Calibration and signal reconstruction in the ATLAS Tile Hadronic calorimeter

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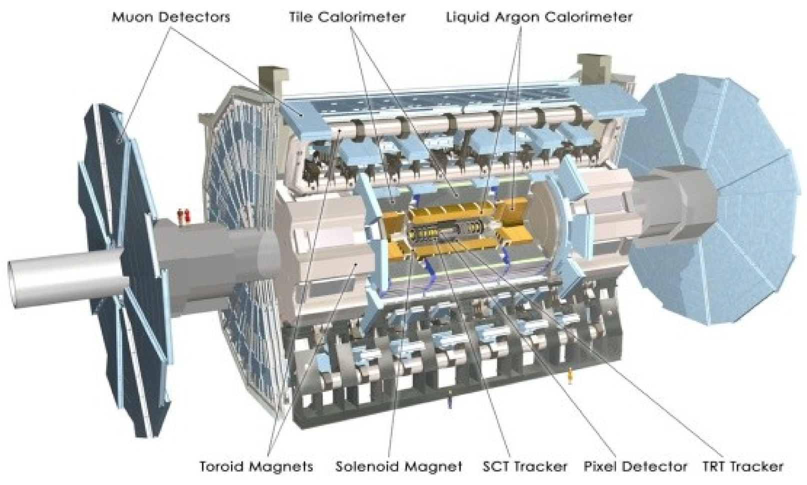
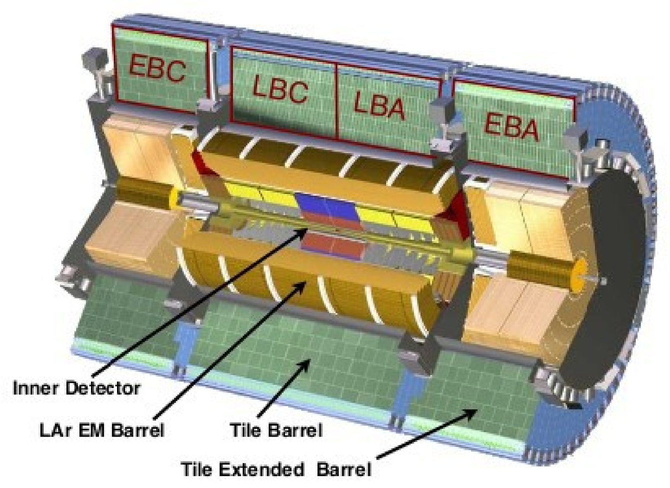
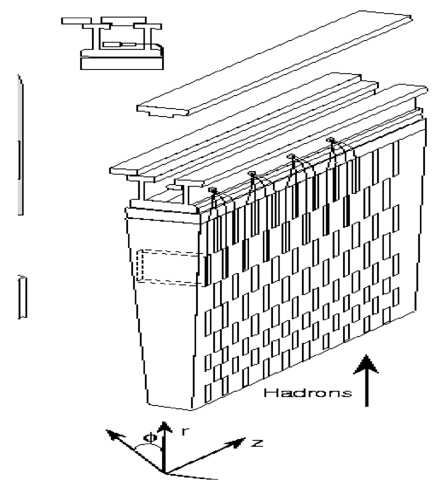
The Context…the ATLAS Tile Calorimeter



TileCal is the central hadronic calorimeter of ATLAS. With the central LAr EM calorimeter, it measures the energy and direction of particle jets and contribute to the determination of the missing transverse energy in selected events, in the region of |η| < 1.7.
TileCal is made up by two barrels (a central, Long Barrel LB, and two Extended Barrels EB) divided along phi in 64 modules. The modules are divided in three radial layers, and cells with a of 0.1. Each side of the Long Barrel, and each of the Extended Barrels constitutes one partition



