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CMS-SMP-12-021

Measurement of the muon charge asymmetry in inclusive
 $pp \rightarrow W + X$ production at $\sqrt{s} = 7$ TeV and an improved
determination of light parton distribution functions

—Supplemental Material—

The CMS Collaboration

Submitted to Physical Review D

1 Additional PDF distributions

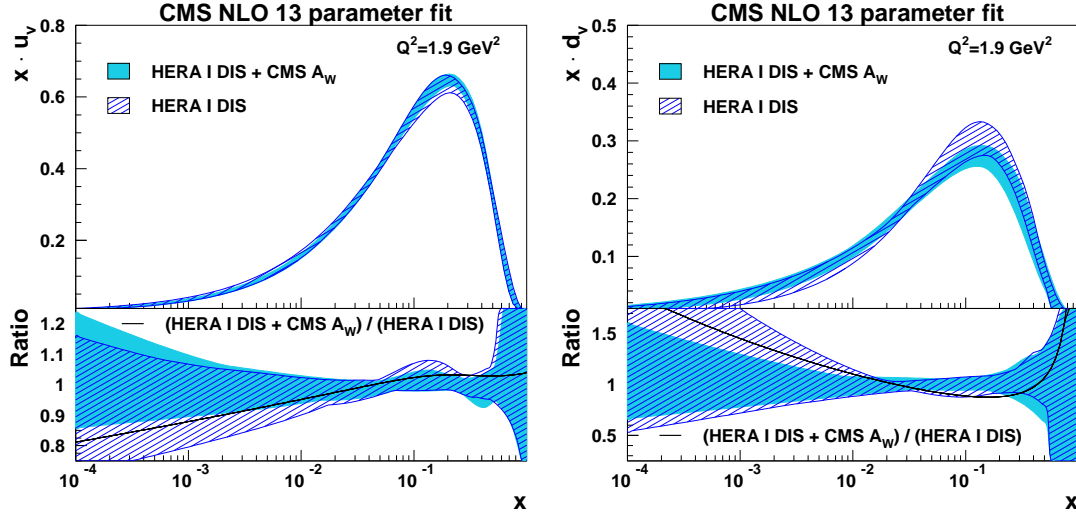


Figure 1: Distributions of u valence (left) and d valence (right) quarks as functions of x at the scale $Q^2 = 1.9 \text{ GeV}^2$. The results of the 13-parameter fixed-s fit to the HERA data and muon asymmetry measurements (light shaded band), and to HERA only (dark hatched band) are compared. The total PDF uncertainties are shown. In the bottom panels the distributions are normalized to one for a direct comparison of the uncertainties. The change of the PDFs with respect to the HERA-only fit is represented by a solid line.

