Hard Diffractive Dijet Photoproduction in ep and UPCs

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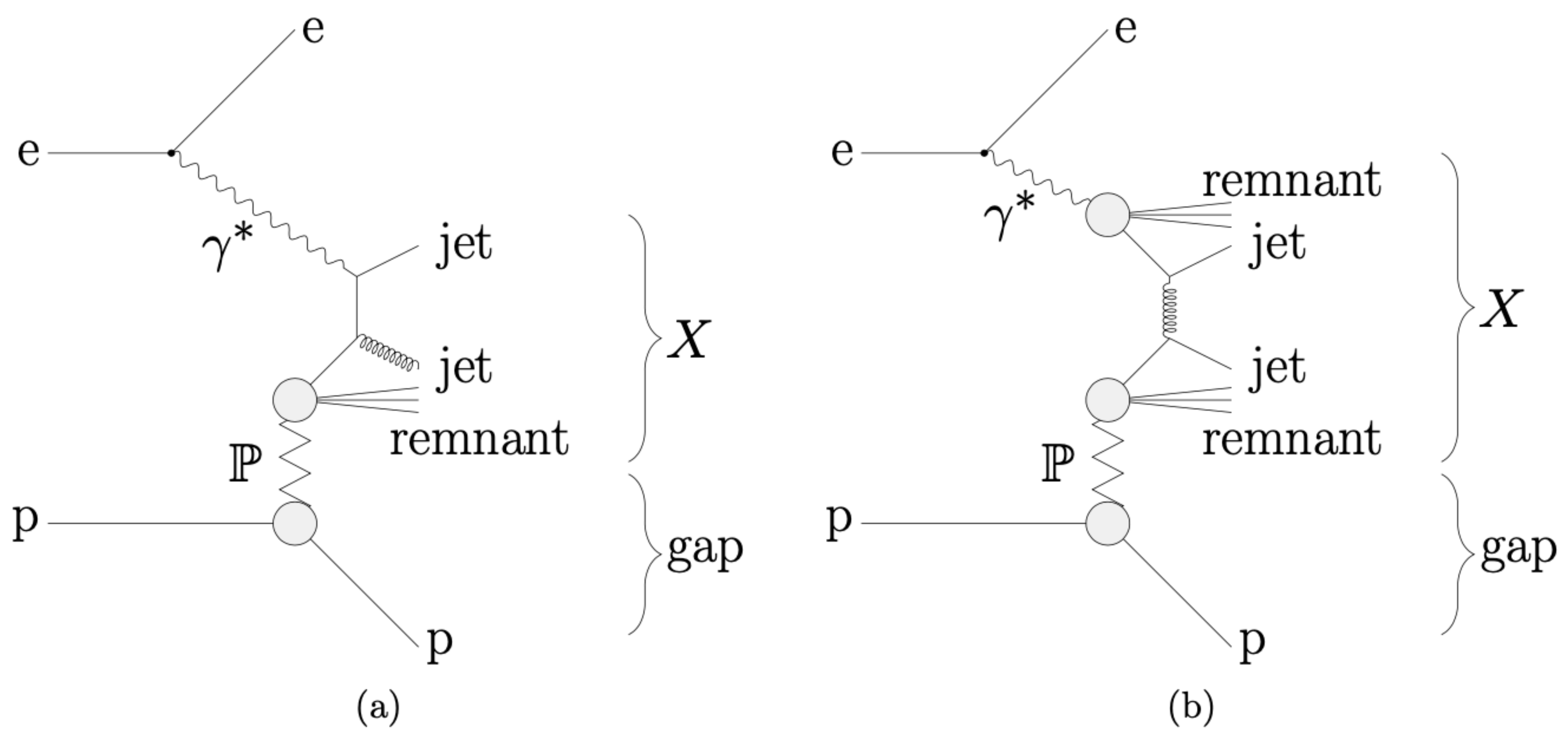
Diffractive dijet photoproduction in ep



- Leading-order Feynman graphs for diffractive dijet production with photons in ep collsions;
- Left part is from direct photon contribution;
- Right part is from resolved photon contribution;
- Using Pythia8301 for our simulation;

