Update on vertexing studies at EPIC

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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)
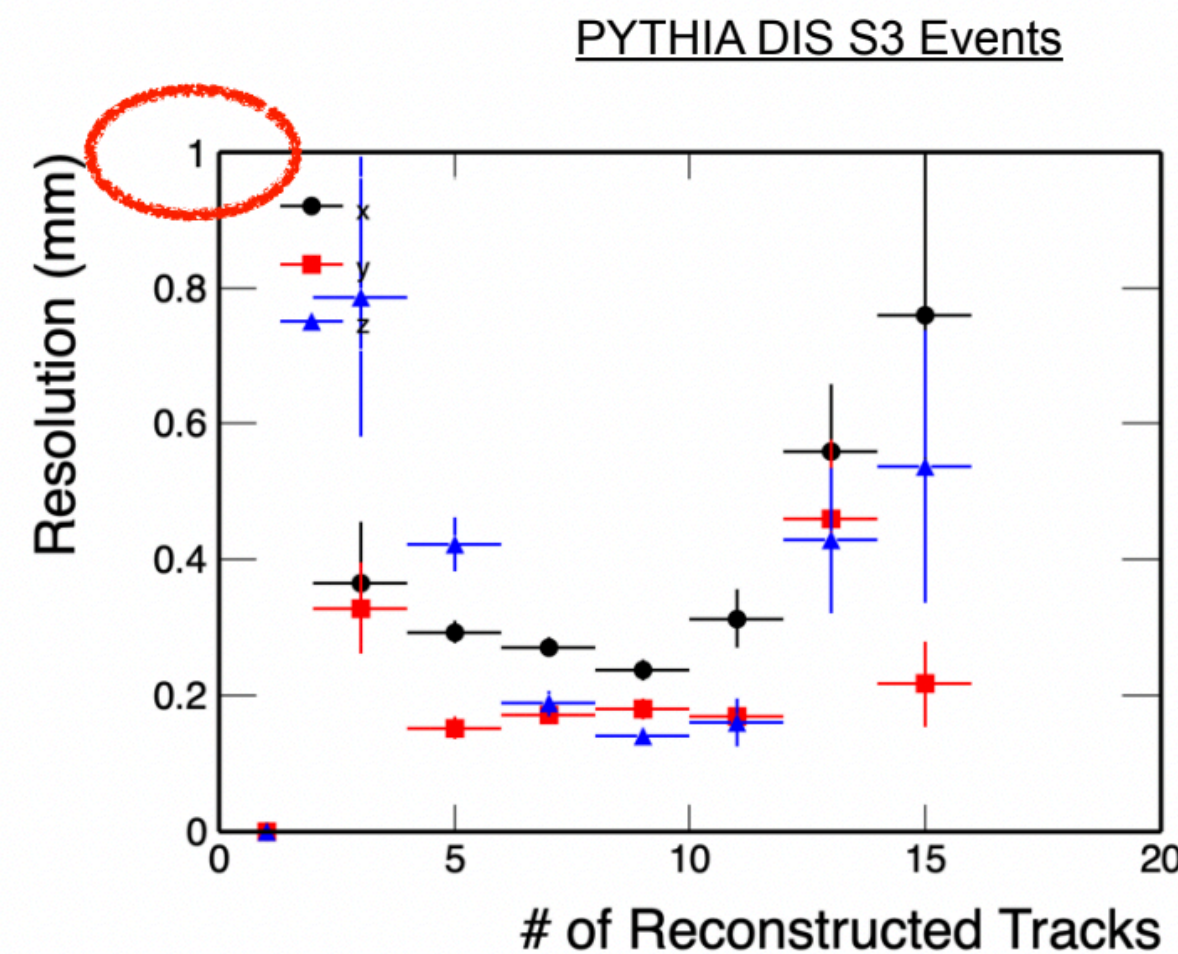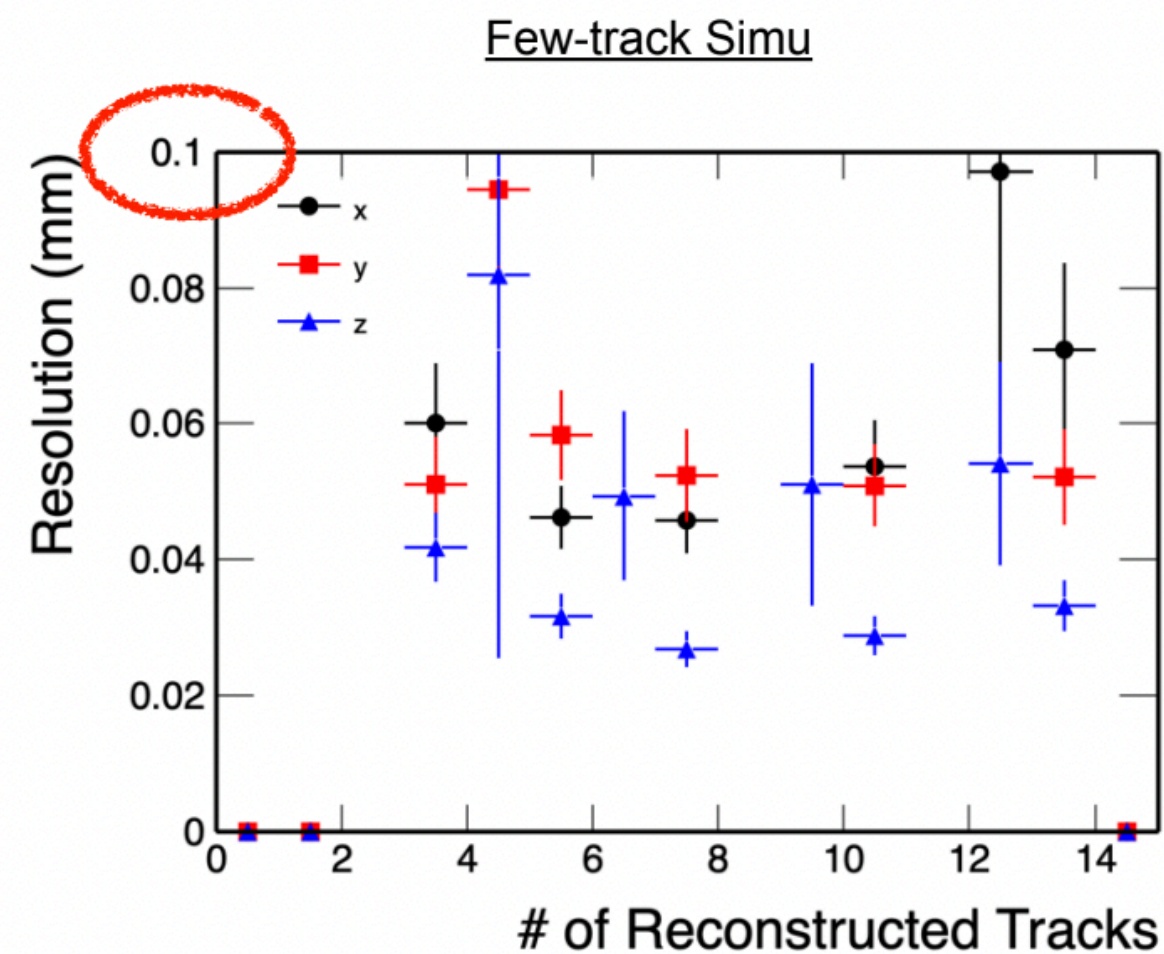
+ Shujie Li, Barak Schmookler (Reconstruction WG)
+ Ernst Sichtermann (Tracking WG)

