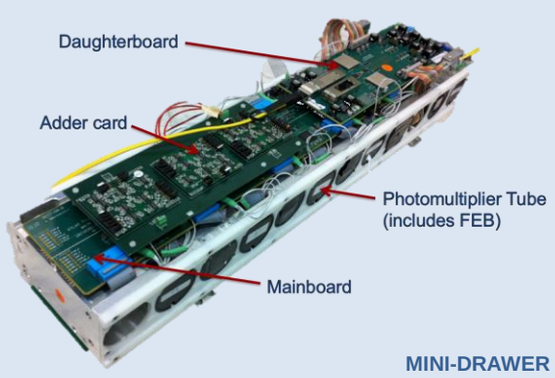
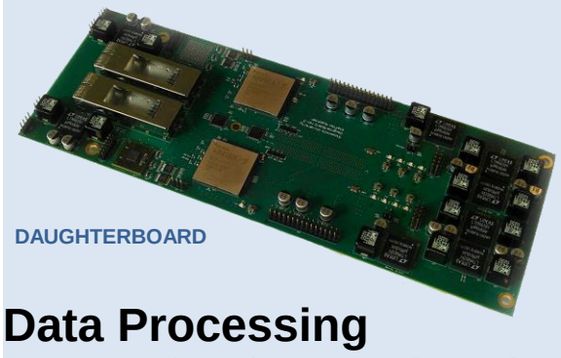
TRIGGER AND DATA ACQUISITION OF THE ATLAS TILE CALORIMETER DEMONSTRATOR

Frontend Electronics

The on-detector read-out electronics consist on three components. The 3-in-1 card, the Mainboard and the Daughterboard. The 3-in-1 card takes the analog signal from the PMT and provides amplified output signals in two different gains. It also provides calibration capabilities (charge injection and integration). The Mainboard is the data and control interface between the 3-in-1 cards and the Daughterboard. It digitizes the signals coming from 12 PMTs at 40 MHz and transmits the digital samples to the Daughterboard. It also contains two Altera FPGAs to configure and control the read-out and calibration in the 3-in-1 card. The Daughterboard represents the interface between the On- and Off-Detector electronics through 9,6 Gb/s optic fiber connections. The power is provided by in-situ redundant Low Voltage Power Supplies (LVPS) while the High Voltage it distributed remotely. Everything is mounted in so-called mini-drawers, 4 of those turn into a complete drawer which is inserted into the detector.



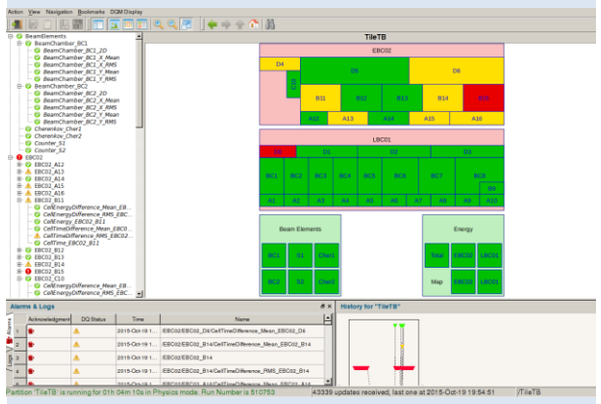
MINI-DRAWER



DAUGHTERBOARD

Data Processing

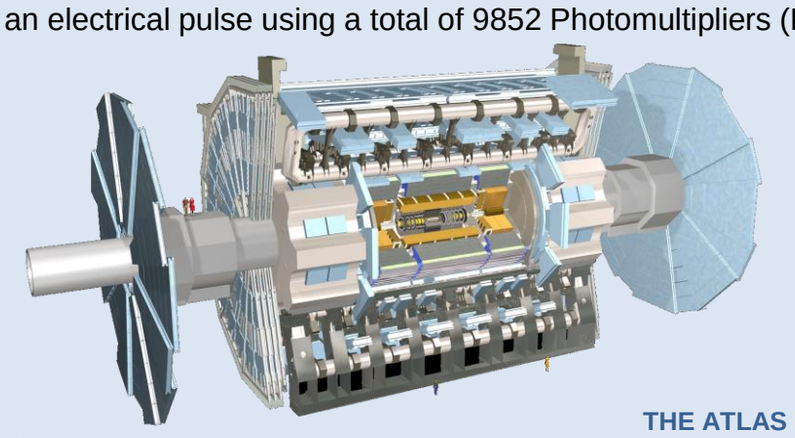
ATHENA is the ATLAS software framework used to reconstruct the detector data. In the TileCal Demonstrator it is used online to present reconstructed information in the Data Quality Monitoring (DQM) tool for real-time verification. Then, it is used for offline data analysis and the results are presented in the Demonstrator Data Interface (DDI) web application. Calibration runs are taken daily to verify the correct behavior of the electronics and to provide calibration of the detector at the electromagnetic scale.



