

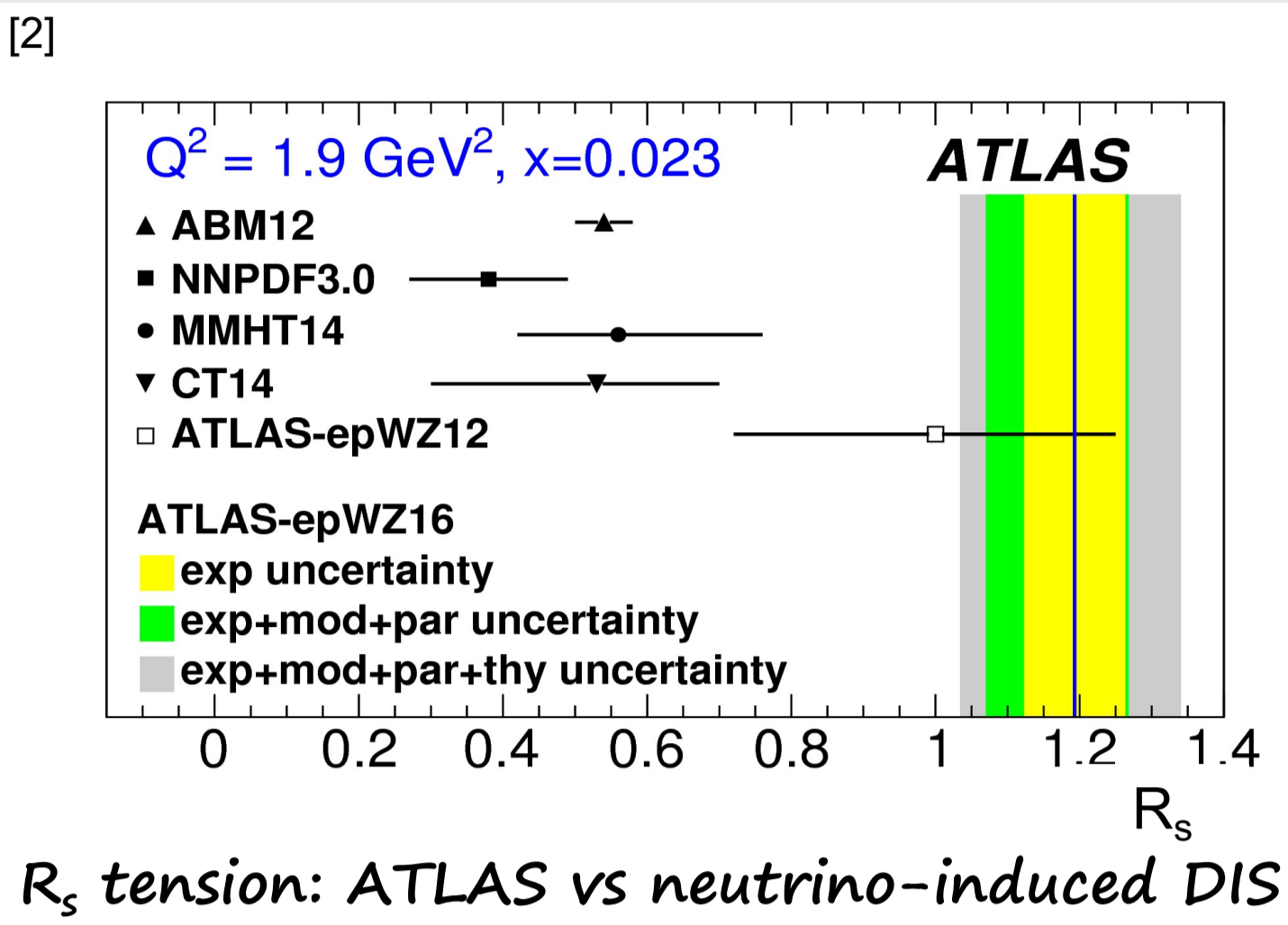
The impact of ATLAS V+jet measurements on PDF fits^[1]

