Low-p_T UPC D^0 analysis

with '23 data & '23 UPC reconstruction

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Group Meeting

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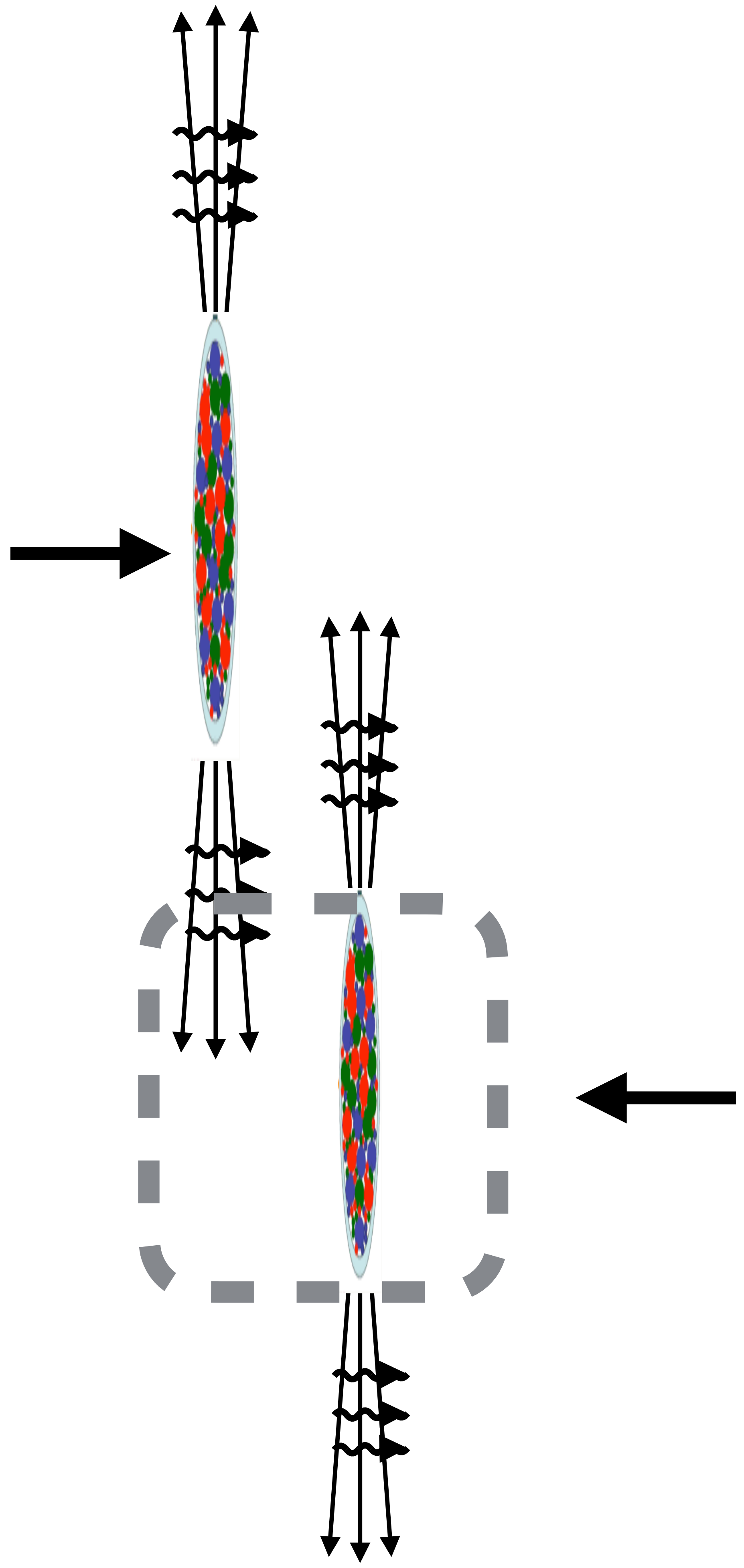
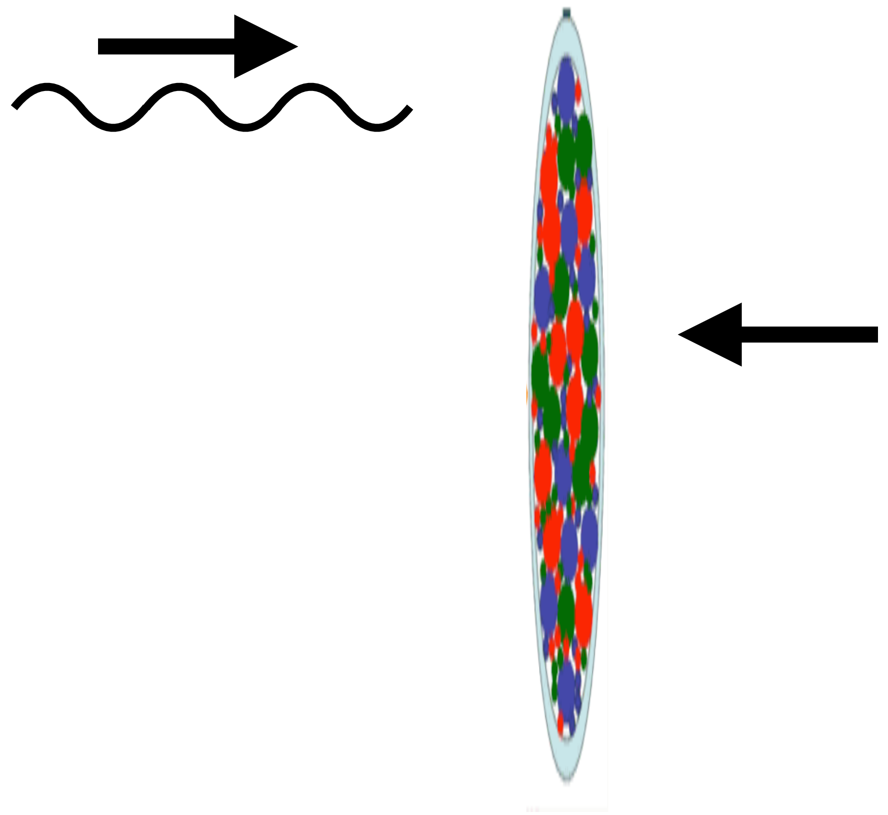
UPCs in the Large Hadron "Photon" Collider

→ many photon-photon or photon nucleus collisions in so-called **ultraperipheral heavy-ion collisions (UPCs)**





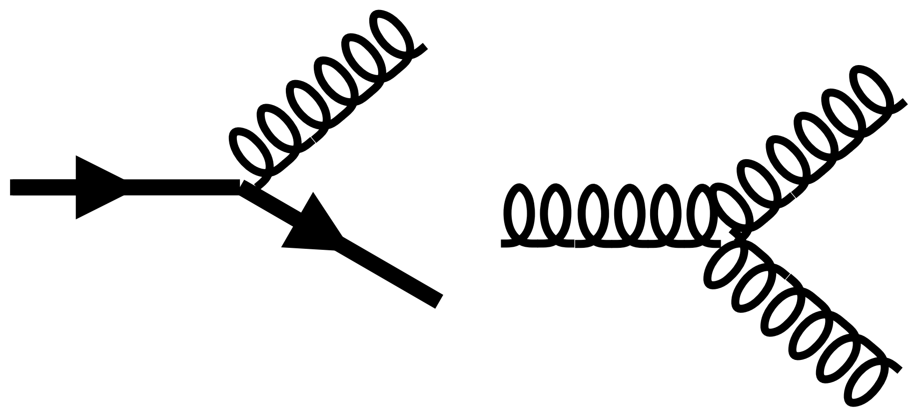
CMS HIN-24-003

High-energy photon-nucleus collision in UPCs:

→ unique tools to study the **properties of quarks and gluons in nuclei at extremely high partonic densities**

