Atlas Tile Calorimeter

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The hadron Tile Calorimeter

Introduction

The Tile calorimeter (TileCal) is the central hadron calorimeter in ATLAS and measures energy and position of absorbed particles. Hadronic means that the calorimeter designed to measure particles that interact via the strong nuclear force

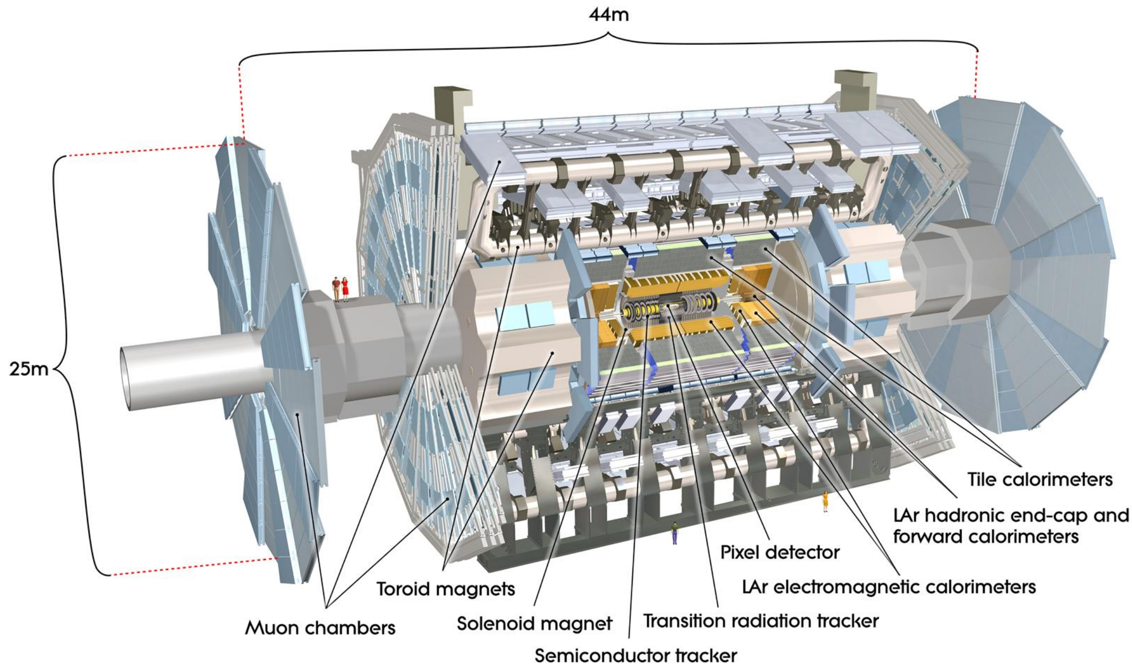

FIGURE 1 – Global view of ATLAS

ATLAS collision hall in 2004 and the first signals from cosmic ray muons were logged in 2005. Since then the detector has been commissioned using cosmic rays and brought into full operation, together with the other ATLAS detector systems. The first beam-beam collisions in the LHC occurred in late 2009 and the first production operation at a center of mass energy of 7 TeV began in March 2010.

Description

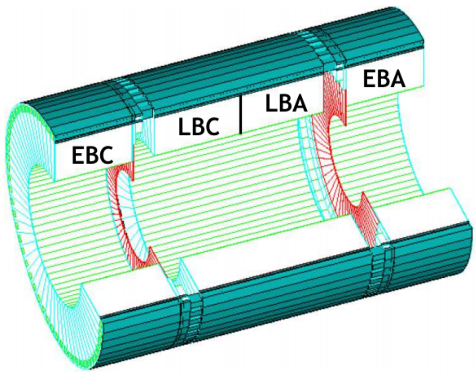

Figure 2 – The Tile Calorimeter and his barrels

The Tile calorimeter is constructed in 3 sections, one central barrel (the long barrel) and two extended barrels. Each section comprising 64 individually constructed modules, which are stacked on each other to form each cylinder.

The names of the barrels were chosen by dint of the direction of the detector. LBA means Long Barrel in the Airport side and EBC means Extended Barrel in the Charly's pub side (in honor of a famous pub near the CERN site).

Dimensions

Figure 3 – 6 azimuthal modules

A barrel module weighs 20020 kg and an extended barrel module weighs 9600 kg. The structure has a nominal outer diameter of 4230 mm and an inner diameter of 2288 mm. A barrel (extended barrel) module has a length of 5640 mm (2900 mm). There is a gap of 60 cm between barrels. The long barrel measures 654 cm and one extended barrels 219 cm.

