

GPU Computing Application: Particle Trajectory Fitting

Dorothea vom Bruch

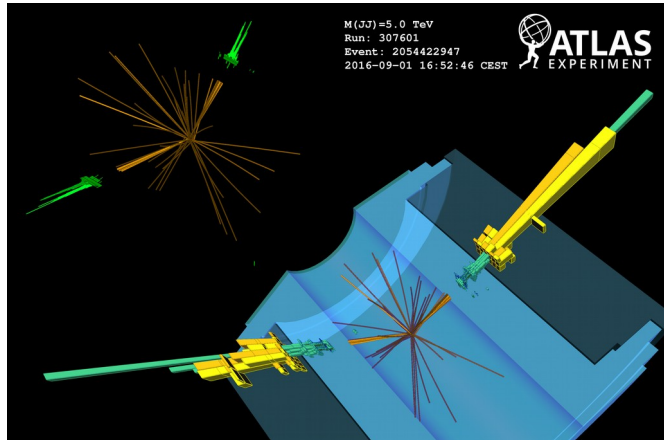
May 2019
5th Infiери Summer School
HUST, Wuhan, China



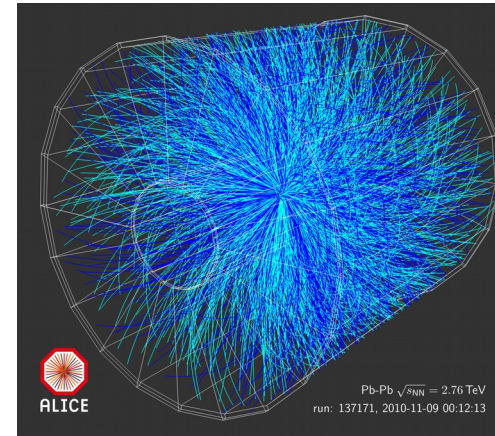
Particle physics event selection

Modern particle physics experiments have to handle high data rates and reduce them in real time → Select interesting data in in real time

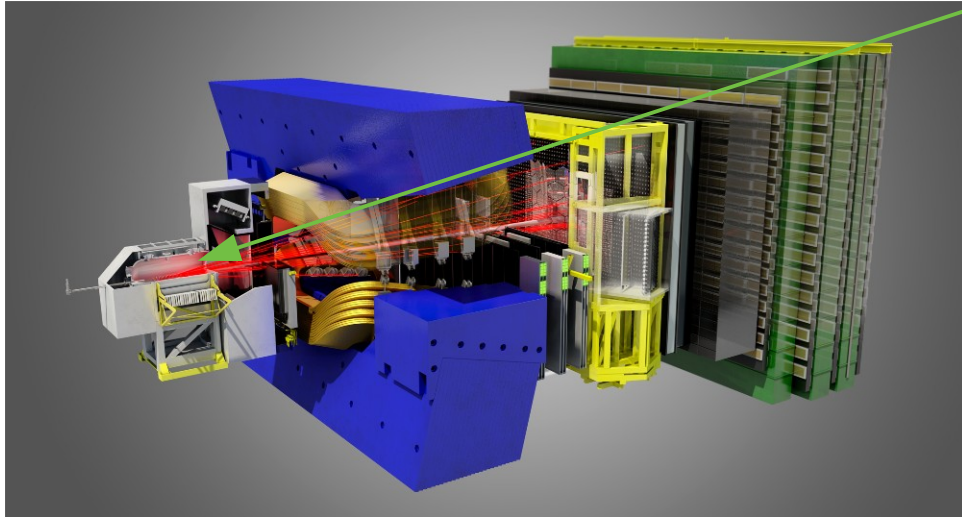
Can be “easy”, for example when looking for high energy / high transverse momentum particles
→ Selection in hardware



Can be more difficult, for example if particle trajectories have to be reconstructed fully to understand properties of a collision
→ Selection in software



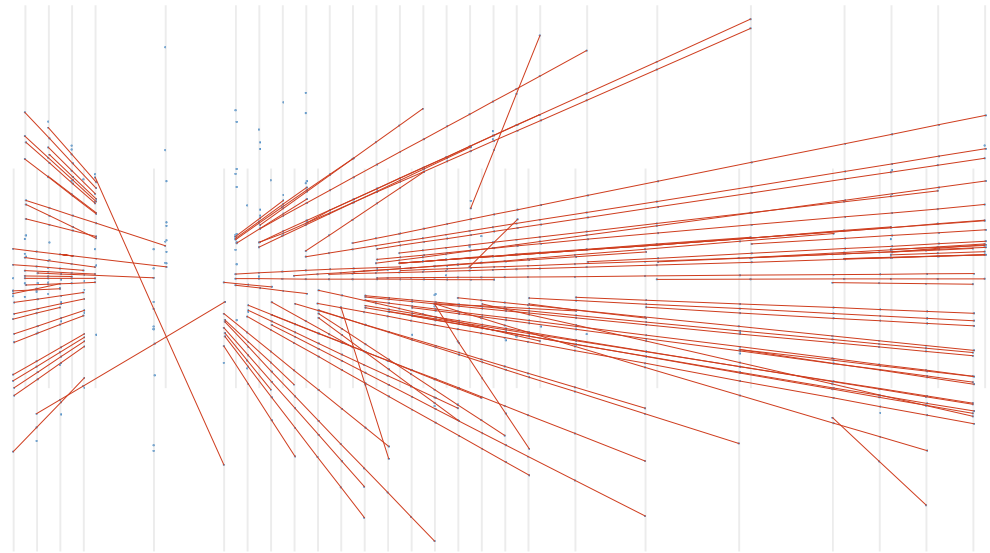
LHCb track reconstruction



- Particles travel in a straight line around the proton-proton collision region
- Trajectories measured with silicon pixel sensors → 3D measurements
- For event selection:
 - Reconstruct trajectories in real time
 - → Find positions of proton-proton collisions
 - → Extend the tracks through the other LHCb detectors

Lab: Fit particle trajectories

- Use LHCb simulation data from [RAPID](#) challenge last year
- Provide hits in detector, represented as 3D space point
- Provide tracks: which hits originate from the same particle?
- Task: fit the trajectory using a Kalman filter and find the direction and covariance matrix closest to the beam line



Lab session

First: Introduction to particle track reconstruction and the Kalman filter for track fitting

Second: hands on exercise

- Start from CPU code for fitting the particle trajectories
- Port the code to CUDA
- Decide how to parallelize the problem
- Explore single and double precision representation
- Find a data layout that is suitable for the GPU
- Work with concurrent streams in CUDA to hide the latency of copying data from the host to the device

Pre-requisites

- Some experience with CUDA programming: at the level of the introductory lab session
- Need a laptop to connect to the server where the GPUs for this lab are located
→ Please verify that ssh works for you

- Please note that this lab is only available during lab sessions 2, 4, 6, 8, 10