

Update on vertexing studies

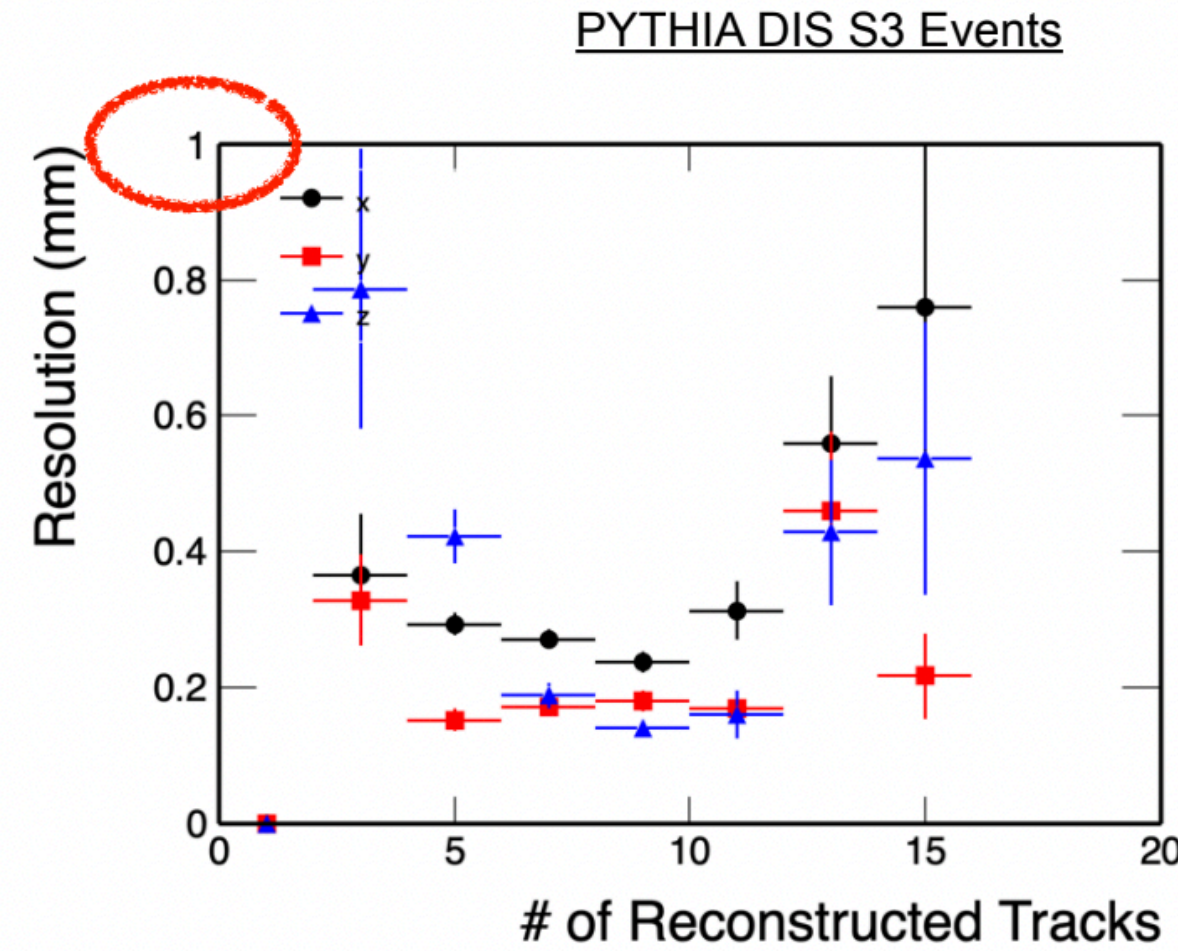
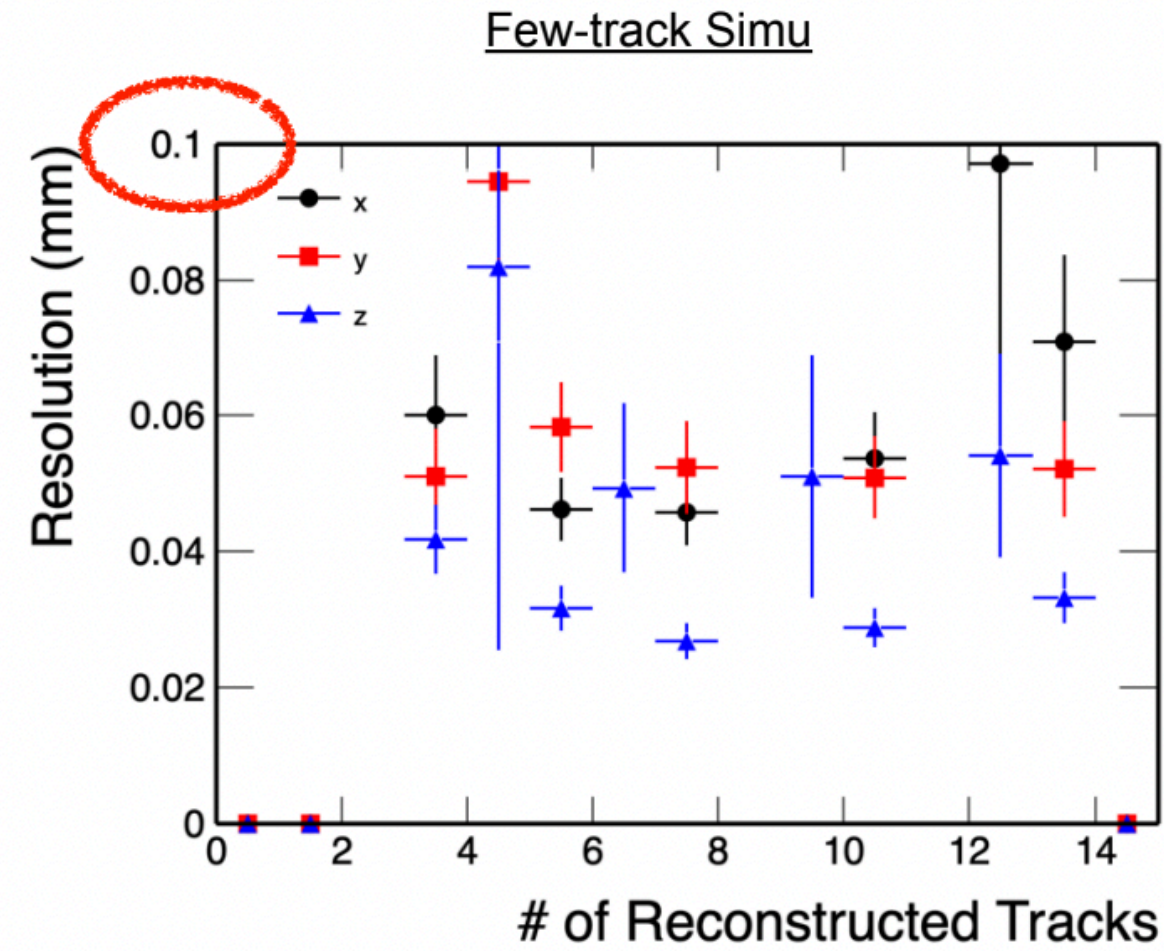
Sooraj Radhakrishnan

