

# Performance of the ATLAS Hadronic Tile Calorimeter at the LHC Startup

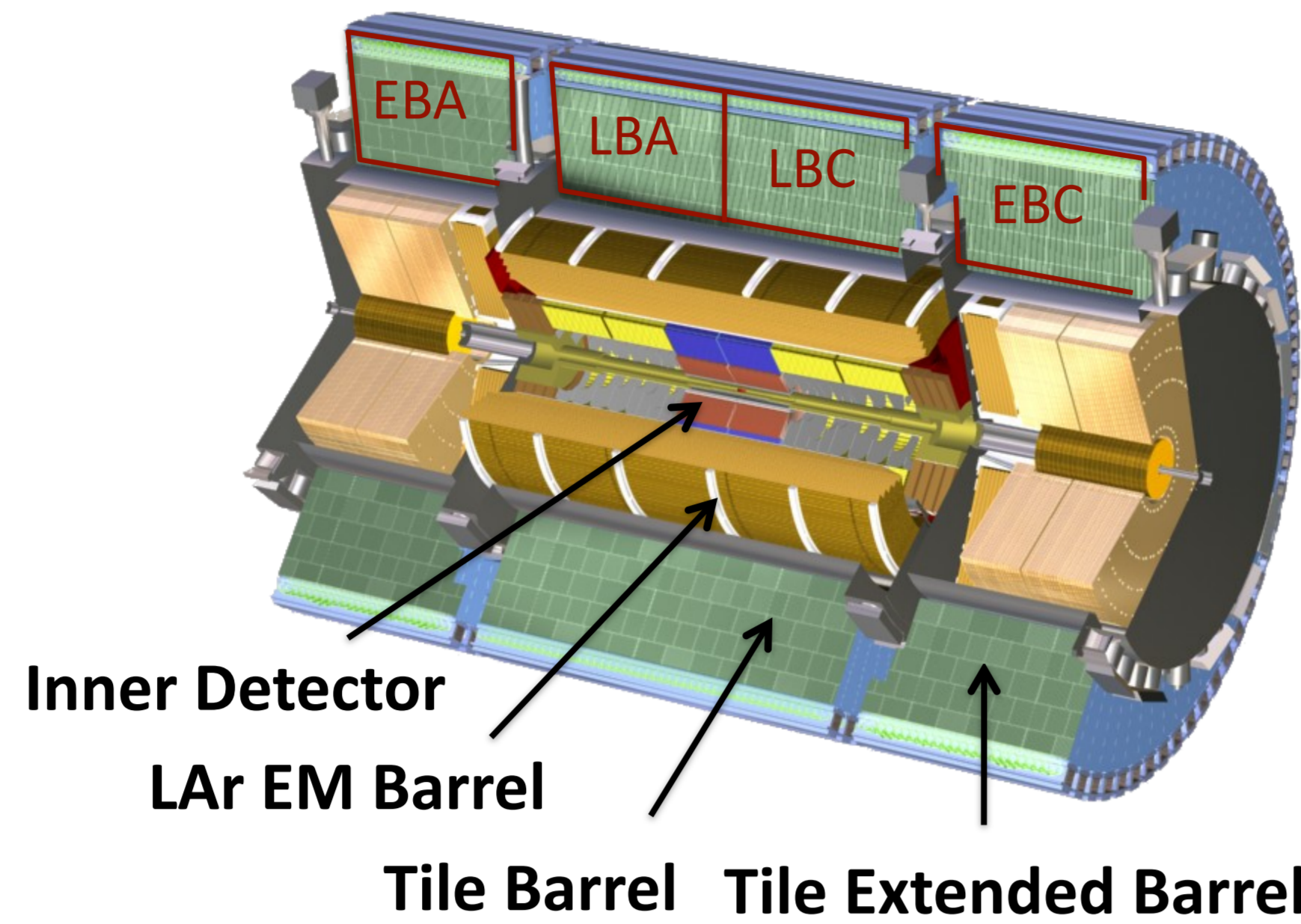


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IFIC (Universitat de Valencia - CSIC)

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## The ATLAS Tile Calorimeter

The ATLAS Tile Calorimeter is based on a sampling technique where plastic scintillating plates (tiles) are embedded in iron absorber plates and read-out by wavelength shifting fibers. Groups of tiles are bundled together into cells, each of which is read-out by two photo-multiplier tubes (PMTs).

