Towards Particle Flow Reconstruction in FCC Software

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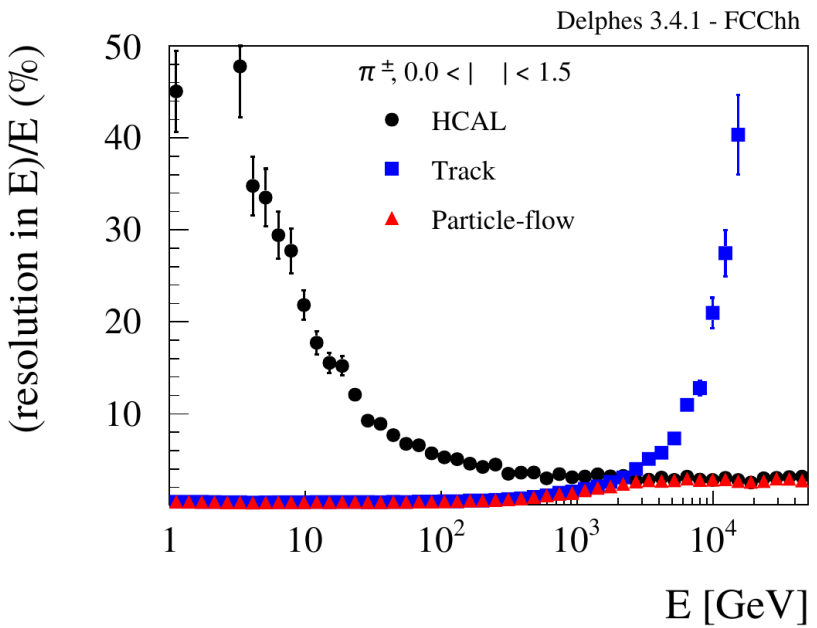
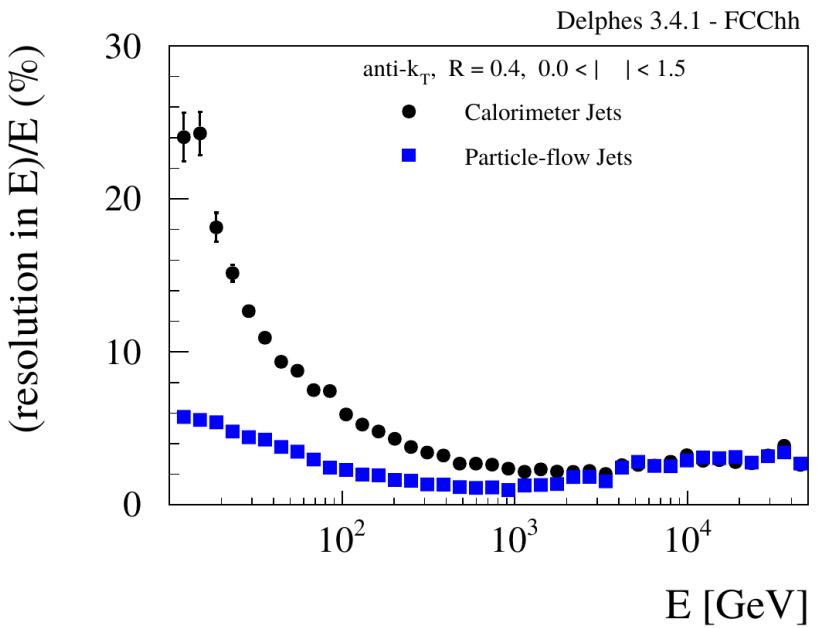
Introduction

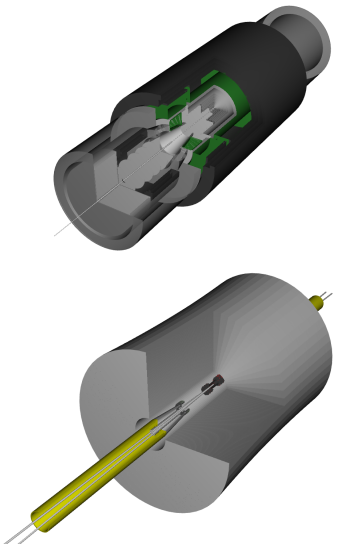
- Different requirements for
  - ee,
  - hh
  - and eh
- Validate FastSim assumptions
- Jet energy resolution
- Evaluate existing packages (**Pandora**)





The Foundation

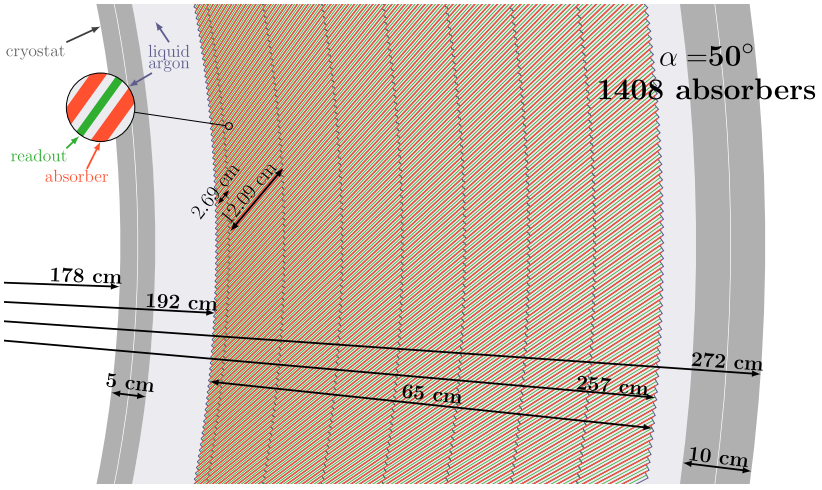
- Common Detector Description



- Common Datamodel:

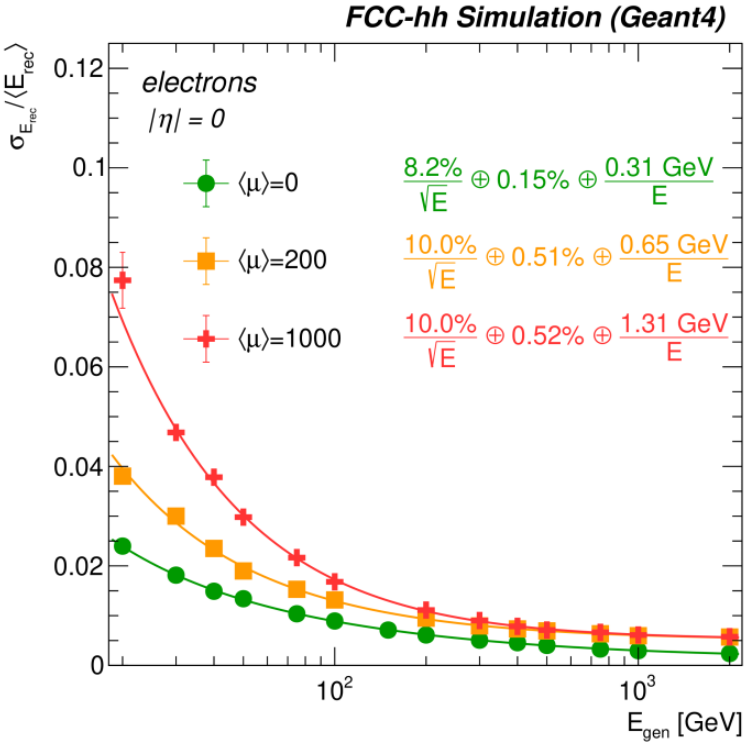
```
fcc::Track:
  Members:
    - float chi2 // from track fit
    - unsigned ndf //
    - unsigned bits // stores flags
  OneToManyRelations :
    - fcc::PositionedTrackHit hits
    - fcc::TrackState states
```

Calorimeter Reconstruction

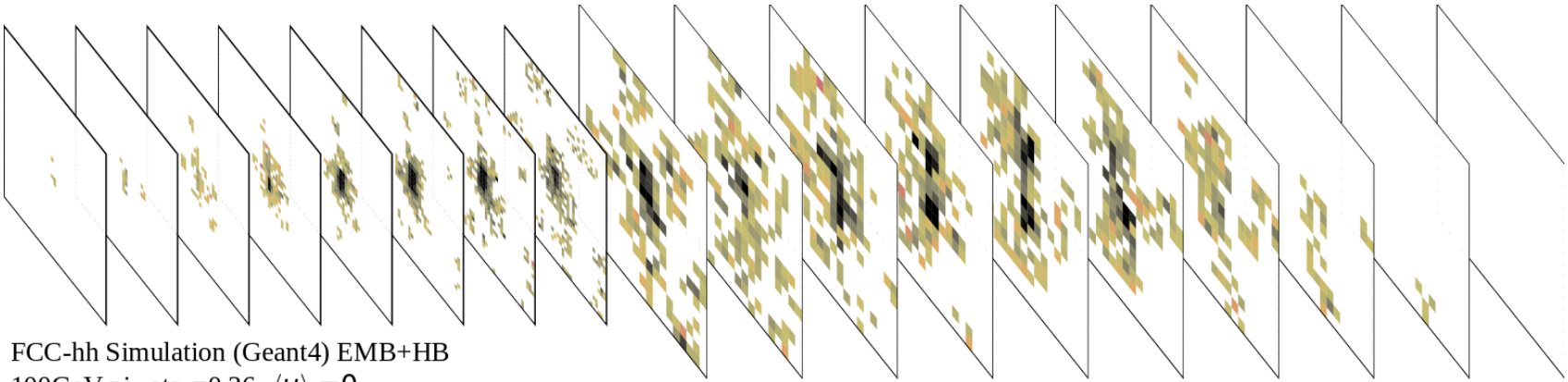


- Example: ATLAS-inspired LAr ECal for FCC-hh
  - also under consideration for FCC-ee

- Reconstruction code in FCCSW:
  - Sliding Window
  - Topo-Clusters
  - Noise / Pileup