Kent State University/Lawrence Berkeley National Laboratory

Tracking WG Meeting, March 14, 2024

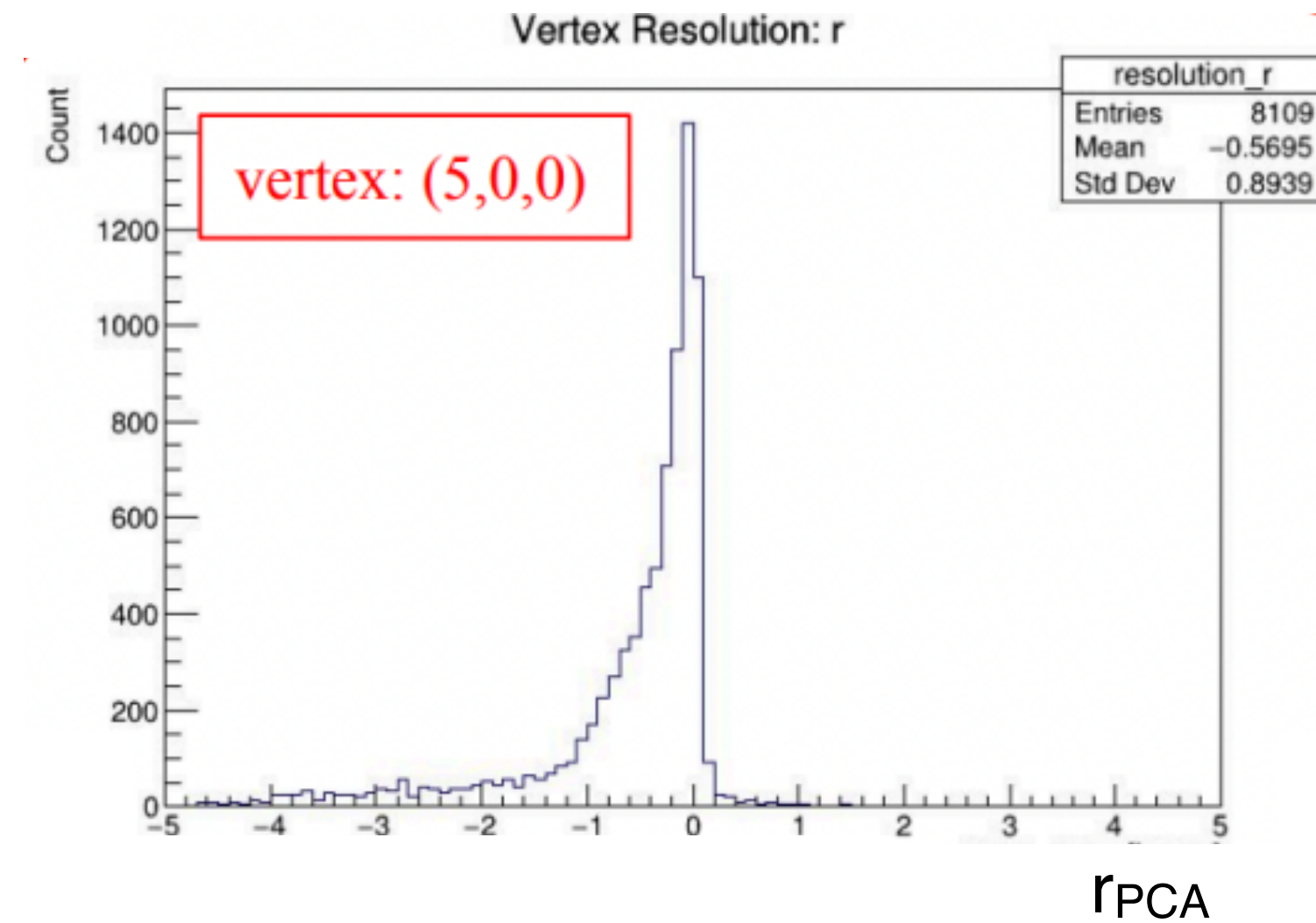
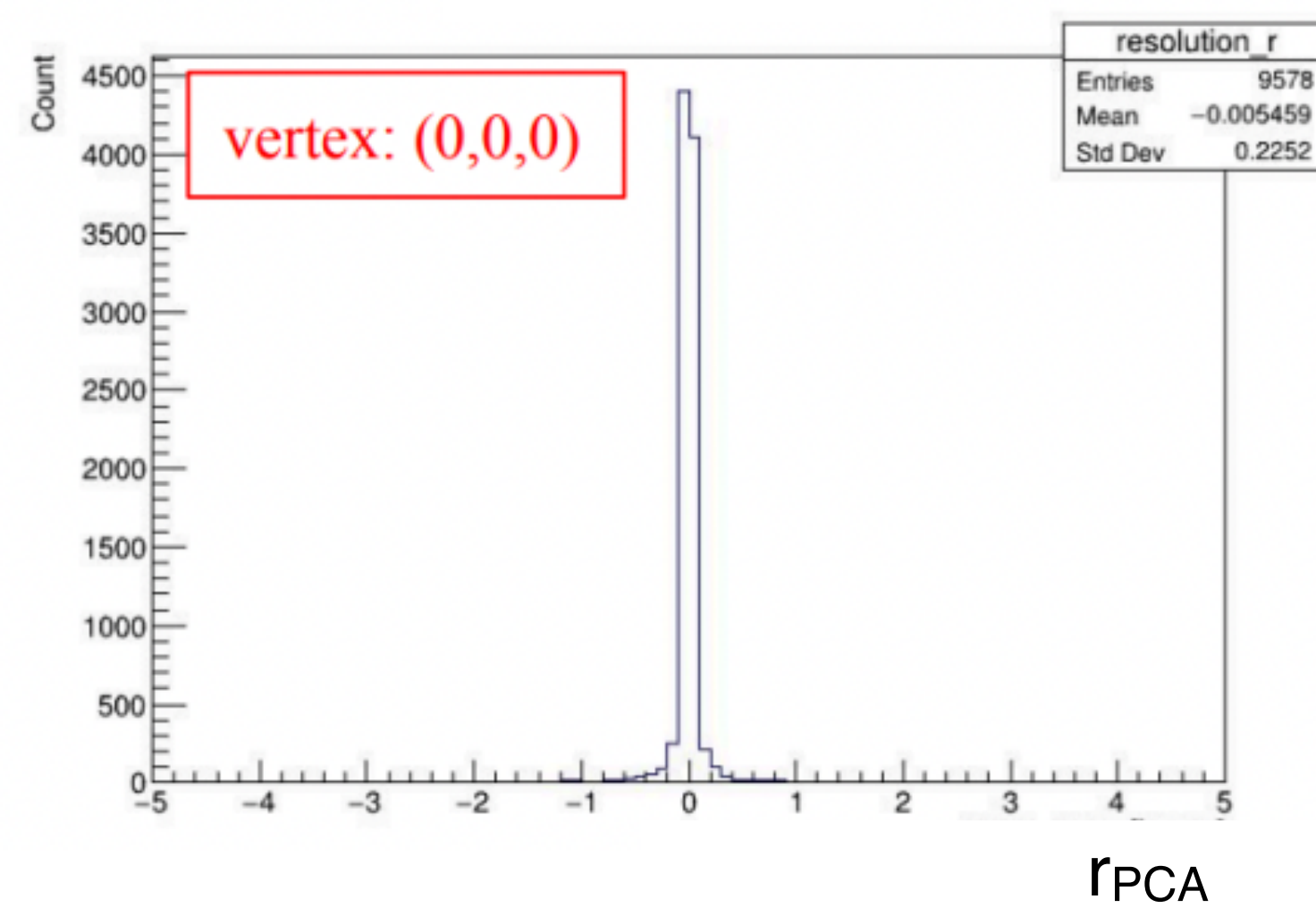