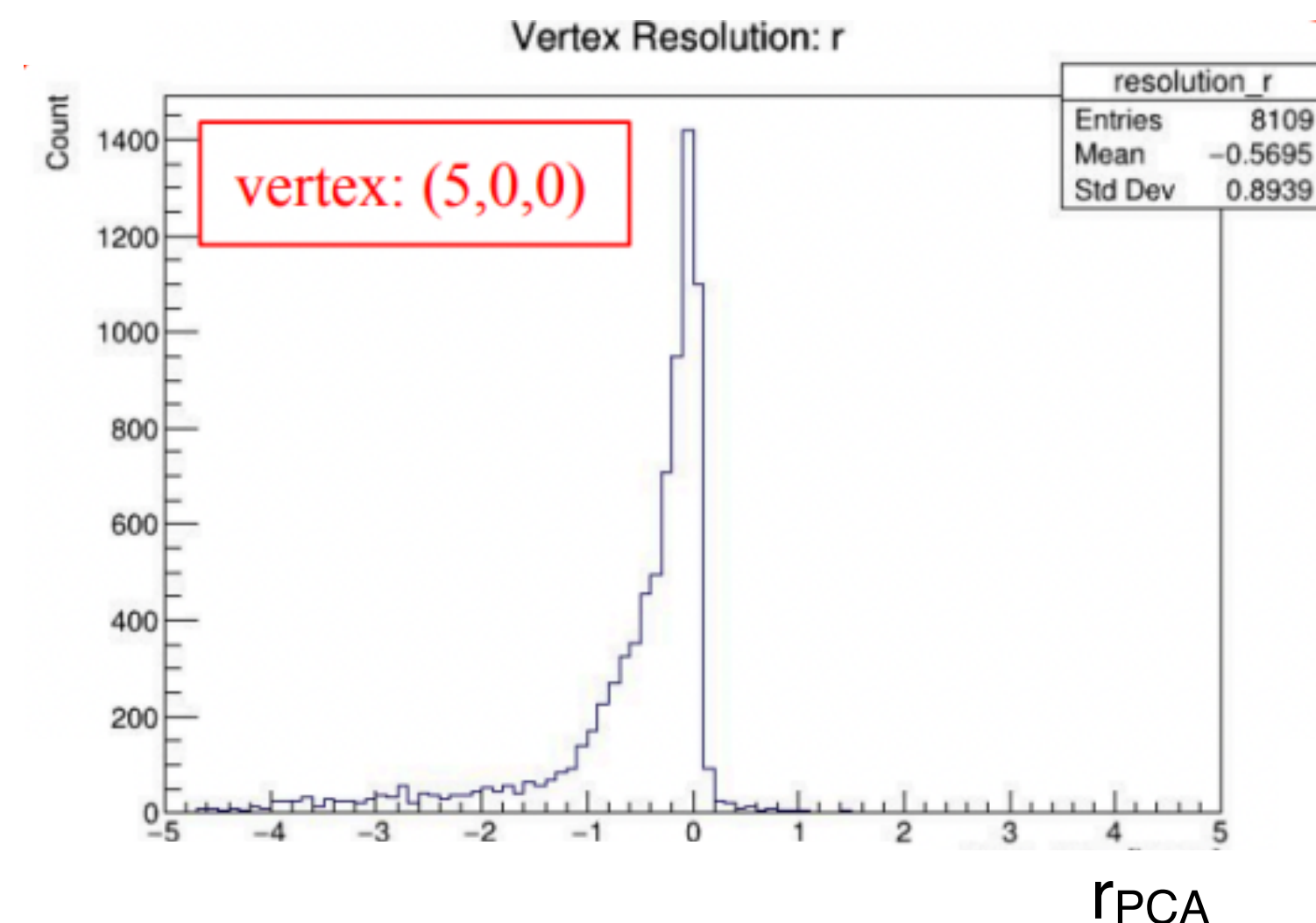Bi-Weekly Focus Meeting:

Thursdays, 12pm BNL Time

    + Track Reconstruction weekly meeting (Thursdays,

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Issues at last collaboration meeting

Few-track Simu


PYTHIA DIS S3 Events

- 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

vertex: (0,0,0)

resolution_r	
Entries	9578
Mean	−0.005459
Std Dev	0.2252

r_{PCA}

Vertex Resolution: r
vertex: (5,0,0)

