Diffractive DIS Results Summary

ePIC Simulation 10x100 GeV

Feb 3, 2026

Overview

- Inclusive kinematics and phase-space coverage
- Diffractive observables: M_X^2, $x_{\mathbb{P}}$, β, and $|t|$
- Closure-test style efficiency corrections (A/B split)
- B0 vs RP proton-tagged comparisons

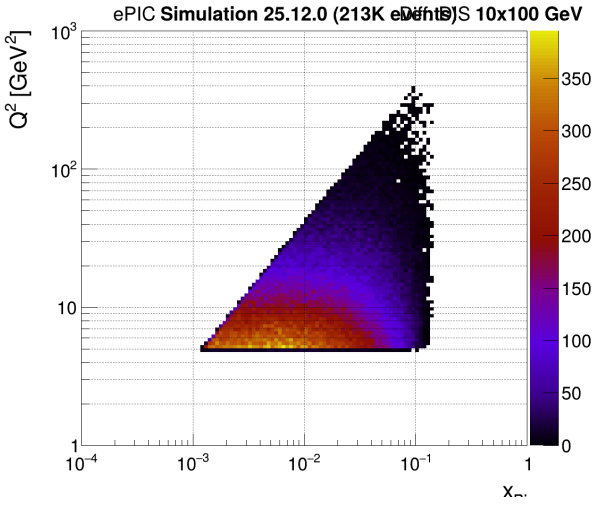
Inclusive Reconstruction (Inputs)

- Electron method (EM) from scattered electron energy E'_e and angle θ_e:

$$Q^2_e = 4E_e E'_e \sin^2\left(\frac{\theta_e}{2}\right), \quad y_e = 1 - \frac{E'_e}{E_e}\cos^2\left(\frac{\theta_e}{2}\right), \quad x_e = \frac{Q^2_e}{s\, y_e}$$

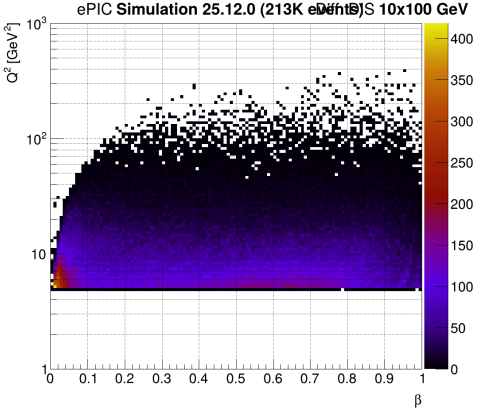
- Double-angle (DA): uses (θ_e, θ_h) with standard DA definitions.
- Sigma/ESigma: uses hadronic energy flow $\Sigma_h = \sum_h (E_h - p_{z,h})$ (standard JB/$e\Sigma$ definitions).
- $W^2 = Q^2\left(\frac{1}{x} - 1\right) + m_p^2$ (all methods).

Inclusive Phase Space

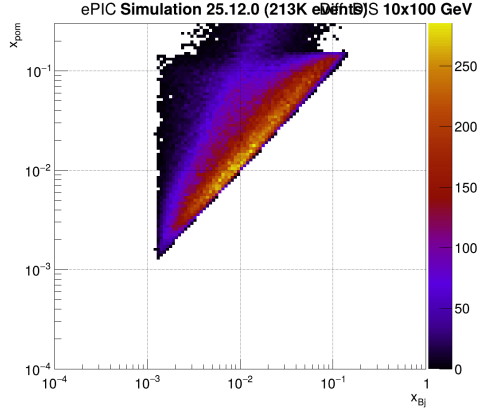


Event density in (x_{Bj}, Q^2) shows the phase-space coverage.

Diffractive Phase Space I

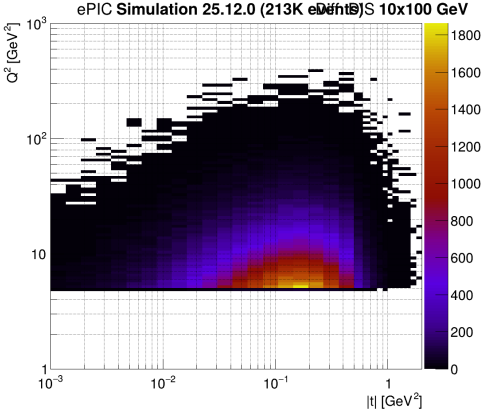


(β, Q^2) density.