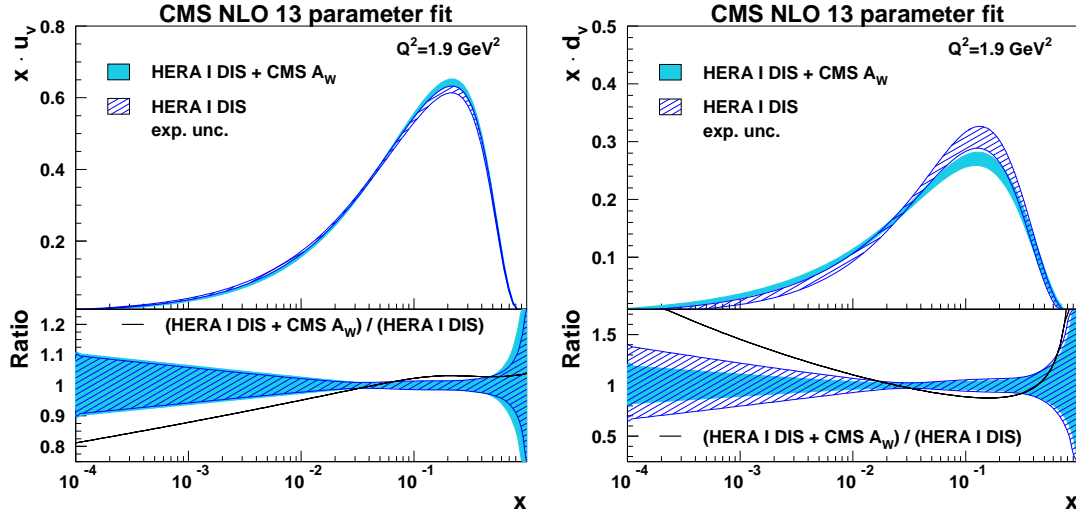


Figure 2: Distributions of u valence (left) and d valence (right) quarks as functions of x at the scale $Q^2 = 1.9 \text{ GeV}^2$. The results of the 13-parameter fixed- s fit to the HERA data and muon asymmetry measurements (light shaded band), and to HERA only (dark hatched band) are compared. The experimental PDF uncertainties are shown. In the bottom panels the distributions are normalized to one for a direct comparison of the uncertainties. The change of the PDFs with respect to the HERA-only fit is represented by a solid line.

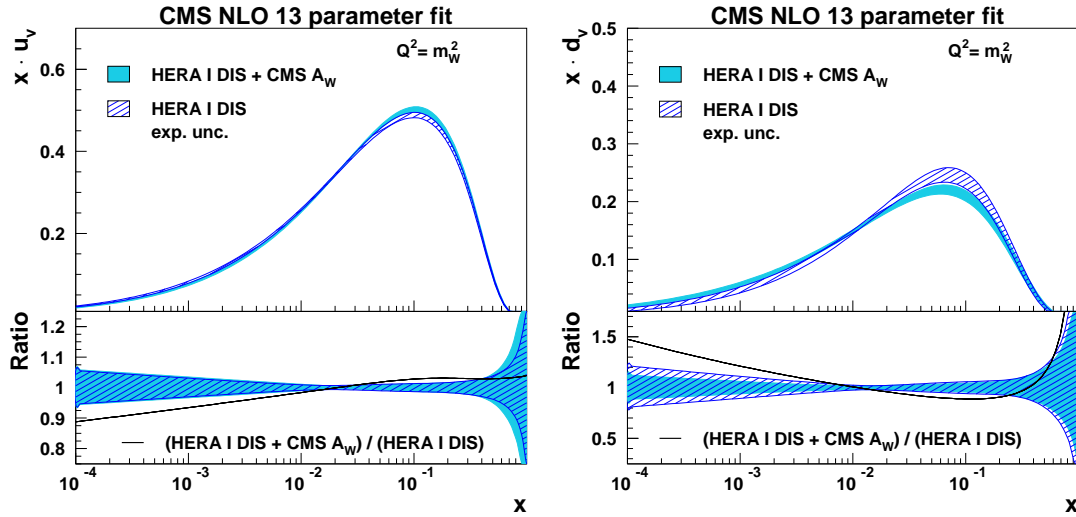


Figure 3: Distributions of u valence (left) and d valence (right) quarks as functions of x at the scale $Q^2 = m_W^2$. The results of the 13-parameter fixed- s fit to the HERA data and muon asymmetry measurements (light shaded band), and to HERA only (dark hatched band) are compared. The experimental PDF uncertainties are shown. In the bottom panels the distributions are normalized to one for a direct comparison of the uncertainties. The change of the PDFs with respect to the HERA-only fit is represented by a solid line.

