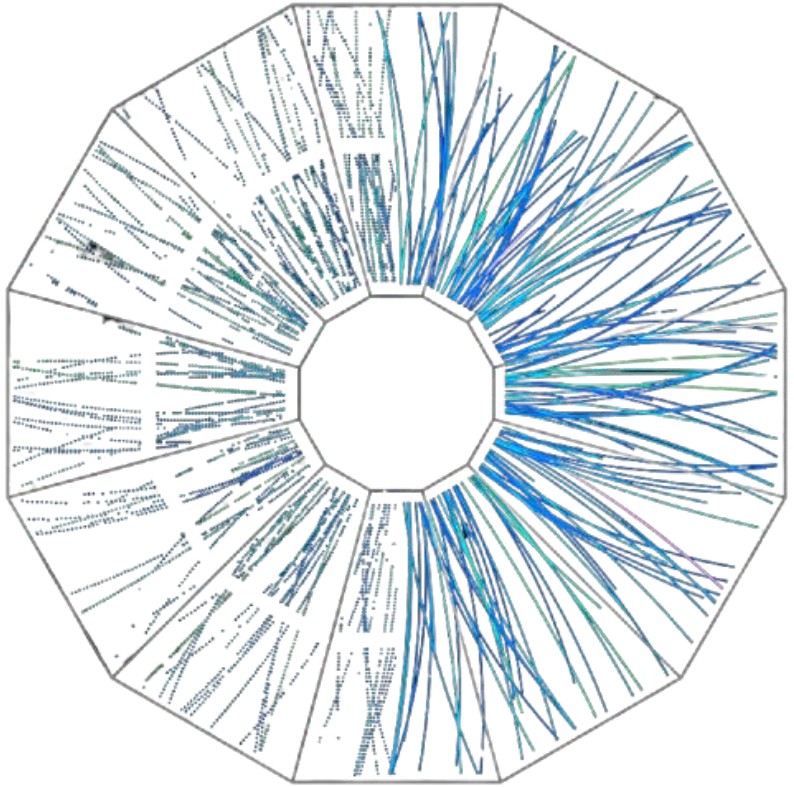
Jet Analysis for ESR

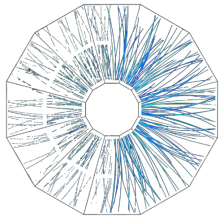


Dener De Souza Lemos (BNL)

Jets&HF Working Group

May 19st, 2026

Brookhaven National Laboratory

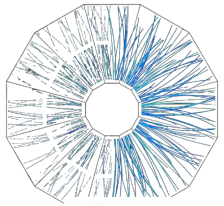


Simulation Details

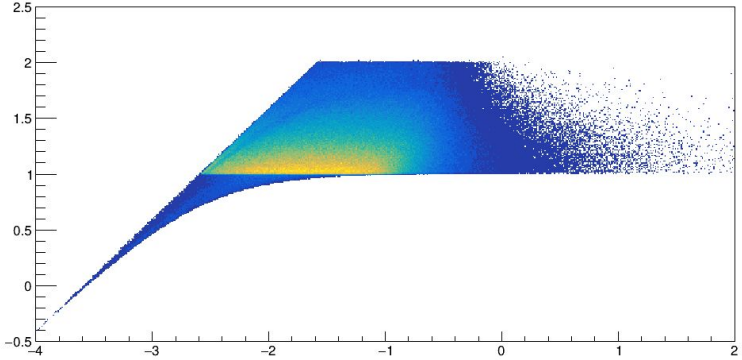
- Geometry: **26.04.1**
- **$10 < q^2 < 100$**
- ep: PYTHIA 6.428 – 10x130
  - *epic:/RECO/26.04.1/epic_craterlake/DIS/pythia6.428-1.0/NC/noRad/ep/10x130/q2_10to100*
- eAu: BeAGLE 1.03.02-2.0 – 10x100
  - *epic:/RECO/26.04.1/epic_craterlake_without_zdc/DIS/BeAGLE1.03.02-2.0/eAu/10x100/q2_10to100*

- Jet reconstruction
  - Charged jets:
    - Electron removed using true PID
    - Remove jets with 1 track inside
    - Cuts presented in plots/slides
  - anti-k_T with R = 0.3, 0.5, 0.8 and 1.0
  - Jet Tree maker:
    - https://github.com/denerslemos/CHJetsReCluster
    - Trees can be found at:

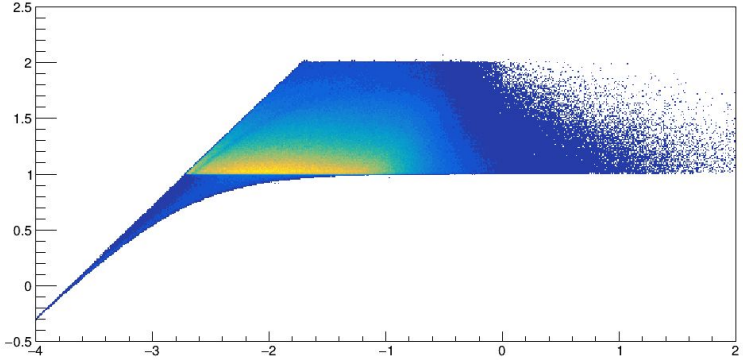
      /gpfs02/eic/ddesouza/JetTrees/April2026