Two main issues (largely resolved now)



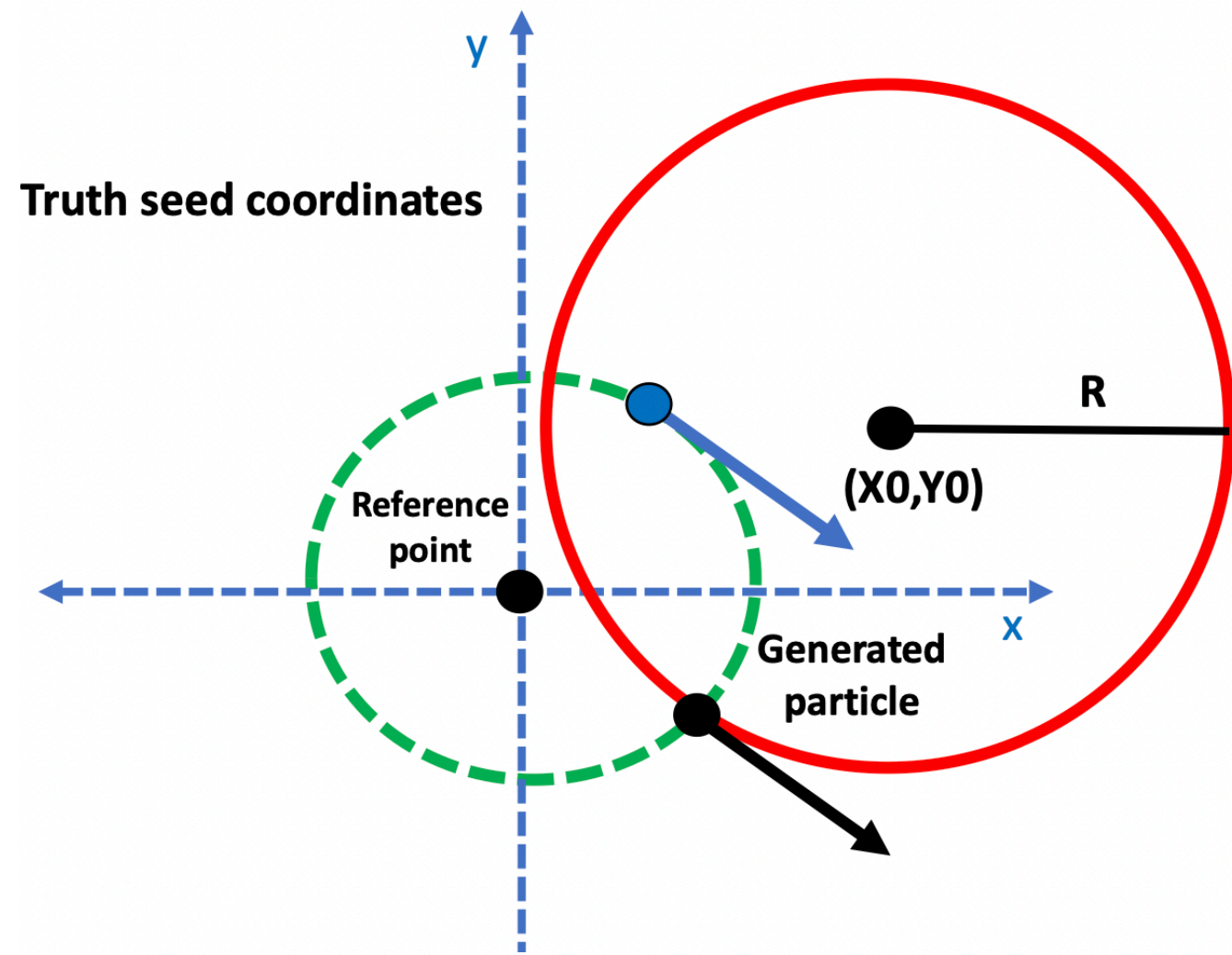
- Significantly poorer vertex resolution seen for DIS events compared to tracks thrown at a vertex

- Issue with reconstruction for tracks from off beam axis vertex
- Arising from truth seeding parameters, related to issue in PR#1185 fix



- More details in slides from Xin at CM: https://indico.bnl.gov/event/20473/contributions/84248/attachments/51909/88753/20240109_ePICColl_Vtx.pdf

