Update on Vertexing

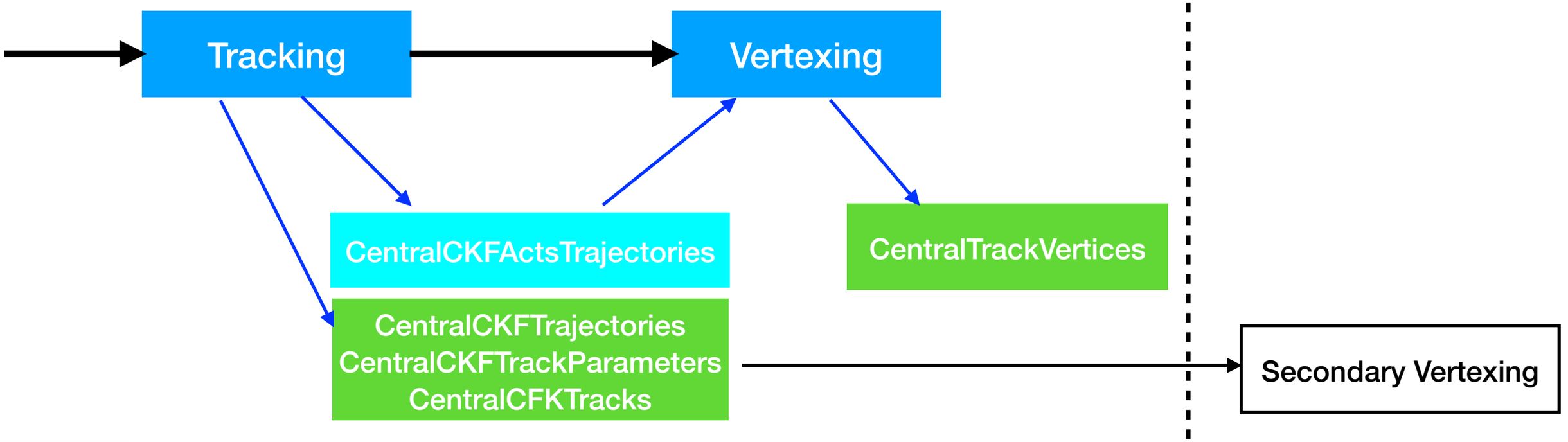
Xin Dong

Khushi Singla (Panjab Univ.), Rongrong Ma (BNL)

1) Track-vertex association added (PR #1576 merged)
2) PrimaryVertices (subsetCollection) (PR #1609 submitted)
3) On-going activities
    a) vertex benchmark preparation
    b) secondary vertex study

Tracking/Vertexing Workflow

July Collaboration Meeting



PODIO

Production

Overall Status:
- Basic workflow in place
- What's in place?
  > All basic components
- What's missing?
  > edm4eic::Vertex associatedParticles not filled

Workflow Inputs/Outputs
- Inputs: CentralCKF(Seeded)ActsTrajectories
- Outputs: CentralTrackVertices (edm4eic::Vertex)

Analysis/User?

Near Term Goals:
- primary-vertexing benchmark for TDR
- **fill in missing associatedParticles in output**

Long Term Goals:
- algorithm/parameter tuning for different classes of events
- MC/generated vertices and associations
- secondary vertexing

Green: done
Blue: ongoing activities

Vertex-Track Association (PR# 1576)

https://github.com/eic/EICrecon/blob/main/src/global/tracking/tracking.cc

```
210        app->Add(new JOmniFactoryGeneratorT<IterativeVertexFinder_factory>(
211                "CentralTrackVertices",
212                {"CentralCKFActsTrajectories"},
213                {"CentralTrackVertices"},
214                {},
215                app
216                ));
```

```
app->Add(new JOmniFactoryGeneratorT<IterativeVertexFinder_factory>(
        "CentralTrackVertices",
        {"CentralCKFActsTrajectories","ReconstructedChargedParticles"},
        {"CentralTrackVertices"},
        {},
        app
        ));
```