Coverage

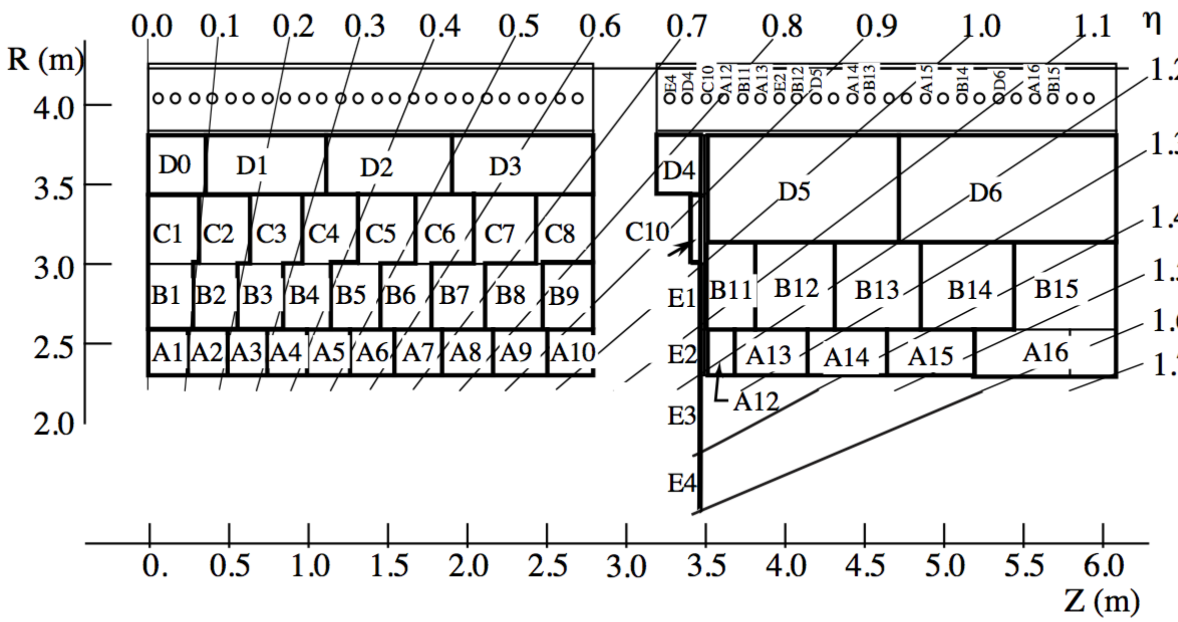

FIGURE 4 – TileCal cells and η, solid angle along length of ATLAS

The figure shows the barrel and extended barrel sections of the Tile Calorimeter. Signals from the scintillators are grouped into the rectangular cells shown and each cell is viewed by a pair of photomultipliers. In the barrel section, cells Bi and Ci are viewed by the same pair of photomultipliers.

The cell dimensions are chosen to obtain pseudo-projective towers of nominal width $\Delta\eta = 0.1$. The D cells, which normally contain very little energy, have a width $\Delta\eta = 0.2$. One PMT is put in each of the two appropriate $\Delta\eta = 0.1$ towers. Thus each tower contains three longitudinal segments. The PMT in bold font is also connected to the Muon Output trigger.

TileCal : a sampling calorimeter

TileCal finds a particle's position, energy and arrival time using alternating layers of steel (absorber) and fluorescent scintillator (active medium) materials that produce a rapid light pulse when the particle passes through.

Special optic fibres collect up this light and feed it into readout boxes where photodetectors amplify the signal. When the amount of light in a given region is summed up over many layers of tiles in depth, called a “tower”, this total amount of light is a measure of a particle's energy.

Stability study results using muons

The motivation was to validate the calibration of TileCal cells, measuring the dE/dx response using muons from proton-proton collisions for different run periods over 2011-2012 (period A-M). We chose to plot histograms for each period, each barrel and each layer.

Cuts

Isolation cuts

— p_T (transverse momentum) in cone 0.4 < 1 GeV
— Energy in the Liquid Argon in cone 0.4 < 3Gev

Event selection

— E_T^{miss} (missing transverse energy per event) > 25 GeV
— At least (and at most) one muon in the event

Muon selection

— p_{muon} (muon momentum) >15 GeV
— One muon with at least one track associated to it

