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U.S. DEPARTMENT OF ENERGY
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ePIC/ACTS Integration

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ePIC Collaboration Meeting
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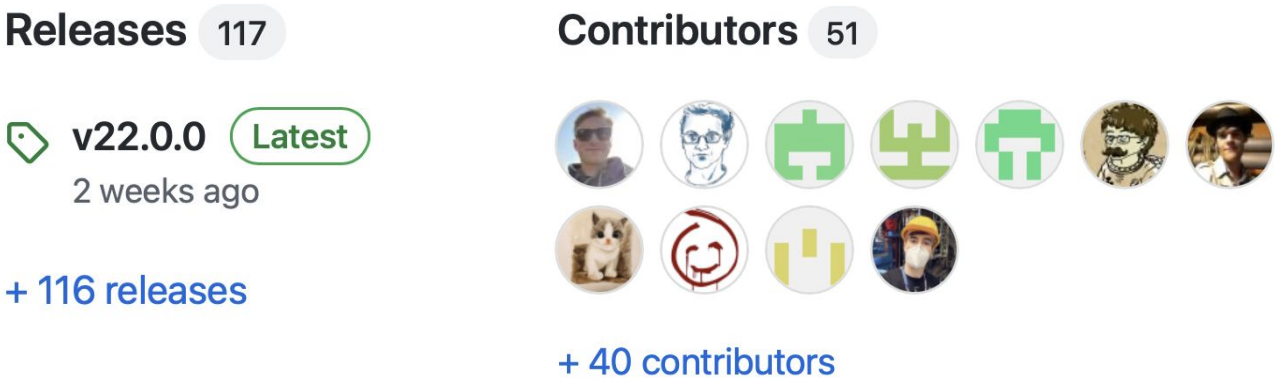
arXiv:1910.03128

