Integration of the ALTI module in the ATLAS Tile Calorimeter system

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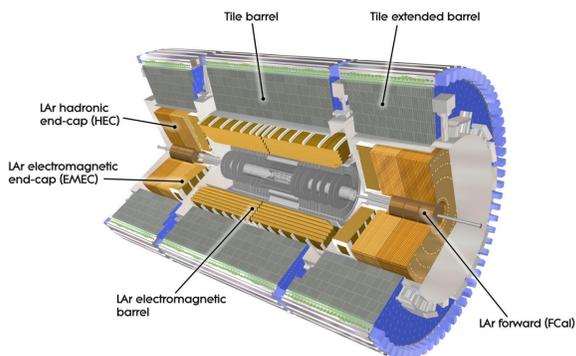
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Introduction: In preparation for Run-3 data-taking period, the TileCal DAQ software for the ALTI module has been developed and integrated into the ATLAS TileCal system software. The TileCal ALTI boards are being prepared to be installed in the Back-End electronics counting room in ATLAS USA15 cavern at CERN, as part of the Phase-I upgrades

The ATLAS Tile Calorimeter

The Tile Calorimeter (TileCal) is the central hadronic calorimeter ($|\eta|<1.7$) of the ATLAS experiment at the Large Hadron Collider (LHC) [1]

➢ It is made out of iron plates and plastic scintillators
➢ It is divided into three cylinders along the beam axis, each of which is azimuthally segmented into 64 wedge-shaped modules, staggered in the ϕ direction
➢ TileCal online software is a set of Trigger and Data Acquisition (TDAQ) software, and its main purpose is to readout, transport and store physics data originating from collisions at the LHC
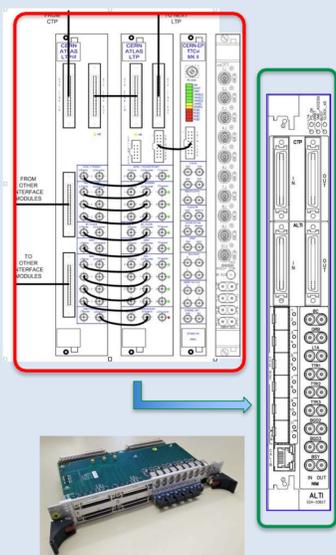➢ In Run-3, TileCal will be collecting data with upgraded ALTI boards and software

Test bench for ALTI hardware and software

➢ A test bench (left) has been set up in a lab at CERN, for the development and testing of the TileCal software for ATLAS Local Trigger Interface (ALTI) module [2]
➢ To be deployed in ATLAS TileCal Timing, Trigger and Control (TTC) crates in the USA15 counting room in Point 1(right)
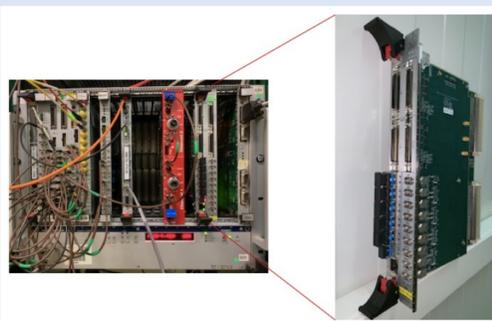
Motivation for the ALTI project

Set of local trigger processor boards (LTPi, LTP, TTCvi, TTCex) replaced by single ALTI board

➢ Aging legacy modules, spares (obsolute components)
➢ New sub-systems in Run-3 need TTC modules

Migration to ALTI recommended

➢ Adds powerful monitoring capabilities
    ○ Rates, busy, TTC stream, per-bunch monitoring
➢ Also adds some CTP-like functionalities
    ○ More tests can be done independently from the Central Trigger Processor(CTP)
➢ Old system continues to work, with limitations

The TTC crate and ALTI

The ALTI module is a new electronic board, designed for the ATLAS experiment, a part of the TTC system

➢ A 6U VME module integrating the functionalities of 4 legacy modules, currently used in the experiment: LTP, LTPi, TTCvi and the TTCex

ALTI provides the interface between the Level-1 CTP and the TTC optical broadcasting network to the front-end electronics of each of the ATLAS sub-detectors

