Vertexing @ ePIC

Current Working 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)

Recap - Vertexing Performance Issue

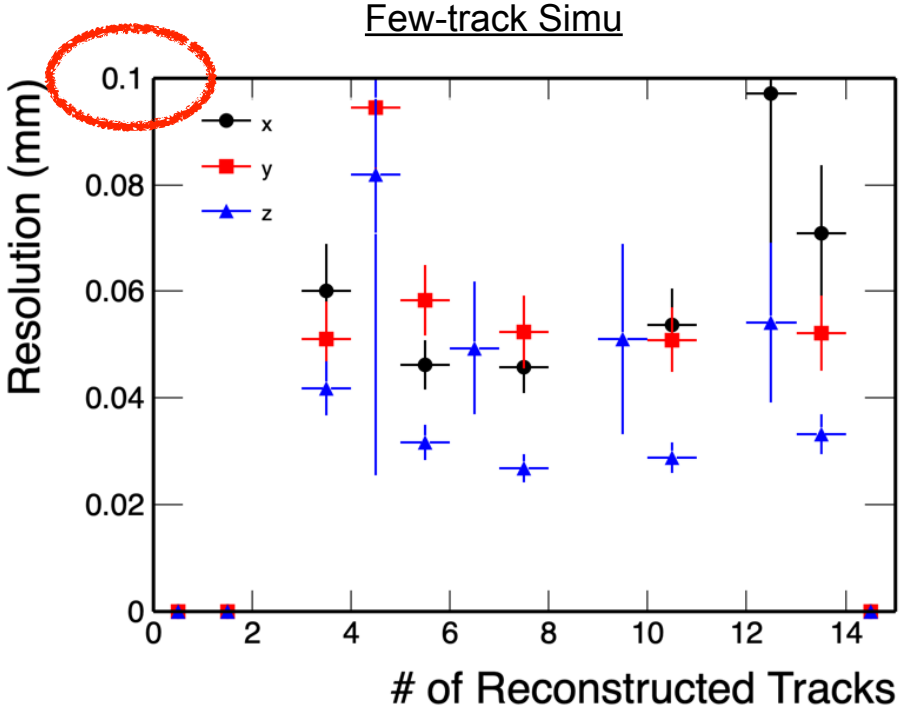
Few-track simulation: starting vertex at (0,0,z0) - **Show decent vertexing position resolution**

PYTHIA DIS event: simulation campaign events with crossing angles and random vertex positions

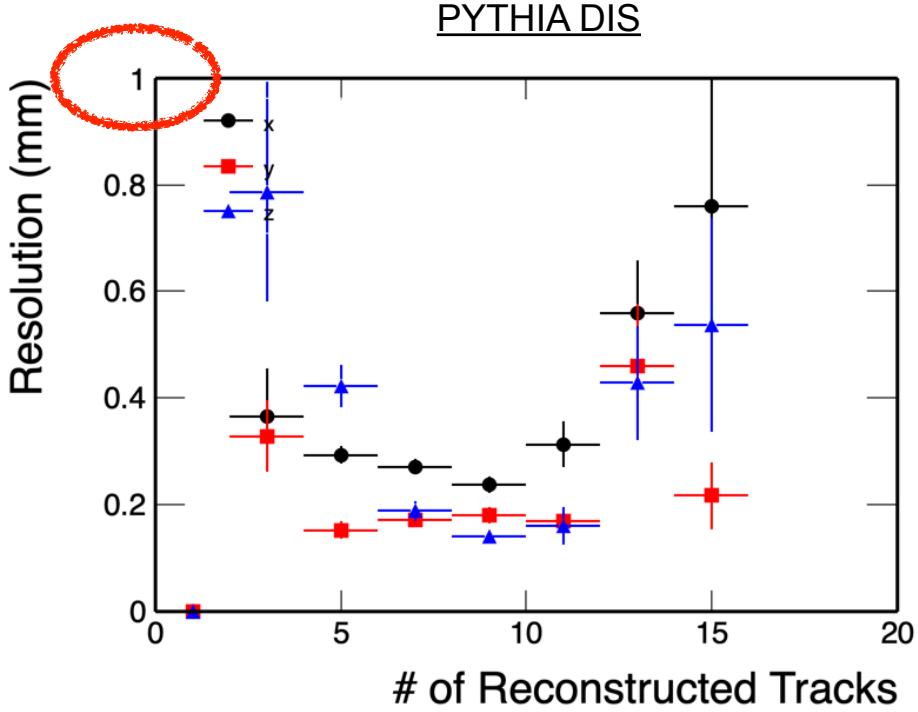
- vertex resolution worsen by ~ a factor of 5 or more