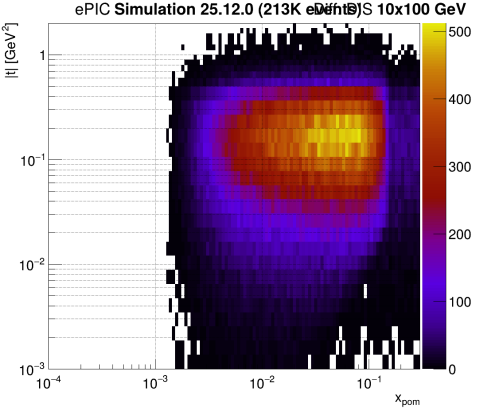


$(x_{Bj}, x_{\mathbb{P}})$ density.

Diffractive Phase Space II

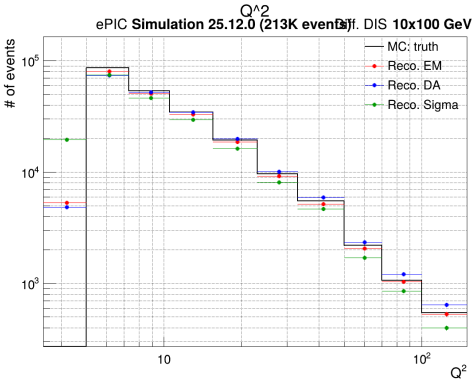


$(|t|, Q^2)$ density.

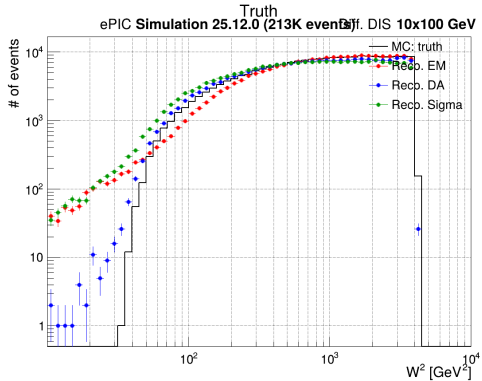


$(x_{\mathbb{P}}, |t|)$ density.

Inclusive Kinematics Methods



Q^2 reconstructed by EM/DA/Sigma methods.



W^2 reconstructed by EM/DA/Sigma methods.

Diffractive Definitions

$$M_X^2 = \left(\sum_{i \in X} p_i \right)^2$$

$$x_{\mathbb{P}} = \frac{Q^2 + M_X^2 - t}{Q^2 + W^2 - m_p^2}$$

$$\beta = \frac{x_{Bj}}{x_{\mathbb{P}}}$$

$$t = (p_p - p_p')^2$$

These are computed using the electron method for Q^2 and W^2 unless noted.

Efficiency Correction (Closure Test)

- Split the sample 50/50 into two independent sets (A and B).
- Efficiency from MC set A:

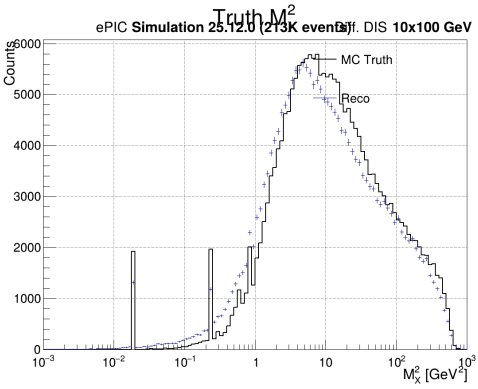
$$\epsilon_i = \frac{N^A_{\text{reco},i}}{N^A_{\text{truth},i}}$$

- Apply to pseudo-data set B:

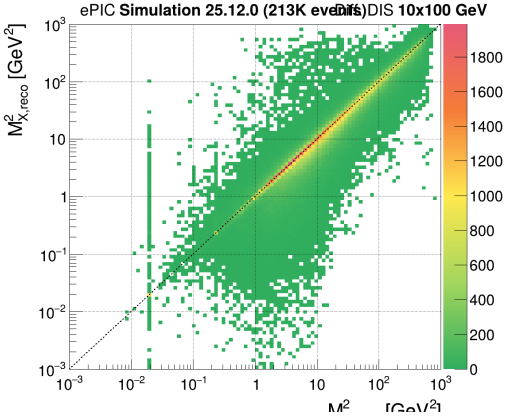
$$N^B_{\text{corr},i} = \frac{N^B_{\text{reco},i}}{\epsilon_i}$$

- Compare corrected pseudo-data (B) to truth from the same set (B), with no acceptance cuts on truth.

Hadronic Mass M_X^2

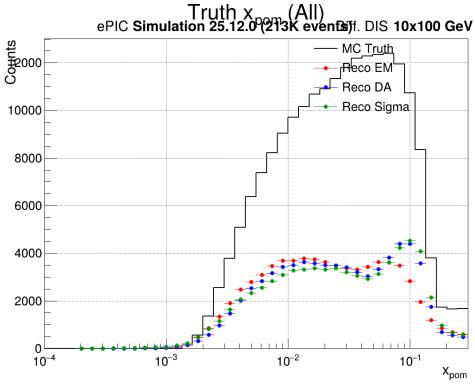


Truth vs reco M_X^2 distributions.

