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Integration and commissioning of the ATLAS Muon-to-Central-Trigger-Processor Interface for Run-3

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The Muon-to-Central Trigger Processor Interface (MUCTPI) was completely redesigned as part of the ATLAS Level-1 trigger upgrade for Run 3 of the LHC. The new system is implemented as a single ATCA module, using three large state-of-the-art FPGAs and high-density fibre-optic modules. 208 high-speed links receive trigger information from the muon trigger detectors, while 60 links are used to send processed trigger information to the Topological Trigger and the Central-Trigger-Processor. Extensive integration tests with all input and output systems have shown that the data transfer is stable and reliable. We will also report on the commissioning of the MUCTPI.

Summary (500 words)

The Muon-to-Central Trigger Processor Interface (MUCTPI) is part of the Level-1 trigger system of the ATLAS experiment at the LHC. It interfaces the output of the muon trigger detectors to the Central Trigger Processor (CTP), the Topological Trigger Processor (L1Topo), and the Data Acquisition (DAQ) system. The MUCTPI receives information on the muon candidates from the muon trigger sectors and calculates the total number of muon candidates for various transverse momentum thresholds taking into account double counting of muon candidates in different sectors due to overlap regions. It further extracts topological information and sends it to the L1Topo.

The MUCTPI has been completely redesigned for Run-3. The new MUCTPI is a highly-integrated system implemented on a single ATCA module, which completely replaces the 18 VMEbus modules of the Run-1/2 system. It uses three large state-of-the-art Xilinx FPGAs (Ultrascale/Ultrascale+) to implement the trigger and readout data processing, and a Xilinx System-on-Chip to control, configure and monitor the board. The MUCTPI receives the muon candidates from 208 muon sector logic modules through high-speed speed serial optical links operating at 6.4 Gbps. Topological information is extracted, sorted by transverse momentum and the data from up to 16 muon candidates is sent to two L1Topo modules over 8 serial optical links operating at 11.2 Gbps. The calculated muon threshold multiplicity triggers are sent to the CTP through a fixed latency serial optical links at 6.4 Gbps. The optical input/output connections are implemented using high-density 12-channel fibre optic transmitter and receiver modules.

Three fully working MUCTPI prototypes have been designed and extensively tested. The performance of the 276 on-board serial optical links has been validated. Eye diagram measurements were used in order to determine the best transceiver settings and to check the eye-opening. In addition, long bit error rate (BER) test runs have been carried out demonstrating that all the links can operate with a BER of less than 10-15. The functional firmware for using the MUCTPI in the experiment has also been developed and extensively tested. Interface tests with the connected subsystems, i.e. the sector logic modules, L1Topo and the CTP, have also been performed successfully. The correctness of data transmission has been verified, using memories to capture the incoming data and CRC checks. Latency measurements for the trigger data links have been performed and shown that the values are within the specifications. One MUCTPI module is currently being installed in the ATLAS experiment.

We will present the results of the integrations tests with all the subsystems, as well as the status of the installation and commissioning of the MUCTPI in the ATLAS experiment.

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