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Flexible Hough Transform FPGA Implementation for the ATLAS Event Filter

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The ATLAS Run3 will conclude as planned in late 2025 and will be followed by the so-called Long Shutdown 3. During this period all the activities exclusively dedicated to Run4 will converge on the closing of the prototyping development and in the start of the production and integration, to reach the data collection in 2029. These upgrades are principally led by the increase of the peak of luminosity up to 5-7.5 x 1034 cm-2 s-1 of LHC expected for the future High Luminosity-LHC operations. One of the major changes ATLAS will face will be an increase in the amount of data to be managed in its Trigger and Data Acquisition system. The triggering operations are targeting to reach from 40 MHz of input event a discrimination in the middle throughput of 1 MHz and finally in the last stage of 10 kHz. The second process will use all the information acquired by the ATLAS detector to complete the event selection, including the study of the tracks of the innermost sub-detector, the Inner Tracker. This tracking operation is planned to be performed with a PC farm because of the need for high precision. The list of the architectures under study to speed-up this process includes the use of a "hardware accelerator"farm, an infrastructure made of interconnected accelerators such as GPUs and FPGAs to speed up the tracking processes. The project described here is a proposal for a tuned Hough Transform algorithm implementation on high-end FPGA technology, versatile to adapt to different tracking situations. The development platform allows the study of different datasets from an ATHENA software simulating the firmware. AMD-Xilinx FPGA has been chosen to test and evaluate this implementation. The system was tested with a ATLAS realistic environment. Simulated 200 pile up events have been exploited to measure the effectiveness of the algorithm. The processing time is averagely in the order of < 10 μs according to internal preliminary estimates, with the possibility to run two events at a time per algorithm instance. Internal efficiency tests have shown conditions that reach > 95 % of the track-finding performance for single muon tracking.

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