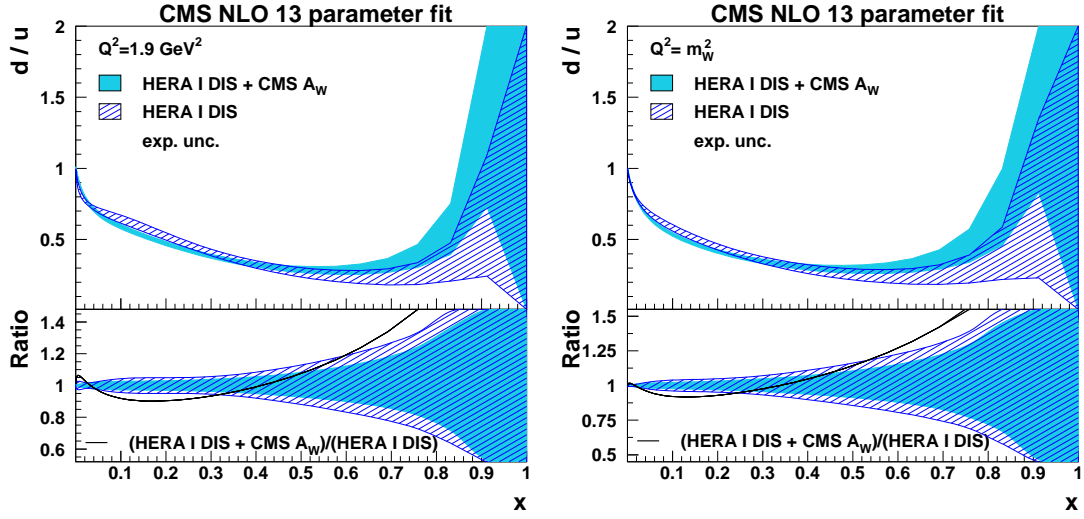


Figure 4: Ratio of d- and u-quark distributions, d/u , presented as functions of x at the scales $Q^2 = 1.9 \text{ GeV}^2$ (left) and $Q^2 = m_W^2$ (right). The results of the 13-parameter fixed- s fit to the HERA data and muon asymmetry measurements (light shaded band), and to HERA only (dark hatched band) are compared. The experimental PDF uncertainties are shown. In the bottom panels the distributions are normalized to one for a direct comparison of the uncertainties. The change of the d/u ratio with respect to the result of the HERA-only fit is represented by a solid line.

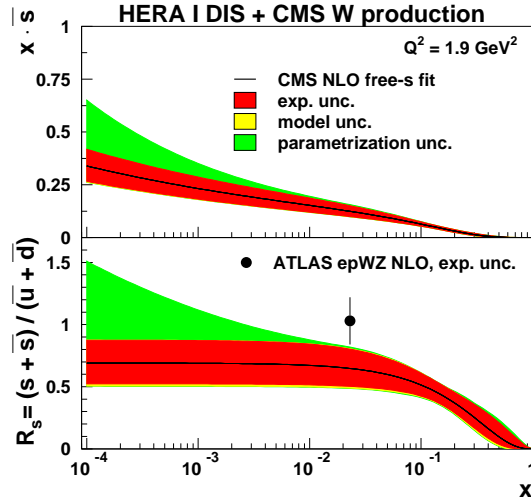


Figure 5: Antistrange-quark distribution $\bar{s}(x, Q)$ (top) and the ratio $R_s(x, Q)$ (bottom), obtained in the NLO QCD analysis of HERA and CMS data, shown as functions of x at the scale $Q^2 = 1.9 \text{ GeV}^2$. The full band represents the total uncertainty. The individual contributions from the experimental, model, and parametrization uncertainties are represented by the bands of different shades. For comparison, the NLO result of the ATLAS analysis [1] of $r_s = 0.5(s + \bar{s})/\bar{d}$ using inclusive W- and Z-boson production, is presented by a closed symbol. Only the experimental uncertainty from ATLAS is available and is shown by the vertical error bar.