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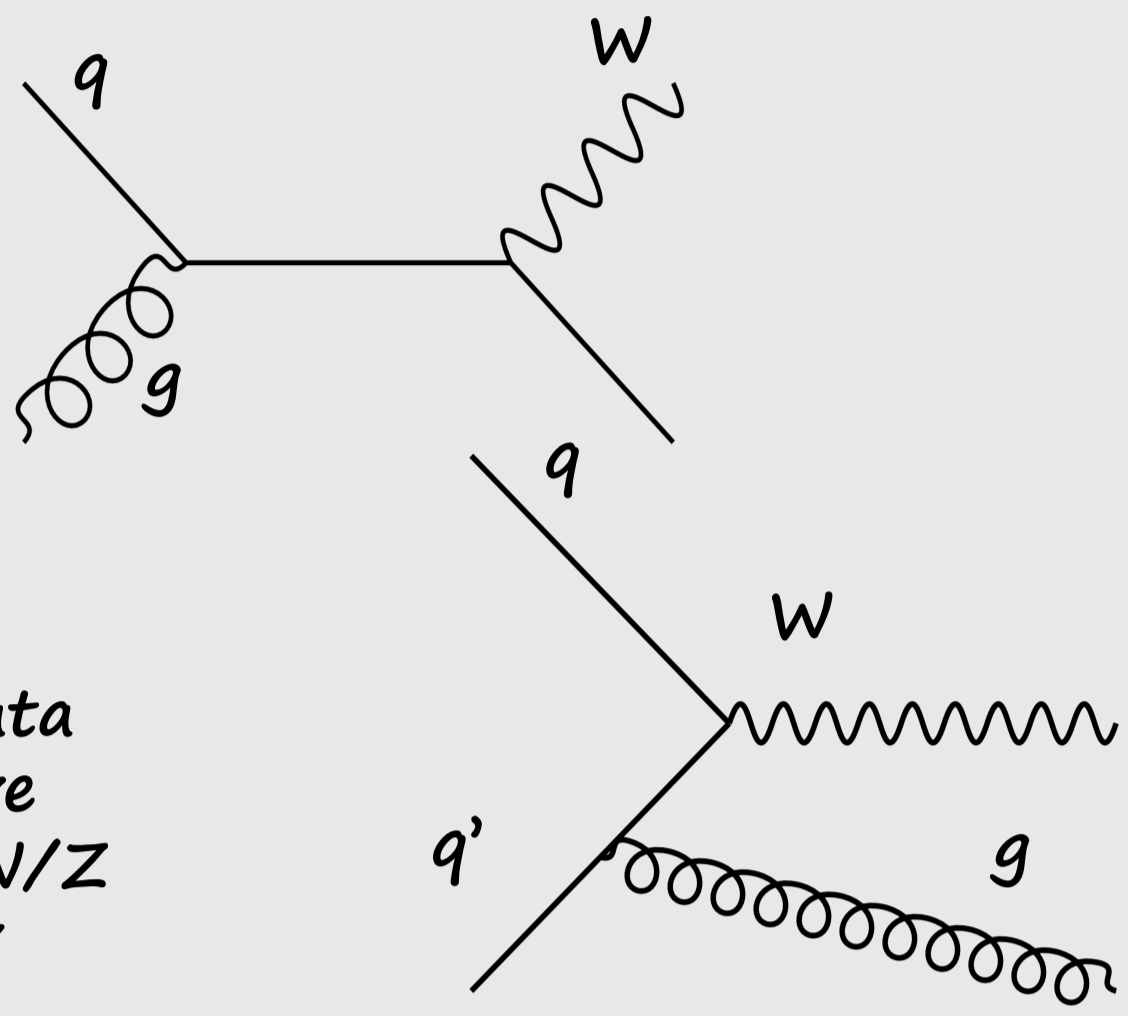
1. The motivations