Diffractive dijet photoproduction in H1

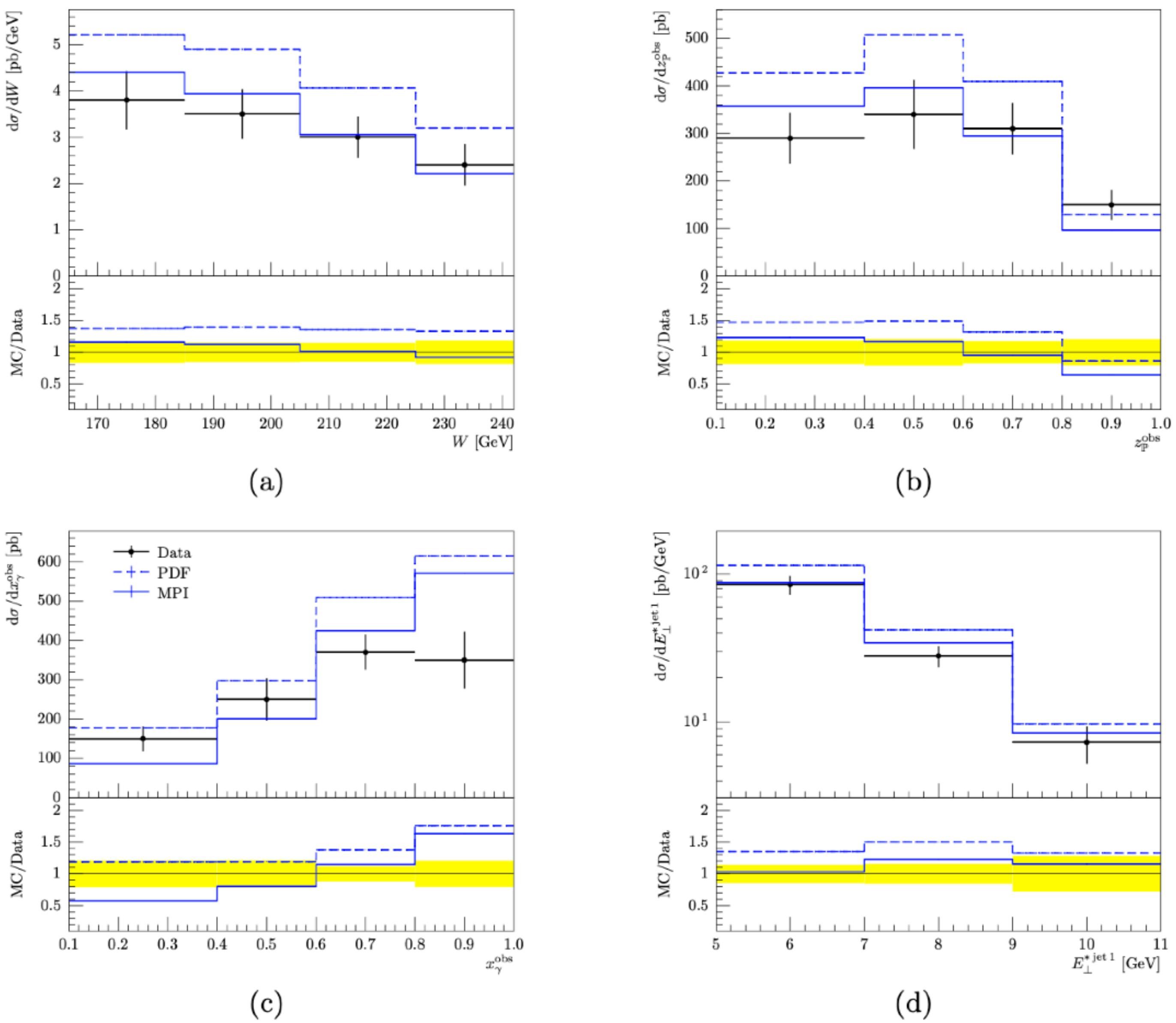


Figure 7: The model with (solid lines) and without (dashed lines) gap survival compared to H1 data on W (a), $z_{\mathbb{P}}^{\text{obs}}$ (b), x_{γ}^{obs} (c) and $E_{\perp}^{*\,\text{jet}\,1}$ (d).

arXiv:1901.05261v2

- Ee = 27.5 GeV
- Ep = 920 GeV
- $Q^2 < 0.01$ GeV^2
- pT_jet1 > 5 GeV
- pT_jet2 > 4 GeV
- -1 < Eta < 2.0

- Two simulated samples, one based on dPDFs solely without the dynamic gap survival (the “PDF” sample, dashed lines);
- one including the dynamic gap survival (the “MPI” sample, solid lines) which only include the multiple scatterings or multiparton interactions (MPIs) between the remnants (not include the ones in the larger photon-proton system.)
- W is the invariant mass for the photon-proton system;

$$x_{\gamma}^{\text{obs}} = \frac{\sum_{i=1}^{2} E_{\perp}^{\text{jet},\,i} \exp(-\eta^{\text{jet},i})}{2yE_e} \,,$$

$$z_{\mathbb{P}}^{\text{obs}} = \frac{\sum_{i=1}^{2} E_{\perp}^{\text{jet},\,i} \exp(\eta^{\text{jet},i})}{2x_{\mathbb{P}}E_p} \,,$$