Calorimeter Reconstruction – TopoClustering

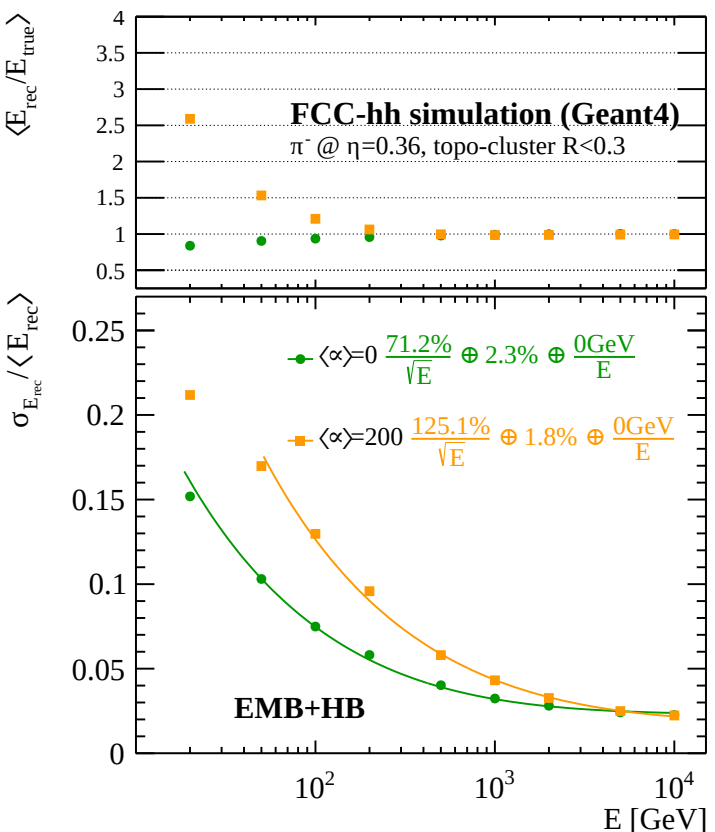


Performance on single pions:

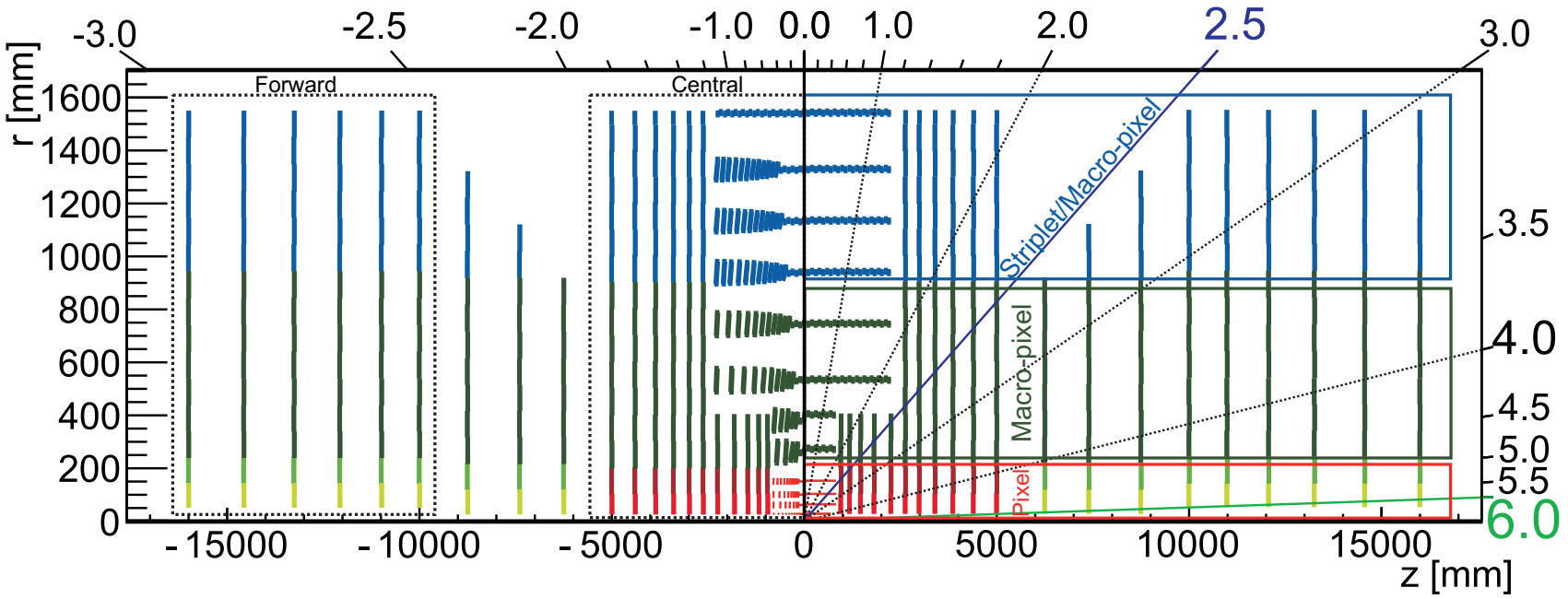
- Suppression of electronics noise

  → visible in **o** noise contribution in resolution fit
- Not sufficient for pile-up rejection