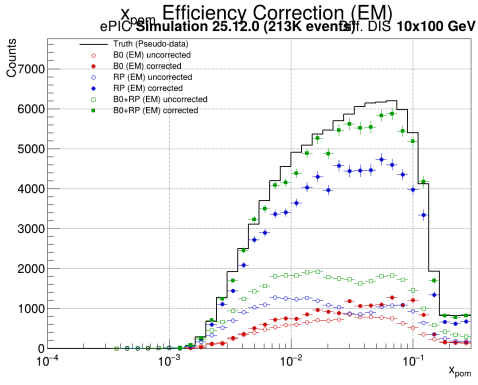


Unbinned truth vs reco correlation.

$x_{\mathbb{P}}$: Uncorrected vs Efficiency-Corrected

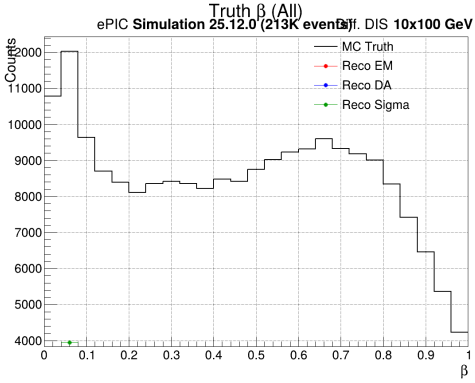


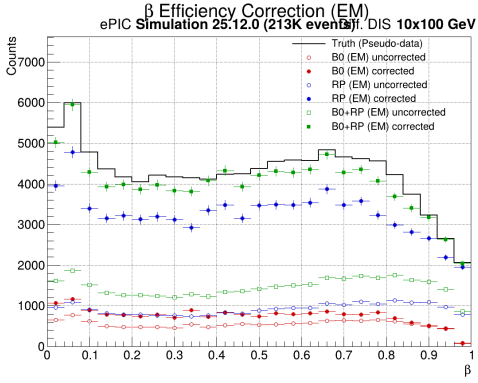
Uncorrected $x_{\mathbb{P}}$ (truth vs reco).



Efficiency-corrected $x_{\mathbb{P}}$ (B0/RP split).

β: Uncorrected vs Efficiency-Corrected



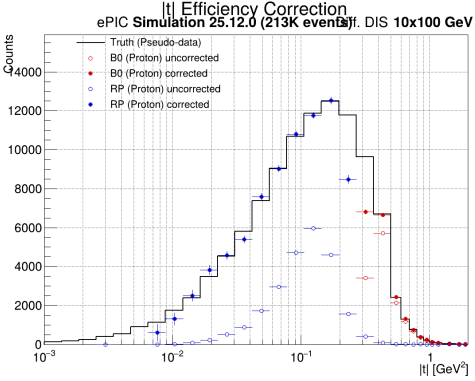


Uncorrected β (truth vs reco).

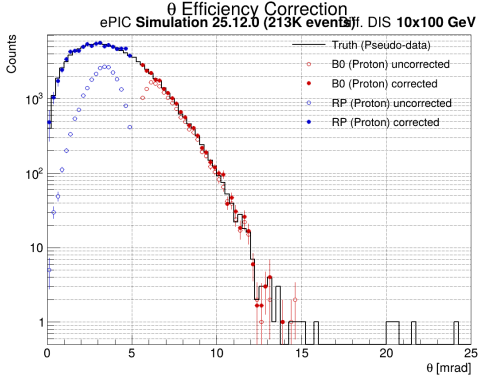
Efficiency-corrected β (B0/RP split).

Efficiency: $\epsilon = N_{\text{reco}}/N_{\text{truth}}$, corrected pseudo-data: $N_{\text{corr}} = N_{\text{pdata}}/\epsilon$.

Proton-Tagged Closure Test: $|t|$ and θ

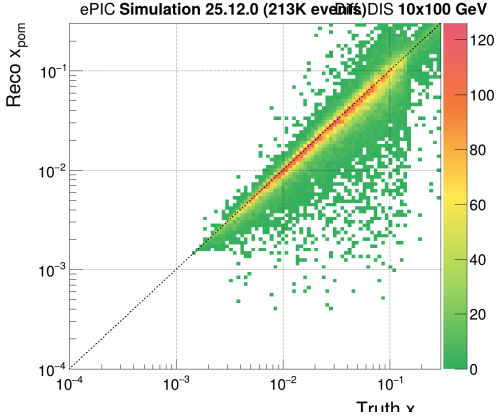


$|t|$ closure test (B0 vs RP).