Diffractive dijet photoproduction in ZEUS

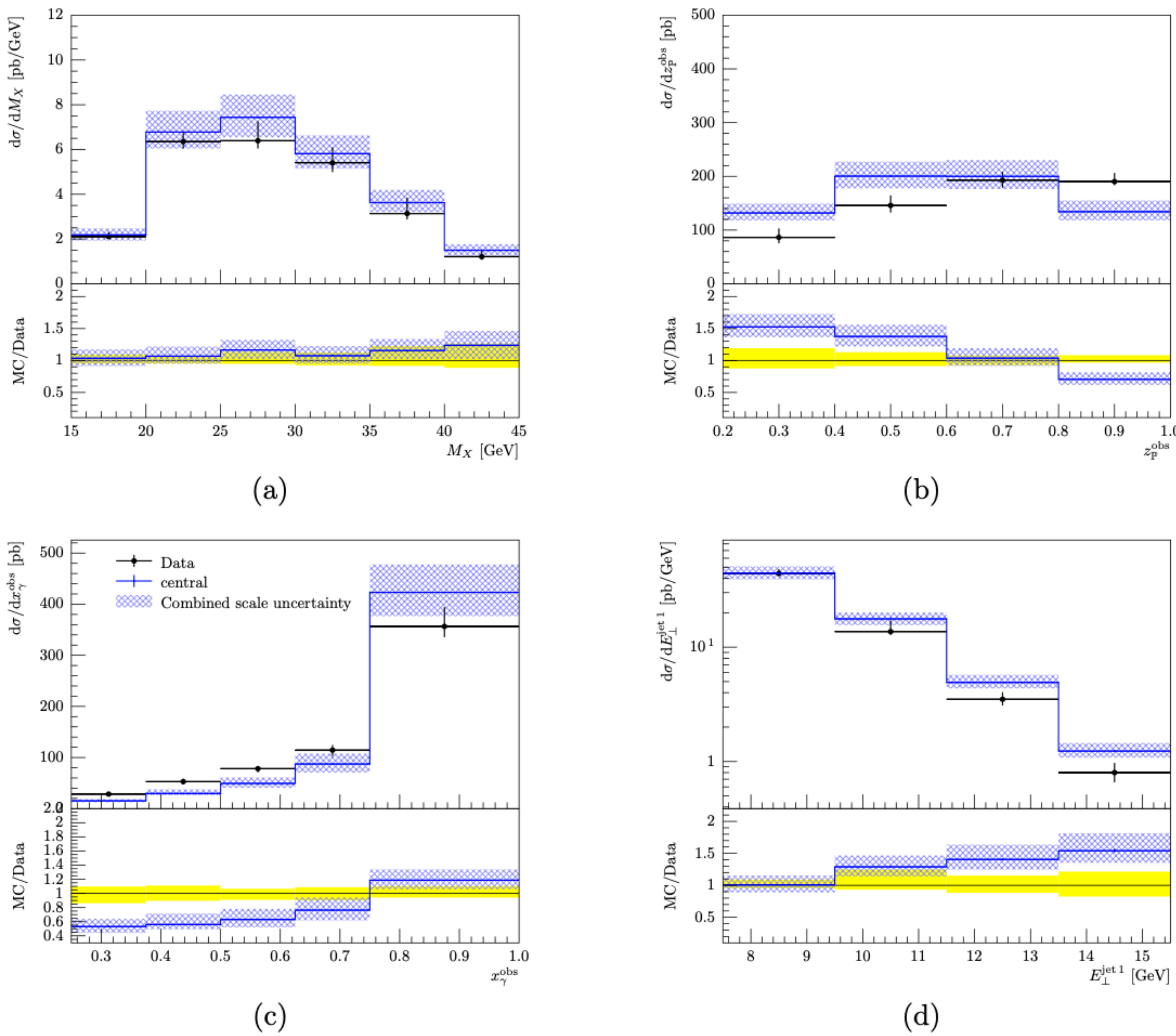


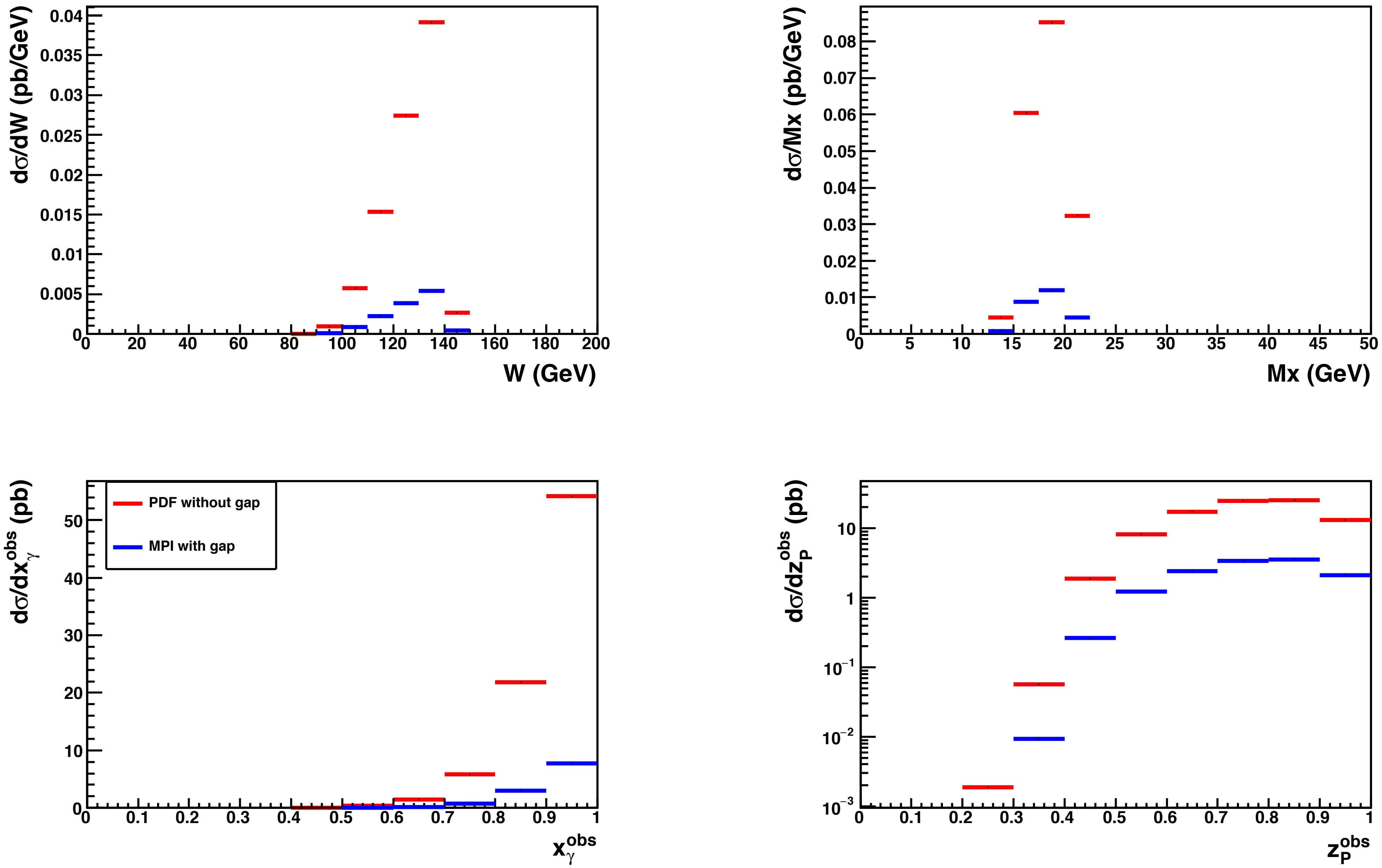
Figure 9: The model along with the uncertainty bands arising from varying the renormalization- and factorization scales compared to ZEUS data on M_X (a), $z_{\mathbb{P}}^{obs}$ (b), x_γ^{obs} (c) and $E_\perp^{jet\,1}$ (d).

arXiv:1901.05261v2

- Ee = 27.5 GeV
- Ep = 920 GeV
- $Q^2 < 1\ GeV^2$
- pT_jet1 > 7.5 GeV
- pT_jet2 > 6.5 GeV
- -1.5 < Eta < 1.5

- Mx is the invariant mass for the photon-Pomeron system;
- In general, most distribution are well described by the model including dynamical gap survival;

Diffractive dijet photoproduction in EIC



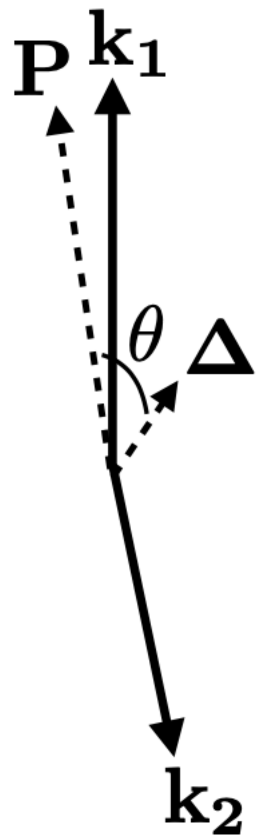
- Ee = 18 GeV
- Ep = 275 GeV
- pT_jet1 > 5 GeV
- pT_jet2 > 4 GeV
- -4.4< Eta < 4.4