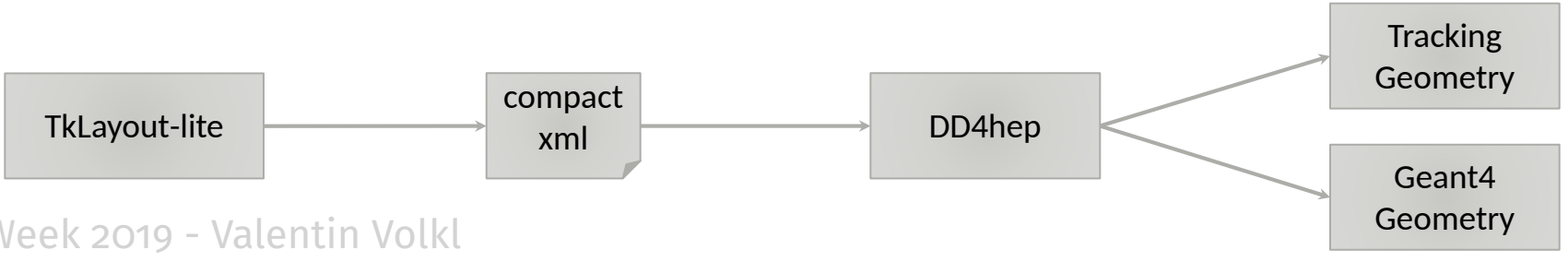
C. Neubuser



tKLayout

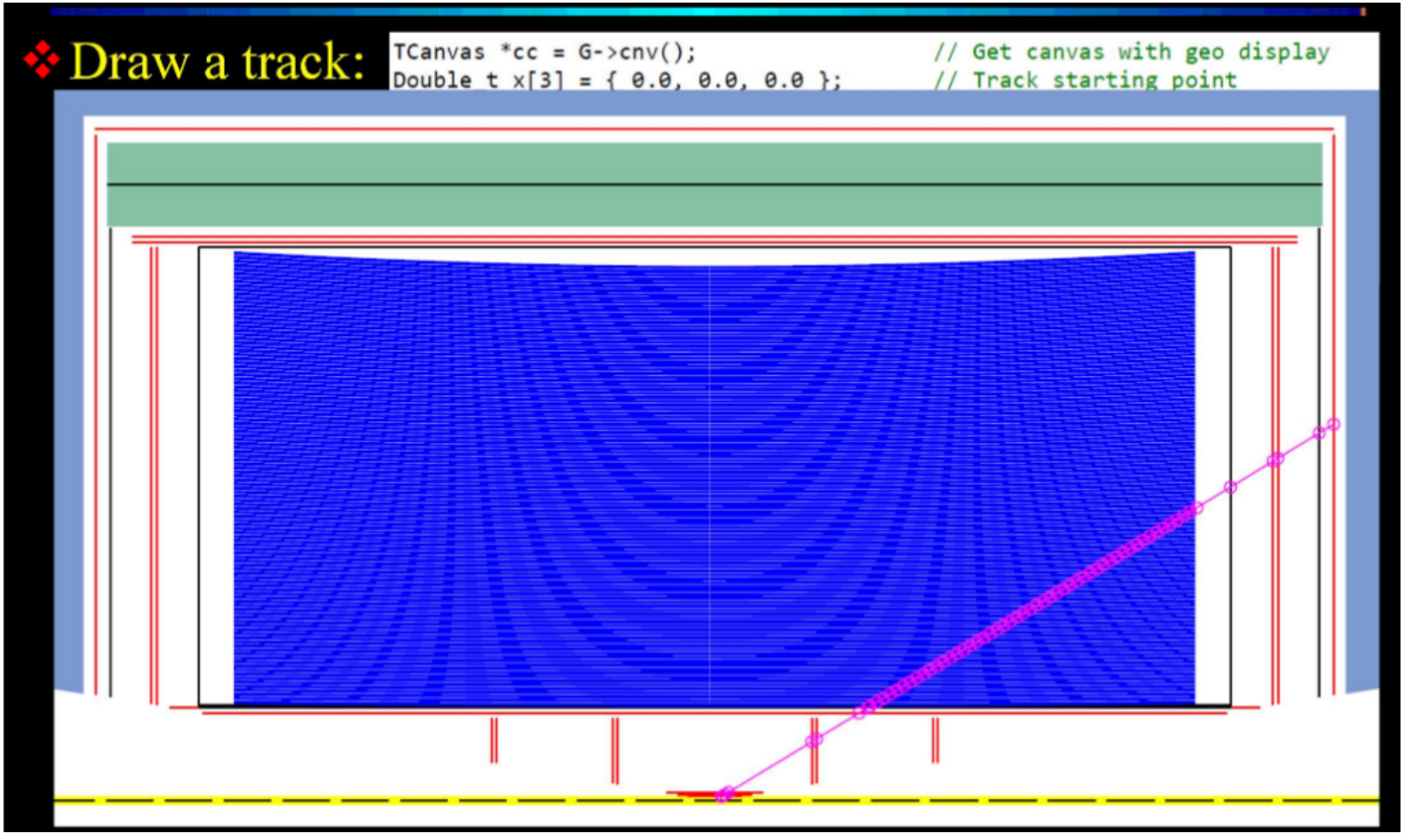


1. Used to study silicon detector layout for FCC-hh
2. `fcc-tkLayout` includes track analysis code and geometry export to DD4hep



