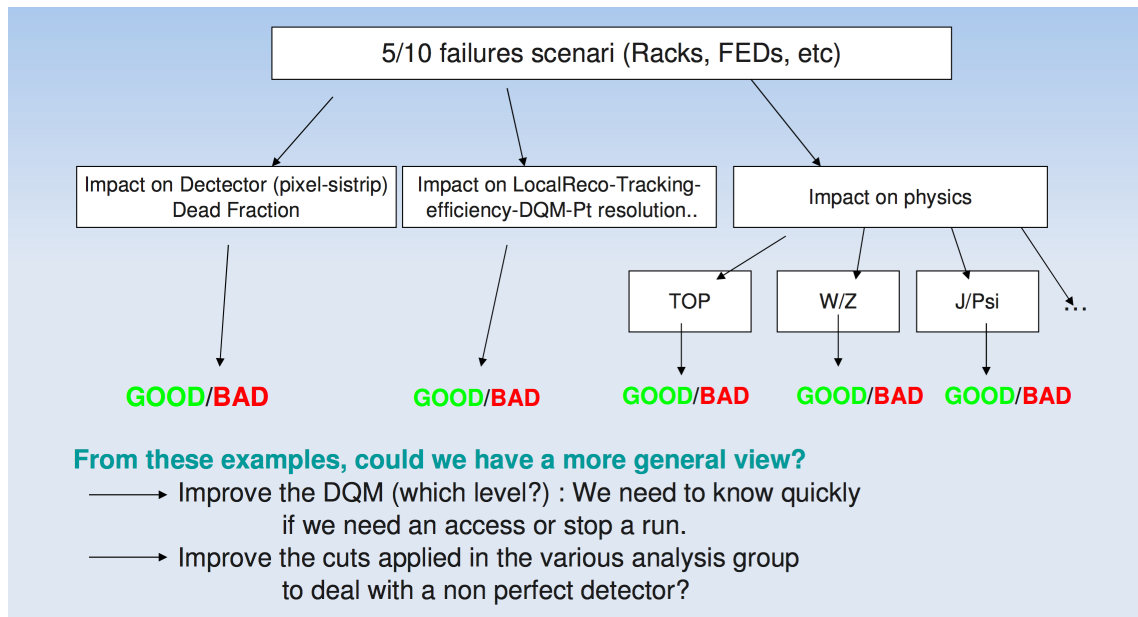
Example : Power Supply Rack Failure:
Missing regions in TEC- D1->9 + TOB L4-L5

Longer term plan

- Strips DAQ and DPG took note of the request from the HI community to increase the L1 rate for the 2018 running

- In HI running there is an efficiency loss due to APV baseline deformations which cause problems in Zero Suppression
  - (N.B. this effect is still present also with lower VFP)
  - Needs change in FED firmware to have more elaborate ZS algorithm (akin to **baseline follower** which has been used in HLT during HI runs for ZS)
  - Will start discussion with HI community and tracker firmware developers
- Even if the target is 2018 HI data taking, this should be adressed already in 2017

Outlook

- Strips Online & offline Group are actively preparing the data taking
  - To be ready for CMS physics measurements and discoveries to come !

- Goals :
  - Provide the best calibrations of the detector for high quality physics data

  - Provide the best possible data/MC agreement

  - Reduce the load in 'every day ' operation
    - Simplify worklows, procedures
    - Allow more time to anticipate , avoid, or eventually fix any bad surprises
  - Be prepared for an 'unlikely case of emergency ' (*)
    - Failure scenario, tools for diagnose and feedback, efficient shift crew

  - Enjoy running the Strip detector, calibrating it, and eventually presenting results of the performance of it

(*) quote from security message in planes before takeoff

Backup

Remember, CRAFT Workshop 2009 Torino