ATLAS Geometry on GPUs

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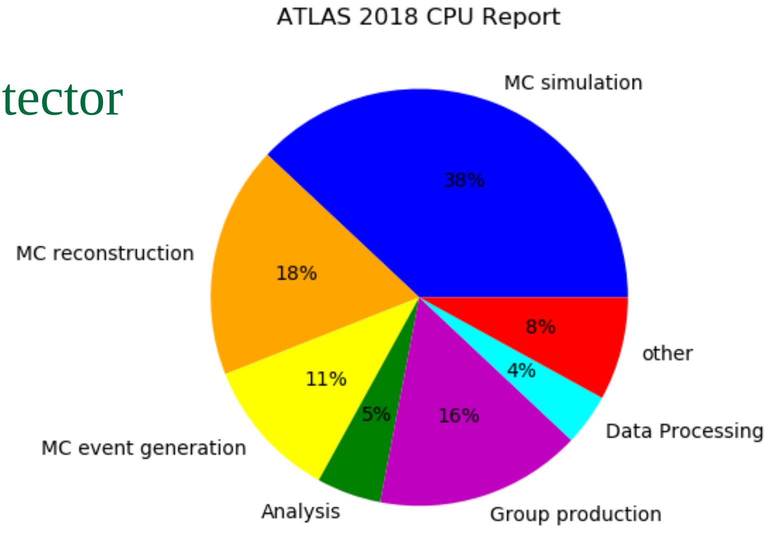
Project

- Detector simulation consumes most CPU
  - Many ongoing efforts to provide GPU accelerated particle transport https://geant4.web.cern.ch/collaboration/task_force_rd
  - GPUs are becoming more prevalent at computing sites (particularly HPC centres)

- Focus on electromagnetic calorimeter of the ATLAS detector
  - Computationally dominant part of full Geant4 simulation
  - Relatively tractable number of processes



- Implement EM Calorimeter geometry on GPU
  - We will start some R&D on how this could be done
  - Study the current code in Athena
  - Think also about alternative approaches (e.g. looking at tessellation, which GPUs handle very efficiently)

Challenges and Approach

- ATLAS calorimeter has accordion structure
  - Not implemented using standard G4 geometry primitives

- Geant4 is a large code base
  - many C++ features non trivial for porting to GPU in present form
  - Particle transport requires significant algorithmic modification beyond syntax conversion

- Working under the VecGeom umbrella
  - This is part of a larger R&D effort that examines how to use GPUs for particle transport in Geant4
  - Code was developed mainly with SIMD CPU execution as the target, but it was generically adaptable to both CPU and GPU execution (Talk from Andrei)
  - Currently a demonstrator that does **ray tracing** through a HEP detector (eg. TrackML detector)

- Merge well with other R&D activities to make sure ATLAS is well integrated into the general geometry on GPU

Support

- Sinead Farrington and Graeme Stewart for the suggestions and start of project
- Andrei Gheata and Guilherme Amadio for VecGeom introduction
- **Suggested ideas:**
  - Tessellated geometry: Implement as triangles so that the geometry look-up is fast for each particle
  - Twisted geometry
- Connection with industrial partners (currently Nvidia)
  - Monthly mentorship from Nvidia solution architect (Paul Graham) and also engaged with other members who work with physicists to discuss projects (eg. SHIFT)
  - Training for Nvidia ambassador in CUDA programming
- Selected for the GPU hackathon in Sheffield to take place in July
  - My aim is to do profiling of the current code