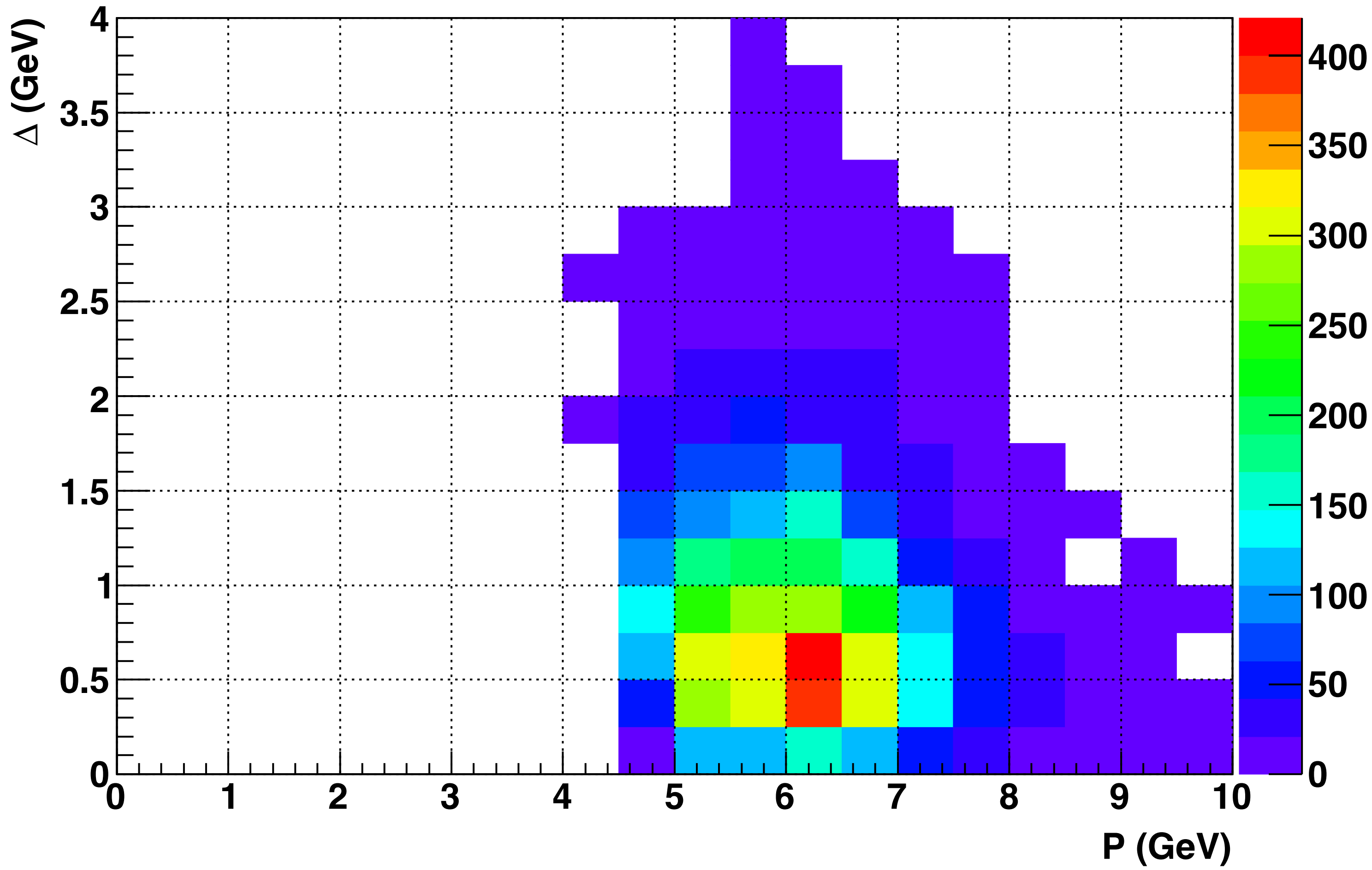
Dijet kinematics in EIC

$$\gamma^* + p \to \underset{(k_1)}{\mathrm{jet}_1} + \underset{(k_2)}{\mathrm{jet}_2} + p$$

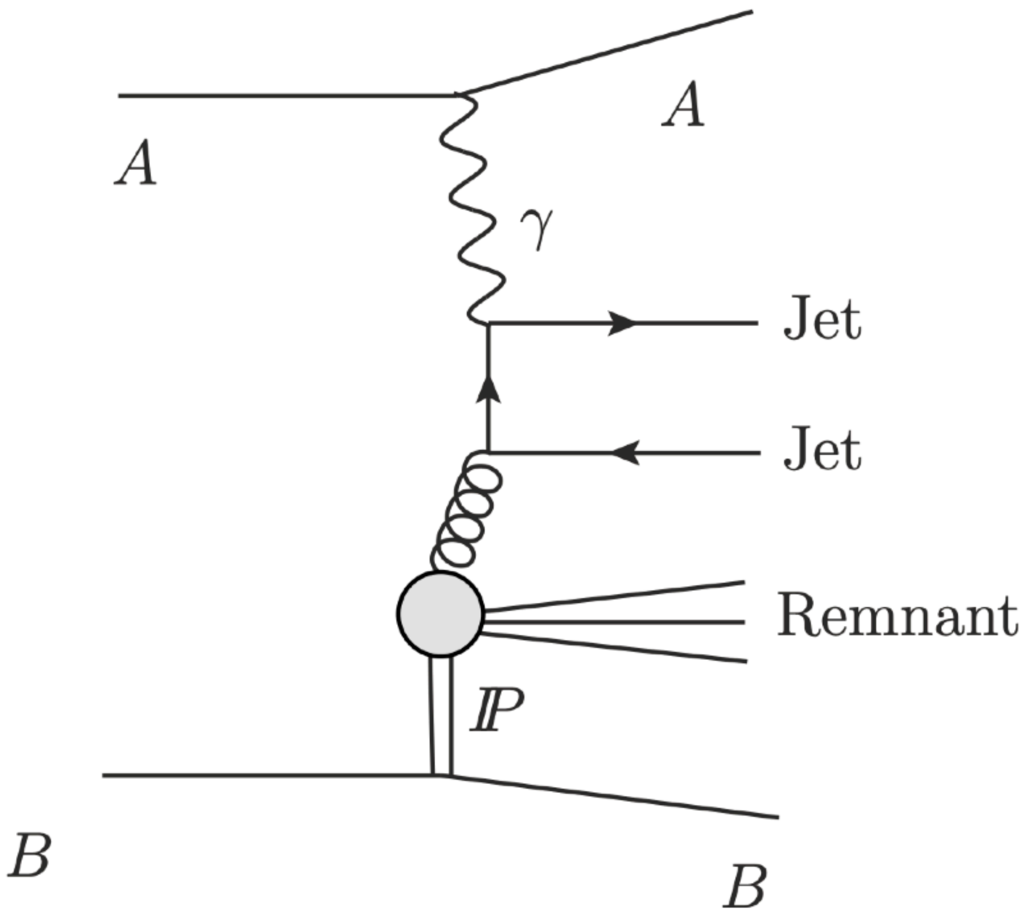
- **P** = 0.5(**k₁**-**k₂**); "mean jet Pt"
- **Δ = k₁ + k₂**; recoil momentum

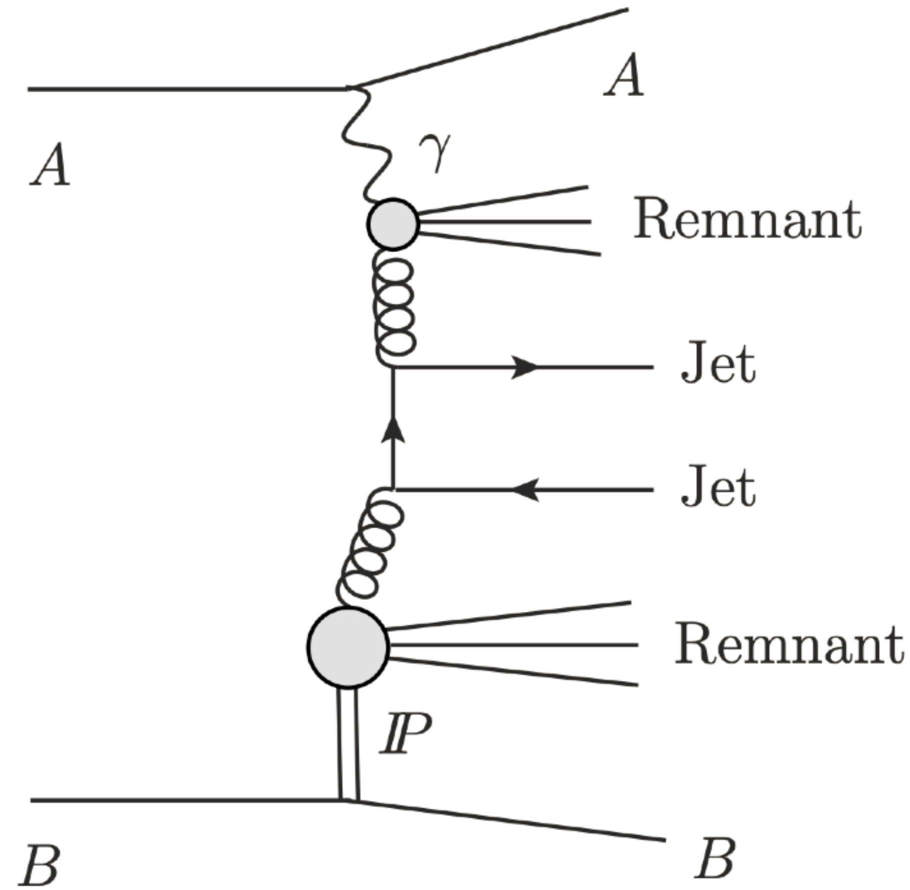
- Ee = 18 GeV
- Ep = 275 GeV
- pT_jet1 > 5 GeV
- pT_jet2 > 4 GeV
- -4.4< Eta < 4.4