Fix for off-axis tracking issue



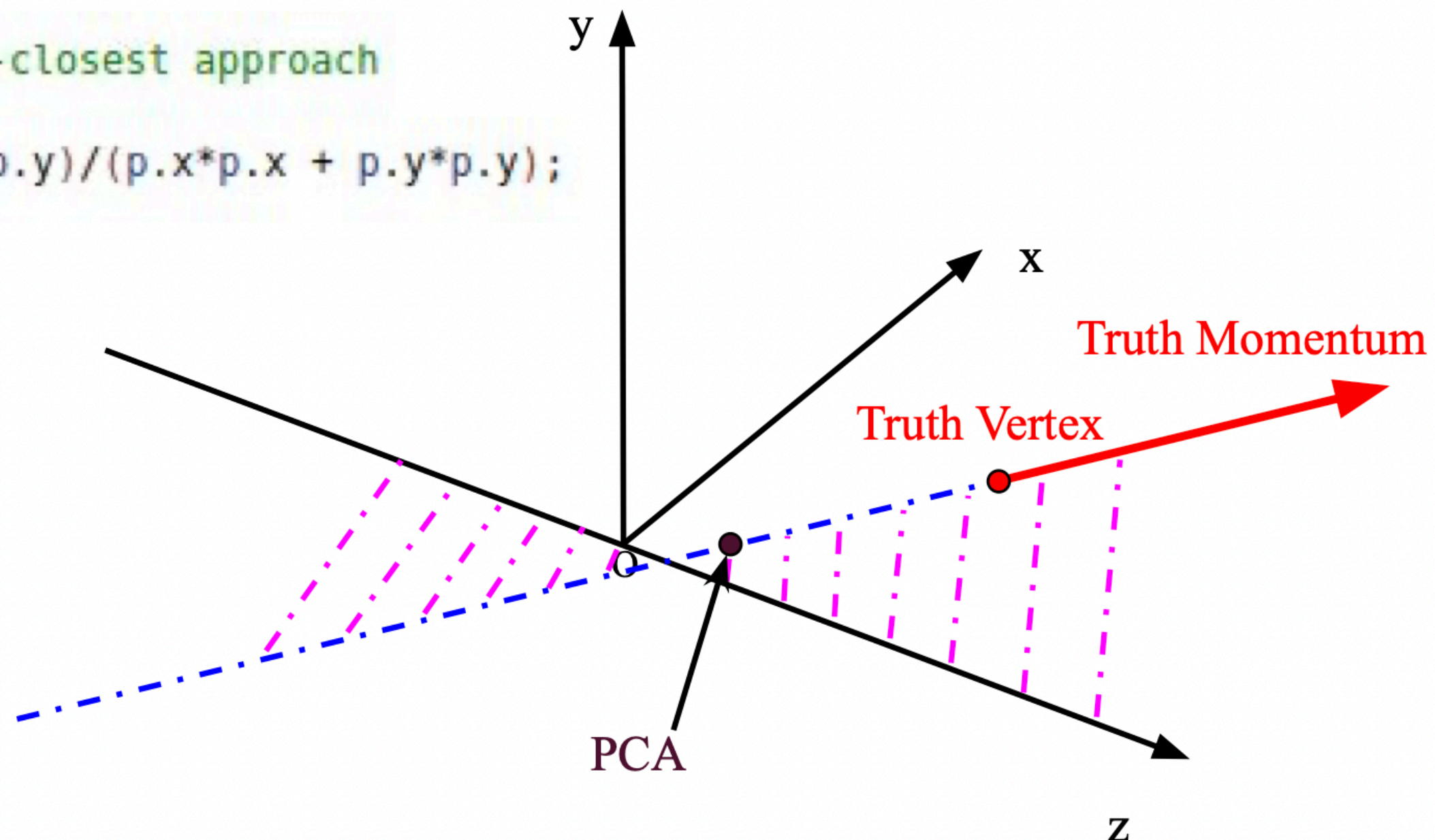
- Acts assumes perigee surface defined around (0,0,0)
- Causes wrong assumption for track parameters in truth seeding for tracks from (X,Y,0) vertices

```
// track particle back to transverse point-of-closest approach
// with respect to the defined line surface
auto linesurface_parameter = -(v.x*p.x + v.y*p.y)/(p.x*p.x + p.y*p.y);

auto xpca = v.x + linesurface_parameter*p.x;
auto ypca = v.y + linesurface_parameter*p.y;
auto zpca = v.z + linesurface_parameter*p.z;
```

Truth Vertex
Components

Truth Momentum
Components

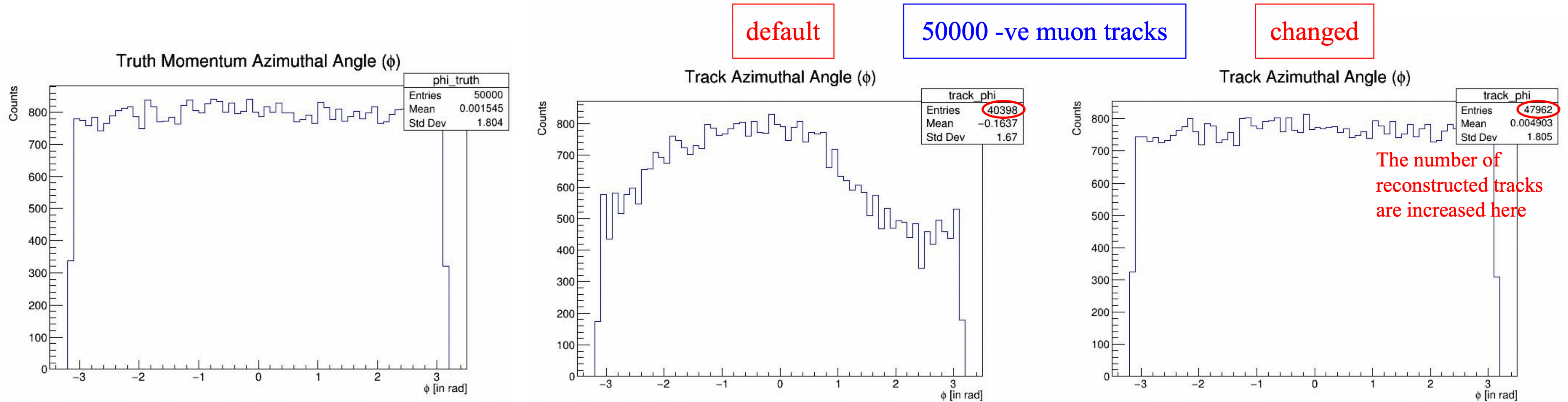


- Fix: Track particles back to calculate the correct PCA to z=0
- Implemented by Harsimran

Fix to off-axis tracking

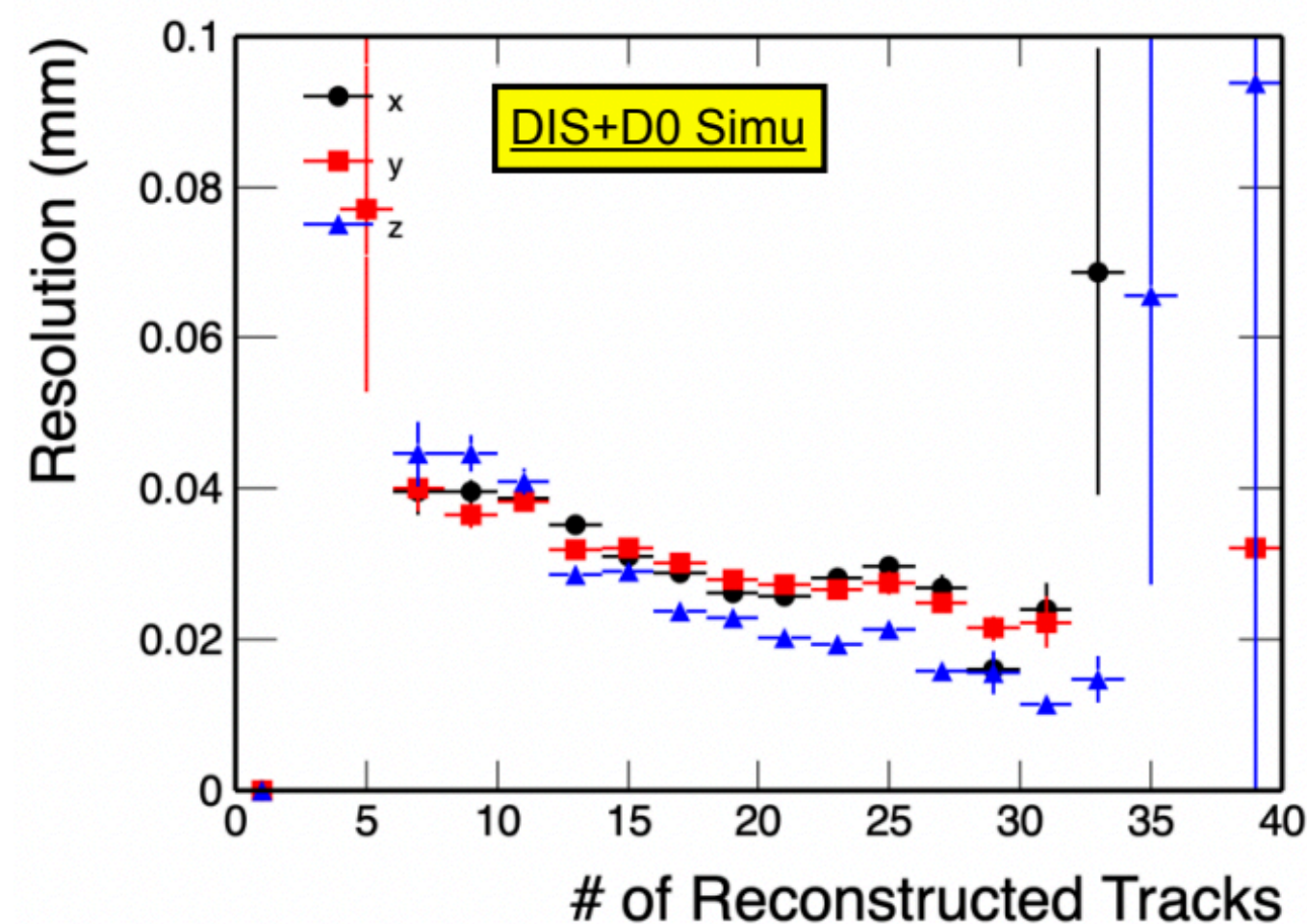
- PR: <https://github.com/eic/EICrecon/pull/1291> (merged now)

