

Computational Steering of GEM Simulations



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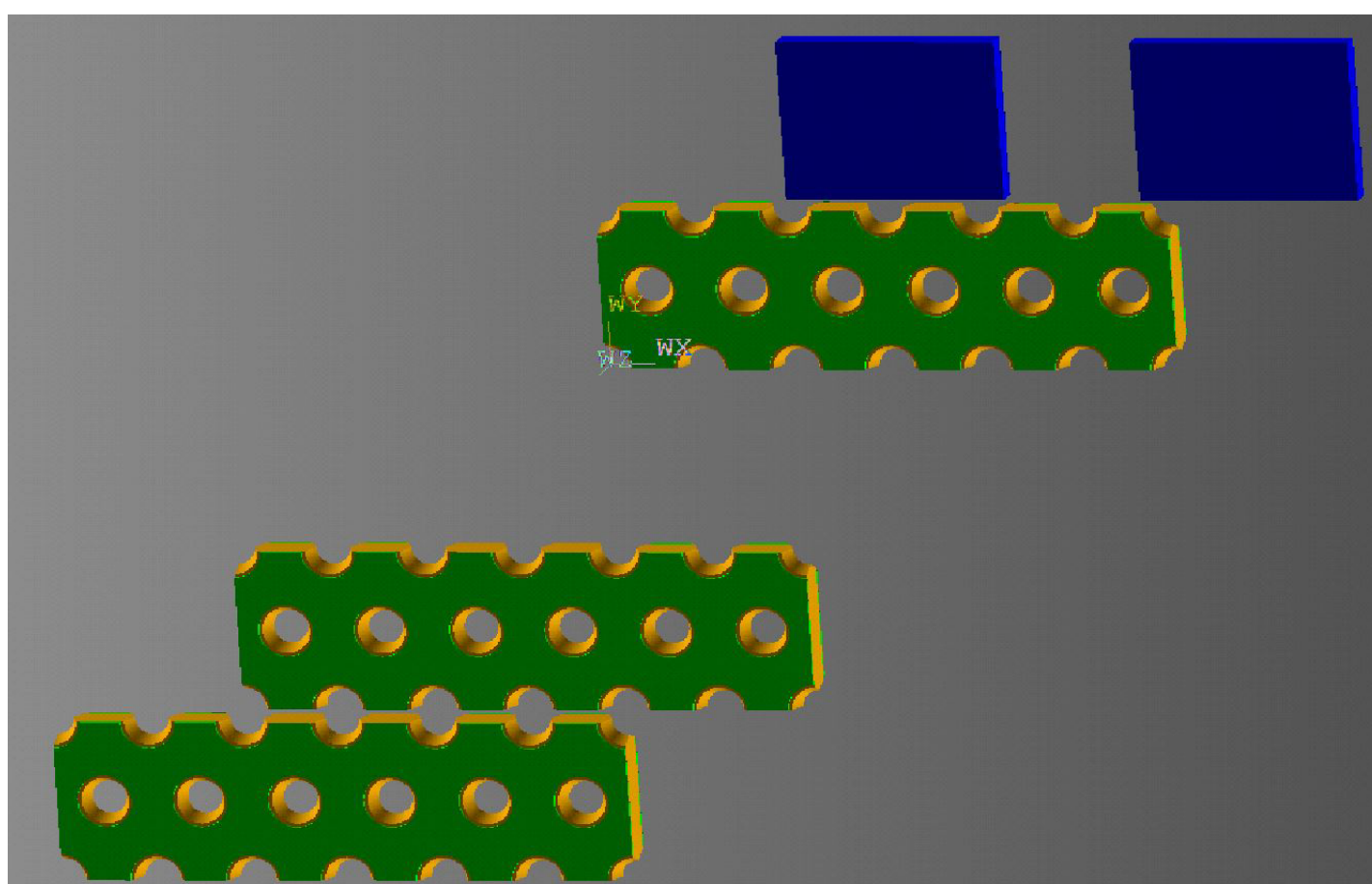
