10 Particle Physics at DESY/HERA (H1)

K. Müller, P. Robmann, U. Straumann, and P. Truöl

in collaboration with: C. Grab (Institut für Teilchenphysik der ETH, Zürich), S. Egli, M. Hildebrandt and R. Horisberger (Paul–Scherrer–Institut, Villigen), and 39 institutes outside Switzerland

(H1 - Collaboration)

Working groups with representatives from both the H1- and the ZEUS-collaboration have finished combining the full body of deep-inelastic neutral and charged current scattering data taken at the HERA collider. We recall that HERA was operated in two phases: HERA-I, from 1992 to 2000, and HERA-II, from 2002 to 2007. Whereas the electron or positron beam energy was 27.5 GeV during all these years, the proton energy varied as E_p = 460, 575, 820 and 920 GeV corresponding to maximum centre-of-mass energies $\sqrt{s}$ = 225, 252, 301 and 319 GeV, respectively.

The total luminosity collected by H1 and ZEUS together was ≈500 pb^{-1}, shared about equally between e^+p and e^-p. The results briefly referred to below [1, 2] combine all published H1 and ZEUS measurements [3]. The HERA-II measurements with polarized beams were individually averaged to obtain cross sections for unpolarized beams used as inputs to the combination: 2927 initial data points were combined into 1307 in the final set. Combining data points requires averaging, shifting the points to a common grid in Bjorken-x and momentum transfer Q^2 (see Fig. 10.1) which introduces model dependent corrections at the percent level. Fig. 10.2 illustrates the procedure for a subset of the data.

In the previous annual report we detailed how parton density functions (PDF) are extracted. PDF's evolved to leading order (LO) in α_s are essential for the proper simulation of parton showers (PS) and underlying event properties in LO+PS Monte Carlo (MC) event generators. In the light of the imminent restart of the LHC with increased E_p, new tunes for the underlying events and minimum bias studies are needed for the various MC generators. Higher proton energy corresponds to lower Bjorken-x and the HERA PDF sets with their special emphasis on low-x structure functions are crucial in this program. The new PDF version HERAPDF2.0 (prel.) NNLO [4] based on the procedures mentioned above will eventually replace the HERAPDF1.5 NNLO [5], widely used at present. Typical results of the new fit are shown in Fig. 10.3. Fig. 10.4 directly compares the two PDF sets.

For a few exclusive channels preliminary results were shown at conferences and some final data appeared in print. The D^* production data have been combined from the two HERA experiments [6] (see Fig. 10.5). Diffraction models are tested in the dijet channel [7, 8]

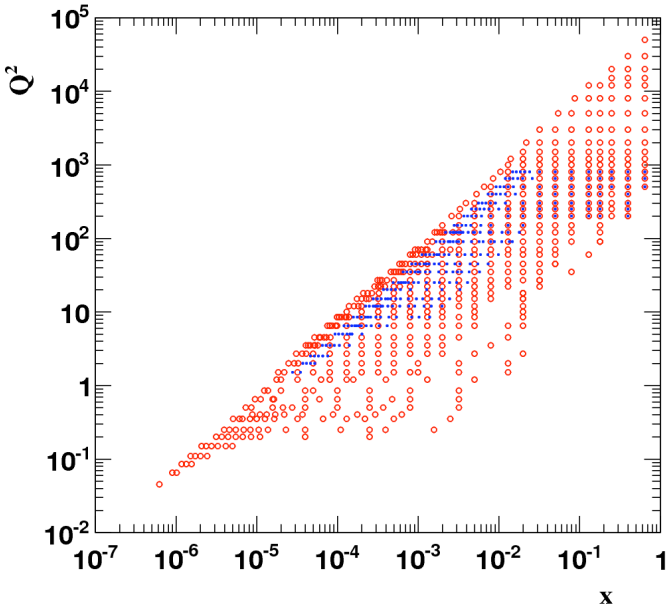

FIG. 10.1 – The grids for E_p = 920 and 820 GeV (red circles) as well as E_p = 575 GeV and 460 GeV (blue squares). The latter grid has a finer x binning.

