

D^0 Reconstruction

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Physics Goal and Strategy

Overall Objective

- Extract Gluon Sivers Asymmetry via charm production in DIS
- Use $D^0 \rightarrow K^- \pi^+$ as a clean probe of charm dynamics
- Access gluon transverse momentum distributions

Analysis Strategy

- Reconstruct D^0 candidates from kaon-pion pairs
- Select DIS events: $Q^2 > 1 \text{ GeV}^2$, $W > 5 \text{ GeV}$, $y < 0.95$
- Match Reco to MC particles to validate candidates
- Bin in azimuthal and kinematic variables for asymmetry extraction

File Source and Used Branches

DIS Dataset Location

```
root://dtn-eic.jlab.org//volatile/eic/EPIC/RECO/25.03.1  
/epic_craterlake/DIS/NC/18x275/minQ2=10/
```

Used Branches

- MCParticles
- ReconstructedChargedParticles
- ReconstructedChargedParticleAssociations
- InclusiveKinematicsElectron

Reco–MC Association with Weights

Purpose of Association Weighting

- Multiple reconstructed particles can be associated with multiple MCParticles
- Each association has a weight (confidence of match)
- Keep only the match with the highest weight per reconstructed particle

Branches Used

- ReconstructedChargedParticles
- MCParticles
- ReconstructedChargedParticleAssociations.reco
- ReconstructedChargedParticleAssociations.sim
- ReconstructedChargedParticleAssociations.weight

Final-State Particle Cuts by η Region (Last Update)

Momentum Cuts

- **Kaon Cut:**

- $-3.5 < \eta < -1.56 \Rightarrow p < 2.0 \text{ GeV}$
- $-1.56 < \eta < 1.56 \Rightarrow p < 6.0 \text{ GeV}$
- $1.56 < \eta < 3.5 \Rightarrow p < 20.0 \text{ GeV}$

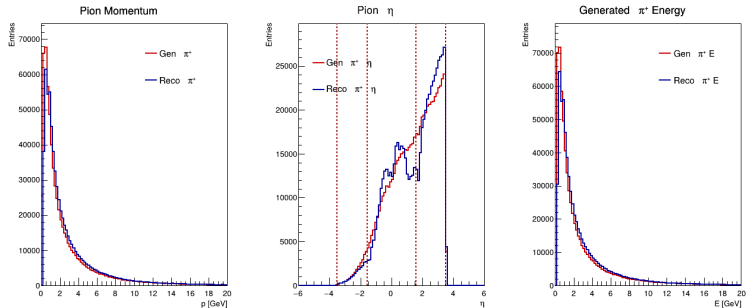
- **Pion Cut:** (same as kaon)

- $-3.5 < \eta < -1.56 \Rightarrow p < 2.0 \text{ GeV}$
- $-1.56 < \eta < 1.56 \Rightarrow p < 6.0 \text{ GeV}$
- $1.56 < \eta < 3.5 \Rightarrow p < 20.0 \text{ GeV}$

η Region Cuts

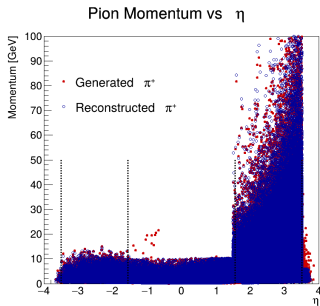
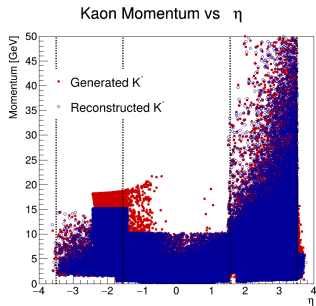
- **Generated tracks:** $-3.5 < \eta < 3.5$
- **Reconstructed tracks:** $-3.5 < \eta < 3.5$

Final State and Matched Pions (Last Update)



Observation: A mismatch is visible at low momentum. Matching was implemented *incorrectly*.

Corrected η vs Momentum Distributions Before Momentum Cuts



Note: A visible mismatch appears for high-energy kaons, caused by particle misidentification at large momenta.

Final-State Particle Cuts by η Region

Momentum Cuts(Updated)

- **Kaon Cut:**

- $-3.5 < \eta < -1.56 \Rightarrow p < 5.0 \text{ GeV}$
- $-1.56 < \eta < 1.56 \Rightarrow p < 6.0 \text{ GeV}$
- $1.56 < \eta < 3.5 \Rightarrow p < 50.0 \text{ GeV}$

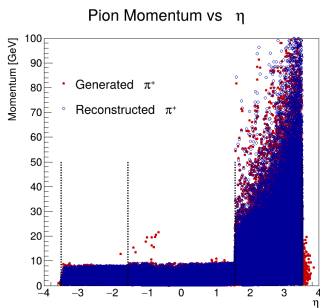
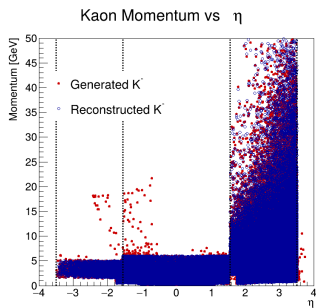
- **Pion Cut:** (same as kaon)

- $-3.5 < \eta < -1.56 \Rightarrow p < 8.0 \text{ GeV}$
- $-1.56 < \eta < 1.56 \Rightarrow p < 9.0 \text{ GeV}$
- $1.56 < \eta < 3.5 \Rightarrow p < 100.0 \text{ GeV}$