TrackSim

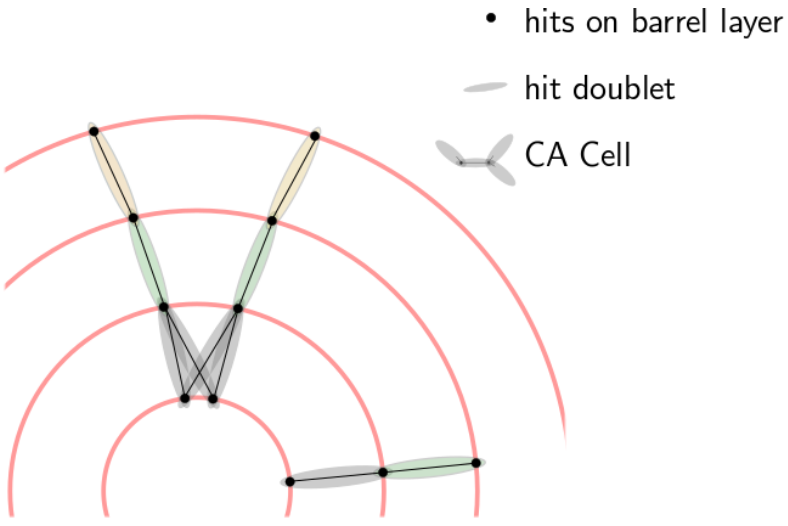
F. Bedeschi : Root Macro for fast tracking sim in ee

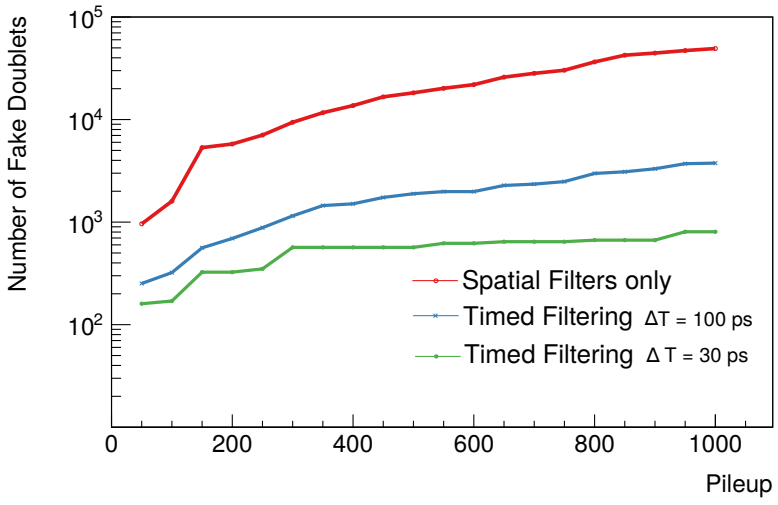


https://www.pi.infn.it/~bedeschi/RD_FA/Software

Track Seeding

`TrickTrack` is a standalone library with cellular-automaton code from CMSSW.



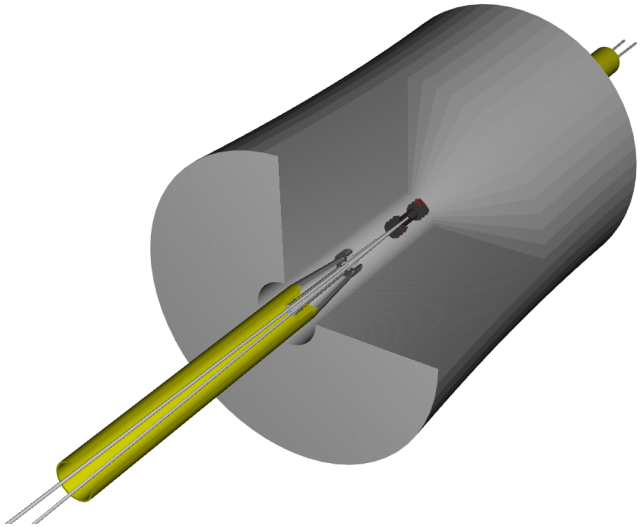


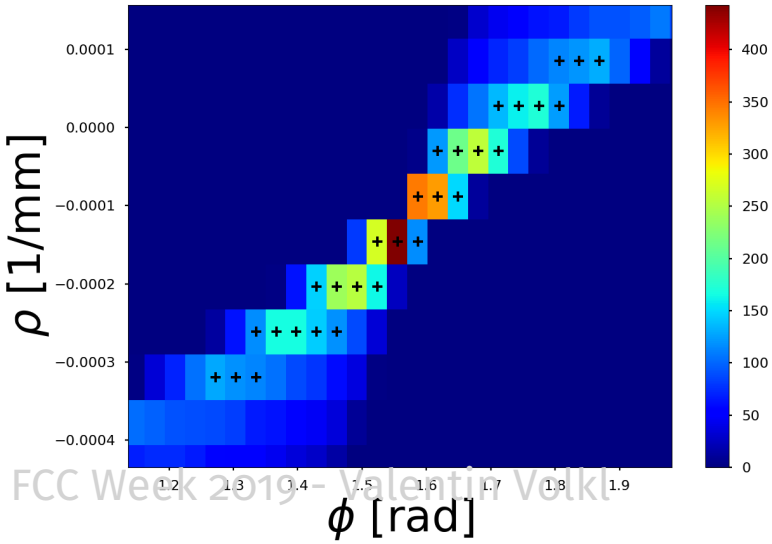
- Used in particular for studies of timed tracking in FCC-hh
- Now hosted by the HEP-Software foundation