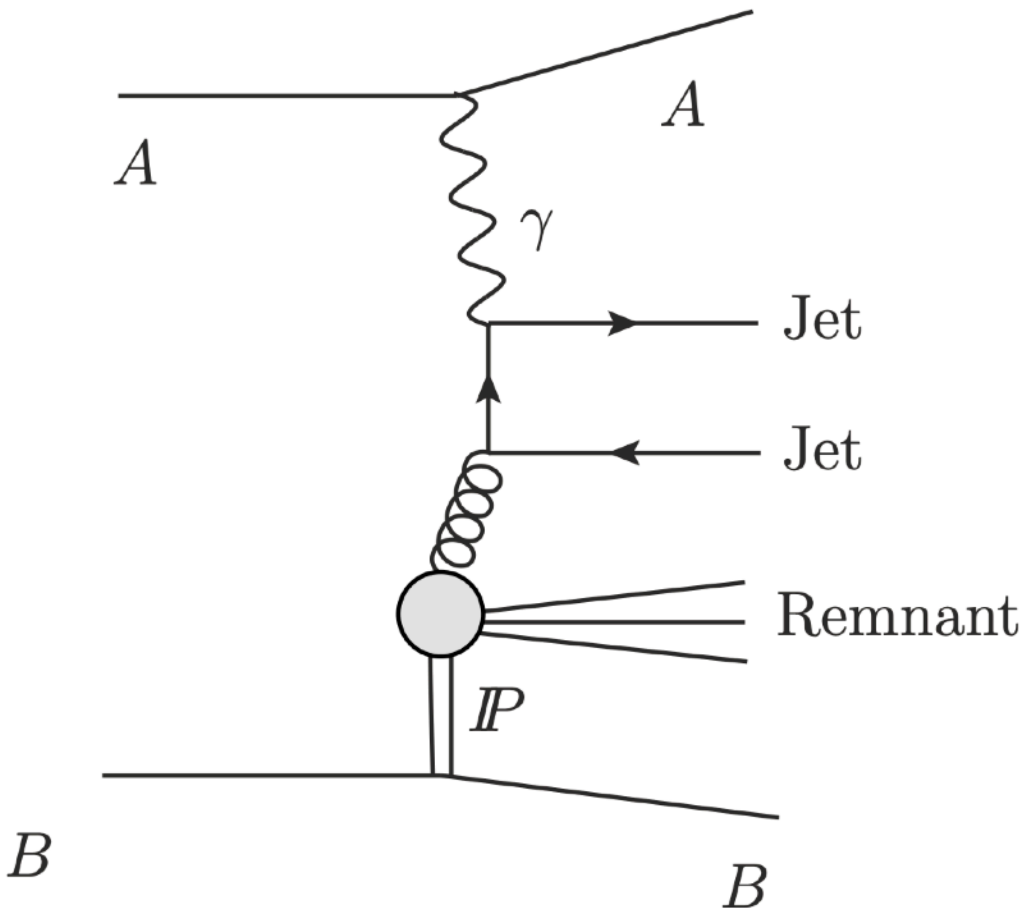
Diffractive dijet photoproduction

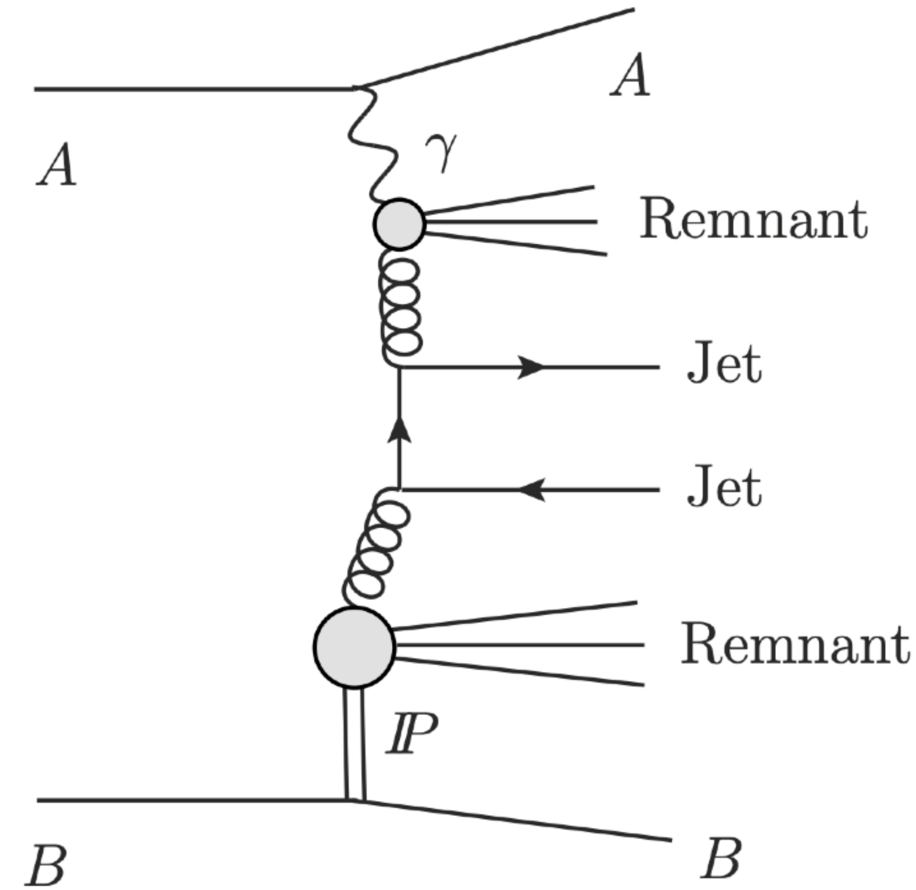




- Leading-order Feynman graphs for diffractive dijet photoproduction in UPCs for A and B;
- Left part is from direction photon contribution;
- Right part is from resolved photon contribution;

