UPGRADE OF THE LASER CALIBRATION SYSTEM OF THE ATLAS HADRON CALORIMETER TILECAL

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ATLAS hadron calorimeter calibration system

The Tile Calorimeter (TileCal) is the barrel hadronic calorimeter of the ATLAS experiment at the CERN LHC. TileCal is a sampling calorimeter using plastic scintillator as the active material and low-carbon steel (iron) as the absorber. Wavelength-shifting fibers connected to the tiles collect the produced light and are readout by photomultiplier tubes (PMTs).

PMT response drift is one of the main sources of systematic uncertainty in estimating the calorimeter energy scale: a continuous, percent-level calibration of each cell is then required to maintain the performance within 4%.

The TileCal calibration scheme treats different sections of the readout chain. The laser system monitors both the PMTs and the front-end electronics. Light pulses similar to those produced by ionizing particles are transmitted simultaneously to all TileCal PMTs through a bunch of ~100 meter long clear fibers. The light injected is measured by a set of photodiodes.

New Laser System

Upgrade

The laser system has been upgraded for 2015 LHC run with the goal to monitor signal stability at the sub-percent level. Many improvements wrt the previous laser system:

- Laser light distributing scheme re-designed to improve its stability:
  - New design of end-line beam expander to improve light mixing and transmission and to reduce sensitivity to misalignment effects.
  - More compact and vibration insensitive setup.

- Innovative electronics to drive the system, perform signal digitization, and communicate with LHC:
  - New VME card integrating all control, timing and readout functionalities.
  - Increase of the dynamic range to avoid saturation.

- New internal calibration scheme to cope with the increase of the number of photodiodes used to monitor the laser light:
  - Redundant system based on LED light normalized to a reference photodiode (Phocal).
  - Phocal photodiode monitored by an a source, charge injection system to monitor the stability of the electronics.

Performance

The laser upgraded system was installed on October 2014 and used on a regular basis since then. During collision runs, the LASER is flashed every second (in empty bunch-crossings). Internal calibration runs are performed twice a week.

Stability performance:

- Internal (pedestals, LED, α, charge injection, laser modes): stability at the sub-percent level observed for electronics and photodiodes.
- TileCal PMTs: laser runs are performed between Cesium scans to survey PMT responses of the TileCal. A stability at the subpercent level is observed.

- These results are compatible with expectations.

References and contacts

Laser public plots: https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ApprovedPlotsTileCalibration

Fig. 1: ATLAS inner detector and calorimeters.
Fig. 2: Mechanical assembly and optical readout of a TileCal ϕ wedge.
Fig. 3: Scheme of TileCal calibration system.
Fig. 4: Scheme of the upgraded laser system.

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Fig. 5: Laser internal calibration system: High Gain (HG) setting runs (filter transmission is 1%).
Fig. 6: Final setup of the optics box with the following main components:
(a) Laser head
(b) Light mixer
(c) Beam expander
(d) Filter wheel
Fig. 7: Scheme of the LASer CALibration card. This innovative VME board includes a 13-bits 32 channels charge ADC, a charge injection system and interfaces with ATLAS DAQ.
Fig. 8: Laser internal calibration system: pedestal, LED signal and alpha signals (low and high gains) QDC distributions for the Phocal photodiode.
Fig. 9: Laser internal monitor system: High Gain (HG) setting runs (filter transmission is 1%).
Fig. 10: Laser internal calibration system: relative LED signal variation as a function of time.