Impact of jet-production data on the next-to-next-to-leading-order determination of HERAPDF2.0 parton distributions

H1 and ZEUS collaborations

Deutsches Elektronen-Synchotron DESY

Introduction

- Deep inelastic scattering (DIS) data from *ep* collisions at HERA are essential for exploration of proton-structure and pQCD dynamics
- HERAPDF2.0 ensemble of PDFs was introduced in 2015, consisting of HERAPDF2.0 NLO, NNLO and Jets NLO
- Now, HERAPDF2.0Jets NNLO completes the HERAPDF2.0 family which is one of the major legacies of HERA

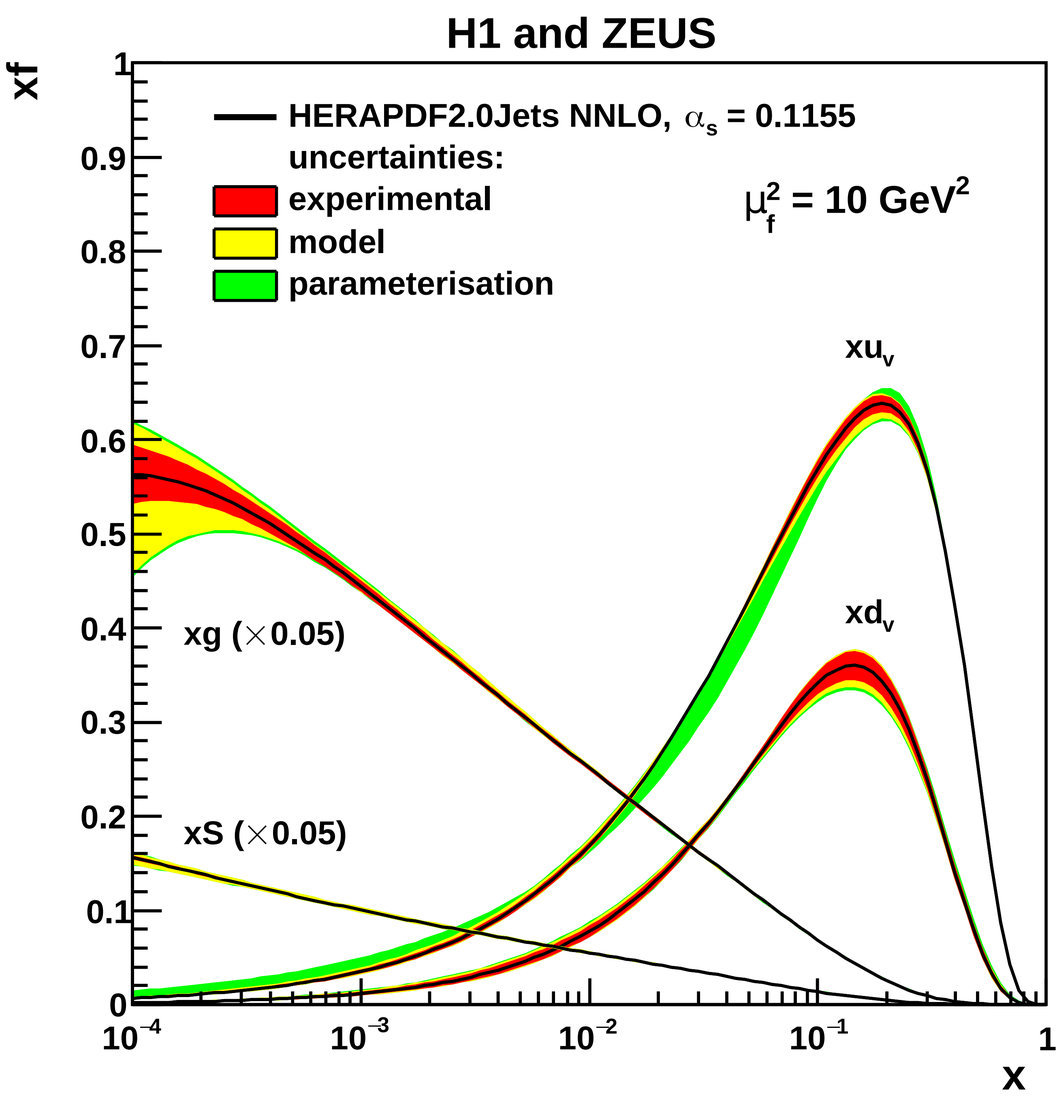
Strategy

- The same overall strategy as for the original HERAPDF2.0 is used
- The gluon xg, valence-quark xu_v, xd_v, and anti-quark distributions $x\bar{U}$, $x\bar{D}$ are parameterised at a starting scale and evolved to desired scale using DGLAP equations