Vertex: (3,4,5) mm



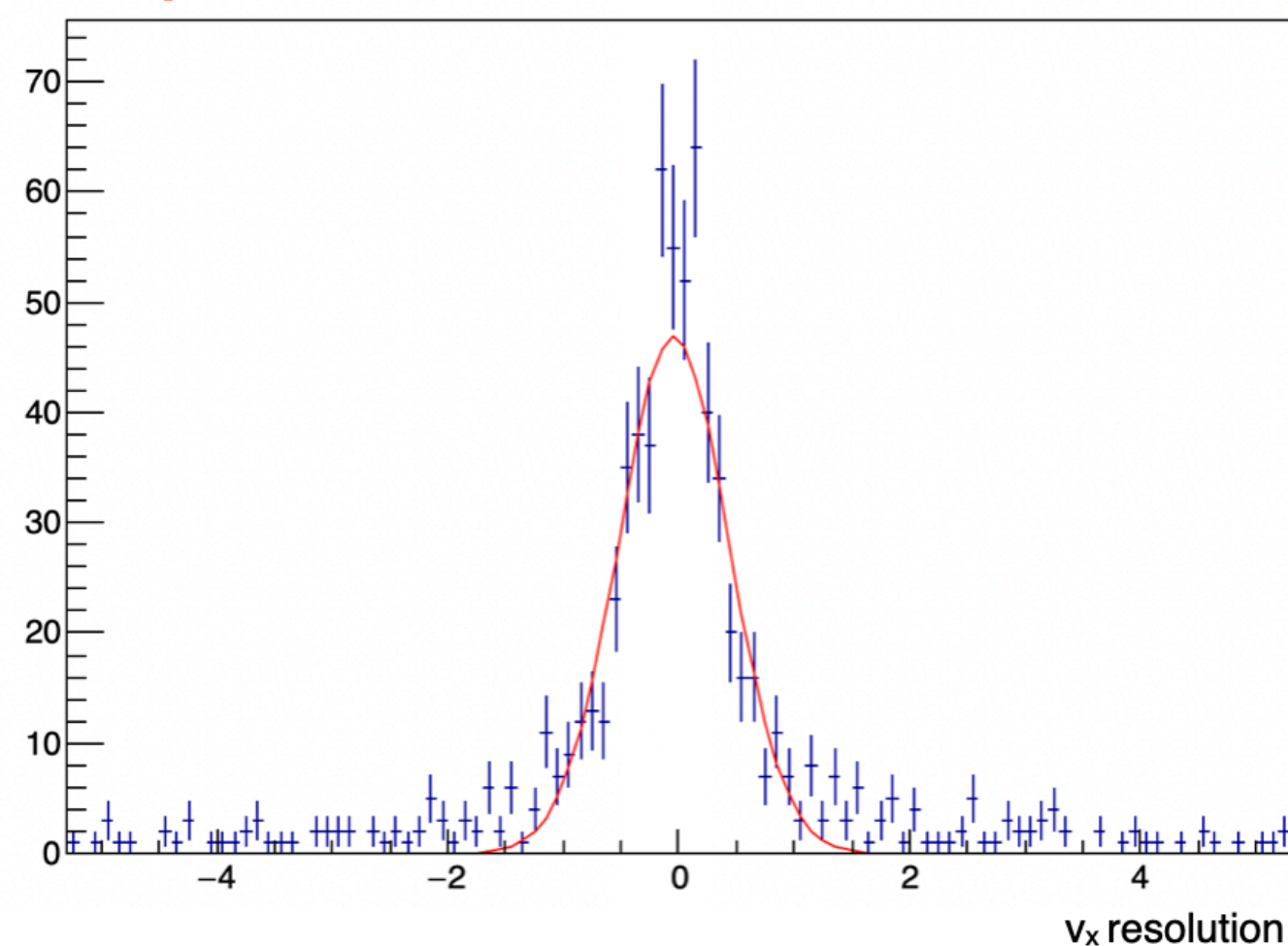
- Update fixes the tracking issue, Acts is now able to pick up the correct parameters for the tracks and reconstruct more tracks
- More details in Harsimran's slides: <https://indico.bnl.gov/indico/category/107624/attachments/52736/90178/off-axis-tracking-issue-fix.pdf>

