

Proton parton distribution functions using ATLAS data^[1]



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on behalf of the
ATLAS
collaboration

References

[1] ATLAS Collaboration, CERN-EP-2021-239, arXiv: 2112.11266 [hep-ex] (accepted by EPJC)

[2] H. Abramowicz et al., Eur. Phys. J. C 75 (2015) 580, arXiv: 1506.06042 [hep-ex]

[3] S. Alekhin et al., Eur. Phys. J. C 75, 304 (2015) 304, arXiv: 1410.4412 [hep-ph]

[4] H1, ZEUS Collaborations, Eur. Phys. J. C 75, 580 (2015), arXiv: 1506.06042 [hep-ex]

[5] ATLAS Collaboration, Eur. Phys. J. C 77 (2017) 367, arXiv: 1612.03016 [hep-ex]

[6] ATLAS Collaboration, JHEP 07 (2021) 223, arXiv: 2101.05095 [hep-ex]

Highlights

Technicities

Results

Demonstrating the impact of a diverse range of ATLAS measurements and the full treatment of their uncertainties on constraining PDFs

Datasets	
HERA combination ^[2]	Wide x, Q^2 range
ATLAS Data set	\sqrt{s} [TeV]
Inclusive $W, Z/\gamma^*$	7
$t\bar{t}$	8
$W^\pm + \text{jets}$	8
$Z + \text{jets}$	8
Inclusive Z/γ^*	8
Inclusive W	8
Inclusive isolated γ	8, 13
$t\bar{t}$	13
Inclusive jets	8

For input data refs, see [1]

Medium-high x, Q^2 , quark flavour separation, high-x gluon sensitivity

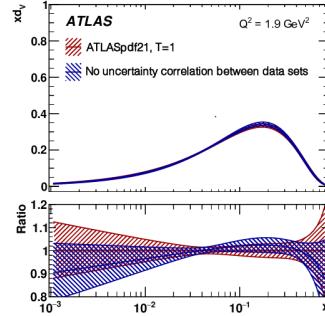
Scales

$Q_{x_0}^{2,0} = 1.9 \text{ GeV}^2$ starting scale evolved with DGLAP

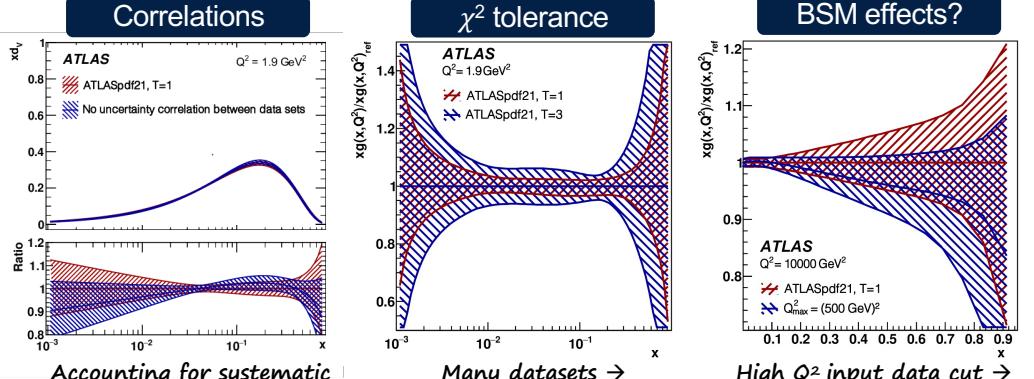
$$\alpha_s(m_z) = 0.118$$

$Q_{x_{\min}}^{2,0} = 10 \text{ GeV}^2$ (avoid region with poor HERA χ^2 , more sophisticated small-x treatment needed)

Correlations



Accounting for systematic correlations between datasets → PDF variations up to 20%



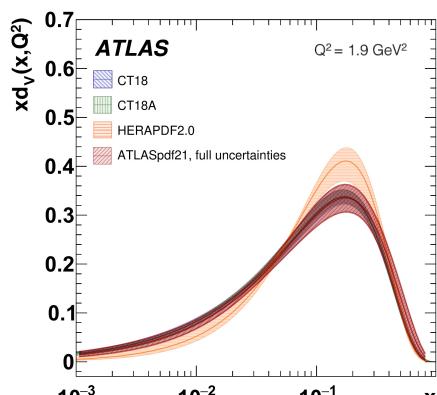
ATLASPDF21 fit

total χ^2/NDF

2010/1620 (1.24)

Lower for these data than the global fitters

Comparison: Global PDFs



$d_v, d_{\bar{v}}$: More like global fitters than HERAPDF^[4] → Replicating features of Tevatron, DIS etc.

Analysis

NNLO in QCD

performed using



Parameterisation

$$xf(x) = Ax^B(1-x)^C(1+Dx+Ex^2+Fx^3)$$

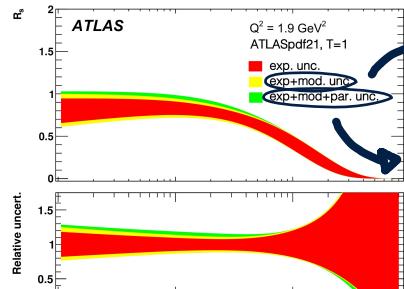
(extra gluon term: $-A'_g x^{B'_g}(1-x)^{C'_g}$)

→ 21 free parameters

previous ATLAS fits: 15/16)

Constraints: sum rules

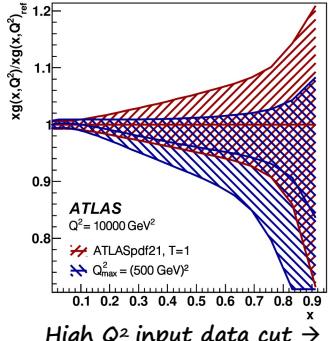
Uncertainties



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

Vary theoretical assumptions: $Q_{x_{\min}}^{2,0}$, $Q_{x_0}^{2,0}$, heavy quark masses etc.

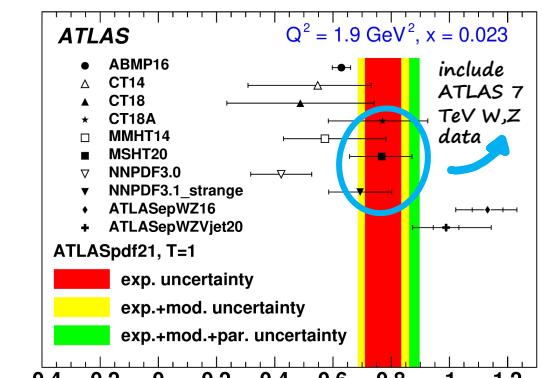
BSM effects?



High Q^2 input data cut → little PDF shape & uncertainty impact

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

R_s



R_s still unsuppressed at low-x but less tension with global fitters than previous ATLAS fits^{[5][6]}