x-Q^2 maps

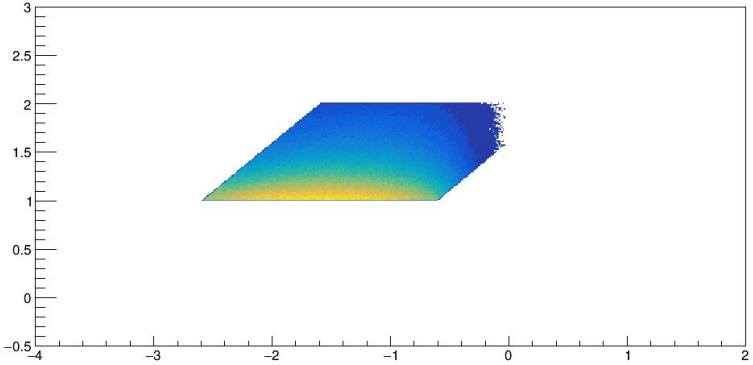


RECO

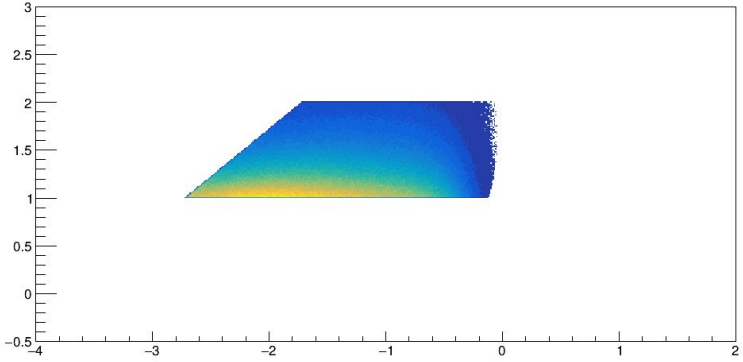


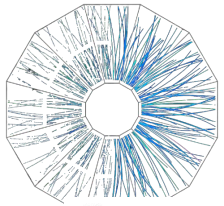
e+Au

e+p



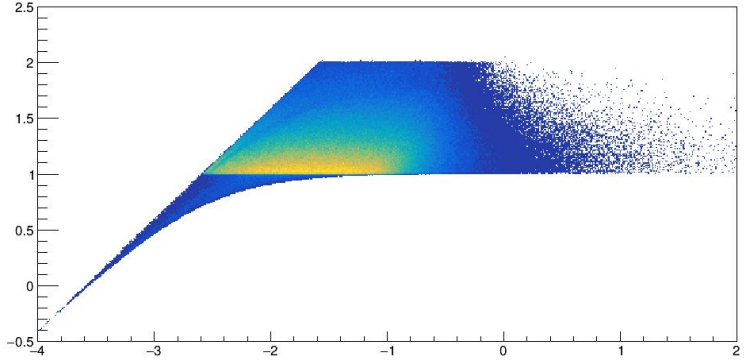
GEN





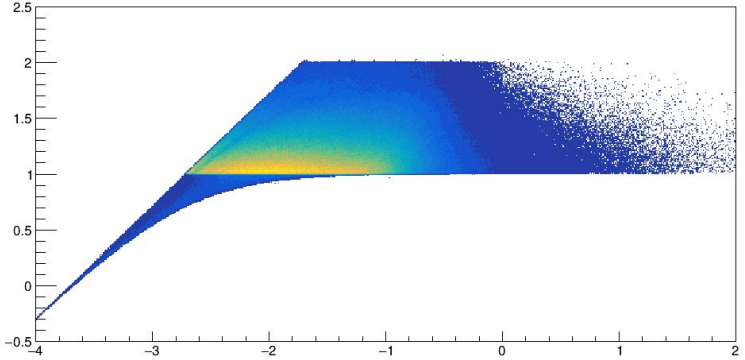
x-Q^2 maps

ALL log(x) dependency uses gen variables

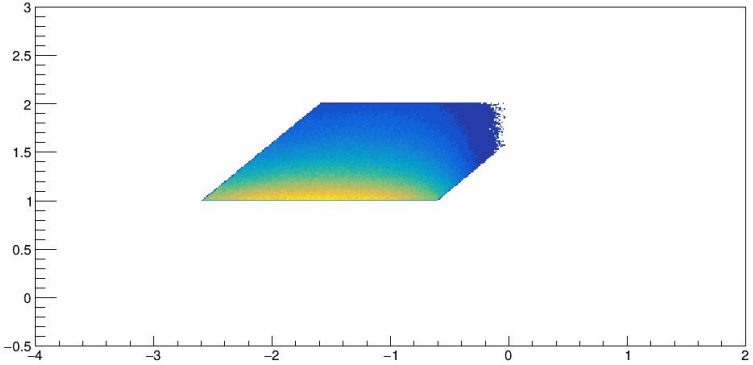


e+Au

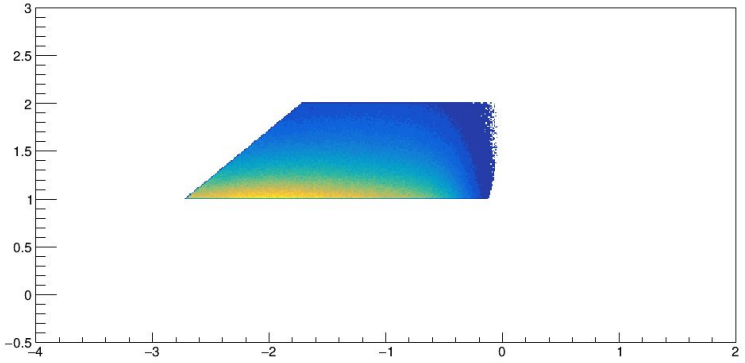
RECO



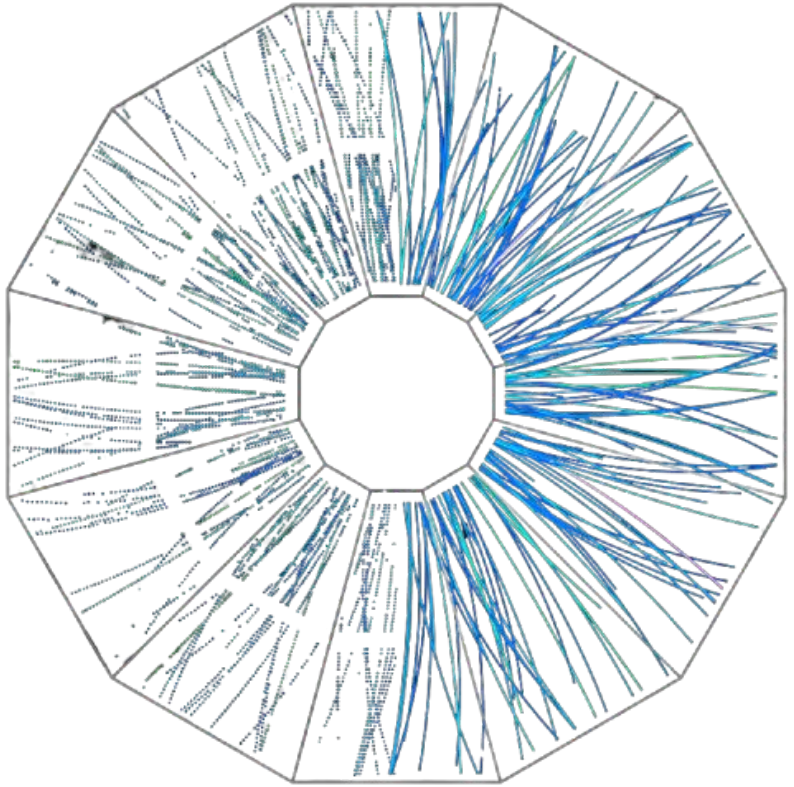
e+p



GEN



Jet Kinematics



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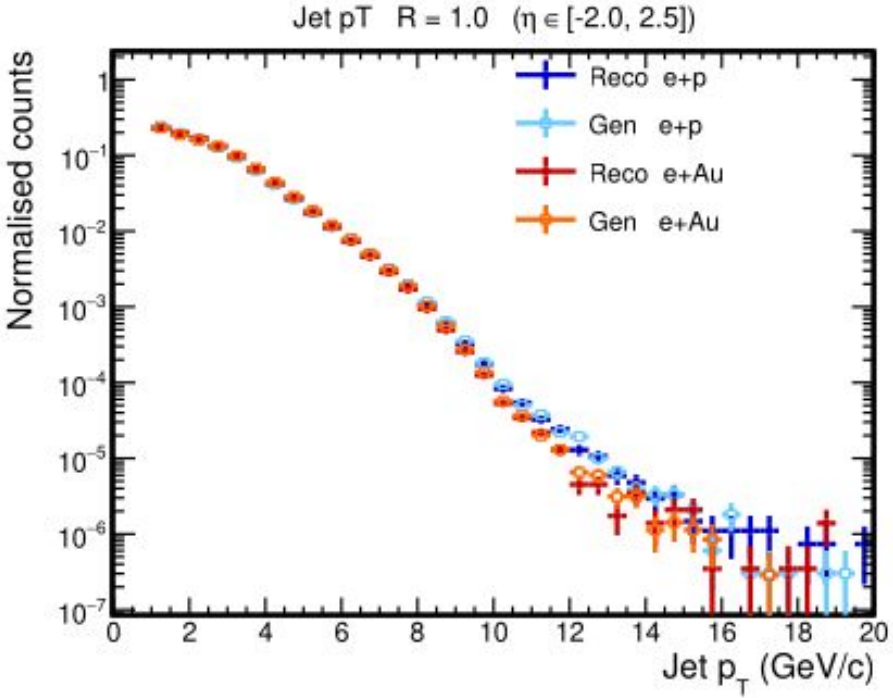
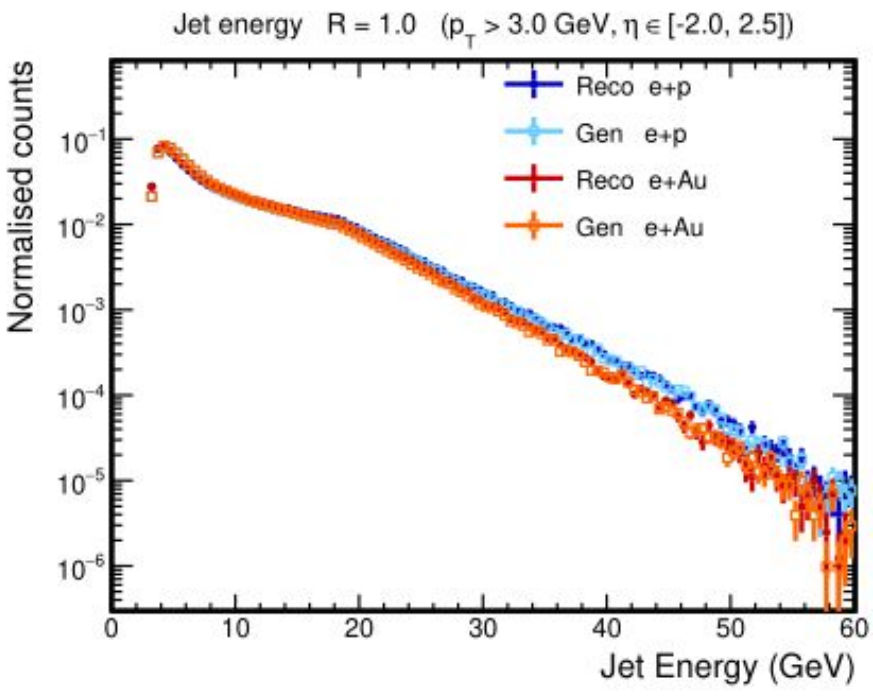
Jet Kinematics (I)





e+p shows harder spectrum (due to colliding energy)