- Sooraj tested when limiting kinematic acceptance, resolution better by ~ 2, but not enough

Few-track Simu



PYTHIA DIS



Strategies:

1) Few-track simulation, check single track performances (resolution, efficiency, DCA), then moving away from (0,0) in (x,y) - Harsimran S.

2) PYTHIA DIS simulation, starting from (0,0,0) - Khushi S. just getting started

Progresses and Findings

Harsimran

10 muons per event, flat theta, pT

Simulation was run for 4 different Gun Positions i.e. vertices (1000 events each):

1. Gun Position: (0.0 0.0 0.0) // r = 0 mm, z = 0 mm (default)
2. Gun Position: (0.0 0.0 5.0) //r = 0 mm, z = 5 mm
3. Gun Position: (5.0 0.0 0.0) //r = 5 mm, z = 0 mm
4. Gun Position: (3.0 4.0 5.0) //r = 5 mm, z = 5 mm

r_{rec} : Reconstructed vertex position r (accessed as *CentralCKFTrackParameters.getLoc().a*)

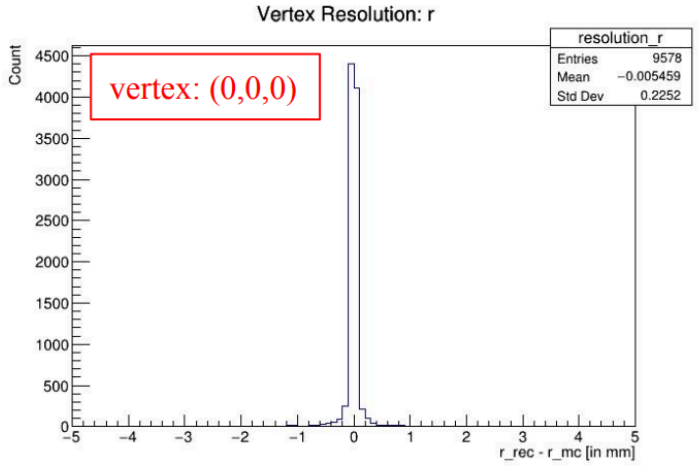
r_{mc} : Truth(MC) vertex position r

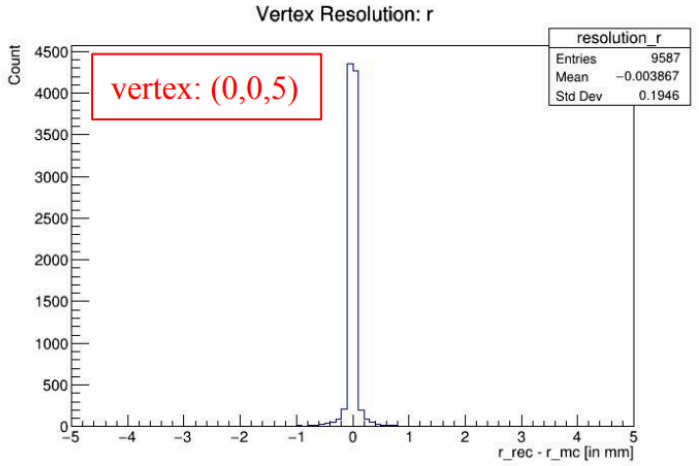
z_{rec} : Reconstructed vertex position z (accessed as *CentralCKFTrackParameters.getLoc().b*)

