Study of primary vertexing performance in DIS events

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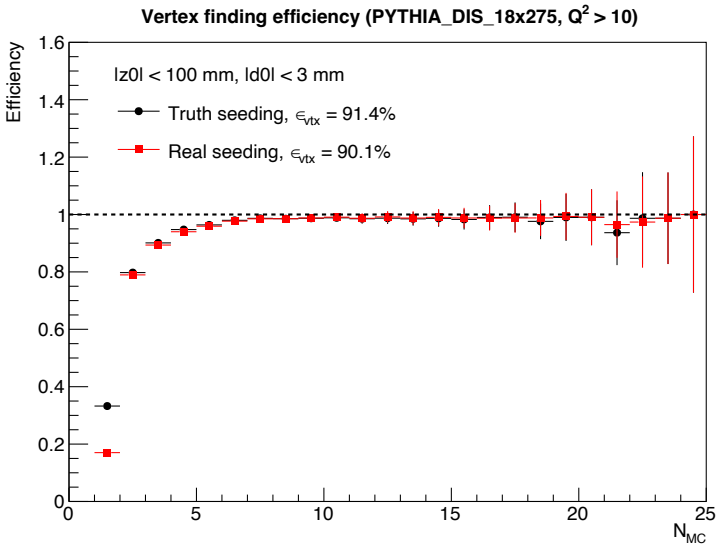
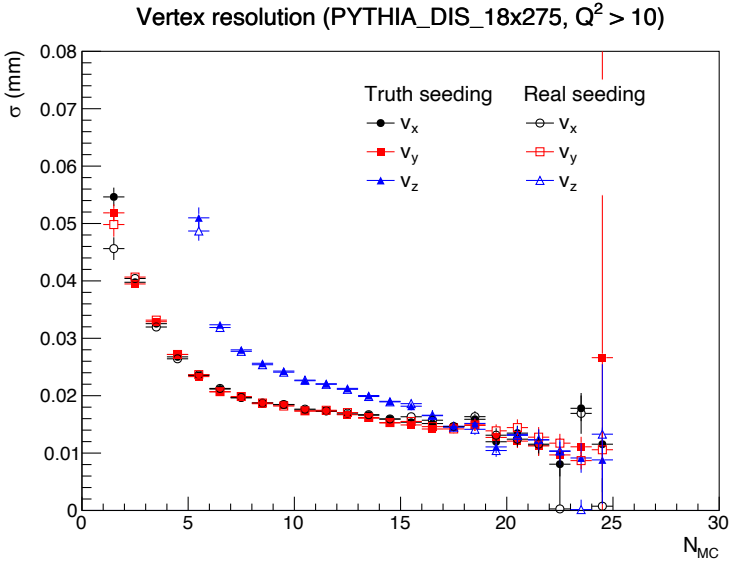
Truth vs. real seeding

Δr < 1 mm

Efficiency vs. N_{MC}



Resolution vs. N_{MC}



✓ Switch to realistic seeding as default. (PR #1605 ongoing)

Associate tracks with vertex

- List of tracks used to reconstruct a vertex is now accessible
- Merged into main branch on Aug. 26 (PR #1576)

```
edm4eic::Vertex:
  Description: "EIC vertex"
  Author: "J. Osborn"
  Members:
    - int32_t             type          // Type flag, to identify what type of vertex it is (e.g. primary, secondary, generated, etc.)
    - float               chi2          // Chi-squared of the vertex fit
    - int                 ndf           // NDF of the vertex fit
    - edm4hep::Vector4f   position      // position [mm] + time t0 [ns] of the vertex. Time is 4th component in vector
    ## this is named "covMatrix" in EDM4hep, renamed for consistency with the rest of edm4eic
    - edm4eic::Cov4f      positionError // Covariance matrix of the position+time. Time is 4th component, similarly to 4vector
  OneToManyRelations:
    - edm4eic::ReconstructedParticle associatedParticles // particles associated to this vertex.
```

