Vertexing @ ePIC

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Outline

- Vertexing algorithm implementation (Joe Osborn)
- Test with a-few-track simulation (JO/XD)
- Test with DIS events and Discussion
- Plans

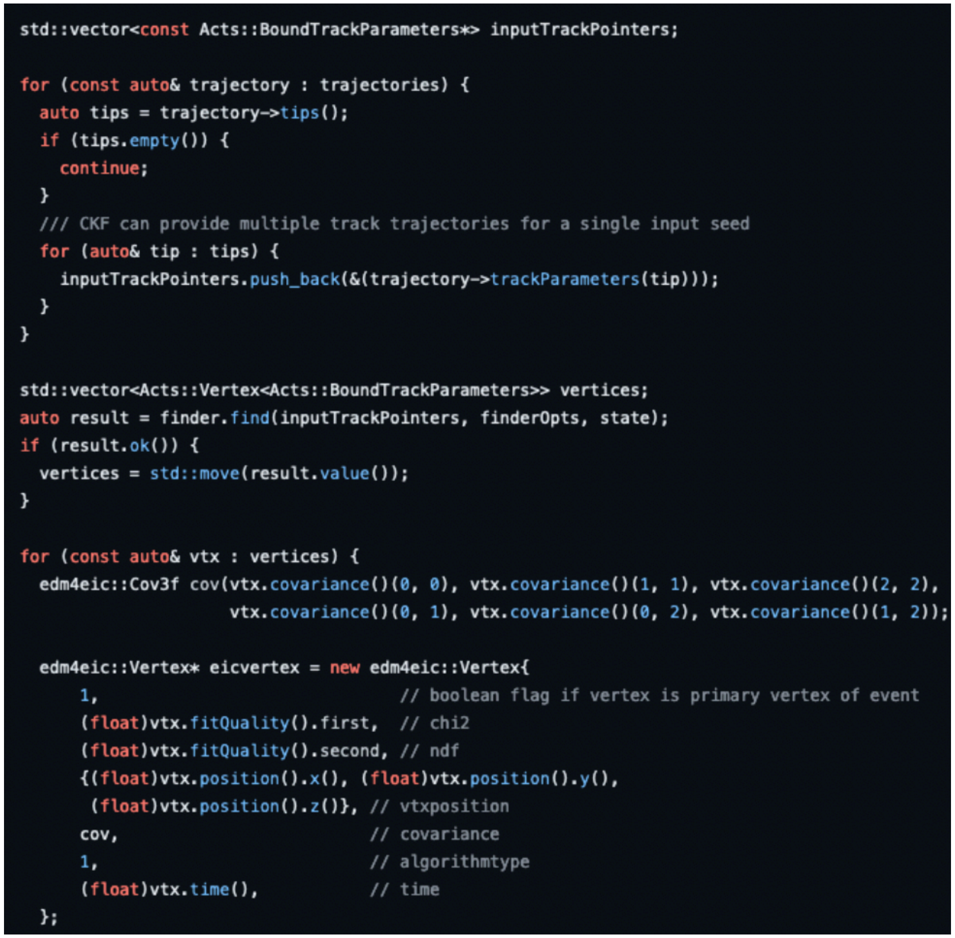
Vertexing Algorithm

See details in Joe Osborn's presentation on May 18 at ePIC Track Reconstruction Meeting
https://indico.bnl.gov/event/19358/contributions/76588/attachments/47593/80693/vertexing.pdf

- Acts::IterativeVertexFinder implemented in EICrecon
- Trajectories used as input to Acts
- Fitted vertices filled into edm4eic::Vertex objects, stored in PODIO output

edm4eic::Vertex struct missing key fields
- to-be-updated

See Joe's presentation on June 8
https://indico.bnl.gov/event/19364/contributions/77394/attachments/47877/81232/vertex_edm.pdf