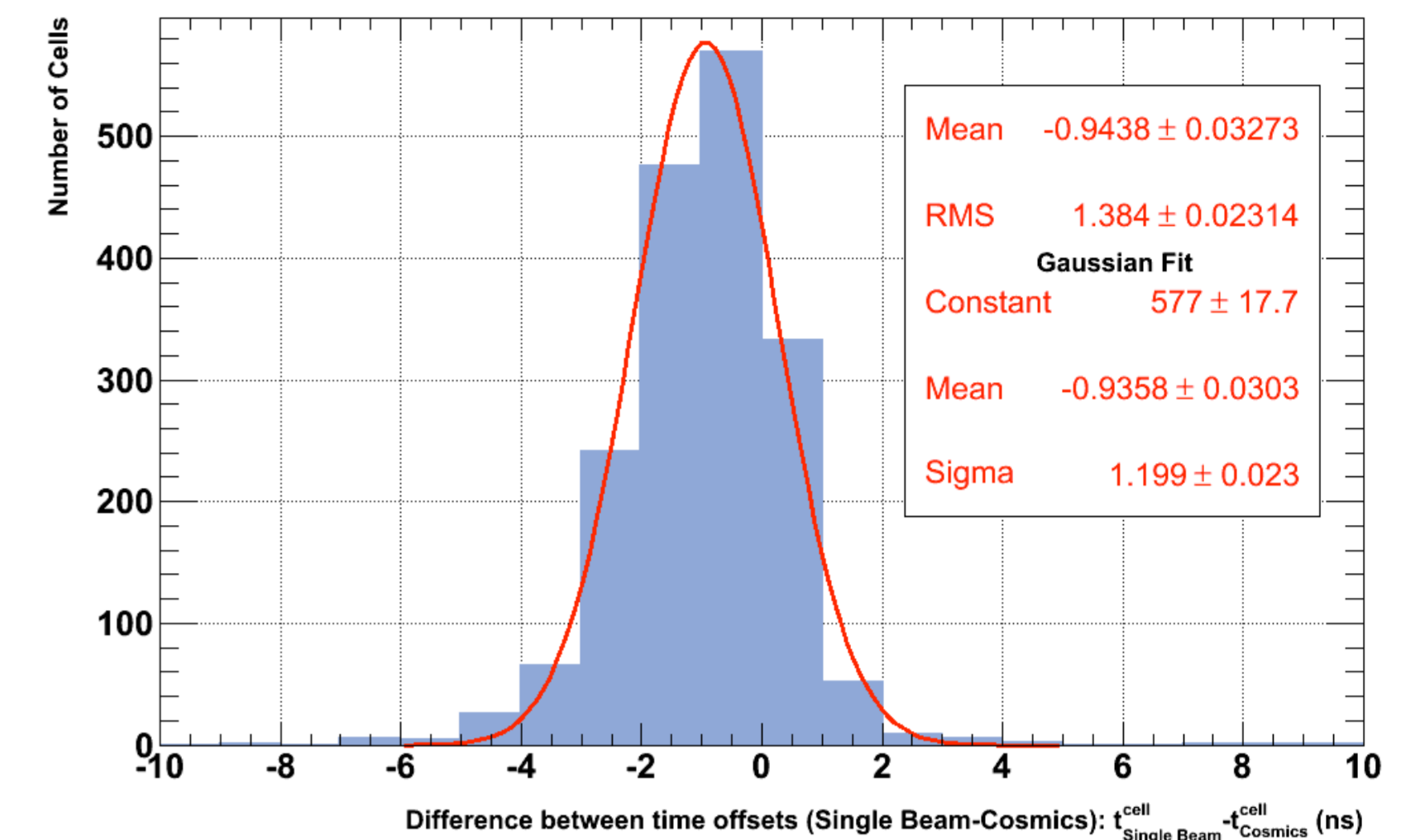
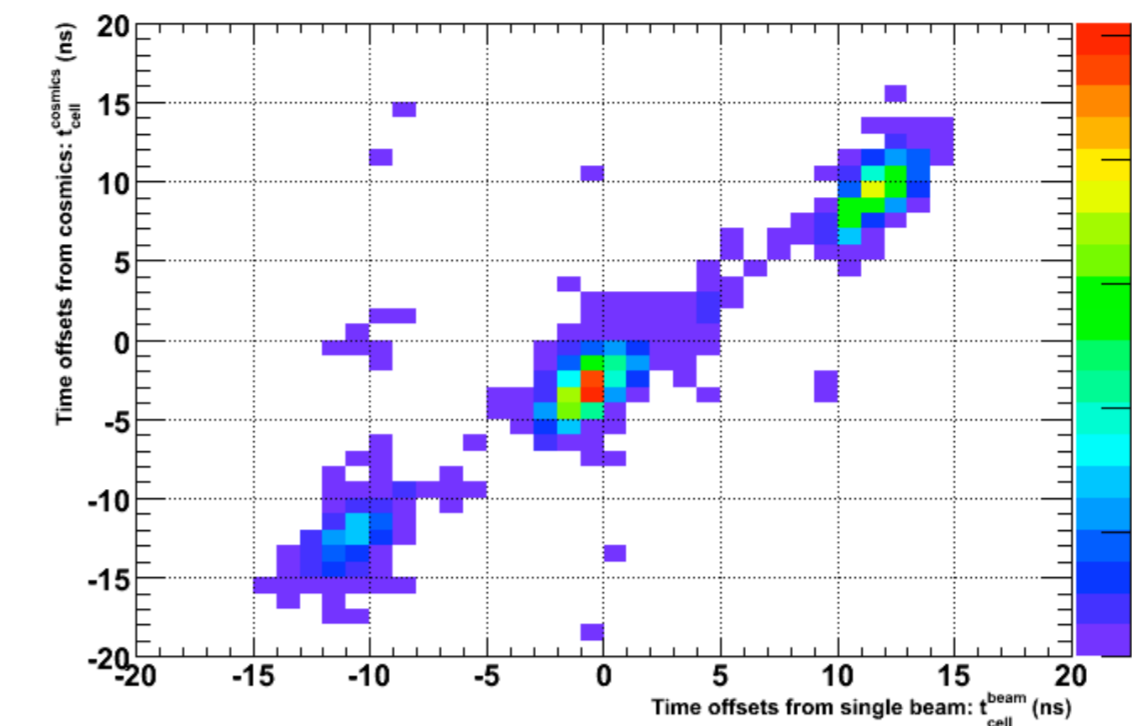


The Tile Calorimeter is a hollow cylinder with inner radius of 2.28m and outer radius of 4.23m. The length of the central Long Barrel (LB) is 5.56m, the length of the Extended Barrels (EB) is 2.91m each. The Long Barrel is divided into two partitions LBA and LBC. The two extended barrels are labeled as EBA and EBC.

**Modules:** Each partition is assembled out of 64 wedge-shaped modules, staggered in  $\phi$ .  
**Granularity:**  $\Delta\eta \times \Delta\phi$  cell segmentation of  $0.1 \times 0.1$ , three layers of cells in radial direction.  
**Read-out channels:**  $\approx 10000$   
**Weight:** 2300 tons