resolution_r	
Entries	8109
Mean	−0.5695
Std Dev	0.8939

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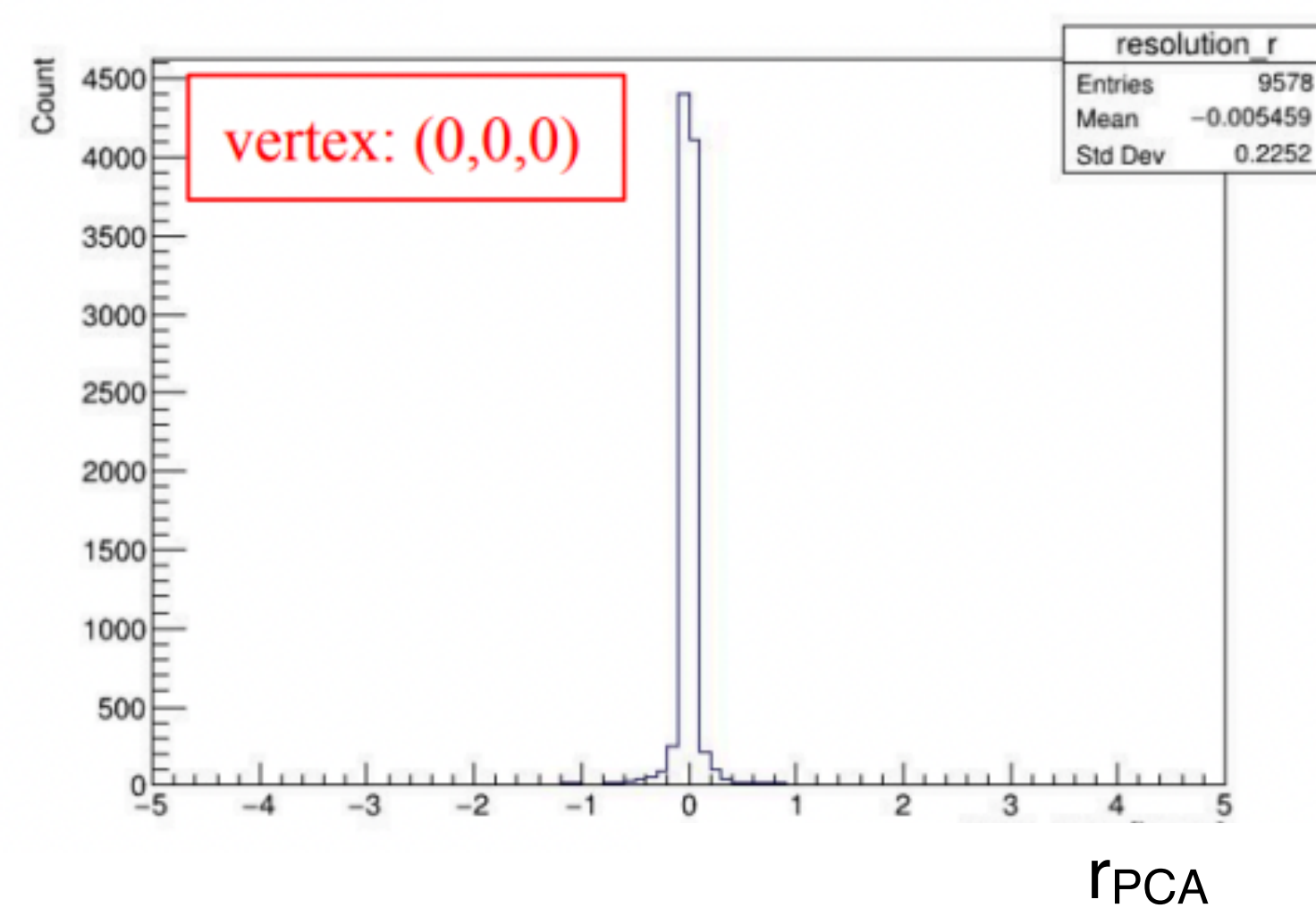
- More details in slides from Xin at CM: https://indico.bnl.gov/event/20473/contributions/84248/attachments/51909/88753/20240109_ePICColl_Vtx.pdf

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Fix for off-axis tracking issue
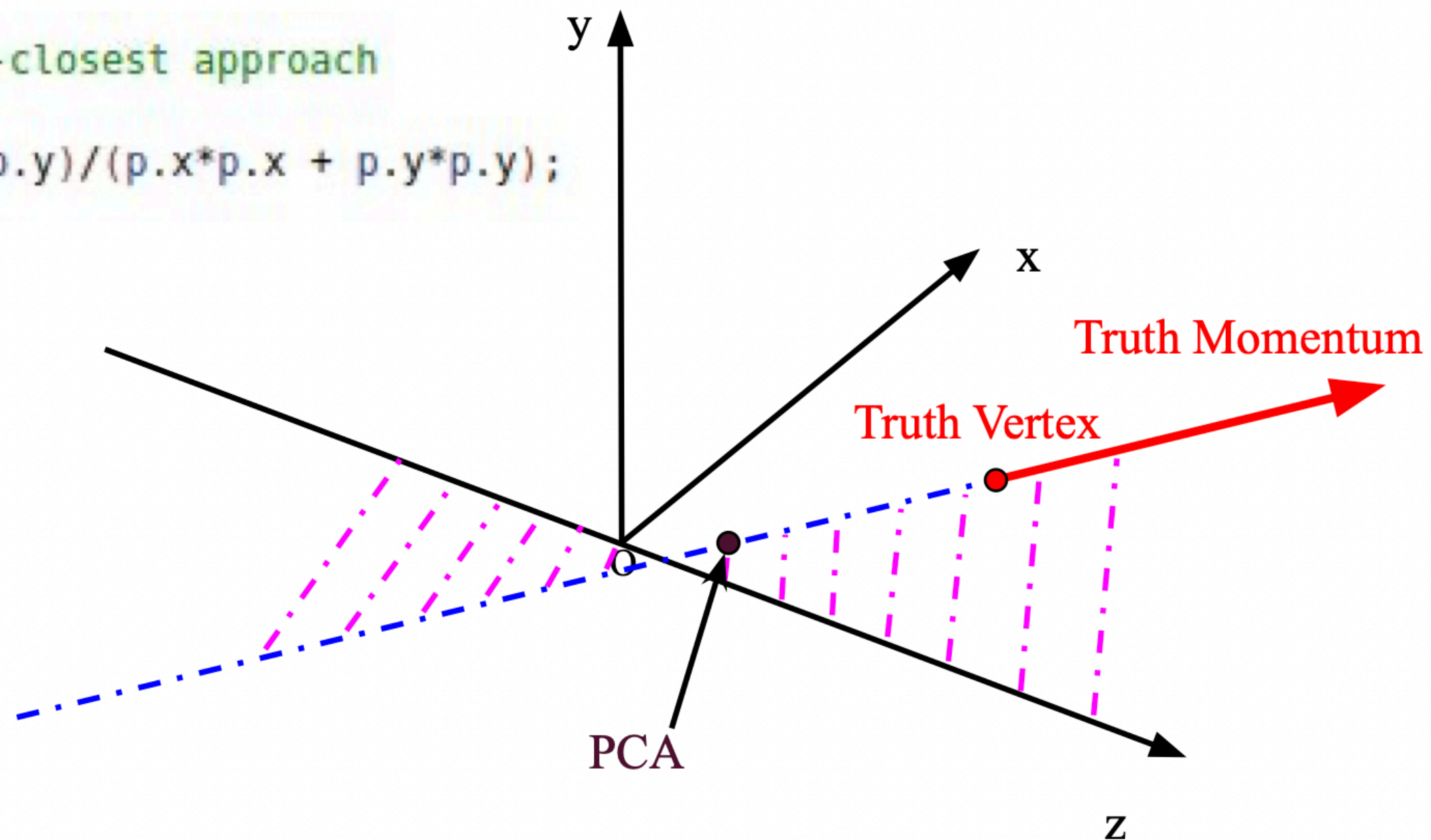
Truth seed coordinates
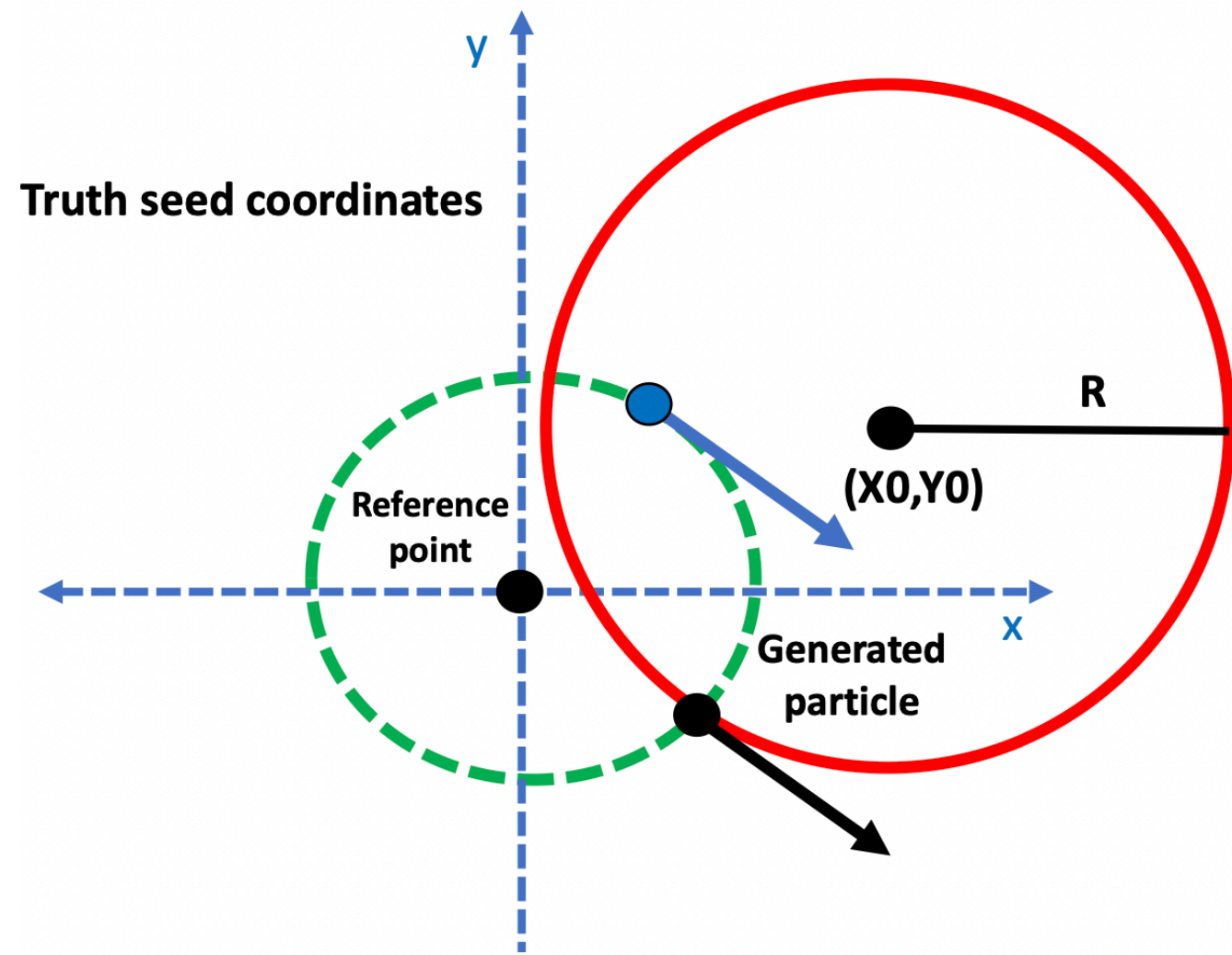
- Acts assumes perigee surface defined around (0,0,0)
- Causes wrong assumption for track parameters in truth seeding for tracks from (X,Y,0) vertices