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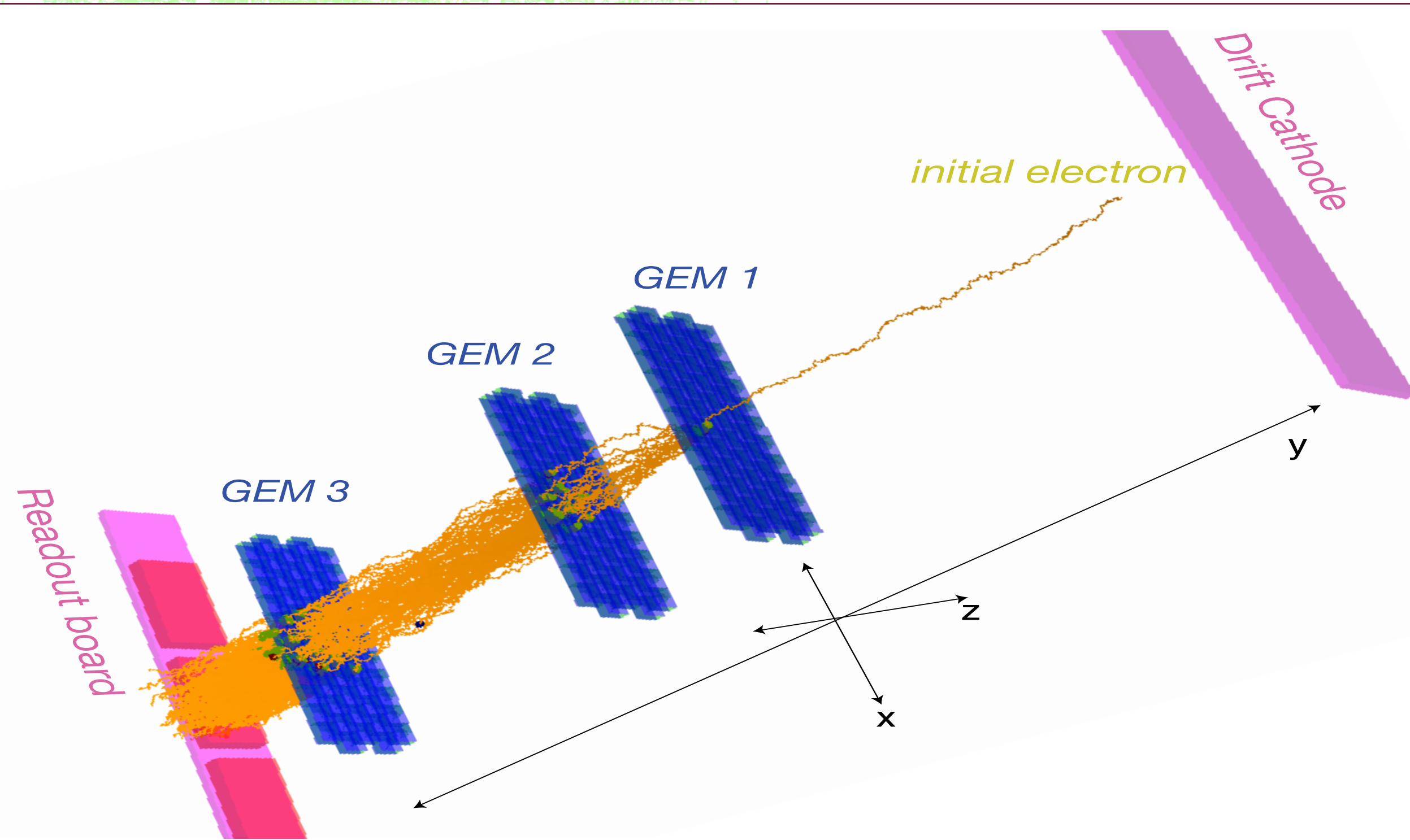
1. INTRODUCTION