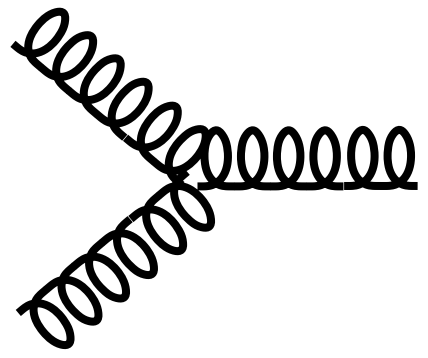
From low to high gluonic densities

Gluon splitting

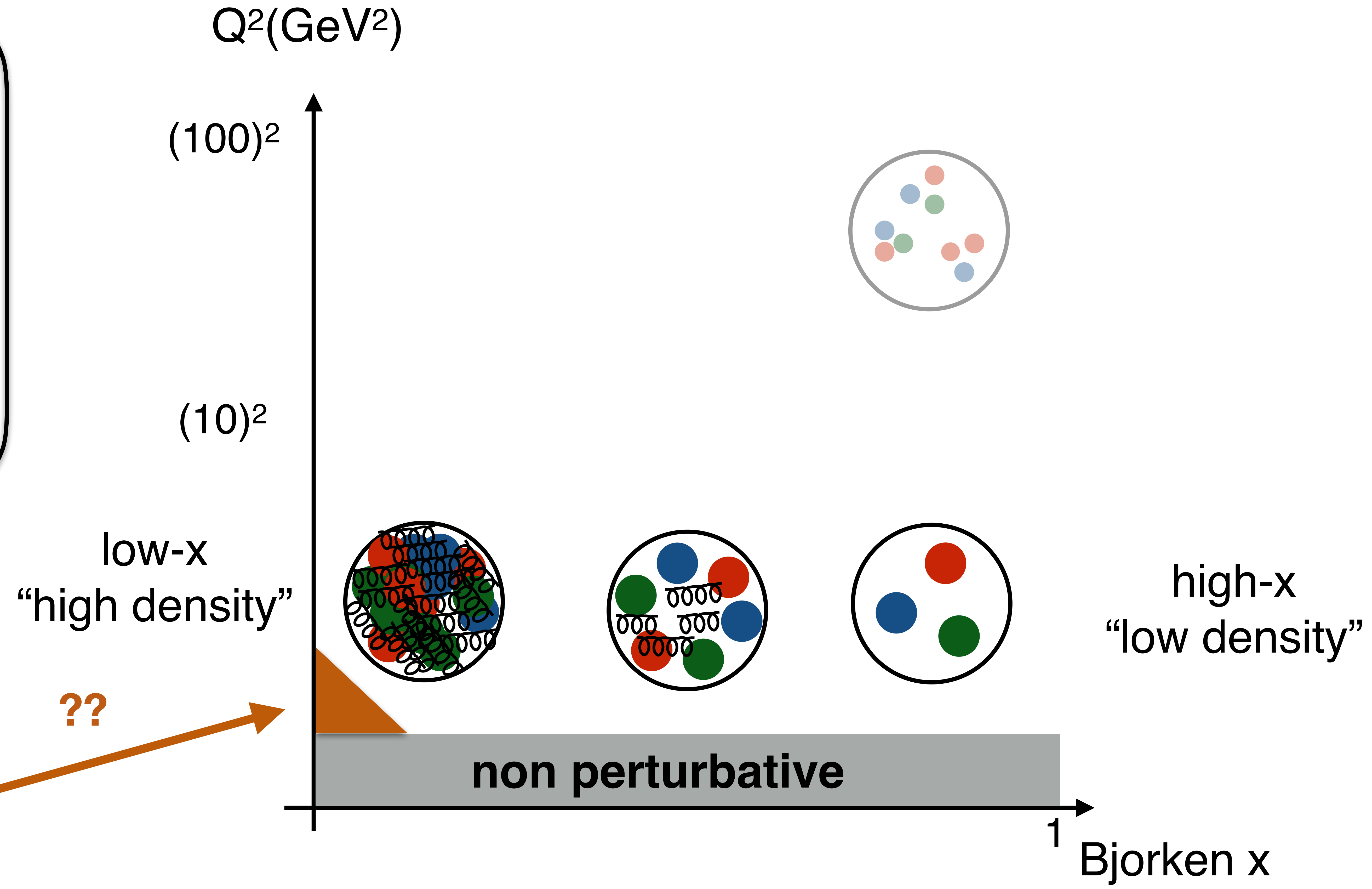


High-x gluons splitting in small-x gluons ***g→gg***

Gluon "merging"

