Calibration of the ATLAS Tile Calorimeter

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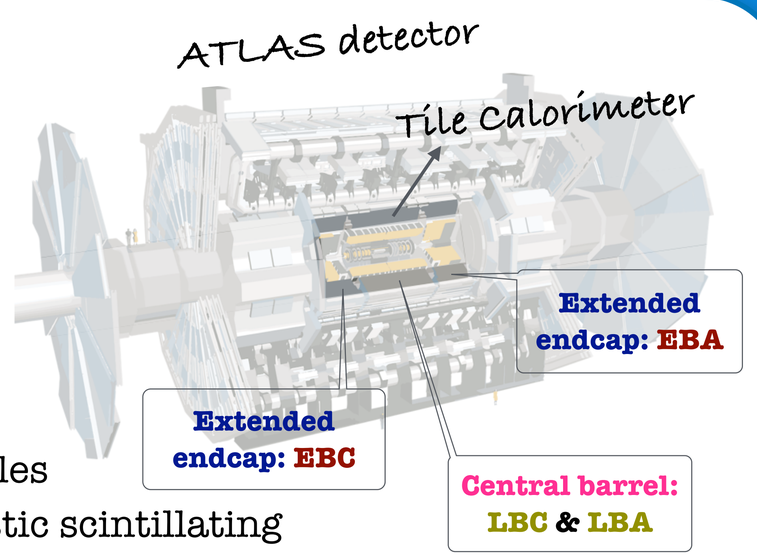
on behalf of the ATLAS Collaboration

ICHEP 2024

ATLAS TILE CALORIMETER

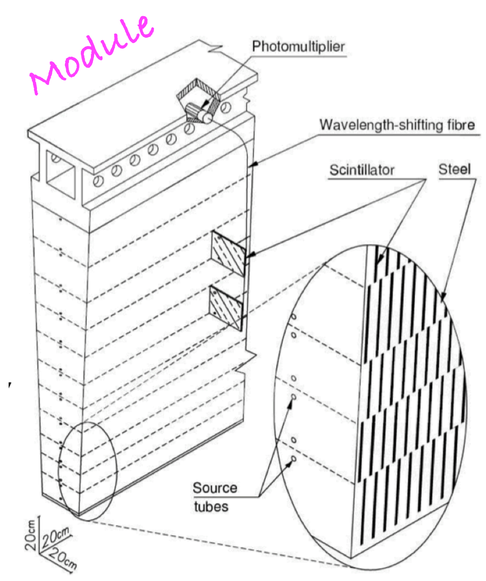


⇛ Central hadronic calorimeter (|η|<1.7) of the ATLAS detector

⇛ Performs the measurement of hadrons, jets, hadronically decaying tau-leptons, missing transverse momentum as well as provides input signal to the Level-1 Calorimeter Trigger

⇛ Divided into 4 parts: 2 halves of central barrel and 2 extended endcaps

⇛ Four readout partitions: EBA, LBA, LBC, and EBC



⇛ Each partition is azimuthally segmented into 64 modules

⇛ Modules are composed of steel absorbers and scintillating tiles

⇛ Light produced by a charged particle passing through a plastic scintillating tile is transmitted to photomultiplier tubes (PMTs)

⇛ Scintillating tiles are read out via ~ 550k wave length shifting fibers coupled to 9852 PMTs

⇛ 5182 cells in total (2 PMTs per cell) grouped into 3 radial layers: A, B(C) and D

⇛ Energy reconstruction is calculated from signal amplitude A

$$E\ [\mathrm{GeV}] = \frac{A\ [\mathrm{ADC}]}{C_{\mathrm{ADC}\to\mathrm{pC}} \times C_{\mathrm{pC}\to\mathrm{GeV}} \times C_{\mathrm{Cs}} \times C_{\mathrm{MB}} \times C_{\mathrm{Las}}}$$

⇛ $C_{\mathrm{pC}\to\mathrm{GeV}}$ is the electromagnetic energy scale constant measured during the test beam, while the other constants are obtained using data from the calibration systems