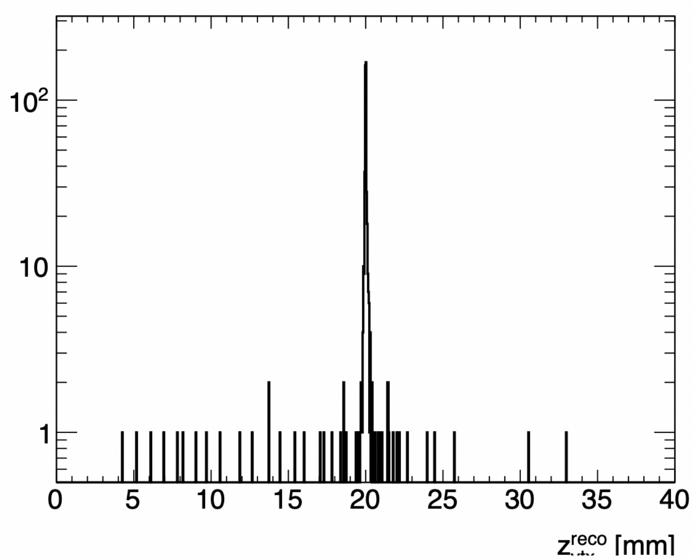


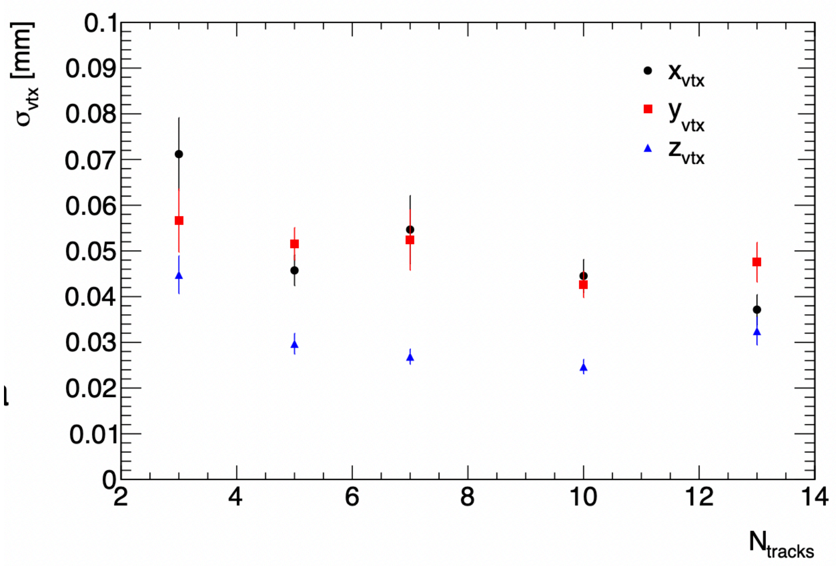
```
std::vector<const Acts::BoundTrackParameters*> inputTrackPointers;

for (const auto& trajectory : trajectories) {
  auto tips = trajectory->tips();
  if (tips.empty()) {
    continue;
  }
  /// CKF can provide multiple track trajectories for a single input seed
  for (auto& tip : tips) {
    inputTrackPointers.push_back(&(trajectory->trackParameters(tip)));
  }
}

std::vector<Acts::Vertex<Acts::BoundTrackParameters>> vertices;
auto result = finder.find(inputTrackPointers, finderOpts, state);
if (result.ok()) {
  vertices = std::move(result.value());
}

for (const auto& vtx : vertices) {
  edm4eic::Cov3f cov(vtx.covariance()(0, 0), vtx.covariance()(1, 1), vtx.covariance()(2, 2),
                     vtx.covariance()(0, 1), vtx.covariance()(0, 2), vtx.covariance()(1, 2));

  edm4eic::Vertex* eicvertex = new edm4eic::Vertex{
      1,                                 // boolean flag if vertex is primary vertex of event
      (float)vtx.fitQuality().first,  // chi2
      (float)vtx.fitQuality().second, // ndf
      {(float)vtx.position().x(), (float)vtx.position().y(),
       (float)vtx.position().z()}, // vtxposition
      cov,                          // covariance
      1,                            // algorithmtype
      (float)vtx.time(),            // time
  };
```

