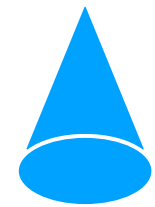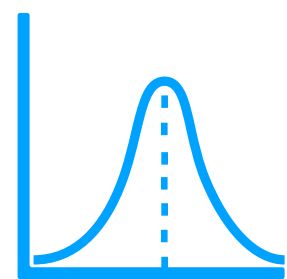# Recent/Upcoming developments

A. Salzburger (CERN)

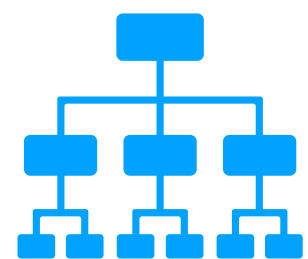# Upcoming developments

Geometry & Material

Event Data Model

Track Finding & Fitters

Vertexing
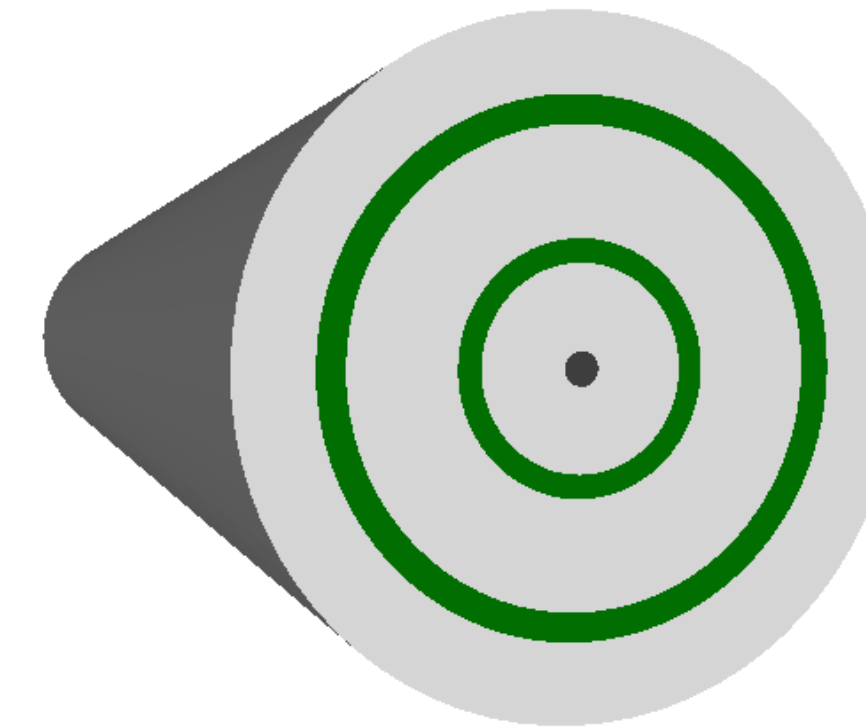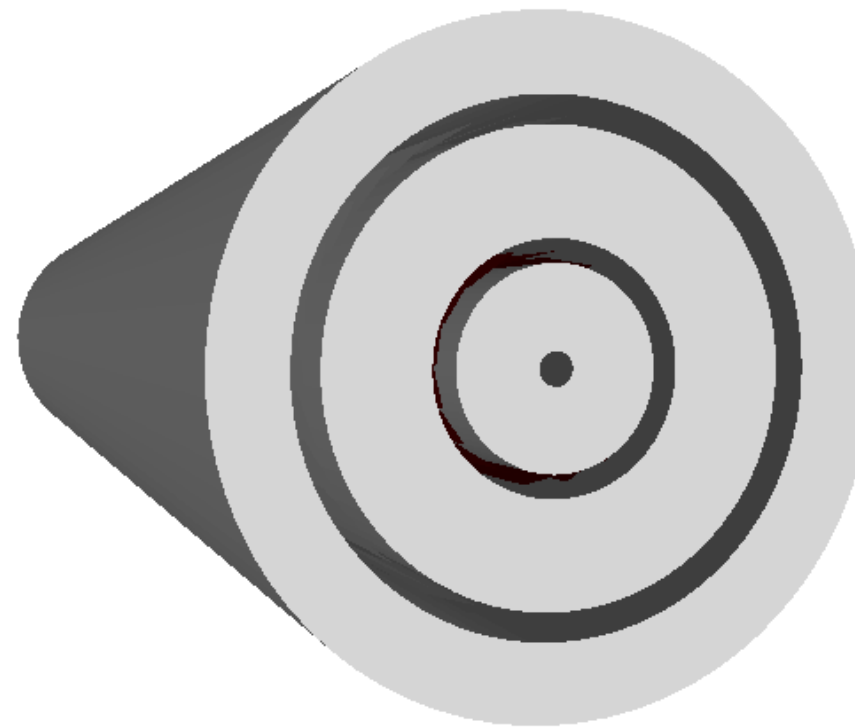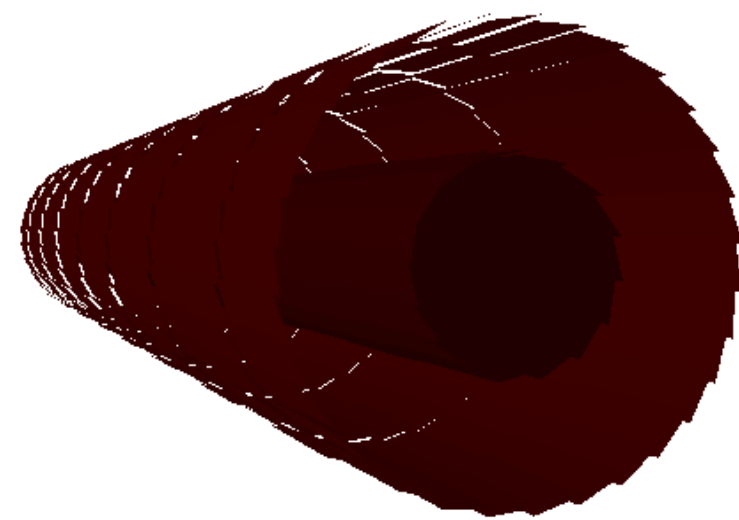
R&D lines (ML, GPU)

Geometry (1)