A Common Tracking Software

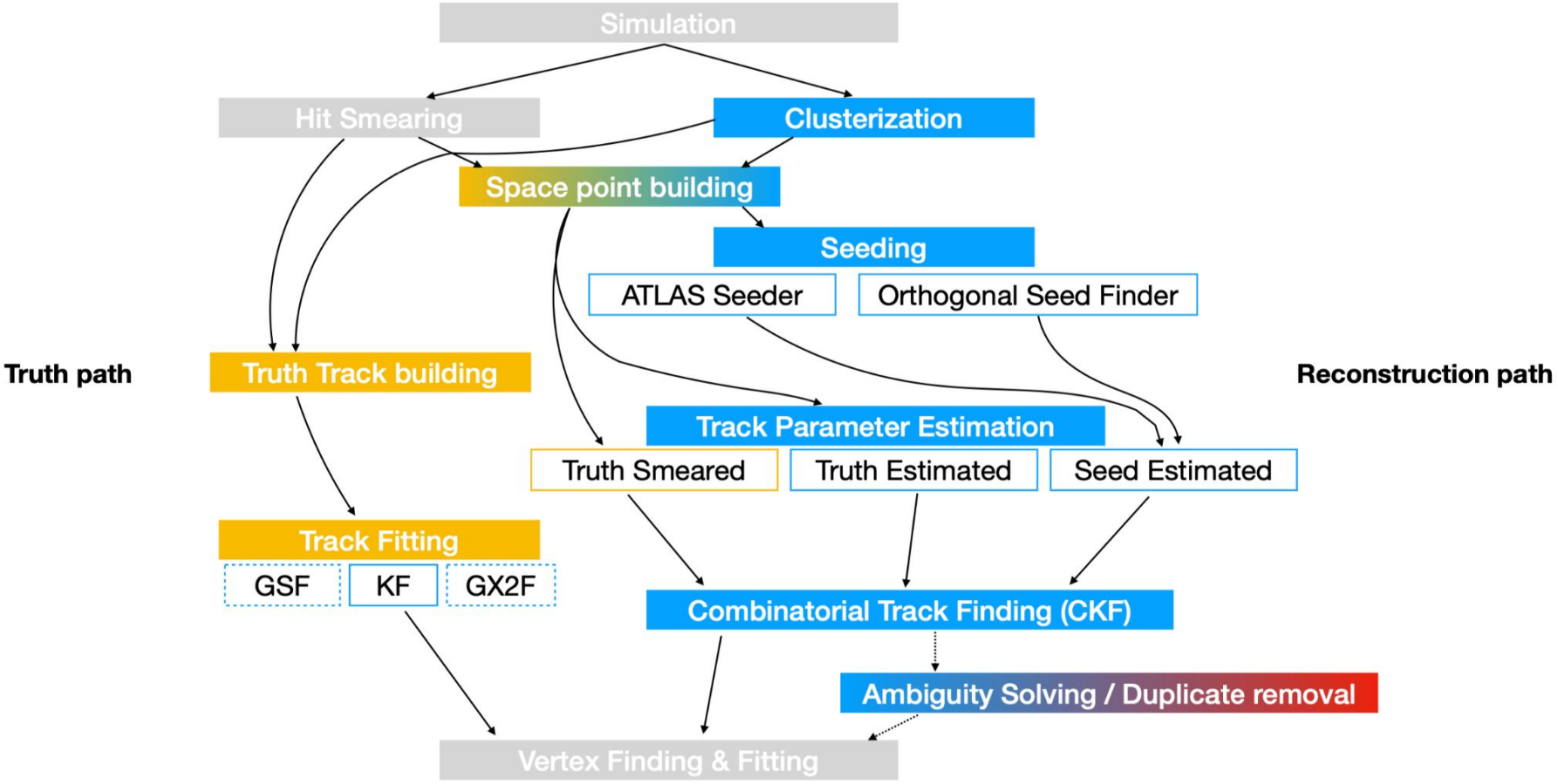
- A C++ library that contains components for assembling a (charged) particle track reconstruction suite for High Energy Physics and Nuclear Physics.
- Initiated in 2016 for ATLAS, now widely used in HEP and NP including sPHENIX, ALICE3, FASER, ePIC …