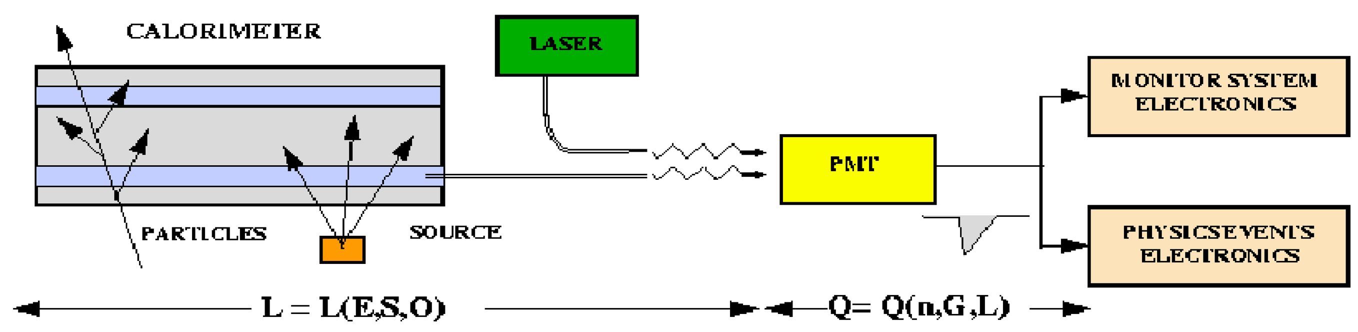


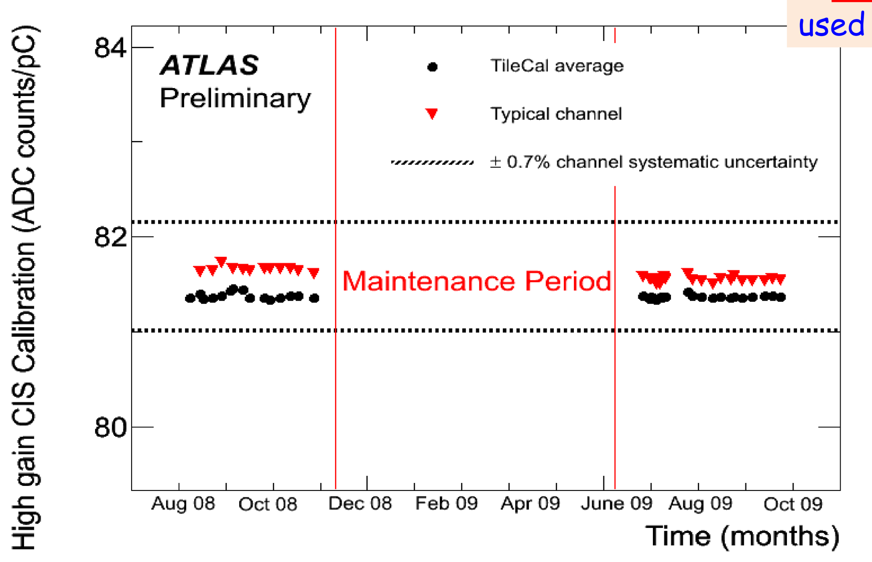
TileCal is a sampling calorimeter using iron as absorber and tiles of scintillating plastic as the active material. The tiles are oriented perpendicularly to the beam direction. The light readout is assured by WLS optical fibers, that are connected to PMTs in the outer part of each module. In the outer part of each module also are placed the detector electronics services: the electronics for signal shaping, digitization and integration, for the analog trigger, the charge injection calibration system, the low voltage power supply and a set of optical fibers dedicated for the Laser calibration system.