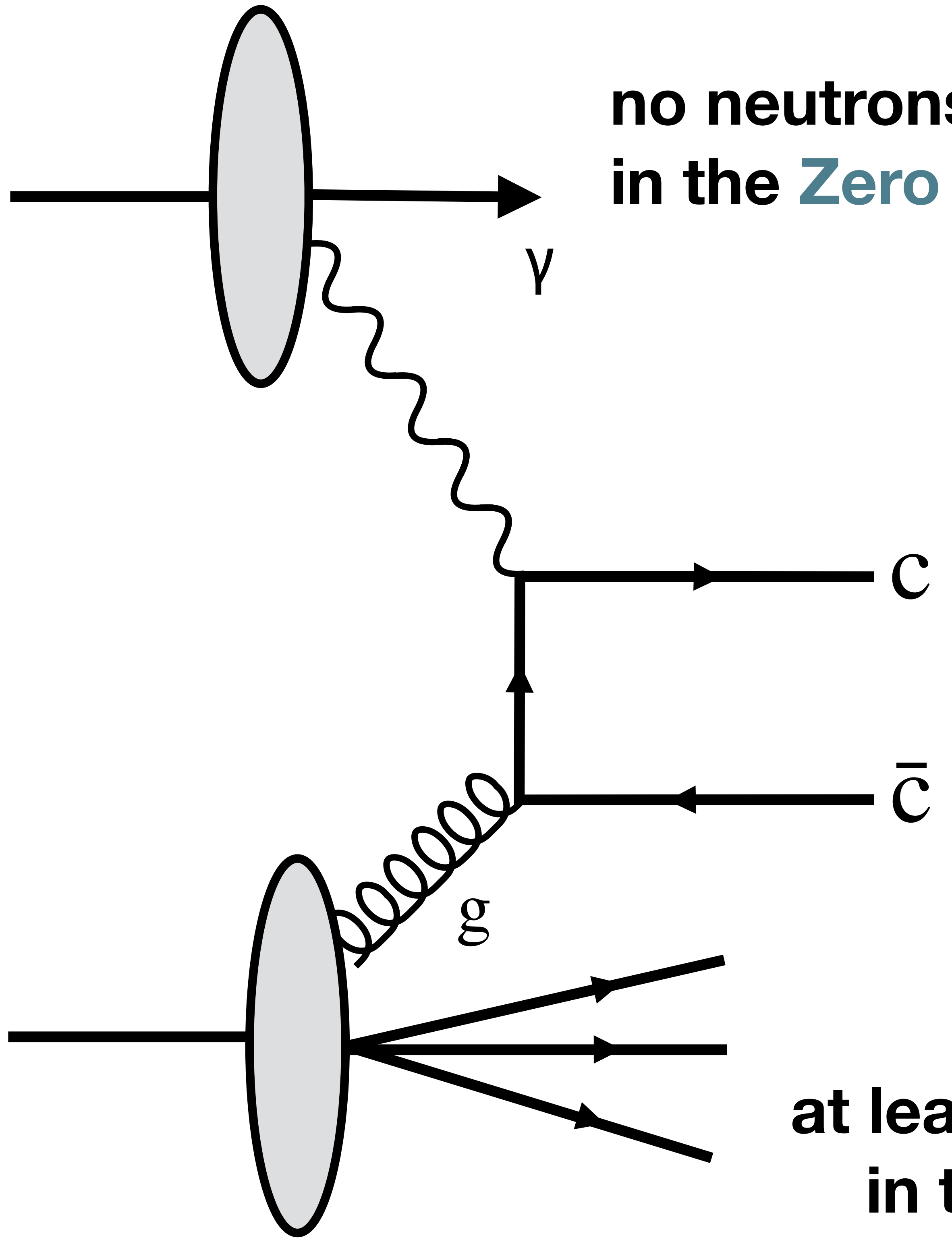


Low-x gluons combining into higher-x gluons ***gg→g***



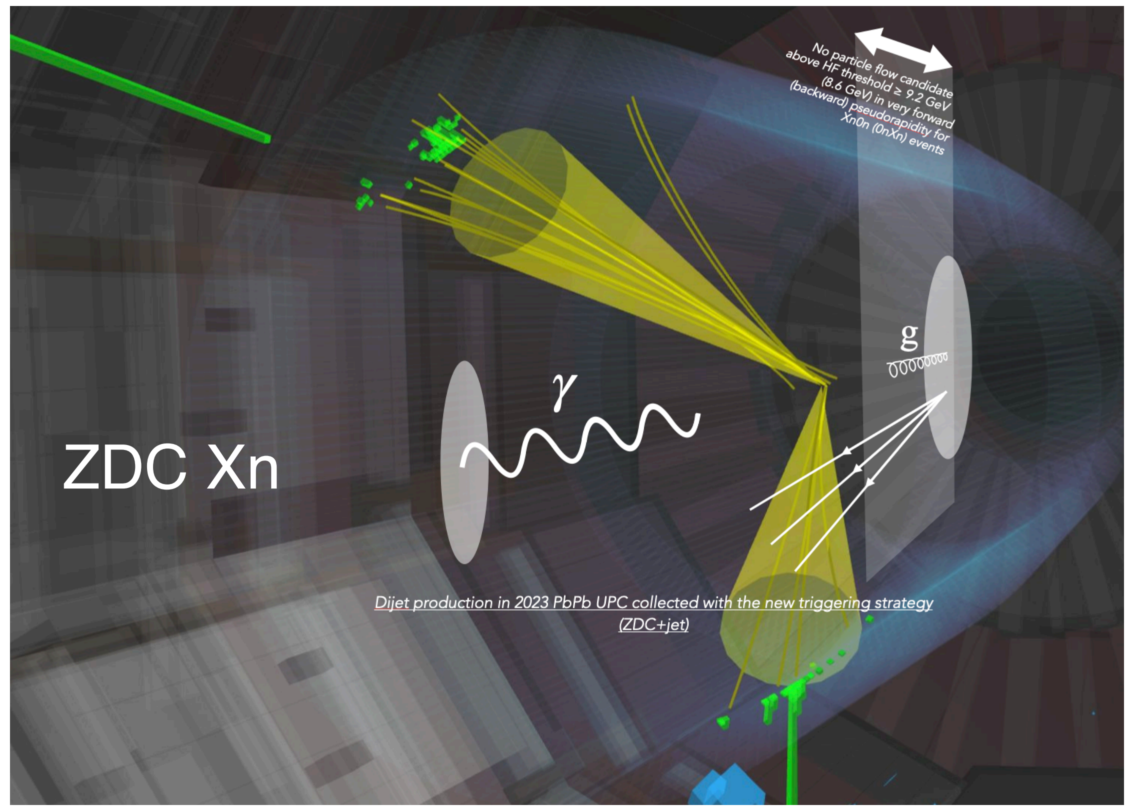
Gluon saturation predicted by QCD

Overview of the analysis strategy



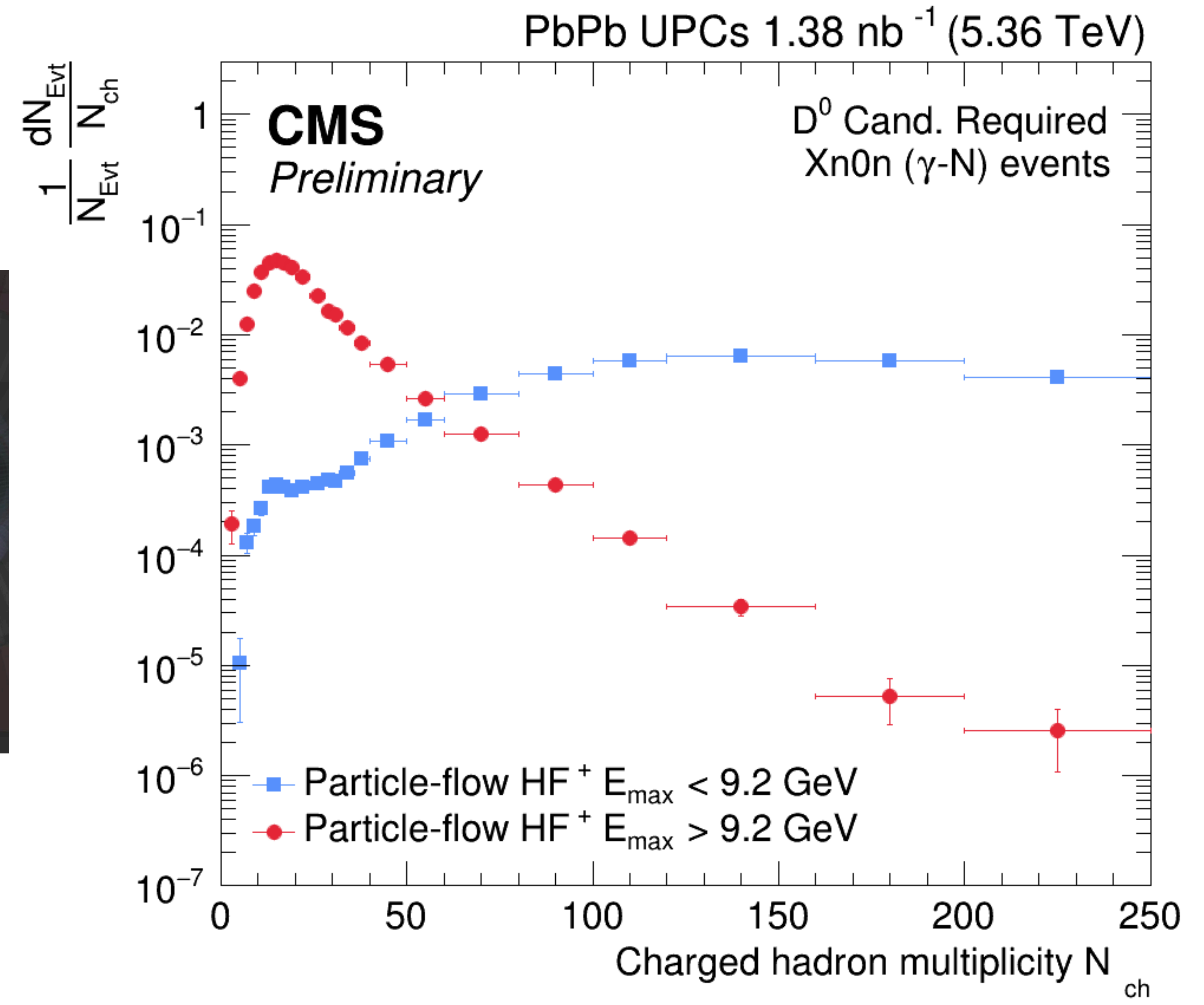
no neutrons (0n)
in the Zero Degree Calorimeter (ZDC)

Rapidity gap in the hadronic forward calorimeter (HF) in the photon-going direction