Vertex resolution in DIS events

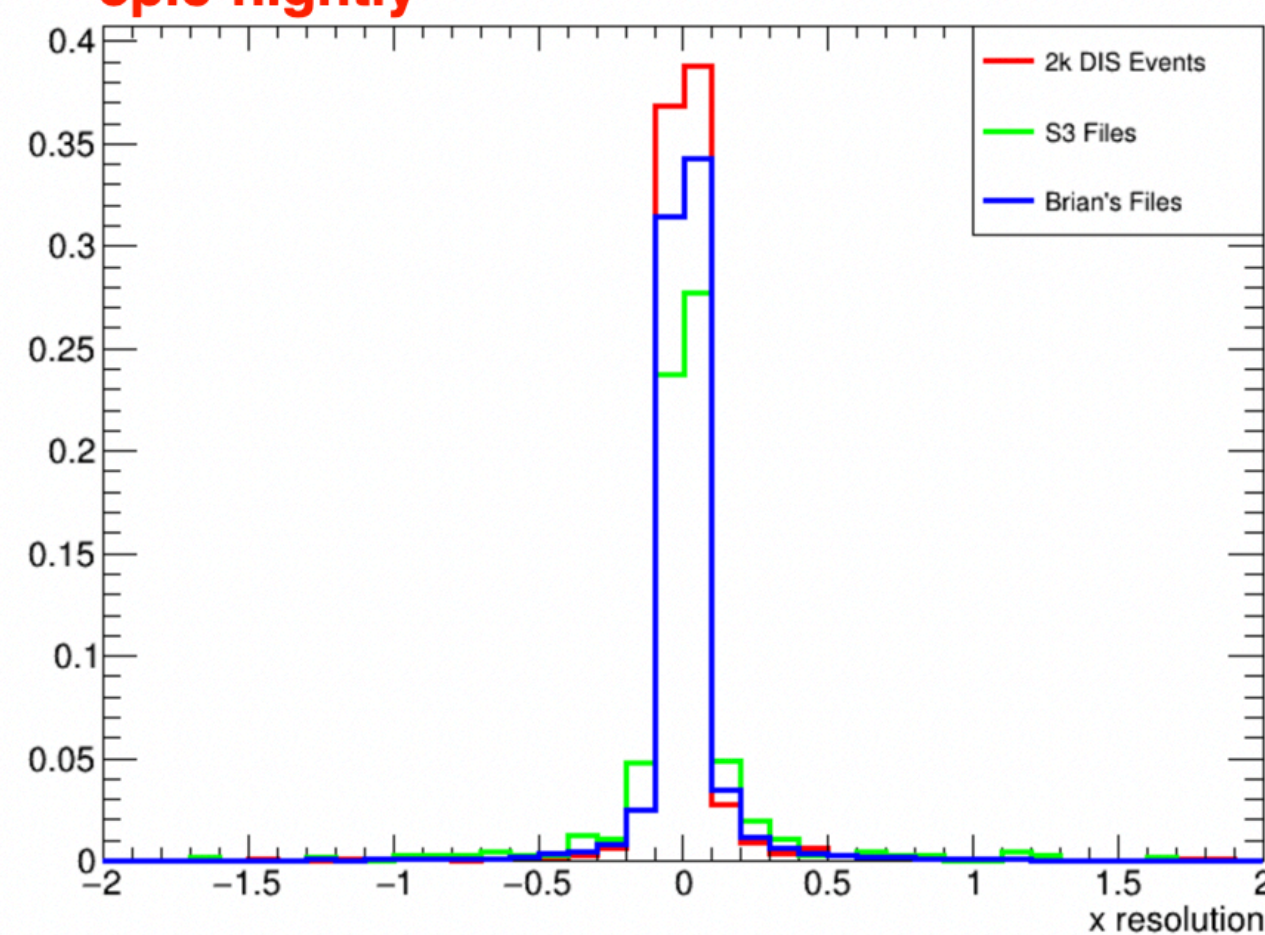


- Good resolution seen for DIS events generated at (0,0,0)
- Also see good vertex resolution for DIS events with smeared generated vertex distribution from newer geometry!
- Havent been able to pin down the source of discrepancy - Khushi is looking into this

epic-23.08.0



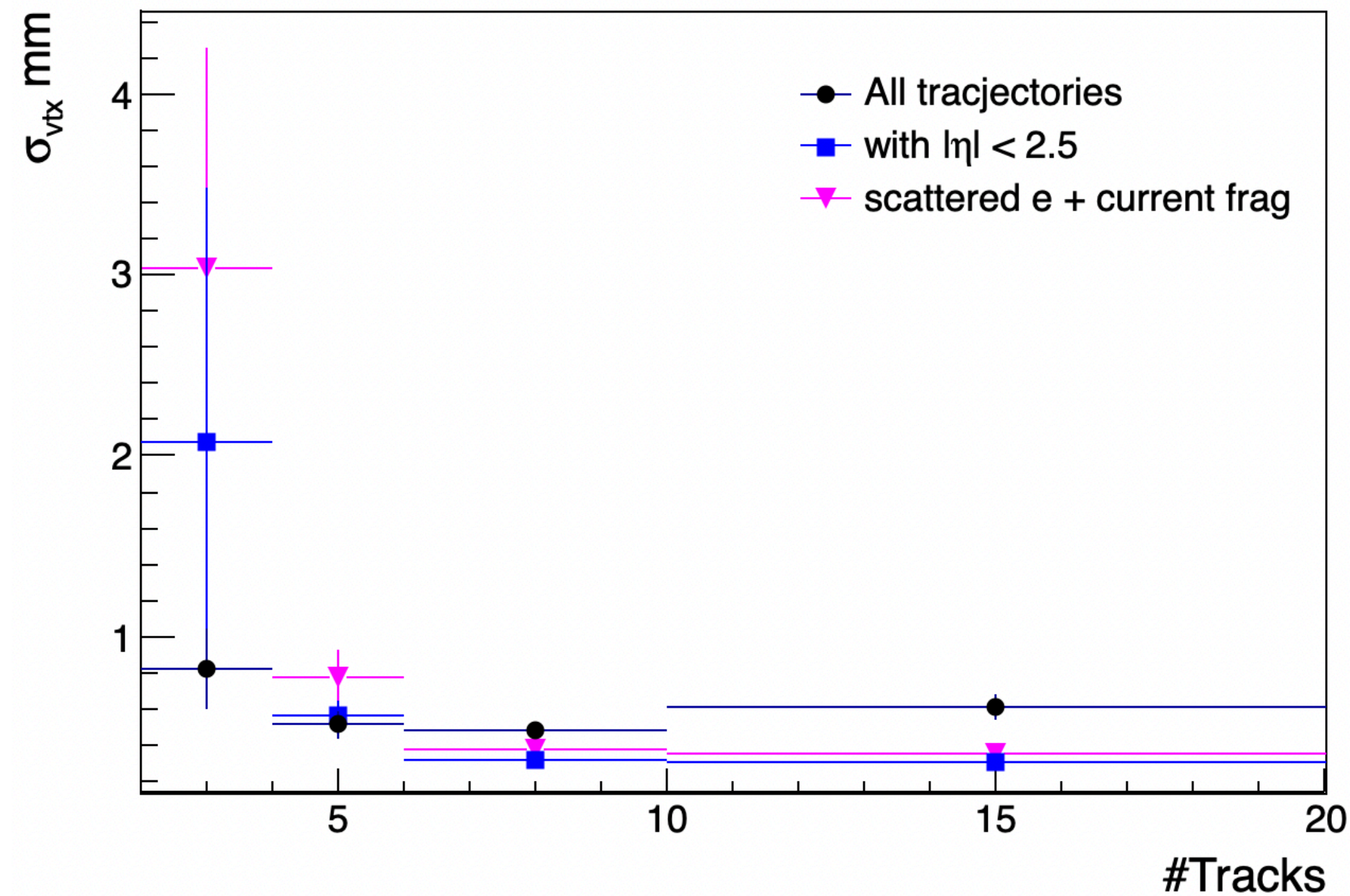
epic-nightly x resolution : projection y Plot from Khushi



- Vertex resolution in DIS events now is comparable to that for tracks thrown at fixed vertex

