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A High Luminosity LHC Track Trigger for the CMS Detector

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During the High Luminosity LHC, to maintain a manageable trigger rate and achieve its physics goals, the CMS detector will need charged particle tracking at the hardware trigger level. The tracklet approach is a track-finding algorithm based on a road-search algorithm that has been implemented on commercially available FPGA technology. This algorithm has achieved high performance in track-finding and completes tracking within $3.4 \mu\text{s}$ on a Xilinx Virtex-7 FPGA. An overview of the algorithm and its implementation on an FPGA are discussed and the results of an end-to-end demonstrator system that meets timing and performance requirements are presented.

Summary

The upgrades of the Compact Muon Solenoid particle physics experiment at CERN's Large Hadron Collider provide a major challenge for the real-time collision data selection. We present a novel approach to pattern recognition and charged particle trajectory reconstruction using an all-FPGA solution. The challenges include a large input data rate of about 20 to 40 Tbps, processing a new batch of input data every 25 ns, each consisting of about 10,000 precise pairs of position measurements of particles ('stubs'), perform the pattern recognition on these stubs to find the trajectories, and produce the list of parameters describing these trajectories within $4 \mu\text{s}$. A proposed solution to this problem is described, in particular, the implementation of the pattern recognition and particle trajectory determination using an all-FPGA system. The results of an end-to-end demonstrator system based on Xilinx Virtex-7 FPGAs that meets timing and performance requirements are presented. This is presented on behalf of the CMS Collaboration.

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