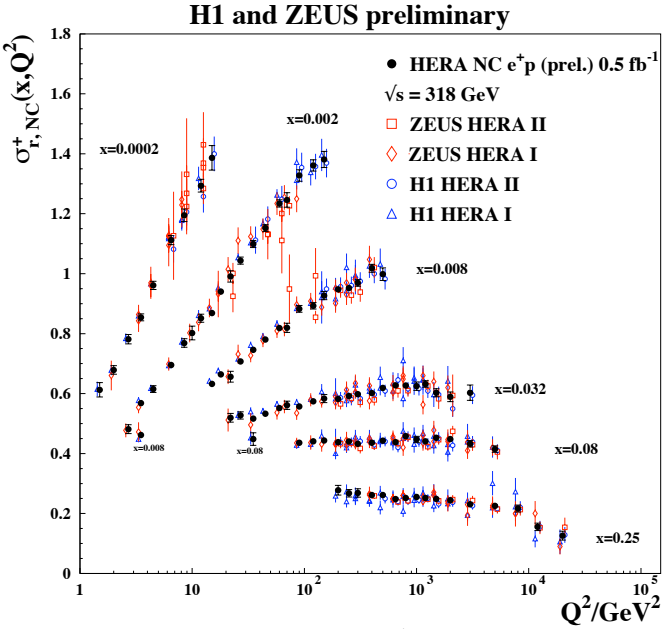

FIG. 10.2 – HERA combined NC e^+p reduced cross section as a function of Q^2 for six selected x-bins compared to the separate H1 and ZEUS results used as input. The individual measurements are displaced horizontally for better visibility. Error bars represent total uncertainties.

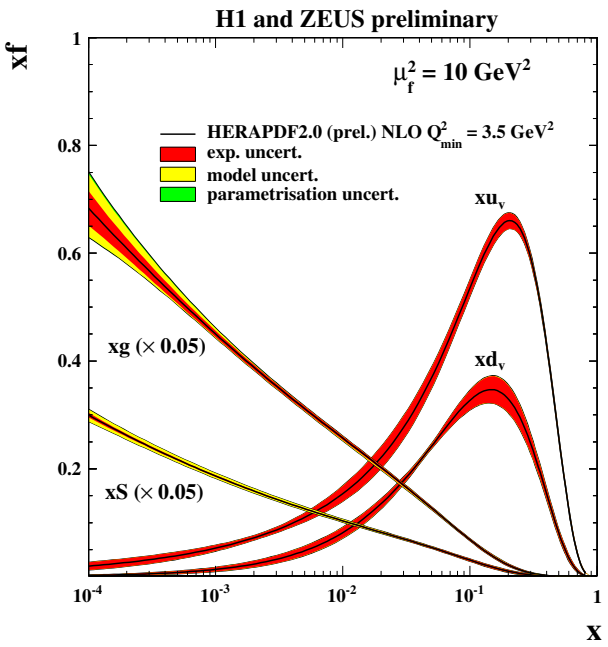

FIG. 10.3 – Valence, sea and gluon x distributions of HERAPDF2.0 (prel.) NNLO with $Q^2_{min} = 3.5$ GeV^2. The different sources of uncertainty are indicated.