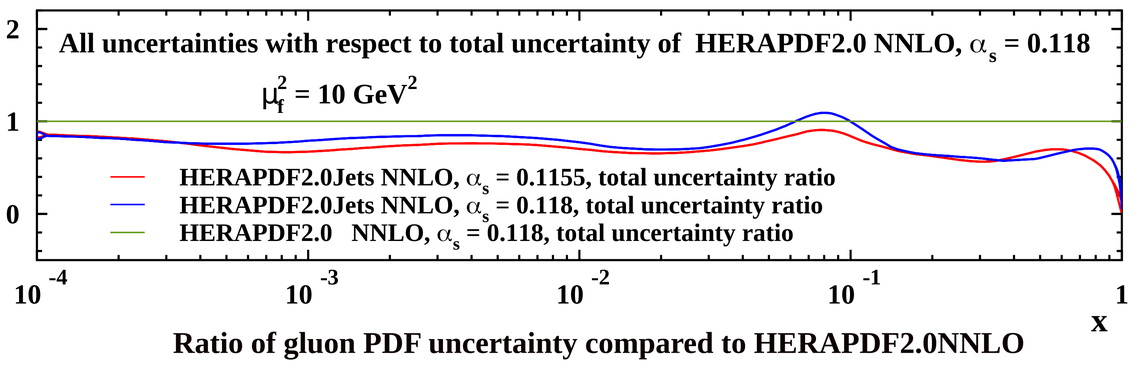
Procedural improvements

- At NLO, scale choice was $\mu_f^2 = Q^2$, $\mu_r^2 = (Q^2 + p_\perp^2)/2$, at NNLO $\mu_f^2 = \mu_r^2 = Q^2 + p_\perp^2 \rightarrow$ improved description of data
- Uncertainties of theory predictions are taken into account
- Hadronisation uncertainties are treated as systematic uncertainties of data points $\rightarrow$ become part of experimental/fit uncertainties

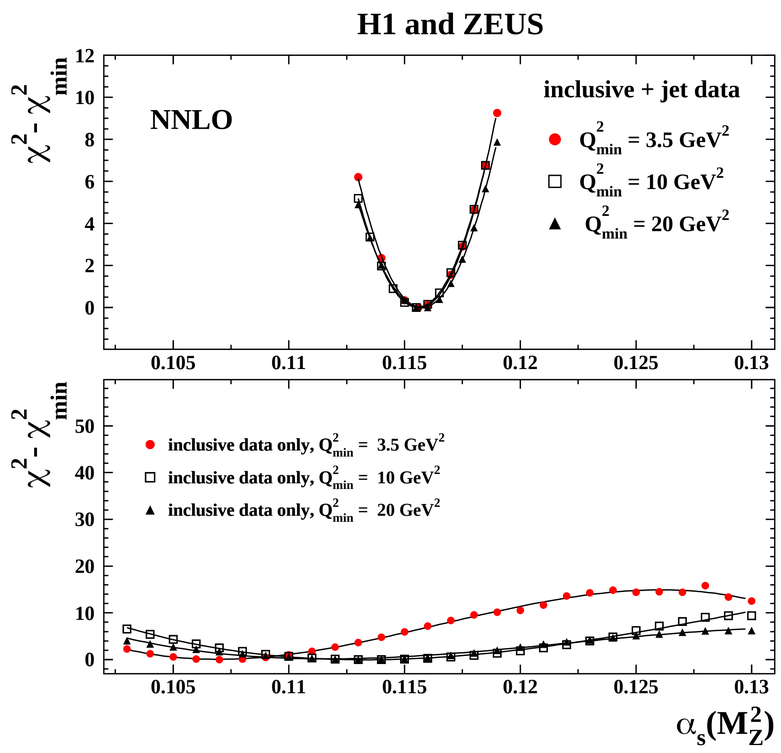
Determination of PDFs



- Inclusion of jet data has little effect on PDF central values (when determined for the same value of $\alpha_s(M_Z^2)$)
- Uncertainties of gluon PDF are significantly reduced