‣ Geometry model of ACTS stems from ATLAS `Trk::TrackingGeometry`

- Conceptual building blocks

> `TrackingVolume`
> `Layer`
> `Surface`

Quite some overlap between those

- `detray` GPU R&D geometry: re-implemented w/o layer concept

  - huge simplification in navigation code

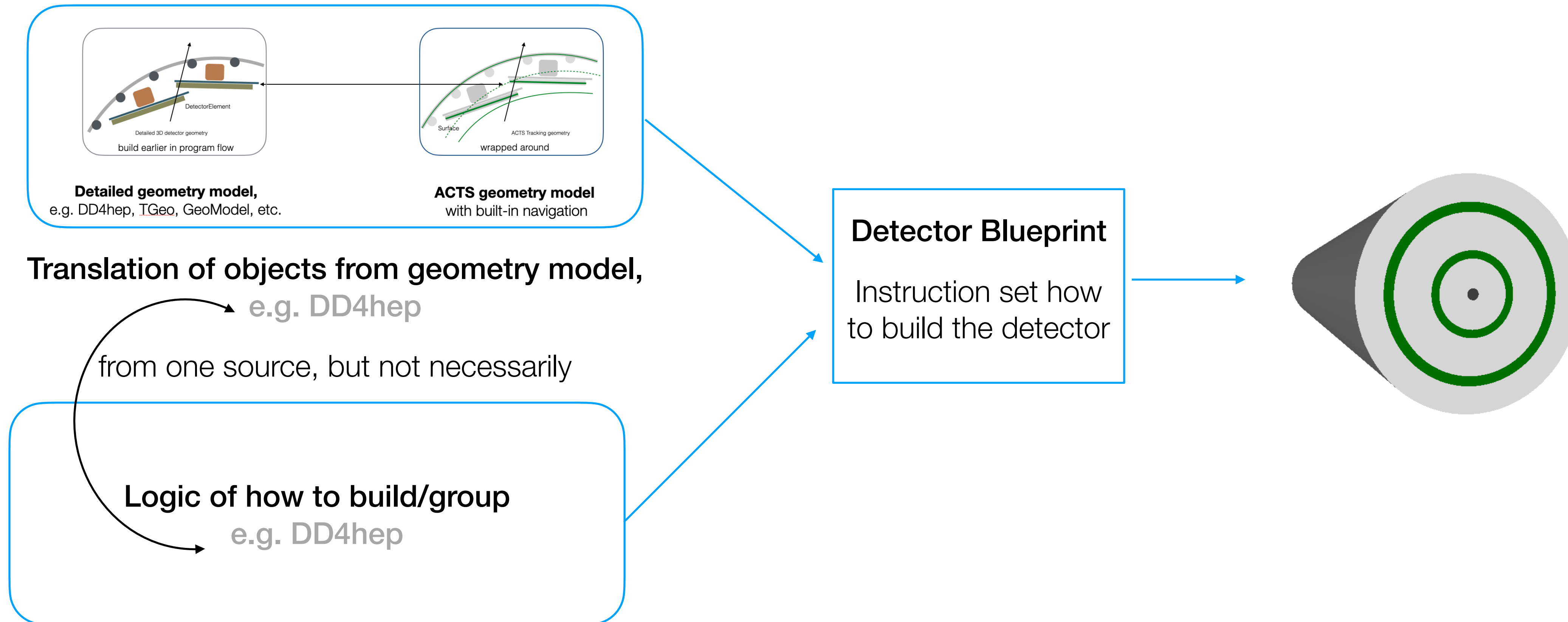 - can we do this also for ACTS/Core ?

Geometry (2) - Experimental

‣ `Experimental::Detector` Geometry model of ACTS

`Acts::Surface`	`Acts::Surface`	Surface objects are unchanged, allows client code to be untouched
`Acts::Layer`		Layer objects do not exist anymore, they are represented by volumes
`Acts::TrackingVolume`	`Acts::Experimental::DetectorVolume`	Double serving of volumes as containers or navigation volumes omitted
`Acts::BoundarySurfaceT<Acts::TrackingVolume>`	`Acts::Experimental::Portal`	Portal objects are not templated anymore, they are holder classes of surfaces and volume switches
`Acts::TrackingGeometry`	`Acts::Experimental::Detector`	Portal objects the top level entry point that will guide into the root volumes

Geometry (3) - Blueprint

‣ New type of geometry building using `Experimental::Blueprint`

Detailed geometry model,
e.g. DD4hep, TGeo, GeoModel, etc.