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

```
// 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;
```
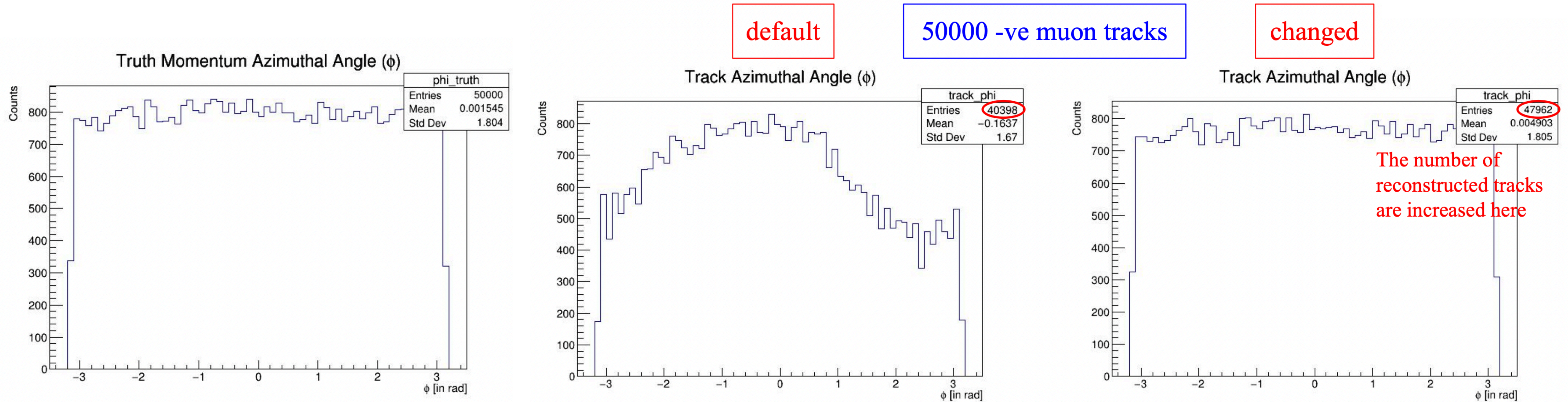
Truth Vertex Components