$D^0 \rightarrow K^-\pi^+$ with charged tracks in the tracker

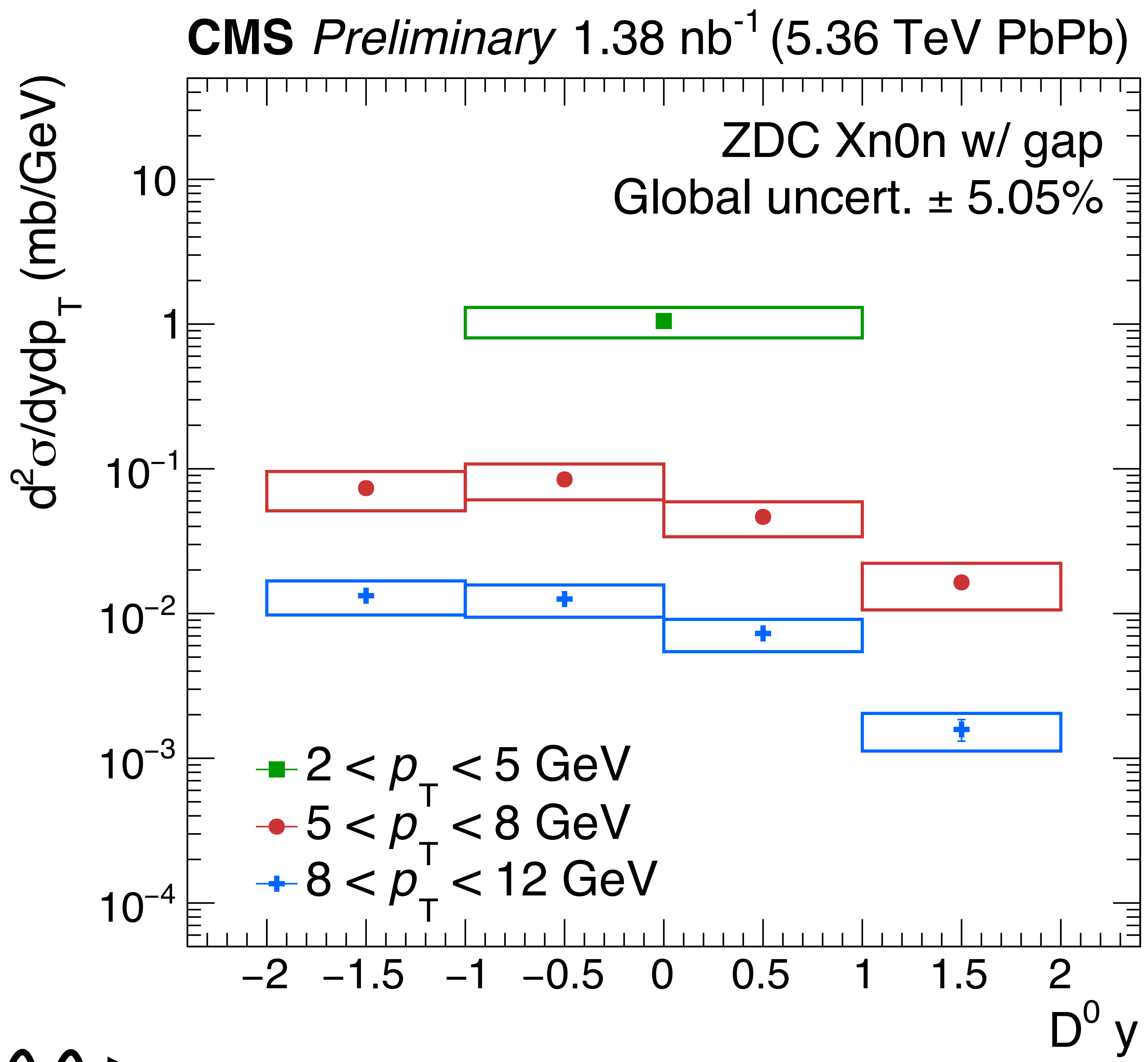
at least one neutron
in the ZDC (Xn)



Events passing the rapidity gap condition
Events failing the rapidity gap condition (high N_{ch})
(mostly coming from "hadronic" PbPb collisions)

For low-p_T D^0 mesons (< 5 GeV)
→ at least one ZDC with >1n signal (**ZDCOR**)
For high-p_T D^0 mesons (> 5 GeV)
→ **ZDCOR in coincidence with a Level-1 jet** (E_{jet} > 8 GeV)

dσ/d$p_T$dy for photonuclear D^0 production in UPC collisions

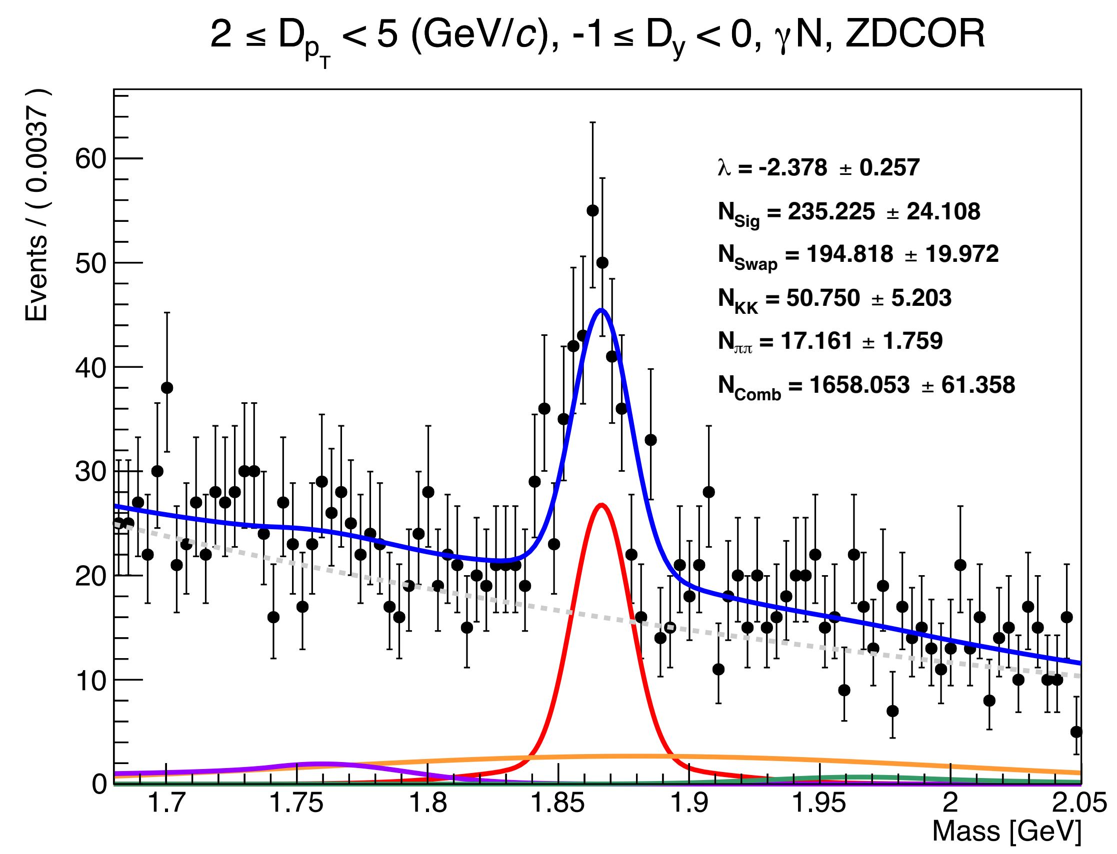


$$\frac{d^2\sigma}{dp_T dy} = \frac{1}{2}\frac{1}{\mathscr{L}_{int}\ P_{\text{trig,presc}}\ BR(D^0 \to K^-\pi^+)}\frac{N^{\text{raw}}_{D^0+\bar{D}^0}}{\Delta p_T \Delta y}\frac{1}{\epsilon_{\text{evt}}\ \epsilon_{\text{trigger}}\ \epsilon^{tot}_{D^0}\ \epsilon_{EMpileup}}$$