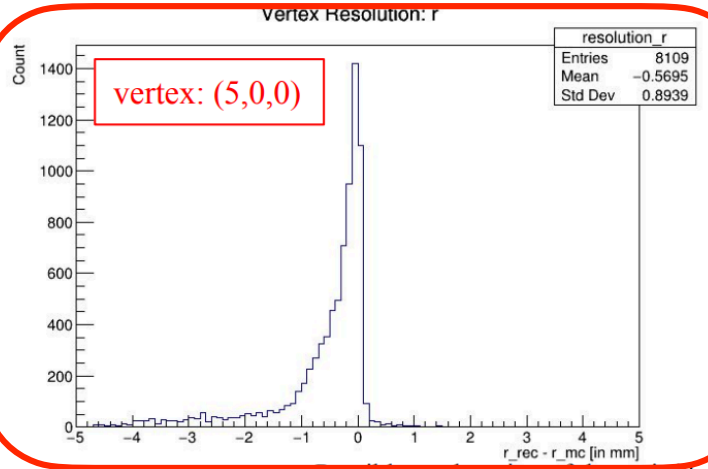
z_{mc} : Truth(MC) vertex position z

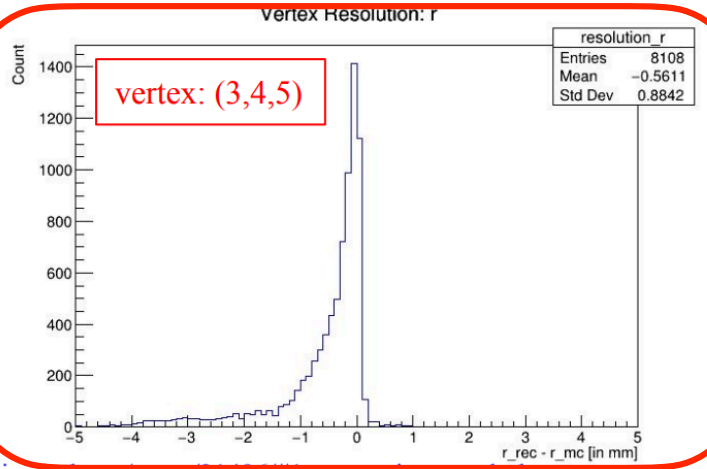
Plots: Comparison of r_{rec} - r_{mc} for all the vertices

Harsimran









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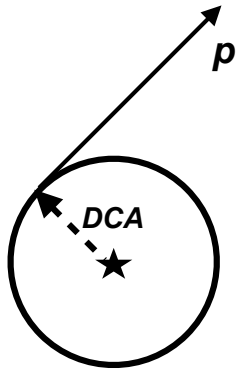
Possible explanation of the weird behaviour of resolution by Barak: https://indico.bnl.gov/event/21496/#1-comparison-study-between-act

Δr distributions are distorted for collisions originated 5mm away from (0,0)
- more fine step checks ongoing

Possible causes: 1) DCA calculation issue in ACTS (Barak's presentation from last week)
2) Limitation in only using the *r* variable in TrackParameters (next slide)

Full DCA Vector in Current TrackParameters Object

```
edm4eic::TrackParameters:
  Description: "ACTS Bound Track parameters"
  Author: "W. Armstrong, S. Joosten, J. Osborn"
  Members:
    - int32_t              type          // Type of track parameters (-1/seed, 0/head, ...)
    - uint64_t             surface       // Surface for bound parameters (geometryID)
    - edm4hep::Vector2f    loc           // 2D location on surface
    - float                theta         // Track polar angle [rad]
    - float                phi           // Track azimuthal angle [rad]
    - float                qOverP        // [e/GeV]
    - float                time          // Track time [ns]
    - int32_t              pdg           // pdg pid for these parameters
    - edm4eic::Cov6f       covariance    // Full covariance in basis [l0,l1,theta,phi,q/p,t]
```



