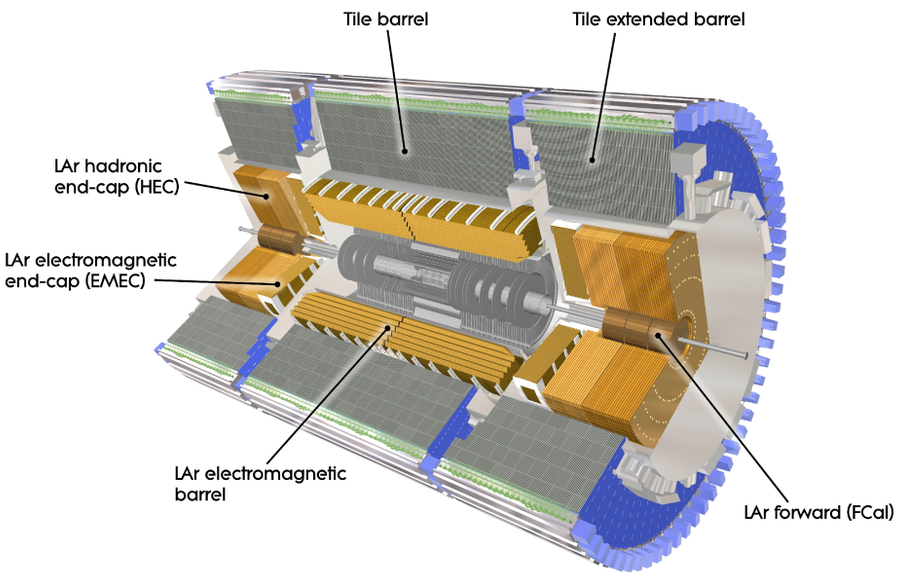
LHCP 2014, New York, 2-7 June 2014

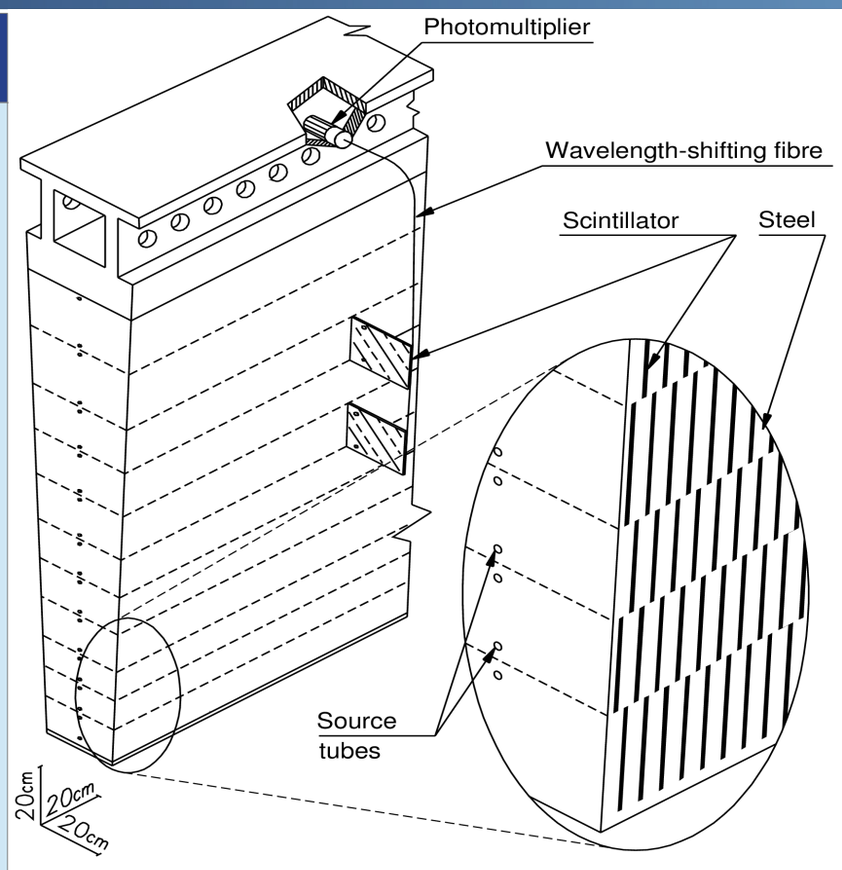
Performance and Calibration of the ATLAS Tile Calorimeter

The ATLAS Tile Calorimeter

Coverage	Granularity
Long barrel $\lvert\eta\rvert<1$	$\Delta\varphi\Delta\eta=0.1\times0.1$
Extended barrel $0.8<\lvert\eta\rvert<1.7$	Outermost layer $\Delta\varphi\Delta\eta=0.1\times0.2$