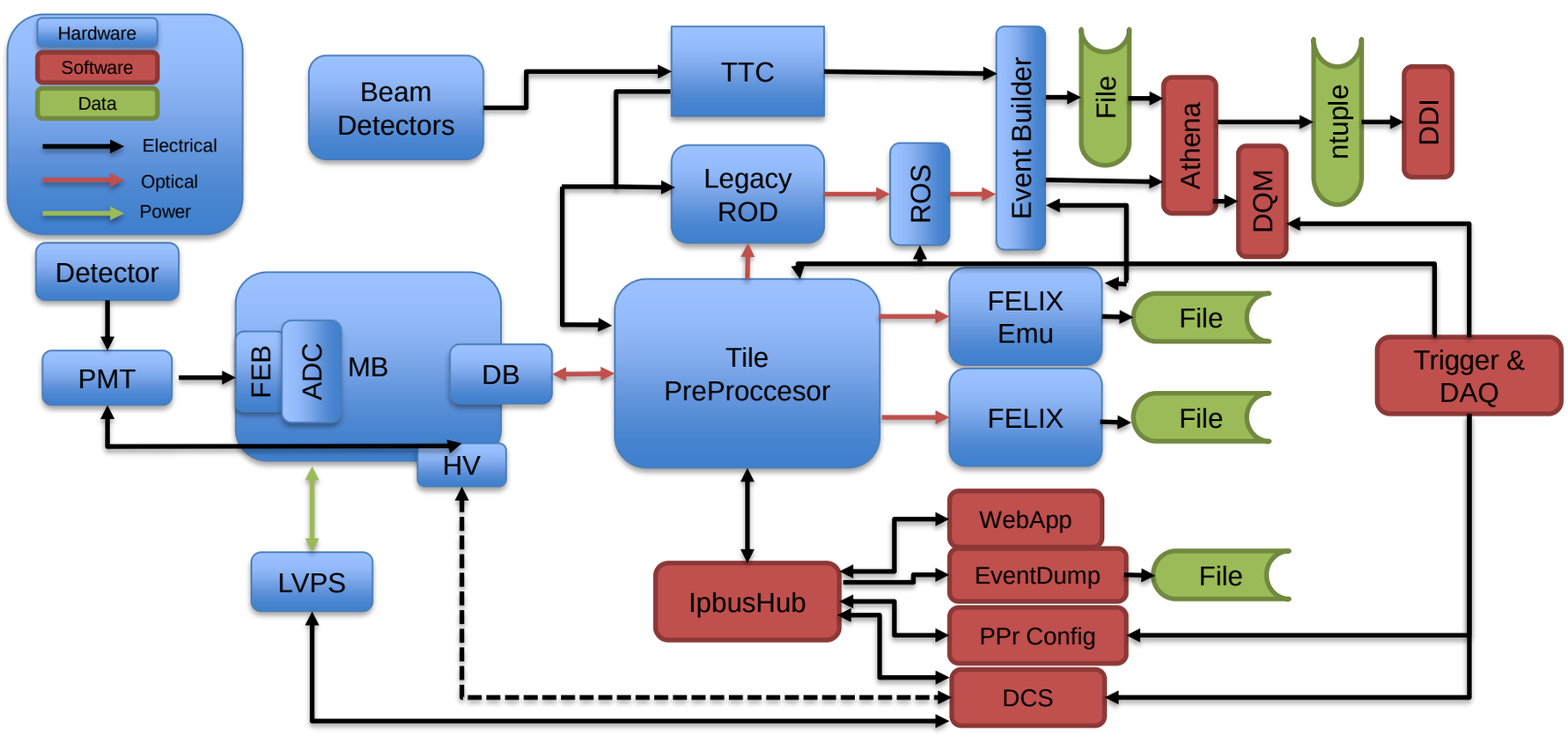
DATA QUALITY MONITORING WINDOW

The Tile Calorimeter Subdetector

The Tile Calorimeter is dedicated to the reconstruction of hadrons, jets, tau leptons and missing transverse energy in the ATLAS detector at the LHC. It is made up of steel as absorbing medium and plastic scintillating tiles as active material. It has the shape of a cylinder and it is divided into four partitions, two in the central barrel and two in the end caps. Each partition is formed by 64 wedge-shaped modules. Charged particles crossing the detector interact with the active medium and the light generated is collected with wavelength shifting fibers and converted to an electrical pulse using a total of 9852 Photomultipliers (PMT).