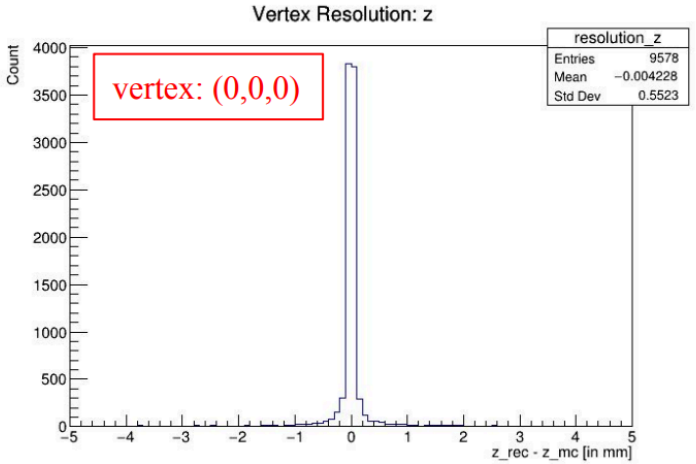
Vector2f: a - projection to (0,0) (2D signed dca to (0,0) line)
b - z component of the projection
direct information of the position phi information hidden

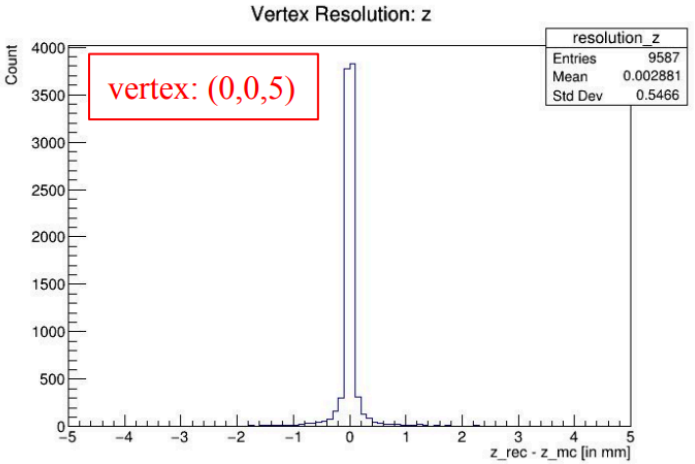
Input from Barak:
one can derive the position phi based on the momentum direction

