ASTRAPÉ

Atmospheric STReamer And relativistic Particle Engine

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The lightning strike



First streamers, then the strike

A Monte Carlo model for streamer physics

- Trace the flight and collisions of individual electrons
- Electrons produce new electrons
- To induce lightning, there is first an avalanche



A Monte Carlo model for streamer physics

- Trace the flight and collisions of individual electrons
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To produce gamma-rays:

- Electrons undergo a specific collision and produce gamma-photons
- Those photons can then collide and produce electrons...

High level of interdependence!

A Monte Carlo model for streamer physics



Streamer code GPU implementation

Swarm code + third-party equation solver (AMReX) + some additional physics



Swarm code implementation

OpenMP offload or HIP

1 LUMI GCD

Both distribute individual particles to threads

OpenMP is used for CPU-based processes in **both** implementations



Swarm code implementation

OMP Offload

- Dynamic iterator to fetch and process new particles
- PCG random number generator
- Full synchronisation occurs for data output

HIP

- Kernel launch for each mobility timestep
- hipRAND random number generator
- Full synchronisation at each mobility timestep

- Develop and implement a model for photon processing that accounts for the interdependence between particle types
- Develop a scheme for distributing photons across multiple devices with MPI
- (Time permitting) Implement MPI for distribution for photons and/or electrons