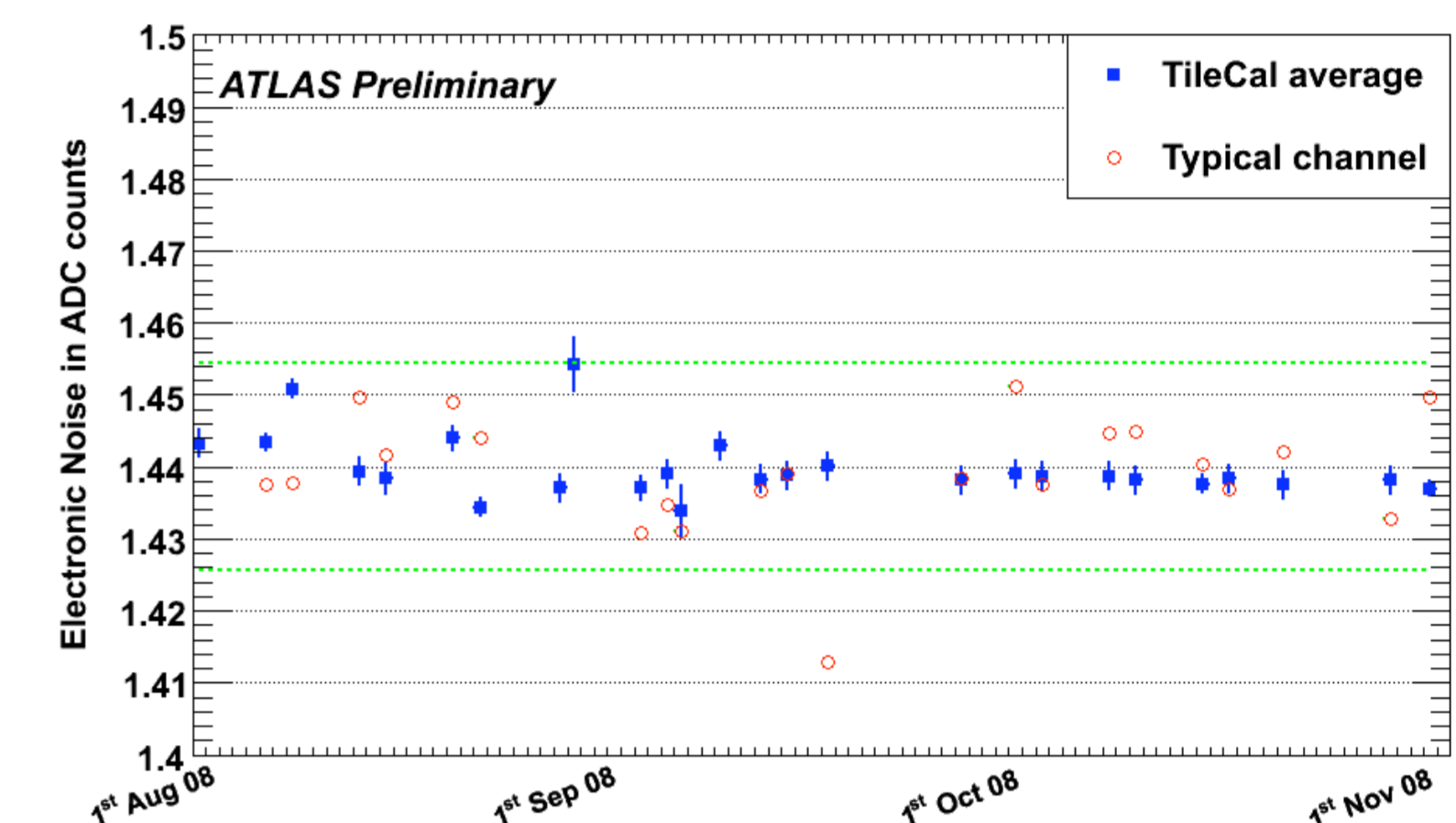
## Timing

The difference of time offsets per cell as seen in the single beam and cosmic data is shown. The two measurements agree within 2 ns at cell level.

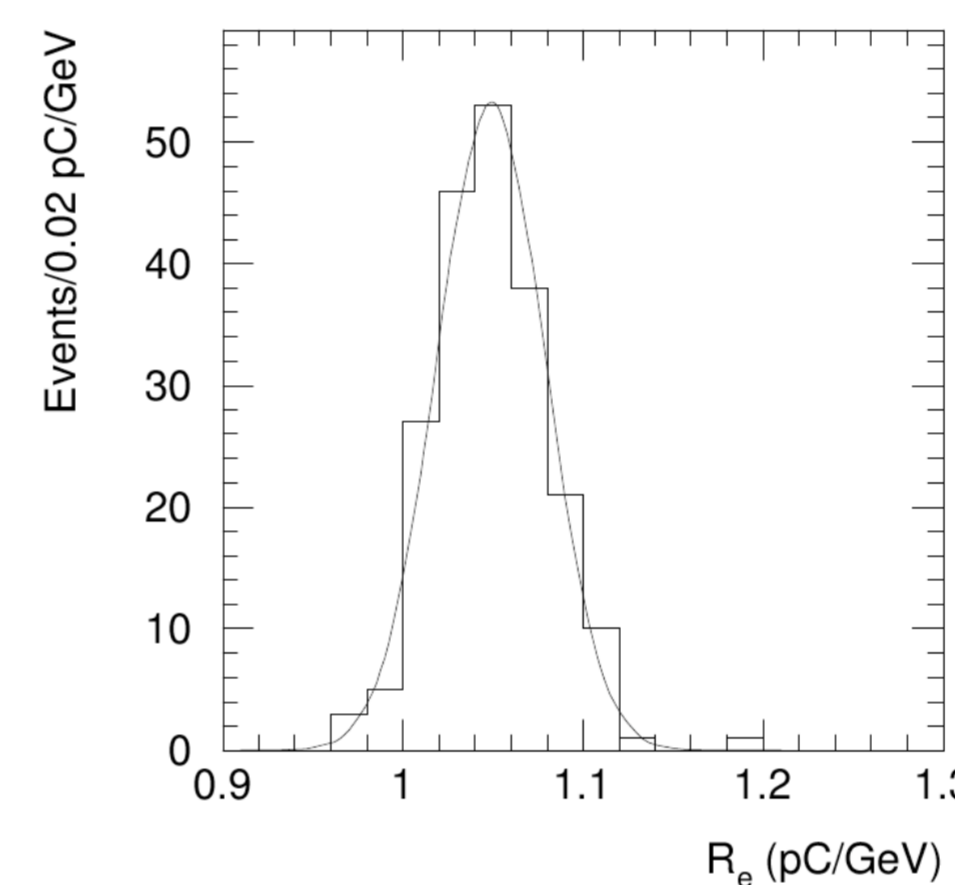


## Noise

Runs of randomly triggered events collected in 2008 were used to evaluate the stability of the electronic noise. The green lines represent the  $\pm 1\%$  variation limits around the average value of 1.44 ADC counts, or equivalent energy of 50 MeV per cell. Blue dots represent the average over the Tile Calorimeter and the red dots represent a typical channel.