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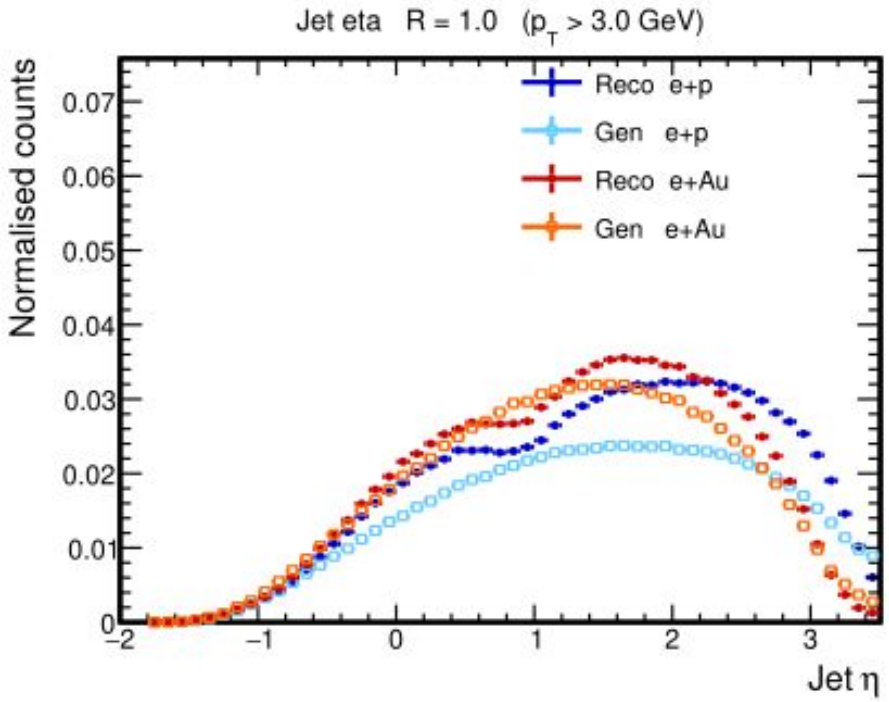
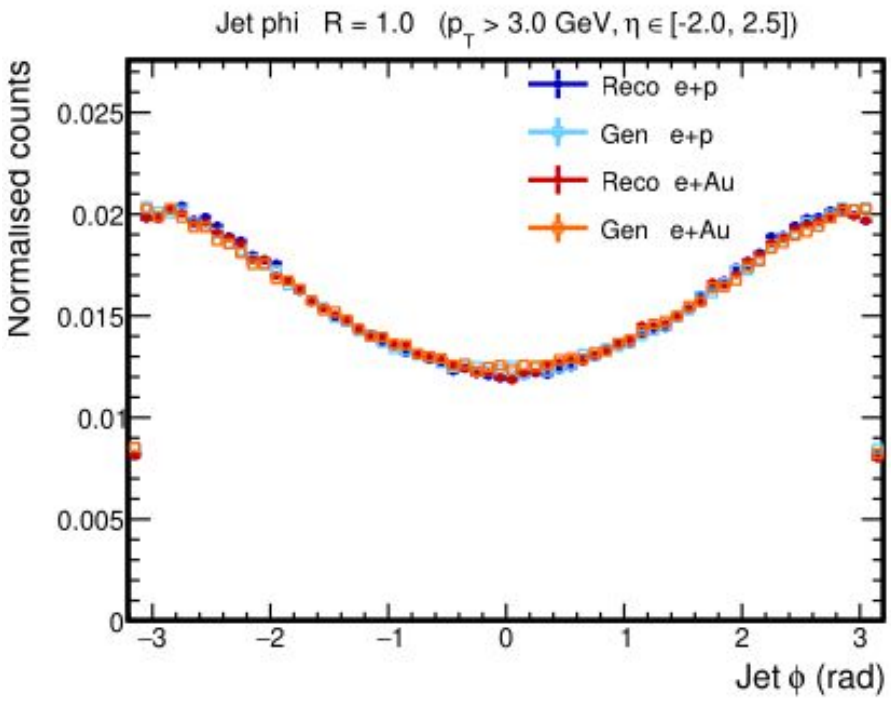
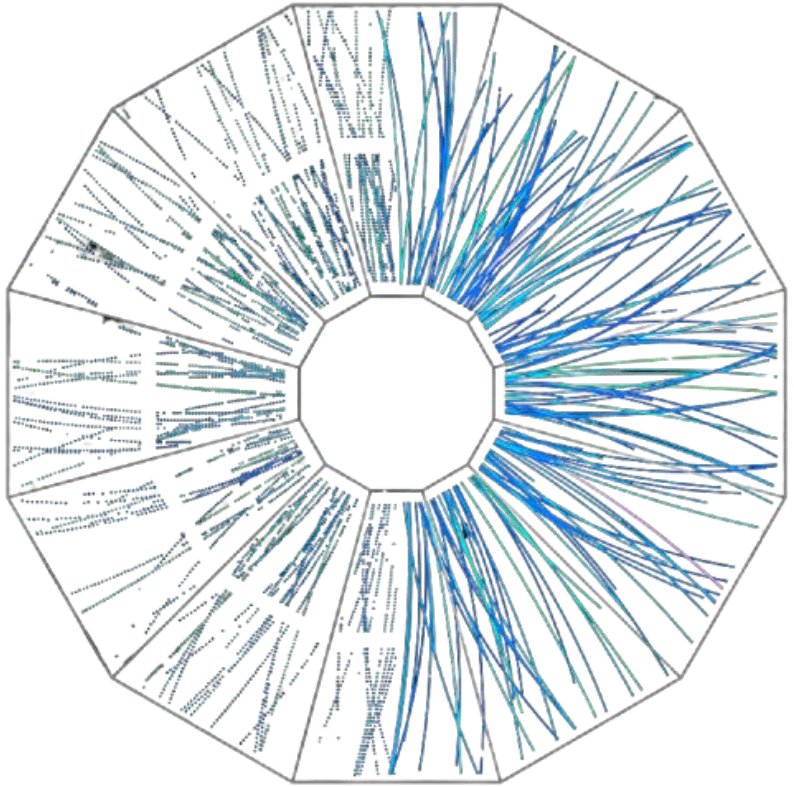
Jet Kinematics (II)





deep around 1 in η still under investigation

Jet R_{eAu}



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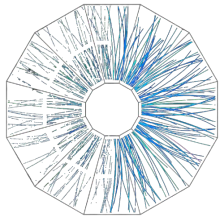
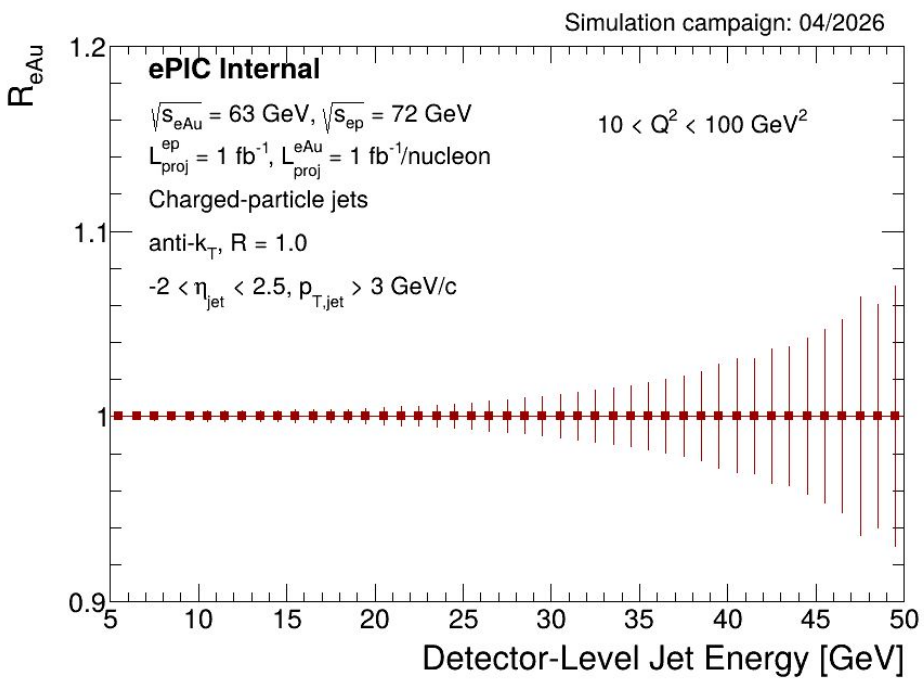
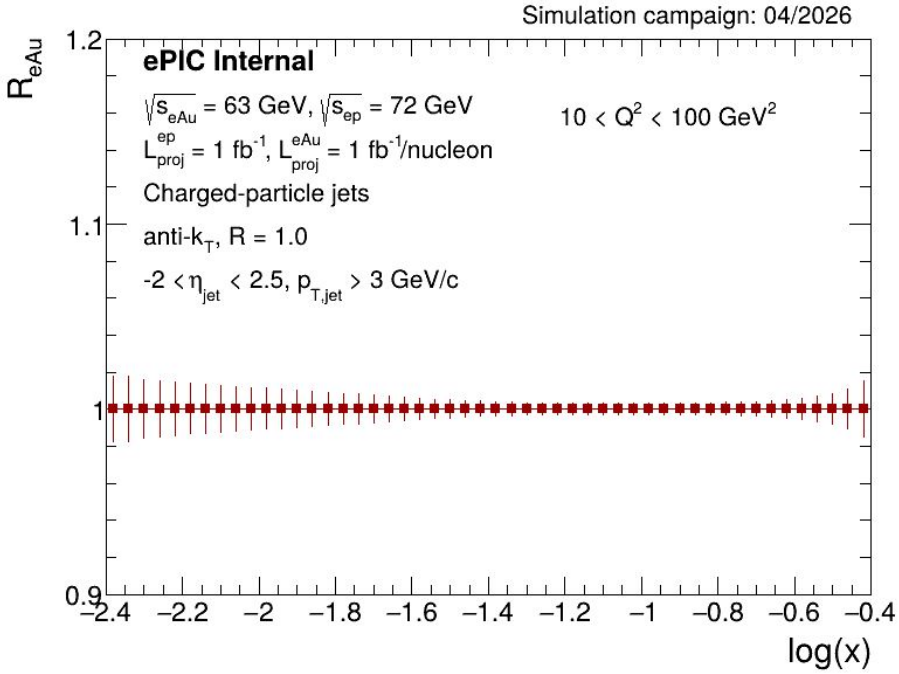


Jet R_{eAu}





R_{eAu} / (F^2_{eAu}/F^2_{ep}) can be used to study ELoss and more w/o nPDF effect (in contact with inclusive group) [9]