Energy Loss by path lengh

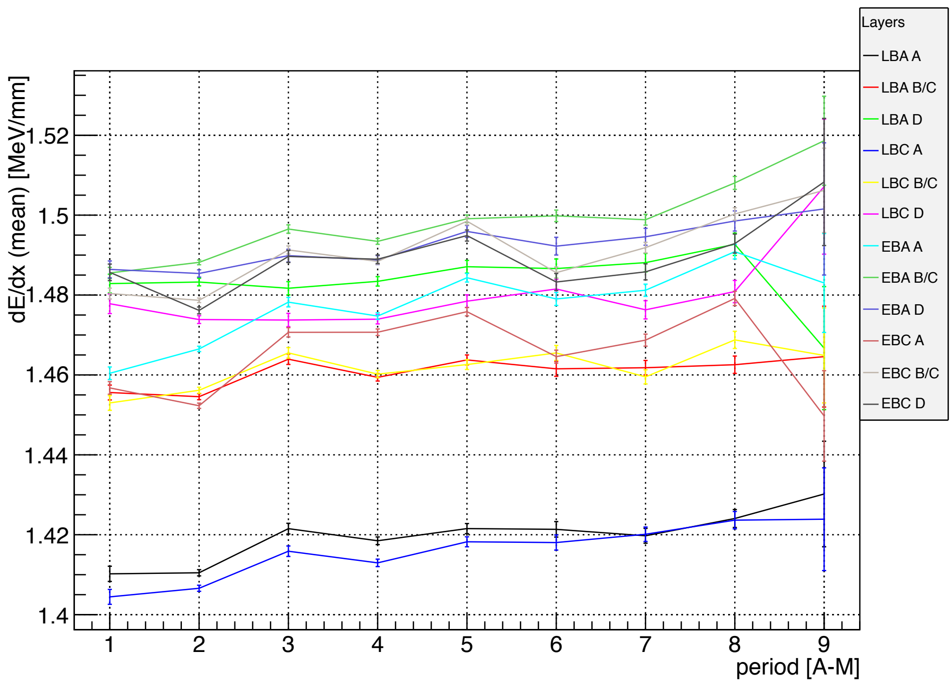

FIGURE 5 – mean of dE/dx versus time

The figure 5 represent the dE/dx mean of the different layers versus time. An ascending tendency appears, maybe due to different beam conditions.

Investigating the tendency

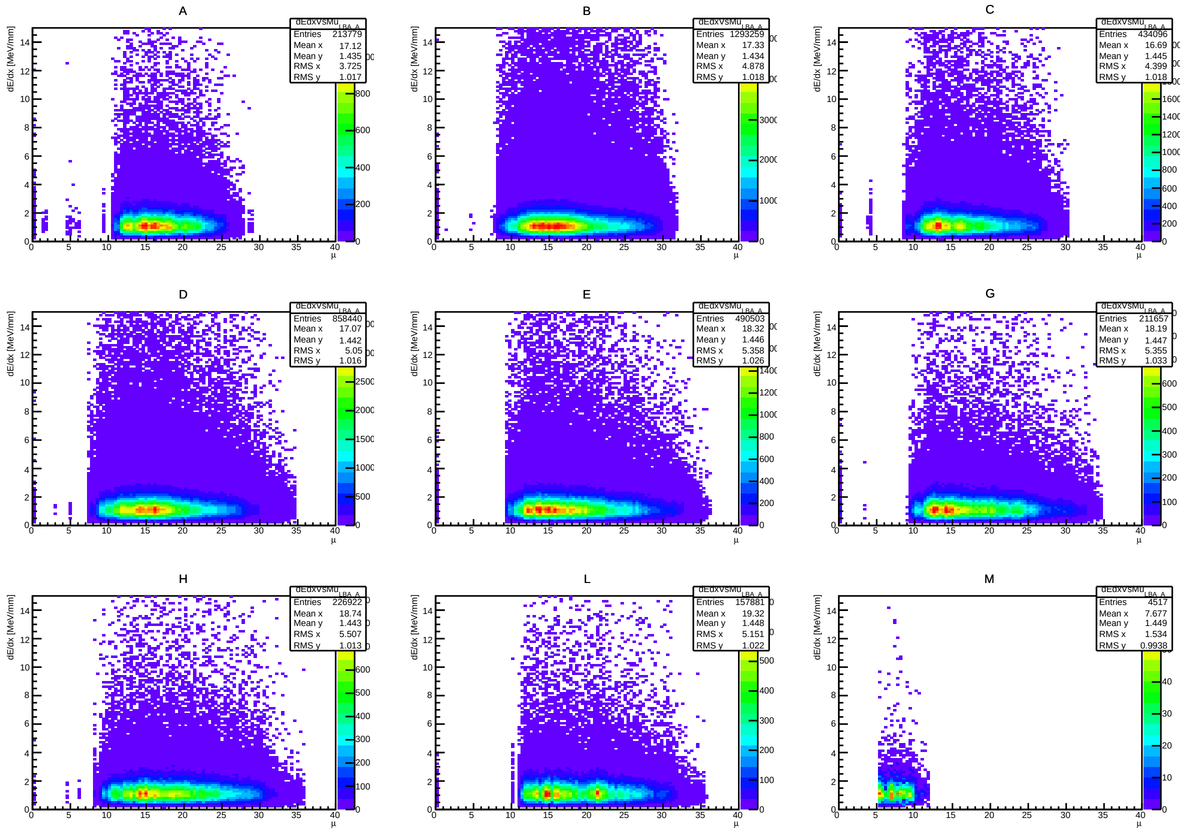

FIGURE 6 – distribution of dE/dx vs average μ - LBA A

First we ploted the distribution of dE/dx versus the average of μ (figure 6). The red peak is moving to higher values of μ with time and confirms that there are different beam conditions for each period.