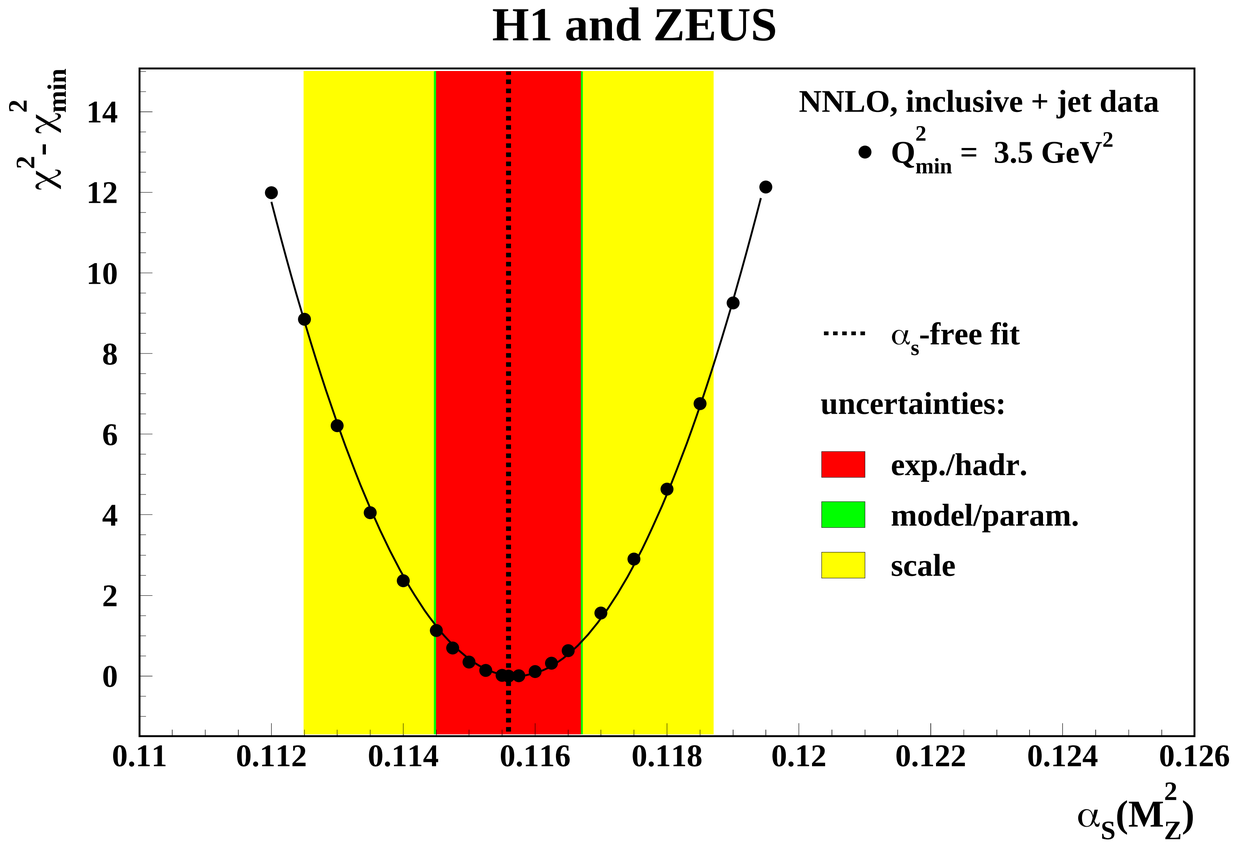


Impact of jet data



- pQCD fits without jets are only sensitive to the gluon PDF via the DGLAP equations using scaling violations
- Jet data provide independent constraint on gluon PDF and are directly sensitive to $\alpha_s(M_Z^2)$

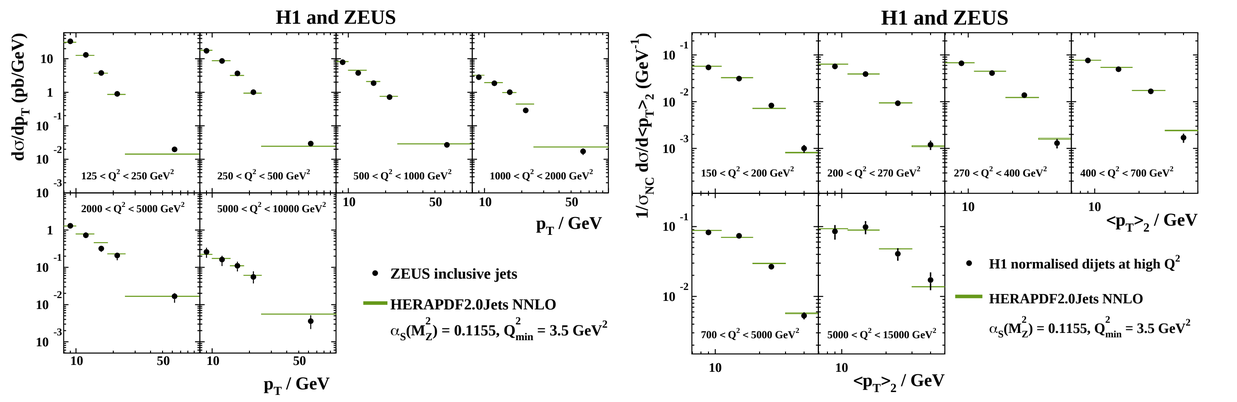
Determination of $\alpha_s(M_Z^2)$



$\alpha_s(M_Z^2) = 0.1156 \pm 0.0011\,\text{(exp.)}\ ^{+0.0001}_{-0.0002}\,\text{(model+param.)} \pm 0.0029\,\text{(scale)}$

- Preferred value of $\alpha_s(M_Z^2)$ is smaller than at NLO ($0.1183 \rightarrow 0.1156$)
- As expected, NNLO predictions reduce scale uncertainty significantly
- Experimental, model and parameterisation uncertainties similar to previous analysis at NLO
- The new $\alpha_s(M_Z^2)$ value is compatible with the world average and competitive with other determinations at NNLO

Comparison to data



- Predictions based on newly determined PDFs and $\alpha_s(M_Z^2)$ are in very good agreement with the jet production data used as input

Florian Lorkowski
florian.lorkowski@desy.de