Contribution ID: **213** Type: **Poster presentation**

Design of a Compact Hough Transform for a new L1 Trigger Primitives Generator for the upgrade of the CMS Drift Tubes muon detector at the HL-LHC

Tuesday, 7 June 2016 15:00 (1h 30m)

The operation of the CMS Drift Tubes muon detectors at the High Luminosity LHC will be possible only with an upgrade of the current readout and trigger electronics, which are based on very old technology and exposed to direct radiation, hence particularly sensitive to ageing. The current Trigger Primitives Generator (TPG) is designed around a synchronous device measuring at once the muon track parameters and the parent buch crossing by means of a time-dependent fitting algorithm. The device is strictly coupled to the readout electronics, sharing the same input signals, and placed on dedicated on-detector crates. The readout will be upgraded becoming sparsified and asynchronous to benefit from the recent fast developments in telecommunications technology, increasing the bandwidth using fast optical drivers such as the Gigabit Bidirectional Transceiver and therefore the trigger electronics must undergo its own upgrade. We present a proposal for a novel L1 Trigger Primitives Generator for the CMS barrel muon detectors able to operate on the asynchronous charge collection time measurements done by the new foreseen TDCs. This new L1 TPG is being designed around the implementation in state-of-the-art FPGA devices of the original development a Compact Hough Transform (CHT) algorithm, identifying the track segment parameters, combined with a Majority Mean-Timer, used to idetify the muon parent bunch crossing. The requirement for the algorithm is fitting inside FPGAs and having O(2) μs latency for decision taking, with efficiency and resolution equal or higher to thecurrent ones, given O(10) measured drift times immersed in a non negligible background. The major challenges are parallelization of the algorithm, fast readout of the CHT parameter matrix, the capability of handling data from a large array of Drift Tubes in minimal number of FPGAs, and coping with the latency requirements. These issues will be addressed proposing valuable solutions.

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Session Classification: Poster session 1

Track Classification: Upgrades