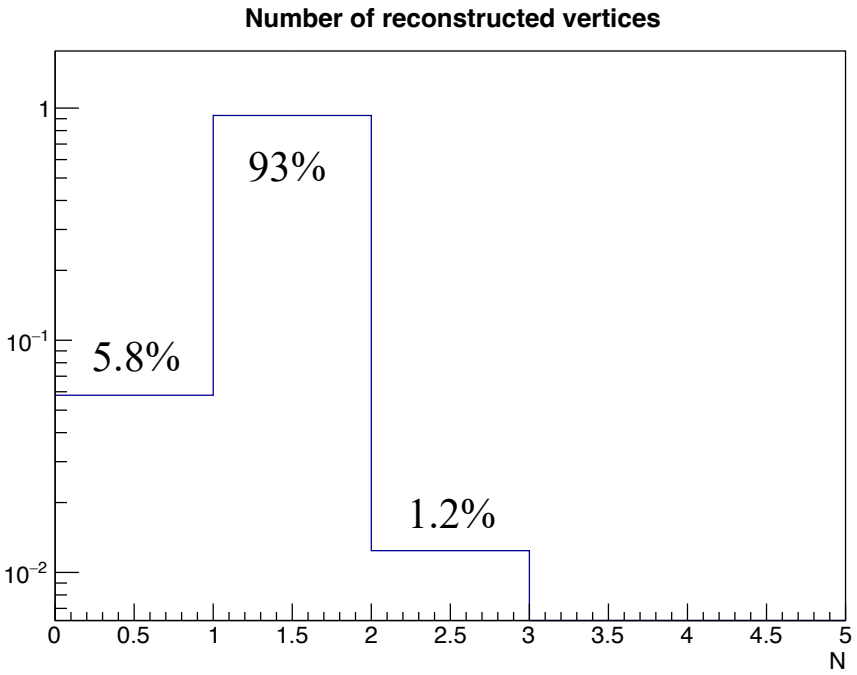
Analysis setup

- PYTHIA ep 18x275
- Vertex position: afterburner to apply beam effects
- $Q^2 > 10\ GeV^2$

- EIC geometry: *epic-24.06.0*
- EICrecon: branch *vertexing_group*

- **Real seeding**

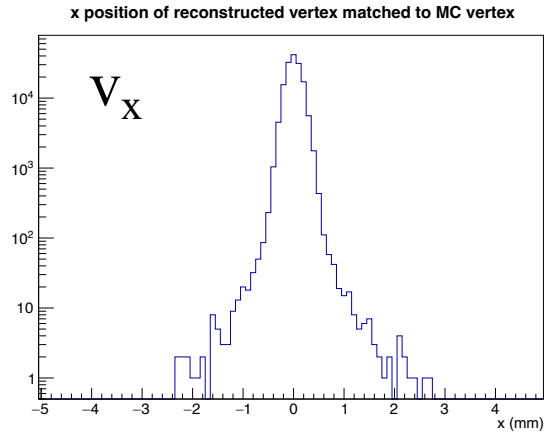
Vertex multiplicity distribution

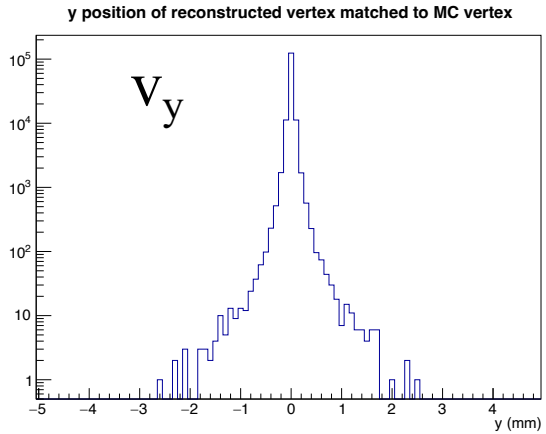


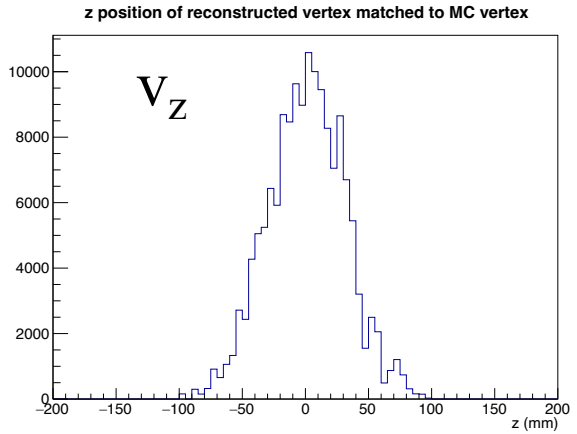
- ✓ Suggestion: select the first vertex in the vertex array as the primary vertex

