



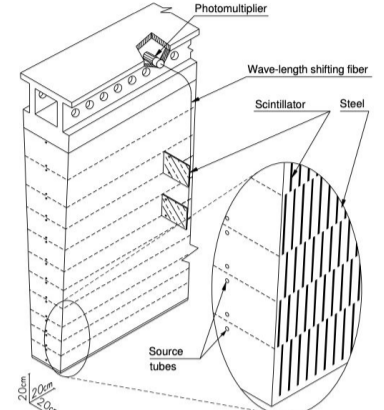
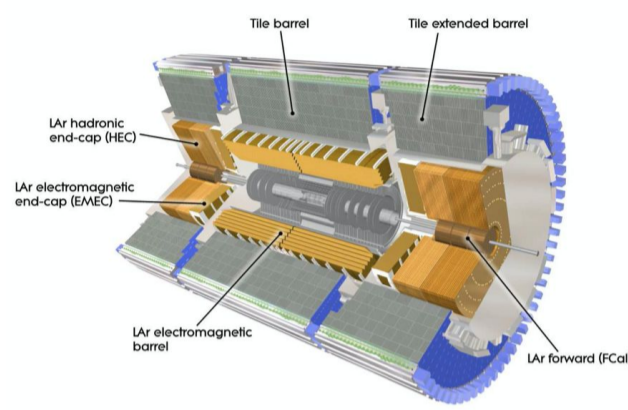
Upgrade of ATLAS Tile Hadronic Calorimeter for the High Luminosity LHC

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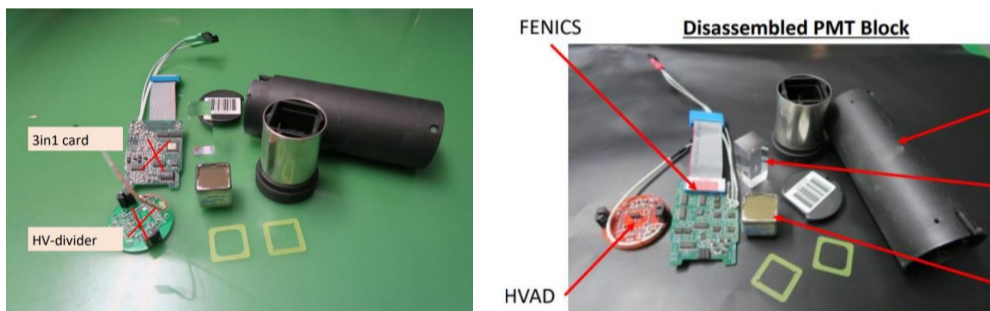
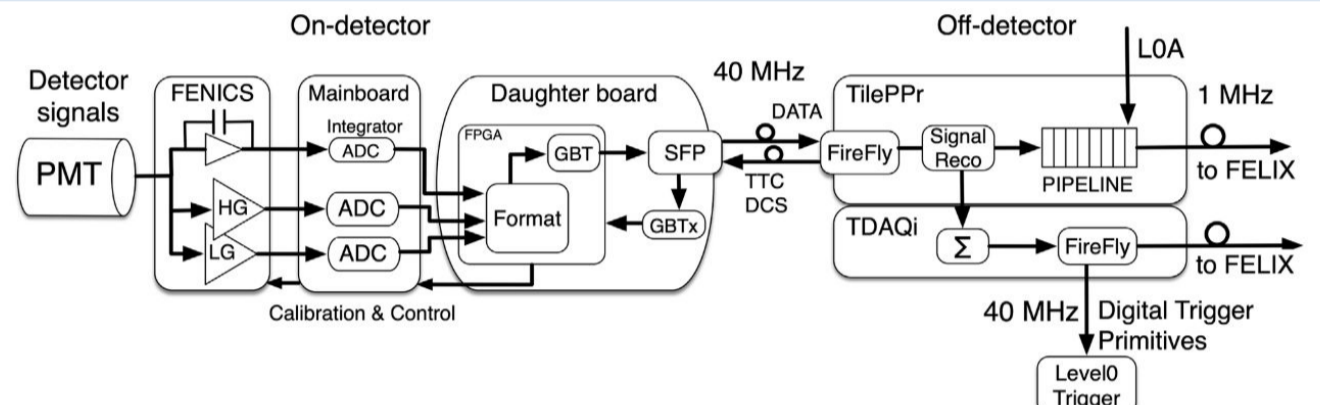
The ATLAS Tile Calorimeter

- Main ATLAS hadronic calorimeter.
- Sampling calorimeter with interleaved steel and scintillator plates.
- Divided into a long barrel (with two sections) and two extended barrels.
- Designed to measure the energy from hadrons, jets and the missing transverse energy.
- The energy from charged particles is absorbed and sampled by the tiles.
- The light is read by PMTs (approximately 10,000 signals are available).
- **Challenge:** Replacement of the on- and off-detector components to meet new radiation, trigger scheme and readout performance.