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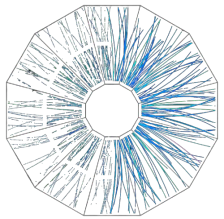
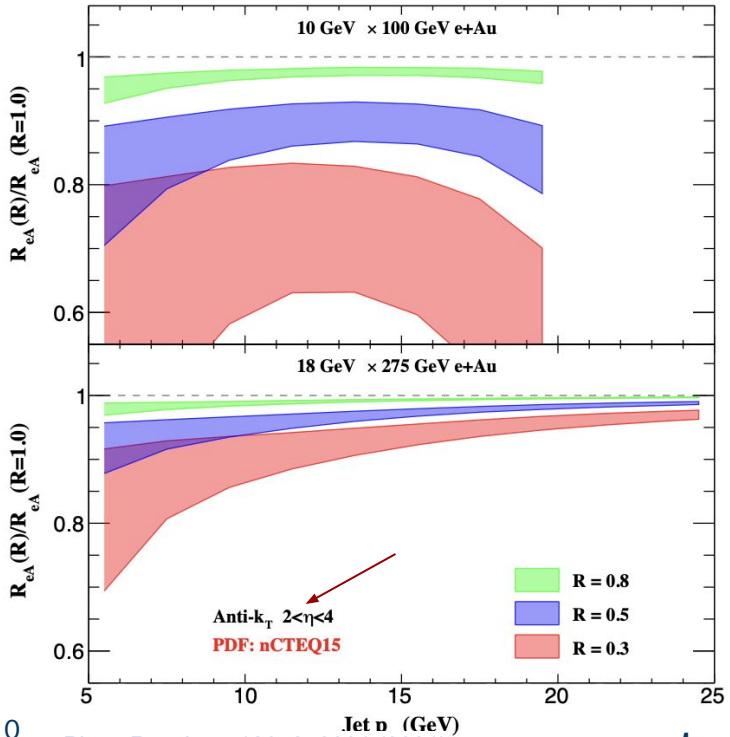
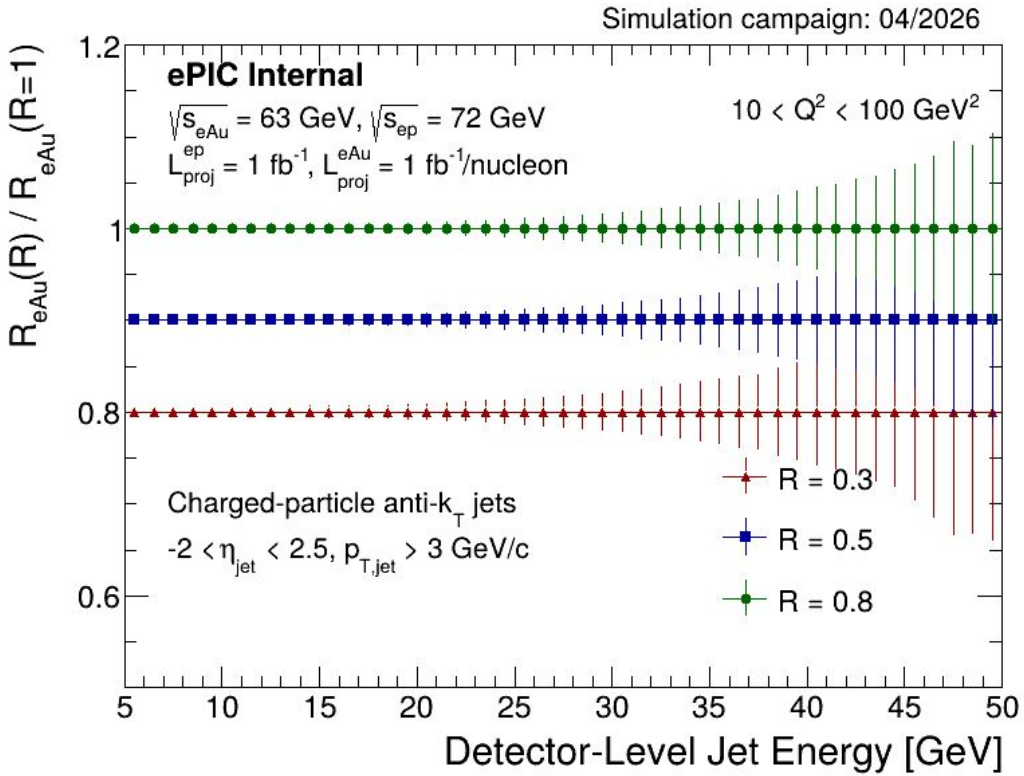


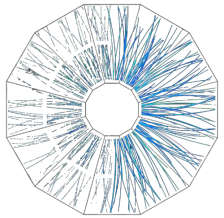
Different radii R_{eAu} (I)



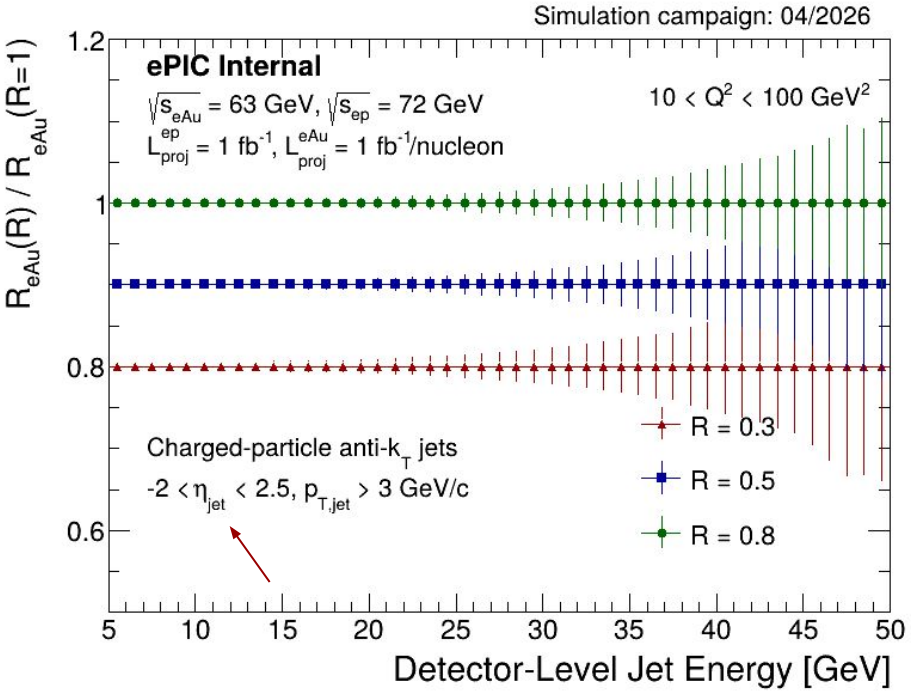


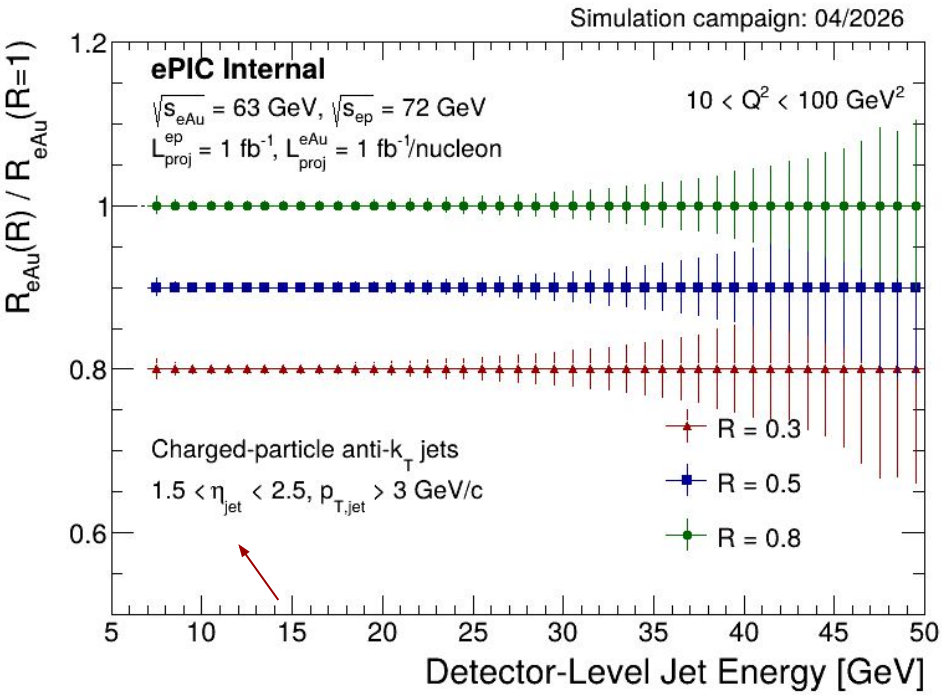
Phys. Rev. Lett. 126, 252001 (2021)

orange to apples comparison



Different radii R_{eAu} (II)





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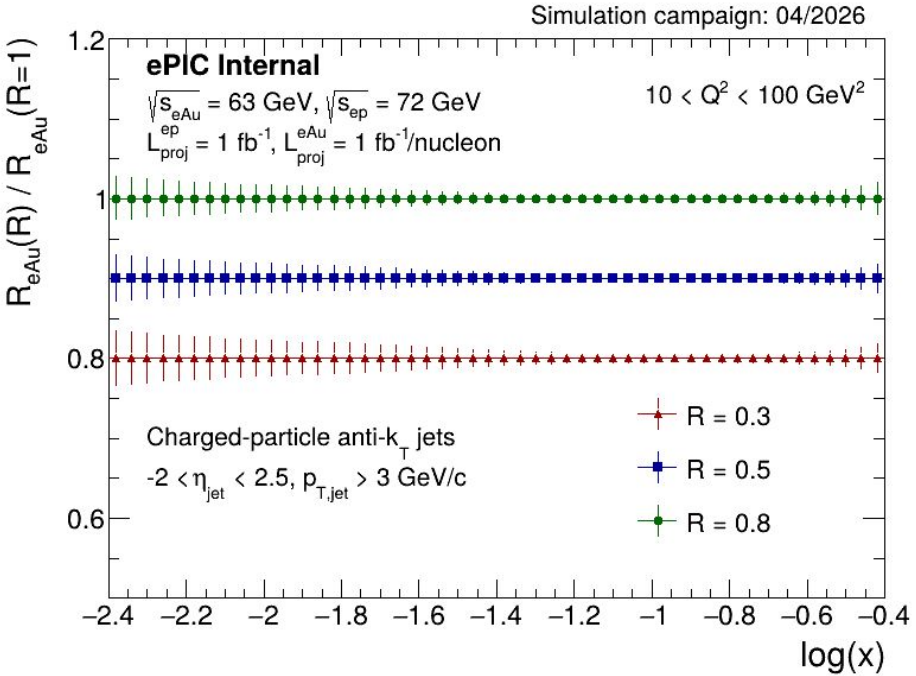
Different radii R_{eAu} (III)



