4.2M-event Study for Exclusive+Diffractive

Response to PWG conveners' requests

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Context from Conveners (Salvatore's email)

- Show more about reconstructed proton distributions and relevant variables.
- Produce 10x fewer events and re-scale uncertainties (fast study).
- Minimum Q^2 cut: why not $Q^2 > 1$ GeV^2 instead of 5?
- (Analysis nice-to-have) Compare FPS tagging with rapidity-gap method.

Timeline: Internal review Tue Sep 2, 16:00; PWG update Mon Sep 8.

Dataset and Selection

- 4.2M events processed with FPS acceptance.
- DIS kinematics reconstructed: x, Q^2, y.
- Proton tagged in FPS; multiple t-reconstruction methods (now we have BABE, can add maybe another).

Reco-level plots already available

- Proton spectrometer: p_p, θ_p, ϕ_p, momentum loss ξ.
- t-spectrum: direct FPS, BABE, lepton-only, mixed methods.
- Correlation reco plots vs truth.
- DIS kinematics x, Q^2, y with different reconstructions.
- Cross sections $d\sigma/dx, d\sigma/dQ^2, d\sigma/dy, d\sigma/d|t|$.
- Resolution and pulls for t, x, Q^2, y.

FPS proton kinematics

Momentum transfer t (methods)

Definitions

$t \approx (p_p - p_p^{\text{beam}})^2 \simeq -(\Delta p_T)^2 - \frac{(\Delta E)^2}{\beta^2}$

- FPS-direct (track based)
- BABE method (using 4-momenta)

t spectrum @ reco (FPS-direct)

t reconstruction: BABE vs truth

DIS kinematics @ reco

Cross sections (single differentials)

Fast statistical scaling study

Uncertainty scaling

$$\delta\sigma \propto \frac{1}{\sqrt{N}}$$

If $N \to N/10$, then

$$\delta\sigma_{N/10} \approx \sqrt{10}\,\delta\sigma_N.$$

Why $Q^2_{min} = 1$ GeV^2?

- Extends reach to lower x, diffractive-enhanced phase space.
- Potentially more statistics, but more sensitive to systematics.
- Plan: compare $Q^2 > 1$ vs > 5 GeV^2 in control plots.

Next steps

- Tue Sep 2, 16:00: internal review with Hadi.
- Mon Sep 8: PWG update with full reco-proton plots and scaling.
- Optional: generate high-Q^2 subsample if needed.

Backup

Extra method comparisons, resolution plots, alternative binning.