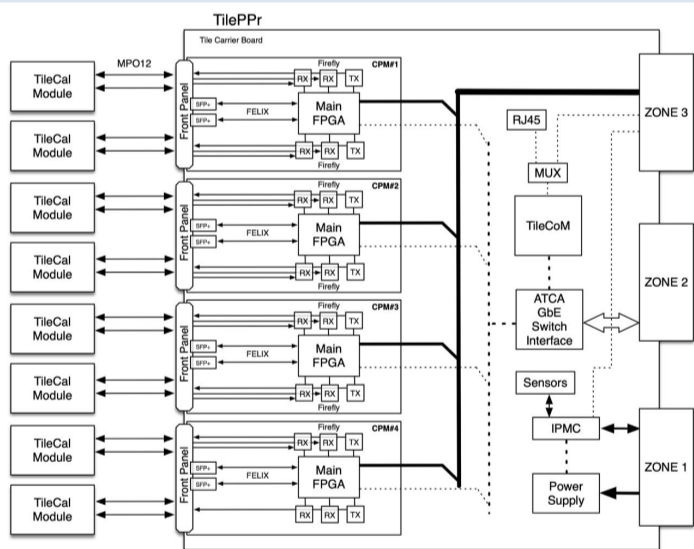
Tile Calorimeter On-detector Upgrade Overview

- PMT: equipment needed to convert light into measurable signals.
 - Replacement of 10% of most exposed PMTs by an improved version (Hamamatsu R11187).
 - Production batches approved and certification under way.
- HV-divider: to be replaced by new active divider (more stable).
- Shaper circuit (3in1 cards) to be replaced by new boards (FENICS).



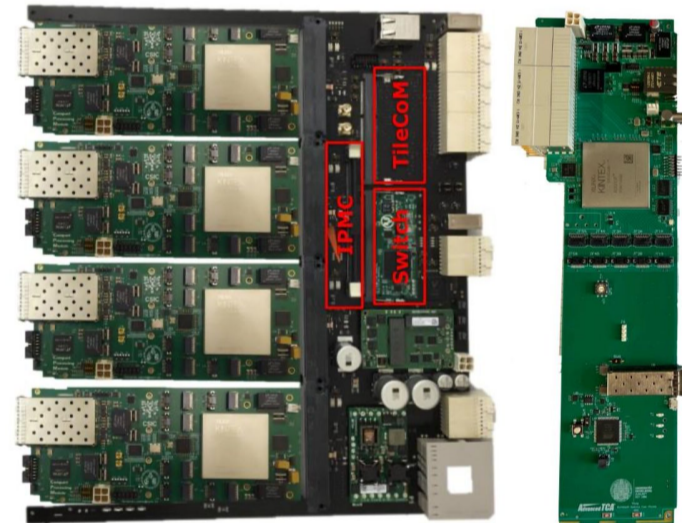
- Fully digital trigger output: Signal conditioning at first step (FENICS and Mainboard) at 40MHz.
- The digital data are formatted and transmitted to the PPr modules (off-detector).

Tile Calorimeter Off-Detector Upgrade Overview



Tile Pre-Processor (PPr) module:

- The PPr stores the digital data in pipelines and in parallel computes and transmits digital trigger objects to the Trigger System through the TDAQi module, where the selected events are transferred to the FELIX system.
- 32 Tile PPr:
 - 4 Compact Processing Modules (CPM).
 - 1 ATCA carrier board to host CPMs Kintex ultrascale + FPGAs.
- Calculates energy and time, and trigger primitive objects.
- Sends data to L0 and DAQ at 40MHz.



Calibration Systems and Results

- **Laser system for PMTs**
 - New DAQ and control interface.
 - New optical line.
 - Pile-up simulation.
 - Prototypes tests under way.
- **Cesium system (movable source)**
 - New electronics using optical links.
 - Preparing for production.

- **Front-end electronics to be assembled into a super drawer before full installation**
 - Portable test bench (PROMETEO) is used to certify performance and functionality.
- **Test beams results**
 - Validation of the new system in realistic conditions.
 - Fixed target test beam of several particles and energies at SPS at CERN.
 - Performance measurements.
 - Promising results.
- **Demonstrator drawer**
 - Backward compatible hybrid demonstrator installed since 2019 on detector.
 - Performance being assessed in real conditions.