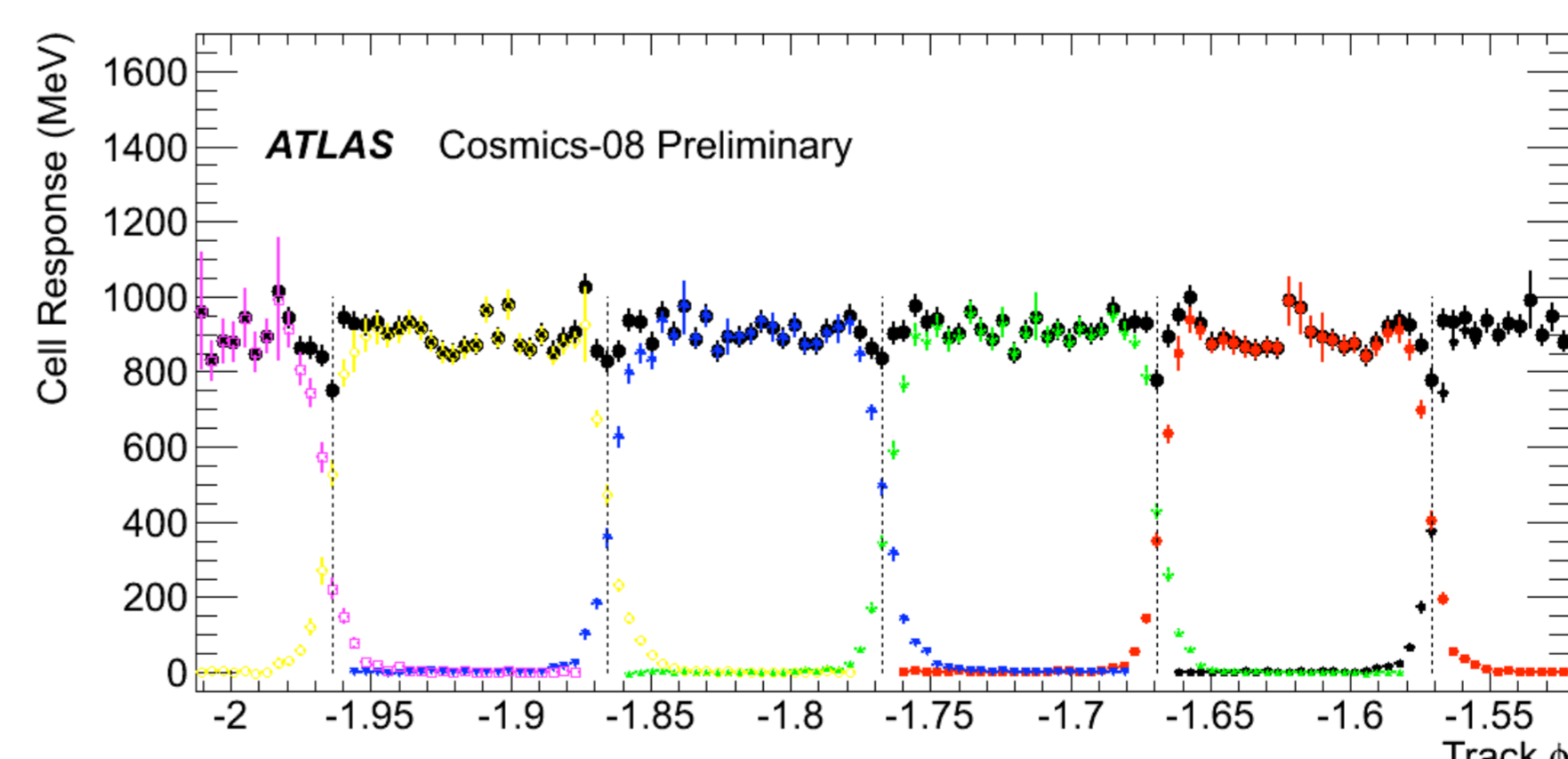
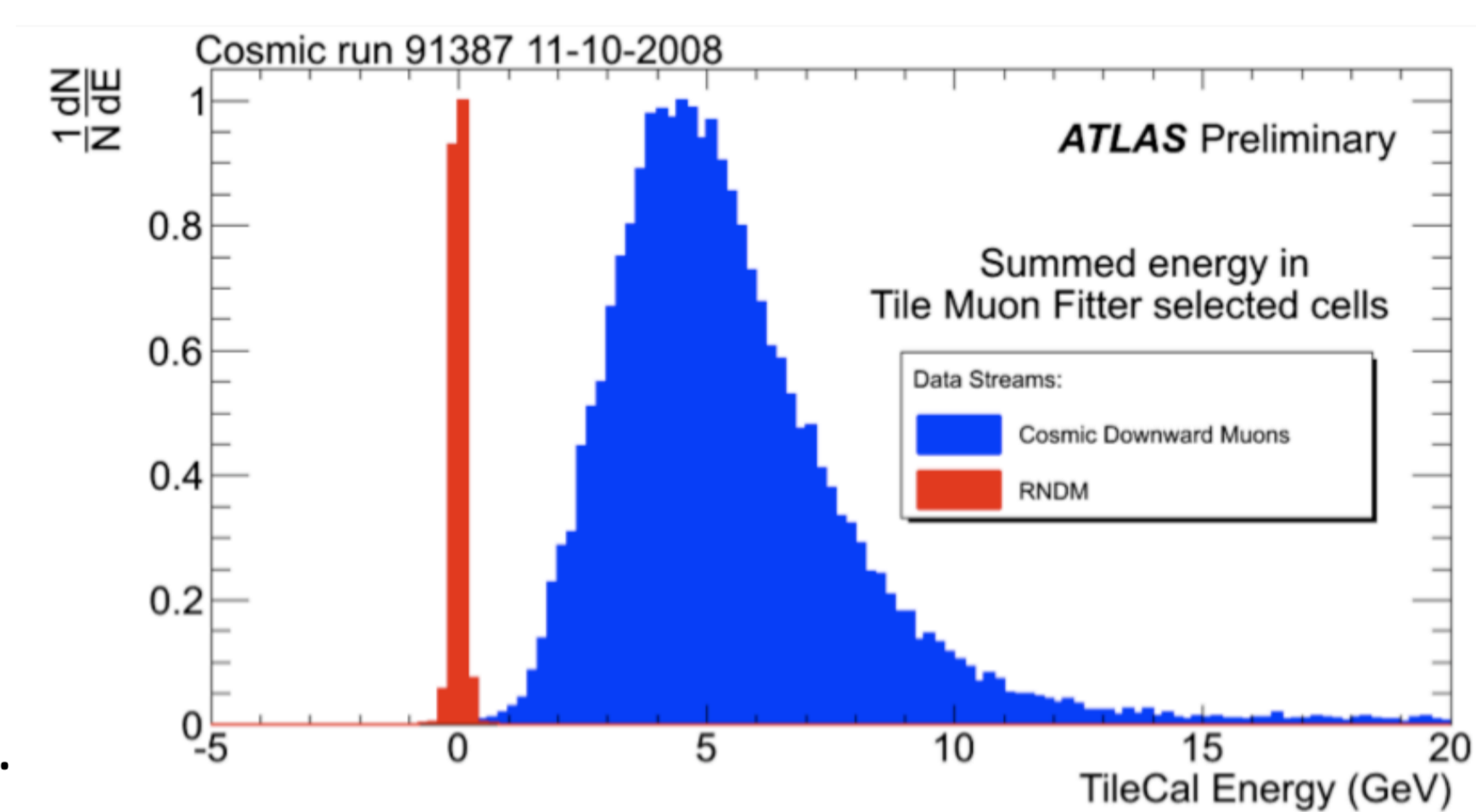