https://github.com/acts-project/acts



ACTS: Core Functionality

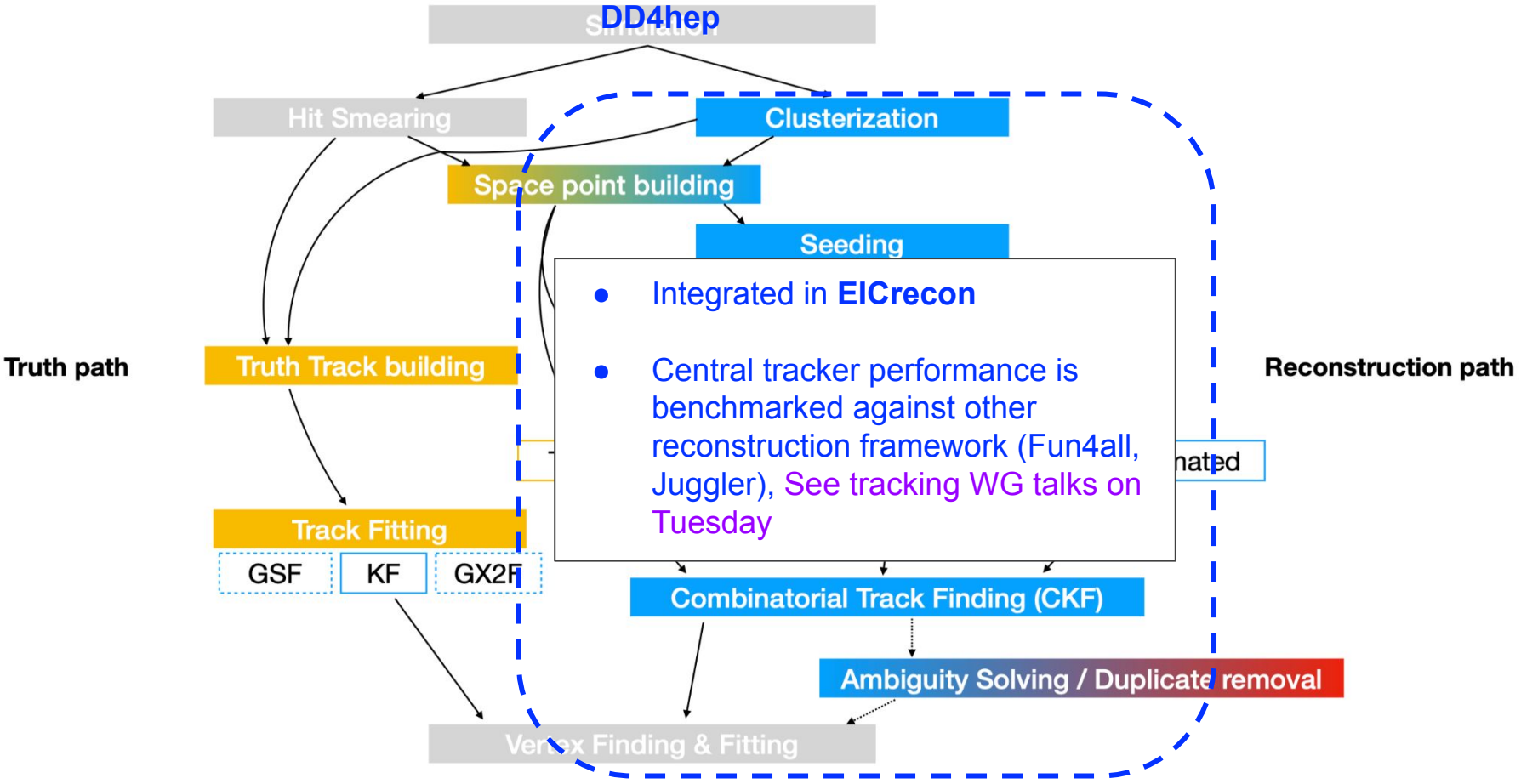
https://acts.readthedocs.io/en/latest/index.html