IterativeVertexFinder.cc

```
            for (const auto& t : vtx.tracks()) {
          #if Acts_VERSION_MAJOR >= 33
                const auto& trk = &t.originalParams;
                const auto& par = finderCfg.extractParameters(trk);
          #else
                const auto& par = *t.originalParams;
          #endif
                m_log->trace("Track local position from vertex = {} mm, {} mm", par.localPosition().x() / Acts::UnitConstants::mm, par.localPosi
          float loc_a = par.localPosition().x();
          float loc_b = par.localPosition().y();

          for (const auto& part : *reconParticles) {
            const auto& tracks = part.getTracks();
            for (const auto trk : tracks) {
              const auto& traj = trk.getTrajectory();
              const auto& trkPars = traj.getTrackParameters();
              for (const auto par : trkPars) {
                const double EPSILON = 1.0e-4; // mm
                if (fabs((par.getLoc().a / edm4eic::unit::mm) - (loc_a / Acts::UnitConstants::mm)) < EPSILON
                  && fabs((par.getLoc().b / edm4eic::unit::mm) - (loc_b / Acts::UnitConstants::mm)) < EPSILON) {
                  m_log->trace("From ReconParticles, track local position [Loc a, Loc b] = {} mm, {} mm", par.getLoc().a / edm4eic::unit::
                  eicvertex.addToAssociatedParticles(part);
                } // endif
              } // end for par
            } // end for trk
          } // end for part
        } // end for t
        m_log->debug("One vertex found at (x,y,z) = ({}, {}, {}) mm.", vtx.position().x() / Acts::UnitConstants::mm, vtx.position().y() /

      } // end for vtx
```

PR#1605 (using Seeded tracks as default) merged

PrimaryVertices (PR# 1609)

SubsetCollection of VertexCollection (index map to sort the vertices)

- very loose primary vertex requirements
- vertices sorted according number of associatedReconstructed particles
- for users, goal: the first vertex would be the default best selected event vertex
  - algorithm/cuts may be adjusted in the future

New commit pushed in following Dmitry's suggestion to use algorithms interface

added PrimaryVertices factory (subCollection of CentralTrackVertices) #1609

Open **starsdong** wants to merge 5 commits into `main` from `pr/primaryvertices`

Conversation 25 | Commits 5 | Checks 76 | Files changed 6

Changes from all commits | File filter | Conversations

Filter changed files

- src
  - algorithms/reco
    - PrimaryVertices.cc
    - PrimaryVertices.h
    - PrimaryVerticesConfig.h
  - global/reco
    - PrimaryVertices_factory.h
    - reco.cc
  - services/io/podio
    - JEventProcessorPODIO.cc

91 src/algorithms/reco/PrimaryVertices.cc

```
@@ -0,0 +1,91 @@
+ // SPDX-License
+ // Copyright (
+
+ #include <edm4
+ #include <edm4
+ #include <edm4
+ #include <fmt/
+ #include <podi
+ #include <itera
+ #include <map>
+ #include <util
+
+ #include "algo
+ #include "algo
+
```

```
struct PrimaryVerticesConfig {

  // For now these are wide open
  // In the future the cut should depend
  // on the generator settings
  float maxVr = 50.0; // mm
  float maxVz = 500.0; // mm
  float maxChi2 = 10000.0; //
  int   minNtrk = 1;  // >=
  int   maxNtrk = 1000000; // <=
};
```