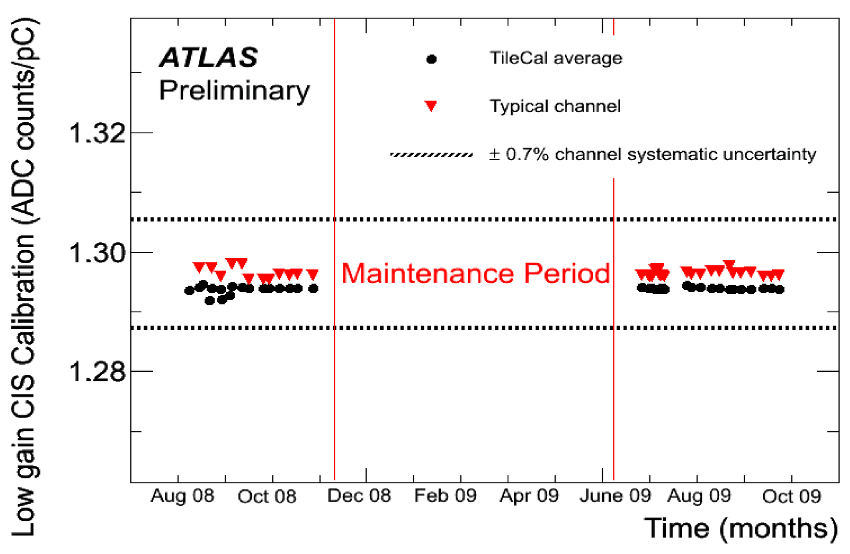
The calibration systems

The response of TileCal is regularly monitored and corrected using a series of calibration systems that focus on each main detector component:

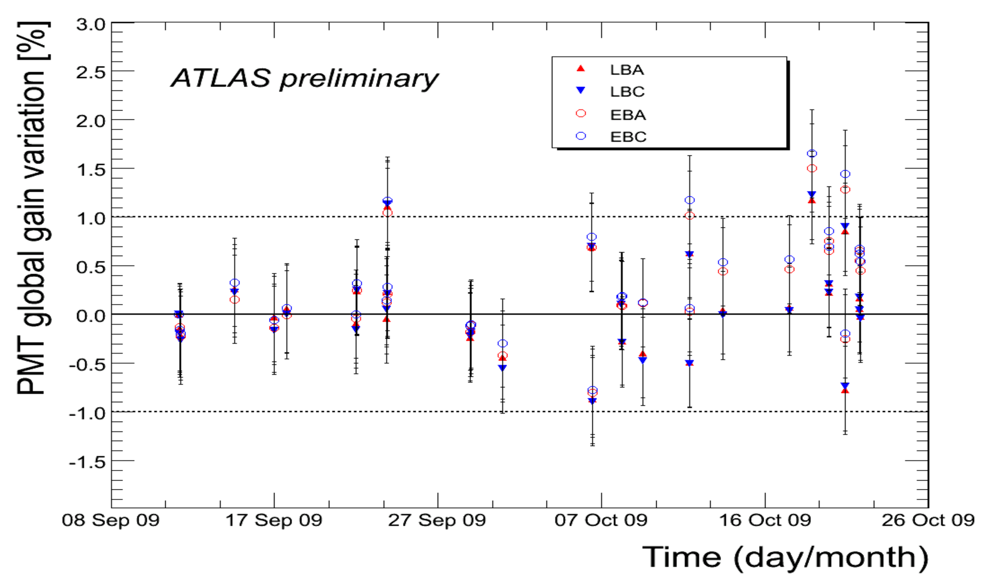
- The Charge Injection System (CIS) generates calibrated amplitude pulses, sent to electronics channel. It allows to compute the calibration constants for the conversion of the number of ADC counts to pC.
- The Laser system provides calibrated light pulses that are sent to all TileCal PMTs using an optical fiber distribution system. It allows the measurement and the correction of the PMT gain stability and linearity as function of the time.
- The Cesium calibration uses an hydraulic system to move a Cesium-137 source through all the TileCal cells. This system Is used to set the gain of the TileCal PMTs to correct for non uniformity of the optics elements.