Files from August simulation campaign: S3/eictest/EPIC/FULL/23.08.0/epic_craterlak
pythia8NCDIS_18x275_minQ2=10_beamEffects_xAngle=-0.025_hiDiv_1.*.edm4hep.root

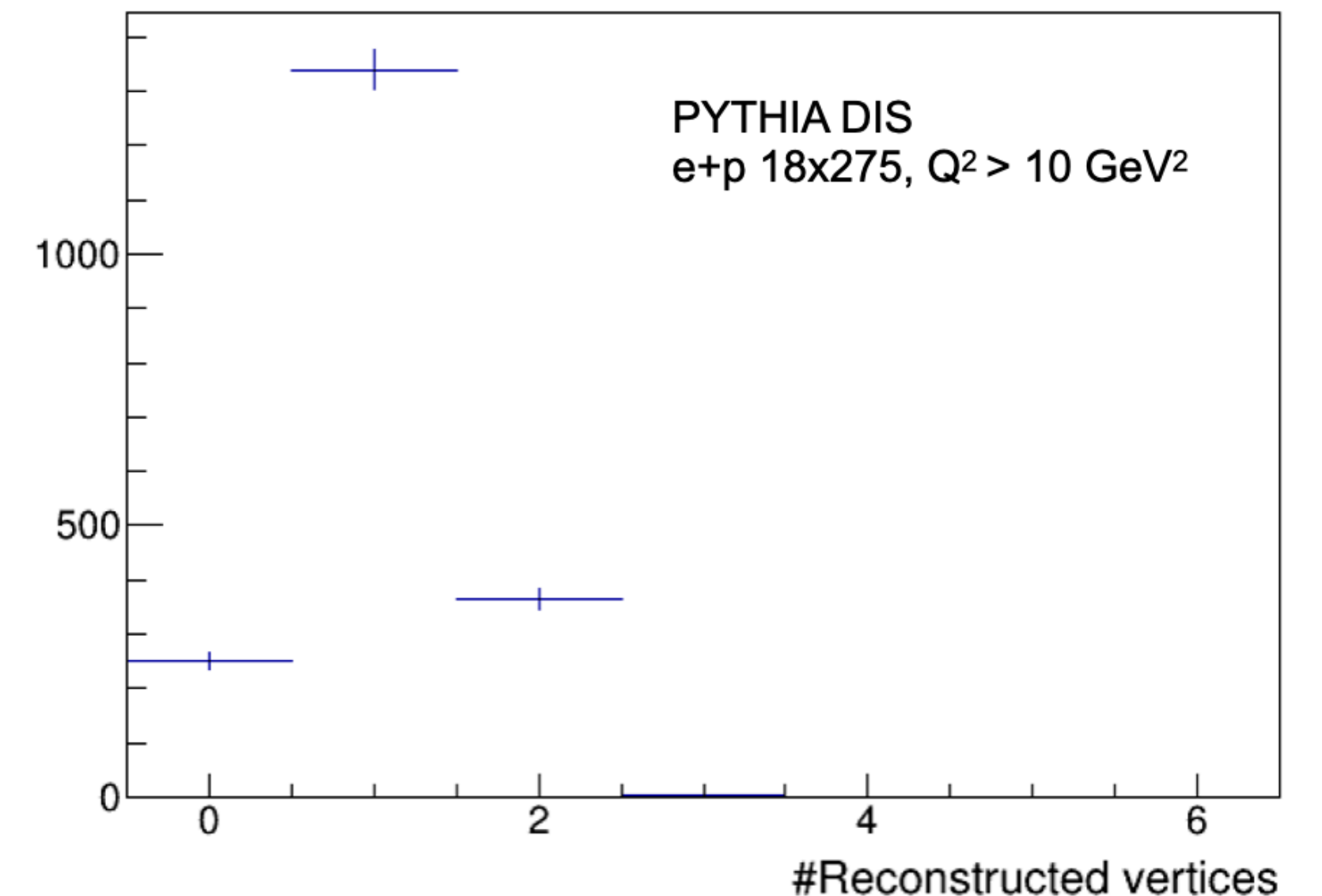
Optimization of vertexing



Scattered electron taken as track with charge = -1 at most negative rapidity
Leading hadrons in transverse plane opposite to it within $\Delta\phi$ of $\pi/4$

- Need to investigate with the new geometry and reconstruction
- Also need to optimize for vertexing efficiency (tolerance cuts etc)

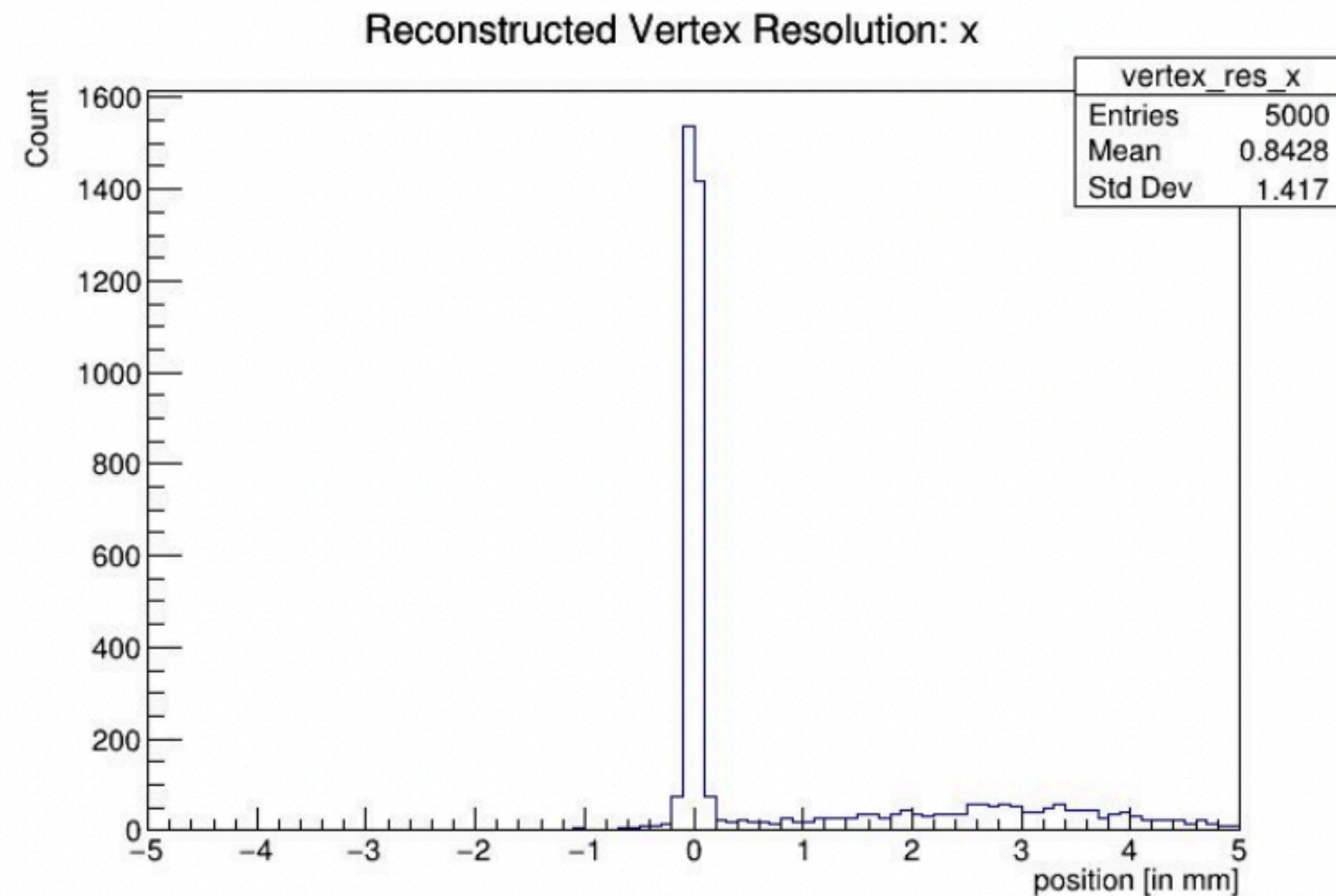
- Previously had looked at impact of defining trajectories used by Acts for reconstructing the vertex
- About a factor of 2 improvement restricting to within the central region or using scattered electron and leading hadrons