- **For events with 2 vertices**
  - Case 1: almost half of the time, the two vertices are very close to each other, resulting from vertex splitting
  - Case 2: one vertex is pulled away from MC vertex by secondary tracks
  - Case 3: the second vertex corresponds to weak decays

RC vertex distributions

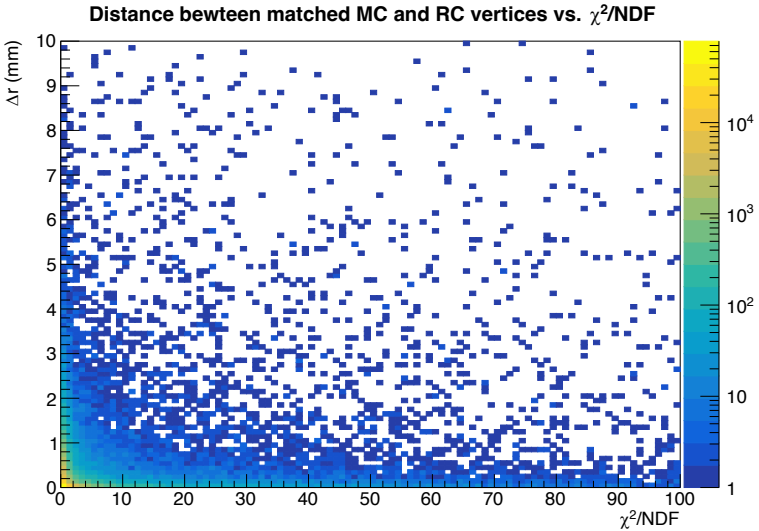


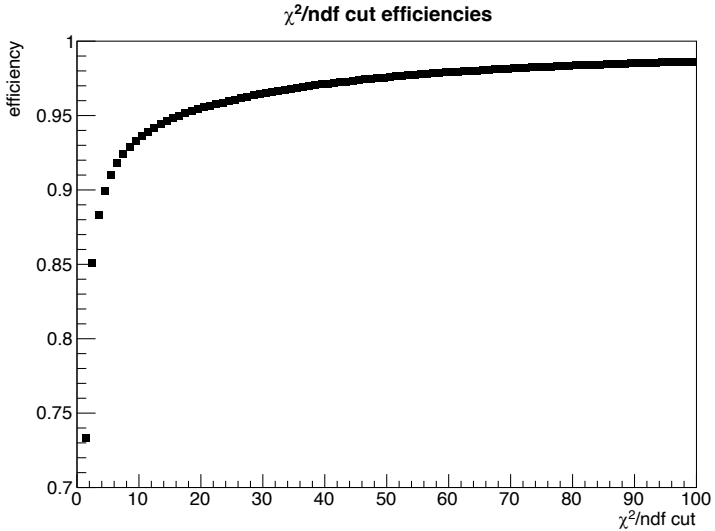




- ✓ Suggested vertex cuts:
  - $\sqrt{(v_x^2 + v_y^2)} < 3$ mm
  - $|v_z| < 100$ mm