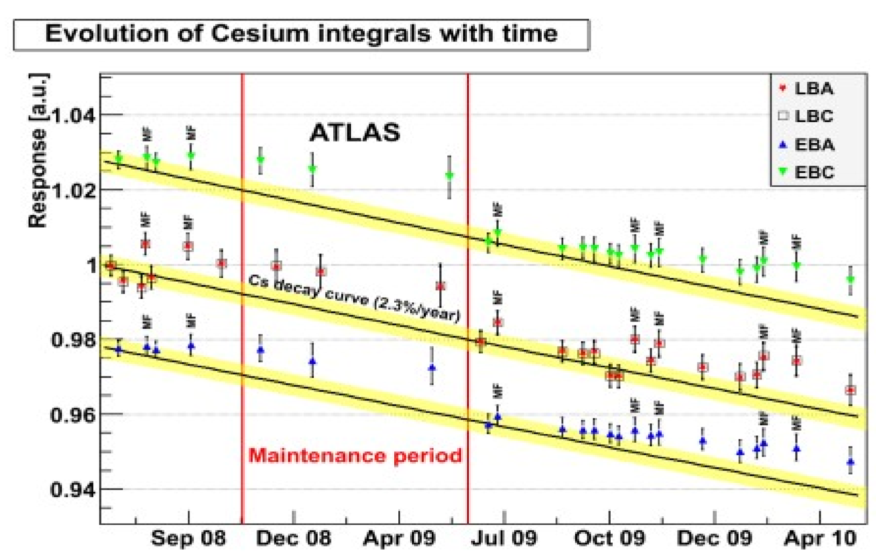




The time stability of the electronics of a typical channel is shown for each gain, with the +/-0.7% systematic uncertainty on the individual calibrations. The RMS variation for the single channel shown is 0.07% and 0.05% in the high gain and low gain. The RMS for the detector wide average is 0.03% and 0.04% for high and low



This variation is found to be within 1.0% over the considered period. The displayed errors of 0.45% account for both, the statistical uncertainty and the systematic effects. The systematic error coming from the non-reproducibility of the LASER system dominates. the systematics of the LASER system

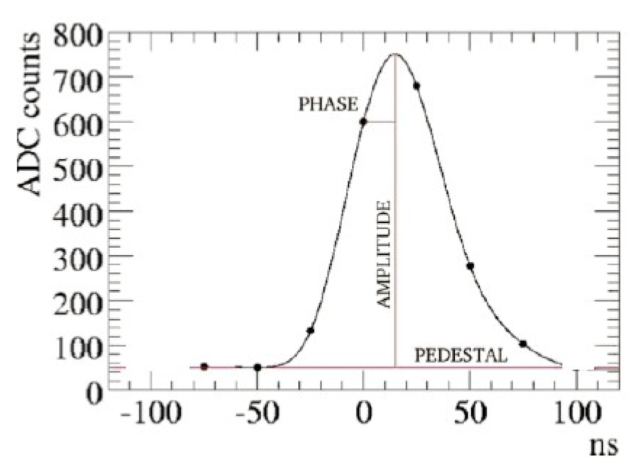


This plot shows evolution of Tile response to radioactive Cesium source as a function of time in all 4 partitions.

Signal reconstruction

The signal produced in TileCal is reconstructed using optimal filter method.
The algorithms are implemented in the Read-Out Drivers (ROD) and in the offline software:

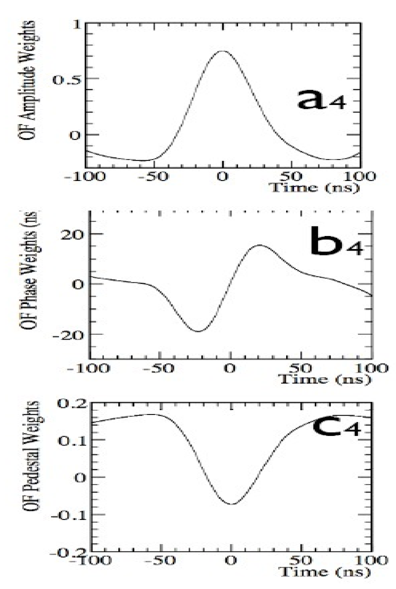
-An iterative algorithm, that doesn't have strong time requirements. Is able to signals that are not synchronous with the trigger.
-A non iterative algorithm, that must receive signals in a window of +/- 1ns otherwise it starts to be not linear. The parabolic correction allows to enlarge the jitter of the signal up to +/- 10 r