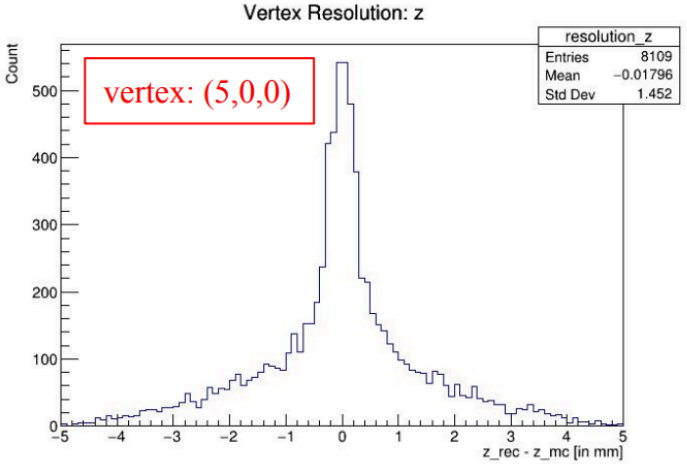
$$\overrightarrow{DCA} \perp \vec{p}$$

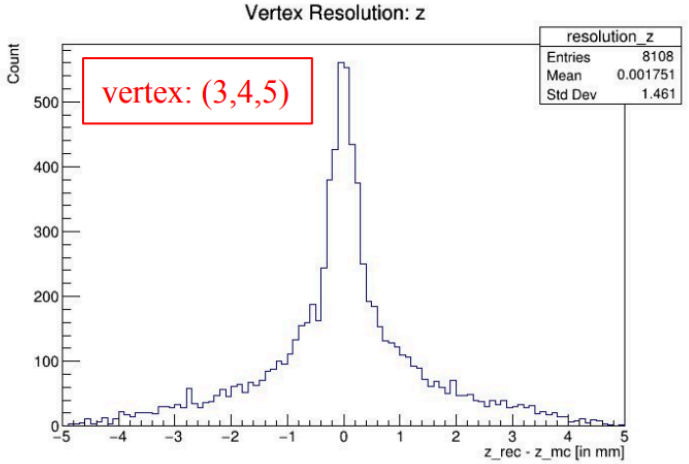
Next: Reconstruct full track helices and re-calculate the DCA to off-axis vertices
Follow up with Barak to help check the tracking issue for off-axis collisions

Plots: Comparison of z_{rec} - z_{mc} for all the vertices









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Infrastructure Updates - edm4eic::Vertex

1) Current edm4eic::Vertex definition - several information missing

2) Discussed in the Track Recon group and then the S&C group

- discussions regarding a generic vertex structure for both Rec. and MC or Generated vertices

3) Joe and I discussed further on this, we prefer to separated structure for Rec and MC vertices. Proposal on changes for Rec Vertex in PR #61.

Reconstructed Vertex

Simulated Vertex:

- Generator level vertices (HepMC data)
- GEANT Vertices

Current edm4eic::Vertex

```
## ============================================================================
## Vertexing
## ============================================================================

edm4eic::Vertex:
  Description: "EIC vertex"
  Author: "W. Armstrong, S. Joosten, based off EDM4hep"
  Members:
    - int32_t             primary       // Boolean flag, if vertex is the primary vertex of the event
    - float               chi2          // Chi-squared of the vertex fit
    - float               probability   // Probability of the vertex fit
    - edm4hep::Vector3f   position      // [mm] position of the vertex.
    ## this is named "covMatrix" in EDM4hep, renamed for consistency with the rest of edm4eic
    - edm4eic::Cov3f      positionError // Covariance matrix of the position
    - int32_t             algorithmType // Type code for the algorithm that has been used to create the v
    ## Additional parameter not in EDM4hep: vertex time
    - float               time          // Vertex time
  VectorMembers:
    - float               parameters    // Additional parameters related to this vertex - check/set the c
  OneToOneRelations:
    ## @TODO: why one and not multiple particles?
    - edm4eic::ReconstructedParticle associatedParticle // reconstructed particle associated to this vert
```

feat: update vertex edm to 4d quantities #61

Open osbornjd wants to merge 1 commit into main from vertex_edm

Conversation 1 Commits 1 Checks 3 Files changed 1

osbornjd commented last week Contributor

Briefly, what does this PR introduce?

This PR modifies the vertex EDM to contain 4D information, which is going to be needed in our streaming readout environment to separate pile up from physics bunch crossings.

Jan. Collaboration Meeting

Joint Tracking/Jets&HF/SVT Session, Wed. (1/10), 8:00-10:00am

Session

Joint Tracking/Jets&HF/SVT Session

Jan 10, 2024, 8:00 AM

Conveners

Joint Tracking/Jets&HF/SVT Session

- Ernst Sichtermann (Lawrence Berkeley National Laboratory)
- Shujie Li (Lawrence Berkeley National Laboratory)
- Brian Page (Brookhaven National Laboratory)
- Barak Schmookler (UC Riverside)
- Matt Posik (Temple University)
- Laura Gonella (University of Birmingham)
- Olga Evdokimov (UIC)