



Combined Electroweak and QCD Fit of Inclusive Neutral and Charged Current Data with Polarised Lepton Beams at HERA

H1 Collaboration

Abstract

Using the deep inelastic e^+p and e^-p neutral and charged current scattering cross sections, including data with polarised electron beams, a combined electroweak and QCD analysis is performed to determine vector and axial-vector couplings v_q and a_q of light quarks u and d to the Z^0 boson accounting for their correlation with parton distributions. The precision has been improved in particular for vector couplings with respect to the published results based on the unpolarized HERA data only. The determinations from HERA are compared with those from LEP and Tevatron.

Table 1: Datasets used in the combined electroweak and QCD fit. The low and medium Q^2 datasets are combined data samples from all the measurements published by H1. For each dataset, the corresponding center-of-mass energy $\sqrt{s}$, the integrated luminosity value and the average polarisation value (for HERA-2 data samples) are given.

Dataset	$\sqrt{s}$ (GeV)	$\mathcal{L}$ (pb $^{-1}$)	P_e (%)
Low Q^2 (e^+p)	301	$0.114 + 1.8$	—
Low Q^2 (e^+p)	319	0.505	—
Medium Q^2 (e^+p)	301	17.9	—
Medium Q^2 (e^+p)	319	$2.1 + 22$	—
NC High Q^2 (e^+p)	301	35.6	—
CC High Q^2 (e^+p)	301	35.6	—
NC High Q^2 (e^-p)	319	16.4	—
CC High Q^2 (e^-p)	319	16.4	—
NC High Q^2 (e^+p)	319	65.2	—
CC High Q^2 (e^+p)	319	65.2	—
NC High Q^2 (e^+p)	319	81.9	-37.6 ± 1.4
CC High Q^2 (e^+p)	319	81.9	-37.6 ± 1.4
NC High Q^2 (e^+p)	319	98.1	32.5 ± 1.2
CC High Q^2 (e^+p)	319	98.1	32.5 ± 1.2
NC High Q^2 (e^-p)	319	103.2	-26.0 ± 1.0
CC High Q^2 (e^-p)	319	103.2	-26.0 ± 1.0
NC High Q^2 (e^-p)	319	45.9	36.9 ± 2.3
CC High Q^2 (e^-p)	319	45.9	36.9 ± 2.3

Table 2: The results of the fits to weak neutral current couplings in comparison with their SM values. The first errors correspond to experimental uncertainties and the second ones to systematic uncertainties covering variations of the strange fraction f_s , the charm and bottom masses m_c and m_b , the minimum Q^2 selection cut $Q_{\min}^2$, the top mass m_t , the Z^0 and W boson masses and the strong coupling α_s as well as variations of PDF parameterisation forms and the initial Q_0^2 value.

Fit	v_u - a_u - v_d - a_d -PDF	v_u - a_u -PDF	v_d - a_d -PDF	SM
a_u	$0.49 \pm 0.06 \pm 0.04$	0.53 ± 0.04	—	0.5
v_u	$0.23 \pm 0.08 \pm 0.02$	0.23 ± 0.04	—	0.191
a_d	$-0.67 \pm 0.19 \pm 0.07$	—	-0.61 ± 0.15	-0.5
v_d	$-0.31 \pm 0.27 \pm 0.06$	—	-0.44 ± 0.13	-0.346
χ^2/dof	1183.8/1230	1184.5/1232	1184.2/1232	—