Truth Momentum Components

Truth Momentum

Truth Vertex

PCA

Fix to off-axis tracking

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

Vertex: (3,4,5) mm

default   50000 -ve muon tracks   changed

The number of reconstructed tracks are increased here
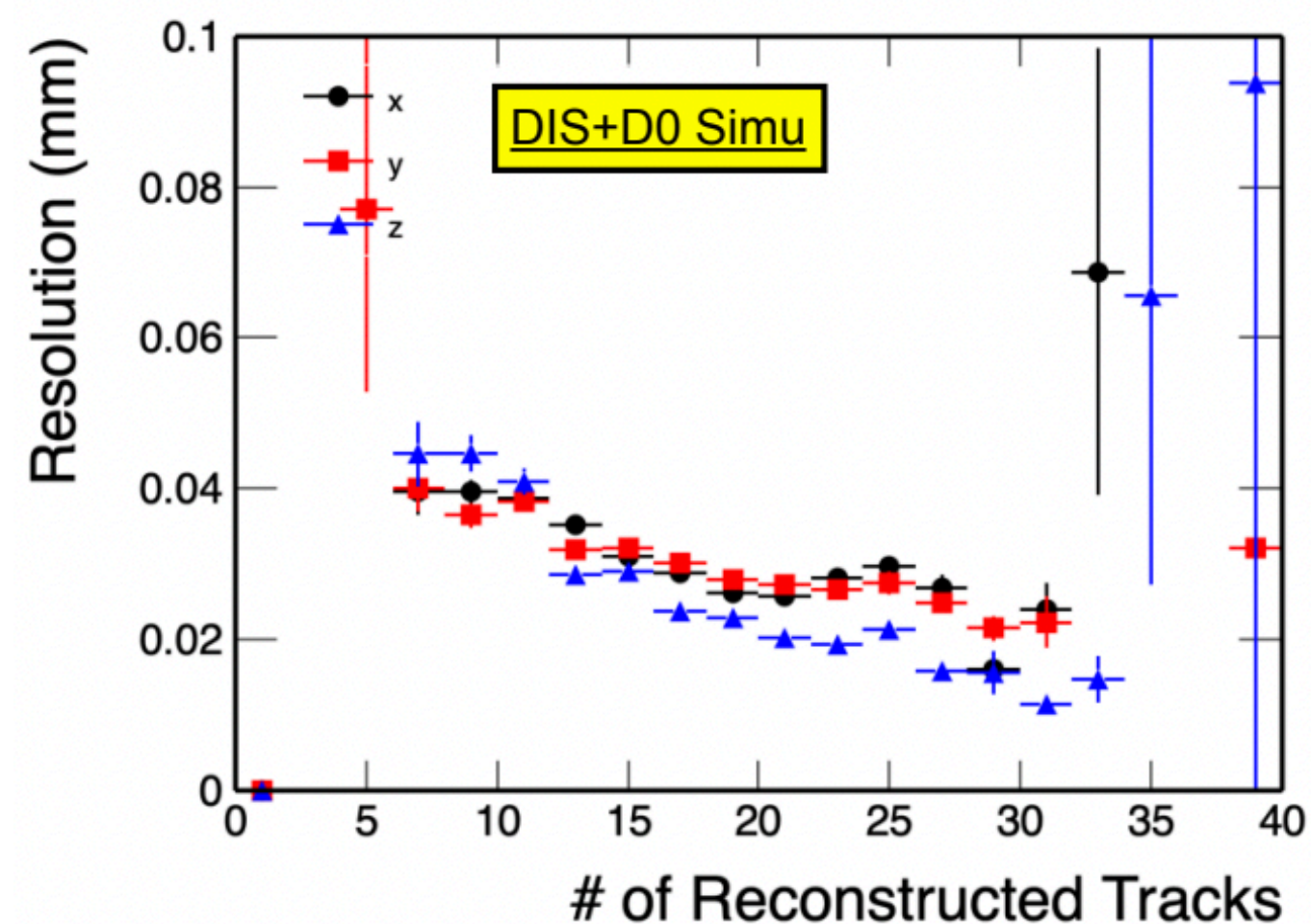
- Update fixes the tracking issue, Acts is now able to pick up the correct parameters for the tracks and reconstruct more tracks
- More details in Harsimran's slides: https://indico.b 87624/attachments/52736/90178/off-axis-tracking-issue-fix.pdf
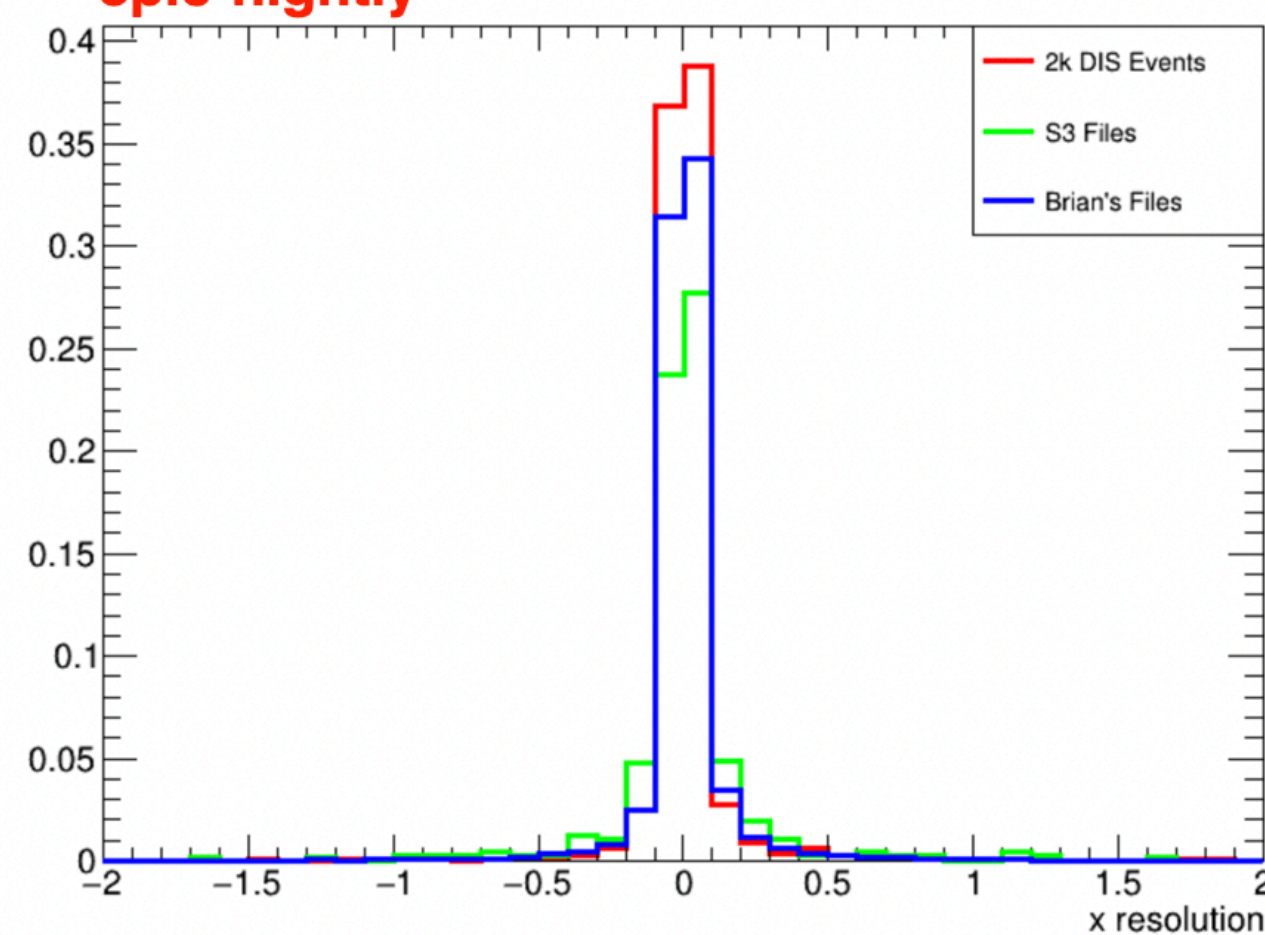
Vertex resolution in DIS events

