LUXE Technical Meeting Update - Summer Student Projects

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DESY.

Project outlines

1. **QC track reconstruction on realistic detector simulation:**

   Positron track reconstruction with quantum computing on fully digitised events.

   (Supervisors: Federico + Yee + David)

2. **Integration of QC track reconstruction into key4hep**:

   Implementing track fitting using the ACTS Kalman Filter on track candidates obtained from the QC approach.

   (Supervisors: Thomas + Yee + David)

1) QC on realistic simulation

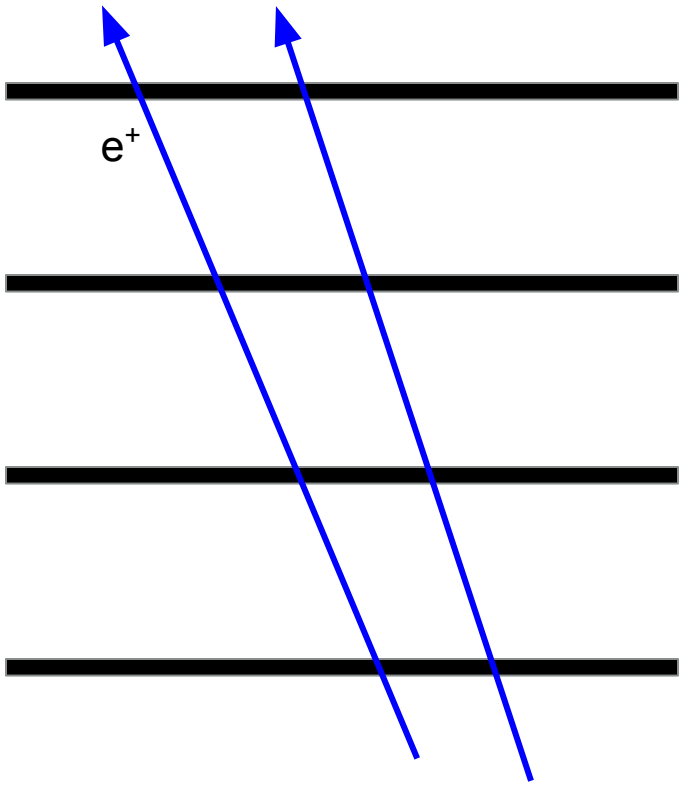
So far:

Studies performed on a custom fast simulation, with a simplified geometry model and no background.

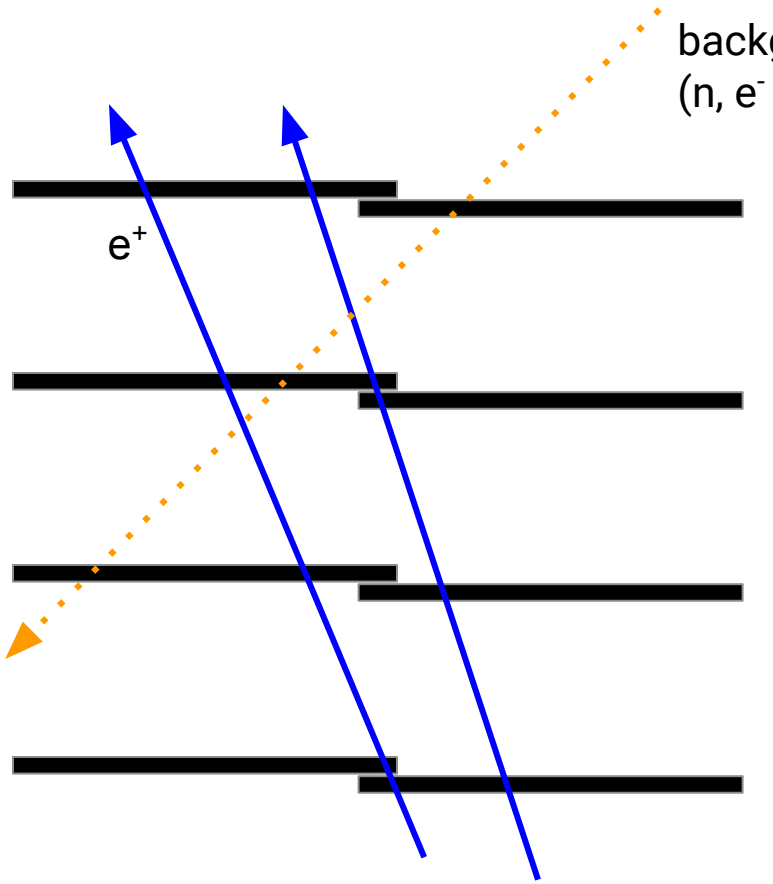
Project Motivation:

Studying the QC pattern recognition approach in a more realistic simulation environment.

1) QC on realistic simulation



custom simulation



realistic simulation (physics processes, detector material, cluster sharing after digitisation, ...)