The Gas Electron Multiplier (GEM) is a type of gaseous ionization detector invented in CERN (European Organization For Nuclear Research) in 1997 and has been since used widely in different fields such as high-energy physics and medical physics. Texas A&M University at Qatar is involved in the development of triple-GEM detectors for the future upgrade of the CMS (Compact Muon Solenoid) experiment at CERN Large Hadron Collider.

The performance of triple GEM detectors can be studied by simulating the electron avalanches using the GARFIELD simulator. Such simulations are usually long running and computationally intensive operations. It is not unusual for a simulation to **keep running for several days or even weeks**.



If the experiment leads to the conclusion that there is incorrect logic in the application, or input parameters were wrong, then simulation has to be **restarted**.



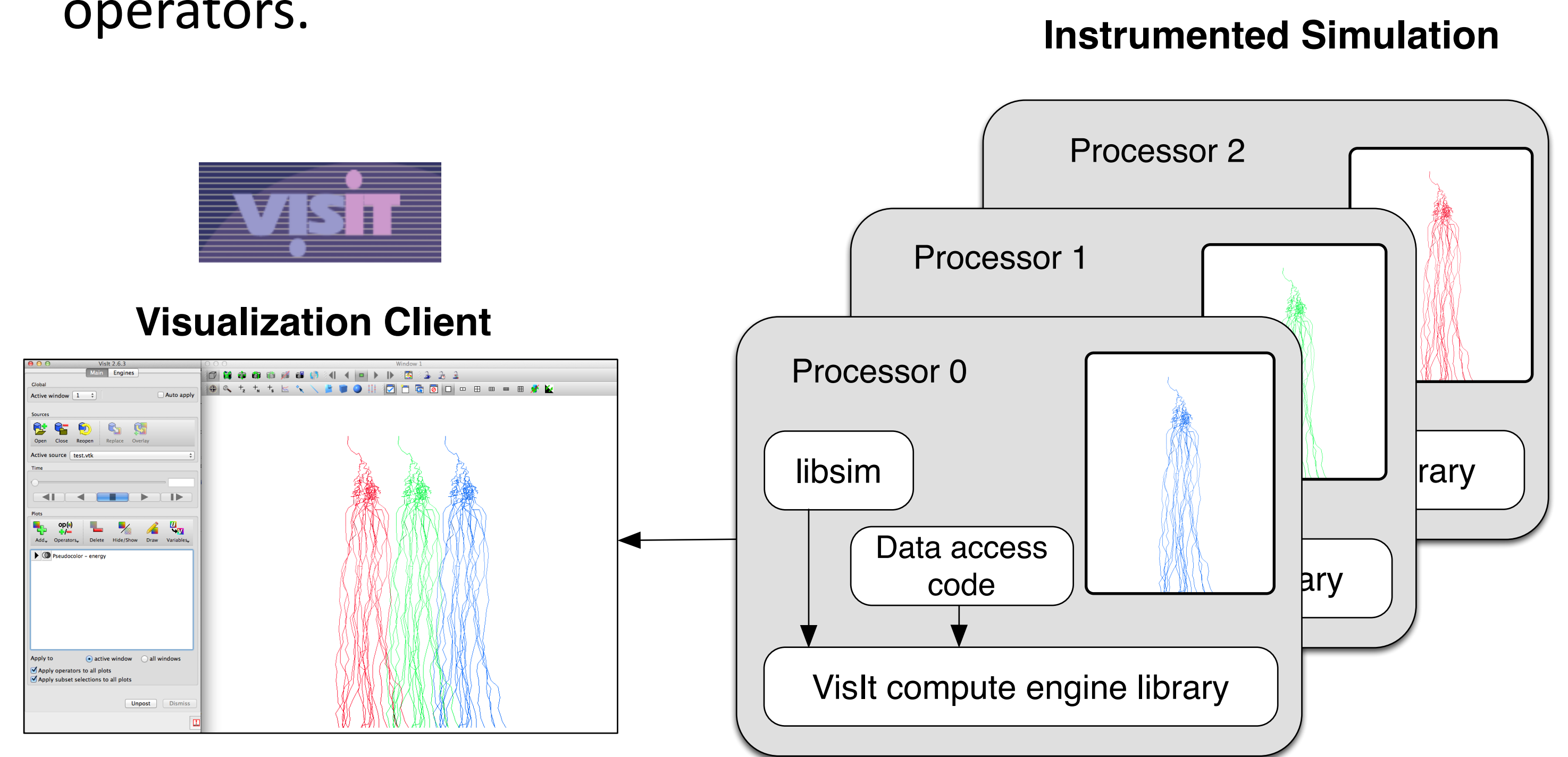
An electron avalanche through a triple GEM detector

2. OBJECTIVES

- Enable real-time **visual debugging** and **interactive exploration** of the electron avalanches.
- Enhance researcher's productivity by enabling them to detect the errors in their simulations at very early stages.
- Allow researchers to change the parameters on the fly (steer) and restart the simulations without requiring them to restart the job on the HPC supercomputer.
- Have no or minimal impact on the simulation performance.

