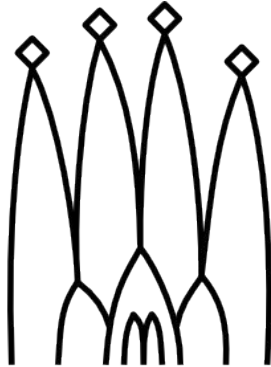


Tracking status in the DD4hep/Gaudi stack

Sylvester Joosten on behalf of CompSW and SimQA
Tracking WG meeting, June 2 2022

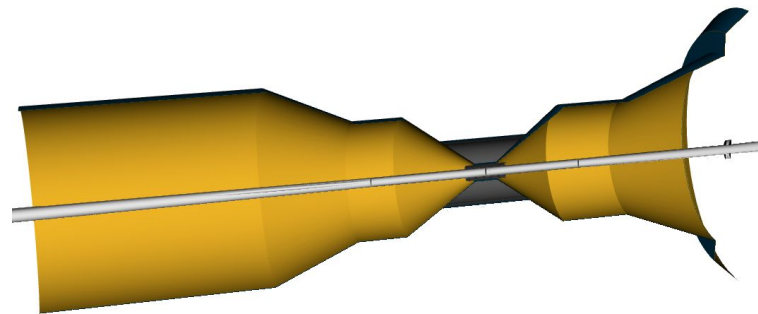
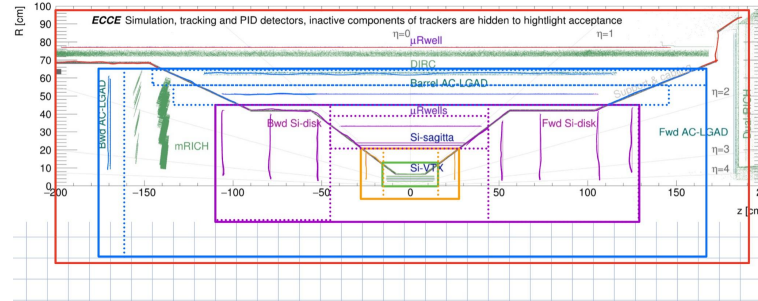


Geometry in DD4hep










- Reparameterized geometry implementation to make changing/swapping single components more straightforward for non-experts.
- Identified geometry subassembly structure for proper translation into ACTS
- Implemented main support structures
- Implemented ECCE vertex and sagitta layers
- Rest of main tracker should be ready by convener meeting tomorrow.
 - Material scan for reconstruction (Shujie)
 - [Automatic ACTS material map generation](#)
 - Implement other tracker variations as needed
- B0 tracker implemented, working with Acts developers to support off-axis geometry translation (Sakib)

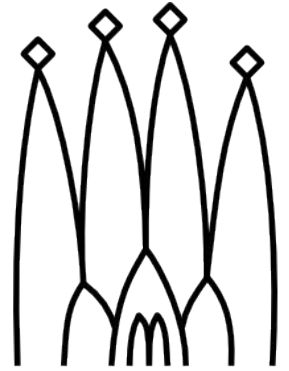
```
> ls tracker*
tracker_ecce.xml

tracker:
central_tracker_hybrid_v2.xml  support_ecce.xml
sagitta_its3_curved.xml      vertex_its3_3la
```





Reconstruction in Juggler/Gaudi

-  Truth seeded tracking: truth seeding followed by the Acts CKF algorithm
-  Simple vertexing and DCA using Acts
-  More realistic vertex finding (Wenqing and Yue-Shi)
-  Realistic track seeding (Yue-Shi), almost complete.
-  /  Arbitrary track projections
-  Realistic background merging during digitization step (no-one allocated, various models available in DD4hep)
-  Cross-validate tracker implementation against ECCE proposal
-  Store additional trajectory info for diagnostics, working with Acts and Podio teams on the data model.



