



Time-Of-Flight PID Performance

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Motivation & Physics Goals

- Coherent exclusive vector meson production is considered an important channel for imaging the spatial distribution of gluons inside nuclei.
- We specifically focus on the ϕ meson decaying into two kaons ($\phi \rightarrow K^+ K^-$).
- The analysis suffers from a background of pions being misidentified as kaons, which distorts the ϕ invariant mass and the diffractive momentum transfer ($|t|$) distributions.
- An example of this is contamination from ρ mesons decaying into pions ($\rho \rightarrow \pi^+ \pi^-$).
- TOF PID provides K/π separation $\rightarrow$ improves the purity of the ϕ signal.

Analysis Overview & Data Source

- **Dataset:** sartre1.39-1.0_coherent_phi_eAu_bs10x100_ab.*.edm4eic.root
- **Key Branches Utilized:**
 - **MC Truth:** MCParticles.PDG, MCParticles.momentum.*
 - **Base Tracker PID:** ReconstructedChargedParticles.PDG, .momentum.*, .charge
 - **TOF PID:** CombinedTOFParticleIDs.PDG, .likelihood

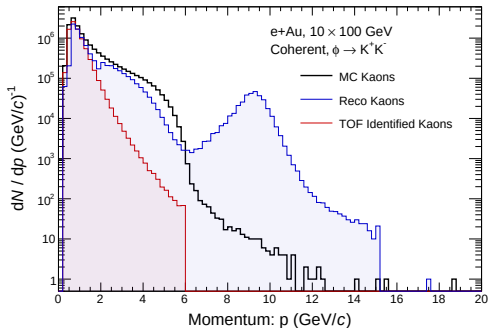
Methodology: TOF PID Extraction

- Each reconstructed track can be linked to multiple PID objects.
- The same tracks are linked to `CombinedTOFParticleIDs` via `particleIDs_begin/end` and `collectionID` (ID: 3016543328).
- For each track, the TOF PID hypothesis with the largest likelihood is assigned:

$$\text{Assigned PDG} = \arg \max_j (\text{CombinedTOFParticleIDs.likelihood}_j)$$

Quality Assurance: Kaon Kinematics I

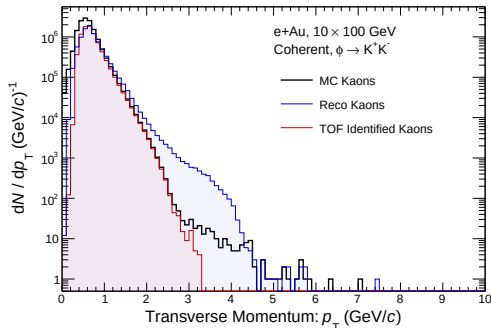
Momentum (p)



Calculated via: $|\vec{p}| = \sqrt{p_x^2 + p_y^2 + p_z^2}$.

MC Kaons: True Kaons — Rec Kaons: Reconstructed Kaons

Transverse Momentum (p_T)

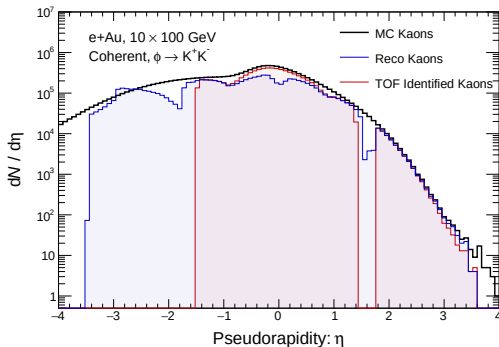


Calculated via: $p_T = \sqrt{p_x^2 + p_y^2}$.