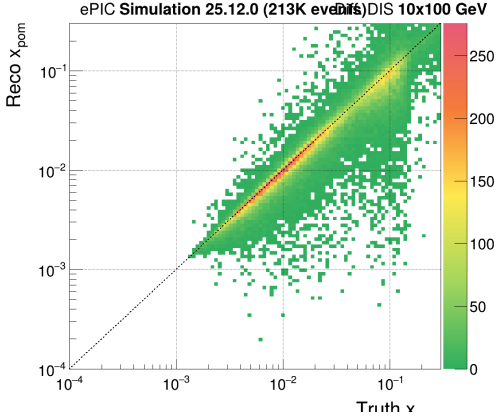


Proton scattering angle θ (log-y).

$x_{\mathbb{P}}$ Correlations (EM)

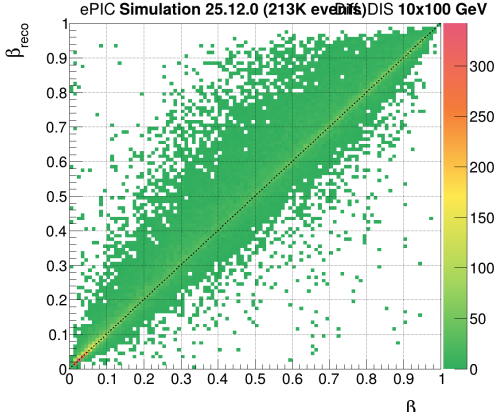


Truth vs reco $x_{\mathbb{P}}$ (B0).

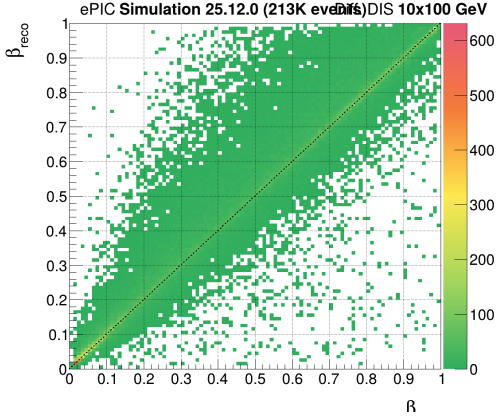


Truth vs reco $x_{\mathbb{P}}$ (RP).

β Correlations (EM)

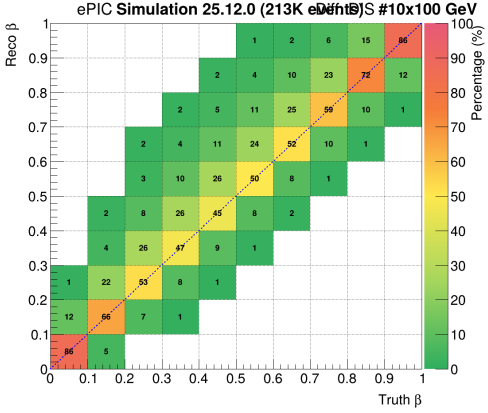


Truth vs reco β (B0).

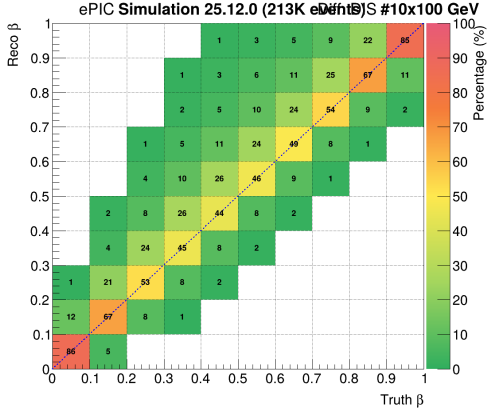


Truth vs reco β (RP).

β Response Matrices (EM)



β response (B0).



β response (RP).

Summary

- Inclusive and diffractive observables show expected phase-space coverage.
- Proton-tagged (B0/RP) closure tests diagnose acceptance effects.
- Efficiency-corrected pseudo-data trends toward truth in most regions.

Plot Coverage

- Included: inclusive (x_{Bj}, Q^2) density, $Q^2/W^2/x_{Bj}/y$ method comparisons, and inclusive efficiency-correction plots.
- Included: diffractive M_X^2, $x_{\mathbb{P}}$, β histograms and truth-vs-reco correlations, plus key density plots.
- Included: B0/RP efficiency-correction closure plots for $x_{\mathbb{P}}$, β, $|t|$, and θ.
- Included: diffractive response matrices and unbinned correlations (EM shown for B0/RP).
- Additional plots live in `figs/` and can be added in an appendix on request.