ACTS geometry model
with built-in navigation

Translation of objects from geometry model,
e.g. DD4hep

from one source, but not necessarily

Logic of how to build/group
e.g. DD4hep

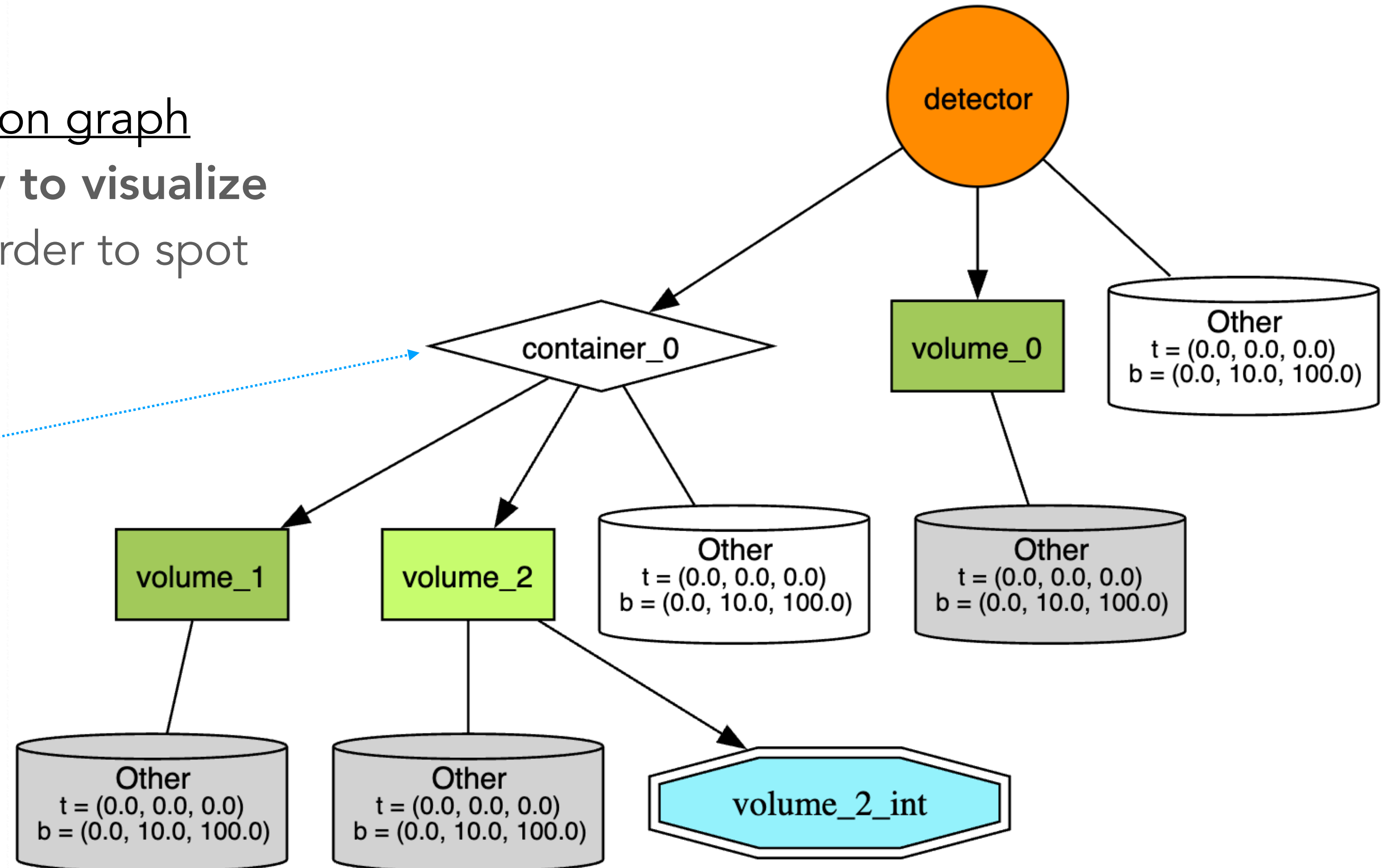**Detector Blueprint**

Instruction set how
to build the detector

Geometry (4) - Blueprint

‣ New type of geometry building using `Experimental::Blueprint`

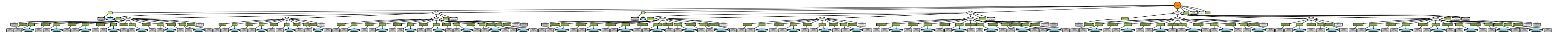Blueprint is an instruction graph
- **Added functionality to visualize** before building, in order to spot problems
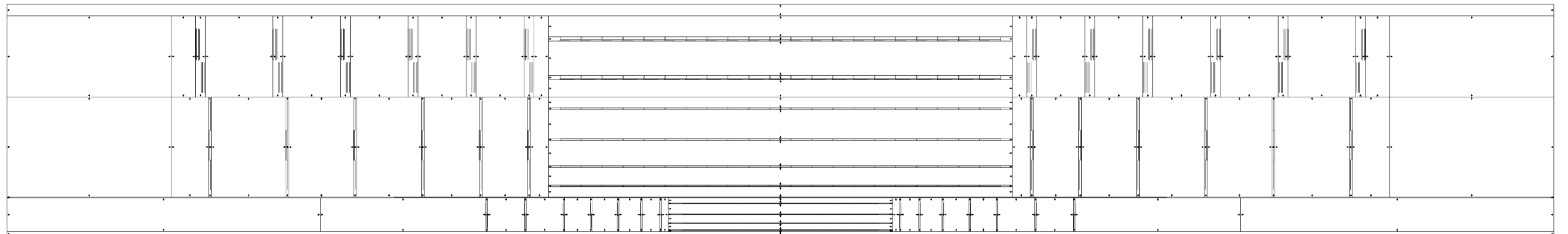
non-coloured nodes
are virtual containers