Test with a-few-track Events

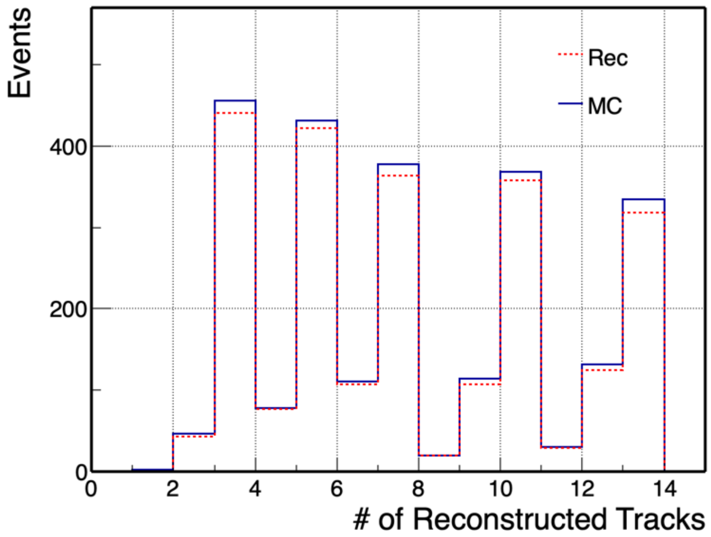
Simulation: N pions thrown flat in acceptance and flat in 0.2<pT<5 GeV at a fixed vertex (0,0,20) mm

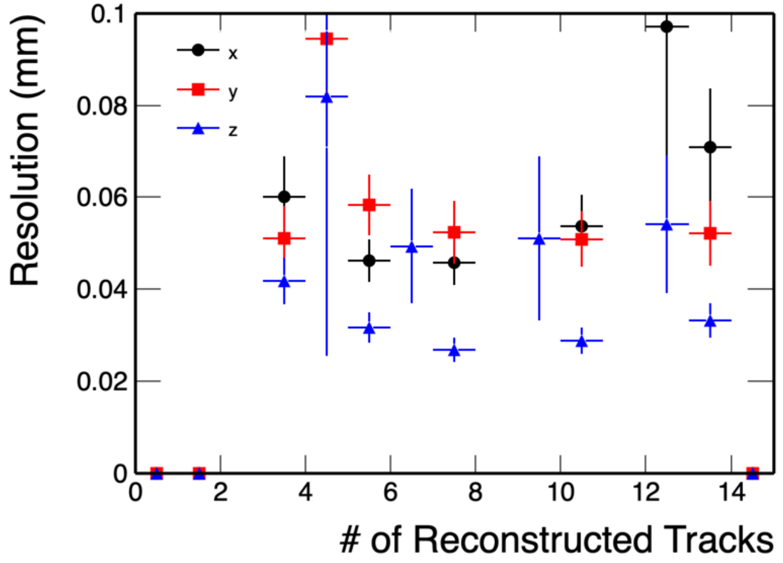
JO's initial test





XD re-ran EICrecon and reproduced observations





Test with DIS Events

DIS sim events on S3: *eictest/EPIC/FULL/23.05.2/epic_brycecanyon/*

As of May 26, default eicrecon crashed on these events
Suggestion from JO: change geometry setup: source /opt/detector/epic-23.05.2/setup.sh