➢ There has been a need to develop and integrate the TileCal ALTI software in the Tile online software
➢ Performance tests and maintenance of the ALTI module software are currently in progress, in preparation for Run 3 data-taking period
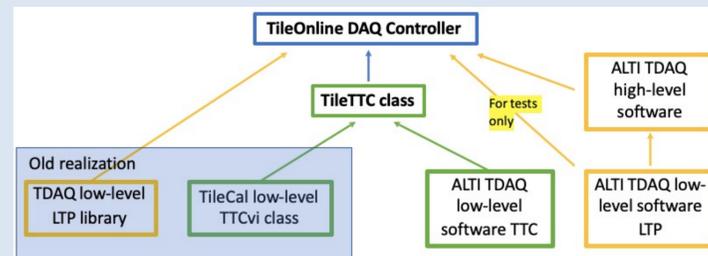
ALTI Software

The TDAQ system provides the software infrastructure for Level-1 trigger, DAQ and HLT systems

➢ The software packages include the low-level software for control, configuration and monitoring of the modules
➢ High-level run control application software, built on top of the low-level APIs is also included in the ATLAS TDAQ
➢ VME-addressable TTC legacy modules (LTPI, LTP and TTCvi) and other modules, have a similar low-level software organization

The ALTI module has its low-level software organized in a similar way

➢ The ALTI package depends on several software packages specific to the TDAQ Read Out Driver Crate DAQ and the Level-1 Central Trigger

The TileCal ALTI low-level software has been developed in order to provide access to the ALTI functionalities

➢ The TileCal online software consists of 29 packages in total
➢ 6 TileCal software packages have been modified and the addition of the new TileTTC class, allows access to the TTCvi and the ALTI low-level software
➢ TileConfiguration, TileVMEboards, TileModules, TileMB, TileCIS and TileDVS packages were modified to be compatible with TileTTC class, which has been included inside the TileVMEboards package
➢ The database has been modified to include new variables for the TileTTC class

Development tools: C++ (main programming language), Java, GitLab and OKS (Object Kernel Support) - an object-oriented database with storage based on XML
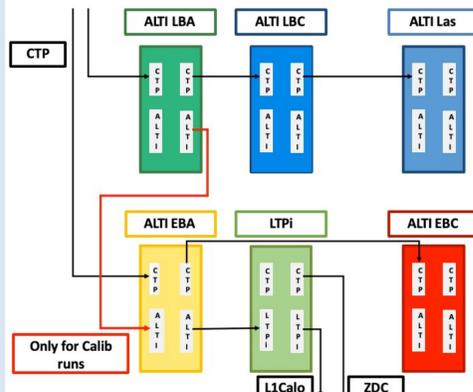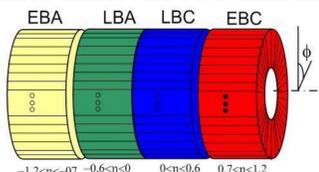
Preparations for the Installation of ALTI boards

One ALTI board has been tested for the barrel partition

➢ Several TTC clock related issues observed, all pointing to problems with light strength
    ○ all light transmitters replaced by more powerful ones with double output strength
➢ New ALTI boards with improved optical light output are now ready for installation in the USA15 carven

TileCal Detector: 4 barrels, 64 Modules/Barrel

The connection scheme and database files have been prepared for the installation
➢ A colour scheme for linking TileCal barrels and the back-end electronics is used
➢ All the LTP, TTCvi and the TTCex boards in EBA, LBA, LBC and EBC TTC partitions will be removed and replaced with 4 ALTI boards
➢ The fifth ALTI board will be installed for the Laser calibration system

The ALTIs will use two different configurations for Physics and calibration runs
➢ Physics runs:
    ✓ All ALTI are CTP_IN slave
➢ Calibration runs:
    ✓ LBA ALTI as Master, generates signals through Pattern Generator (BC, ORB, BGO 0-3, TTR1)
    ✓ EBA ALTI is ALTI_IN Slave
    ✓ Other ALTIs are CTP_IN Slave

Summary

➢ During Long shutdown 2 period, the TileCal is undergoing maintenance and Phase-I upgrades, in preparation for Run-3 (2022-2025) data-taking period
➢ As part of the ATLAS Phase-I upgrade, TileCal is replacing the legacy TTC system with the new ALTI TTC system
➢ The ALTI module integrates the functionalities of four legacy TTC modules: LTP, LTPi, TTCvi and the TTCex
➢ The TileCal ALTI online software has been developed and tested in the test bench and will be fully validated for the ATLAS detector in Point 1
➢ Five ALTI boards are ready for installation in the USA15 counting room
➢ The ALTI TTC system will be calibrated for data taking, after installation

References:
[1] The ATLAS Collaboration. ATLAS tile calorimeter: Technical Design Report ATLAS. Geneva: CERN; 1996. Available from: ATLAS tile calorimeter
[2] Haas S, et al. ALTI specification review and preliminary design review. 2018. Available from: ALTI

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