Geometry (5) - Blueprint on ODD
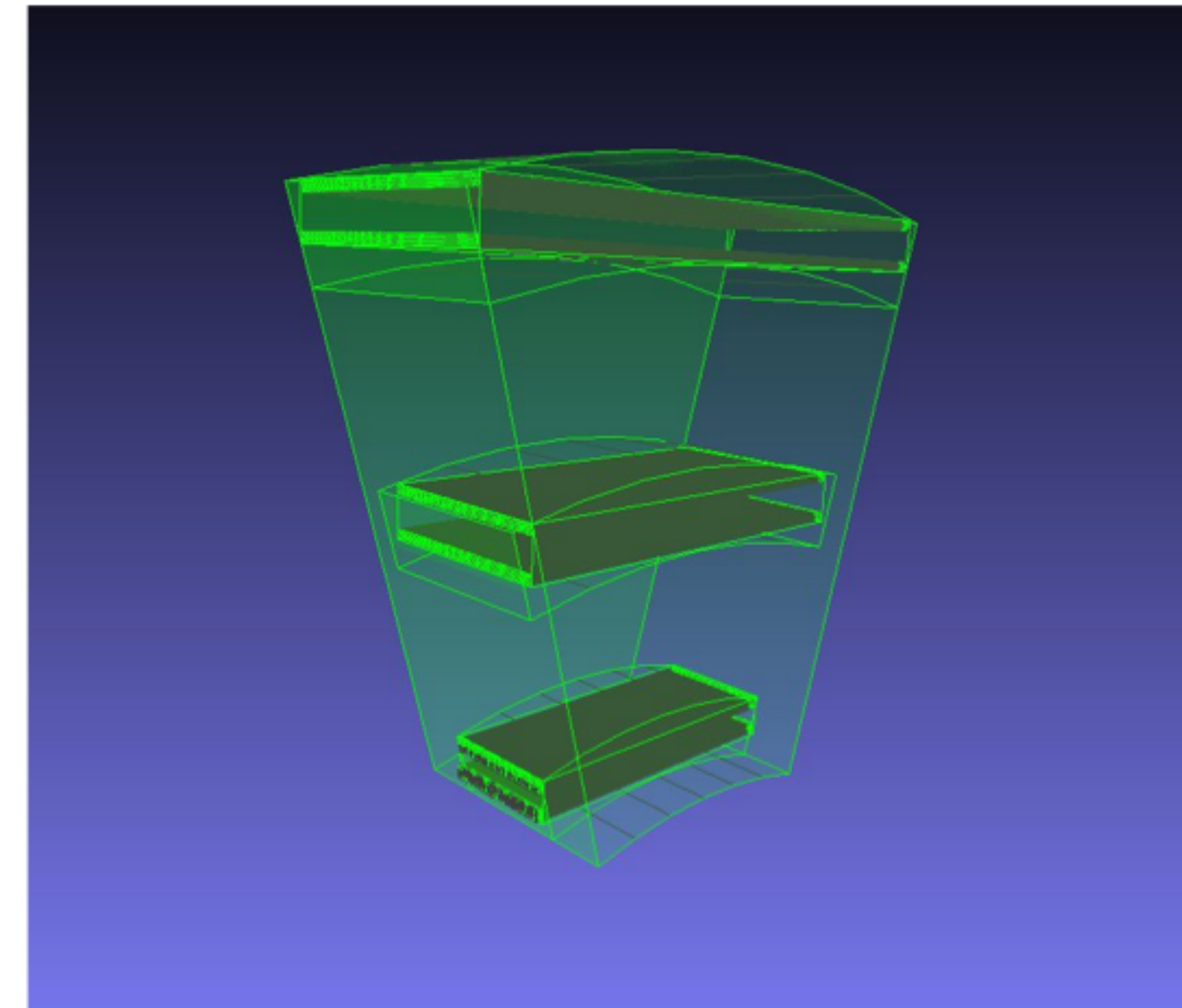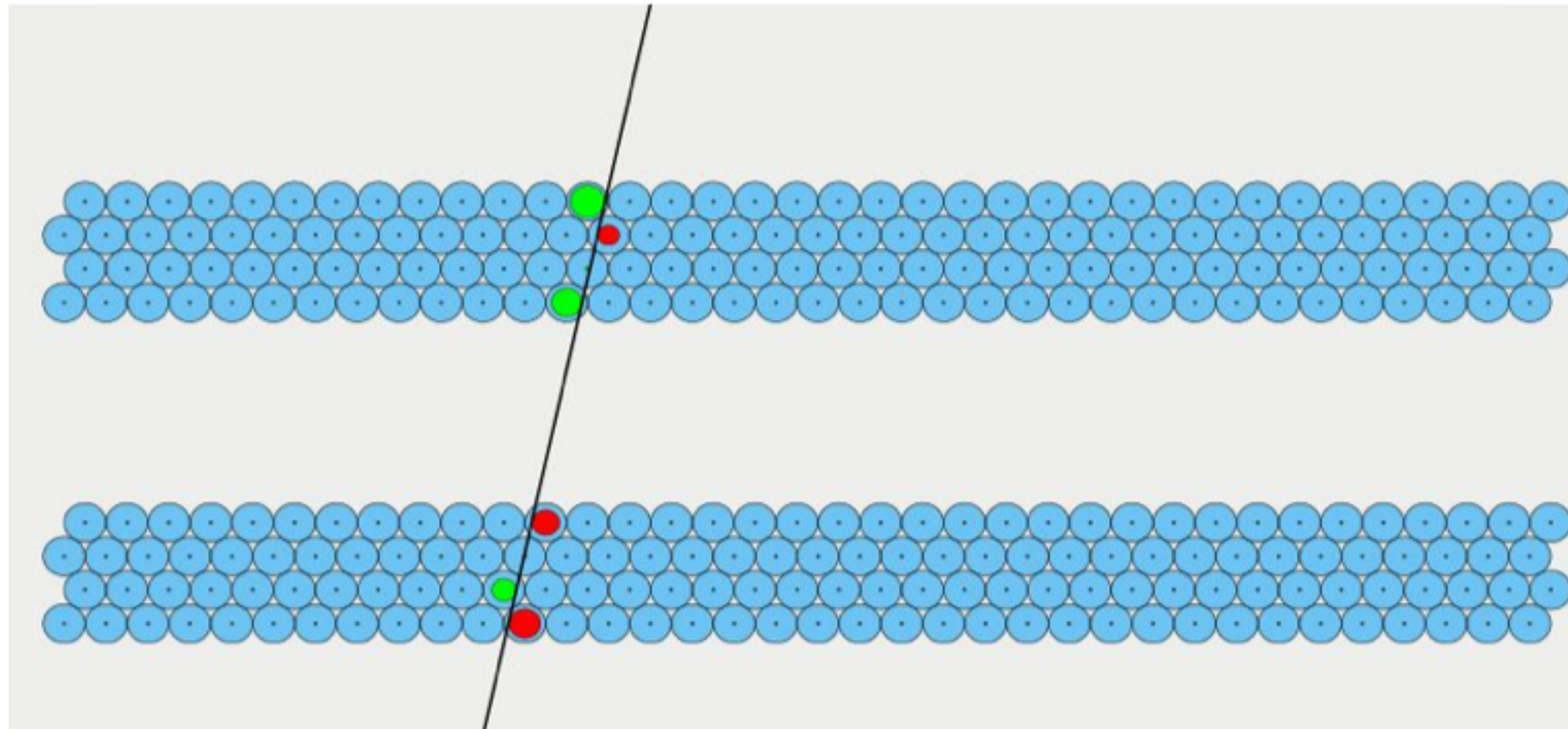
ODD building blueprint from DD4hep:

Resulting ODD detector

Gen2 geometry - more developments

‣ In Gen2 geometry, navigation is outsourced to `Delegates`

  – allows for client-specified navigation

  – helped developing first prototypes for (ATLAS) Muon System

Mock up muon sector spectrometer .
Every detector volume holds the navigation
delegate

Geometry (6) - Quo vadis ?

‣ **Gen1** geometry: `Acts::TrackingGeometry`

    Well established, baseline

‣ **Gen2** geometry: `Acts::Experimental::Detector`

    Blueprint
   Layer-less

    Navigation delegates

‣ **Gen3** geometry:

    - adiabatic merge of those two concepts ?

    - morph of Gen2 into full functionality of Gen1 ?

