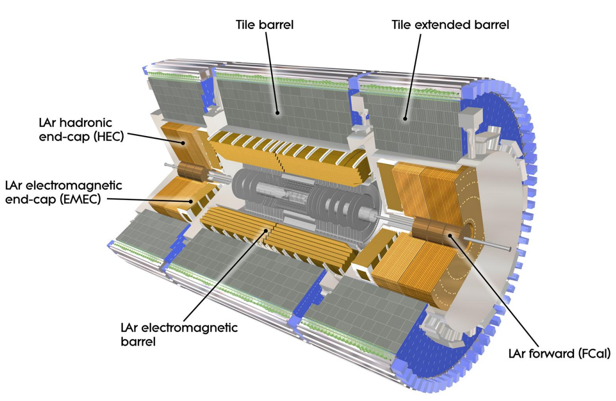
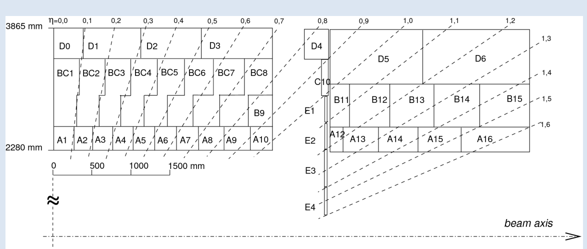
Processing and Quality Monitoring for the ATLAS Tile Hadronic Calorimeter Data

CHEP 2016, San Francisco, California, October 10th – 14th

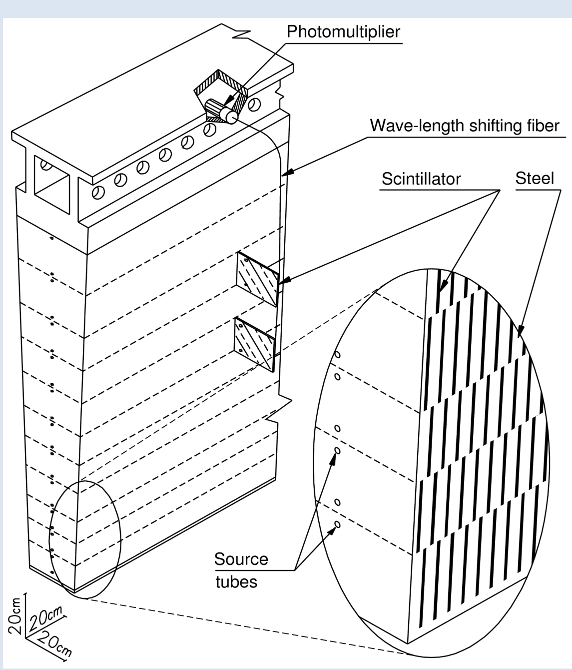


Tile Calorimeter



The ATLAS Tile Calorimeter is a hadronic calorimeter situated just outside the Liquid Argon (LAr) Calorimeter, and covers the $|\eta| < 1.7$ ("barrel") region of the detector. Tile is split into Long Barrel (LB) and Extended Barrel (EB) sections, roughly corresponding to $|\eta|<1.0$ and $|\eta|>1.0$, with special cells (that have only 1 readout channel each) covering the crack region between the Tile LB and EB and the LAr electromagnetic barrel and hadronic end-cap sections.

In addition to ordinary Tile cells, Minimum Bias Trigger Scintillator (MBTS) covers the $2.1 < |\eta| < 3.9$ region, and is used in low-luminosity runs.

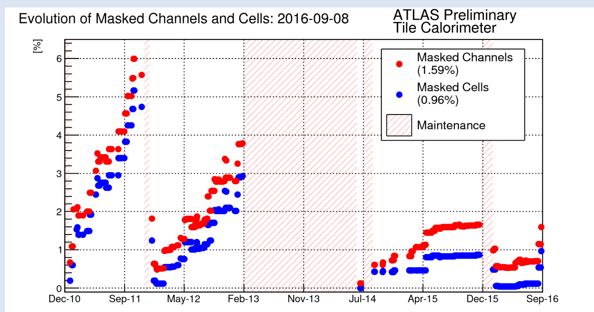


Tile uses steel absorbers and plastic scintillator tiles, which are read out with ~10,000 PMT's and related readout electronics. Tiles are organized into 5,182 cells, with normal cells (not in the crack region) having two readout channels for redundancy.

