Development and Validation of Tile Pre-Processor Sub-Modules for the ATLAS Tile Calorimeter Phase-II Upgrade at the HL-LHC

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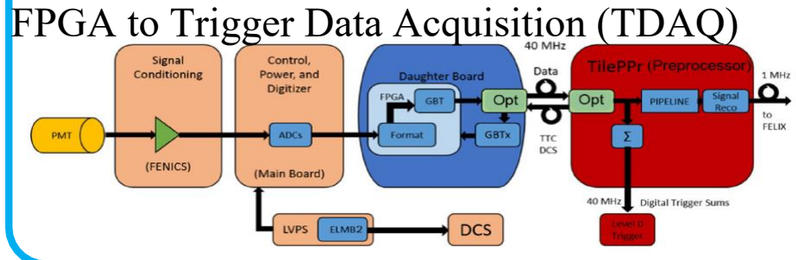
Abstract

The High-Luminosity Large Hadron Collider upgrade places stringent performance and reliability requirements on the ATLAS TileCal readout circuits. A crucial component of this upgrade is the Tile Pre-Processor (TilePPr), a part of the off-detector electronics in charge of data processing, control, and communication. As part of the Phase-II upgrade, crucial TilePPr sub-modules are being created and manufactured at the UJ. The production of Tile GbE Switch PCBs and Tile Computer-on-Module (TileCoM) PCBs by SA industrial partners is the main emphasis of this study. Ten Tile GbE Switch PCBs have been manufactured with a specialized test station has been created to conduct communication interface testing and electrical validation, guaranteeing adherence to system specifications. These tests confirm the TilePPr architecture's functionality, dependability, and integration readiness. The modules are ready to be shipped to CERN for inclusion into the off-detector electronics after successful validation.

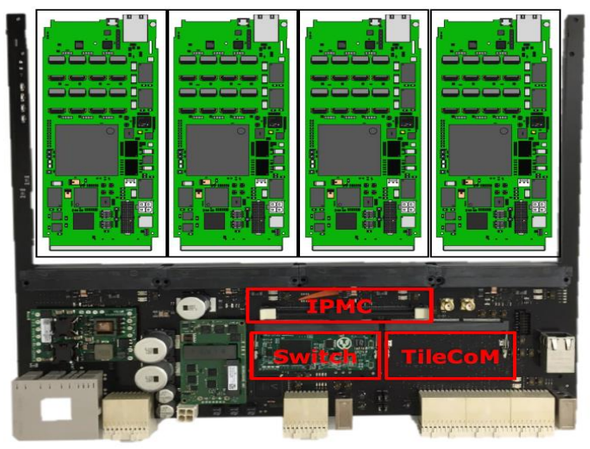
ATLAS TileCal Phase-II

ATLAS Tile Phase II Upgrade system divided into Front-End (FE) electronics that are on the detector and Back-End (BE) electronics that are off the detector. The Back-End (BE) electronics consists of Tile Pre-Processor (TilePPr) that receives digital data and process it in a pipeline FPGA to Trigger Data Acquisition (TDAQ)



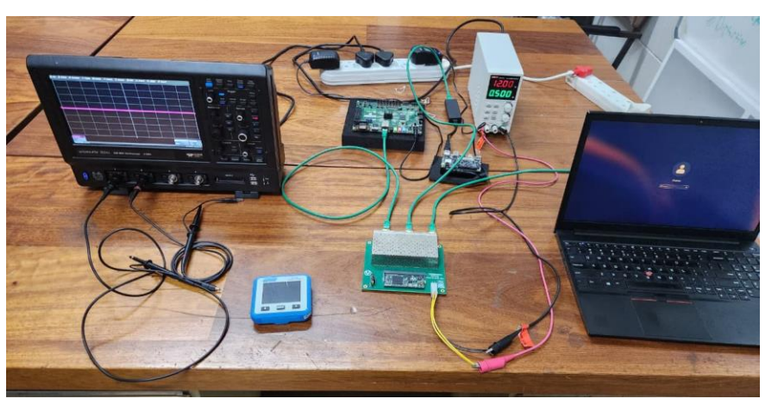
TilePPr Module

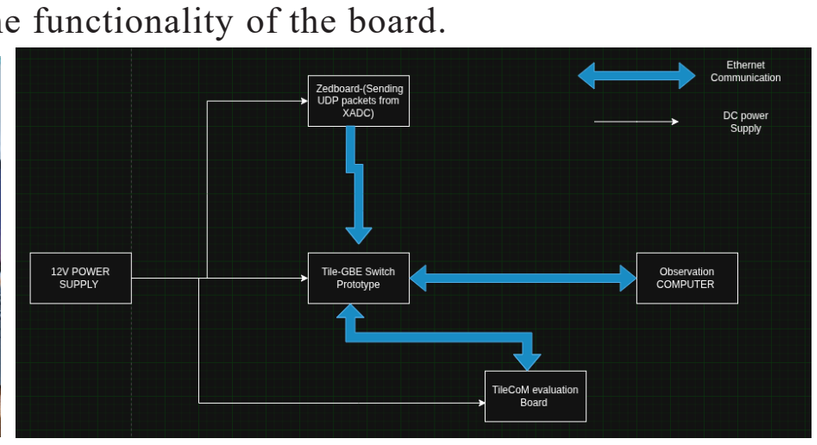
The TilePPr consists of 4 CPM, TileCoM, Tile GbE Switch, and TDAQi. UJ mainly contributes on the TileCoM and Tile GbE Switch.