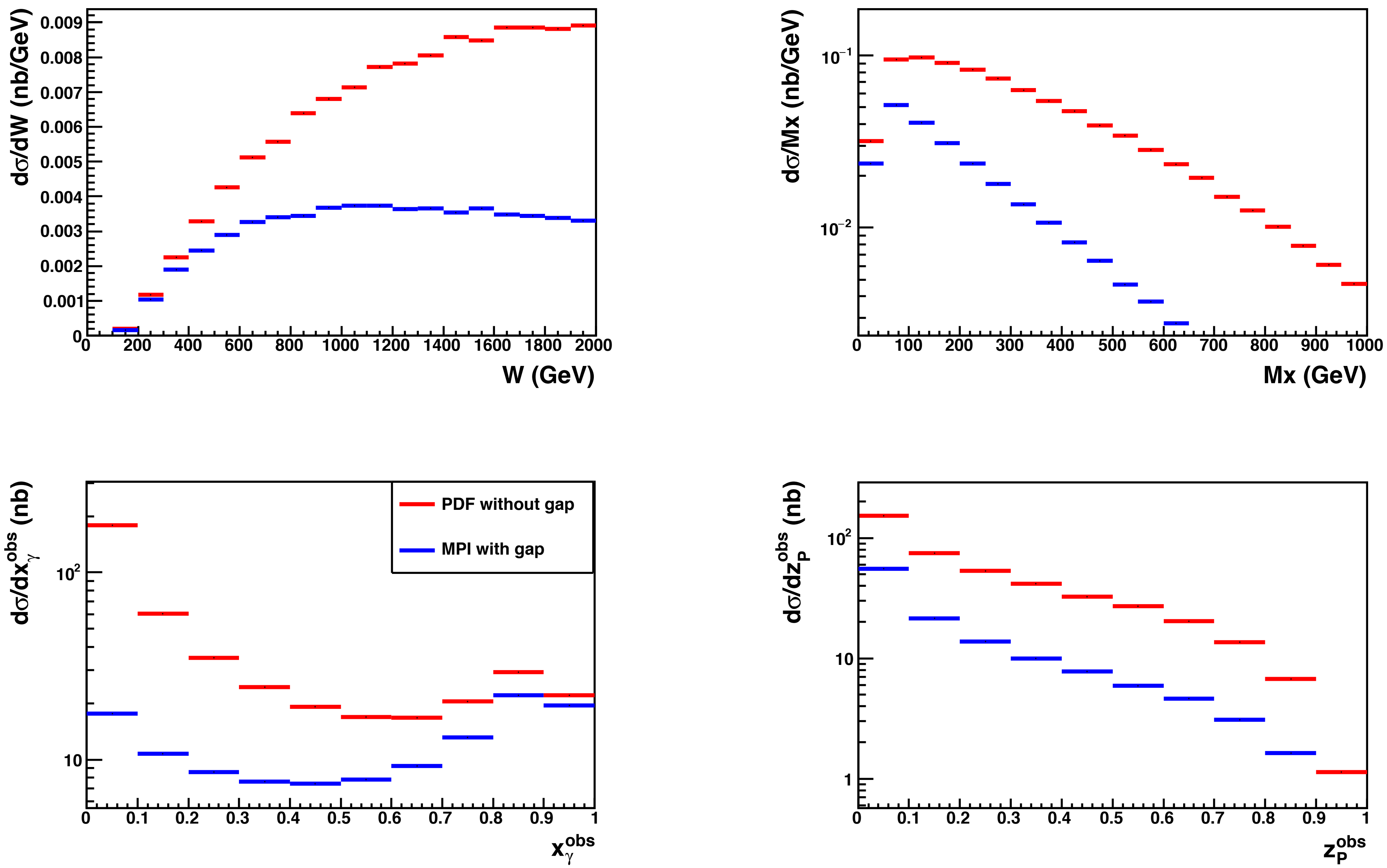
What can we learn?





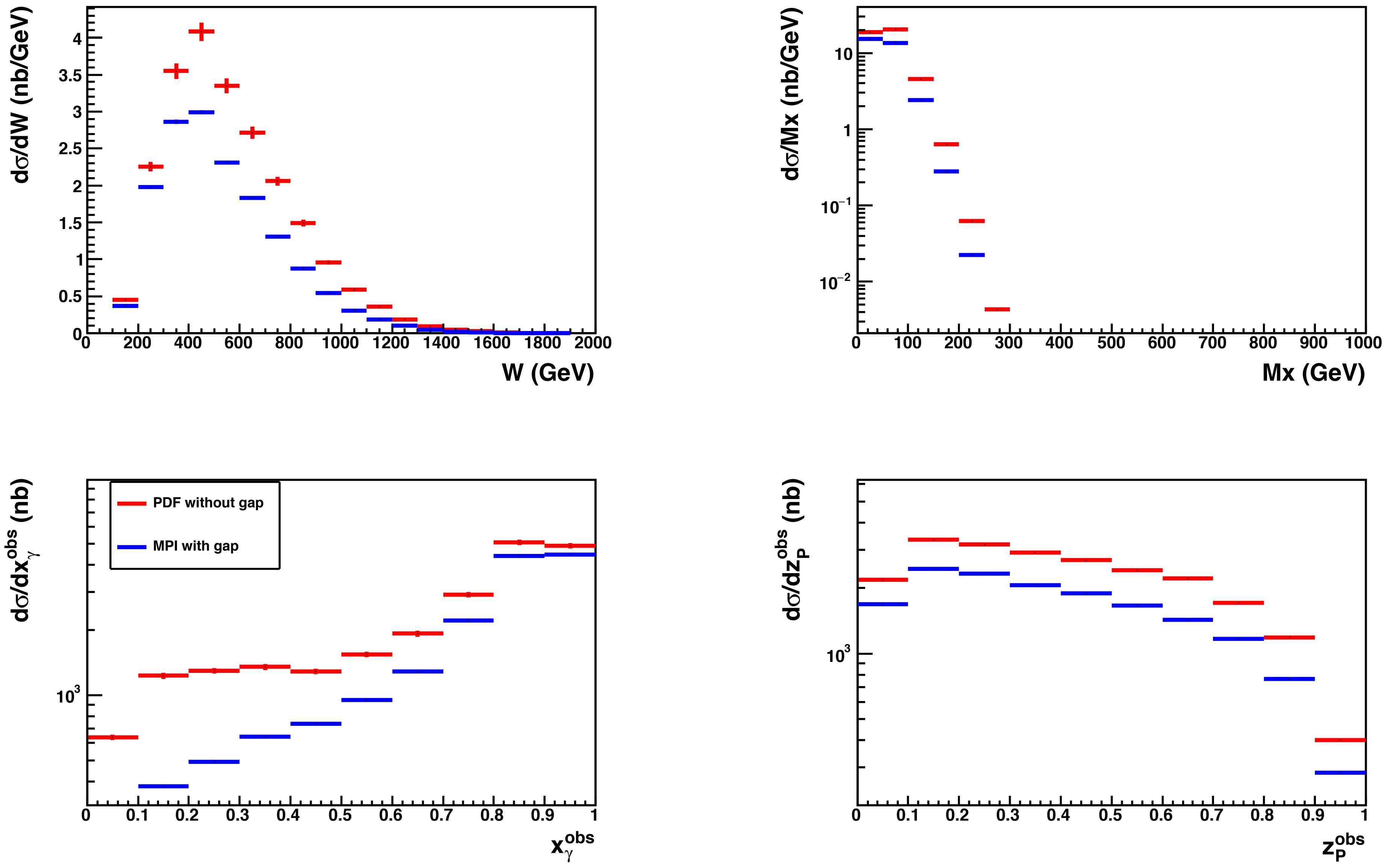
- Improve understanding of QCD factorization breaking in diffraction;
- Determine the nuclear diffractive PDFs;
- Improve the proton diffractive PDFs;
- Accessing the gluon Wigner distribution?