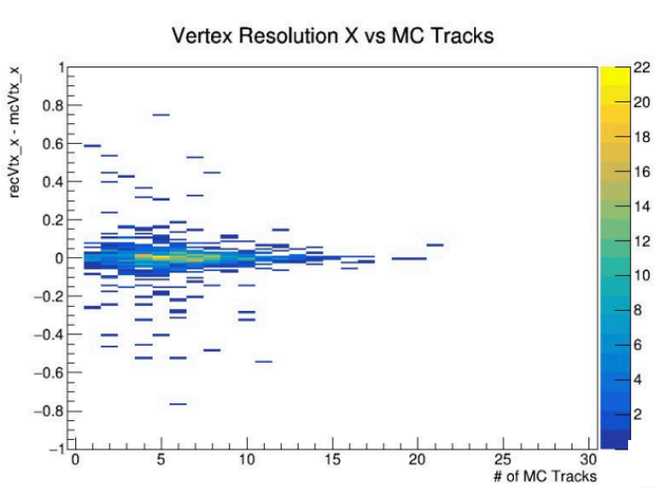
Vertex Benchmark

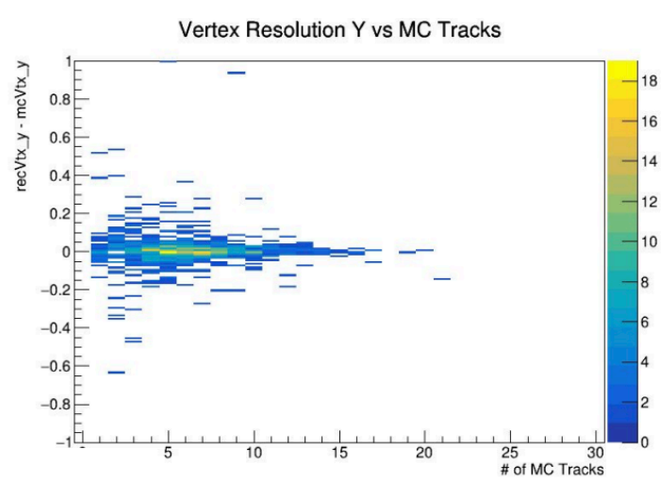
Khushi (Panjan Univ.) is following Barak's instruction working under

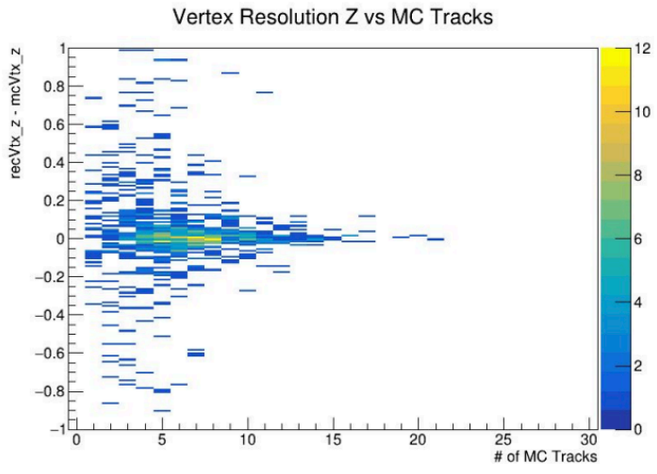
physics_benchmarks/benchmarks/dis/analysis

Following similar structure as other benchmark code

1. Loop all MCParticles, find MC vertex and fill MC tracks (MC vertex to be filled into a separate collection)
2. Loop reconstructed vertices, fill in histograms for efficiency/ resolution etc.
3. Fitting, plotting and saving output histograms