Quark flavour: Fit strange sea directly



$$R_s = \frac{s + \bar{s}}{\bar{u} + \bar{d}}$$

Sensitive to gluon @ leading order in QCD



$(\bar{d} - \bar{u})$ @ high x

E866^[3] → > 0

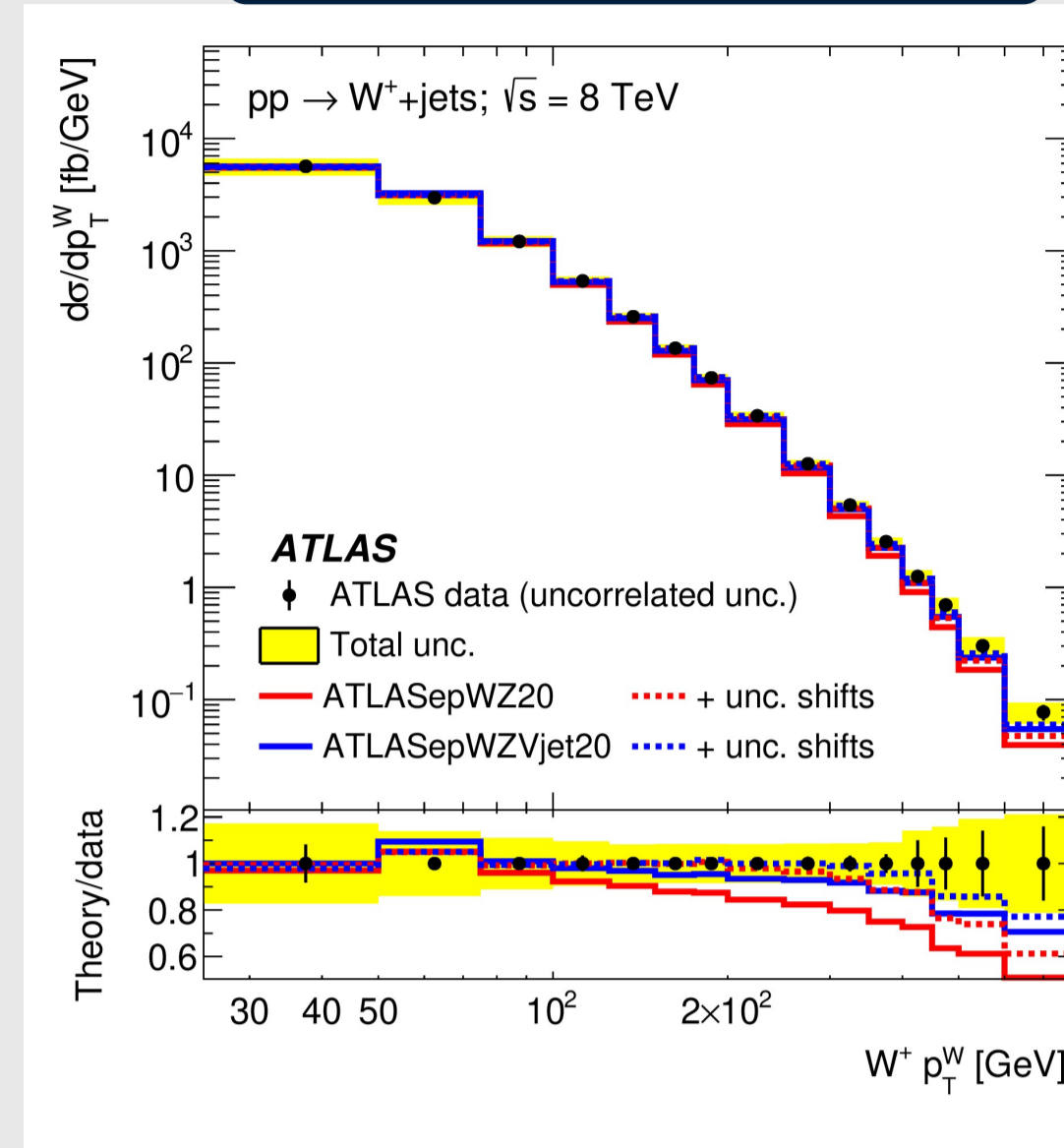
ATLASepWZ16^[2] → Compatible with 0, slightly negative

HERA data + inclusive ATLAS W/Z data @ 7 TEV^[2]

Jets → V boson data: Higher x, Q^2 reach

2. The datasets

W+ jets 8 TeV^[4]



$d\sigma/dp_T^W$ spectrum

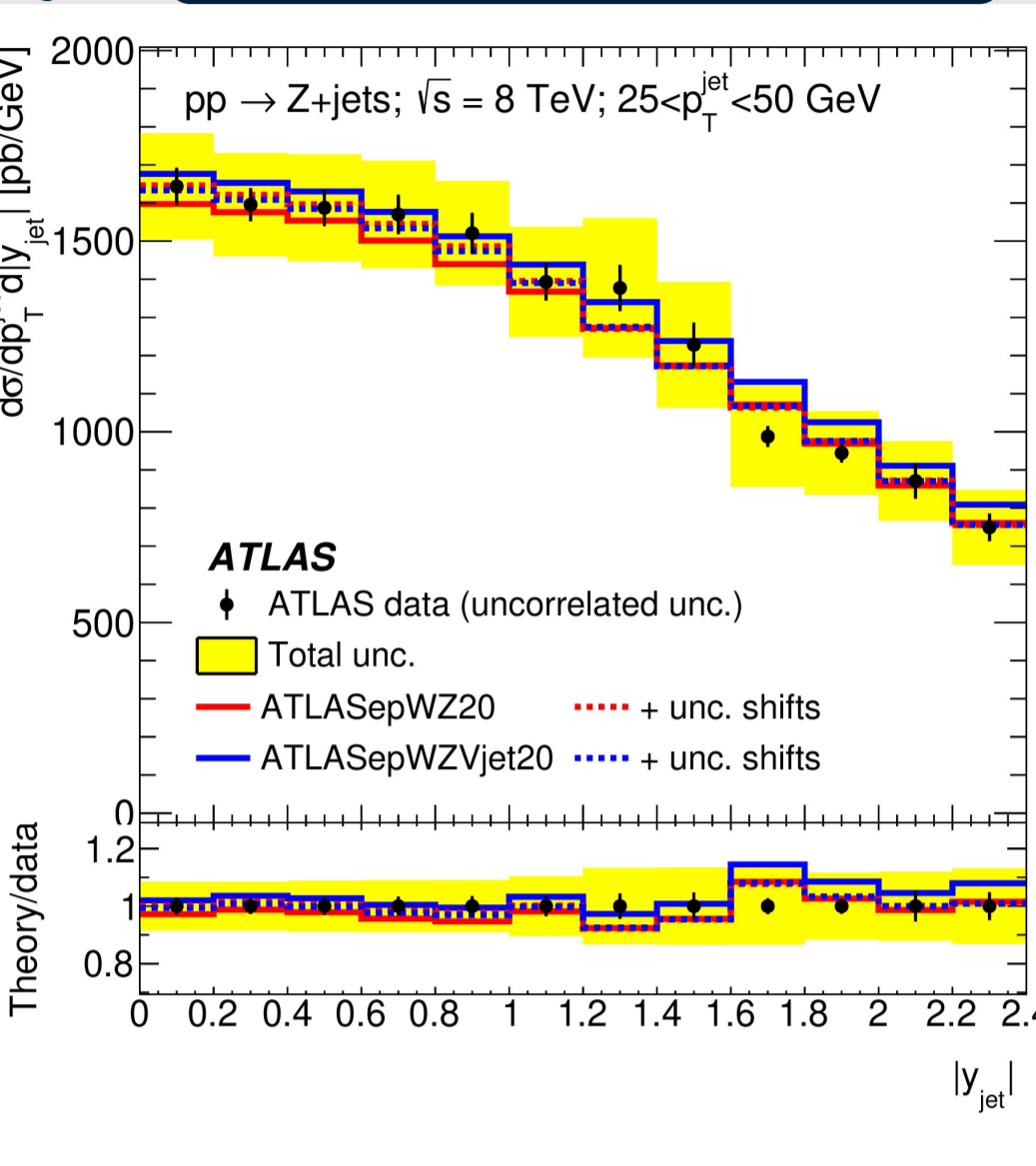
Adding V+jet data to PDF fit ...

