Performance and Calibration of the ATLAS Tile Calorimeter

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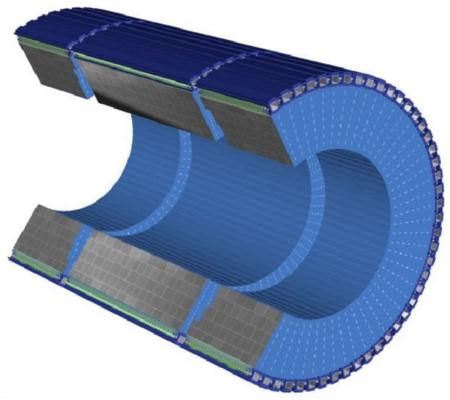
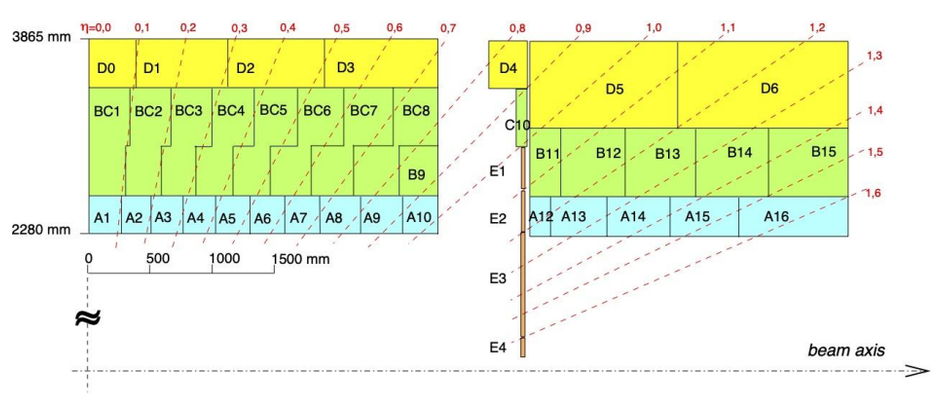
The ATLAS Tile Calorimeter

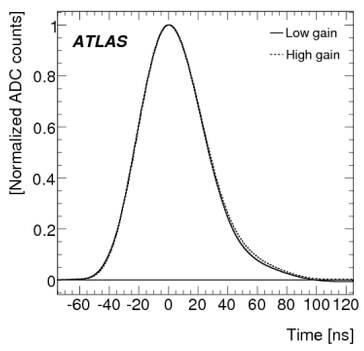
- ATLAS central hadronic calorimeter at LHC.
- Identification of hadronic jets and measurement of their energy and direction of travel
- It contributes to the missing transverse energy reconstruction as well as to the trigger and muon identification.
- Sampling calorimeter: alternating layers of steel and scintillator tiles.
- Comprises one central long barrel and two extended barrels.
- It covers the pseudorapidity range of $|\eta| < 1.7$.
- Segmented in three radial layers: A, BC (B) and D.

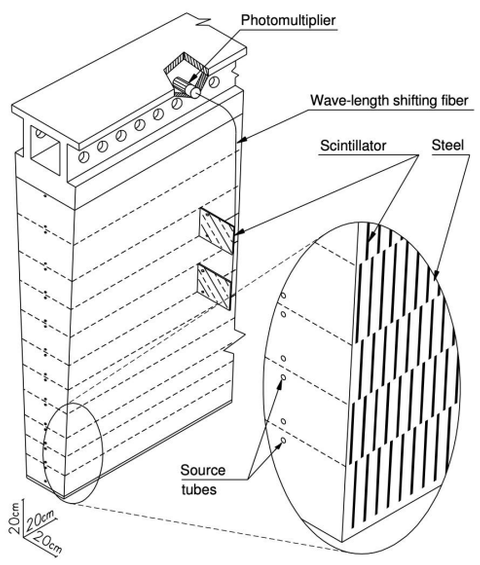




Signal Processing Chain

- Light produced by the tiles are transmitted to PMT tubes.
- 5,182 double readout cells.
- PMT signals are shaped and amplified for digital filtering.