Tracker data structures

-  Full-featured data structures for translation of ACTS results to the reconstruction data model
-  Migrate tracking structures upstream into EDM4hep

```
eicd::TrackerHit:
  Description: "Tracker hit (reconstructed from Raw)"
  Author: "W. Armstrong, S. Joosten"
  Members:
    - uint64_t      cellID           // The detector specific (geometrical) cell id.
    - eicd::Vector3f position        // Hit (cell) position and time [mm, ns]
    - eicd::CovDiag3f positionError // Covariance Matrix
    - float        time             // Hit time
    - float        timeError        // Error on the time
    - float        edep             // Energy deposit in this hit [GeV]
    - float        edepError        // Error on the energy deposit [GeV]

eicd::Trajectory:
  Description: "Raw trajectory from the tracking algorithm"
  Author: "S. Joosten, S. Li"
  Members:
    - uint32_t      type             // 0 (does not have good track fit), 1 (has good track fit)
    - uint32_t      nStates          // Number of tracking steps
    - uint32_t      nMeasurements   // Number of hits used
    - uint32_t      nOutliers       // Number of hits not considered
    - uint32_t      nHoles          // Number of missing hits
    - float        chi2            // Total chi2
    - uint32_t      ndf             // Number of degrees of freedom
    - uint32_t      nSharedHits     // Number of shared hits with other trajectories
  VectorMembers:
    - float        measurementChi2 // Chi2 for each of the measurements
    - float        outlierChi2    // Chi2 for each of the outliers
  OneToOneRelations:
    - eicd::TrackParameters trackParameters // Associated track parameters, if any
  OneToManyRelations:
    - eicd::TrackerHit measurementHits // Measurement hits used in this trajectory
    - eicd::TrackerHit outlierHits    // Outlier hits not used in this trajectory
```

```
eicd::Track:
  Description: "Track information at the vertex"
  Author: "S. Joosten"
  Members:
    - int32_t      type             // Flag that defines the type of track
    - float        chi2            // Total chi2 (sum) of the track fit
    - int32_t      ndf             // Numbers of degrees of freedom of the track fit
    - eicd::Vector3f momentum     // Track 3-momentum at the vertex [GeV]
    - eicd::Cov3f  momentumError  // Covariance matrix on the momentum
    - float        time           // Track time at the vertex [ns]
    - float        timeError      // Error on the track vertex time
    - float        charge         // Particle charge
  OneToManyRelations:
    - eicd::TrackParameters parameters // Track fit parameters, the first entry (if present) is evaluated at the track head
    - eicd::TrackerHit trackerHits    // Hits that were used for this track
    - eicd::Track      tracks         // Tracks (segments) that have been combined to create this track

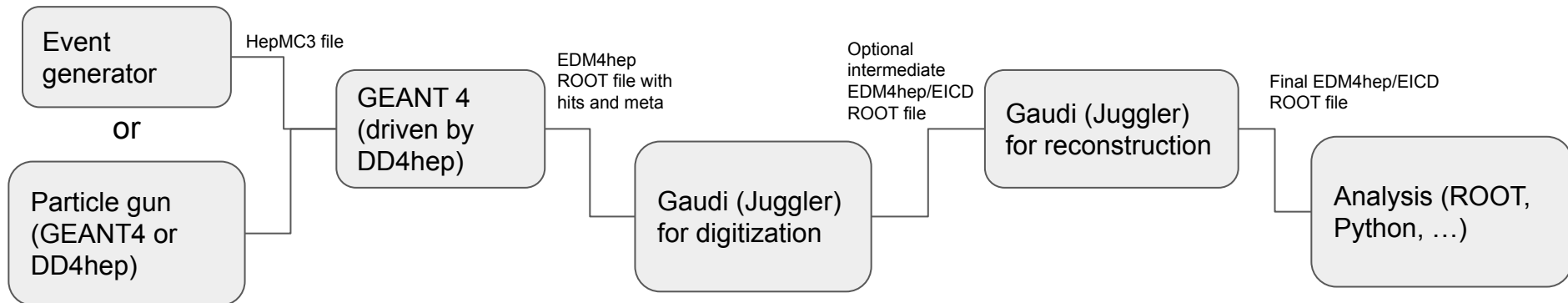
eicd::TrackSegment:
  Description: "A track segment defined by one or more points along a track."
  Author: "S. Joosten"
  Members:
    - float        length         // Pathlength from the first to the last point
    - float        lengthError    // Error on the segment length
  OneToOneRelations:
    - eicd::Track      track       // Track used for this projection
  VectorMembers:
    - eicd::TrackPoint points     // Points where the track parameters were evaluated
```

Minimal example of running just truth-seeded tracking (being updated for Project Detector geometry):

https://eicweb.phy.anl.gov/EIC/benchmarks/reconstruction_benchmarks/-/blob/master/benchmarks/tracking/options/track_reconstruction.py

Running the reconstruction

- [Tutorial 3](#) shows a simple example of running the Juggler algorithms (first start with the [QuickStart guide](#)). Can run everywhere (uses singularity on Linux, Docker on MacOS, and CVMFS where available).
- In a nutshell, Juggler is a set of Gaudi algorithms that are executed by the Gaudi framework. They include the digitization and reconstruction steps. The simulation itself is directly driven from DD4hep. A typical workflow would include running event generation, then simulation, then the digitization and reconstruction.



Joint CompSW & SimQA Office Hours

- **DD4hep-based software stack:**
Monday, Friday 2pm EDT
Wednesday alternating 2pm and 8pm EDT
- **Fun4all-based software stack:**
Tuesday alternating 3pm and 8pm EDT

Links distributed to through indico.



Summary

- 🚧 Initial geometry implementation tentatively ready this week
- 🚧 Integration of far-forward tracking making progress
- 🚧 Good progress on more advanced topics, such as realistic seeding
- ❌ Need WG support to help validate the tracker implementation, and to implement new detector setups
- ✅ Use office-hours for real-time help, or Mattermost outside of the office hours!
- ✅ Will restart weekly tracking meeting with ACTS developers (organized by Shujie), currently Mondays at 10:30am EDT. Expect we will re-optimize this time slot, and add meeting to Indico.