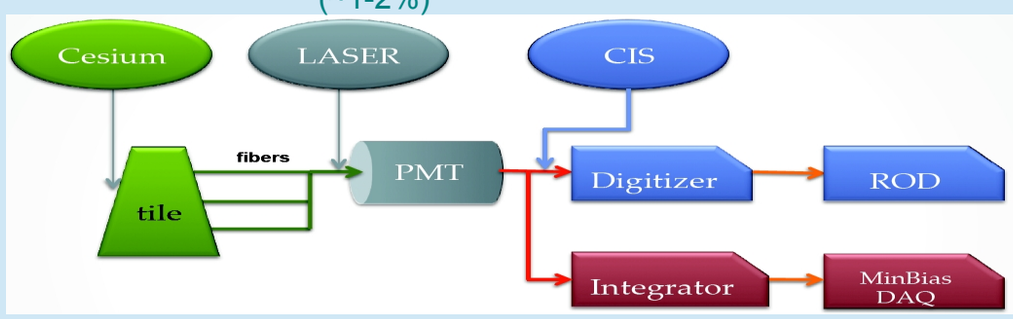


- Non-compensating sampling calorimeter made out of plastic scintillators and iron as an absorber
- Contributes to the measurements of hadrons, jets, tau leptons, e/gamma energy leakage, missing transverse energy and participates in muon identification and measurements
- Consists of three cylinders (long barrel and two extended barrels) segmented in 64 modules and three longitudinal layers (A, BC, D). One additional layer (E) covers gap between Long and Extended Barrels
- Total length: 12 m; diameter: 8.5 m;
- Thickness : 1.5, 4.1, 1.8 λ_{int} at $\eta=0$
- Light produced in scintillators is transmitted by wavelength shifters (WLS) to photo-multipliers (PMT)
- Each cell is read-out by two PMTs to reduce light attenuation dependence and achieve uniform response. Cell energy is the sum of energies measured in two channels



Energy reconstruction and calibration

Every 3-6 weeks (~0.3%) | Every 3 days in empty bunches (~1-2%) | Every 3 days (~0.7%)



$$E[GeV]=A[ADC]\times C_{ADC\to pC}\times C_{laser}\times C_{Cs}\times C_{pC\to GeV}$$

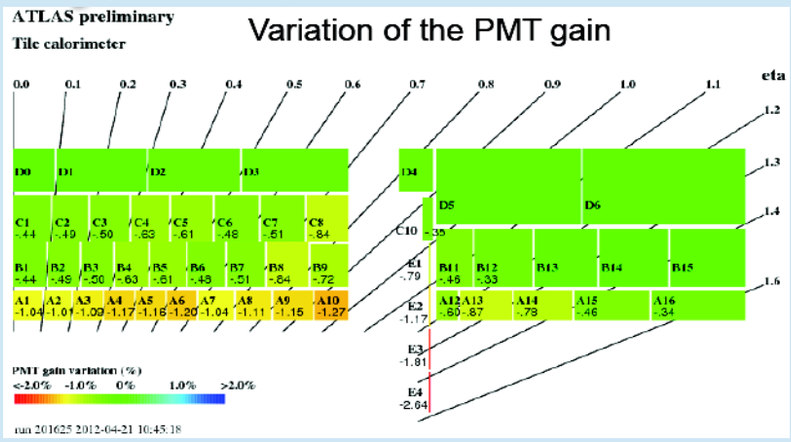
Charge injection system (CIS) : injects a well-defined charge to the readout electronics to derive ADC to pC conversion factors

Laser system : Laser sends light pulse to all the PMTs to monitor PMT gains and timing of each channels in between two Cs scans.

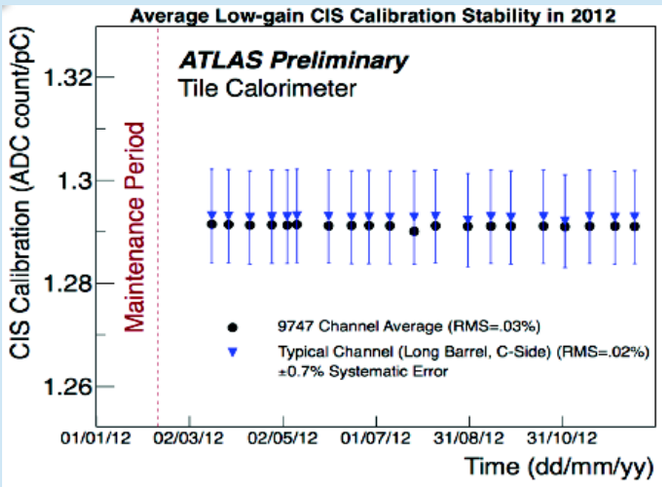
Cesuim system : Cs sources traverse all the tiles in order to equalize the response between individual channels and to monitor stability of optics elements