1) QC on realistic simulation

- Comparison between Geant4 and custom fast simulation output

  → update preselection and QUBO model parameters
- Test QC approach on digitised events w/o and w background
- Run a subset of a BX on an real quantum device from IBM

QUBO =
QUadratic
Unconstrained
Binary
Optimisation

For the first time, pattern recognition of positron tracks from a realistically simulated LUXE event with detailed geometry will run on a quantum computer!

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2) QC track reconstruction inside key4hep

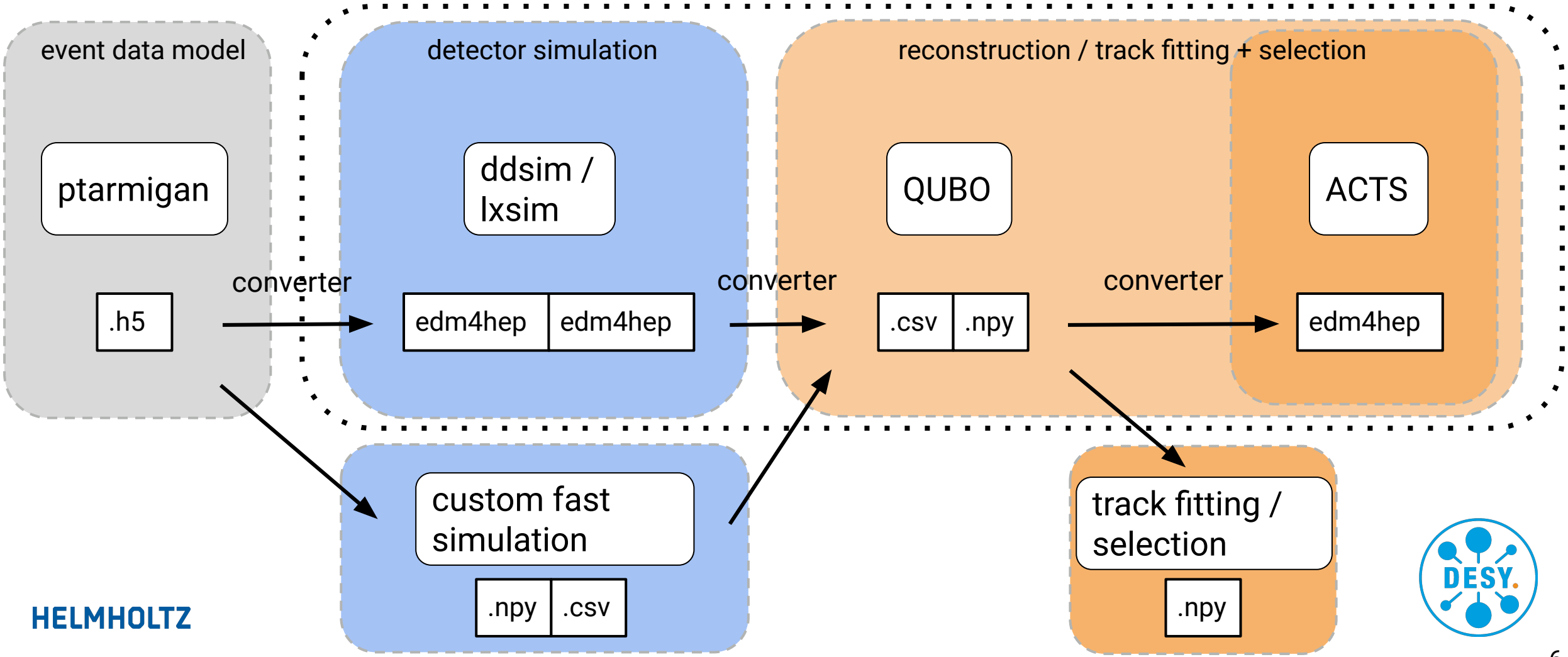
So far:

Track selection (fitting, resolve ambiguities) with a stand-alone python script.

Project Motivation:

Proper comparison between results of different track reconstruction methods in a seamless and consistent way.

2) QC track reconstruction inside key4hep



2) QC track reconstruction inside key4hep

- Event simulation and reconstruction inside key4hep using ddsim already available for the classical method, QC pattern recognition stand-alone outside key4hep
- Integration of QC pattern recognition in key4hep, in particular the implementation of the Kalman filter for track fitting in ACTS.

The integration of track fitting with a Kalman filter into the key4hep environment will allow a proper comparison of the results of different approaches to track reconstruction!

Preparation

- QC pattern recognition framework → adjust pattern building
- Change input/output formats for the QC pattern recognition step (?)
- key4hep python environment ↔ QC pattern recognition compatibility
- IBM Quantum Computer backends compatibility (qiskit, python)
- Priority access of IBM devices? (Zeuthen group)