Corrected yields

MC-based efficiency correction

Yields from D^0 mass fit



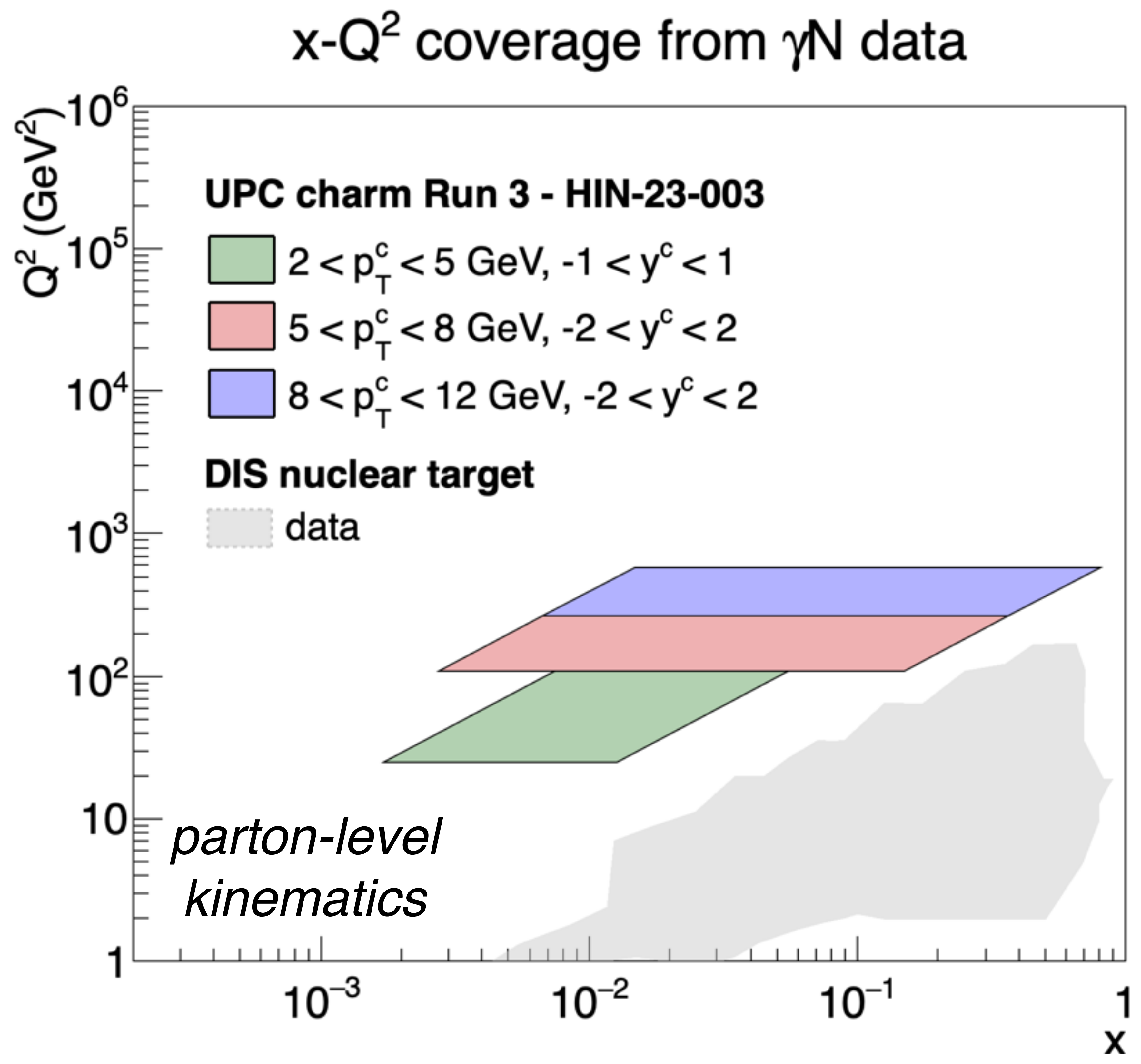
Systematic components:

- **Rapidity-gap condition**
- **D^0-selection efficiency, mostly driven by MC-data differences in:**
  - distributions of selection variables
  - multiplicity, p_T/y shape,
  - fraction of prompt/non prompt D^0, resolved vs direct photon events
- **Yield-extraction and modeling of the peaking backgrounds**