## Energy



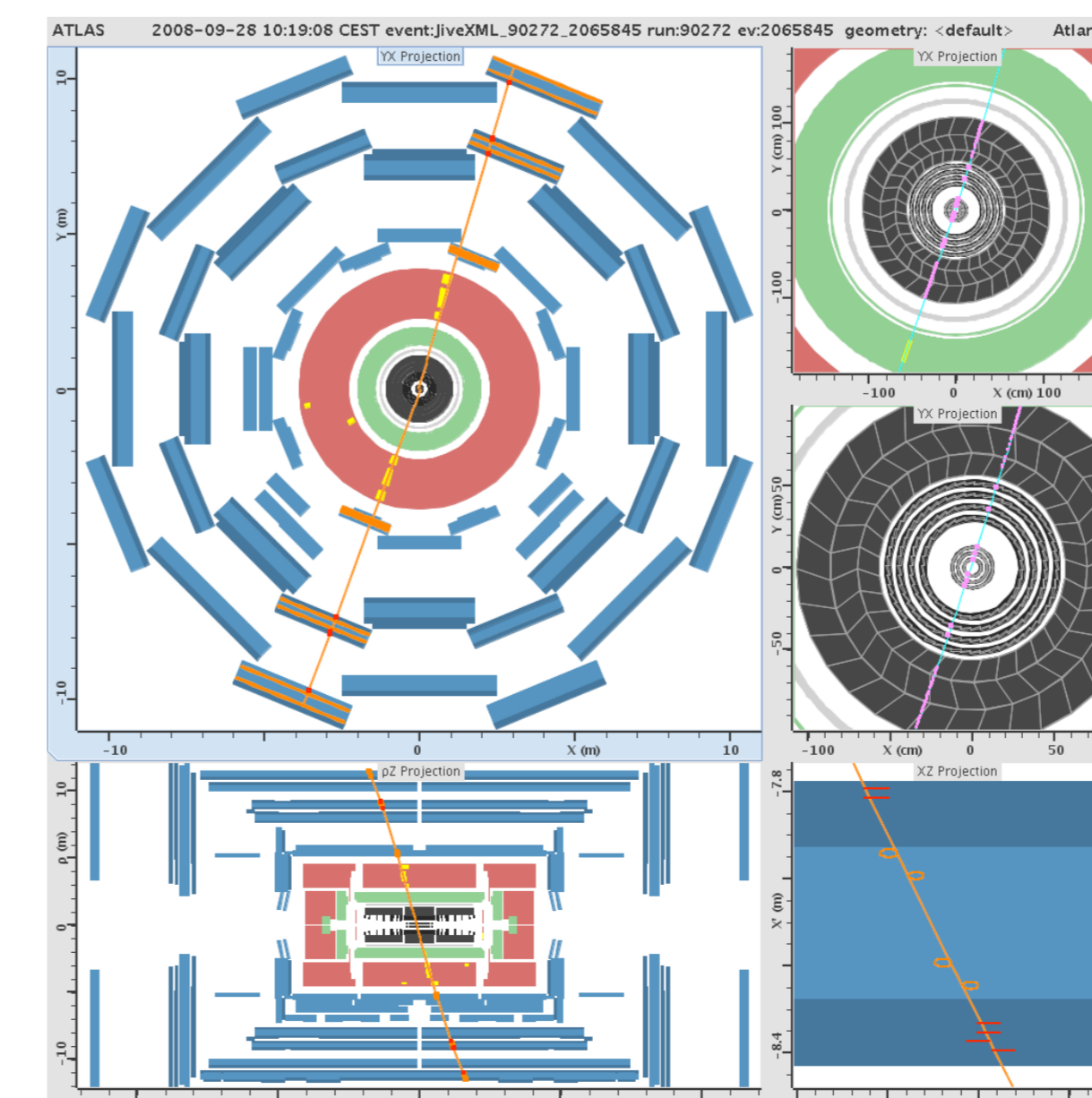
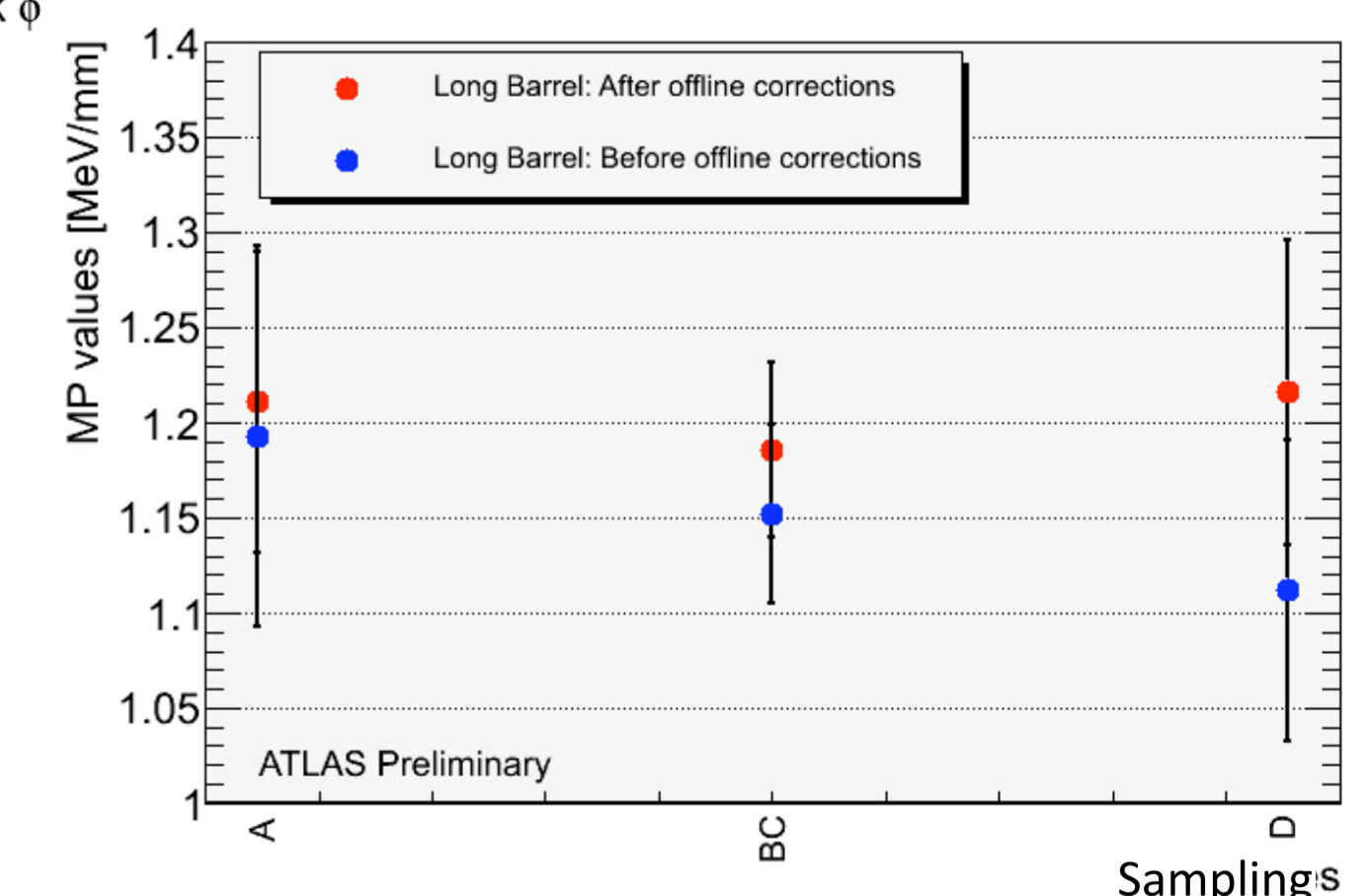
The energy intercalibration from cosmic and single beam is ongoing. Results from Testbeam data analysis provide an electromagnetic scale constant of 1.05 pC/GeV with an RMS of 2.4%. A distribution of the response to electrons ( $R_e$ ) entering the calorimeter modules exposed to the beam at incidence angle of 20 degrees normalized to beam energy, is shown. The plot contains energies from 20 to 180 GeV.