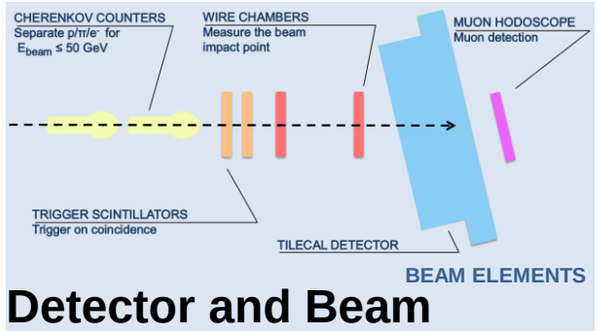
THE ATLAS DETECTOR



PreProcessor

The PreProcessor (PPr) is the main component of the back-end electronics. It represents the interface between the front-end electronics, and the L0/L1 trigger systems, Detector Control System (DCS) and the overall ATLAS DAQ system. The core of the PPr demonstrator are the two high performance Xilinx FPGAs used to process the detector data and to communicate with the front-end electronics with a bandwidth of 260 Gbps. It can read-out up to 4 mini-drawers using 4 QSFP connectors. The detector data are stored in internal buffers in the PPr and upon the reception of a trigger signal the selected events data are transferred to the legacy (ROD) and upgrade (FELIX) systems. It can also use IPbus to transmit data for calibration purposes. It has an AMC form factor, and can be operated in an ATCA carrier or in a µTCA chassis.

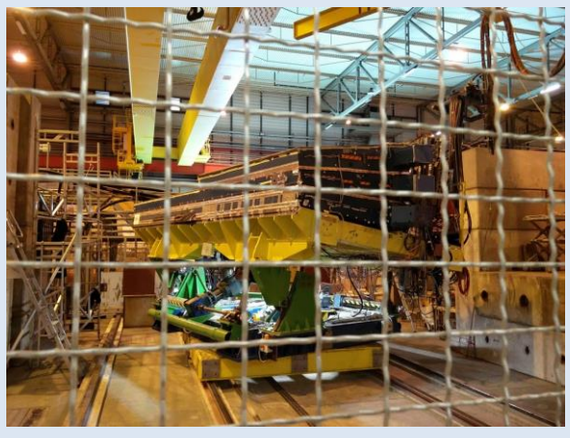
PPR BOARD



BEAM ELEMENTS

Detector and Beam

The detector configuration used in the demonstrator consists on two long barrels (96 channels each) plus an extended barrel (48 channels). One of the long barrels is equipped with the new electronics for the HL-LHC. The rest use the legacy system. All modules are mounted into a remote controlled movement table, which makes it possible for the beam to impact at different angles and positions. A series of beam detectors are also included in the data acquisition system to provide information of the beam during the data analysis and to provide the trigger for the data taking.



TESTBEAM SETUP

The Demonstrator System for the ATLAS Tile Calorimeter

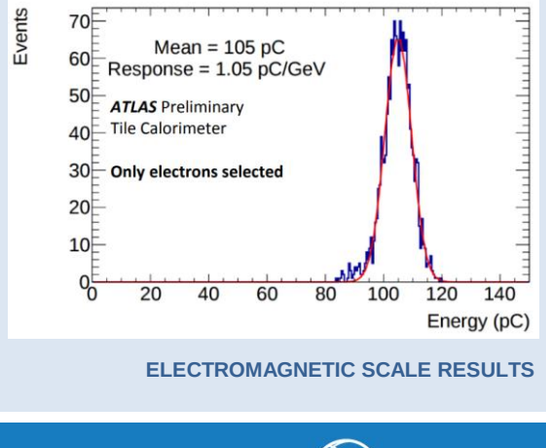
The LHC has planned a series of upgrades culminating in the High Luminosity LHC (HL-LHC) which will require a new ATLAS read-out strategy to cope with the higher luminosity. In the Tile Calorimeter this implies a complete redesign of the read-out and data acquisition electronics.

The Tile Calorimeter Demonstrator is a prototype of the read-out electronics designed for the HL-LHC. During the last years, the Demonstrator has been validated using standalone calibration runs in the laboratories.

In addition, the Demonstrator was installed at the CERN beam facilities and it was tested using different types of particles (electron, muon, and hadron) and energies to certify the performance of the detector with the new read-out system.

Results

The electronics have been tested using hadrons, electrons and muons. The electromagnetic scale has been measured using electrons, separating them from muons and pions exploiting the difference of electromagnetic and hadronic showers profiles in the calorimeter, which gives us a response of 1.05 GeV/pC. The interaction of muons with the detector has also been analyzed in the test-beam using 165 GeV muons at 90 degrees. The response has been studied using the ratio between the energy deposited and the track path-length. The results are qualitatively in agreement with the simulations, but there are some instabilities that indicate that the analytical form does not describe the whole range. Hadrons are identified using the Cherenkov modules in the beam line and the shower energy deposited in the cells. The response of the detector has been measured as function of the beam energy for kaons, pions and protons, which is larger for pions and kaons, and the experimental data are within 5% of the simulation.



ELECTROMAGNETIC SCALE RESULTS

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