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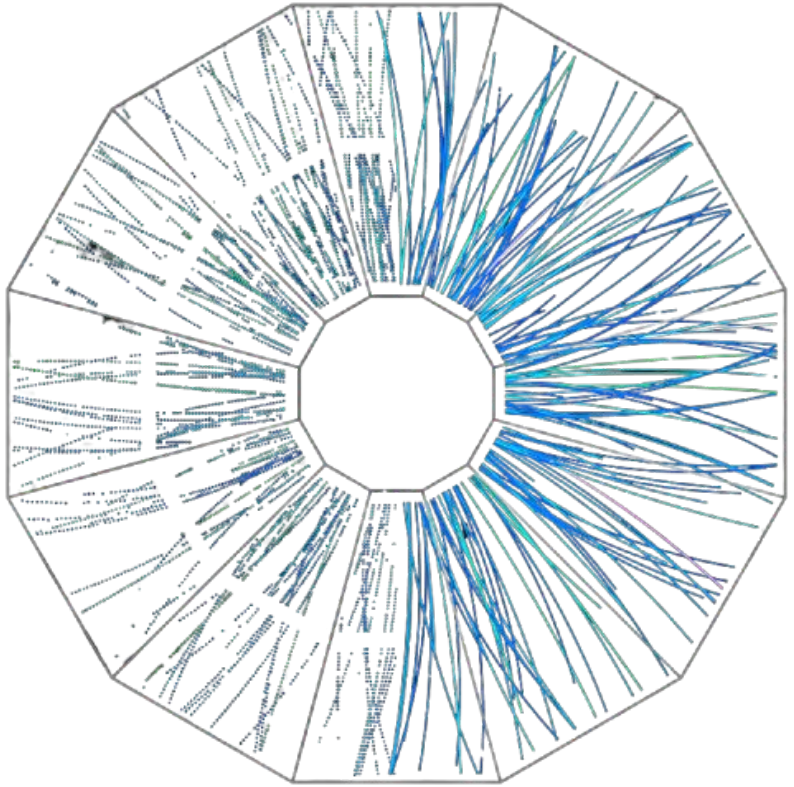
Fragmentation Functions



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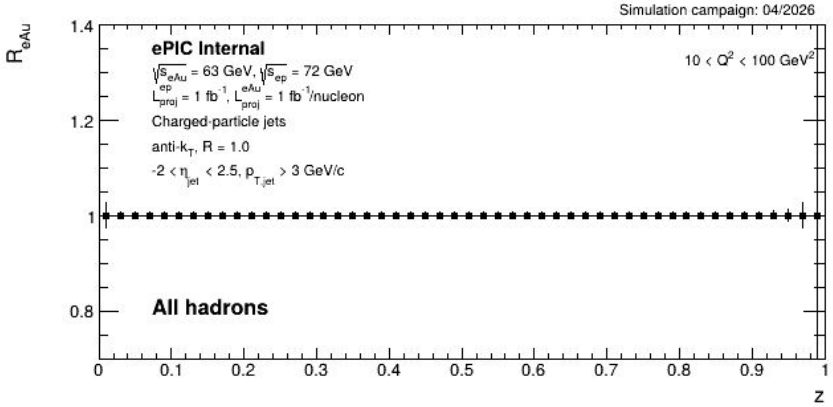
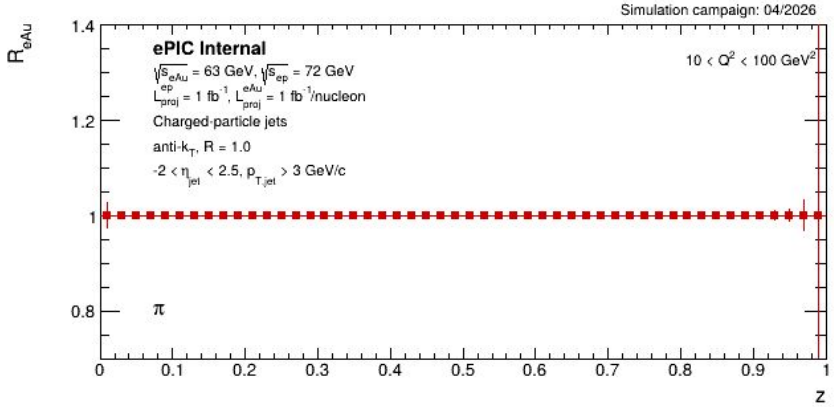
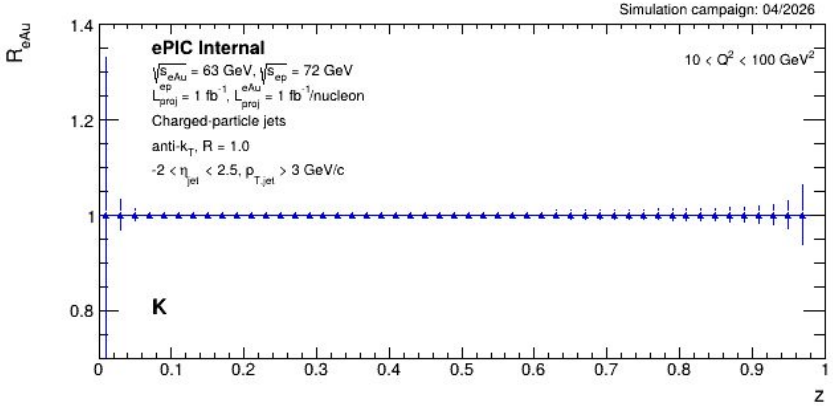
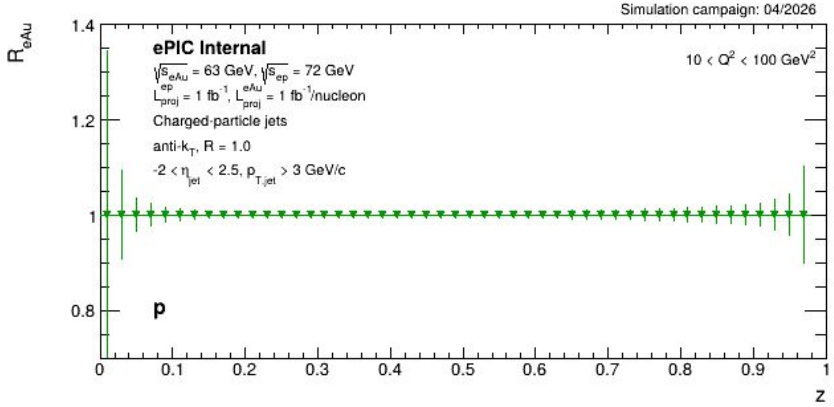
Fragmentation Functions: z-dependency