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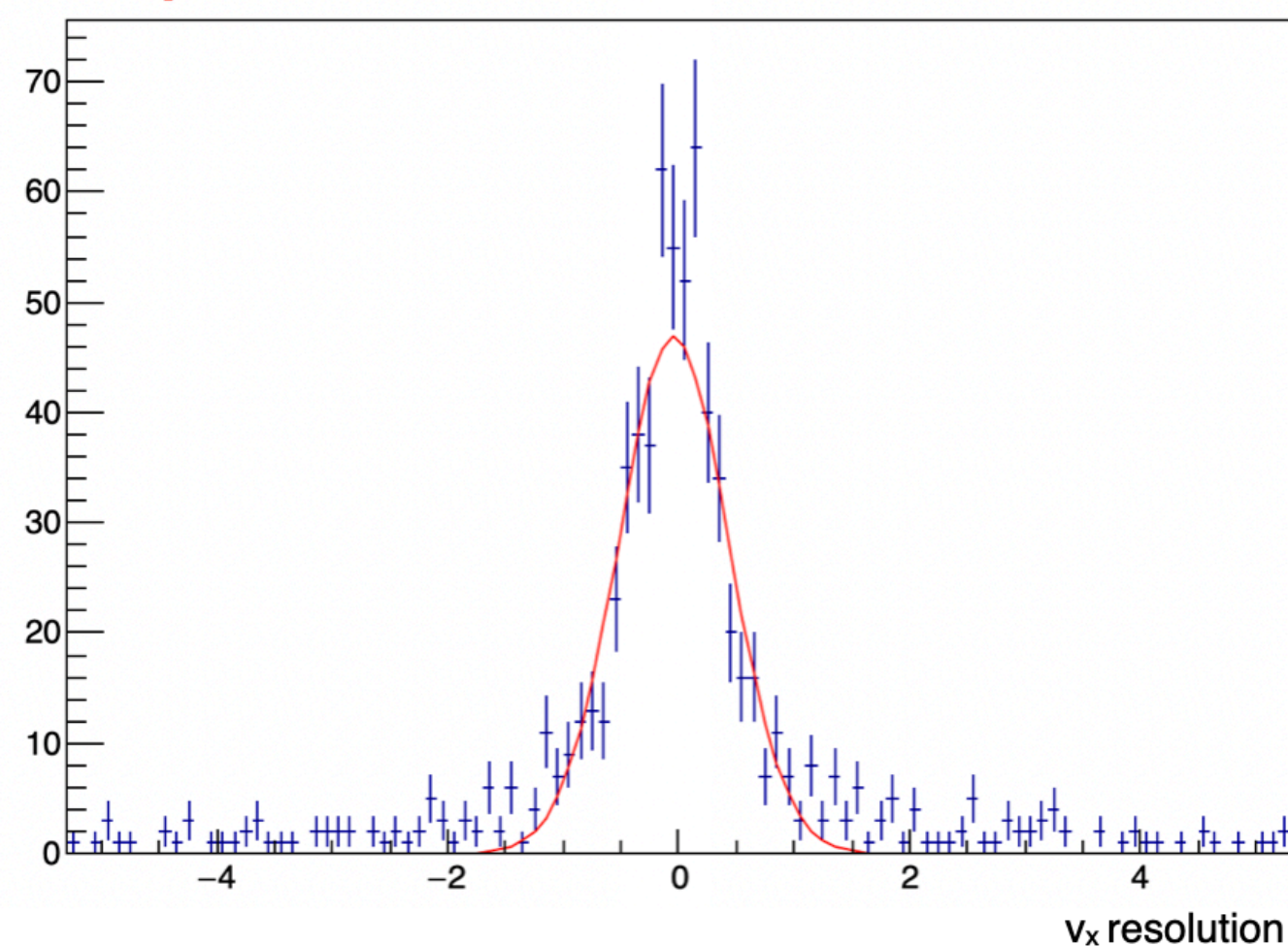
- Vertex resolution in DIS events now is comparable to that for tracks thrown at fixed vertex

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

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Optimization of vertexing
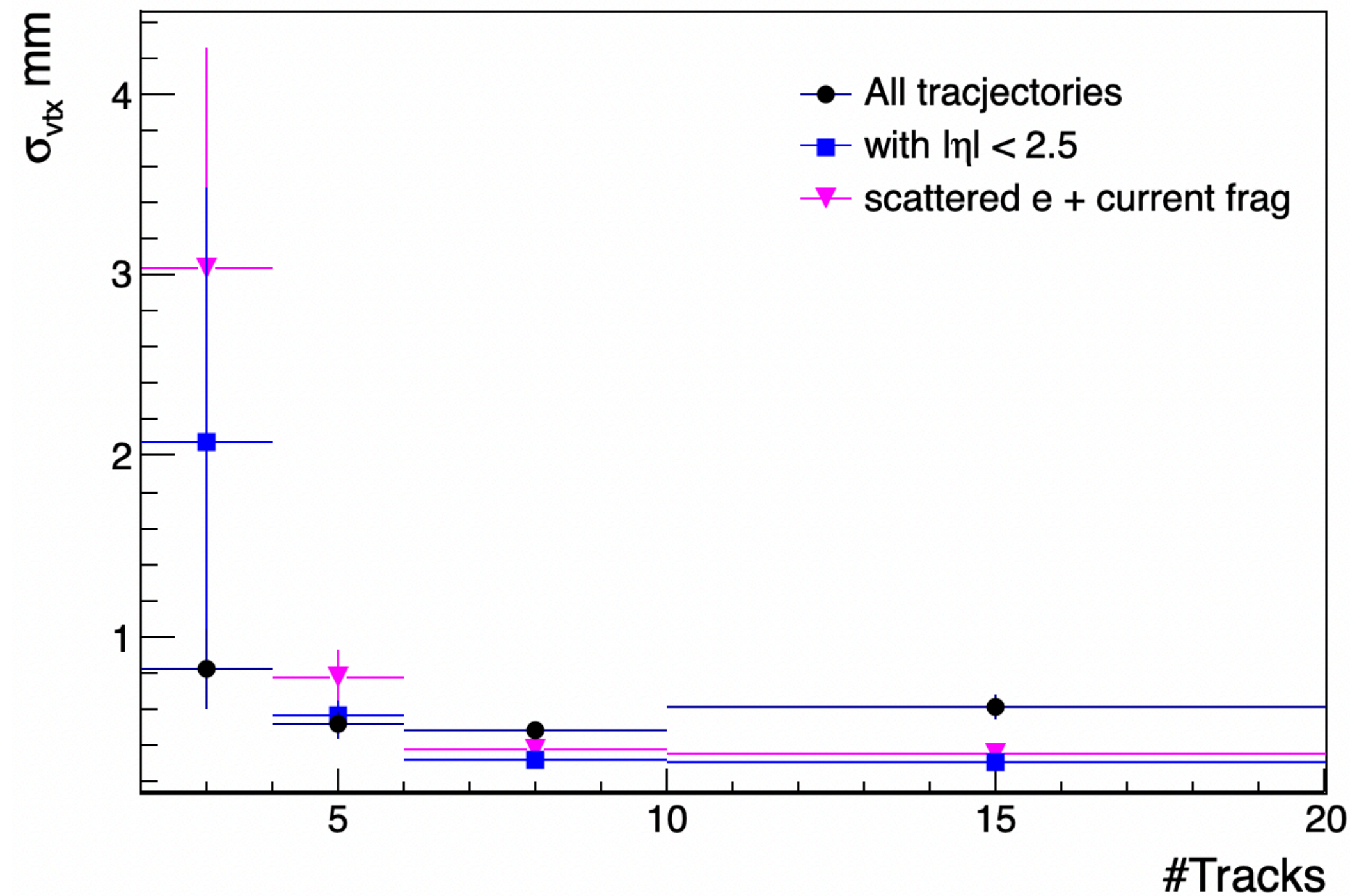
Scattered electron taken as track with charge = -1 at most negative rapidity
Leading hadrons in transverse plane opposite to it within delta_phi of π/4