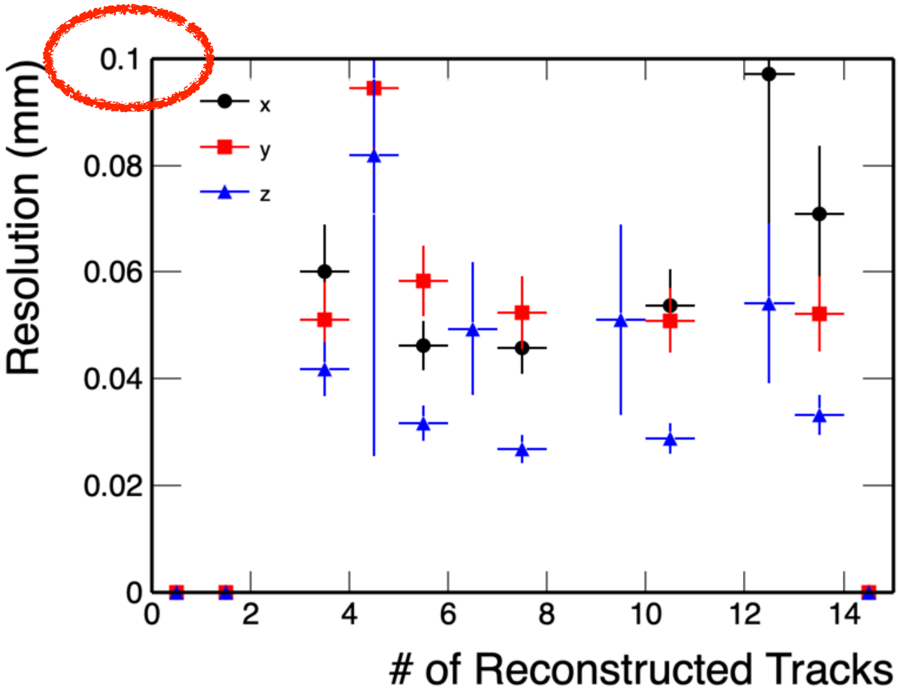
This worked well when running eicrecon on these simulation events.
Tested with ~ 3k events with S3 files:

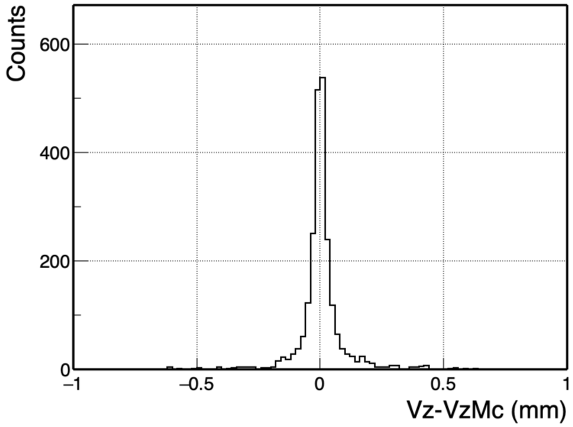
*…/10x100/minQ2=10/pythia8NCDIS_10x100_minQ2=10_beamEffects_xAngle=-0.025_hiDiv_**

Question: example submission script for running massive condor jobs over S3 files