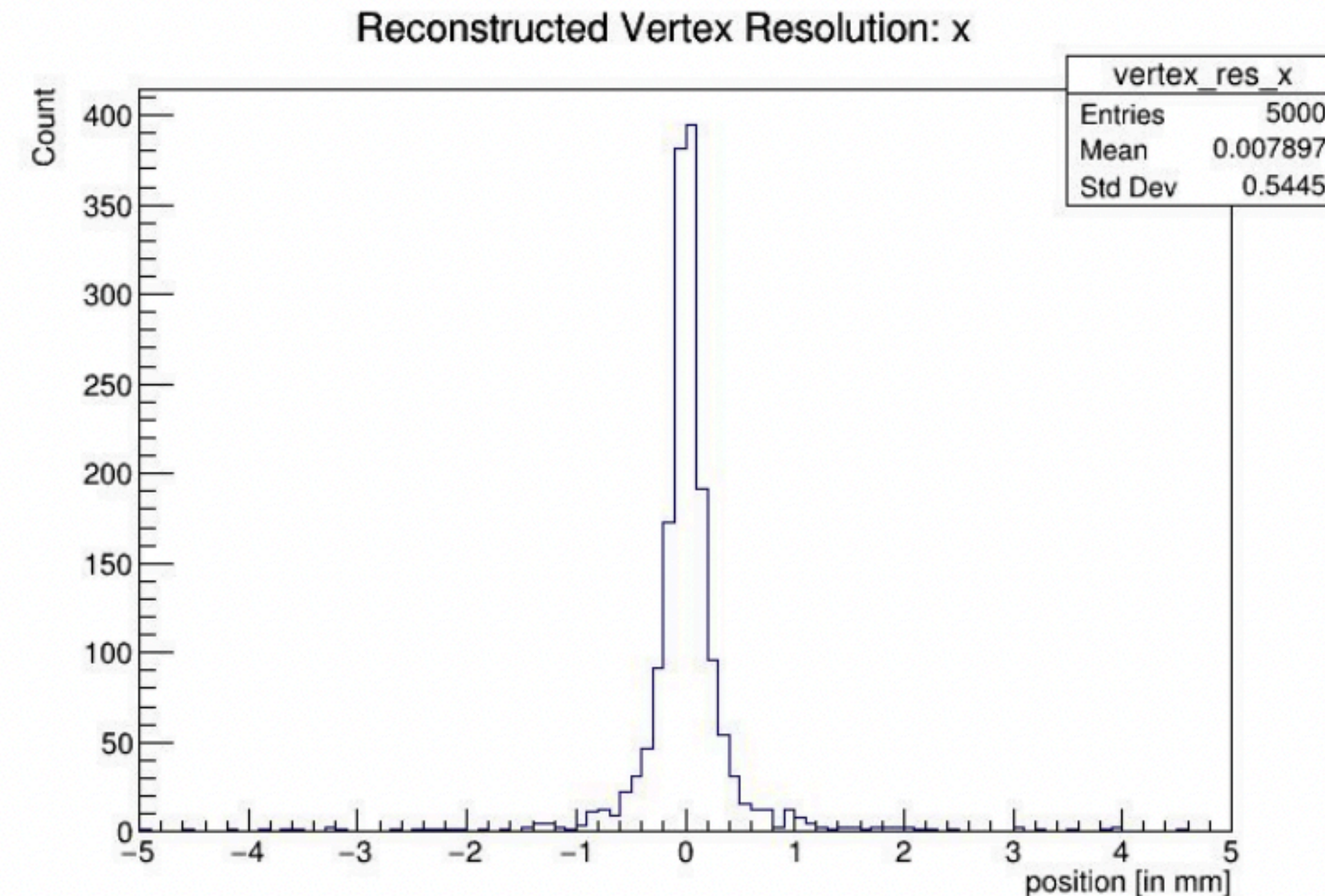
Worsening of resolution after fix?

Vertex: (3,4,5) mm

default



changed



Plots from Harsimran

- Before and after PR#1219 fix
- Removes the vertices at large distances from truth, but the peak is broader
- From different tracks going into the vertexing? Association of trajectories (or tracks) to fitted vertices needed - Harsimran working on implementation

Track association to vertices

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

- IterativeVertexFinder passed ActsTrajectories now.
- Need to switch to using tracks as association of trajectories to tracks are not done
- Should not be an issue, might have to refit tracks after vertex finding. But that is not done now

Summary/Outlook

- Fix for tracking issue for track reconstruction from off beam axis vertices (PR#1219)
- Vertex resolution in DIS events are better with newer geometry — comparable to that for tracks thrown at fixed vertices

- Next: steps to optimize vertex resolution, efficiency
- Investigating broader resolution peak with PR#1219
- Having track association to reconstructed vertex objects

- Benchmark vertexing performance
 - Produced large statistics PYTHIA DIS event sample at fixed vertex
 - Can be used to produce performance plots

Thank You!!

Current workforce and meetings

Vertex reconstruction (implemented by Joe):

Acts::IterativeVertexFinder implemented in EICRecon

Using Trajectories as input

```
app->Add(new JChainFactoryGeneratorT<IterativeVertexFinder_factory>(
    {"CentralCKFTrajectories"}, "CentralTrackVertices"));
```

Currently truth seeding for tracks

Current Work Force:

Lokesh Kumar (Panjab U.)

Harsimran Singh (Panjab U.) - master student started ~ 3 months ago

Khushi Singla (Panjab U.) - master student just getting started

Sooraj Radhakrishnan (KSU/LBNL)

Joe Osborn (BNL)

Xin Dong (LBNL)

+ Shujie Li, Barak Schmookler (Reconstruction WG)

+ Ernst Sichtermann (Tracking WG)

Bi-Weekly Focus Meeting:

Thursdays, 12pm BNL Time

+ Track Reconstruction weekly meeting (Thursdays,