Scope of the new analysis

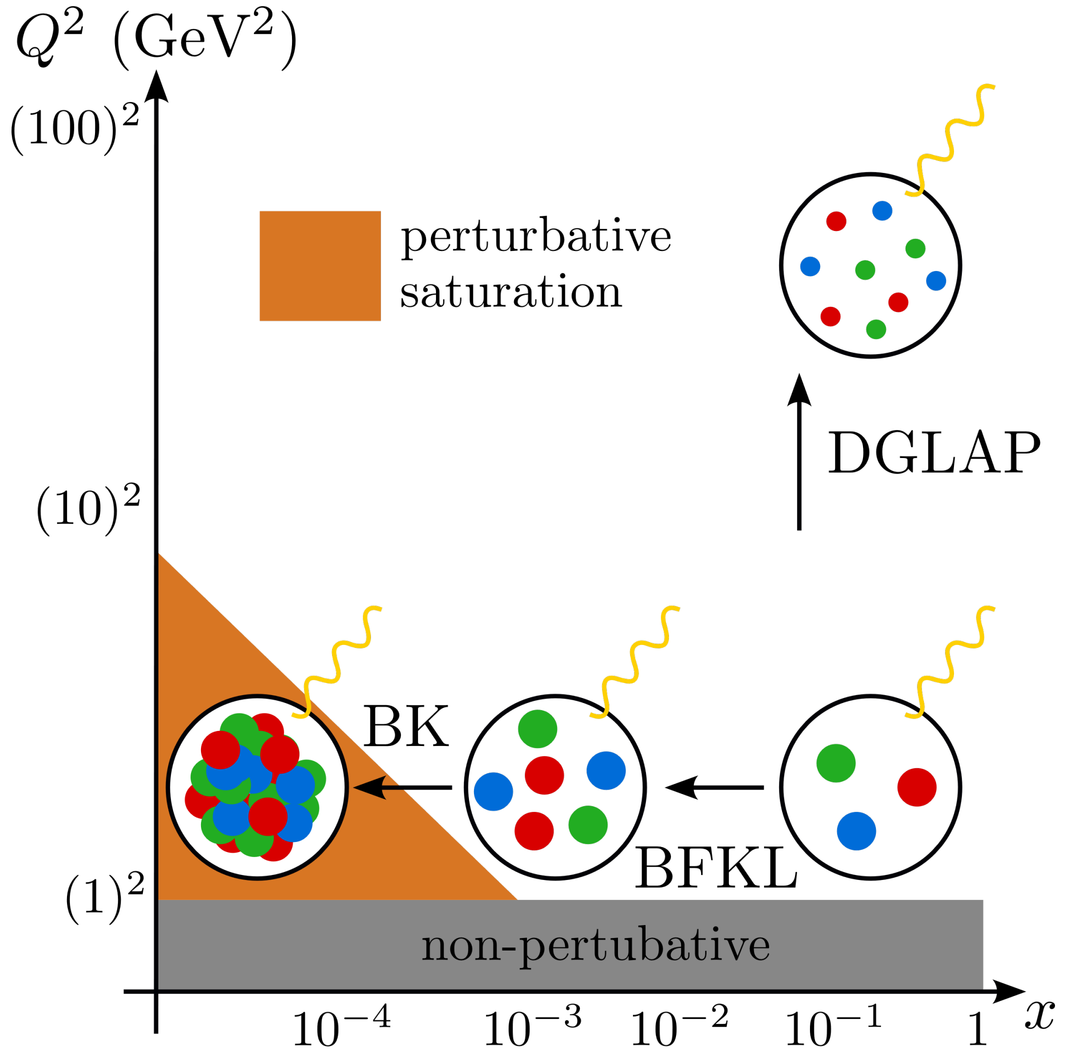
2023 analysis

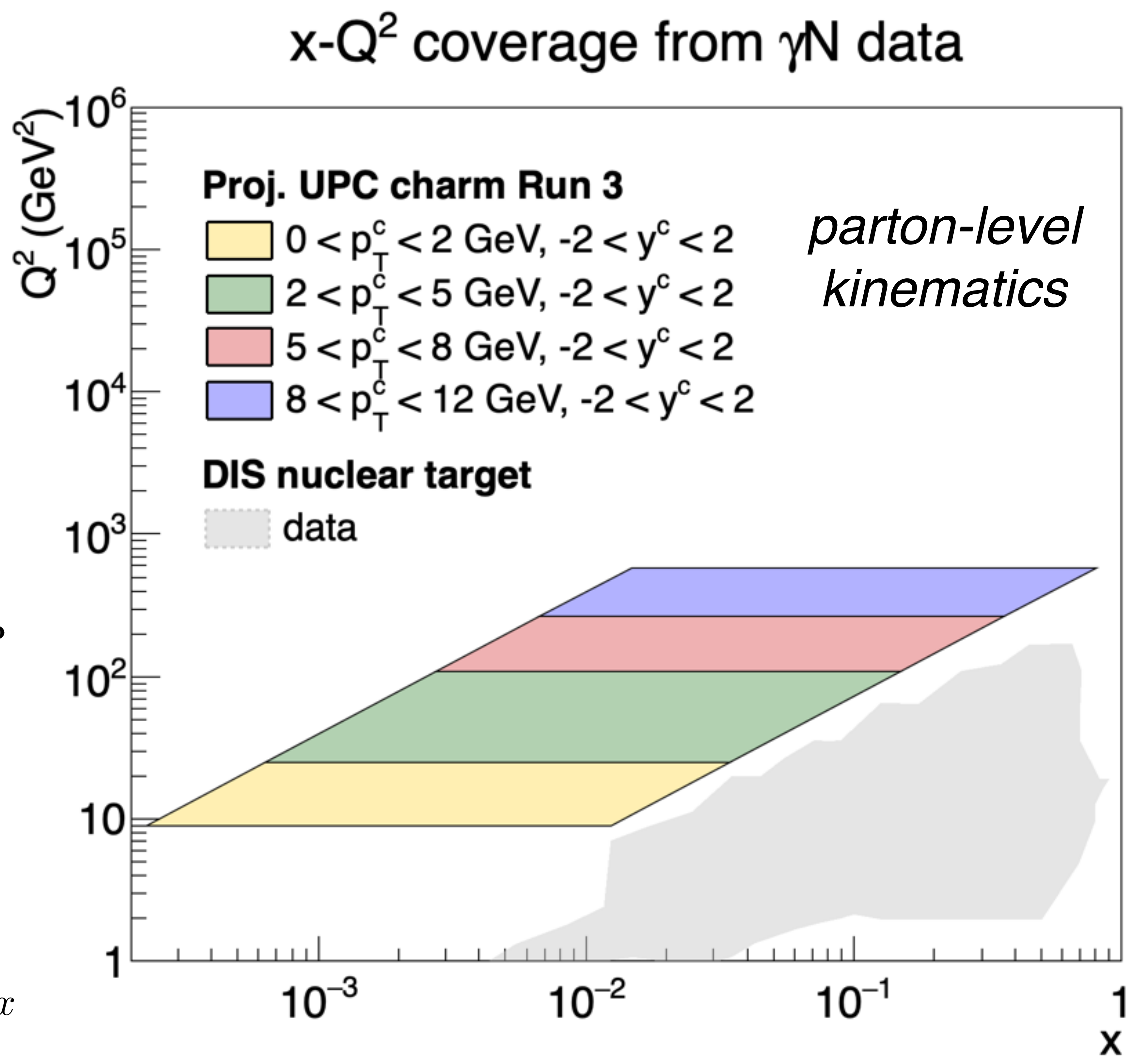
- $p_T >$ 2 GeV
- limited y range at low p_T



Goal for 2025

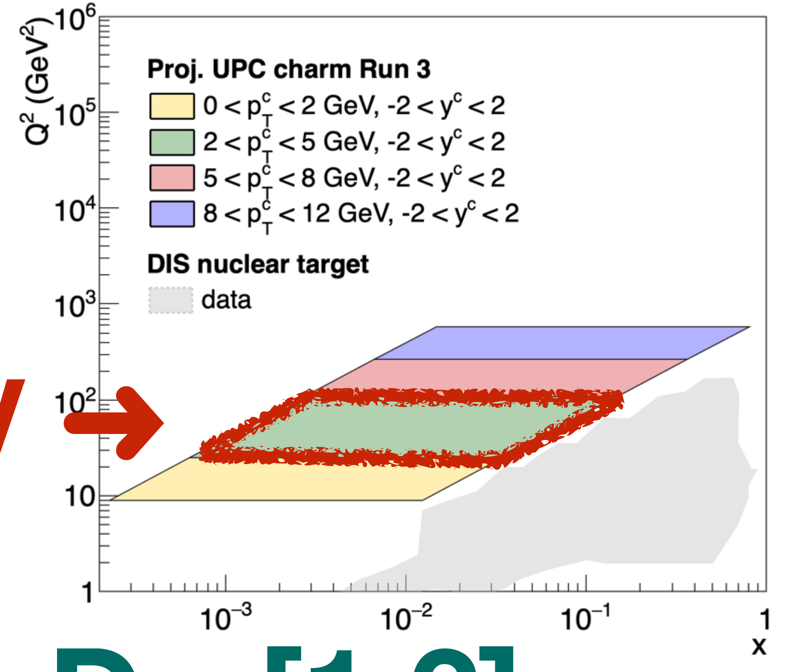
- Rapidity dependence of the low p_T measurement
- Extend to lower p_T D
- **reduced systematic uncertainty**
- **forward-backward ratios** (substantial cancellation of systematics)