Material

‣ New Grid based material classes introduced

‣ Material mapping/validation without &
  with propagation/navigation

  – This is to allow for material mapping/
    validation with optionally bypassing the
    propagator infrastructure

  – Support for Gen1/Gen2 geometry model

‣ Move most material mapping/validation into Core

  – Allow for more seemingness integration into SW stack

t_X0:v_eta
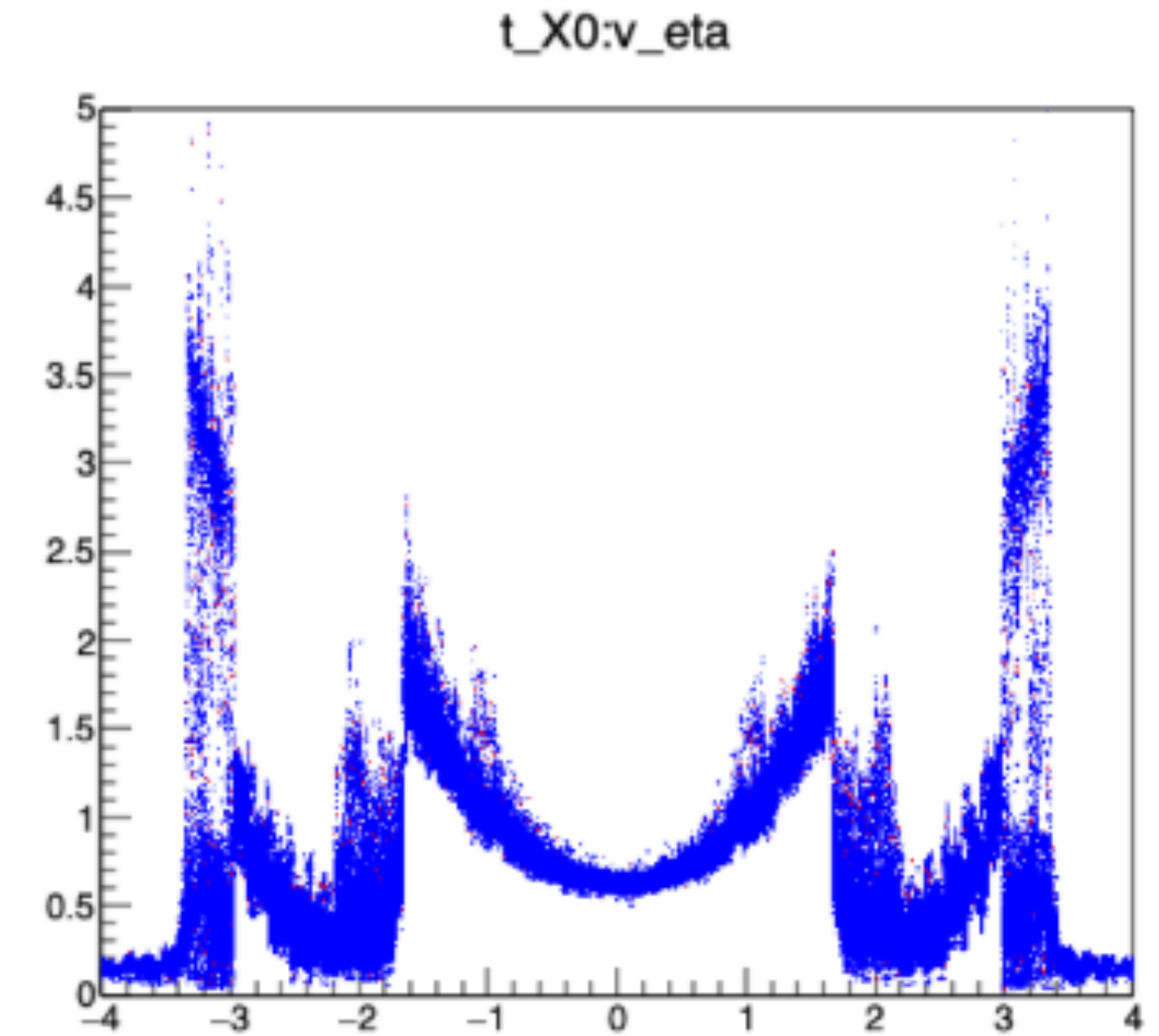
Event Data model

‣ MultiTrajectory with frontend/backend split

ACTS has an internal EDM optimised for track reconstruction.
- recent work to separate transient model from I/O backend
- demonstrator with PODIO established
- Non-optimised EDM4Hep version also available