η Region Cuts

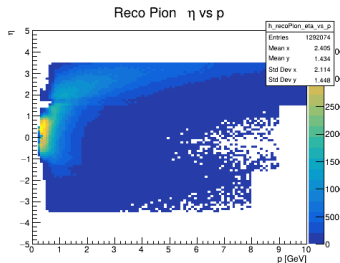
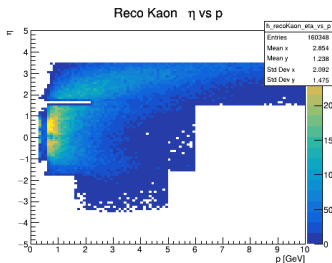
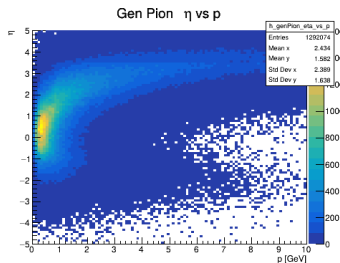
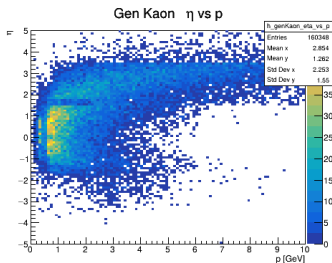
- **Reconstructed tracks:** $-3.5 < \eta < 3.5$

Corrected η vs Momentum Distributions After Momentum Cuts

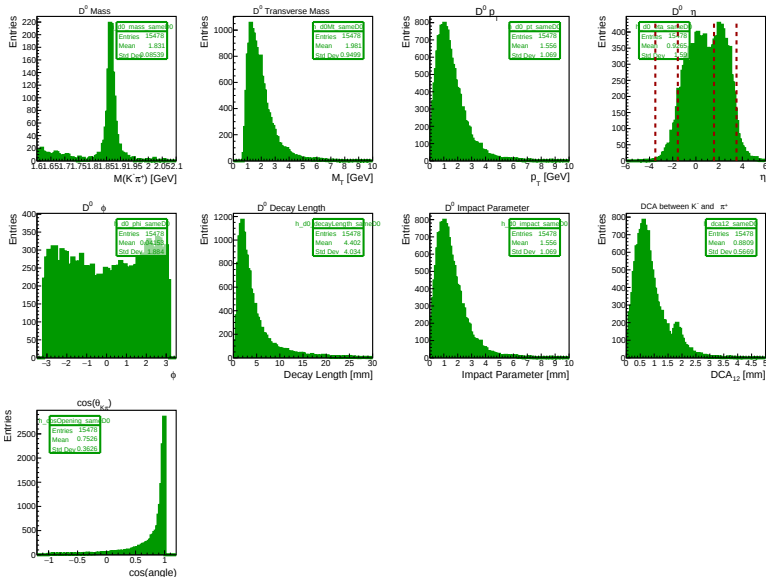


Note: Momentum cuts effectively suppress misidentified electrons and protons.

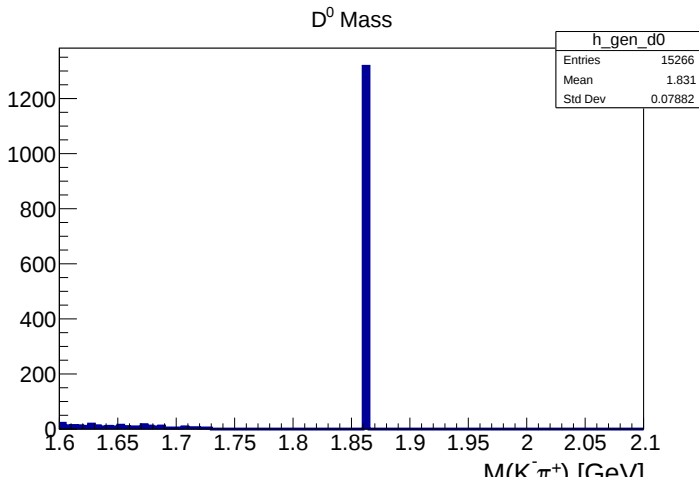
η vs Momentum for Generated and Reconstructed Particles



Updated D^0 Distributions



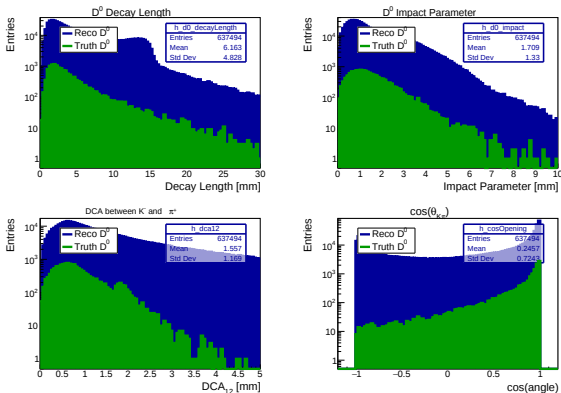
Generated D^0 Mass Check



As expected, due to multi-body decay channels, some generated combinations have invariant masses below the D^0 peak, but not above it.

D^0 Event Statistics Summary

Decay Channel	DIS Events	$\pi^- K^+$ Pairs	Generated D^0	Reconstructed D^0
$K^- \pi^+$	858,182	637,474	15,378	12,815



Summary of $D^0 \rightarrow K^- \pi^+$ reconstruction from DIS dataset.