Energy distribution of muons in the Tile Calorimeter triggered by RPCs and reconstructed by the muon track reconstruction using calorimeter cells (blue) compared to the noise from the same cells (red) measured from random trigger stream show a good signal and noise separation. Muons crossing both top and bottom modules are considered.



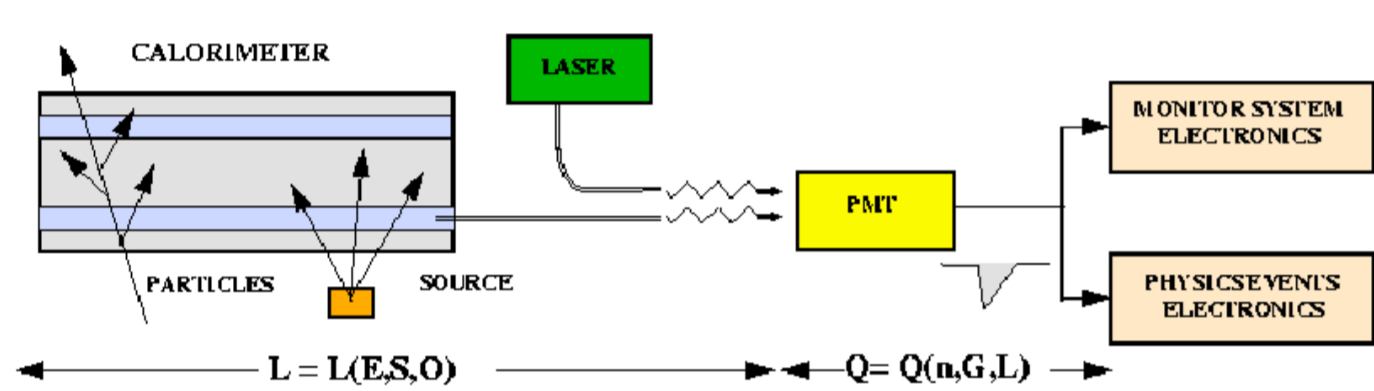
Response of the second layer cells as a function of reconstructed track phi is shown. The response for the individual cells is shown by the different colored points whereas the total response summed over all cells is shown by the black points.

Energy scale corrections per longitudinal sampling are derived from dedicated test beam measurements and  $^{90}\text{Sr}$  radioactive source scans. Most Probable (MP) value of the  $dE/dx$  distribution for first beam data is shown as a function of the sampling. Colors represent calorimeter response before (blue) and after (red) the corrections.

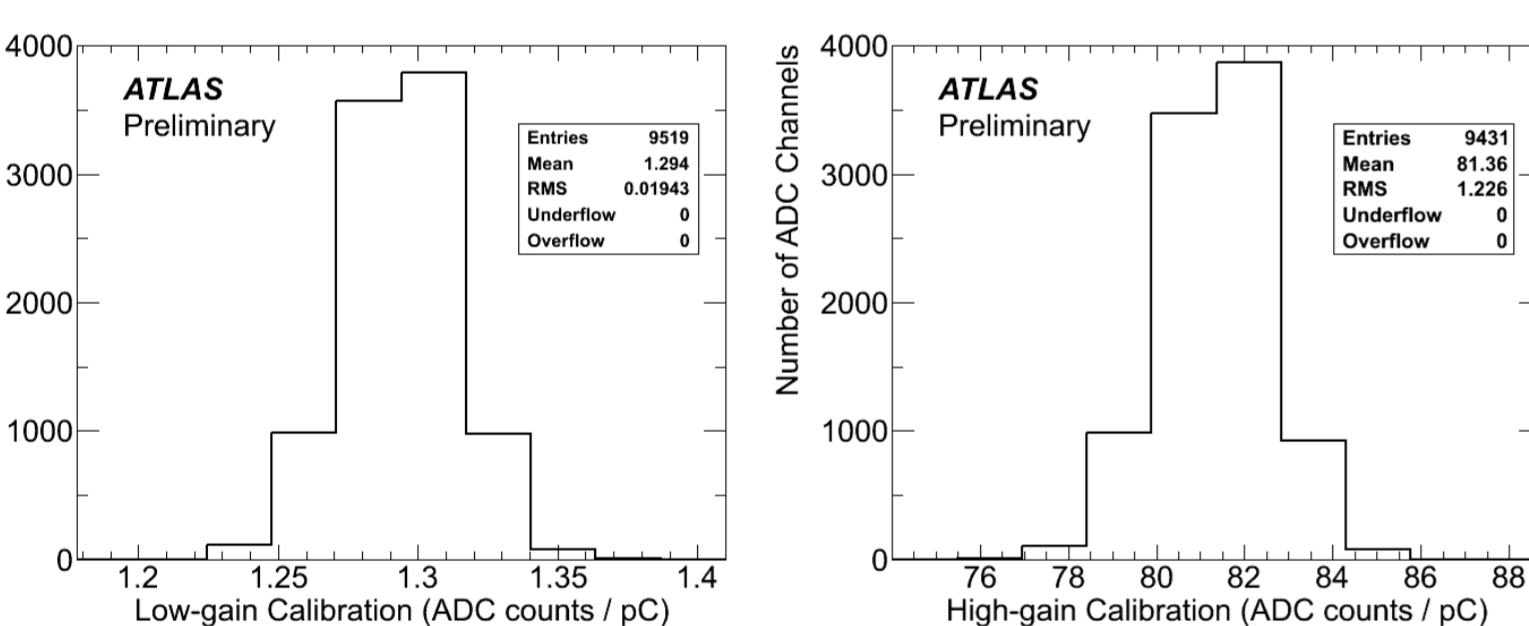


Atlantis is an ATLAS event display that provides a variety of projections. It is independent from the ATLAS software allowing remote event display from ATLAS web server. Detailed track and calorimetric information are available for each event. A muon event is shown in Atlantis crossing the whole detector (top left) leaving a track in the RPCs and through the Tile Calorimeter. Zoomed in view of LAr (top right) and TRT (middle right) display the track associated to the muon.