η-dependence in 2 ≤ D_{pT} ≤ 5 GeV

2-5 GeV

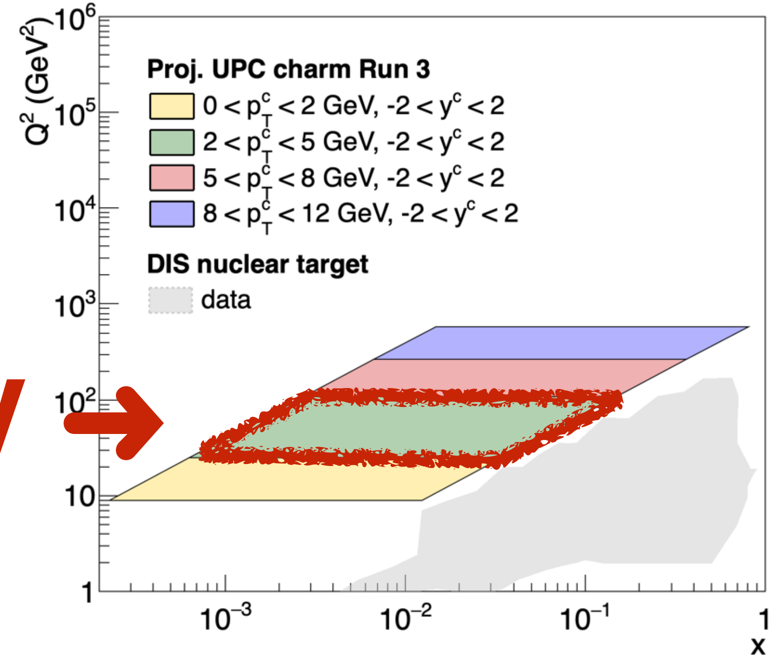


γN

D_y: [-2,-1] **D_y: [-1,0]** **D_y: [0,1]** **D_y: [1,2]**

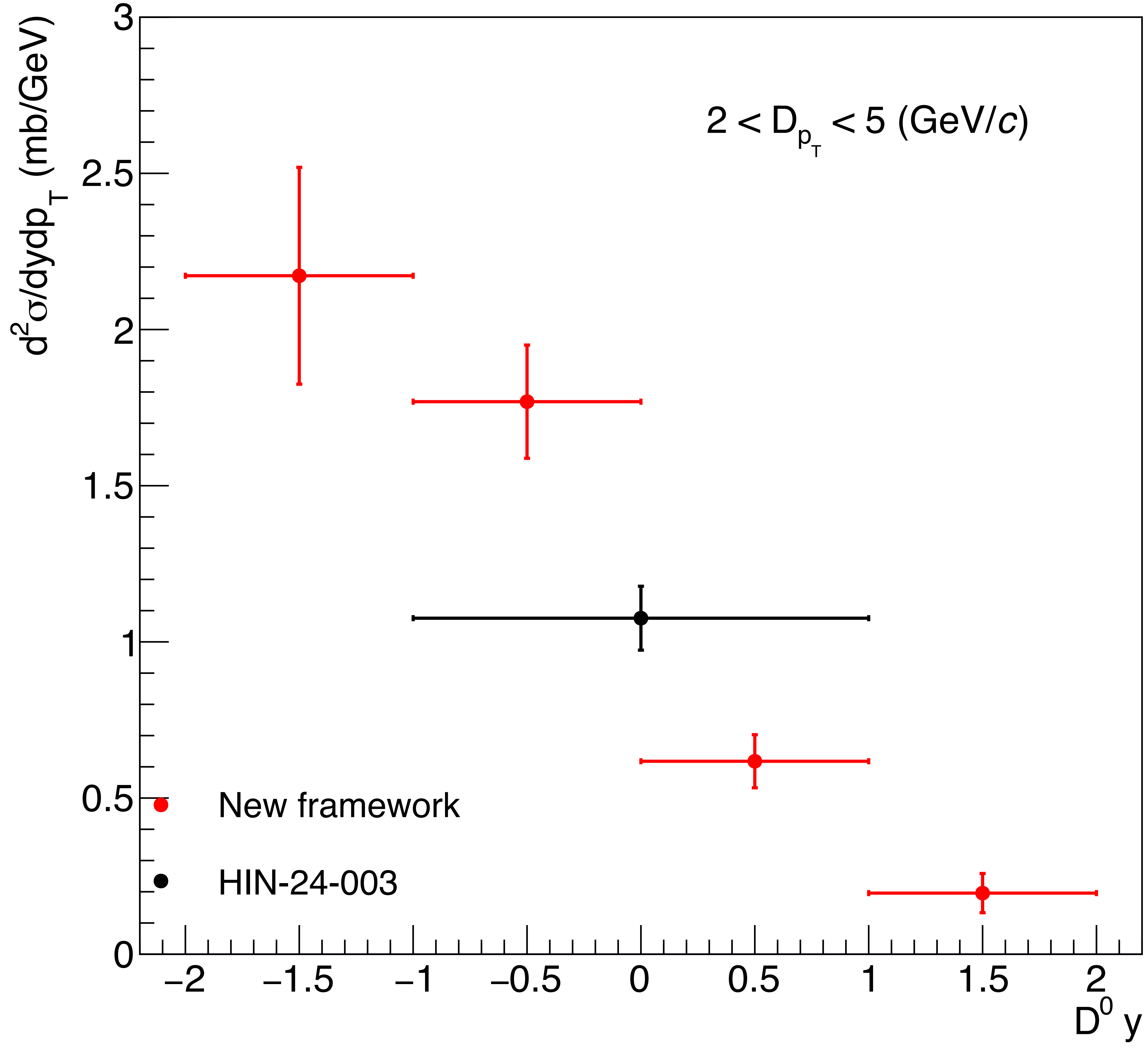
Nγ

$d^2\sigma/dydp_T$ in $2 \le D_{pT} \le 5$ GeV

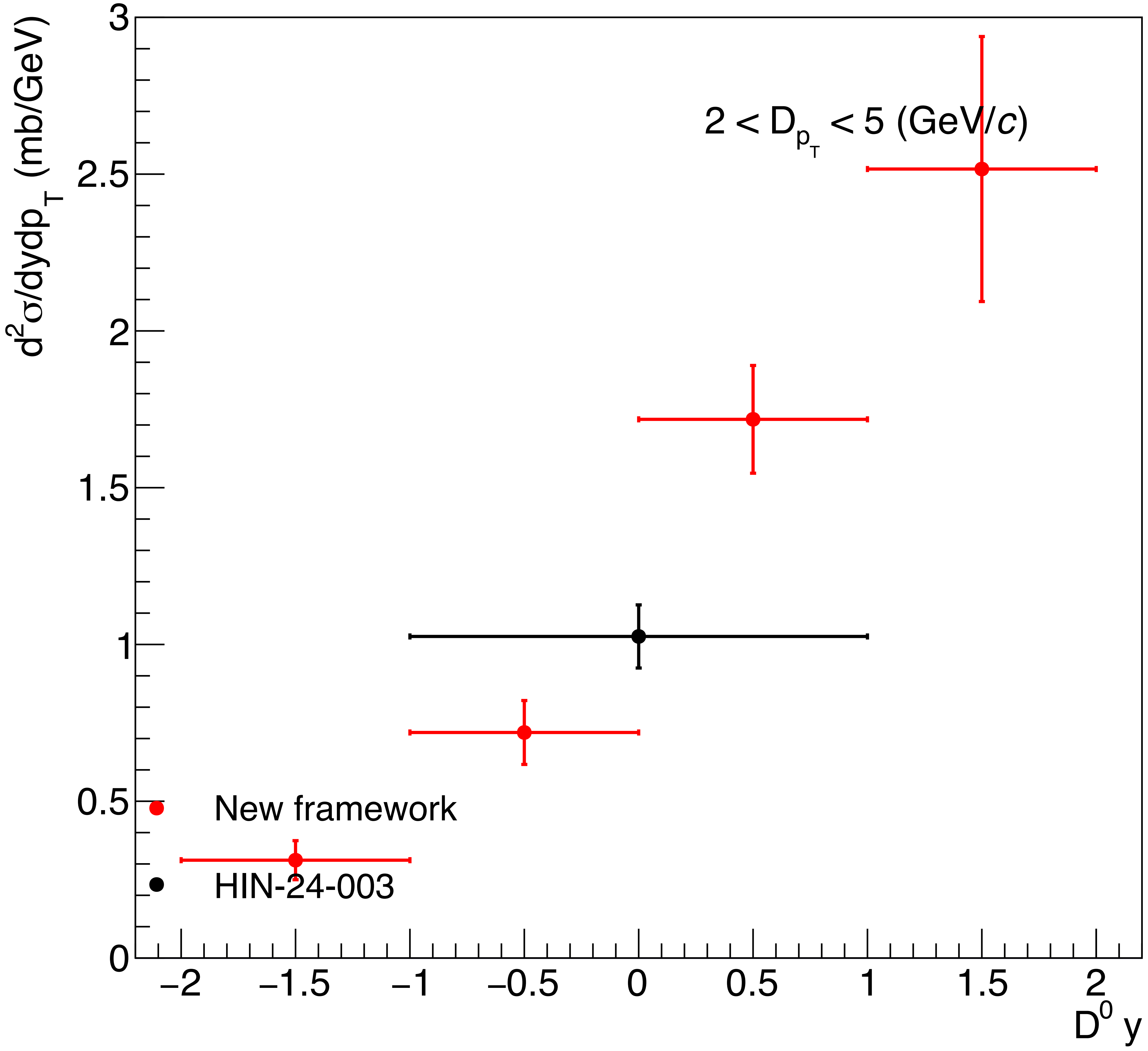


2-5 GeV

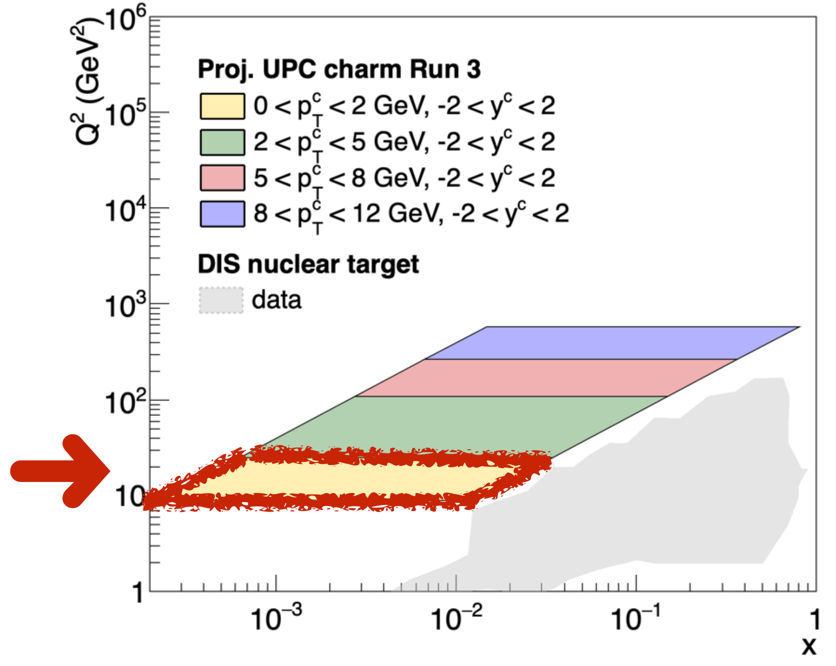
γN



Nγ

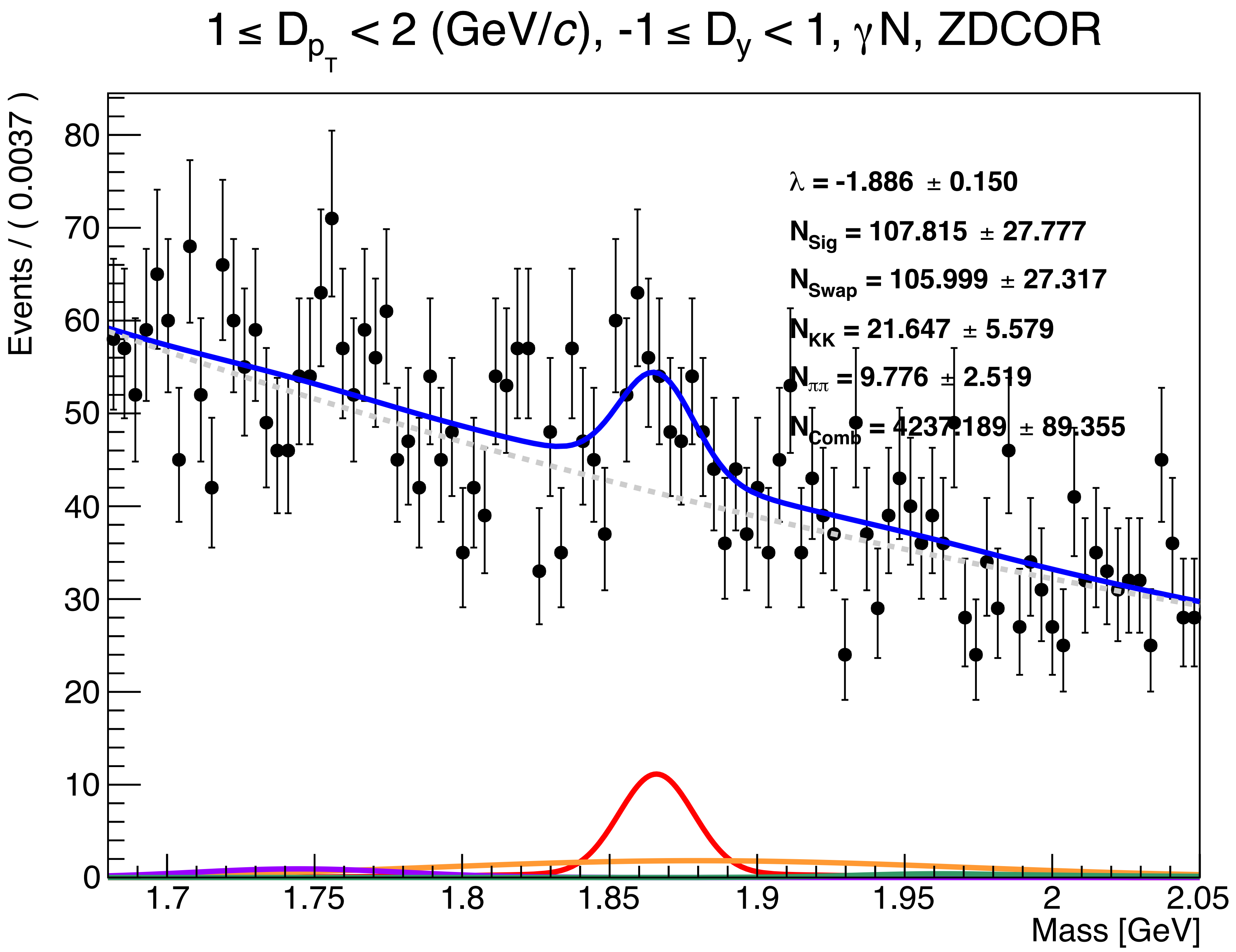


First look at the $1 \leq D_{pT} \leq 2$ GeV bin