better data description @ high p_T

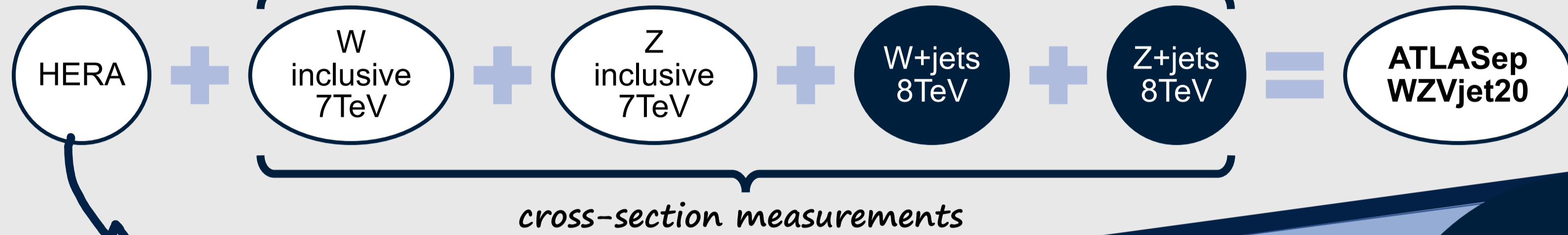
normalization change only

$d\sigma/dp_T^{\text{jet}}|y_{\text{jet}}$ spectra

Z+ jets 8 TeV^[5]



kfactors: NLO QCD predictions → NNLO & LO EW predictions → NLO



NNLO QCD analysis performed with xFitter^[6] framework + MINUIT^[7]

3. The technicalities^[1]

Parameterisation

Scales

$Q_o^2 = 1.9 \text{ GeV}^2$ starting scale evolved with DGLAP

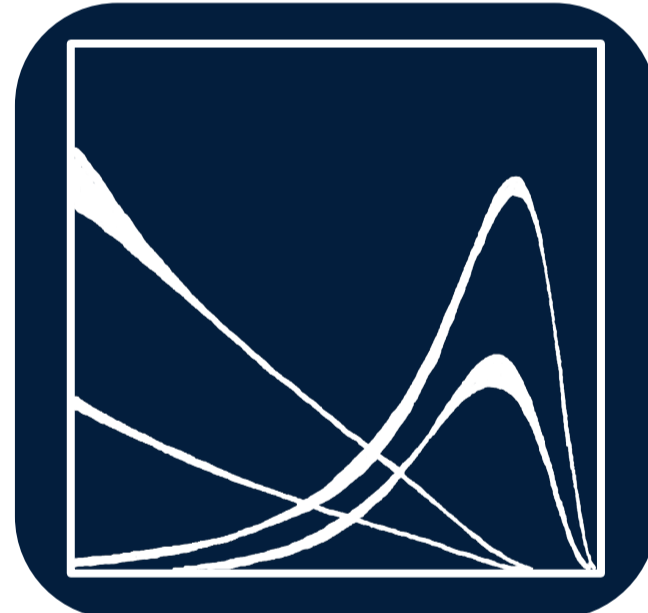
$Q_{min}^2 = 10 \text{ GeV}^2$ (avoid region with poor HERA χ^2)