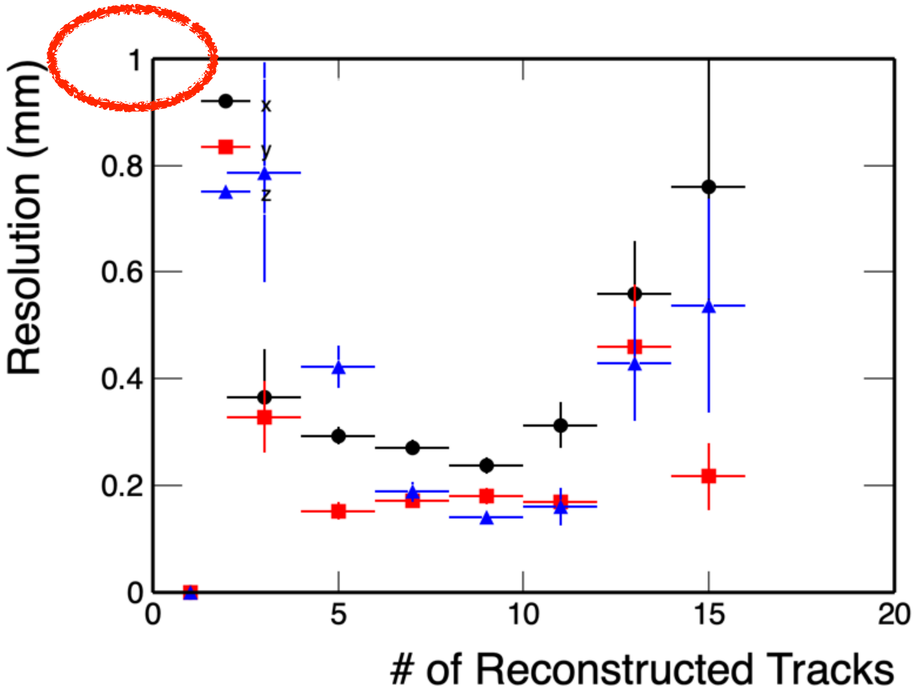
Vertex Resolution Comparison

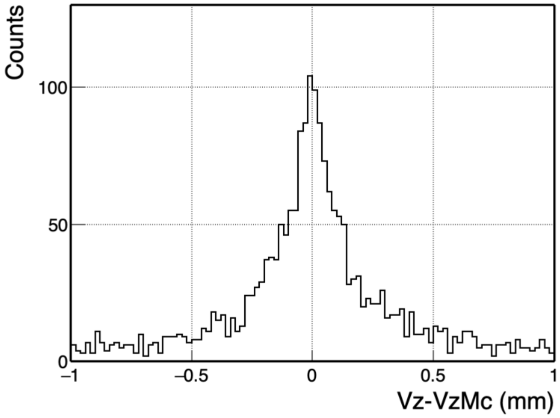
Few-track Simu





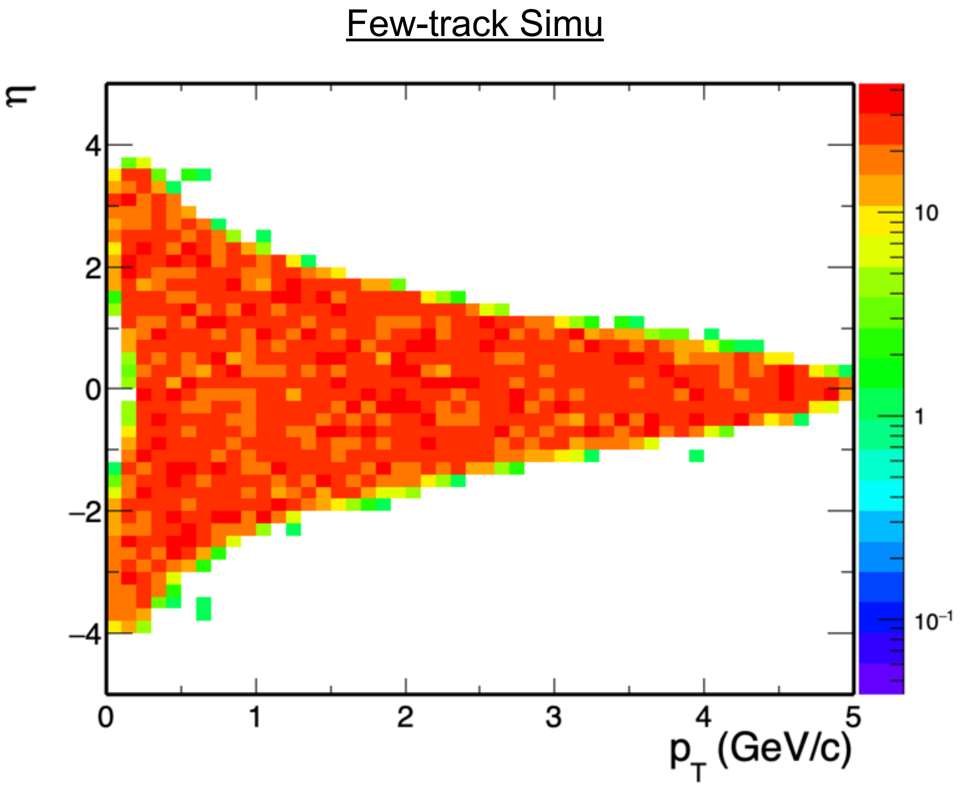