Tile is organized into 4 partitions, LBA and LBC for the A side (positive "z" direction) and C side of the barrel region, and separate EBA and EBC partitions in the extended barrel region. The cells in each partition, along with their corresponding electronics, are divided into 64 symmetric phi slices (modules), with 45 instrumented channels in LB modules and 32 channels in modules from the EB.

Physics Monitoring and Data Quality

Tile monitoring includes identifying and masking problematic channels (below), correcting for timing jumps, monitoring data corruption or other hardware issues, and (since 2015) monitoring and correcting for changes in pedestal.



Immediately after a physics run finishes, a subset of data (the "express stream") is processed and reviewed. There is a short delay known as the "calibration loop" (typically 48 hours) before the full run is processed, during which any problems identified in the express stream may be corrected.

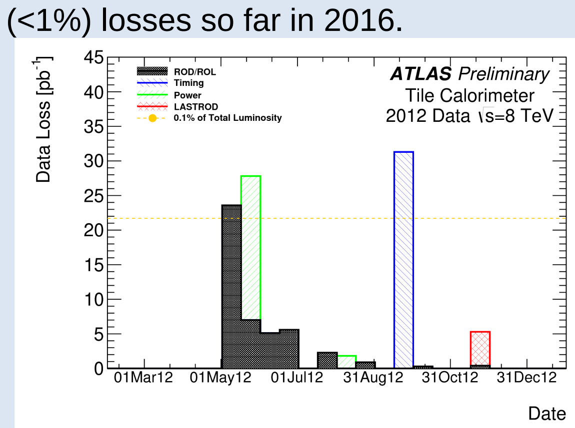
The Tile Data Quality Validator (DQV) remote shifter reviews the express stream processing of each run to check for any issues. Tile uses a specialized web interface to generate an initial report for the shifter to finish, based on the results of automated data quality monitoring tests.

The Tile Data Quality Leader (DQL) shifter reviews the DQV's report and takes any necessary action.

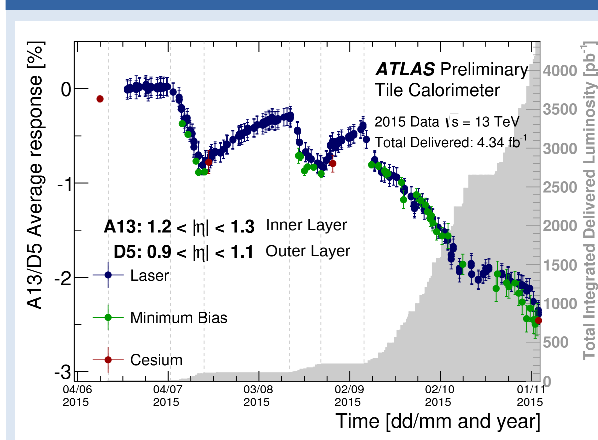
Changes to Tile timing within collision runs are monitored by Laser calibration events in the empty bunch crossings of Physics runs, used to apply timing offset corrections to data.

If a problem cannot be corrected, it is entered into the ATLAS defect database. If the problem is considered intolerable, then the affected data is removed from the ATLAS Good Run List and is not used in physics analyses.

A fraction of Tile data losses in Run 1 (below) were related to Low-Voltage Power Supply (LVPS) trips. Redesigned LVPS units were tried on a part of the detector in 2012, and found to virtually eliminate the problem. All older units were then replaced by the new ones during Long Shutdown 1. This exercise is also thought to have led to a significant reduction in the number of bad channels, and the rate of its increase, from Run 1 to Run 2, as well as a reduction in timing jumps. Tile achieved 99.6% DQ efficiency in 2012 and 100% in 2015, with minor (<1%) losses so far in 2016.