CALIBRATION SYSTEMS OF ATLAS TILE CALORIMETER

1 Cesium System

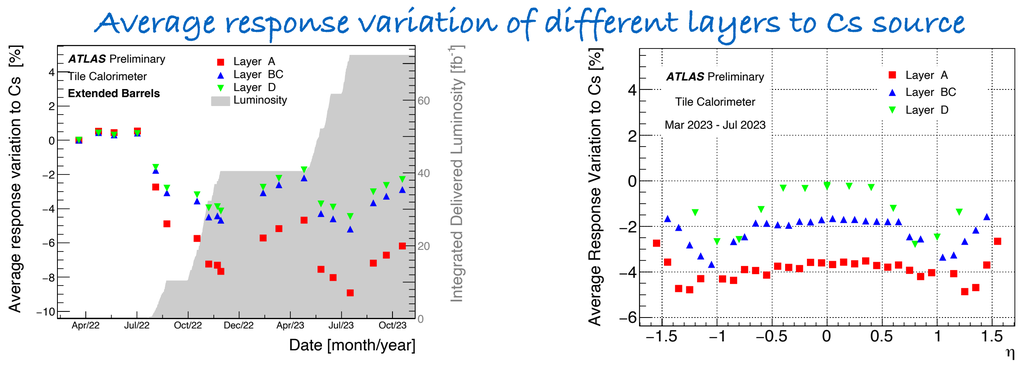
⇛ Employs three ^{137}Cs radioactive γ-sources

⇛ Hydraulic system moves the source through the calorimeter using a network of stainless steel tubes parallel to the beam line running through small holes in each tile scintillator

⇛ Calibrates optical components and PMTs: **C_{Cs}**

⇛ Monthly scans, a 8-hour gap between physics runs is used

Average response variation of different layers to Cs source



4 Minimum Bias System

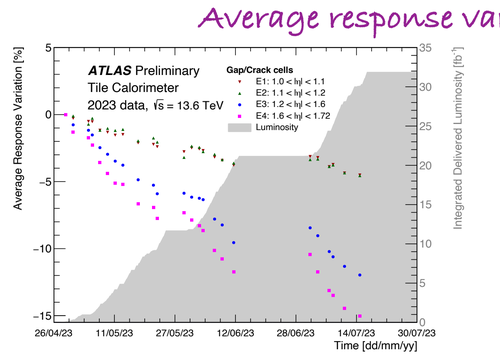
⇛ Integrates signals from PMTs over a time period of 10-20 ms

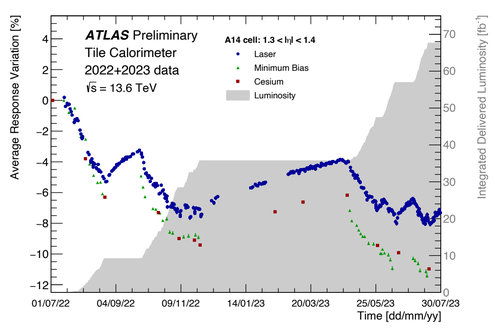
⇛ Reads out continuous currents from minimum bias collision events

⇛ Monitors beam conditions, optic components and PMT gains: **C_{MB}**

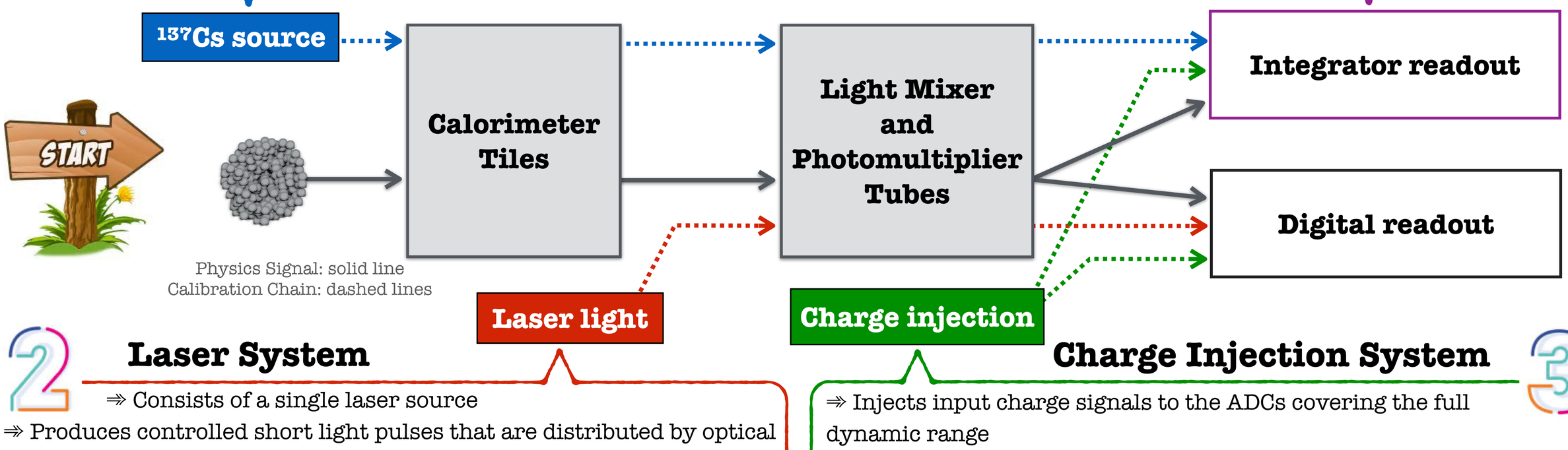
⇛ It is specially relevant for E-cells which are not scanned with the Cesium system