UJ ATLAS TileCal Phase-II Projects status

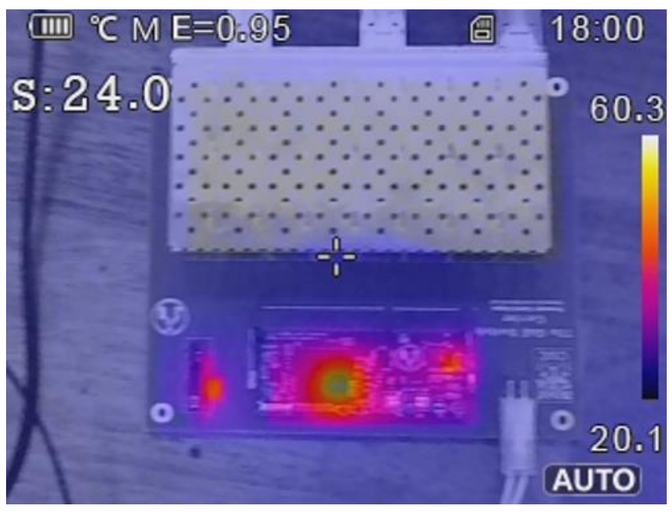
A test station is used to test Tile Gigabit Ethernet (GbE) Switch Printed Circuit Boards (PCB) after production at UJ. The test station includes a 12V input power supply, oscilloscope, GbE Switch motherboard, Ultra96v2 and Zedboard to test the functionality of the board.

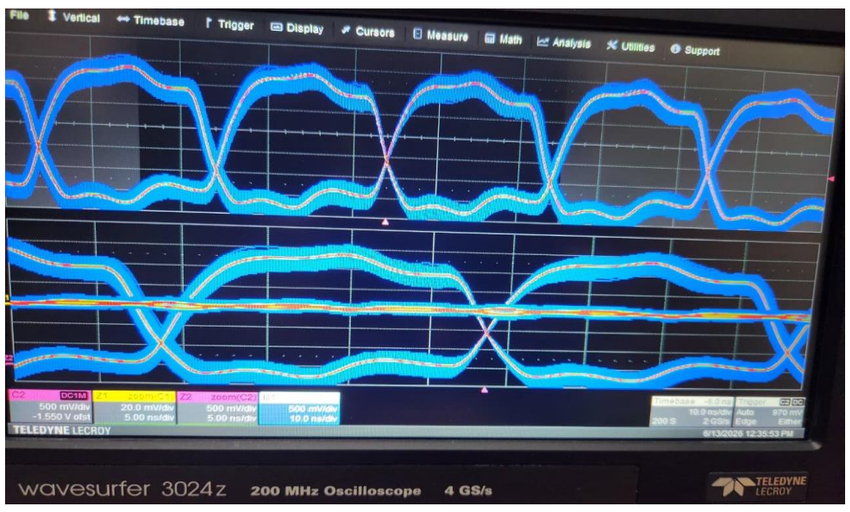




Test station results for the newly produced PCBs

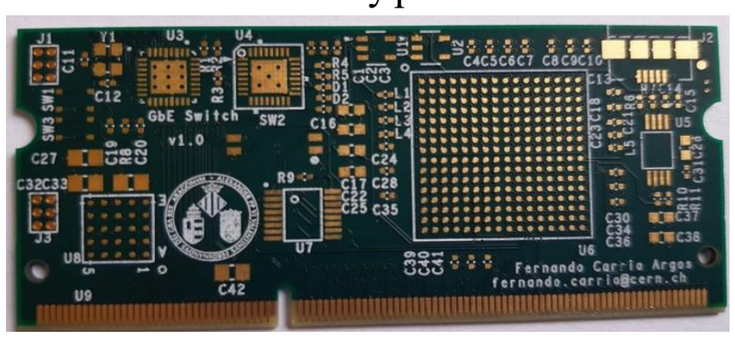
The following two figures show the eye diagram which measures the signal integrity amongst the components on the board. The thermal camera was used to measure the heat on the main component: BCM5396KFBG.





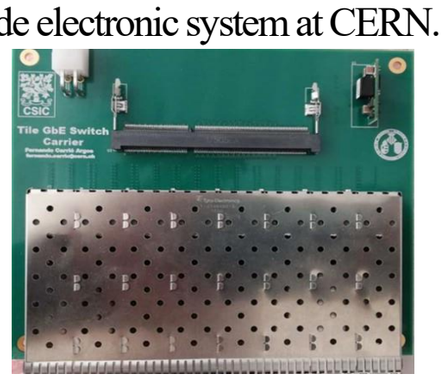
TilePPr –Preproduction status and test bench

In preparation for full production of the TilePPr module, 10 Tile GbE Switch PCBs have been produced from the South African companies: Jemstech and Trax Interconnect. These PCBs are currently tested in the UJ laboratory to perform a number of tests: electrical continuity test, thermal tests, communication, and visual inspection. These tests are done to ensure full functionality of the produced PCBs before they can be shipped to CERN for assembly and installation. All the proposed tests have been successfully performed at UJ and the PCBs are fully functional to be fully integrated into the Phase-II upgrade electronic system at CERN.



Tile GbE Bare PCB

Tile GbE PCB populated with components



Tile GbE motherboard to insert Switch

Summary and Acknowledgement

The University of the Johannesburg is contributing 24% to the back-end electronics for Tile Calorimeter Phase-II upgrades. The current contribution involves software and firmware implementation on the TileCoM and; production and testing of the Tile GbE Switch and the TileCoM. Pre-production of PCBs currently in progress from South African companies, Trax and Jemstech, and PCBs are tested at UJ in the laboratory.

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