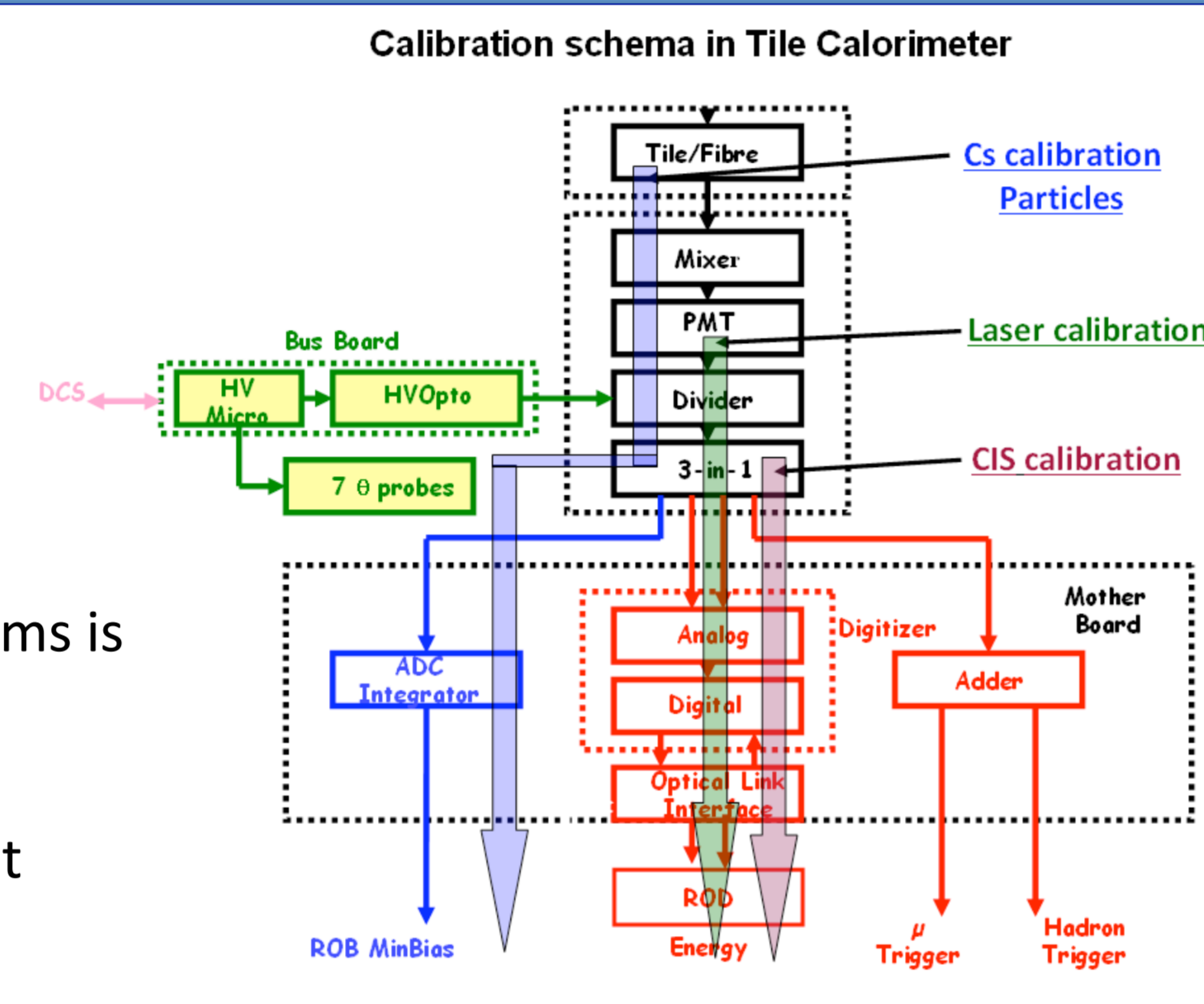
## Calibration systems



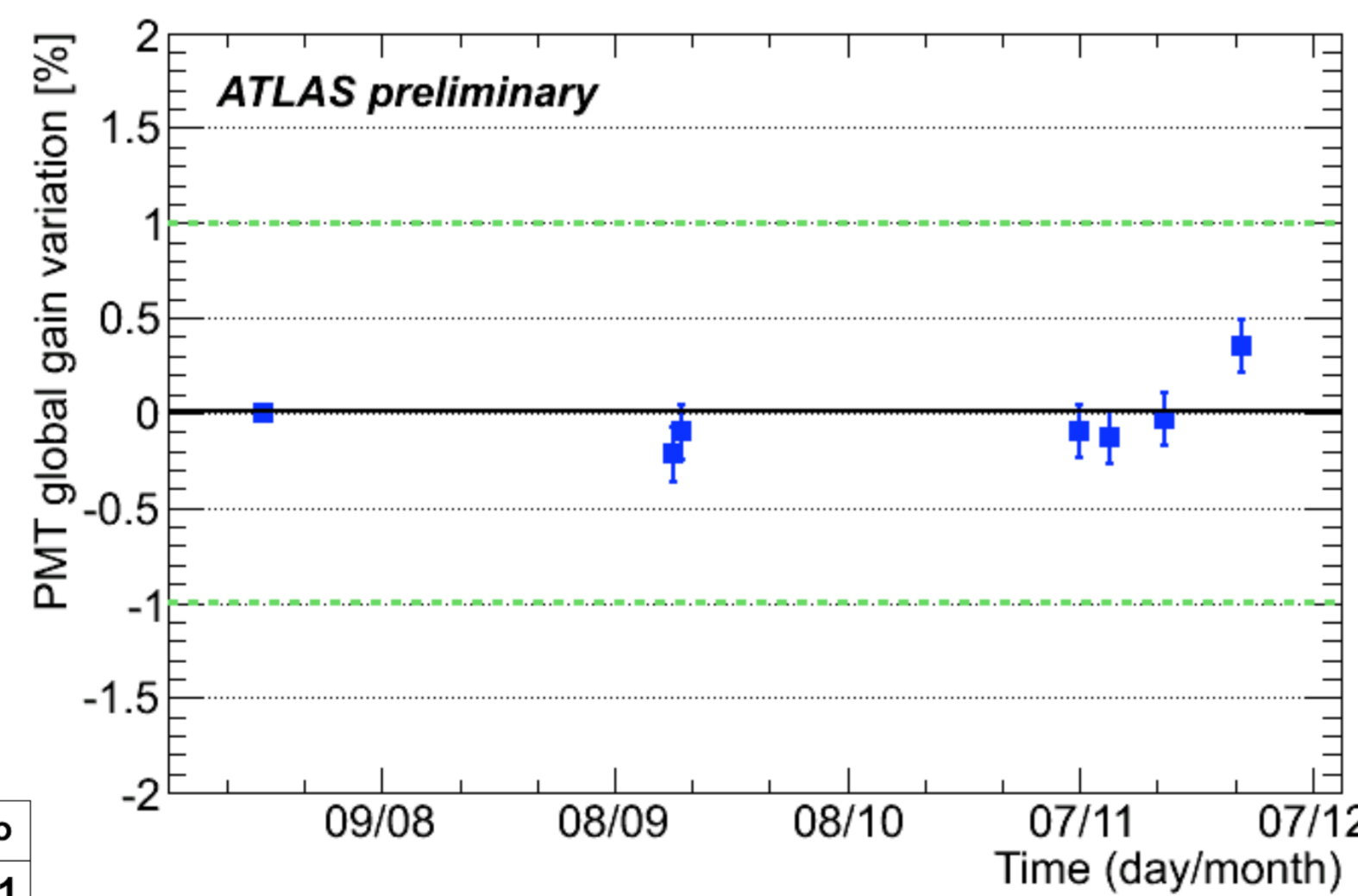
The main purpose of the calibration systems is to provide calibration of the energy of the cells to the electromagnetic scale. Each calibration system acts on a specific element inside the read-out chain.



