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Young Scientist Forum : Online Track and Vertex Reconstruction on GPUs for the Mu3e Experiment

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The Mu3e experiment searches for the lepton flavour violating decay $\mu^+ \rightarrow e^+ e^- e^+$, aiming at a branching ratio sensitivity better than 10^{-16} . To reach this sensitivity, muon rates above $10^9 \mu/s$ are required. A high precision silicon tracking detector combined with excellent timing resolution from scintillating fibers and tiles will measure the momenta, vertices and timing of the decay products of muons stopped in the target to suppress background.

During the first phase of the experiment, a muon rate of $10^8 \mu/s$ will be available, resulting in a rate of ~ 10 GB/s of zero-suppressed data. The trigger-less readout system consists of optical links and switching FPGAs sending the complete detector data for a time slice to one node of the filter farm.

Since we can only store ~ 100 MB/s of data, a full online reconstruction is necessary for an event selection. This is the ideal situation to make use of the highly parallel structure of graphics processing units (GPUs).

An FPGA inside the filter farm PC therefore transfers the event data to the main memory of the PC and then to GPU memory via PCIe direct memory access. The GPU

finds and fits tracks using a non-iterative 3D tracking algorithm for multiple scattering dominated resolution. For three hits from subsequent detector planes, a helix is fitted by assuming that multiple scattering at the middle hit is the only source of uncertainty.

In a second step, a three track vertex selection is performed by calculating the vertex position from the intersections of the tracks in the plane perpendicular to the beam axis and weighting them by the uncertainties from multiple scattering and pixel pitch.

Together with kinematic cuts this allows for a reduction of the output data rate to below 100 MB/s by removing combinatorial background.

The talk will focus on the implementation of the track fit and vertex selection on the GPU and performance studies will be presented.

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Track Classification: 9 : Real Time Pattern Recognition