General form:

$$xf(x) = Ax^B(1-x)^C(1+Dx+Ex^2)e^F \quad (\text{extra gluon term: } -A'_g x^{B'_g}(1-x)^{C'_g})$$

Constrained by:

- Momentum sum rule
- Number sum rule
- $\bar{u} = \bar{d}$ as $x \rightarrow 0$



HERAPDF2.0^[8]

+ E_{uv}, D_g
= 16 free parameters

Chi-square definition

Partial term

$$\chi^2 = \sum_{ik} \left(D_i - T_i \left(1 - \sum_j \gamma_{ij} b_j \right) \right) C_{stat,ik}^{-1} (D_i, D_k) \left(D_k - T_k \left(1 - \sum_j \gamma_{kj} b_j \right) \right) + \sum_j b_j^2 + \sum_i \log \frac{\delta_{i,uncor}^2 T_i^2 + \delta_{i,stat}^2 D_i T_i}{\delta_{i,uncor}^2 D_i^2 + \delta_{i,stat}^2 D_i^2}$$

Correlated term Log penalty (bias correction)

D: Data point T: Theory prediction $\delta_{i,uncor}^2$: Uncorrelated statistical (systematic) uncertainties on D
 γ : Correlated systematic uncertainties b: Nuisance parameters C_{stat} : Statistical correlation matrix

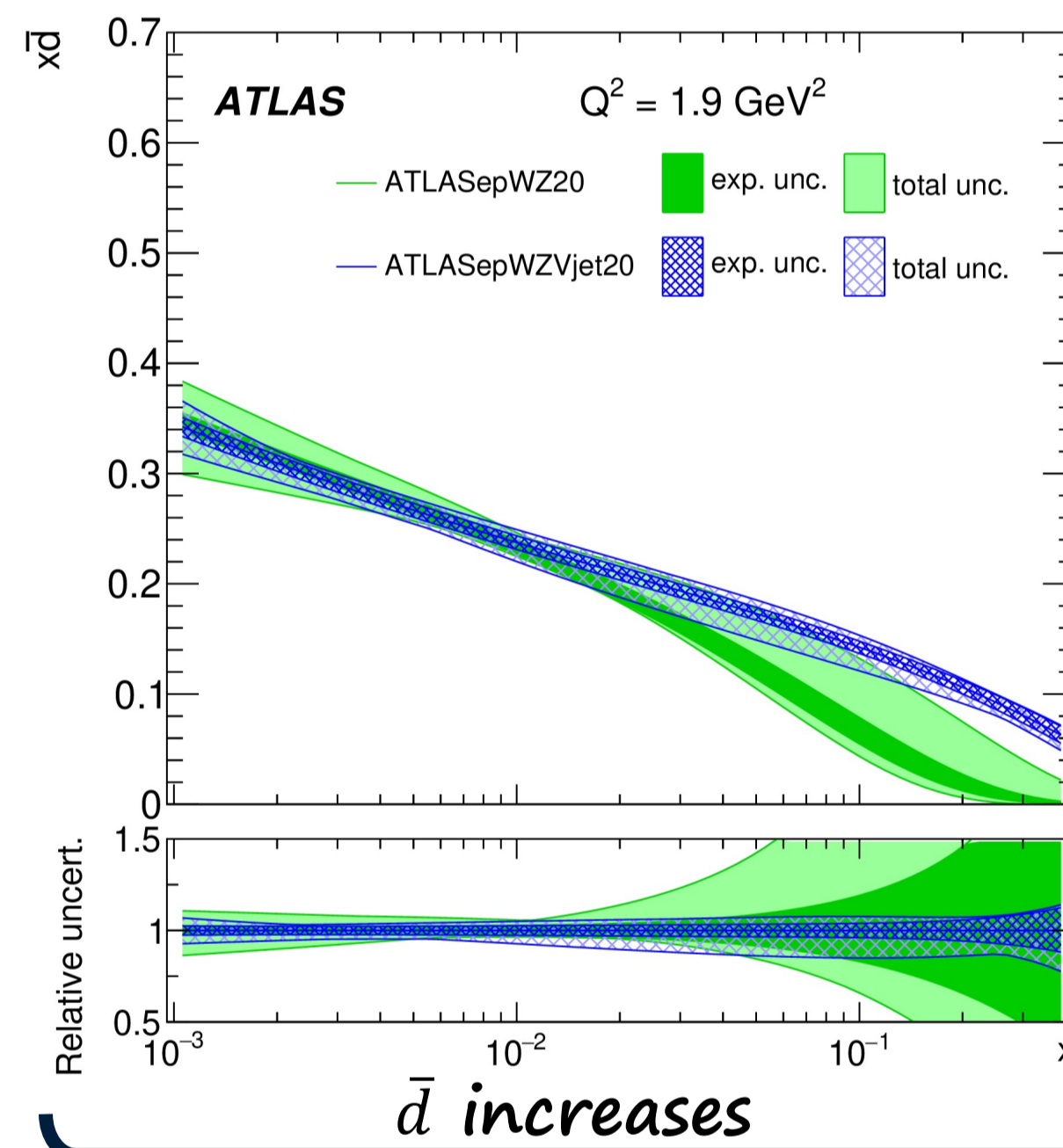
Vary theoretical assumptions: $Q_{min}^2, Q_o^2,$ heavy quark masses, α_s , etc.