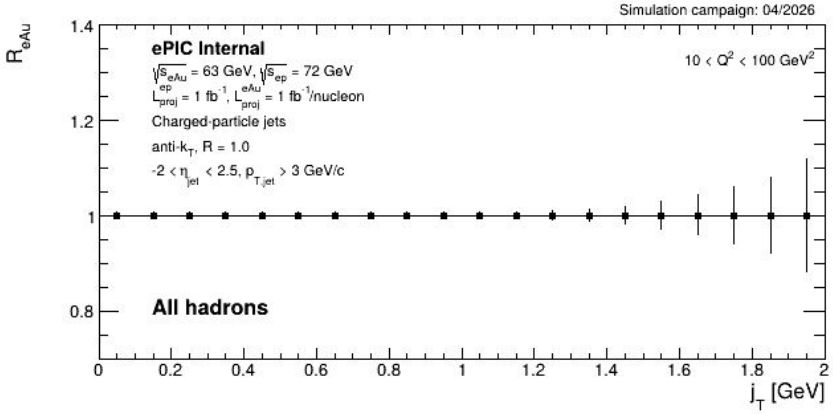


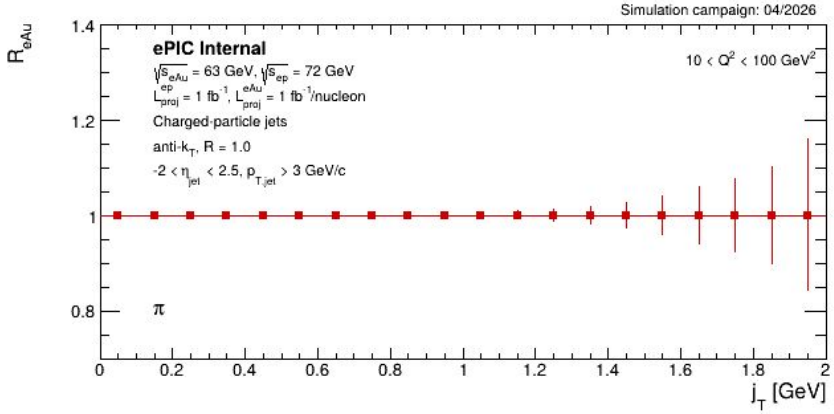


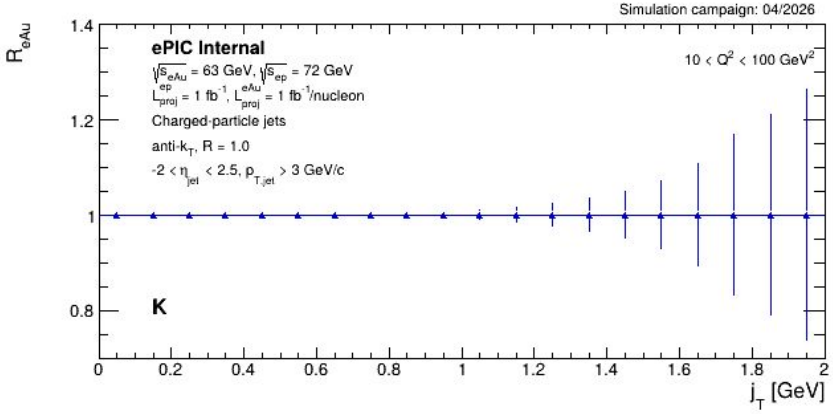


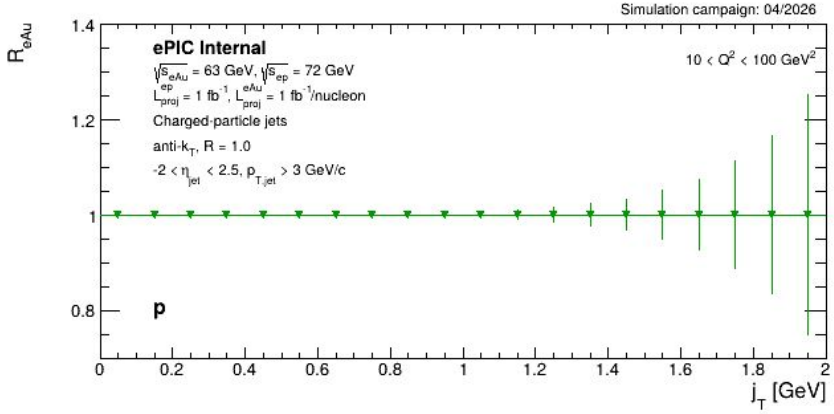


Fragmentation Functions: j_T-dependency

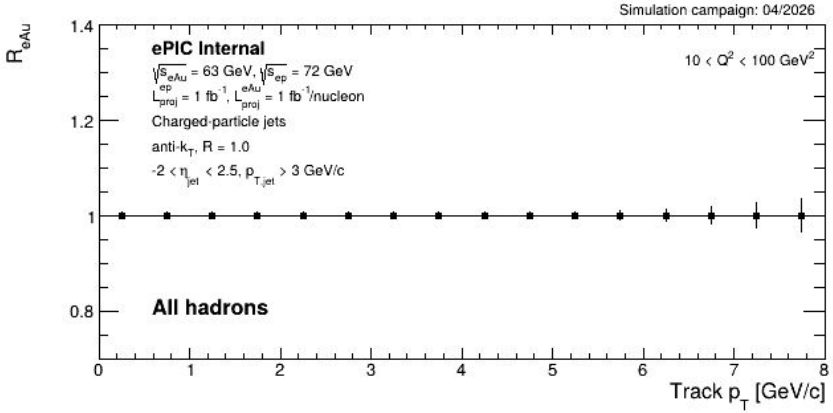


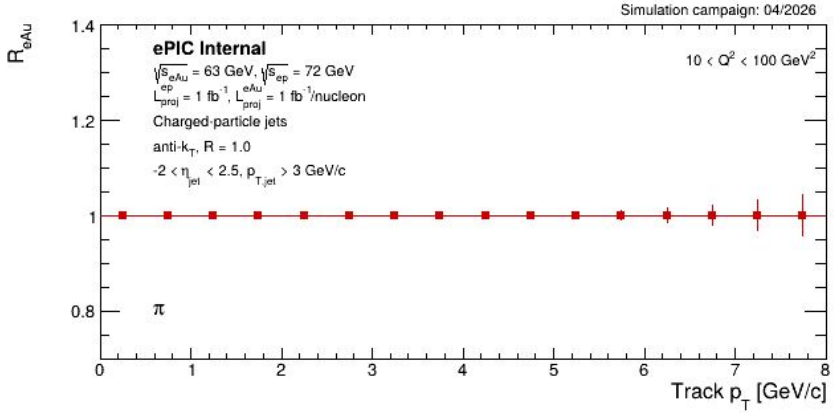


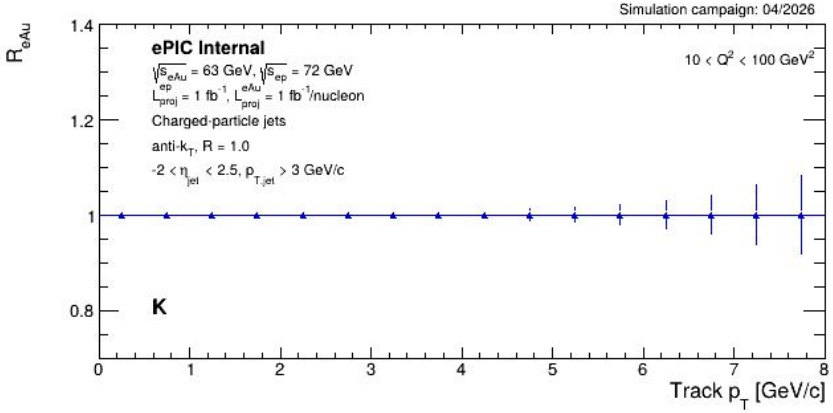


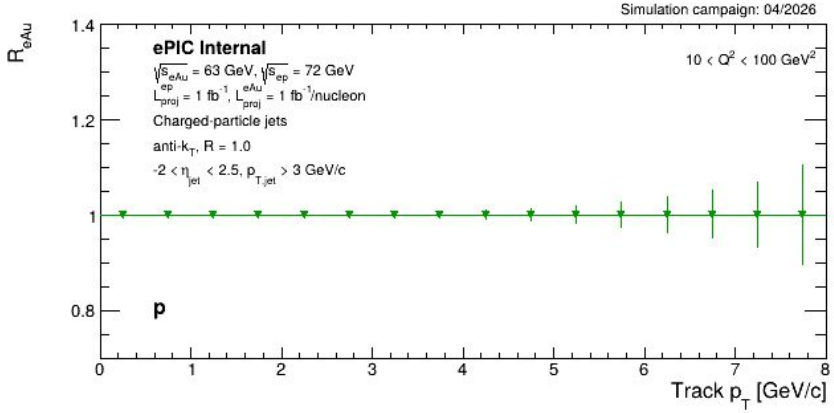


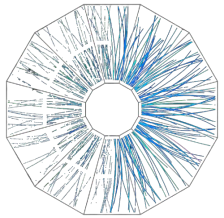
Fragmentation Functions: track p_T-dependency





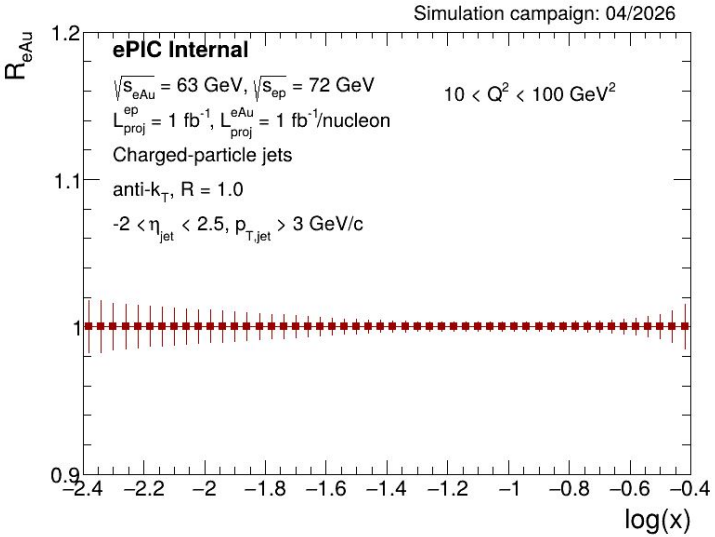


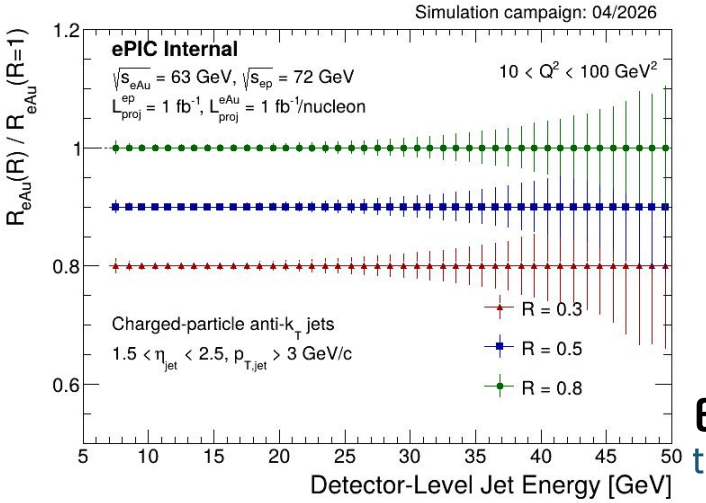




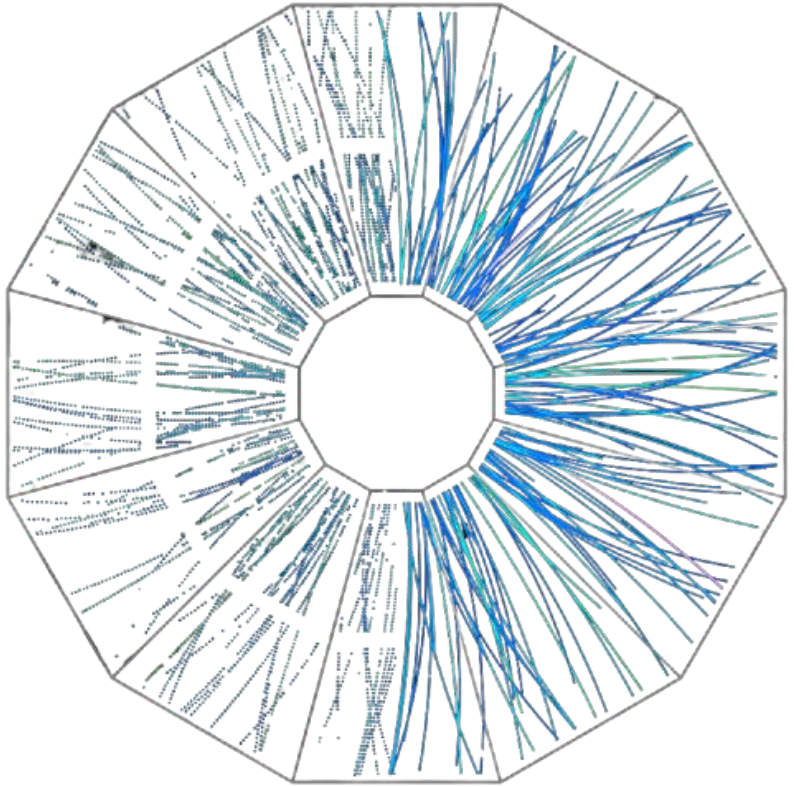
Outlook

- Machinery is ready to make projections once 9x1XX samples are ready
- No changes in R_{eAu} except the lumi projection
- We requested theory projections, but it would be good to have nPDF comparisons
- Still working on Fragmentation Functions, should we add x dependency?
  - Must be ready by this weekend
  - Theory?





