Monitoring and Data Quality Assessment for the ATLAS Liquid Argon Calorimeter at the LHC

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ATLAS and its Liquid Argon Calorimeter

The ATLAS Liquid Argon (LAr) calorimeter:
- Three sampling calorimeters: PB detector in barrel, EMEC, EmHCal (FCAL) in CMS
- 99% active readout channels
- Precise energy measurement of EM objects and good handle on transient missing energy
- At least 20 calibration trigger levels (L1): minimum, full correction using anode signals for barrel
- Coverage completed by EMEC for transient energy
- High-purity argon and radiation-resistant calorimeter with FCAL

ATLAS is a multi-purpose detector built to observe a wide spectrum of events from the proton-proton collisions produced at the Large Hadron Collider (LHC), CERN, Geneva.

LAr Data, Data Quality, and Monitoring

The main purposes of Data Quality (DQ) assessments and Monitoring are:

- Ensure data integrity along the multiple levels of the read-out chain,
- Detect, identify problems, and correct them promptly,
- Provide overall indicators of the performance of the detector.

Primary Signals from LAr
- LAr signals – 400ns at time of operating voltage if ~20\text{\mu}V
- Amplified and shaped to meet with laser/diffuse requirements
- LHC rate of 40MHz (corresponding to 25\text{ns})

LAr Online and Offline Monitoring

Online and Offline Monitoring are complementary:
- Online: in the control room. Operators must catch data corruption and timing problems instantaneously to avoid large amounts of unusable data to be stored.
- Offline: investigators must detect underlying but uncritical problems, confirm with the systems’ experts, and correct them.

LAr Data within ATLAS

Flow of LAr Data to Monitoring
- Energy is checked against threshold (TH) in the hardware to select events
- Time is used to select the energy truth values for offline analysis
- Basic distributions can be made from the energy and time values

Example of Online Monitoring Plots
- Online monitoring of the noise distribution per LAr sub-calorimeter
- Online verification of the coherent noise distribution per LAr sub-calorimeter
- Online verification of the noise distribution per LAr sub-calorimeter
- Online verification of the noise distribution per LAr sub-calorimeter

Example of Offline Monitoring Plots
- Online monitoring of the noise distribution per LAr sub-calorimeter
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Current Status of DQ Offline Checks with Prompt Data

Example of How a Single LAr Cell is Corrected

- Typical examples of problems in LAr calorimeters that are corrected within the loop:
  - Channel properties: pixel drifts and noise increment
  - Corrected within the loop by masking in software
  - Permanently fixed by electronic calibration
  - Isolated channel pathologies
  - Very noisy cells are systematically masked out
  - Occasional noisy cells are rejected after reconnection only if their pulses do not look like LAr ionization pulses (based on quality factor Q)
  - Hardwaire: failing optical transceivers and high-voltage variations
  - Failing detector module can be masked out in software and databases
  - Future software improvements to correct the energy from missing cells in a workstation
  - Changes in high-voltage can be tracked and controlled for within databases
  - Other types of non-physics LAr pulses can efficiently be removed with software
  - Current status of LAr Calorimeters within the ATLAS Calibration Loop:
    - Worked very well with first L3\text{AT} collisions run of 2010
    - Isolated problems in LAr could be corrected promptly
    - High quality data available for early physics analyses

Outlook

- Current DQ assessments are efficient at monitoring the behavior of the ATLAS LAr calorimeters.
- LAr detector problems and/or sudden changes in the detector status are corrected promptly.
- Contributing to provide high-quality ATLAS data rapidly, ready for physics analyses within weeks.
- Future improvements towards automating the mechanics of the calibration loop and database updates.