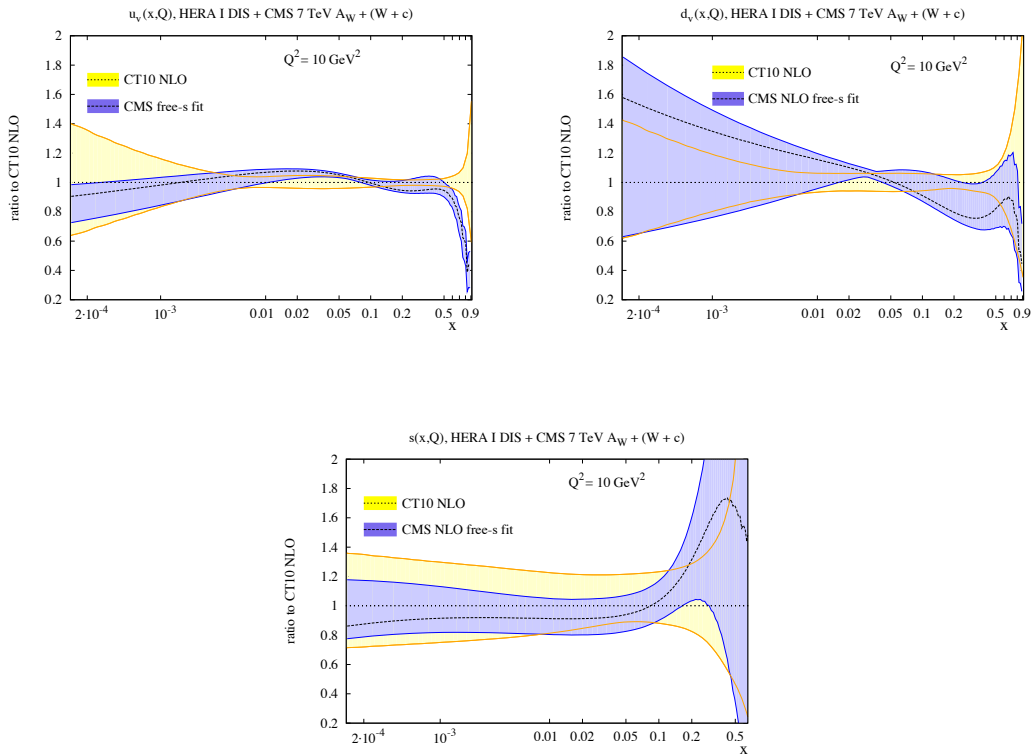


Figure 6: The distributions of u (top left), d (top right), and s (bottom) quarks, resulting from the NLO QCD analysis of HERA and CMS data, shown as functions of x at the scale $Q^2 = 10 \text{ GeV}^2$ in comparison to CT10NLO. The dark shaded band represents the total PDF uncertainty of the current fit, which is normalized to the CT10NLO central value. The light hatched band represents the CT10NLO uncertainty normalized to one. All uncertainties are given at 68% CL.

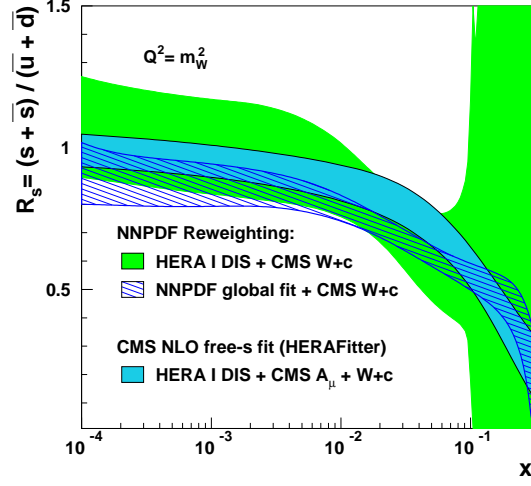


Figure 7: Ratio $R_s(x, Q^2)$ resulting from the NLO QCD analysis of HERA and CMS data, presented as a function of x at the scale $Q^2 = m_W^2$. The light shaded band represents the total PDF uncertainty of the CMS result. For comparison, results of Bayesian reweighting using HERA I inclusive DIS data and the CMS measurement of $W + \text{charm}$ production (dark shaded band). The reweighting results based on the data used in the global NNPDF2.3 fit and the CMS $W + \text{charm}$ production are represented by a hatched band.

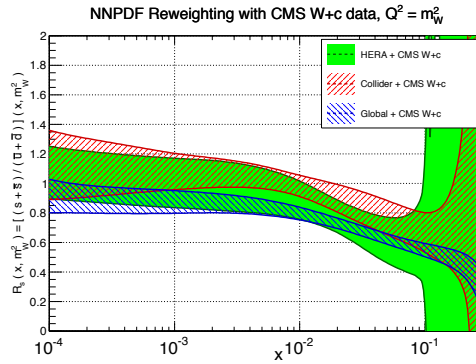


Figure 8: Ratio $R_s(x, Q^2)$, obtained by using Bayesian reweighting, shown as a function of x at the scale $Q^2 = m_W^2$. The dark shaded band represents the result based on the HERA I DIS and CMS $W + \text{charm}$ data. The results of the reweighting obtained by using the CMS $W + \text{charm}$ measurements in addition to collider-only data, and in addition to the data used in the global NNPDF2.3 analysis, are illustrated by bands of different hatches.

References

- [1] ATLAS Collaboration, “Determination of the Strange Quark Density of the Proton from ATLAS Measurements of the $W \rightarrow \ell\nu$ and $Z \rightarrow \ell\ell$ Cross Sections”, *Phys. Rev. Lett.* **109** (2012) 012001, doi:10.1103/PhysRevLett.109.012001, arXiv:1203.4051.