Average response variation for the E and A cells





⇛ The maximum response loss of ~ 15% in the E4 cell



2 Laser System

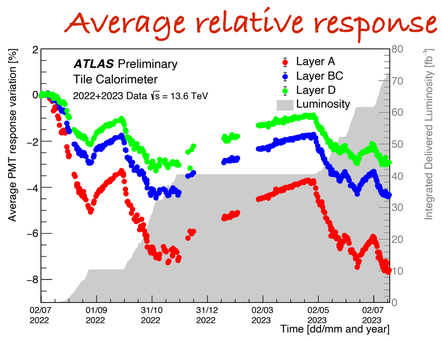
⇛ Consists of a single laser source

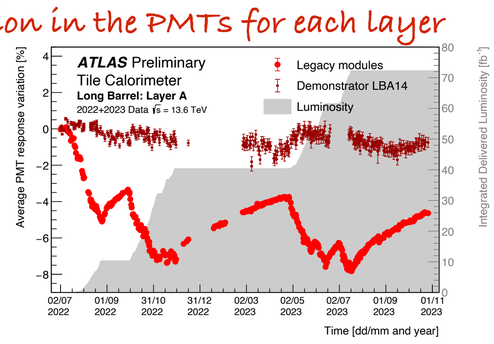
⇛ Produces controlled short light pulses that are distributed by optical fibres to the photocathode of PMTs

⇛ Calibrates variations due to electronics and PMTs: **C_{Las}**

⇛ Calibration is performed weekly or bi-weekly

Average relative response variation in the PMTs for each layer





⇛ Better stability in time can be observed for the Demonstrator LBA14 (newer PMT model [Hamamatsu R11187-SEL])

3 Charge Injection System

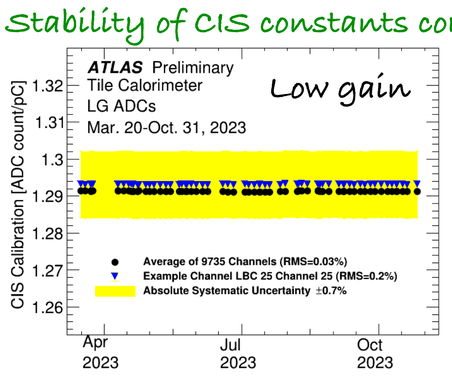
⇛ Injects input charge signals to the ADCs covering the full dynamic range

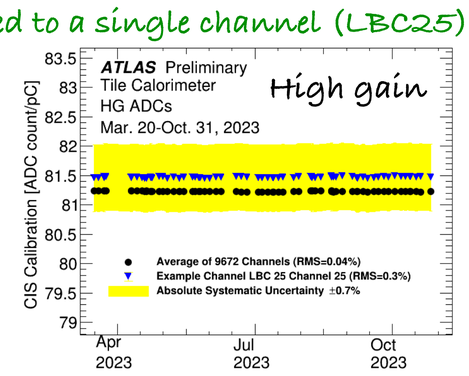
⇛ Determines the conversion factors from sample amplitude (ADC count) to charge (pC): **$C_{ADC\to pC}$**

⇛ System precision is at the level of 0.7%

⇛ Calibration is performed monthly

Stability of CIS constants compared to a single channel (LBC25)





Operation and performance of the ATLAS tile calorimeter in LHC Run 2: arXiv:2401.16034
ATLAS Tile Calorimeter Public Results: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ApprovedPlotsTile