χ^2/ndf correlation

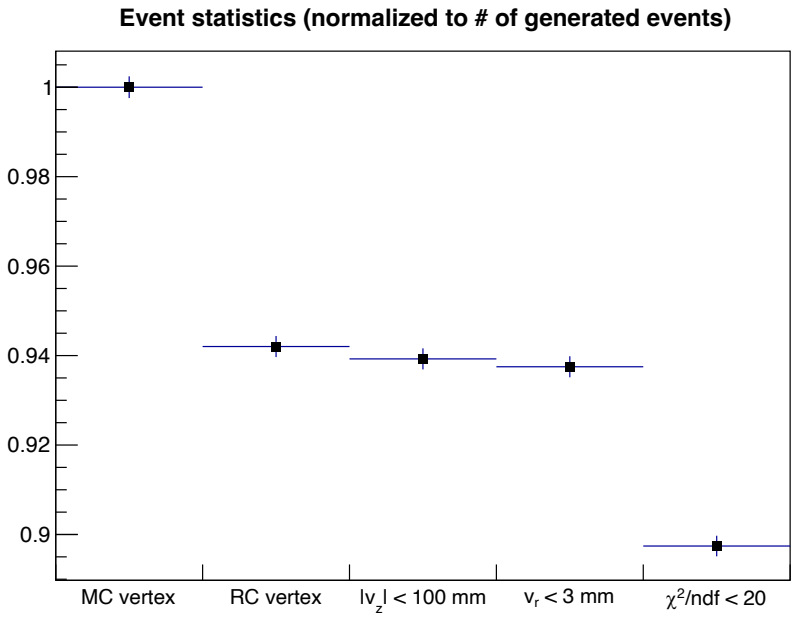




- ✓ Suggested vertex cut (optional):
  - χ^2/ndf < 20 to cut out the tail

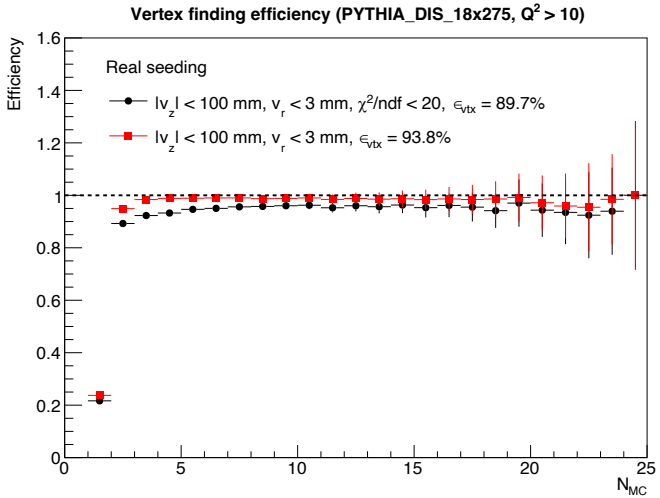
Suggested vertex cuts for analysis

- ✓ Suggested vertex cuts:
  - Choose the first vertex
  - $|v_z| < 100$ mm
  - $\sqrt{(v_x^2 + v_y^2)} < 3$ mm
  - $\chi^2/ndf < 20$ (optional)

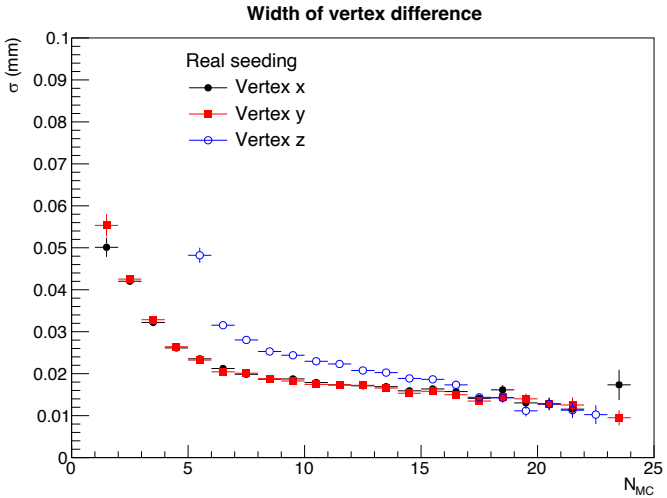


Vertex performance

Efficiency vs. N_{MC}



Resolution vs. N_{MC}



- High vertex finding efficiency at high multiplicity
- About 15 μm resolution at high multiplicity

Summary

- EICrecon
  - Switch to realistic seeding – Ongoing
  - Associate tracks with vertex – Done
- Suggested vertex selection cuts:
  - Choose the first vertex in the vertex array as the primary vertex
  - $|v_z| < 100$ mm; $\sqrt{(v_x^2 + v_y^2)} < 3$ mm
  - $\chi^2/\text{ndf} < 20$ (optional)
- **Good primary vertex performance**

- *Outlook*
  - *Develop vertex benchmark*
  - *Further tune the vertex reconstruction and vertex selection cuts using events with pileup*

Backup

Definitions

Reminder

- N_{MC} = number of charged final-state MC particles within $|\eta| < 3.5$ that are associated with the MC vertex
  - Particle production vertex within $1e^{-4}$ mm of the MC vertex

- N_{trk} or N_{RC} = number of charged tracks used to reconstruct the vertex