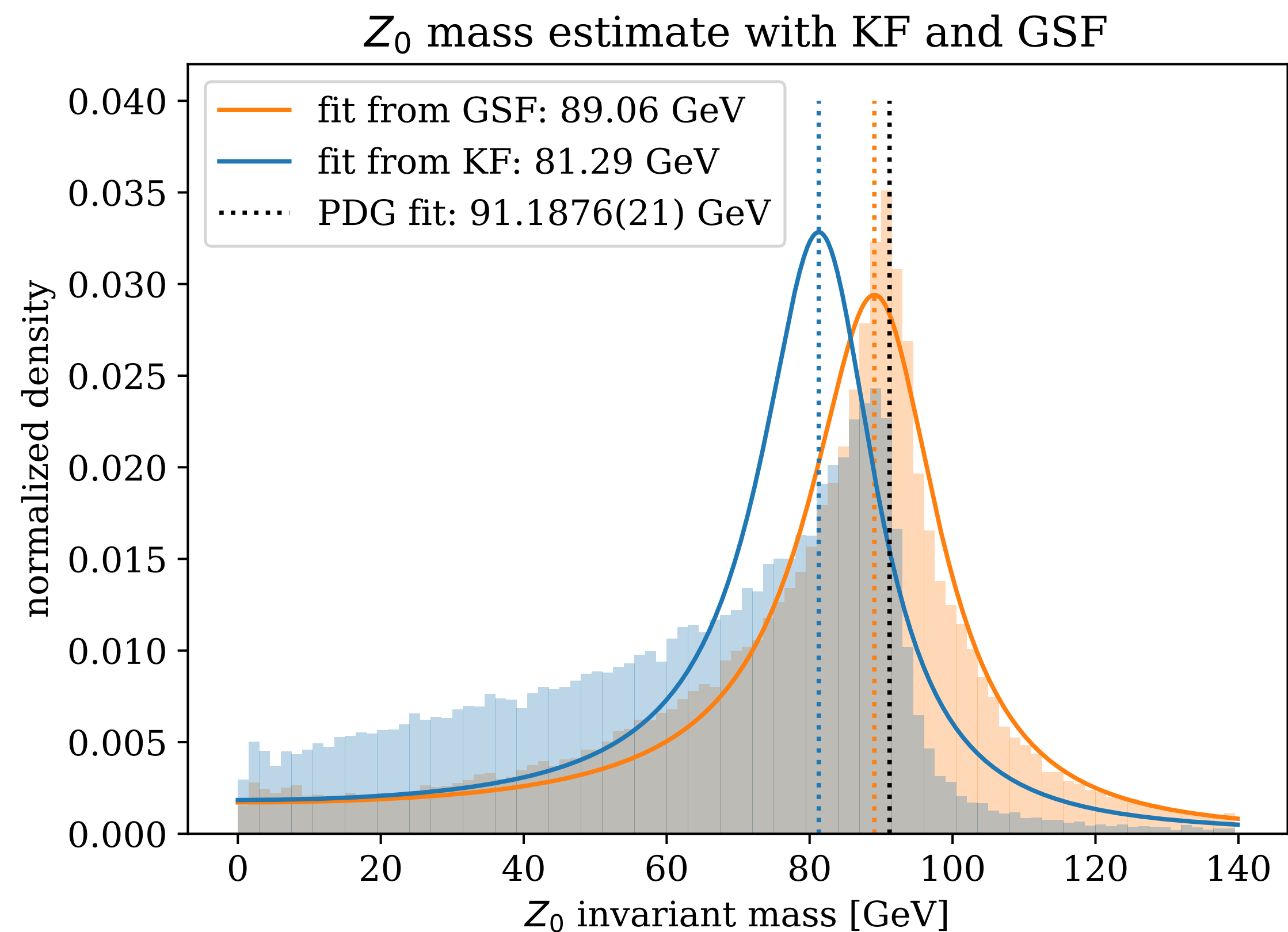[Paul Gessinger-Befurt, CHEP2023, Parallel talk]
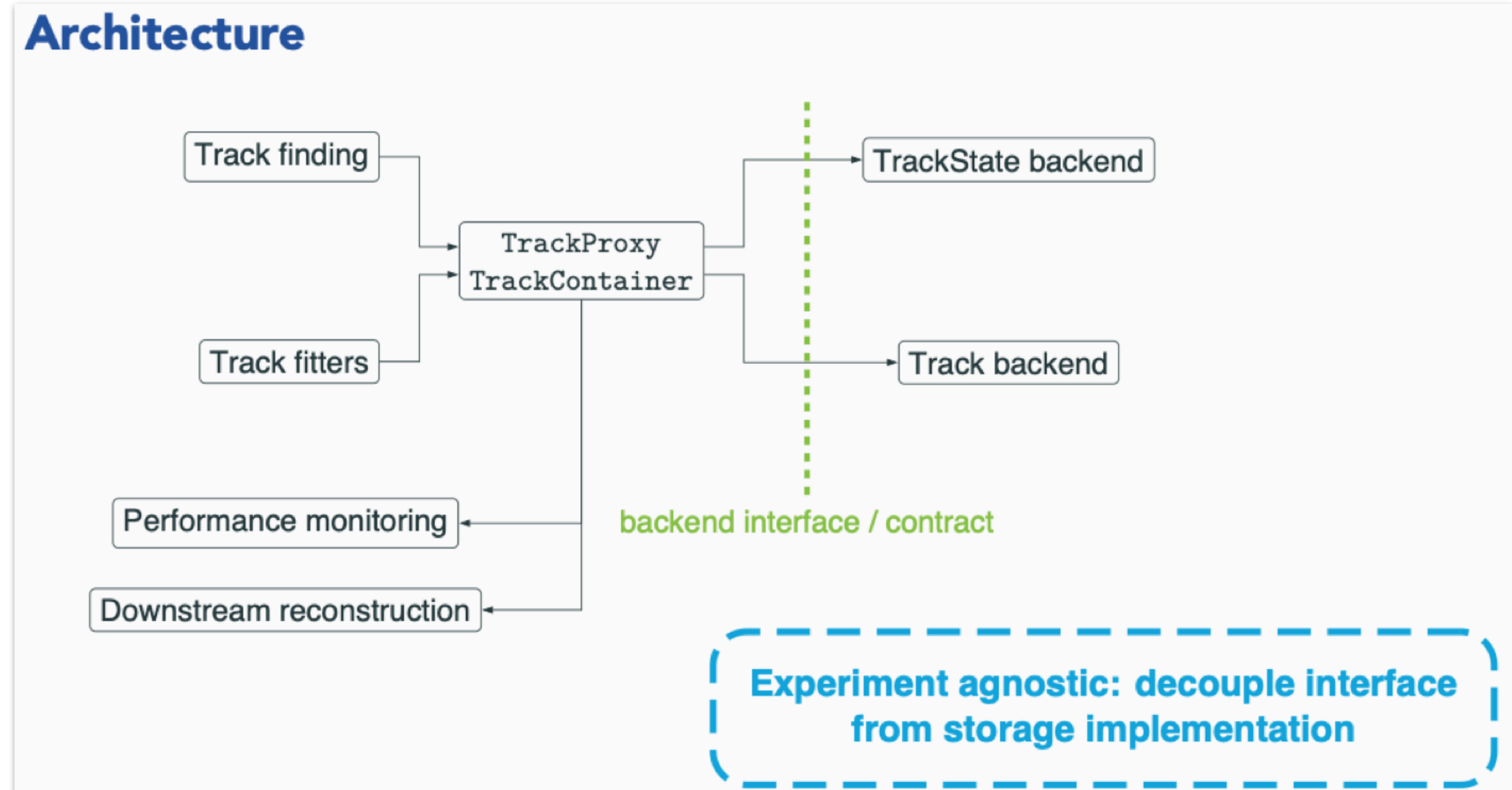
Fitters (1)

‣ Gaussian Sum Filter has been validated on Open Data Detector

- shows nice performance on Geant4 simulated results

- Is designed as a re-fitter, i.e. after electron pattern recognition

‣ Electron pattern recognition not yet implemented

- start with concept from ATLAS to enlarge window if electron hypothesis is triggered …