Calibration

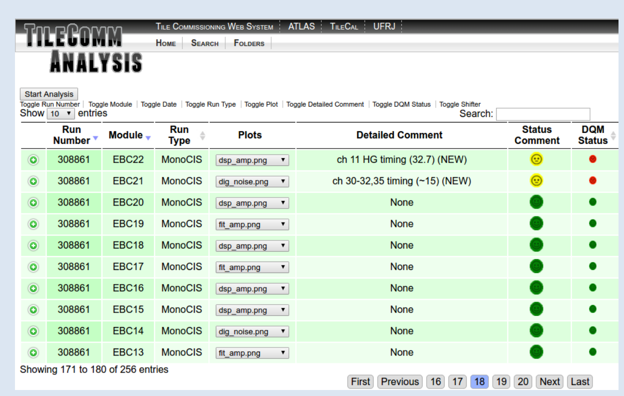


A Cs137 radioactive source is used to calibrate Tile gains. The Laser calibration system is used to correct for drifts between Cs scans in response to scintillator irradiation, validated with gains seen in the Minimum Bias integrator system. Laser, Charge Injection, and Pedestal calibration runs are used to monitor timing, stability, and noise. (Above)

Calibration runs also undergo assessment from a data quality perspective. This serves as an additional cross-check for any problems that may be seen in physics runs, and allows the DQ team to continue monitoring detector status during technical stops or shutdown periods, to help prioritize maintenance tasks.

Slightly different sets of monitoring histograms are produced for each run type (as appropriate), to monitor channel response, timing, pedestal and noise, as well as stuck bits and various other forms of data corruption (which are not always easy to monitor in physics runs). Automatic tests are run to identify and flag channels with problems, and cross reference with known issues from the conditions database.

A specialized web interface is used by the Tile shifters to analyze calibration runs approximately twice per week, excluding Cs scans (which are taken about once every 6 weeks). This displays the results of the automated tests, as well as the corresponding monitoring plots, and is used by the shifter to assess the severity of a problem and classify it accordingly, and to automatically file a summary report when finished.

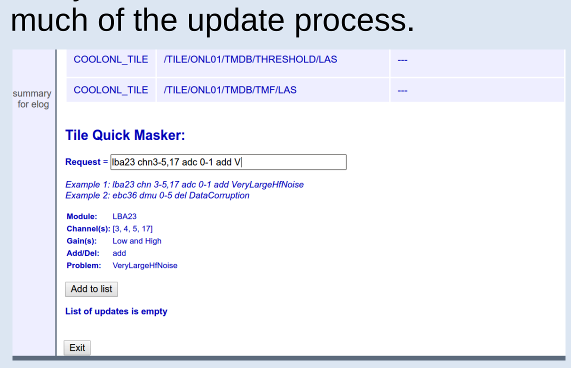


Conditions and Data Preparation

The conditions database is split into separate instances for online data taking, offline data (re)processing, and the production of Monte Carlo (MC) simulated data. Conditions data within each instance is organized into a hierarchical folder structure, similar to a filesystem. Folders in the offline and MC databases support multiple tagged versions, while the online database uses single tag folders.

Each tag contains a set of condition which are split into Intervals of Validity (IOVs) to allow for conditions to be different from run to run (or from lumiblock to lumiblock within a run). One tag from each folder is linked to the global conditions tag, and linked tags are restricted from making changes to IOVs for runs in the past (to ensure reproducibility of results).

Changes to detector status or calibrations are entered into the conditions database during a brief calibration loop between when a run ends and the full ("bulk") processing begins. The updated conditions may be added to the database manually through command line tools, but this process is most often expedited using a custom tile web interface (referred to as the "robot", below), which simplifies many common tasks and automates much of the update process.



A new tag may also be created to include changes to runs that are no longer in the calibration loop. This is often done shortly before any major data reprocessing or MC production campaigns.

The data quality and calibration teams use reprocessing campaigns to correct any problems which could not be fixed at the time of the original processing. This can occur when a change in detector status cannot be corrected for until after the next set of calibration runs. In such cases, the affected channels are masked in the original processing, and may be unmasked in the reprocessing. Channels which remain masked often have the masking extended to the beginning of the data taking period, to simplify detector modeling in MC.

References

https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ApprovedPlotsTile

Blake Burghgrave (Northern Illinois University), on behalf of the ATLAS Collaboration

Northern Illinois University

ATLAS EXPERIMENT