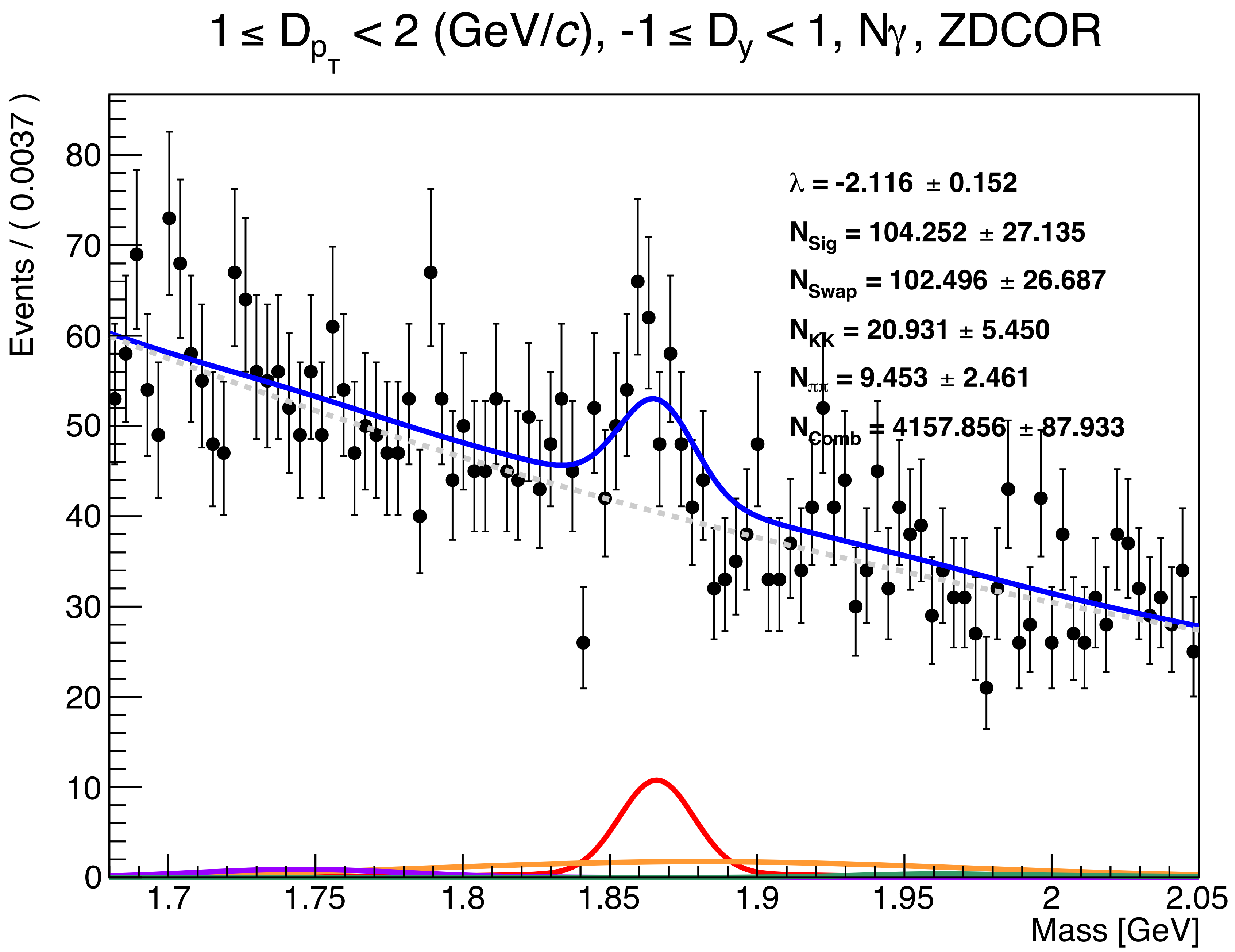


1-2 GeV ➜

γN



Nγ



Selections are preliminary!

- Daughter track's pT ≥ 0.6 GeV/c
- Vertex probability $\chi^2 \geq 0.1$
- Pointing angle $\alpha \leq 0.3$
- Opening angle btw two daughter tracks $\Delta\theta \leq 0.3$
- 3D decay-length significance $d_0/\sigma(d_0) \geq 1.5$

Visible signal peak at a first look!
Still have room for optimization, e.g. using PID