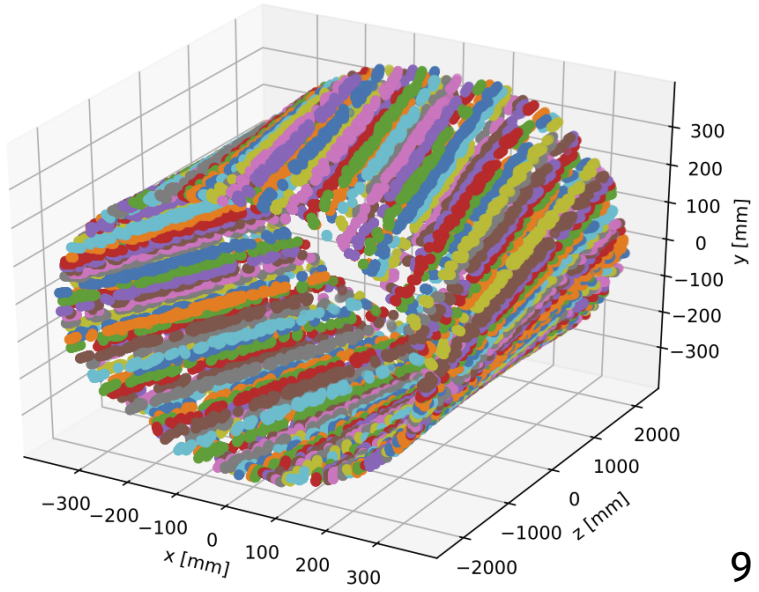
Drift Chamber Reconstruction

Drift Chamber within the `IDEA` detector concept for FCC-ee. In FCCSW:

- Hit reco on each wire
- Hough transform for tracking
  - python implementation in FCC software
  - iLCSoft `ConformalTracking` package to be used in the future

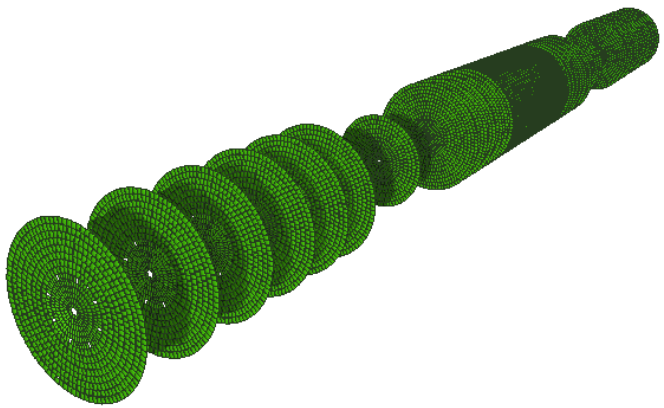


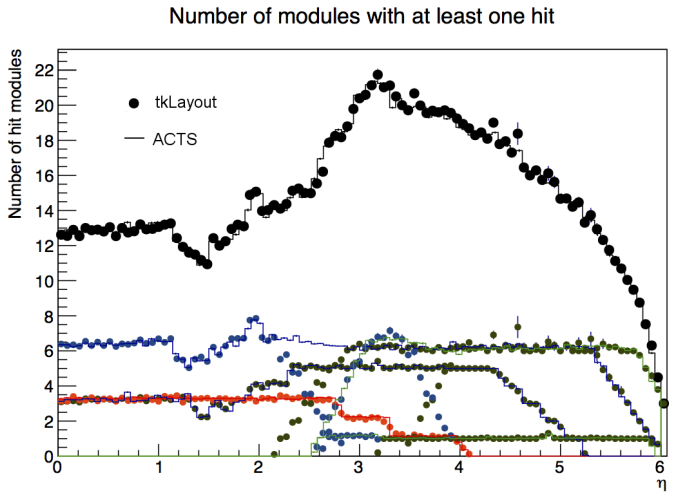




Common Tracking Software - ACTS

- ACTS is integrated in FCC software and was used for building tracking geometry, digitisation, and track extrapolation for FCC-hh