courtesy of A. Salzburger

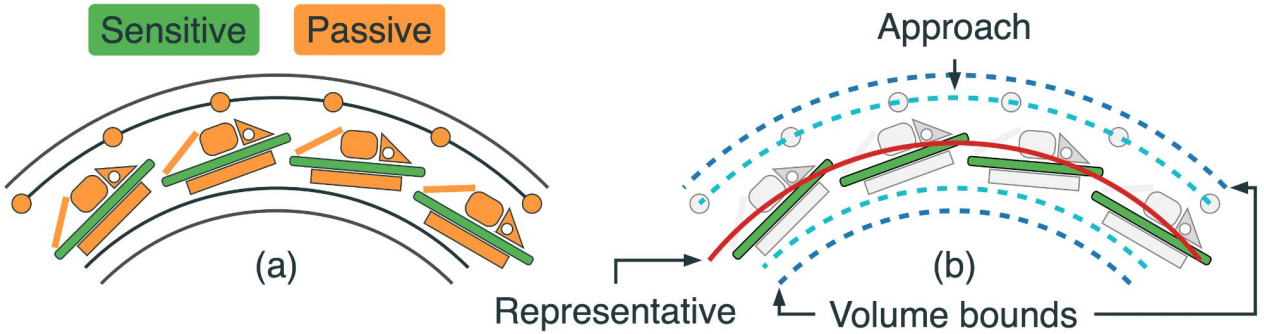
ACTS for ePIC

https://github.com/eic/EICrecon



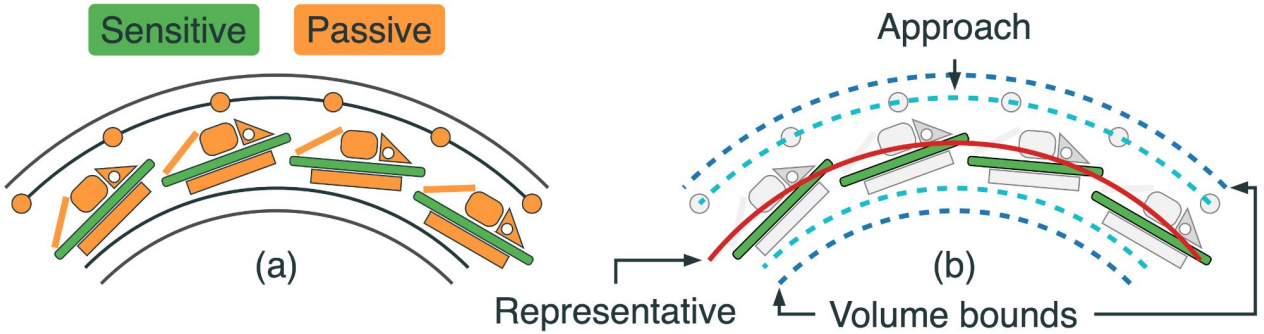
courtesy of A. Salzburger

Geometry and Material Modelling



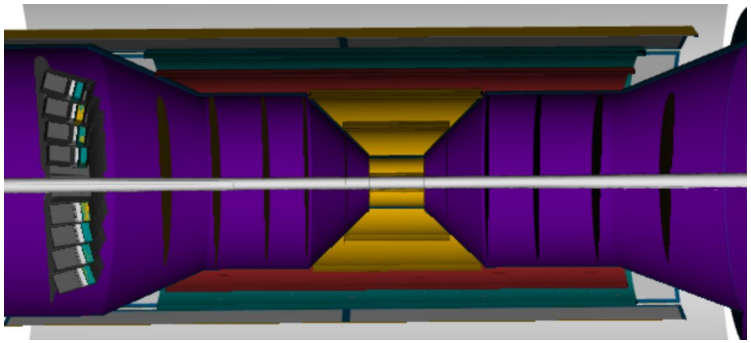
Detector **volumes** are reduced to representing **surfaces** with projected material length to speed up track reconstruction. (<1 sec per track)

Geometry and Material Modelling

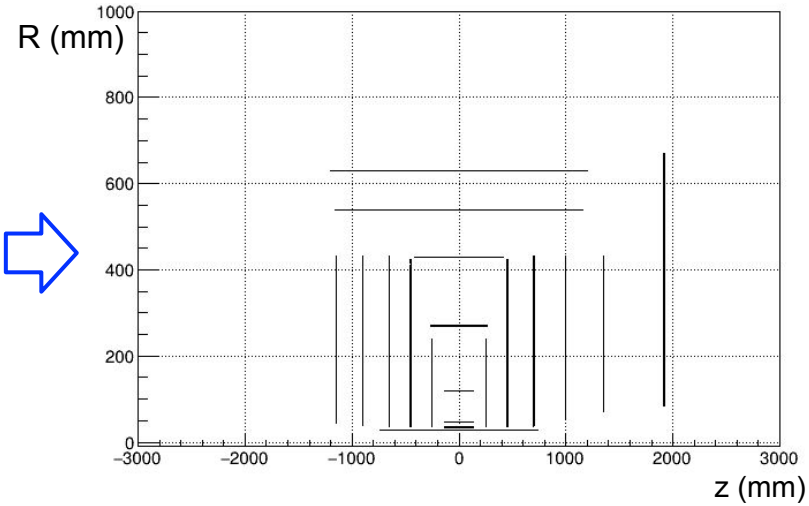


Detector **volumes** are reduced to representing **surfaces** with projected material length to speed up track reconstruction. (<1 sec per track)

