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The Telescope Array Fluorescence Detector Simulation on GPUs

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The Telescope Array Cosmic Rays Detector located in the Western Utah Desert is used for the observation of ultra-high energy cosmic rays. The simulation of a fluorescence detector response to cosmic rays initiated air showers presents many opportunities for parallelization. In this presentation we report on the Monte Carlo program used for the simulation of the Telescope Array fluorescence detector located at the Middle Drum site. The program makes extensive use of GPU acceleration (CUDA) to achieve a 50x speed-up compared to running on a single CPU core.

The main design criteria for the simulation code is that it can be run with/without acceleration while eliminating code duplication as much as possible. This is seen as critical for long term maintainability of the source code. A CMake based build system allows the user to easily select to compile/run the code with or without CUDA, and to include external package, e.g. ROOT, dependent code in the build.

All of the physics simulation from shower development, light production and propagation with atmospheric attenuation, as well as, the realistic detector optics and electronics simulations are done on the GPU. A detailed description of the code implementation is given, and results on the accuracy and performance of the simulation are presented as well.

Detector event reconstruction is performed using an inverse Monte Carlo method. We are in the process of porting that code to make use of the GPU based simulation. Results will be presented on this effort as well.

Primary author: Dr ABUZAYYAD, Tareq (University of Utah)

Presenter: Dr ABUZAYYAD, Tareq (University of Utah)

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