Then we ploted $< dE/dx >$ versus the average of μ with a fit : one parameter straight line in the range of μ from 10 to 30. We recollected the fit value and compare them for each layer and each period as we can see in the figure 7.

Histograms produced with slightly different selection. The one of the figure 5 has a cut on upper value for dE/dx (from 0 to 10 MeV/mm) and the one on the figure 7 hasn't dE/dx selection. The difference observed could be due to this. We reprocessed with the same selection and the problem seems solved.

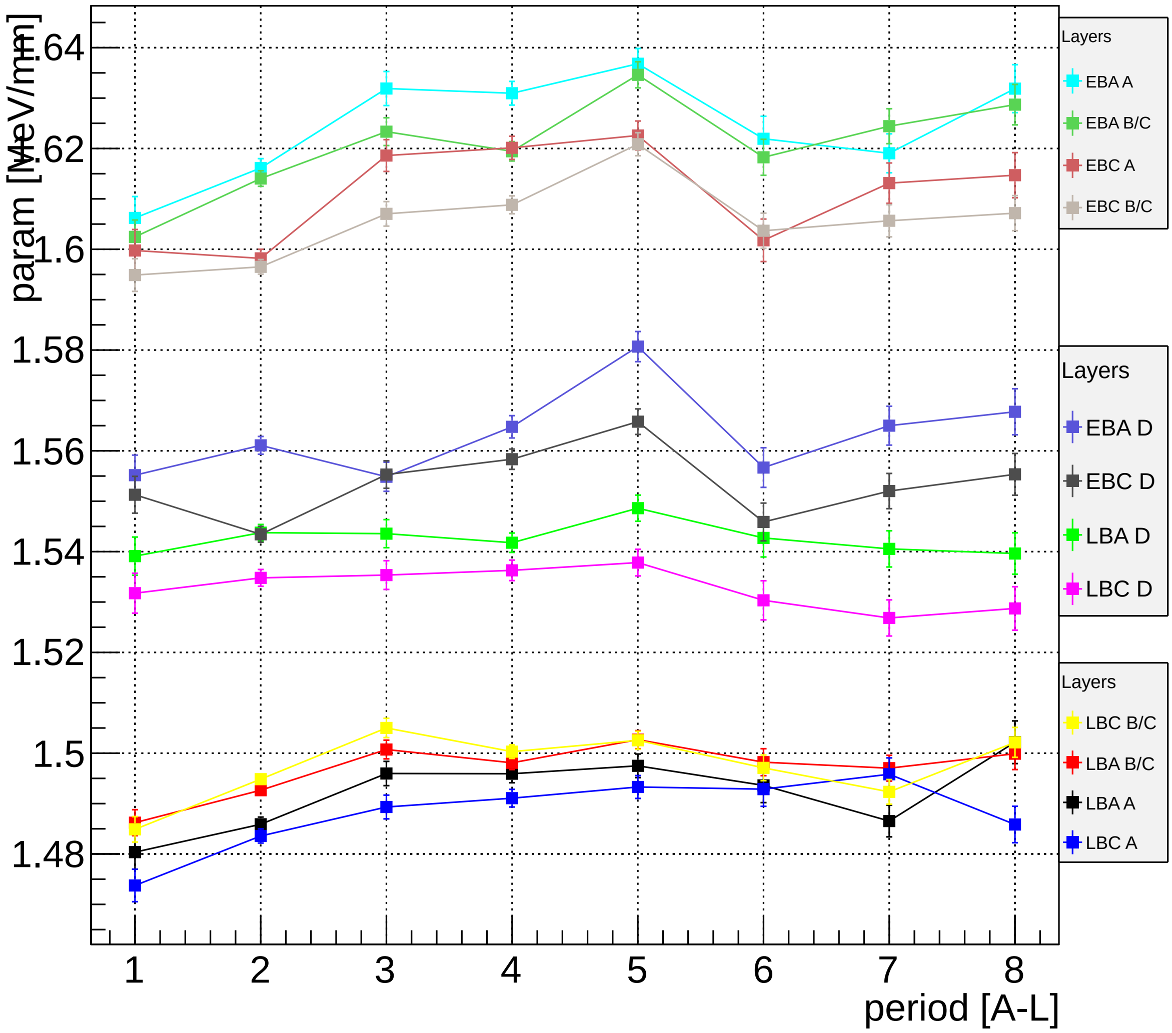

FIGURE 7 – $< dE/dx >$ versus average μ for LBA A