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FPGA based data processing in the ALICE High-Level Trigger in LHC Run 2

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ALICE (A Large Ion Collider Experiment) is a detector system optimized for the study of heavy ion collision detector at the CERN LHC. The ALICE High Level Trigger (HLT) is a computing cluster dedicated to the online reconstruction, analysis and compression of experimental data. The High-Level Trigger receives detector data via serial optical links into custom PCI-Express based FPGA readout cards installed in the cluster machines. The readout cards optionally process the data on a per-link level already inside the FPGA and provide it to the host machines via Direct Memory Access (DMA). The HLT data transport framework collects the data from all machines and performs reconstruction, analysis and compression with CPUs and GPUs as a distributed application across the full cluster.

FPGA based data processing is enabled for the biggest detector of ALICE, the Time Projection Chamber (TPC). TPC raw data is processed in the FPGA with a hardware cluster finding algorithm that is faster than a software implementation and saves a significant amount of CPU resources in the HLT cluster. It also provides some data reduction while introducing only a marginal additional latency into the readout path. This algorithm is an essential part of the HLT already since LHC Run 1 for both proton and heavy ion runs. It was ported to the new HLT readout hardware for Run 2, was improved for higher link rates and adjusted to the recently upgraded TPC Readout Control Unit (RCU2). A flexible firmware implementation allows both the old and the new TPC data format and link rates to be handled transparently. Extended protocol and data error detection, error handling and the enhanced RCU2 data ordering scheme provide an improved physics performance of the cluster finder.

This contribution describes the integration of the FPGA based readout and processing into the HLT framework as well as the FPGA based TPC cluster finding and its adoption to the changed readout hardware during Run 2.

Tertiary Keyword (Optional)

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Primary Keyword (Mandatory)

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Secondary Keyword (Optional)

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