Central Tracker Volume in DD4hep



ACTS Surfaces with Material Mapping

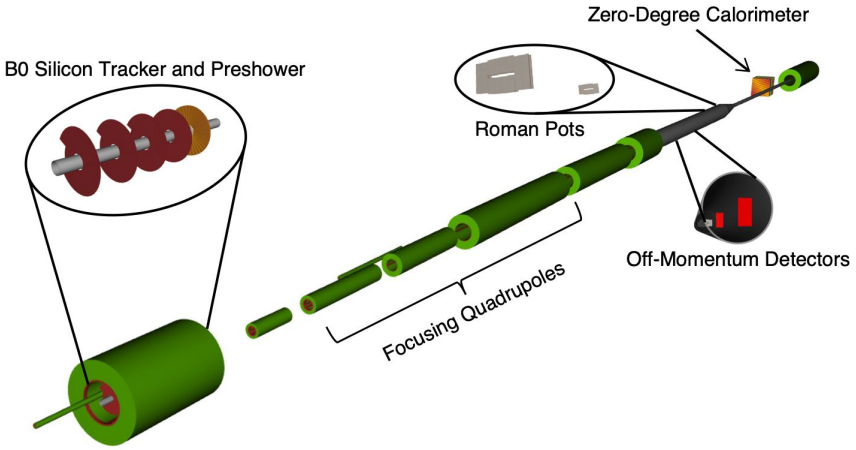


Geometry descriptions need to be supported by ACTS/DD4hep plugins

Geometry and Material Modelling

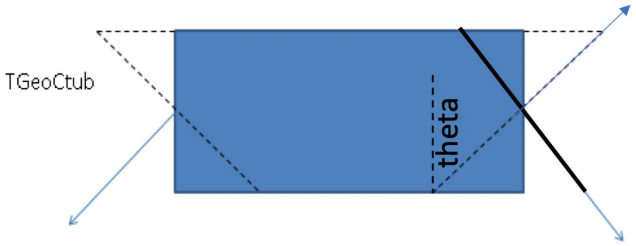
In-progress: far-forward tracking (see S. Rahman's talk)

- Prepare plugins for silicon disks inside the B0 magnet in the hadron (forward) direction

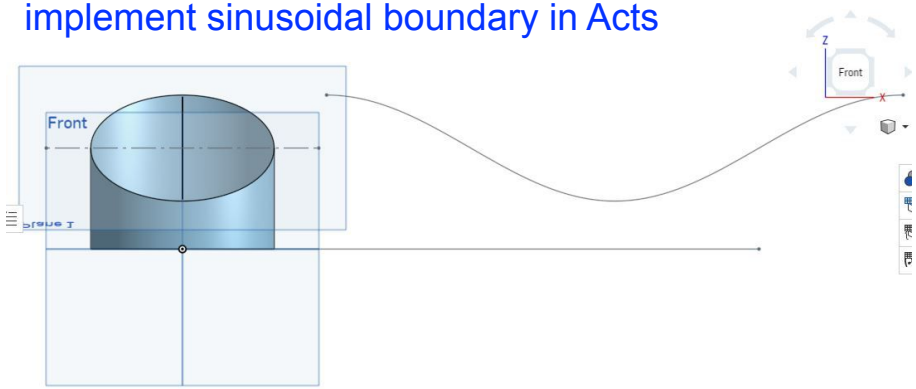


- Add new boundary description to ACTS for non-trivial cut cylinders to describe the electron beampipe (off-axis at an angle).