TOF ID Kaons: Kaons ID'd by the TOF

Quality Assurance: Kaon Kinematics II

Pseudorapidity (η)

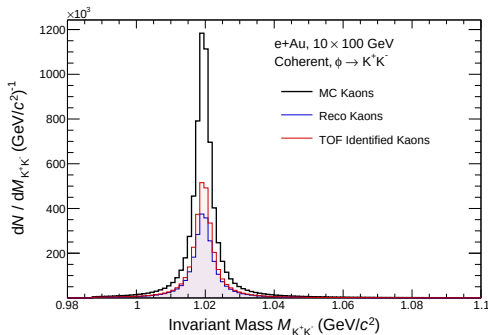


Calculated via: $\eta = -\ln(\tan(\theta/2))$.

MC Kaons: True Kaons **Rec Kaons:** Reconstructed Kaons **TOF ID Kaons:** Kaons ID'd by the TOF

Physics Performance: $\phi \rightarrow K^+ K^-$ Invariant Mass

Invariant Mass



- **Calculated via:** $M_{KK} = \sqrt{(E_1 + E_2)^2 - |\vec{p}_1 + \vec{p}_2|^2}$
- Energy components ($E_{1,2}$) are derived by forcing the Kaon mass hypothesis ($m_K \approx 0.494 \text{ GeV}/c^2$) onto the reconstructed track momenta.

Summary & Outlook

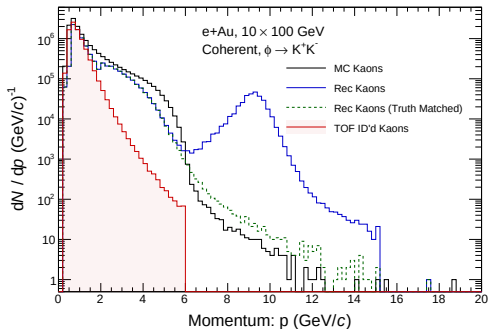
- At high momenta, inner tracker resolution degrades, resulting in a large combinatorial background of misidentified particles falsely labeled as kaons.
- TOF suppresses this high-momentum background.
- Using TOF PID matching reduces combinatorial background $\rightarrow$ improving the purity of the reconstructed $\phi \rightarrow K^+ K^-$ invariant mass peak.
- **Outlook:** Using TOF-identified kaons to study the $|t|$ distribution and evaluate TOF capabilities for exclusive diffractive measurements.

Thank you.

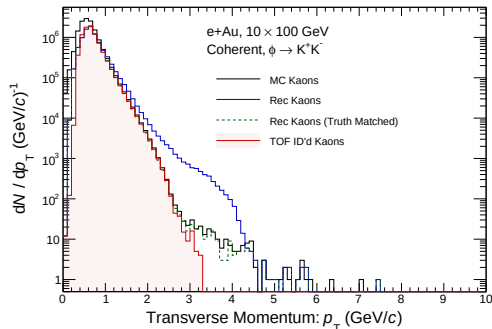
Appendix

Quality Assurance: Kaon Kinematics I

Momentum (p)



Transverse Momentum (p_T)



Calculated via: $|\vec{p}| = \sqrt{p_x^2 + p_y^2 + p_z^2}$.

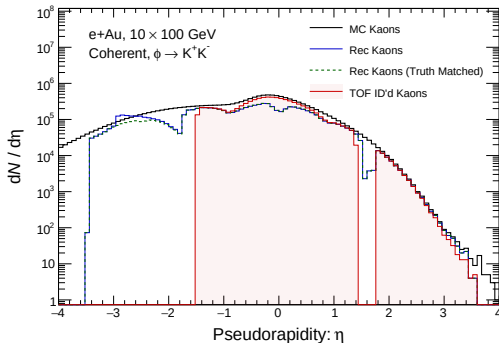
MC Kaons: True Kaons — **Rec Kaons:** Reconstructed Kaons —

Rec Kaons (Truth Matched): Reconstructed Kaons matched with True Kaons — **TOF ID Kaons:** Kaons ID'd by the TOF

Calculated via: $p_T = \sqrt{p_x^2 + p_y^2}$.

Quality Assurance: Kaon Kinematics II

Pseudorapidity (η)



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