Track Reconstruction
Status and challenges

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On behalf of

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Status of the software

Track reconstruction is based on the Combinatorial Kalman Filter.
Reconstruction with conformal transformations must be improved.

The implementation of the seeding and CKF algorithms is contained into ACTS
The version officially supported for the production is 32.1

Track reconstruction consists on a cascade of processors for:

- Seeding, track finding/fitting and duplication removal from ACTSTracking collection
- Track acceptance filters (regional, double layer, etc.)

All processors have been developed on Marlin framework and LCIO data model
With the key4HEP wrapper all the processors can be used in a Gaudi pipeline

```
CKFTracking = MarlinProcessorWrapper("CKFTracking")
CKFTracking.OutputLevel = INFO
CKFTracking.ProcessorType = "ACTSSeededCKFTrackingProc"
CKFTracking.Parameters = {
    "CKF_Chi2CutOff": ["10"],
    "CKF_NumMeasurementsCutOff": ["1"],
    "MatFile": [the_args.MatFile],
    "PropagateBackward": ["False"],
    "RunCKF": ["True"],
    "SeedFinding_CollisionRegion": ["3.5"],
    "SeedFinding_DeltaRMax": ["60"],
    "SeedFinding_DeltaRMin": ["2"],
    "SeedFinding_DeltaRMaxBottom": ["50"],
    "SeedFinding_DeltaRMaxTop": ["50"],
    "SeedFinding_DeltaRMinBottom": ["5"],
    "SeedFinding_DeltaRMinTop": ["2"],
    "SeedFinding_ImpactMax": ["3"],
    "SeedFinding_MinPt": ["500"],
    "SeedFinding_RMax": ["150"],
    "SeedFinding_ZMax": ["500"],
    "SeedFinding_RadLengthPerSeed": ["0.1"],
    "SeedFinding_zBottomBinLen": ["1"],
    "SeedFinding_zTopBinLen": ["1"],
    "SeedFinding_phiBottomBinLen": ["1"],
    "SeedFinding_phiTopBinLen": ["1"],
    "SeedFinding_SigmaScattering": ["3"],
    "SeedingLayers": [
        "13", "2", "13", "6", "13", "10", "13", "14",
        "14", "2", "14", "6", "14", "10", "14", "14",
        "15", "2", "15", "6", "15", "10", "15", "14",
        ],
    "TGeoFile": [the_args.TGeoFile],
    "TrackCollectionName": ["AllTracks"],
    "TrackerHitCollectionNames": ["VXDBarrelHits", "ITBarrelHits",
    "CaloFace_Radius": ["1500"],
    "CaloFace_Z": ["2307"]
}
```

First challenge: Muon Collider in Key4hep

Muon Collider cooperates for an integrated solution with key4hep:

- Moving from Marlin to Gaudi
- Replacing LCIO with EDM4hep

The key4hep distribution already contains:

- A subset of the processors (Gaudi algorithms) required by the reconstruction workflow (BIB overlay, planar digitizer)
- A conversion tool for LCIO and EDM4hep

In principle it's possible to compose a mixed workflow with key4hep algorithms and Marlin processors

Several parts of the key4hep stack, like the tracking algorithm, are not yet at production level

MC contribution to Key4hep

The tracking WG in Muon Collider is following:

- Development of an algorithm for the realistic digitization.
- Conversion of all the Marlin processors for the track reconstruction into native Gaudi algorithms.

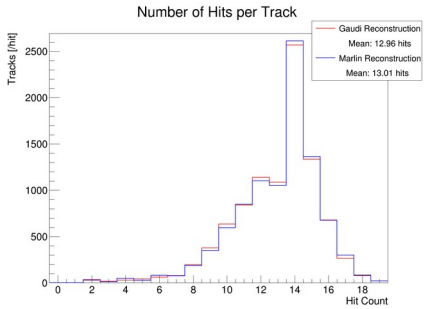
EDM4hep is the only model used for exchanging data among algorithms

The native algorithms for tracking reconstruction:

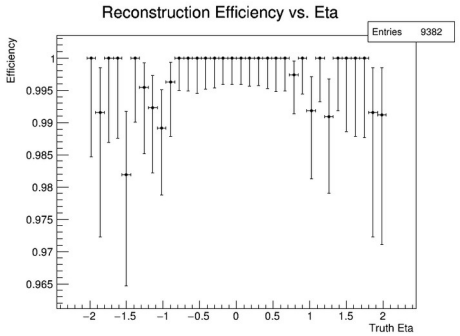
- Successfully match the performance of the corresponding Marlin processors
- Are suitable for exploiting any level of parallelism provided by Gaudi

Next steps:

- Setup and test a parallel workflow
- Keep the compatibility with latest changes in EDM4hep (mainly Links, Tracker Hits)



Comparison between Marlin and Gaudi

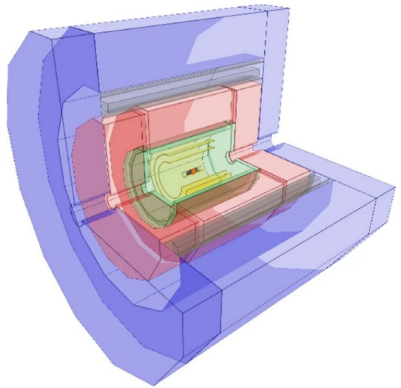


Efficiency of a reconstruction with Gaudi algorithm

Second challenge: ACTS and DD4hep

The ACTS processor supports many detectors:
- MuColl v1 (3TeV)
- MuSIC v2, MAIA (10TeV)

All the geometries are handled by DD4hep



ACTS provides a DD4hep plugin dealing with:
- The detector geometry
- The magnetic field

There's a mismatch between DD4hep and ACTS geometry definitions.
A TGeo based description must be "manually" re-created.

A group, composed of developers from ACTS and experiments, is taking care of the issue
The tasks assigned to the MC tracking team are:
- To keep synchronized the processors with the latest release of ACTS
- To support the integration with the DD4hep plugin

Further activites

Many functionalities in ACTS are still under investigation:

- Measurements selection (regional tracking)
- Fine-grain seeding configuration

Track reconstruction can be tested with non-uniform magnetic field using ACTS DD4hep plugin

Thank you for your attention

Any questions?