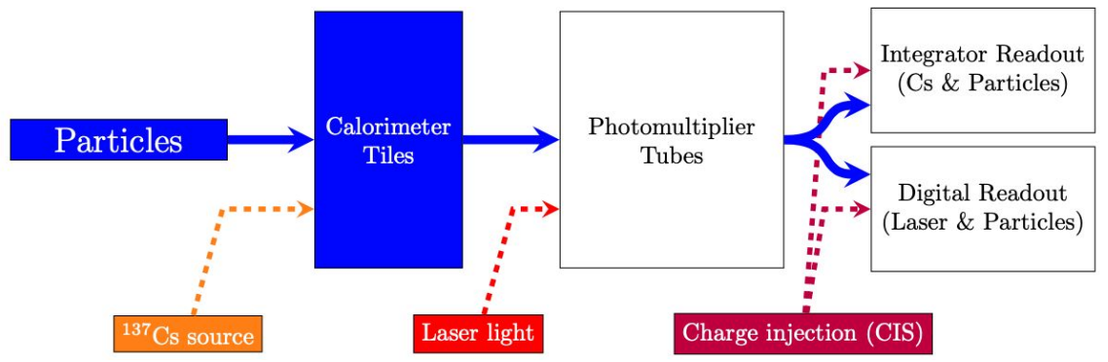
Calibration Systems

- Crucial for ensuring the accurate calibration and monitoring of the signal reconstruction chain.
- Convert the amplitude of the output pulse into energy at the EM scale.

Cs – optics, PMT → C_{Cs}
Laser – PMT, fast readout electronics → C_{las}
Charge Injection System(CIS) - fast readout electronics → C_{CIS}

Energy reconstructed at the EM scale

$$E[GeV] = \frac{A[ADCcounts]}{C_{Cs} \cdot C_{las} \cdot C_{CIS}[ADCcounts/pC] \cdot C_{TB}[pC/GeV]}$$

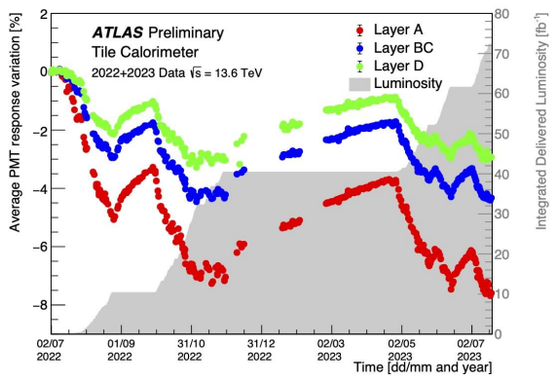


Laser System

- Uses laser light pulses distributed by fibers to the PMTs.

- It monitors PMT gain stability and timing in all readout channels.

- Precision of about 5%

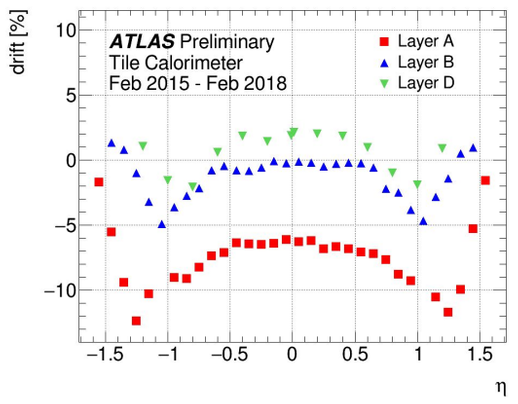


Cesium System

- Uses capsules of ^{137}Cs γ-radiation source that are moved through all tiles using hydraulic system.

- Detects degradation of tiles and WLS.

- Layer A more affected due to radiation exposure.

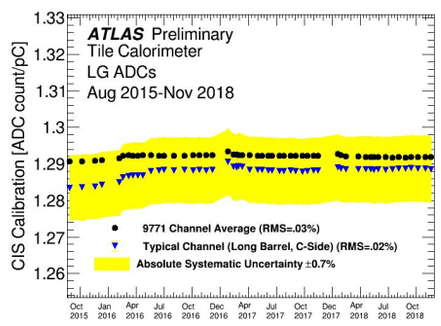


CIS System

- Injects a signal with a well-defined charge, with various magnitude values, to the electronics of all readout channels.