Z_0 mass estimate with KF and GSF

fit from GSF: 89.06 GeV
fit from KF: 81.29 GeV
PDG fit: 91.1876(21) GeV

normalized density

Z_0 invariant mass [GeV]

Fitters (2)

‣ Global chi2 fitter progress

  – First pipe-line on OpenDataDetector
    implemented

‣ Material effect integration not yet implemented

 – Exists in a python based prototype

All surfaces
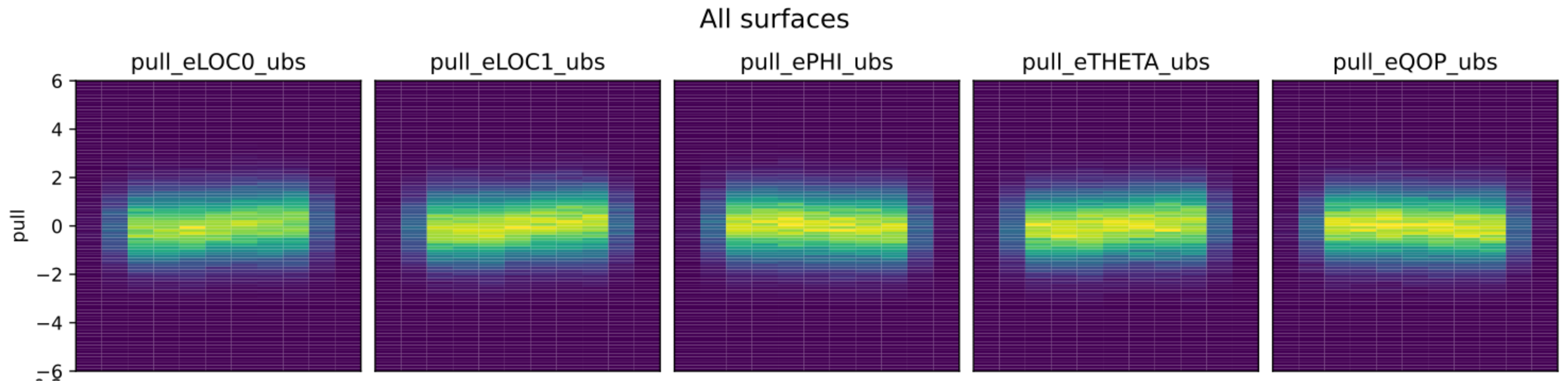
(C)KF refinements

‣ Speed performance optimisation

   – Work on a new stepper has started

‣ Combinatorial Kalman filter updates

   – Improved branch stopping logic introduced

   – Smoothing separated from forward filtering

   – New, alternative CKF with external propagator steering in development
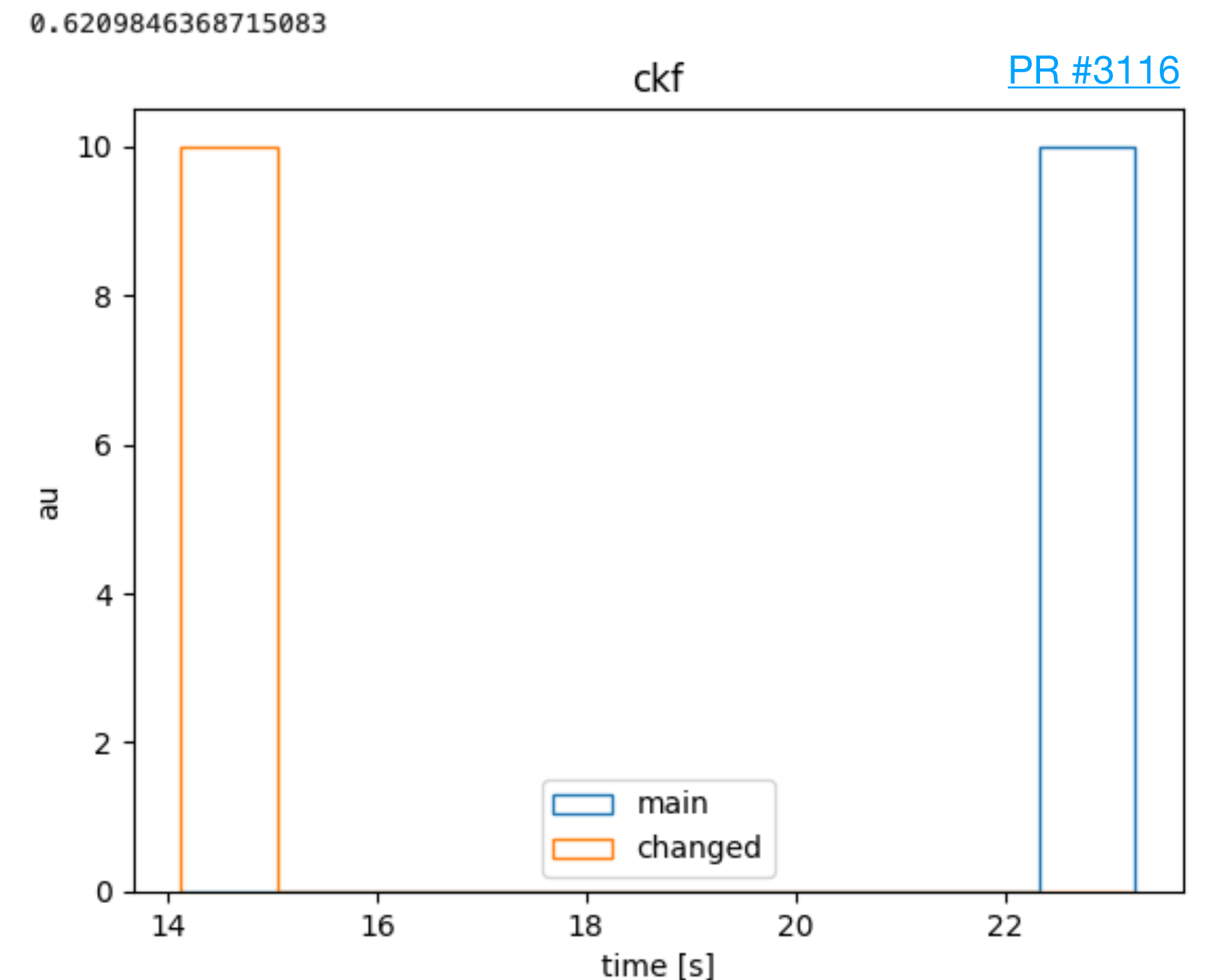
Vertex reconstruction: fully time-aware