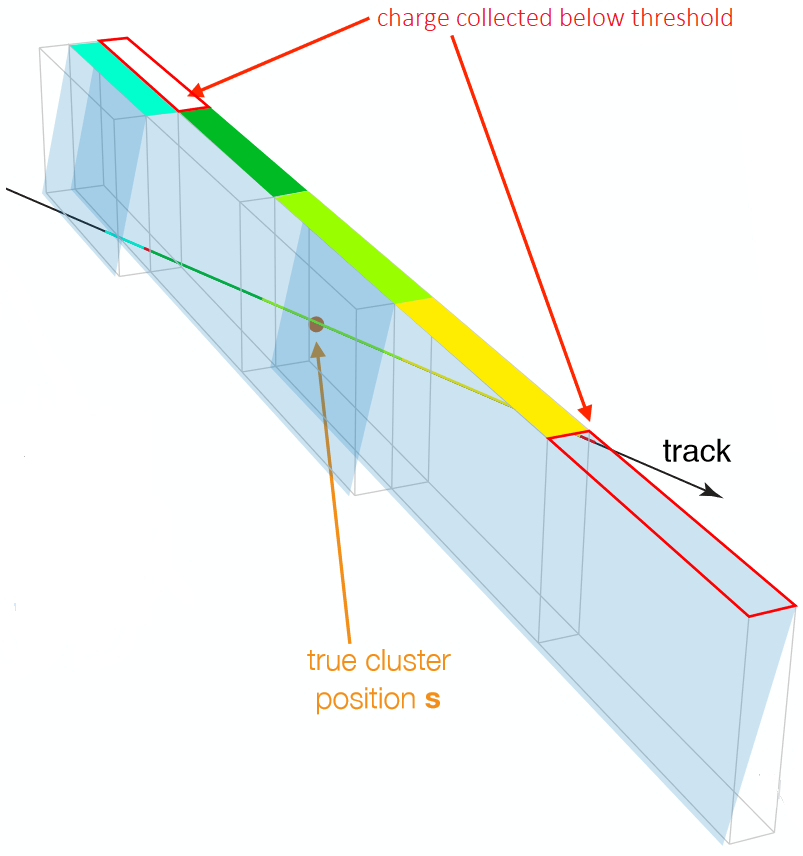
Following future developments closely

Digitization in FCCSW using ACTS

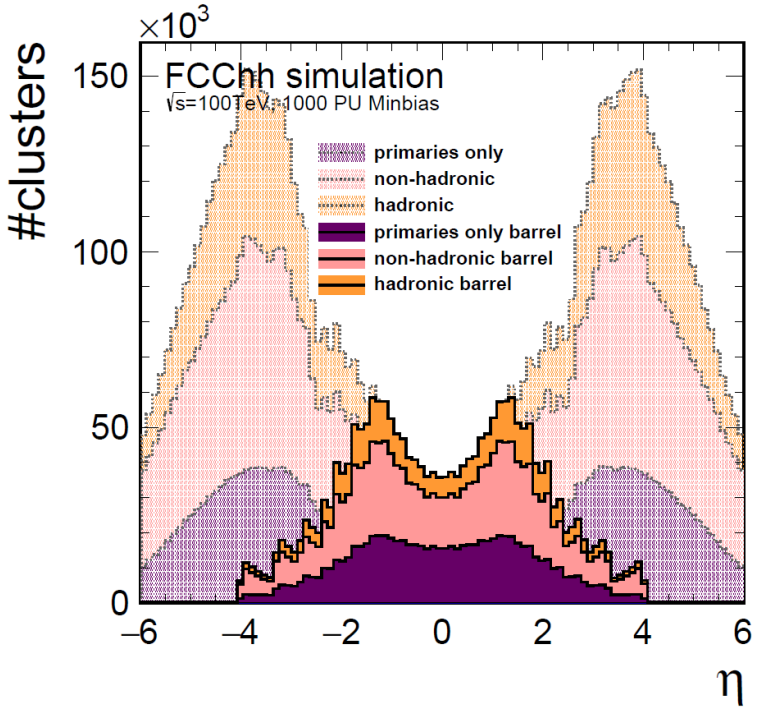
Translate Hit into Measurement

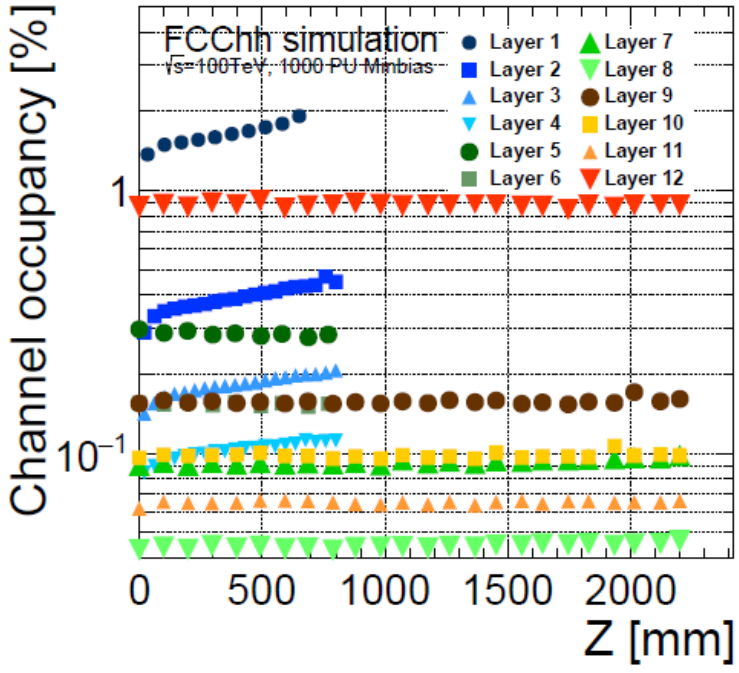
- Currently purely geometric
  (technologies not known yet)
- Followed by clustering