Backup



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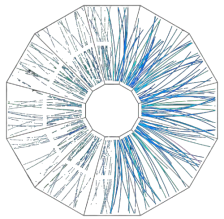
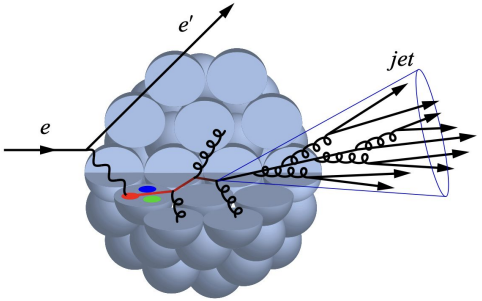
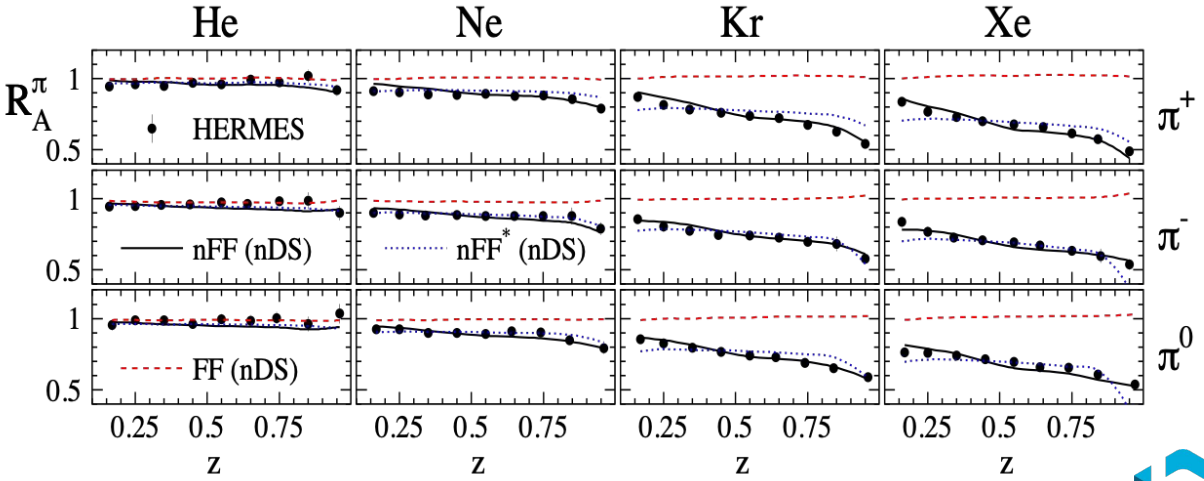


Motivation

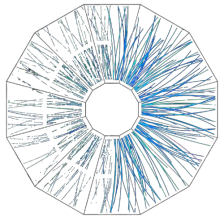


- Study nuclear effects on fragmentation functions
  - What we know?
    - From Hermes (fixed-target mode): Production differs between ep and eA

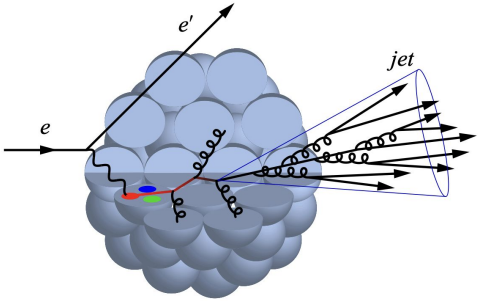


Hadron-level observable

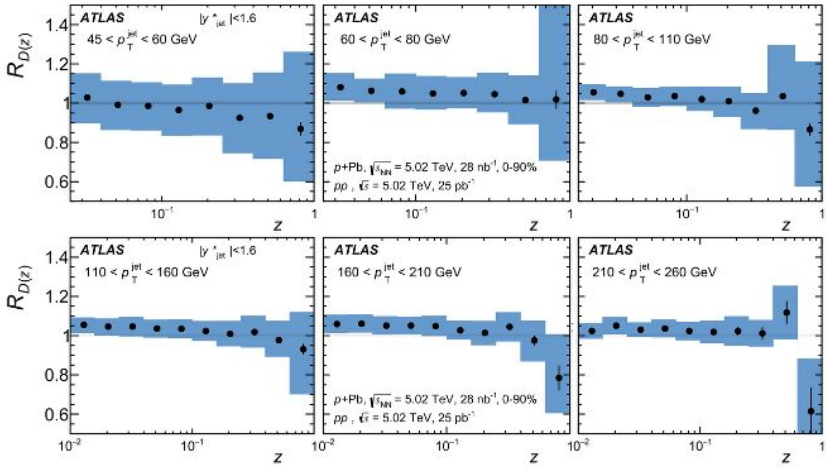
$R_A = (N_h/N_{DIS})^{-1}_{ep} (N_h/N_{DIS})_{eA}$



Motivation

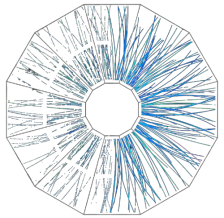


- Study nuclear effects on fragmentation functions
  - What we know?
    - From ATLAS/LHC: Consistent with 1 (within uncertainties) for pA/pp



Hadron inside jet observable

$R_D = (N_h / N_{jet})^{-1}_{pp} (N_h / N_{jet})_{pA}$



Simulation Details

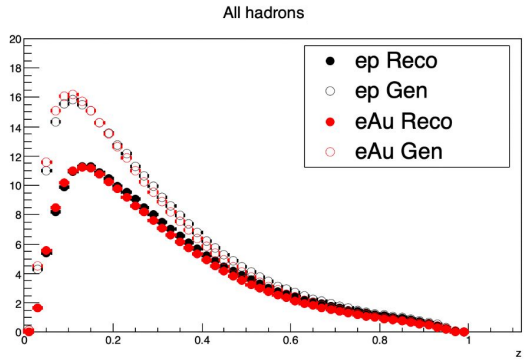
- Energy: 10x100
- Geometry: **25.10**
- ep: official production (NCDIS)
  - PYTHIA8.306
    - **q^2 min = 1 and q^2 min = 10**
- eAu: official production (DIS)
  - BeAGLE103
    - **$1 < q^2 < 10$ and $10 < q^2 < 100$**

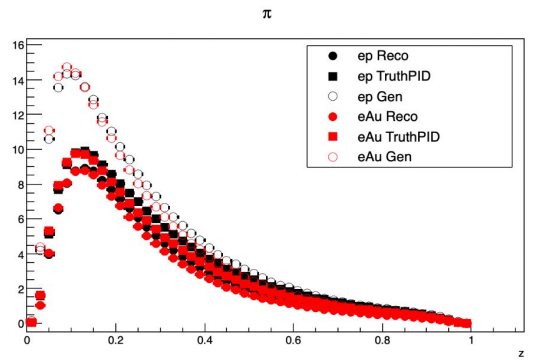
- Jet reconstruction
  - Charged jets:
    - ReconstructedChargedJets
    - GeneratedChargedJets
    - Remove jets with 1 track inside
    - Cuts in the plots
    - Electron removed using true PID
    - Geometrical matching $\Delta R < 1.0$
  - Jet Tree makers (anti-k_T with R = 1.0):
    - https://github.com/denerslemos/CHJetTrees
    - https://github.com/denerslemos/CHJetsReCluster

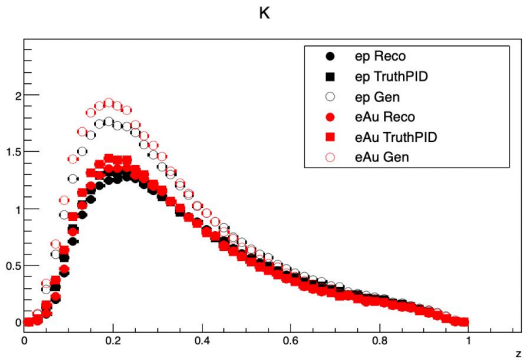
FF as function of z

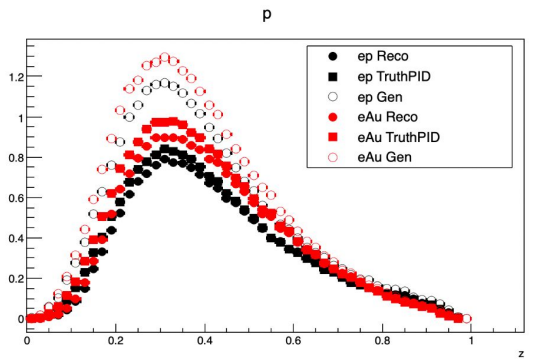
Jet p_T > 3 GeV
Jet E > 5 and < 50 GeV
Jet η between -2 and 2.5
No cut on tracks

$$z = \frac{\vec{p}_{\text{hadron}} \cdot \hat{n}_{\text{jet}}}{|\vec{p}_{\text{jet}}|}$$



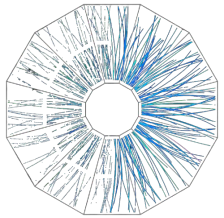






- **Low z**: soft radiation, UE, medium effects
- **High z**: leading fragments (hard splittings)