PYTHIA DIS

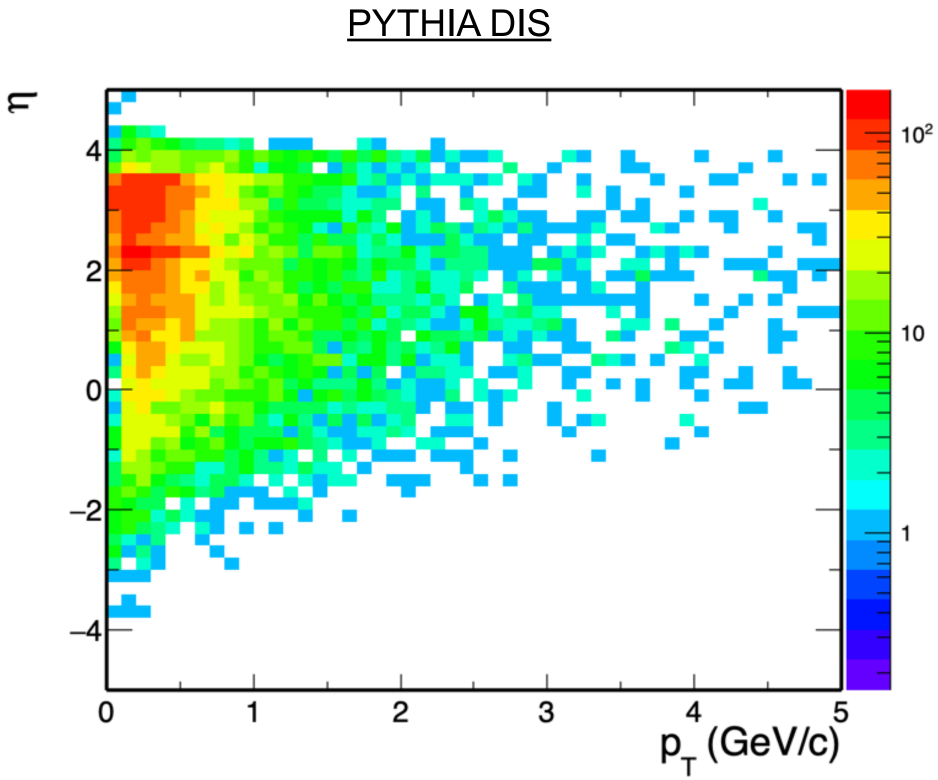




Vertex resolutions: a factor of ~4-5 worse in DIS events compared to few-track events