Diffractive dijet photoproduction for pp in LHC



- Ep1 = 6500 GeV
- Ep2 = 6500 GeV
- pT_jet1 > 8 GeV
- pT_jet2 > 6 GeV
- -4.4< Eta < 4.4

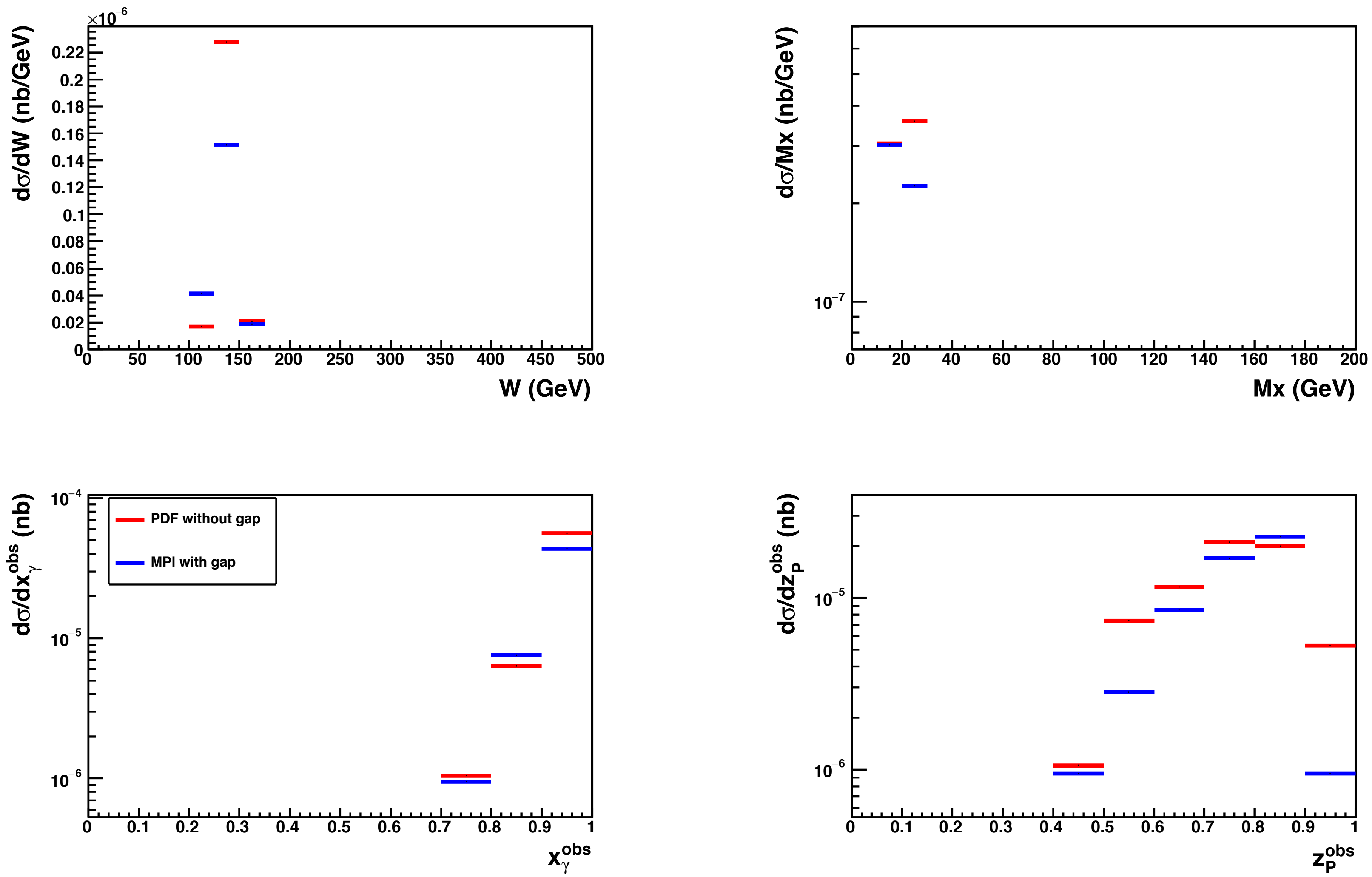
Diffractive dijet photoproduction for pPb in LHC



- Ep1 = 2500 GeV
- Ep2 = 2500 GeV
- pT_jet1 > 8 GeV
- pT_jet2 > 6 GeV
- -4.4< Eta < 4.4