prepare TGeo plugin for cut cylinder



implement sinusoidal boundary in Acts



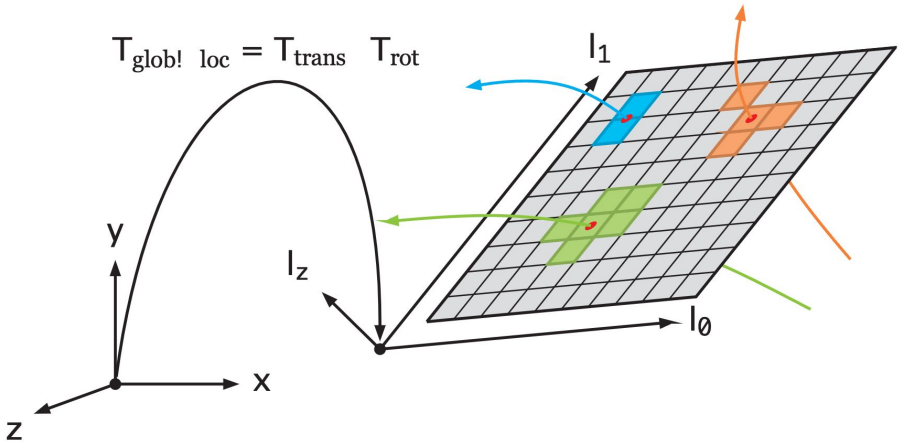
Track Reconstruction

Space point formation

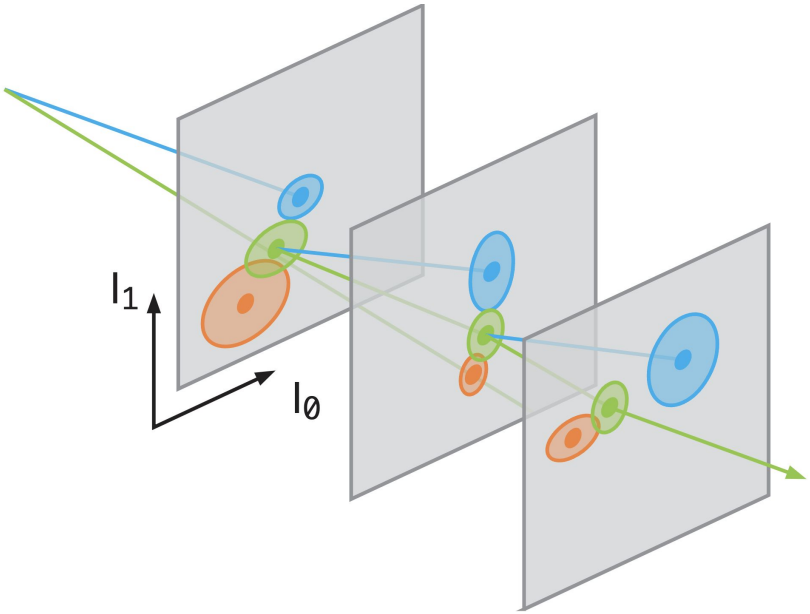
Raw hits from DD4hep

→ digitization/clusterization

→ global/local coordinates transformation



Track finding/fitting



- **Combinatorial Kalman Filter (CKF)**
  - combine track finding and fitting
  - allows track branching
    - → user-defined measurement selector (number, chi2)
  - high efficiency