Uncertainties

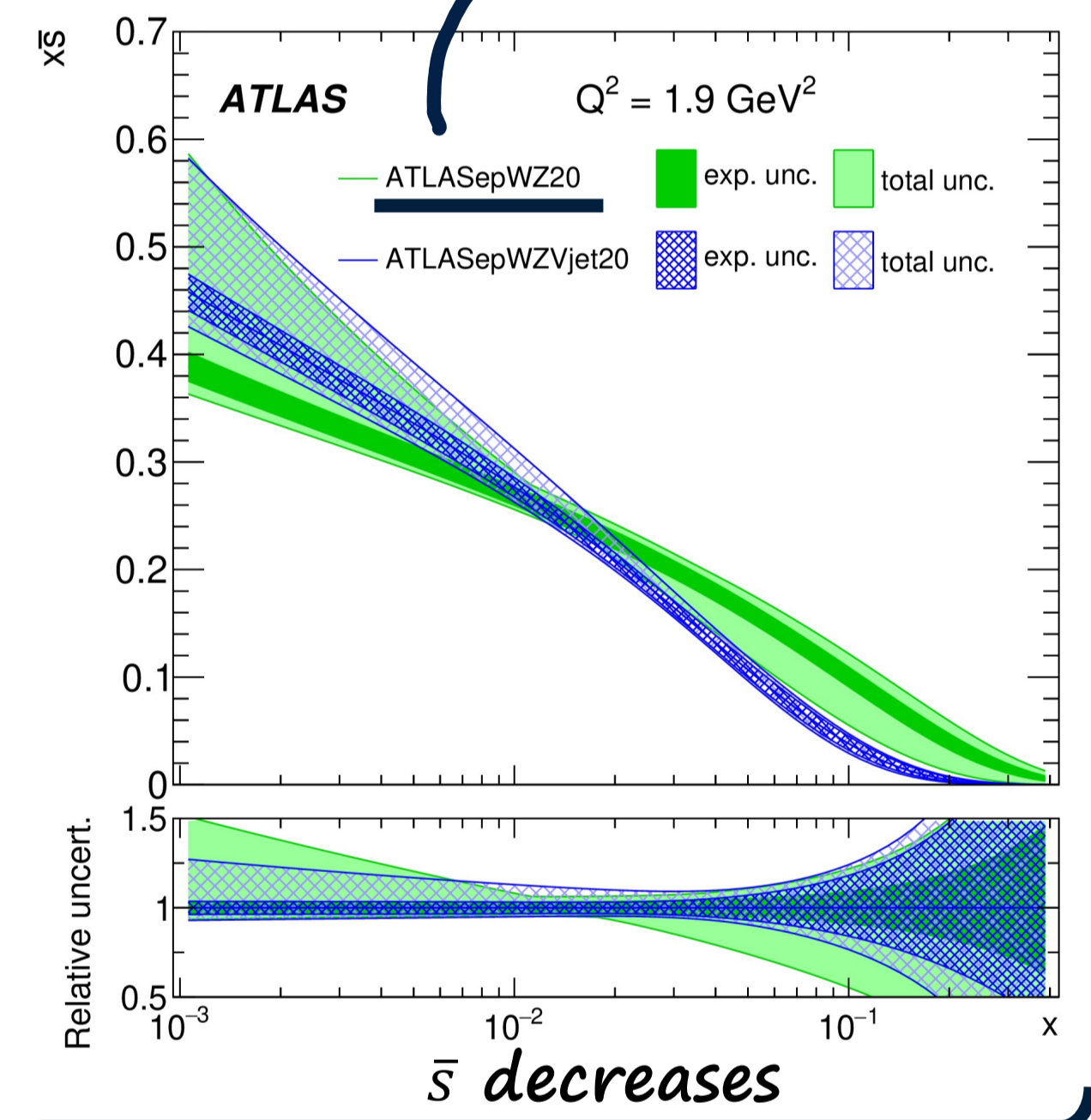
- Experimental
- Model
- Parameterisation

