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An FPGA-based Trigger System with Online Track Recognition in COMET Phase-I

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The COMET Phase-I experiment plans to search for the muon-to-electron conversion with a single event sensitivity of 3×10^{-15}, which has never been observed. The event signature is a mono-energetic electron of $105\,\mathrm{MeV/c}$ for muonic atoms formed in aluminum. This electron is detected by a cylindrical drift chamber (CDC) and a trigger hodoscope in a 1-T solenoidal magnetic field.
A highly intense muon beam is used to reach our sensitivity goal. It gives an unacceptably high trigger rate for data acquisition. To solve this problem, we are developing an FPGA-based online trigger system where the CDC-hit information is utilized with machine learning (ML) technique. A classifier optimized by the ML is implemented on FPGAs in the form of small look-up tables (LUTs). Using them, this system finds out the conversion-electron events and significantly suppresses the background trigger rate. Adopting a distributed trigger architecture makes it possible to handle data for ˜5000 CDC channels. All the processes need to be finished within the required latency which is limited by a buffer size of the CDC readout electronics. The LUTs carry out the ML-based classification in parallel within a clock cycle, and it keeps the latency short enough.
The trigger algorithm was implemented on the trigger-related electronics. In an operation test, the total latency was measured and met the requirement. The performance of the COTTRI system was estimated in a simulation study. In this presentation, we report details about the trigger algorithm, the operation-test result, and the expected performance.

Minioral

Yes

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No

Are you a student?

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