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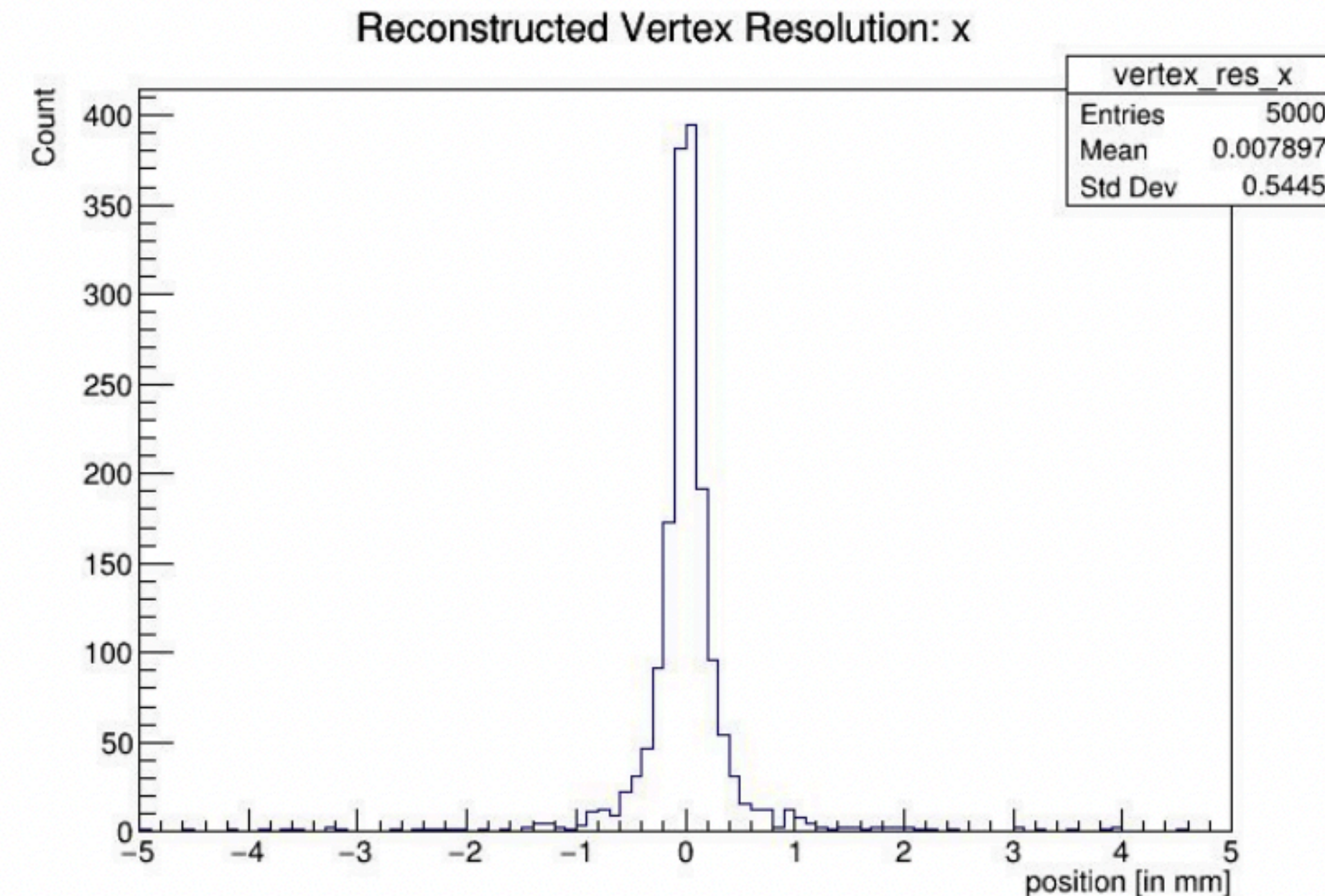
- Need to investigate with the new geometry and reconstruction
- Also need to optimize for vertexing efficiency (tolerance cuts etc)