Add extra D, E, F parameters (low-x sea), relax constraints

4. The results^[1]



identical fit without Vjets data

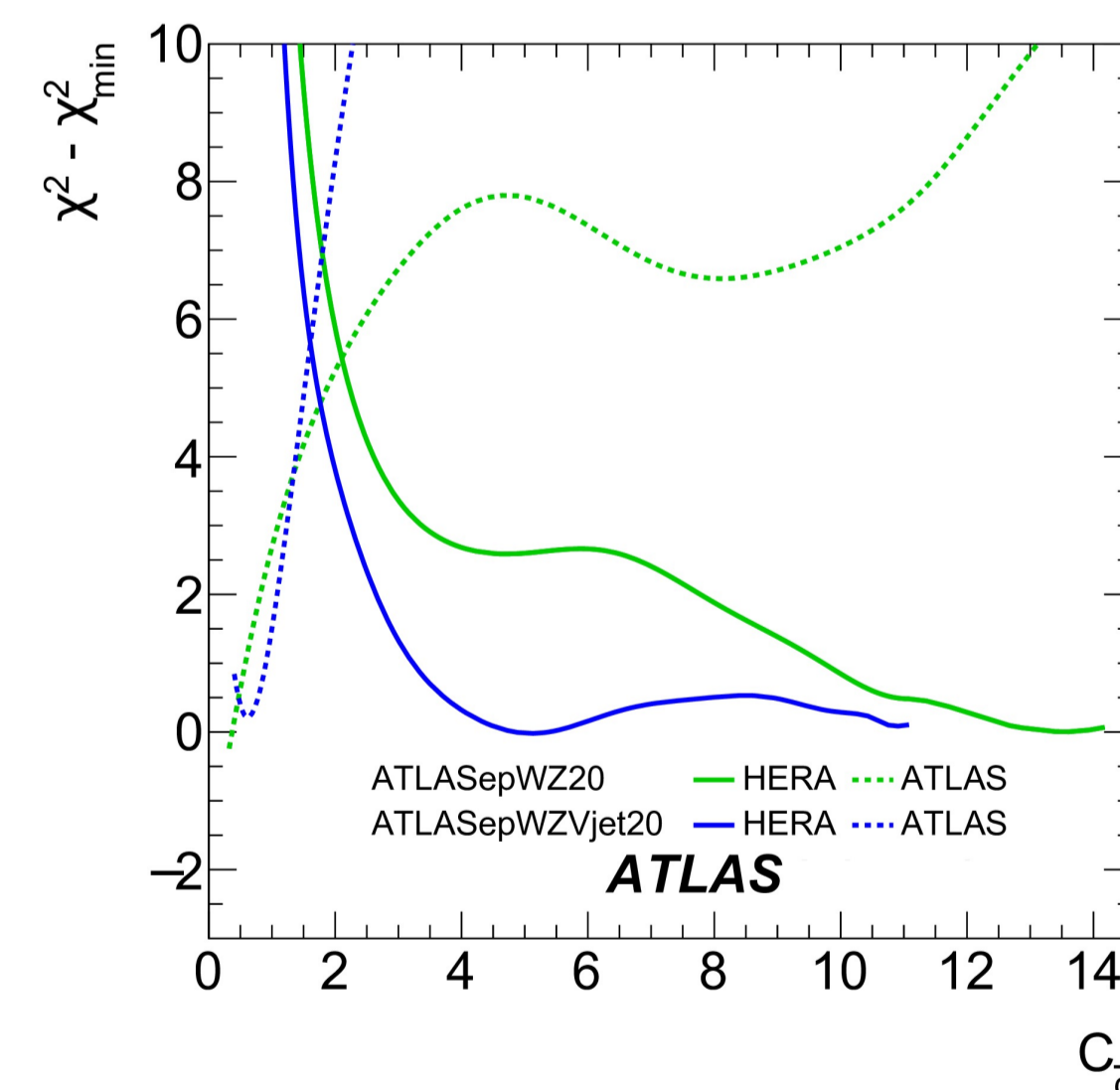


V+jet data in fit → at high x...

HERA constrains sum

uncertainties constrained

$(\bar{d} - \bar{u})$ at high x...