3. METHOD

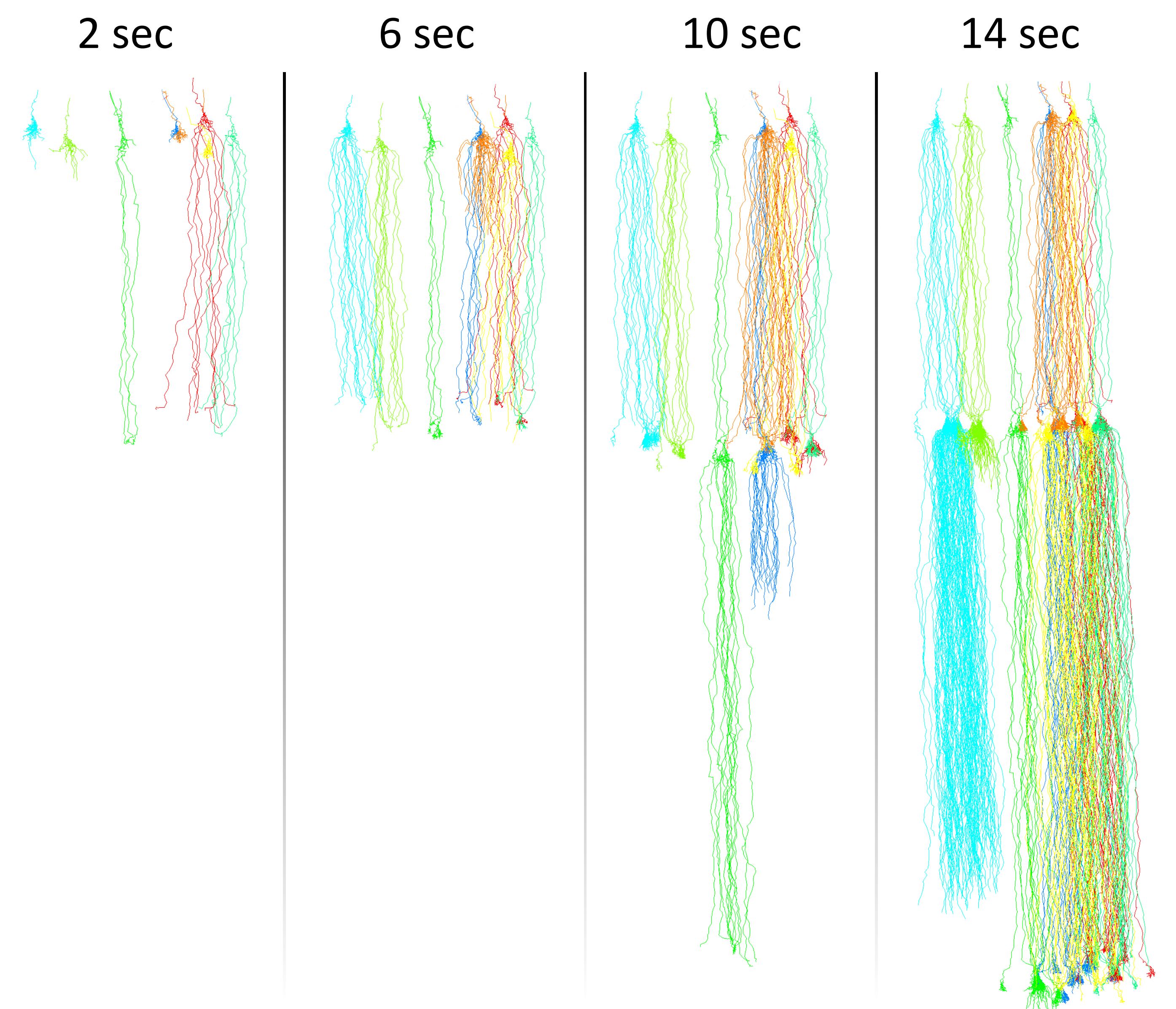
- Couple the simulation with the visualization code by writing the data access functions using VisIt libsimg library.
- Using **in-situ visualization** techniques, extract the data from the live simulation.
- Analyze and interact with the data in VisIt client using several operators.



Instrumented simulation and visualization client

4. RESULTS

The diagram shows the visualization of the evolution of electron avalanche simulation at different times running on 10 processors. Each avalanche has been colored with respect to the processor ID.



5. CONCLUSION

- The proposed method can be scaled up to hundreds of processors.
- There is very minimal performance impact on the simulation.
- Not only the electron avalanche simulation, but any time-consuming simulation can be instrumented to support the visual debugging and interactive exploration of the data.