Diffractive dijet photoproduction for pp in STAR

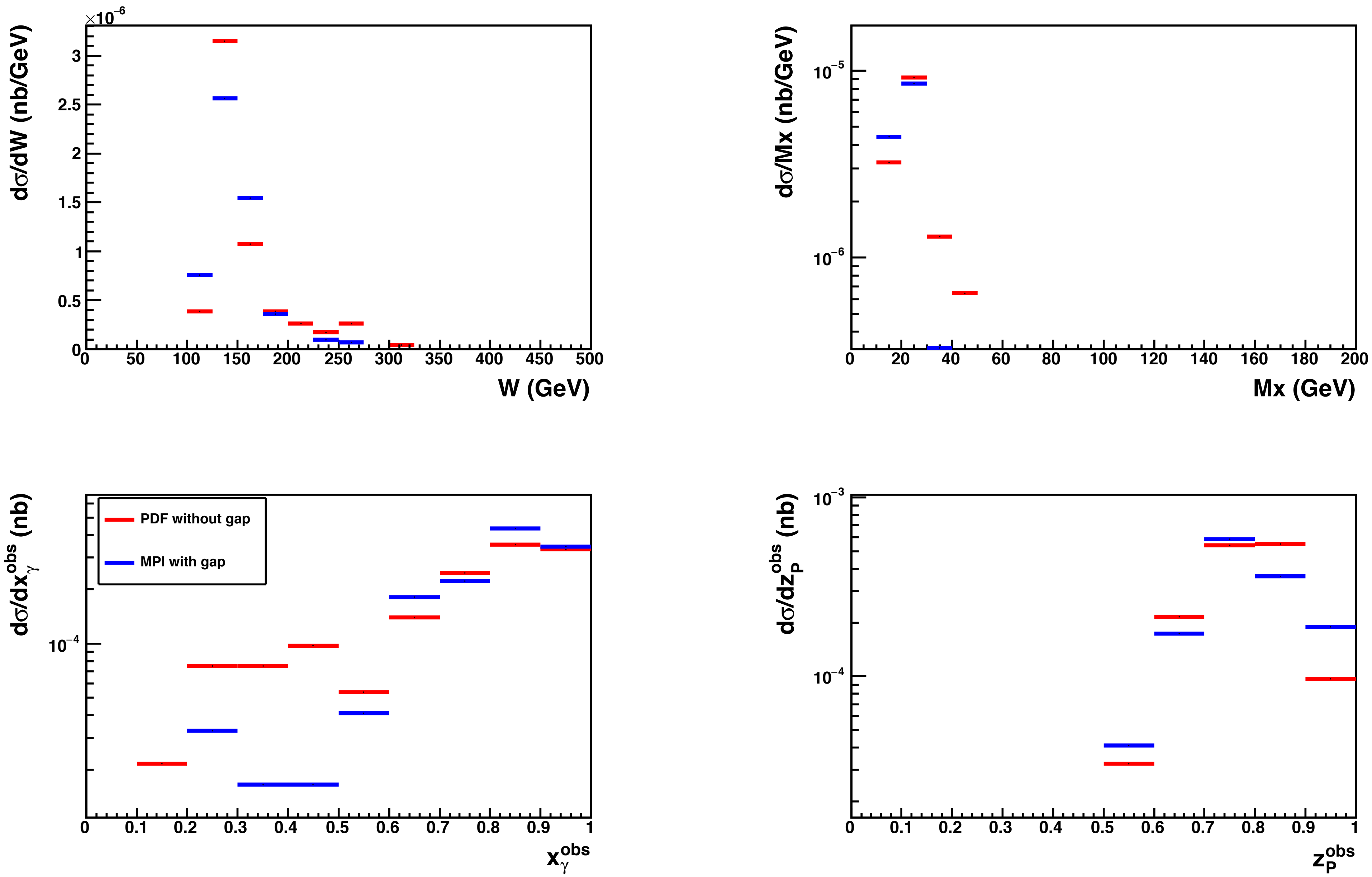
200GeV



- Ep1 = 100 GeV
- Ep2 = 100 GeV
- pT_jet1 > 8 GeV
- pT_jet2 > 6 GeV
- -4.4< Eta < 4.4

Diffractive dijet photoproduction for pp in STAR

500GeV

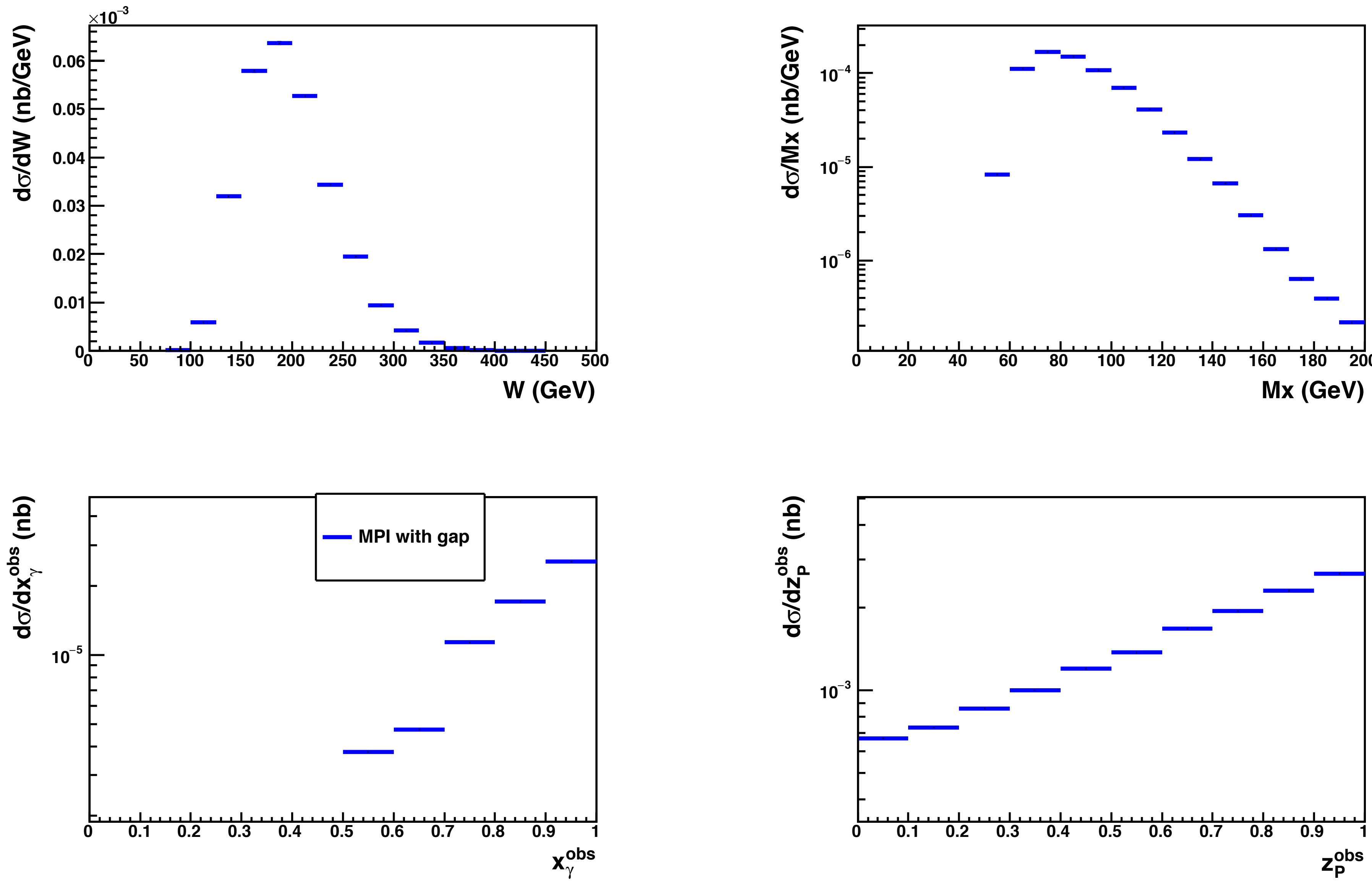


- Ep1 = 250 GeV
- Ep2 = 250 GeV
- pT_jet1 > 8 GeV
- pT_jet2 > 6 GeV
- -4.4< Eta < 4.4

STAR data analysis for pp is ongoing.

Diffractive dijet photoproduction for pAu in STAR

200GeV



- EAu = 100 GeV
- Ep = 100 GeV
- pT_jet1 > 5 GeV
- pT_jet2 > 4 GeV
- -4.4 < Eta < 4.4
- No xPom cut;

STAR data analysis for pAu is ongoing.

Similarly a combination of the current model and the ANGANTYR model for heavy ions is planned by Ilkka Helenius, such that eA and ultraperipheral UPCs in AA collisions could be probed as well.

Requirements for EIC detector

- **The "rapidity gap" in the detector technique can be used to tag on diffraction for ep and eAu;**
  - ✓ This means that there is a region in the detector from the hadron beam towards the center of the detector in which there is no activity from the hadronic final state.
  - ✓ The efficiency for detecting, and the purity of, diffractive events therefore depends strongly on the rapidity coverage of the detector, this needs to be updated with new forward detector setup as well as the better MCs;
- **For ep, the intact proton can be detected by B0 sensor and Roman Pots, the proton acceptance for diffractive events needs to be studied;**
- **For the jet reconstruction efficiency and resolution study, it needs central detector setup;**

Summary

- A new framework for modeling hard diffractive events in photoproduction for ep, pp,pAu, implemented in the general purpose event generator Pythia 8.
- The data from HERA is well described by the model including dynamical gap survival;
- Developing model for hard diffractive events in photoproduction for eAu is planned by Ilkka Helenius;
- The requirements for EIC detector need further study;

Thank you!