PYTHIA DIS
e+p 18x275, $Q^2 > 10$ GeV^2

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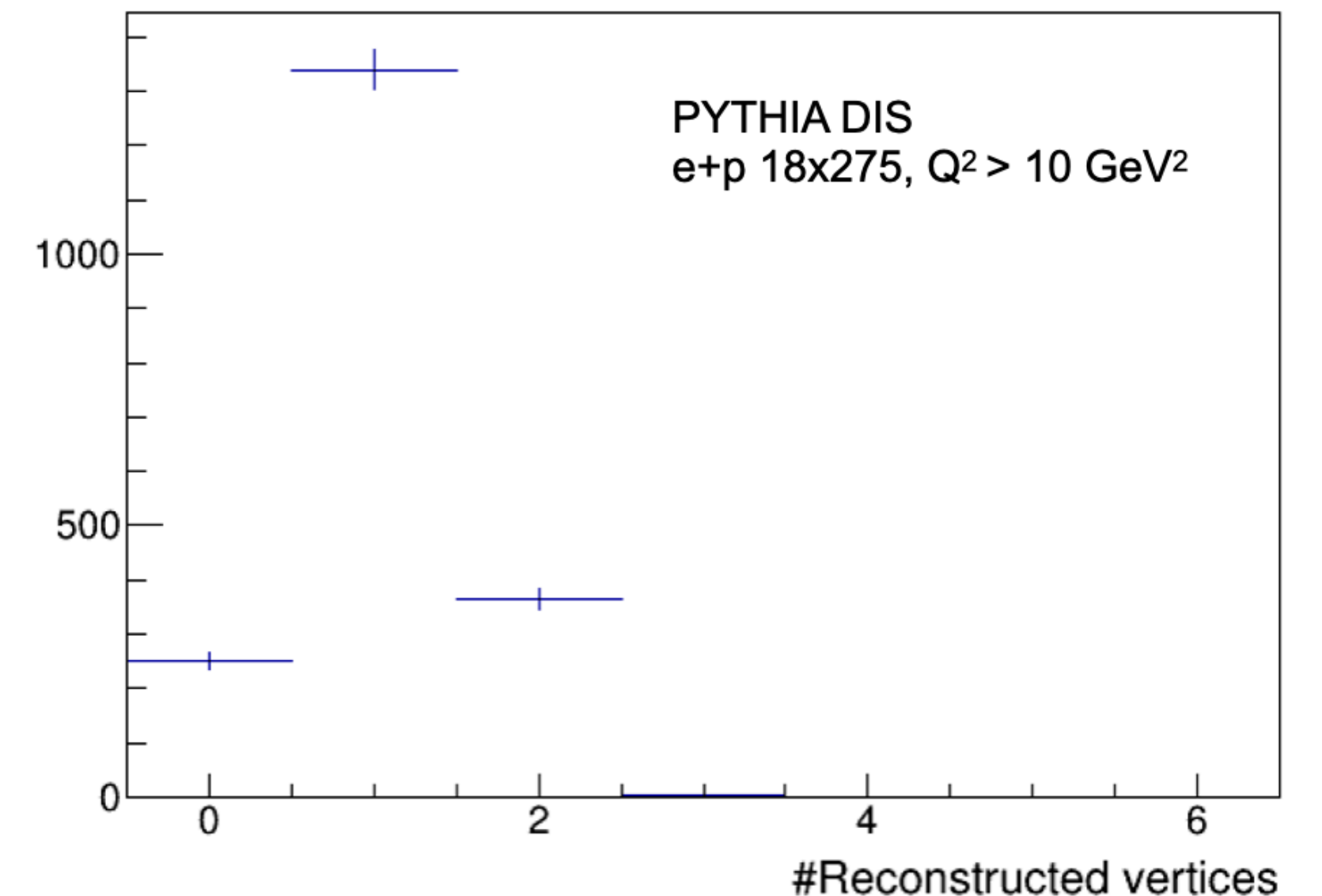
Worsening of resolution after fix?

Vertex: (3,4,5) mm
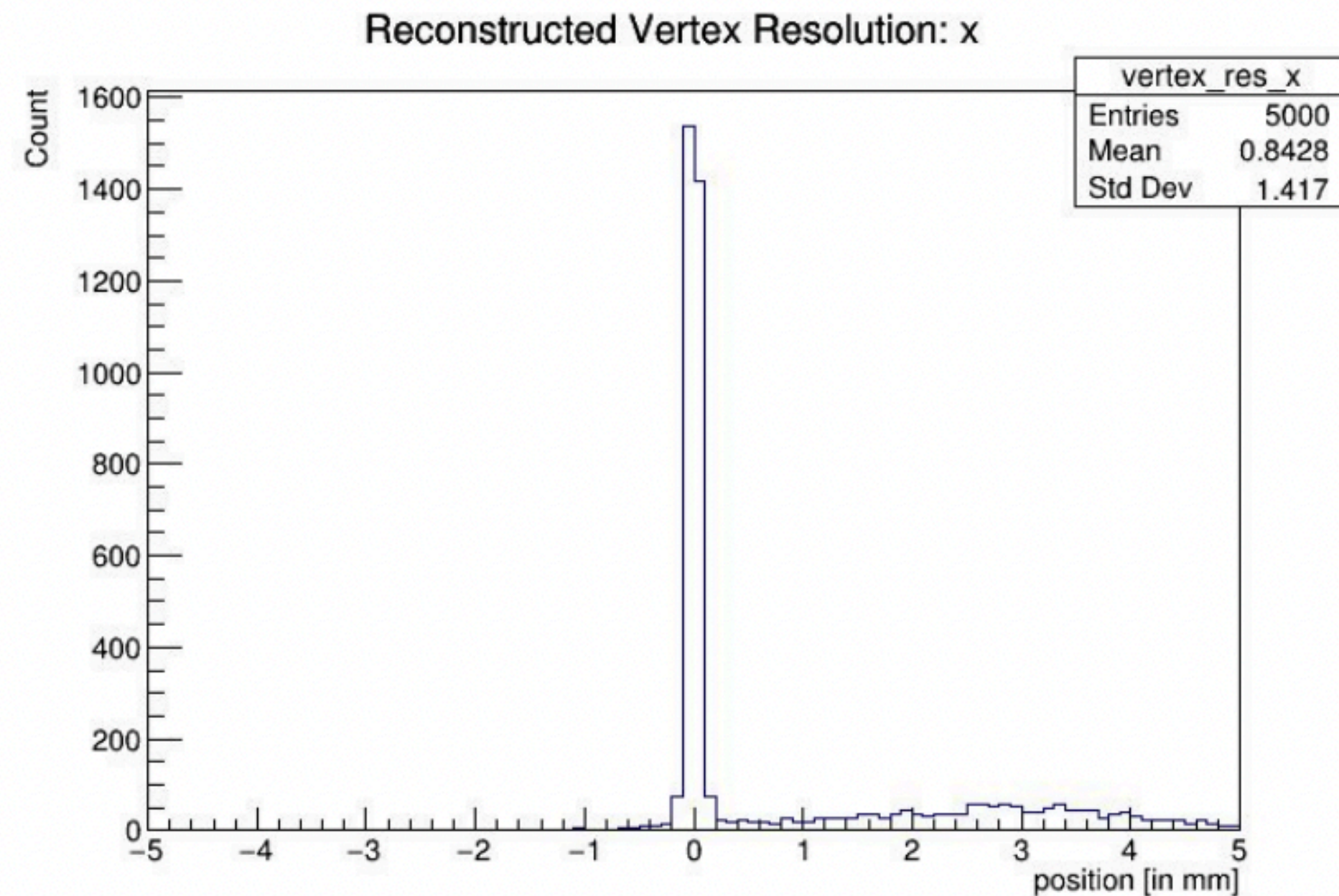
- Before and after PR#1219 fix
- Removes the vertices at large distances from truth, but the peak is broader
- From different tracks going into the vertexing? Association of trajectories (or tracks) to fitted vertices needed - Harsimran working on implementation

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 trajectory/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!!

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