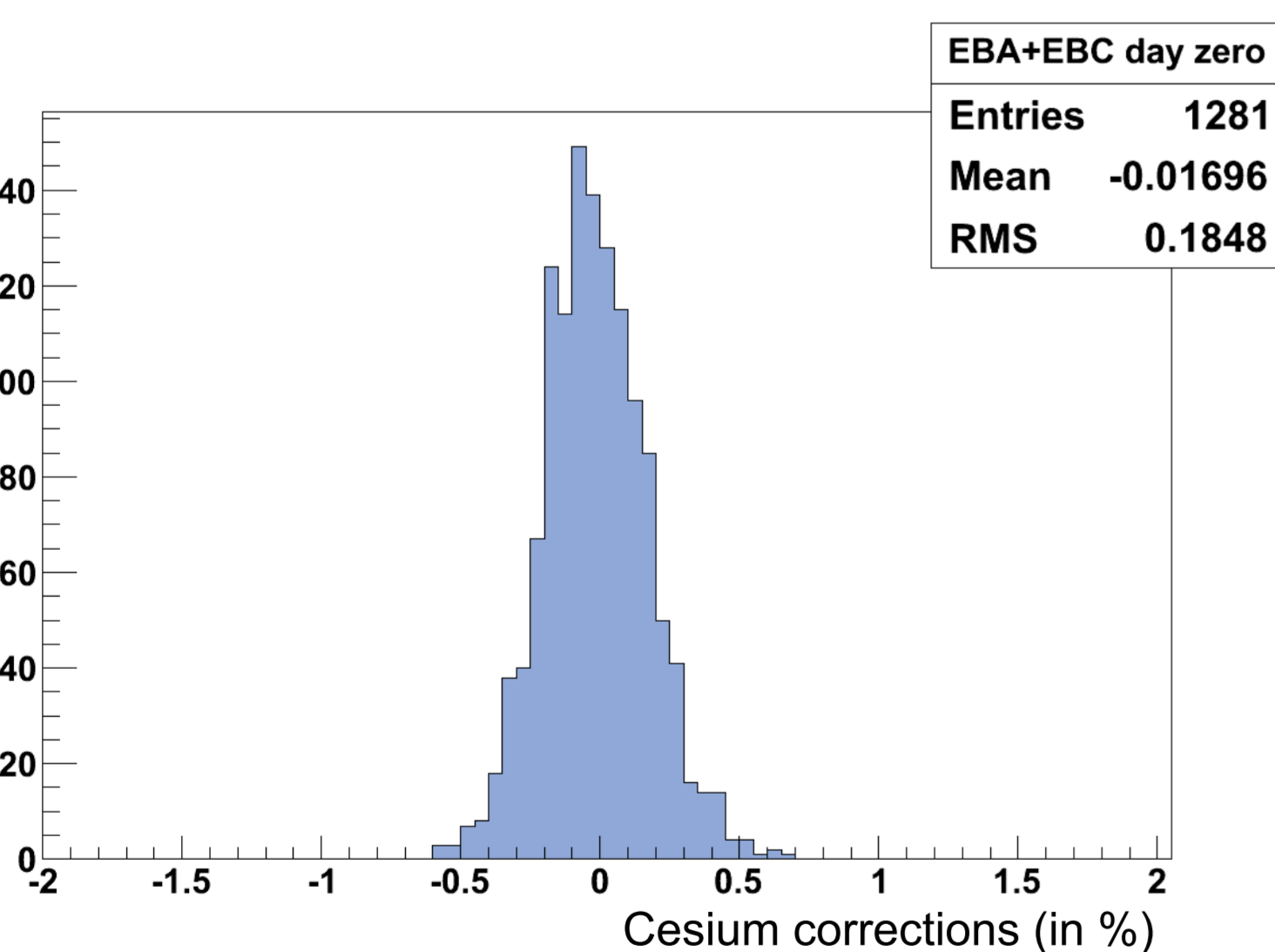
The Laser System provides a correction for the gain linearity and stability over time. Average gain variation is shown as a function of time from the reference run taken on July 25th 2008 to the beginning of December 2008. This variation is found to be within 0.5% over considered period.



The Charge Injection System (CIS) provides calibration of the ADC counts to pC. In situ high and low gain calibration yield a typical variation of 1.5%.



The Cesium System is used to set the gain of the PMTs in order to correct for non-uniformity of the optics elements. It is based on the response of the calorimeter to the photons of a  $^{137}\text{Cs}$  source. Cesium corrections per channel (in %) are shown immediately after equalization via the HV settings in June 2009.



Timeline of the deviation (%) of the mean response of EBA and EBC cells from the expected Cs decay curve. Days 0 (15 July 2008) and 330 (17 June 2009) mark the equalization via the HV settings. Error bars on this plot represent the RMS of the distribution for all cells.