Normalized by N_{jets}

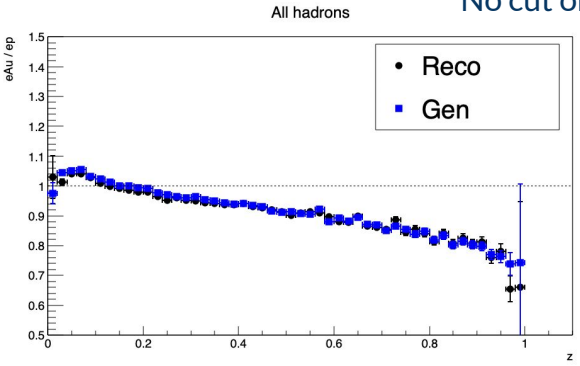


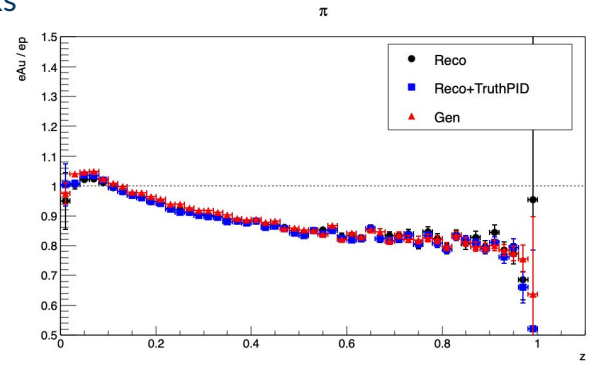
FF as function of z

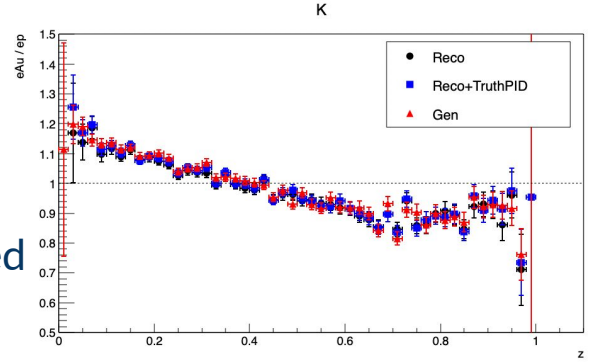
Jet p_T > 3 GeV
Jet E > 5 and < 50 GeV
Jet **η** between -2 and 2.5
No cut on tracks

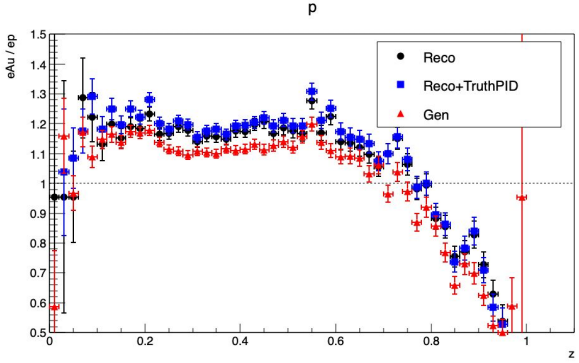
$$z = \frac{\vec{p}_{\text{hadron}} \cdot \hat{n}_{\text{jet}}}{|\vec{p}_{\text{jet}}|}$$

- **Low z**: soft radiation, UE, medium effects
- **High z**: leading fragments (hard splittings)
- PID efficiency seems to be good in general
  - Maybe not for p
- Similar behavior as observed by Hermes









$R_D = (N_h / N_{jet})^{-1}_{pp} (N_h / N_{jet})_{pA}$

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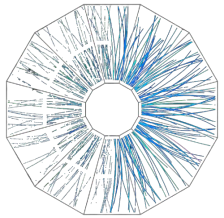
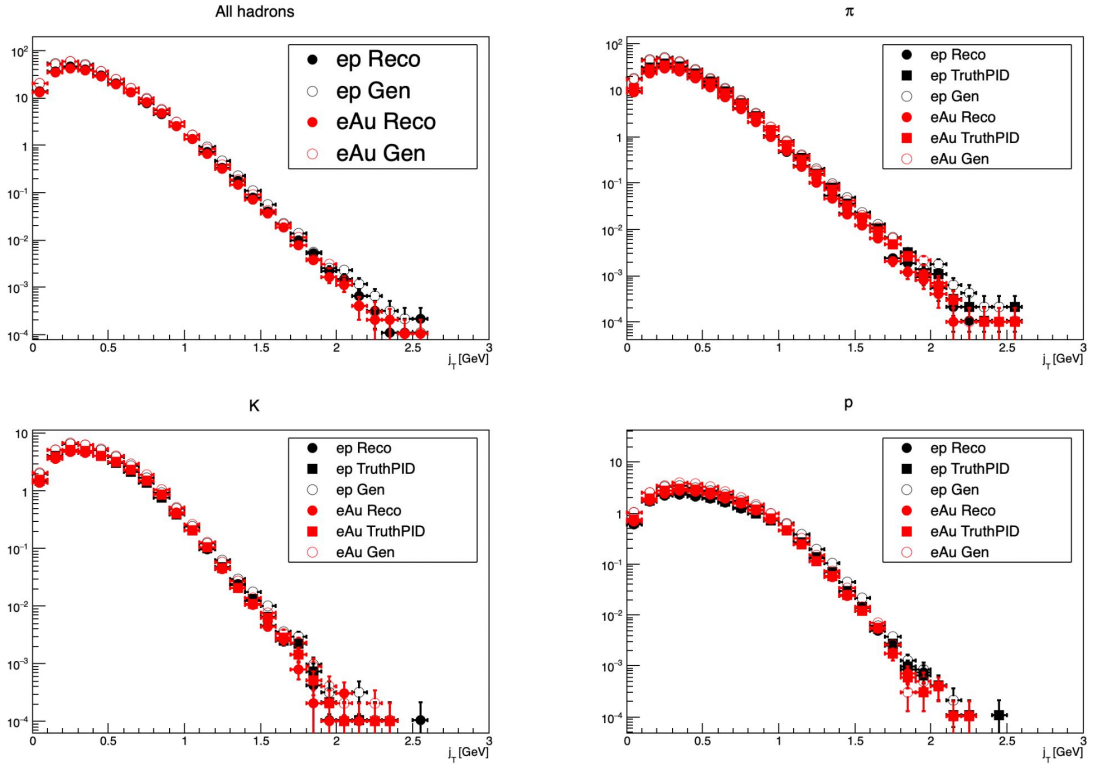


FF as function of j_T

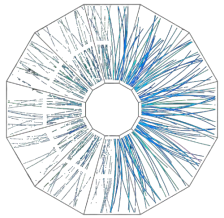
Jet p_T > 3 GeV
Jet E > 5 and < 50 GeV
Jet η between -2 and 2.5
No cut on tracks

$$j_T = |\vec{p}_{\text{hadron}} \times \hat{n}_{\text{jet}}|$$

- **Low j_T**: collimated jet
- **High j_T**: broadening
  - multiple scattering
  - nuclear effects



Normalized by N_{jets}



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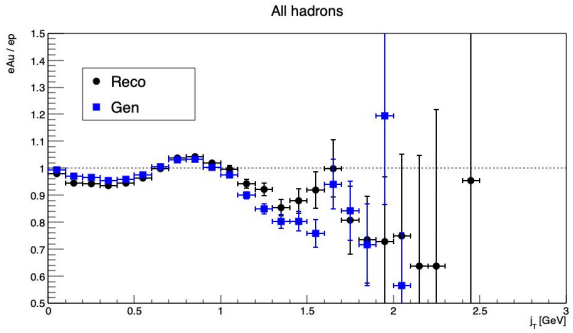

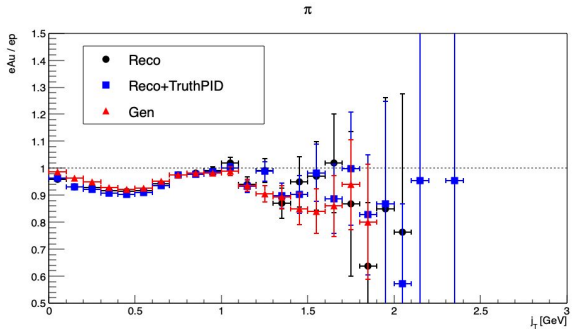

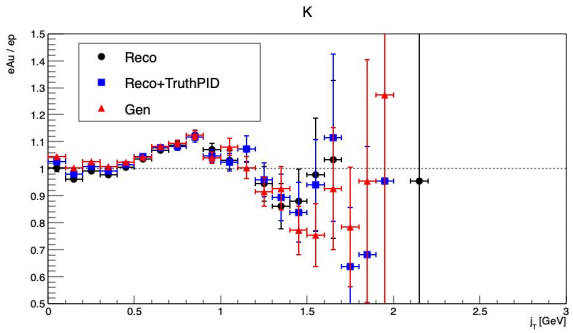

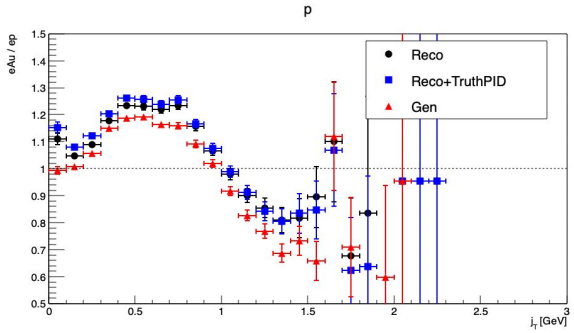

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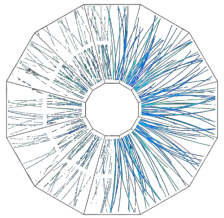

Outlook

- First look at fragmentation functions with PID using ePIC official simulation
- z dependency in MC is similar to observed at Hermes
- This is a first look, need a bit more investigation
  - Improvements coming for next meetings