Different Kinematic Distributions

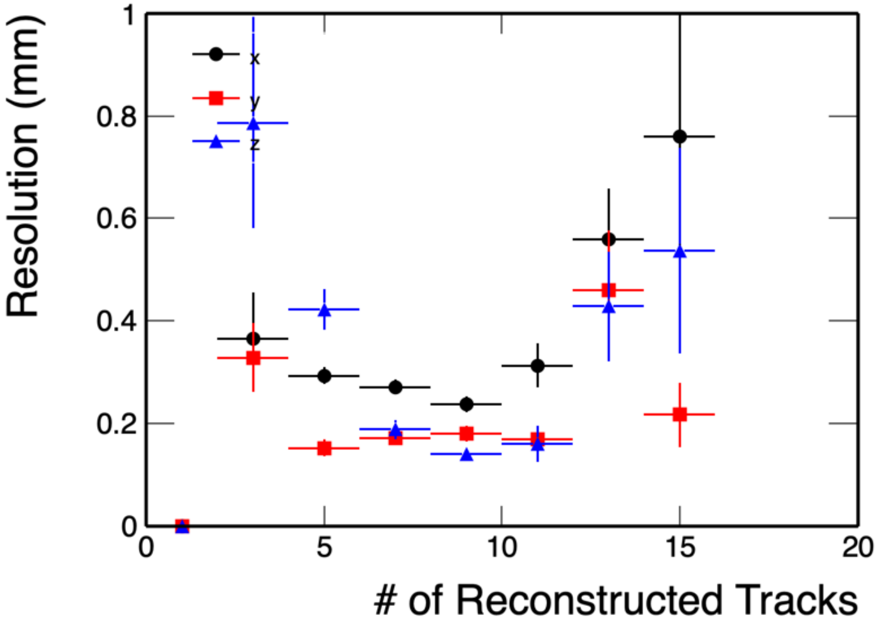




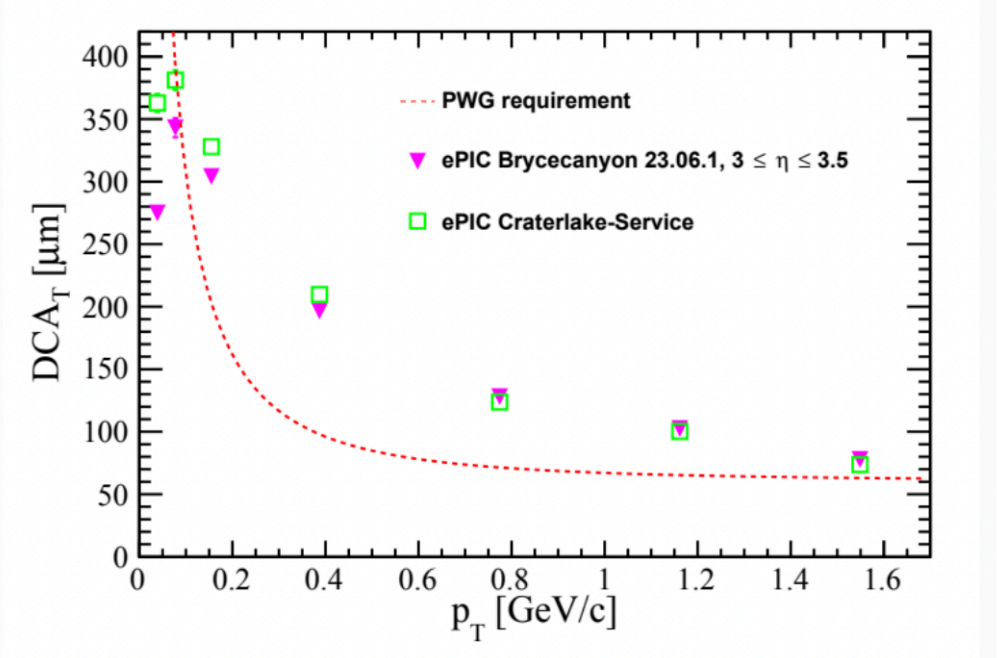
Tracks in DIS events more populated at forward eta (1<eta<3.5) and low pT

Discussion

10x100 GeV GEANT + EICrecon



Single pion DCA$_T$ resolution



Stephen Maple, July 13, TrkRecon Meeting

Single track DCA resolution (Stephen M.) is worse than the PWG requirement in the forward/backward regions

Plans

Personpower:

Joe O.
Xin D. (+ Sooraj R.)
Lokesh K. (+ grad. students)

Near-term studies:

- Single track pointing resolution vs. eta
- Tracking efficiency and vertexing efficiency
- Impact of kinematic distributions (due to collision energy), crossing angle etc.
- Latest geometry
- …

Developments:

- Vertex objects in edm4eic
- Vertexing algorithm tuning
- Secondary vertices
- …