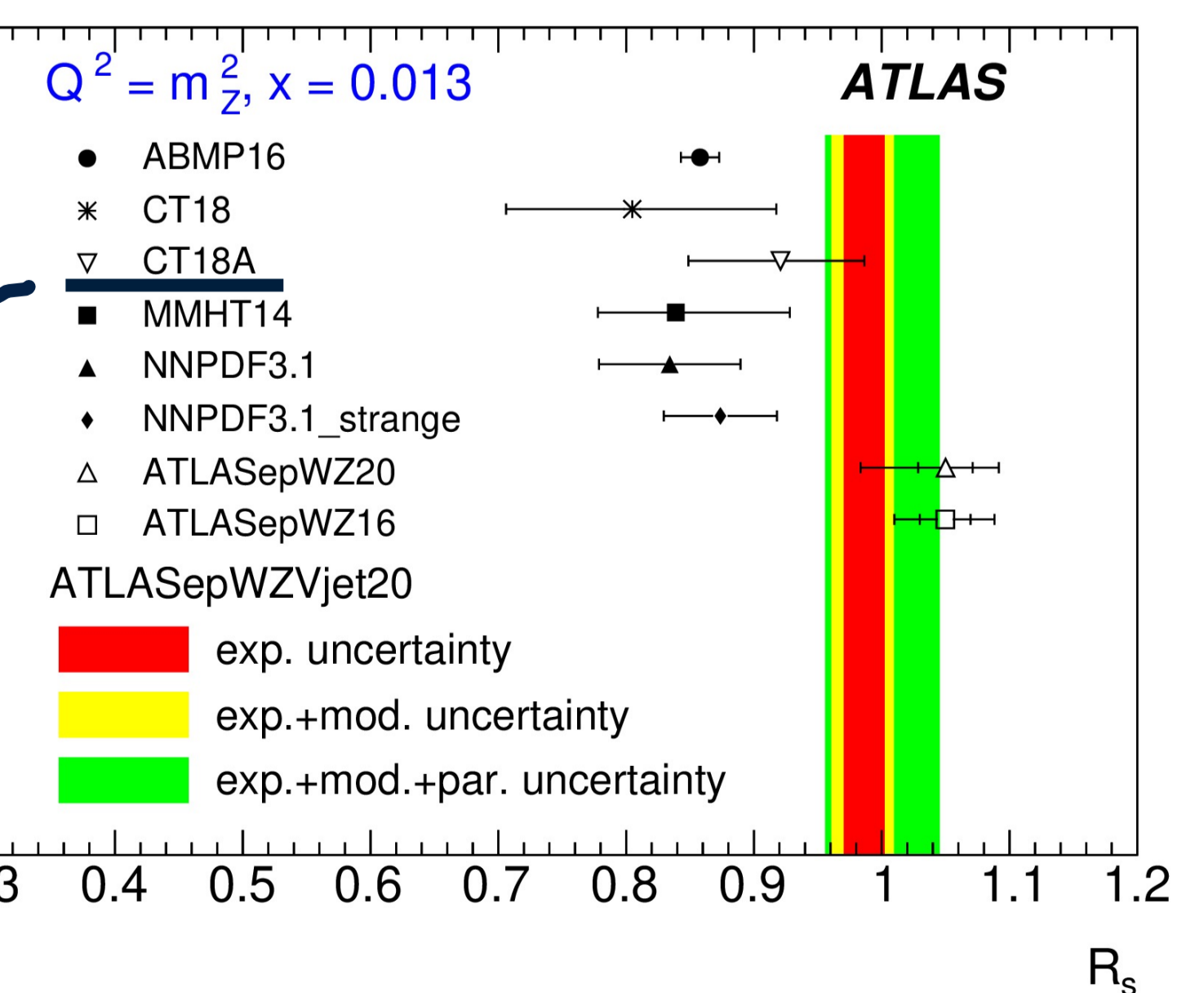
ATLAS preference for large \bar{d} ($C_{\bar{d}}$ small) ...

... → $(\bar{d} - \bar{u}) > 0$

R_s

Tension remains with global fits but reduced vs previous ATLAS fits

Includes ATLAS inclusive W, Z data



References

- [1] ATLAS Collaboration, CERN-EP-2020-237, arXiv: 2101.05095 (accepted by JHEP)
- [2] ATLAS Collaboration, Eur. Phys. J. C 77 (2017) 367, arXiv: 1612.03016 [hep-ex]
- [3] FNAL E866/NuSea Collaboration, Phys. Rev. D 64 (2001) 052002, arXiv: hep-ex/0103030
- [4] ATLAS Collaboration, JHEP 05 (2018) 077, arXiv: 1711.03296 [hep-ex]
- [5] ATLAS Collaboration, Eur. Phys. J. C 79 (2019) 847, arXiv: 1907.06728 [hep-ex]
- [6] S. Alekhin et al., Eur. Phys. J. C 75, 304 (2015) 304, arXiv: 1410.4412 [hep-ph]
- [7] F. James and M. Roos, Comput. Phys. Commun. 10 (1975) 343
- [8] H1, ZEUS Collaborations, Eur. Phys. J. C 75, 580 (2015), arXiv: 1506.06042