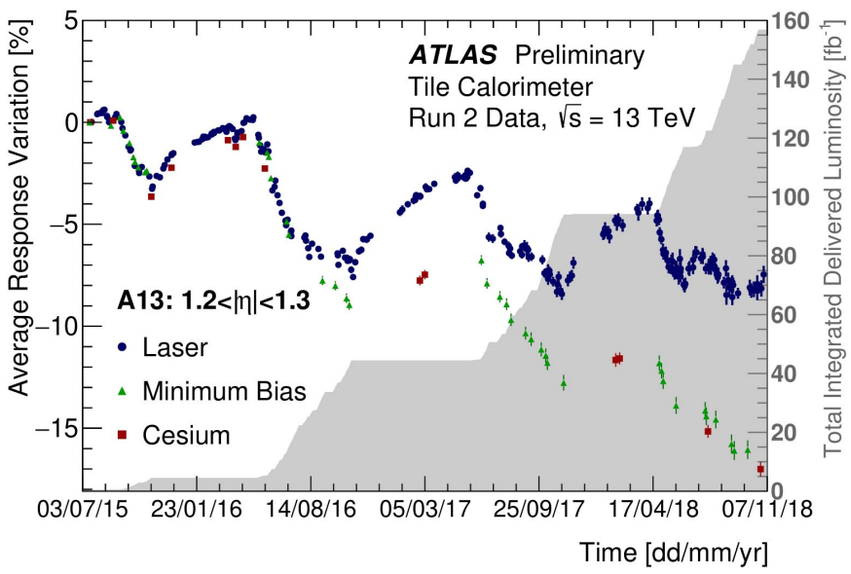
- It monitors the stability of the electronics and response of ADCs.

- Precision of about 0.7%.



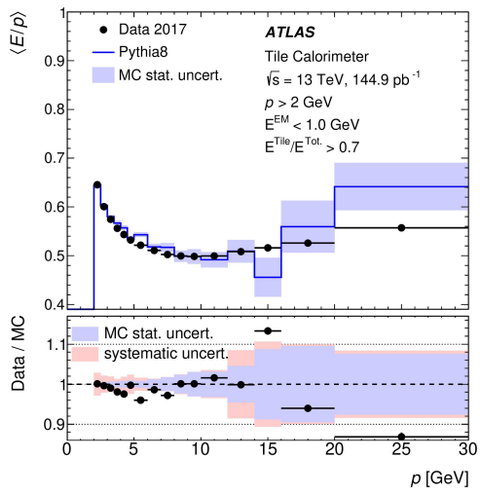
Minimum Bias and Combined Calibration

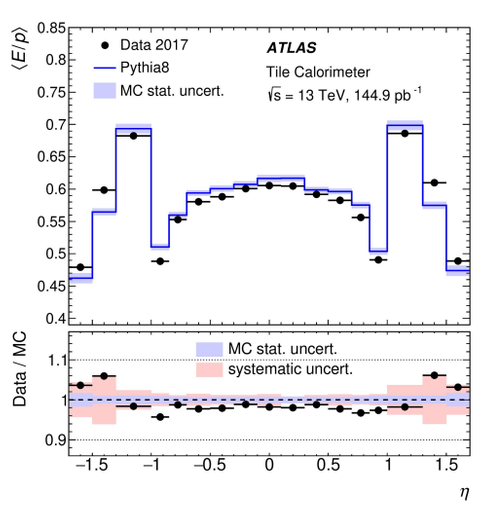
- Integrates the signal from Minimum Bias (MB) inelastic *pp* interactions using the integrator readout shared with the Cesium system.
- Allows the monitoring of the whole optics chain over time.
- Validates response changes from Cs system.
- Calibrates special cells where Cs system is not available.
- Cs and MB are in good agreement.
- Difference between laser and MB (Cs) due to fiber and tile degradation.

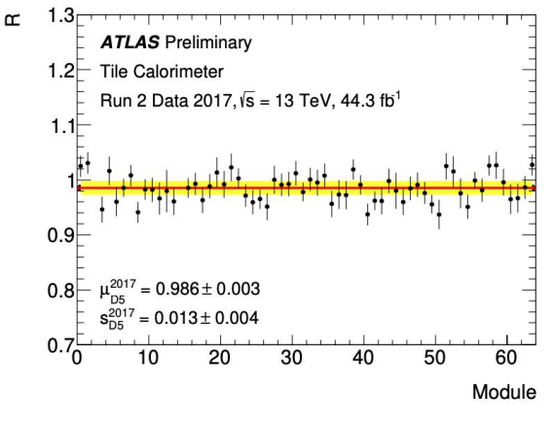


Performance Results

- **Response to isolated hadrons**
  - Evaluated using single hadrons originating from *pp* collisions with a low average number of interactions per crossing.
  - The ratio *E/p* is measured in function of the momentum *p* and η.
  - *E/p* < 1 due to the non compensating nature of the calorimeter.
- **Response to isolated muons**
  - Check EM scale and response uniformity.
  - Muons with momenta between 20 and 80 MeV are used.
  - Cell uniformity consistent considering all different cells.
  - Ratio *R* between ΔE/Δx from MC and data is used to monitor response nonlinearities.







The authors are thankful to CAPES, CNPq, FAPEMIG, FAPERJ and RENAFAE for the support.