‣ Introduction of time in all components of vertex reconstruction

   – full exercise on OpenDataDetector in progress
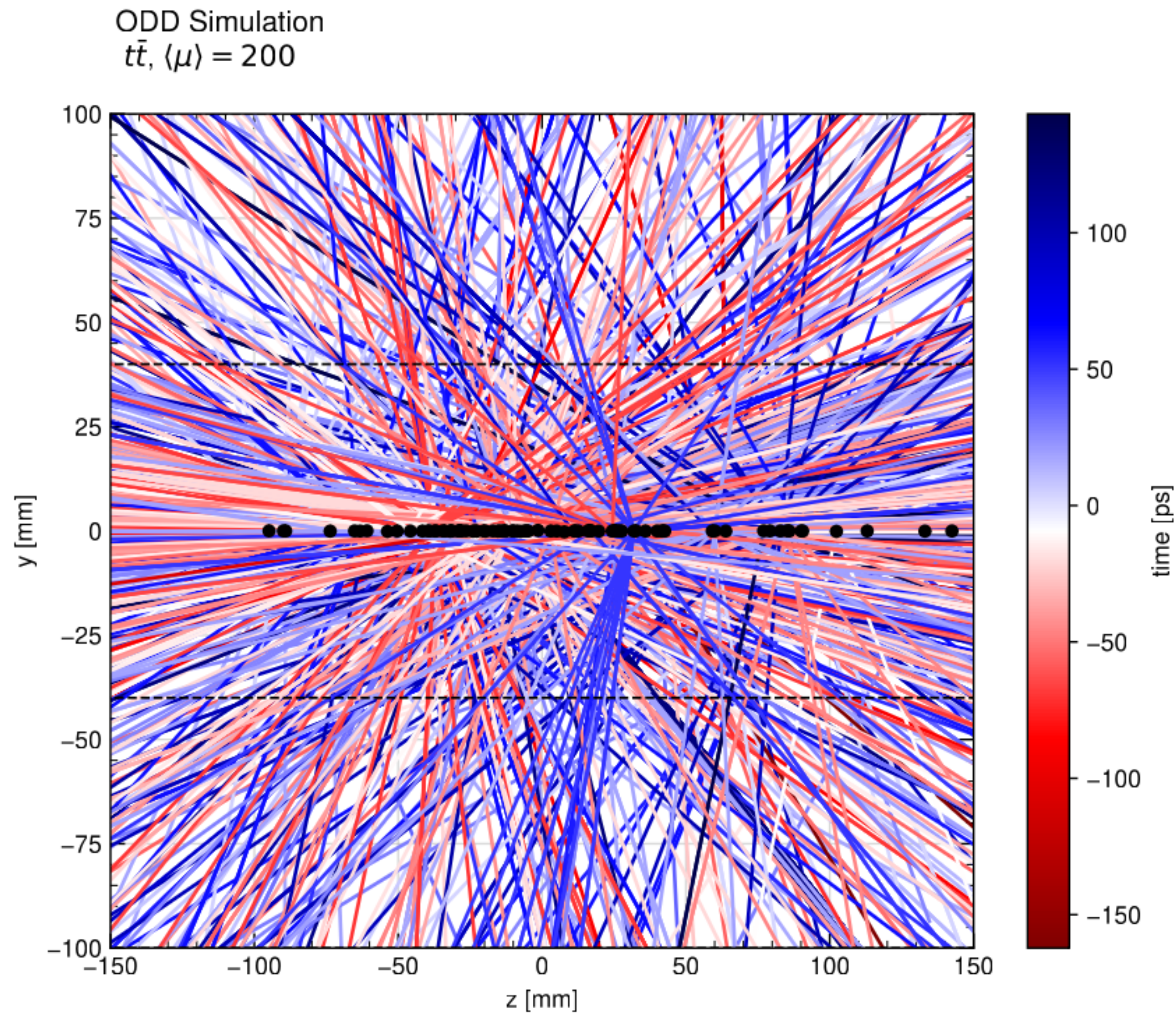
R&D line: parallelisation

‣ First chain runs on OpenDataDetector in stand-alone
  – Performance (physics/computing) evaluation to start

‣ Integration of 'traccc' suite as Plugins started
  – Aim is to be able to evoke a traccc reconstruction chain from ACTS
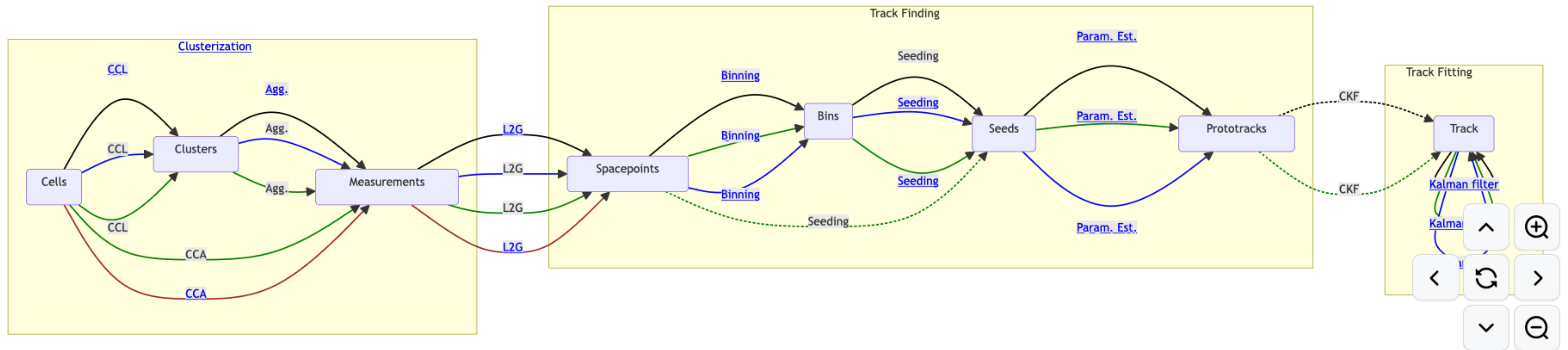
R&D line: machine learning

‣ NN based cluster position / calibration

  – NN based clusterization available