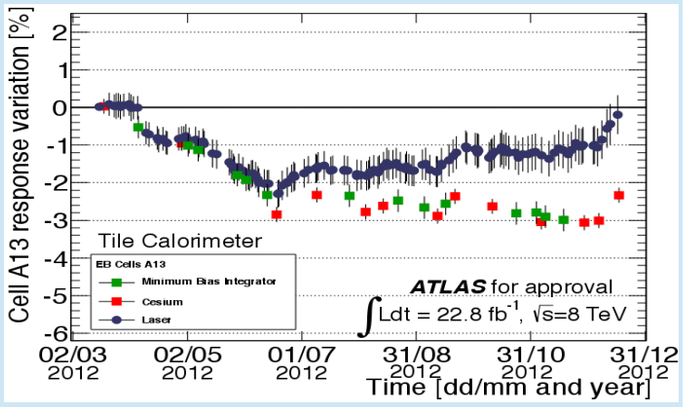
pC->GeV : EM scale measured with electrons at test-beams **A[ADC]** : amplitude of the signal in one channel

Laser system has a precision of <1%. It allows to see a down-drift of <2%.



The CIS calibration constant is stable vs time at the 0.02% level

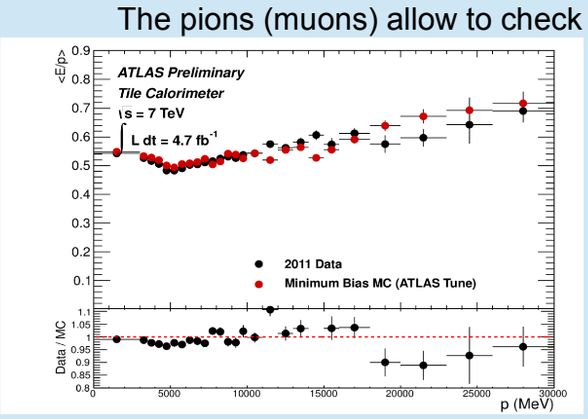


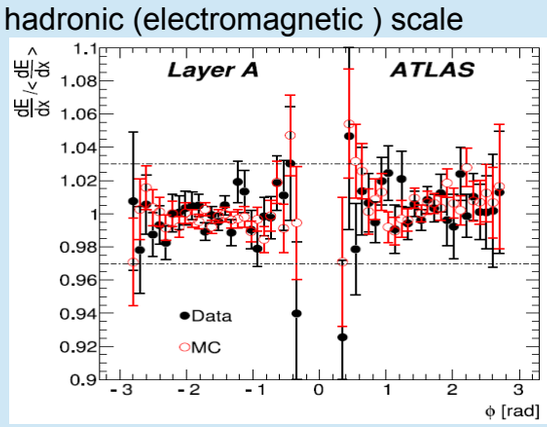


The difference between Cs and Laser system variation is due to scintillator irradiation

In-situ energy scale

The pions (muons) allow to check hadronic (electromagnetic) scale

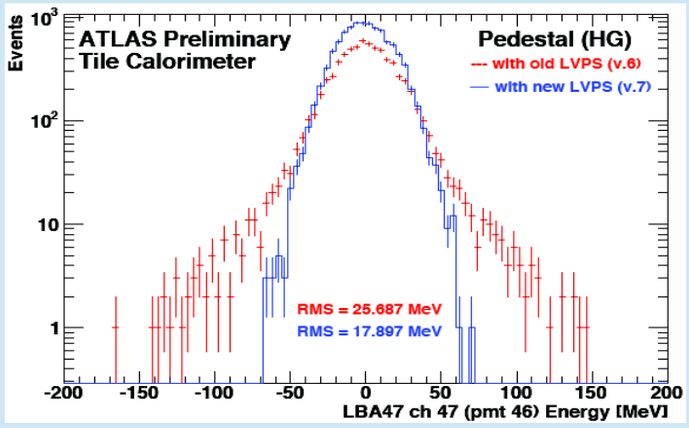


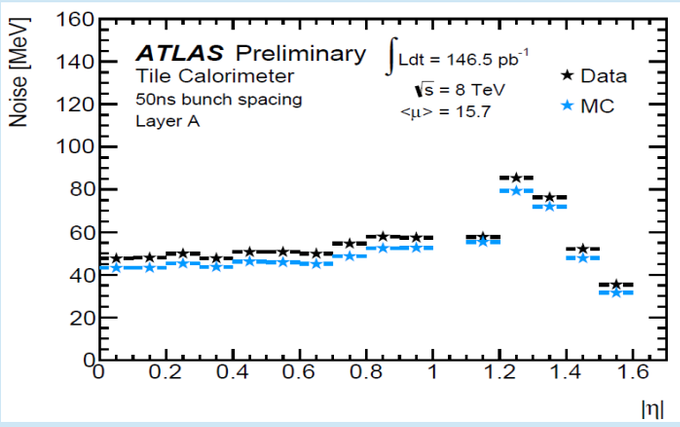


Isolated hadrons : Deposited energy **E** is compared to momentum **p** measured with tracking detector