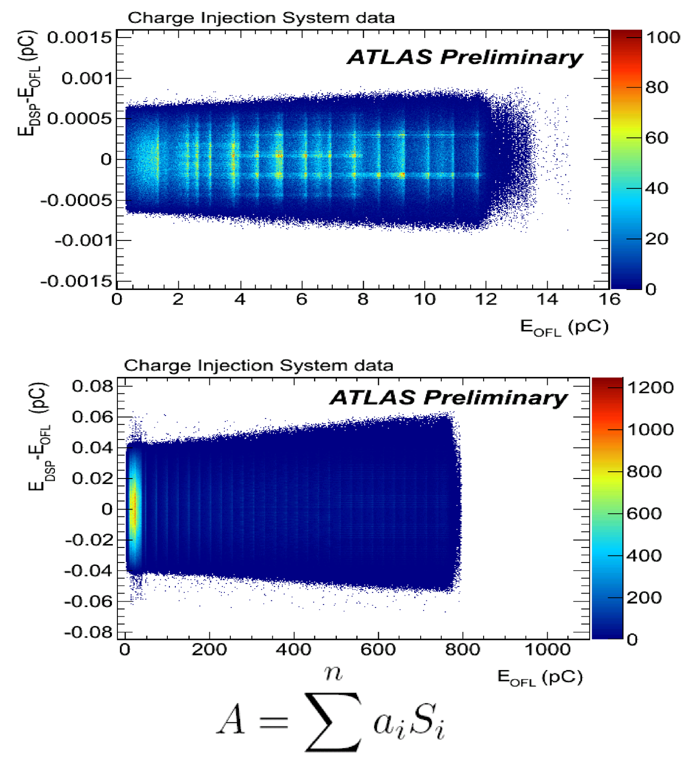
$$A=\sum_{i=1}^{n} a_i S_i$$

$$A\tau=\sum_{i=1}^{n} b_i S_i$$

$$p=\sum_{i=1}^{n} c_i S_i$$

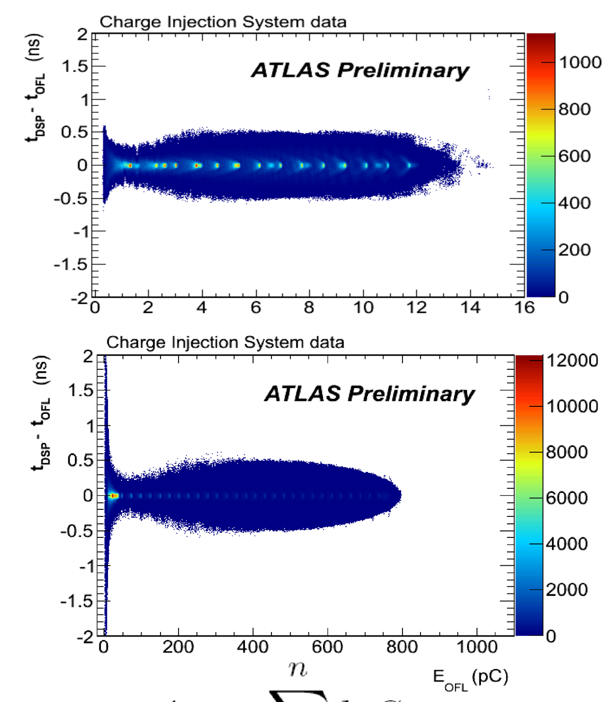


The weights a,b,c are obtained from the pulse shape.



$$A=\sum_{i=1}^{n} a_i S_i$$

Absolute difference between the amplitude reconstructed online (DSP) and offline (OFL) as a function of amplitude (OFL) for Charge Injection data in High Gain (top) and Low Gain (bottom).



$$A\tau=\sum_{i=1}^{n} b_i S_i$$

Absolute difference between the time reconstructed online (DSP) and offline (OFL) as a function of amplitude (OFL) for Charge Injection data in High Gain (top) and Low Gain (bottom).