J. Hrdinka



Digitization – FCC-hh performance





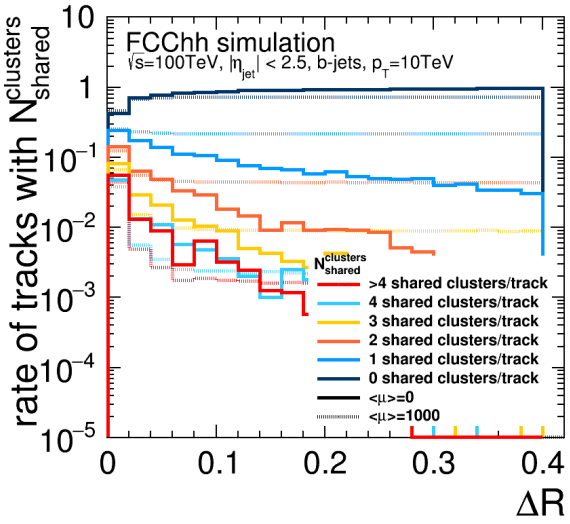
Allows tracker performance studies @ $< \mu >= 1000$

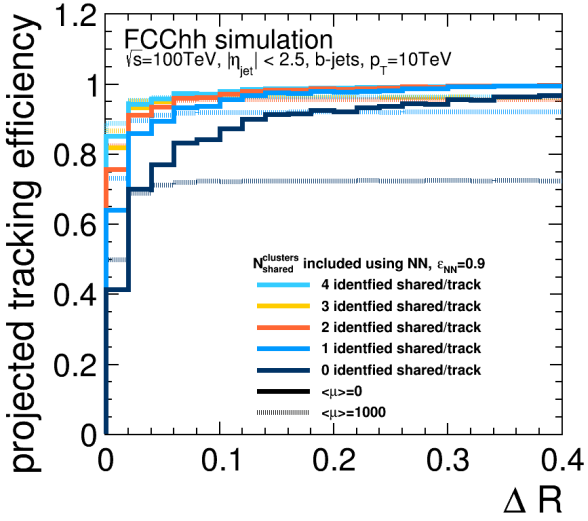
- In total 9-10M clusters
- ~30M activated pixels
- 2-3 PB/s @ first trigger level (assuming binary Readout, 40 MHz event rate)

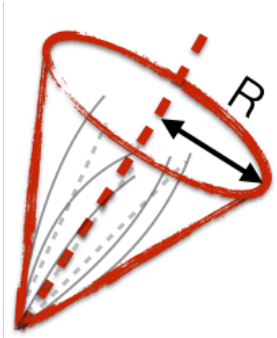
FCC-hh: Jet Reconstruction (FastJet 3.3) Studies

Tracker:

Rate of shared clusters along a track as a function of the distance from the Jet axis

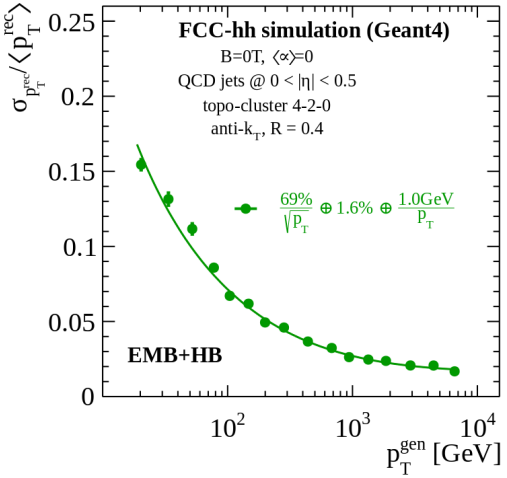




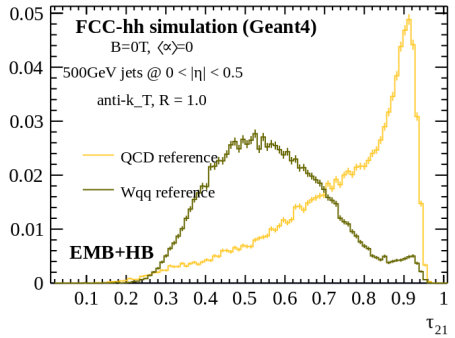


- Close by tracks produce single (thus shared) clusters
- Decreased tracking efficiency in jet core
- DNN needed for shared cluster id
- Otherwise 40% efficiency at jet core

Calorimeters:



Jet energy resolution of the barrel calorimeters standalone



Jet-substructure studies for collimated high pT jets started … see talk by C. Neubuser

Next Steps: Calo - Tracker matching

- uniformise the tracking
- validate the calorimeter implementations and reconstructions
- start with simple matching studies of single particles
- define benchmarks for assessing the performances
- single photon pi0 rejection
- particle identification
- define a common platform to compare the performances of different detector implementations

Conclusions

- Reconstruction code in FCCSW has been driven by studies for the Conceptual Design report
- Particle Flow essential to achieve performance targets in many detector scenarios
- No small task, collaborations essential