Cosmic muons : the uncertainty is<1% in Long Barrel and <3% in the Extended Barrel

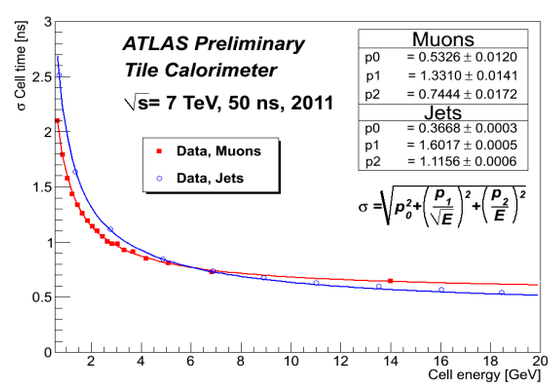
Calorimeter noise



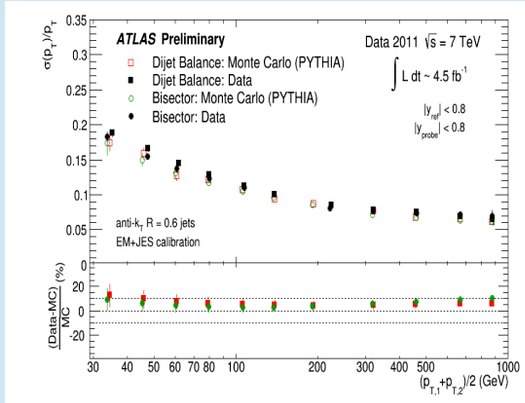


- Two Gaussian model was used to describe the cell noise for Run 1. Newly installed LVPS show lower noise and a Gaussian-shape distribution
- Total noise (sum of electronics and pileup noise) is well modeled by the simulation

Energy and time resolution

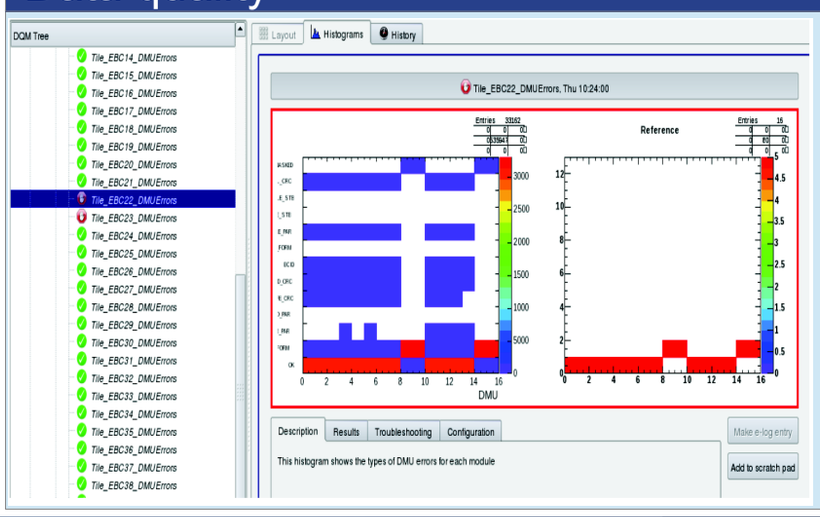


Cell time resolution is measured in data Muons:0.75ns(@10GeV) Jets:0.55ns (@20GeV)



Jet energy resolution is measured in-situ: ~20% (@20GeV) ~5%(@1TeV)

Data quality



ATLAS p-p run: April-December 2012										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.9	99.1	99.8	99.1	99.6	99.6	99.8	100.	99.6	99.8	99.5
All good for physics: 95.5%										

Luminosity weighted relative detector uptime and good quality data delivery during 2012 stable beams in pp collisions at √s=8 TeV between April 4th and December 6th (in %) – corresponding to 21.3 fb⁻¹ of recorded data.

- DQ monitoring framework collects information about the quality of the data and performs quality checks: problems flagged automatically
- Automatic recovery procedures implemented in the Data Acquisition System (DAQ) and Detector Control System (DCS)

Pavel Starovoitov for the ATLAS Collaboration

ATLAS EXPERIMENT