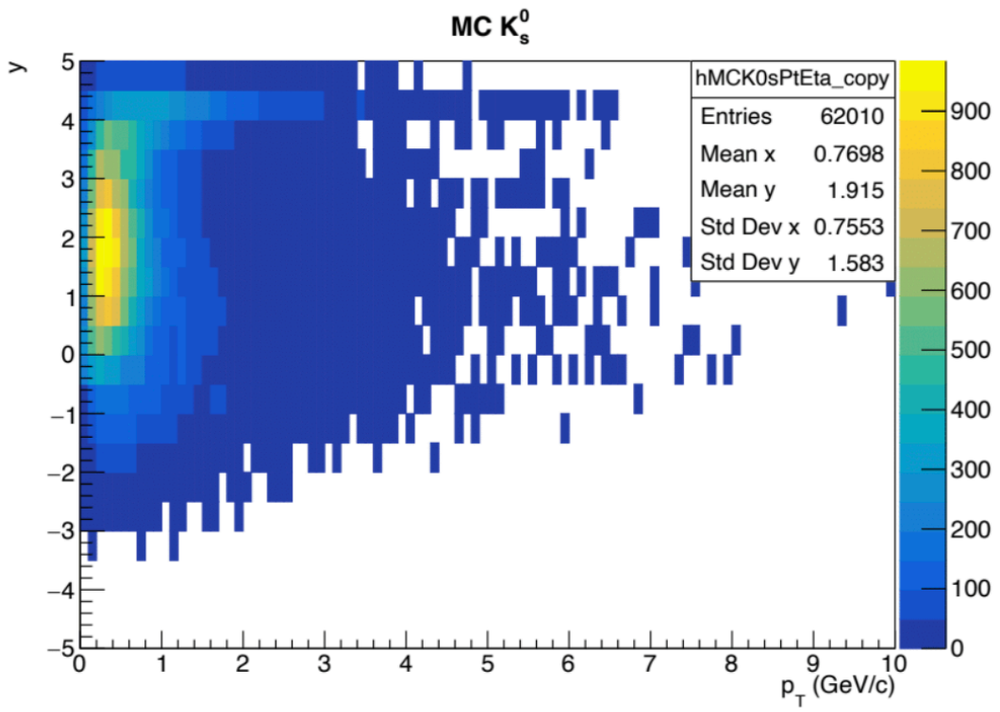


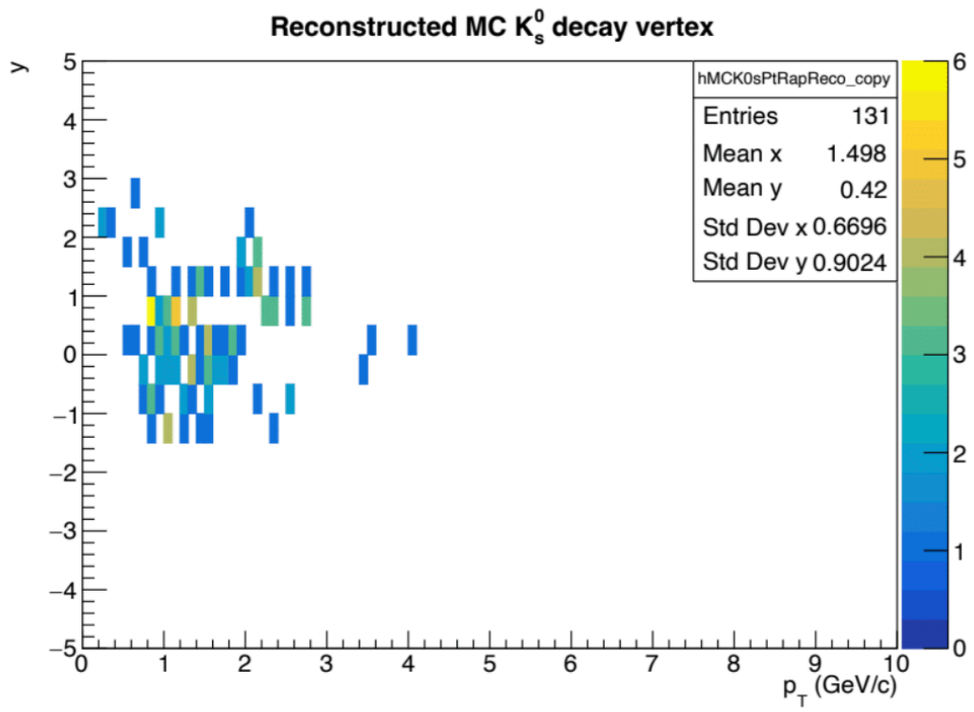
11

Secondary Vertexing Study

IterativeVertexFinder can reconstruct secondary vertices other than primary ones, however, efficiency seems to be quite low.

```
[i] Vertex 1: (x, y, z) = (-0.05, 0.02, -1.30), Ntrk = 4, chi2/ndf = 0.20, (dx, dy, dz) to MC vtx = (-0.04, 0.01, 0.11)

[i] MC Partile 28 with mass 0.13957, pdg = 211, status = 1, (vx, vy, vz) = (-0.007, 0.001, -1.407)

[i] MC Partile 9 with mass 0.00051, pdg = 11, status = 1, (vx, vy, vz) = (-0.007, 0.001, -1.407)

[i] MC Partile 19 with mass 0.13957, pdg = -211, status = 1, (vx, vy, vz) = (-0.007, 0.001, -1.407)

[i] MC Partile 23 with mass 0.13957, pdg = -211, status = 1, (vx, vy, vz) = (-0.007, 0.001, -1.407)
[i] Vertex 2: (x, y, z) = (7.90, -12.41, -2.11), Ntrk = 2, chi2/ndf = 69.22, (dx, dy, dz) to MC vtx = (7.91, -12.41, -0.71)

[i] MC Partile 34 with mass 0.13957, pdg = -211, status = 1, (vx, vy, vz) = (-9.935, 8.964, -2.178)

[i] MC Partile 35 with mass 0.13957, pdg = 211, status = 1, (vx, vy, vz) = (-7.997, 13.938, 3.018)
```





Secondary Vertexing Study

Currently, seeded tracking efficiency for off-beam tracks is also low - under study.
Besides, IVF prefers to attach tracks to primary vertices.

Current plan:

1) Short term, to establish DCA resolution performances w.r.t. MC/RC vertices

2) User-side development first, taking reconstructed tracks for secondary vertex reconstruction (helix swimming or KFParticle etc.)

- helpers are very welcome!