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Computational Steering of GEM Simulations

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One of the primary objectives of the research on GEMs at CERN is the testing and simulation of prototypes, manufacturing of large-scale GEM detectors and installation into CMS detector sections at the outer layer, where only highly energetic muons particles are detected. When a muon particle traverses a GEM detector, it ionizes the gas molecules generating a freely moving electron that starts ionizing the gas molecules and produces the secondary electrons. These secondary electrons also ionize the gas and subsequently form an avalanche of electrons under the influence of the applied drift field. The simulations of this physical phenomenon especially those with complex scenarios such as those involving high detector voltages or gas with larger gains are computationally intensive and may take several days or even weeks to complete.

These long-running simulations usually run on the high-performance supercomputers in batch mode. If the results lead to unexpected behavior, then the simulation might be rerun with different parameters. However, the simulations (or jobs) have to wait in a queue until they get a chance to run again because the supercomputer is a shared resource that maintains a queue of all other users programs as well and executes them as time and priorities permit. It results in inefficient utilization of computing resource and increases the turnaround time for the scientific experiment.

To overcome this issue, the monitoring of the behavior of a simulation, while it is running (or live), is essential. One method of monitoring is to write the data, produced by the simulation, periodically to the disk. But, the disk being inherently slow can become a bottleneck and can affect the performance. Another approach is to use the computational steering technique, in which simulation is coupled with a visualization system to enable the exploration of "live" data as it is produced by the simulation.

In this work, we employ the computational steering method by coupling the GEM simulations with a visualization package named VisIt. A user can connect to the running simulation with the VisIt client over the network, and can visualize the "live" data to monitor the simulation behavior. Also, the simulation can be restarted immediately on the fly with different parameters without requiring resubmitting the job on the supercomputer.

Secondary Keyword (Optional)

High performance computing

Primary Keyword (Mandatory)

Visualization

Tertiary Keyword (Optional)

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