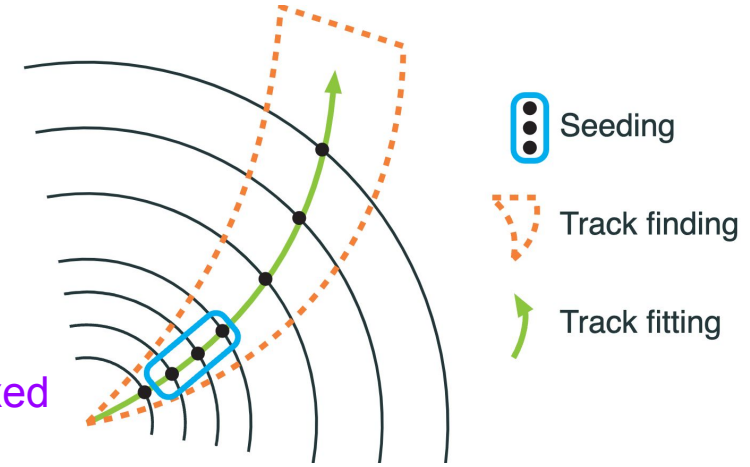
Track Reconstruction

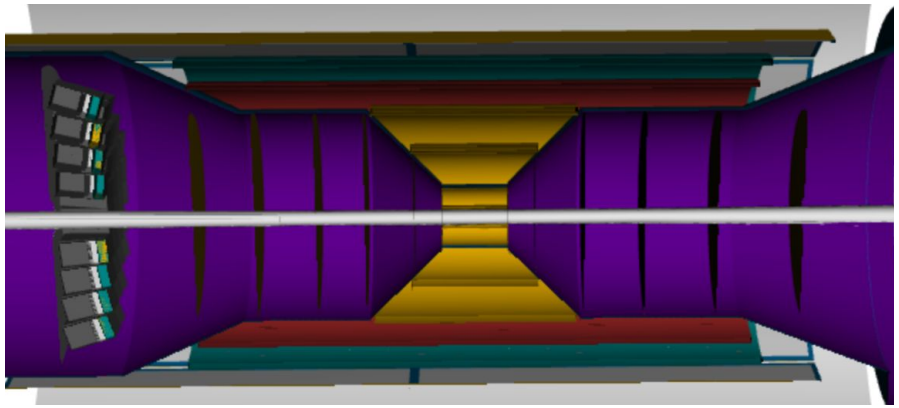
In-progress: seeding/pattern recognition

(work of Y.S. Lai, J. Osborn, W. Fan, R. Cruz-Torres, B. Liang-Gilman) ← see Tuesday talks

To provide the initial guess for track finding (kalman filter):

- use **truth** track information from simulation (clearly cheating) benchmarked
- find a set of three space points to estimate initial track parameters (**pattern recognition**)
  - Binned seeder: loop over φ-z binning to try all combinations. Slow at large η tested and bugs fixed





  - Orthogonal seed finder: can efficiently search for space points within a given range. under development

Seeding algorithm development

Stand-alone test

↓

port to EICrecon

↓

performance study

ePIC-ACTS Taskforce

Collaboration between Software, Simulation, and Tracking WGs:

- U. of Manitoba: Sakib Rahman (Far-forward tracking), Wouter Deconinck
- LBL: Wenqing Fan (tracking performance), Rey Cruz-Torres (background study), Beatrice Liang-Gilman (tracking performance), SL, YueShi Lai (realistic seeding)
- ANL: Sylvester Joosten, Whitney Armstrong
- BNL: Joe Osborn (realistic seeding)
- INFN and University Bari, Italy: Shyam Kumar (EICrecon)
- JLab: Dmitry Romanov (EICrecon)
- and many others…

Weekly discussion with ACTS experts (Andreas Salzburger, Corentin Allaire, Xiaocong Ai, Paul Gessinger, etc)

maillist: https://lists.bnl.gov/mailman/listinfo/eic-projdet-trk-recon-l

indico: https://indico.bnl.gov/category/436/

EIC mattermost channel: track-recon

Summary

ACTS provides easy-to-use libraries for charged particle track reconstructions. The main structure has been integrated into the JANA2-based EICrecon framework. Customizations are needed for special geometry and seeding.

Tracking performance (see tracking WG talks) with truth info has been benchmarked. Tracking with realistic seeding is demonstrated to work but not optimized. A new orthogonal seed finder is under development.

We are thankful for the tremendous support provided by ACTS developers.

Looking forward, we plan to:

- continue the EIC-ACTS meeting, and work closely with ACTS developers on track reconstruction. Also study background noise, vertex reconstruction, trajectory projection and cluster matching.
- make sure ACTS works fully with JANA2
- follow the integration of ACTS tracking structure in EDM4hep
- explore SYCL and other multi-core/GPU parallelization strategies.

Thank You