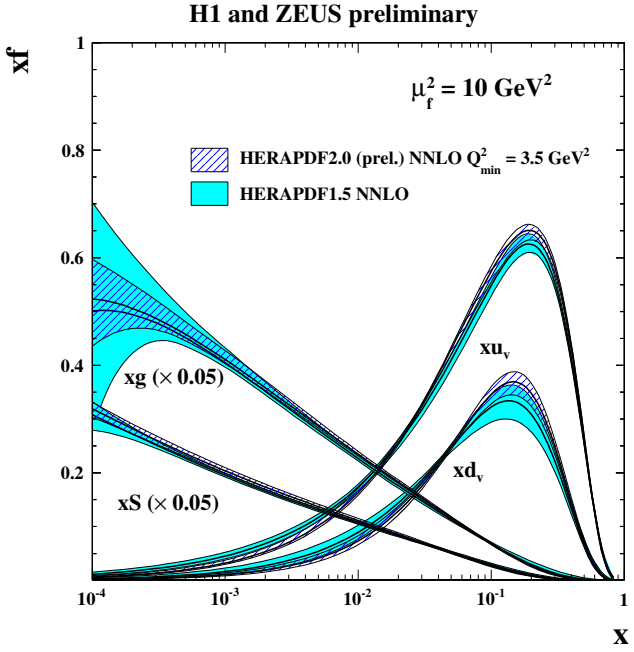

FIG. 10.4 – Comparison between HERAPDF2.0 (prel.) NNLO and HERAPDF1.5 NNLO.

and addressed in single particle production channels where use is being made of the forward proton and neutron counter data [9, 10].

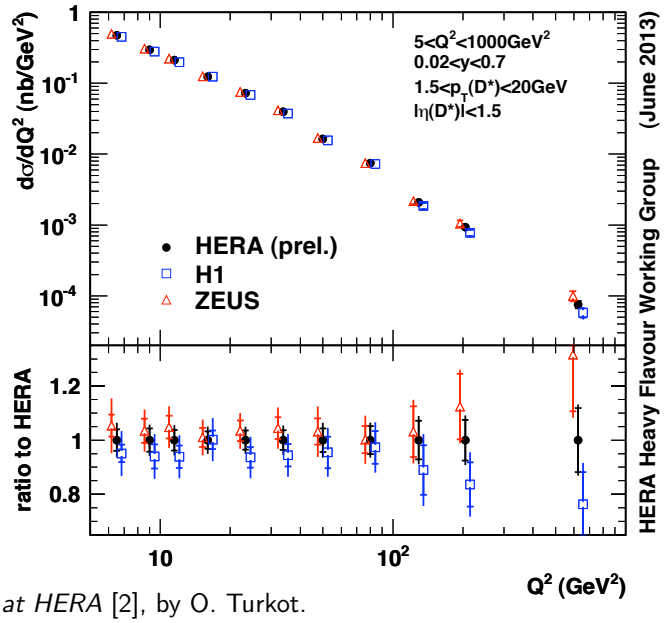

FIG. 10.5 – D^* production cross section vs. Q^2. Shown are results from H1 and ZEUS, and their combination. The inner error bars indicate the statistical uncertainties before combination, and the uncorrelated part of the uncertainties after combination. The outer error bars represent the total uncertainties. The bottom part shows the ratio between these cross sections and the central value of the combined result.

[1] *Combination of inclusive $e^{\pm}p$ cross section measurements at HERA* [2], by O. Turkot.

[2] XXII Int. Workshop on *Deep-Inelastic Scattering and Related Subjects*, DIS2014, April 28 - May 2 2014, Warsaw, Poland.

[3] V. Andreev *et al.* (H1-Collaboration), Eur. Phys. J. C **74** (2014), 2814.

[4] *HERAPDF2.0 fits including all HERAI+II inclusive data sets* [2], by V. Radescu.

[5] *HERAPDF1.5LO PDF set with experimental uncertainties* [2], by M. Cooper-Sarkar.

[6] *Combination of D^* differential cross section measurements in deep-inelastic ep scattering at HERA* [2], by M. Lisovyi.

[7] *Dijet production with large rapidity gap in deep-inelastic scattering at HERA* [2], by B. Pokorny.

[8] *Diffractive dijet production with a leading proton in ep collisions at HERA* [2], by R. Zlebcik.

[9] *Measurement of Feynman-x spectra of photons and neutrons in the very forward direction in deep-inelastic scattering at HERA*, V. Andreev *et al.* (H1-Collaboration), submitted to Eur. Phys. J. C, arXiv:1404.0201 [hep-ex].

[10] *Exclusive photoproduction of ρ^0 with leading neutron at HERA* [2], by S. Levonian.