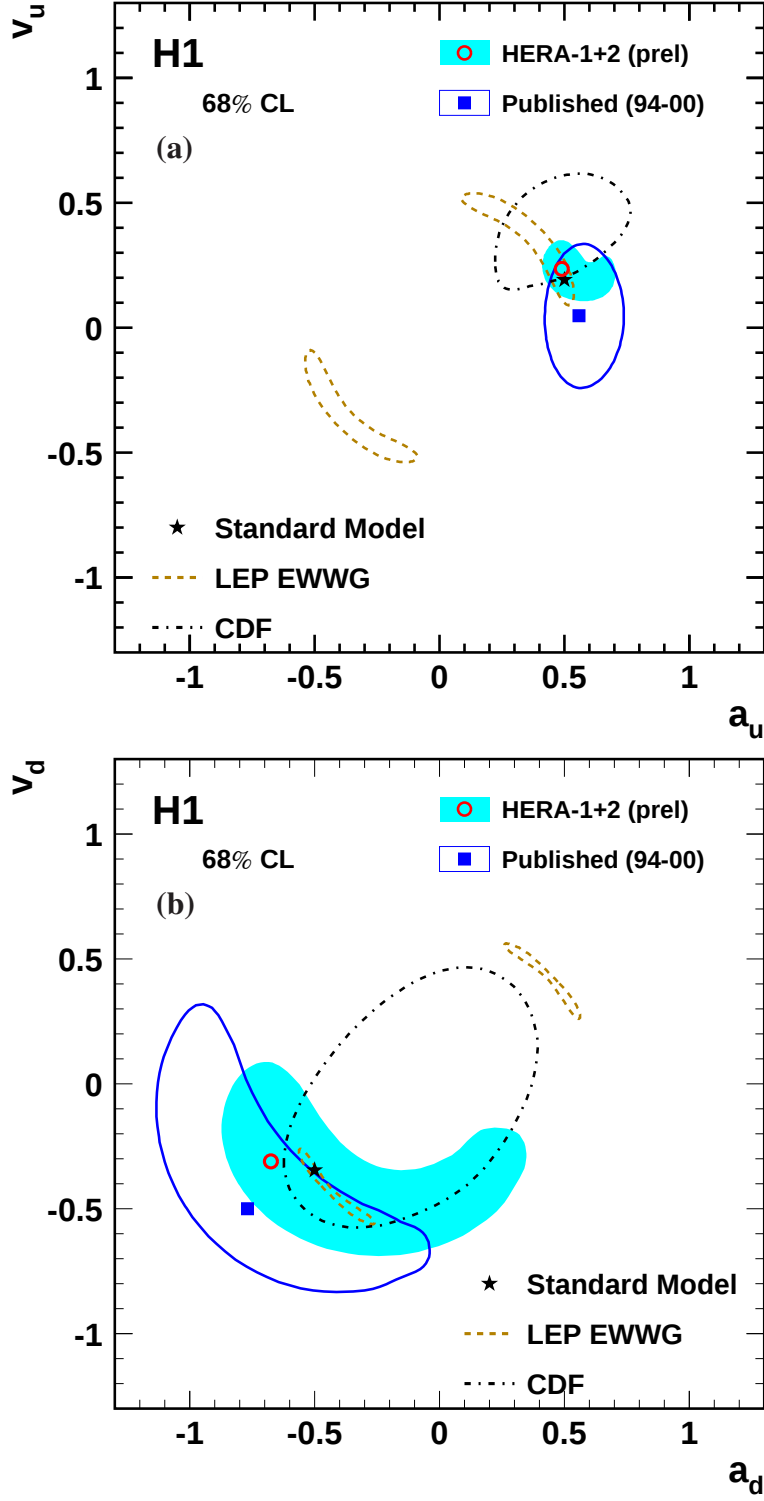


Figure 1: Results at 68% confidence level (CL) on the weak neutral current couplings of u (a) and d (b) quarks to the Z^0 boson determined in this analysis using the full HERA-1+2 H1 data (shaded contours) in comparison with the corresponding results published previously using the HERA-1 data [1]. These results can be compared with those determined by the LEP EWWG [2] and the CDF experiment [3]. The stars show the expected SM values.

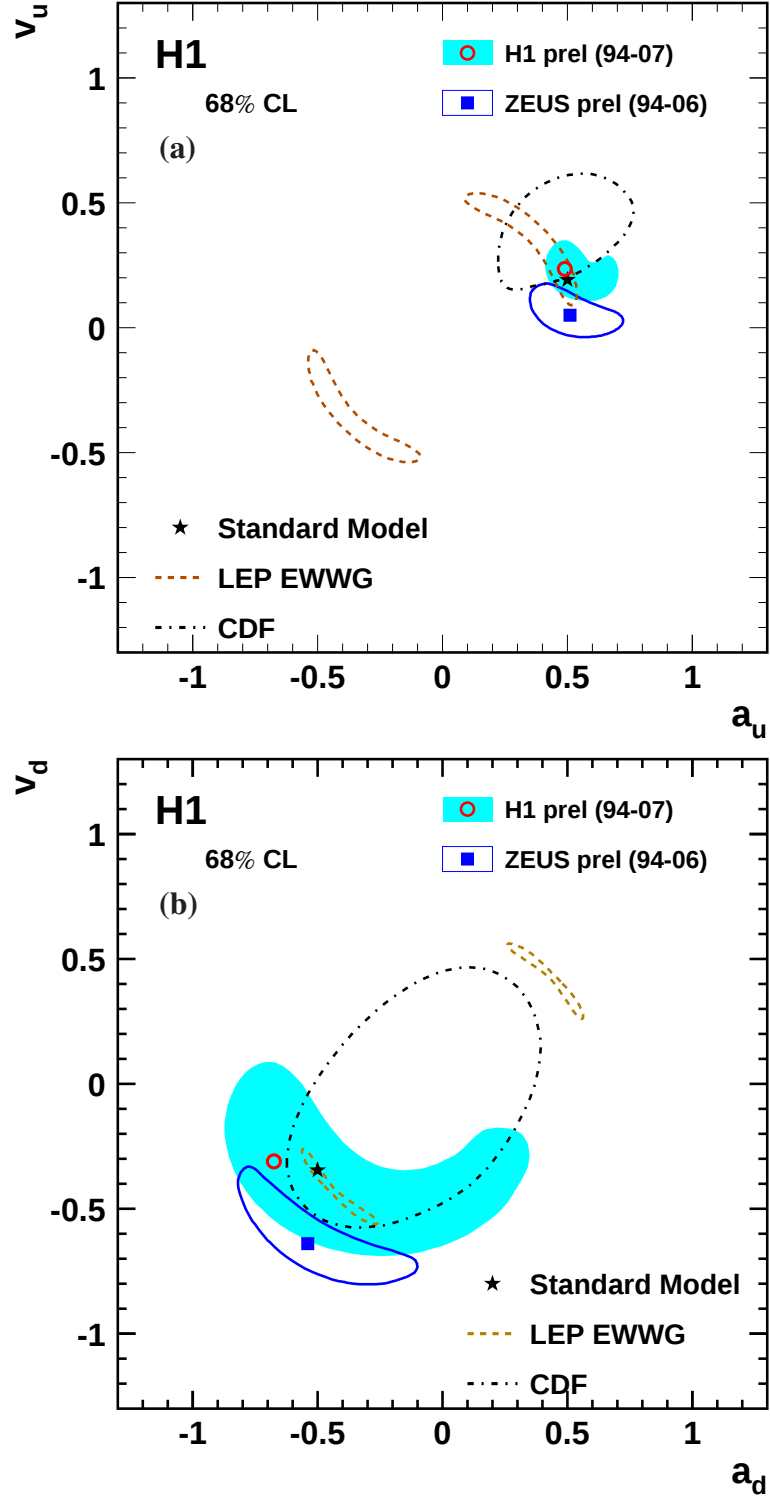


Figure 2: Same as Fig. 1, the new H1 preliminary results are compared with the results from ZEUS [4], LEP [2] and CDF [3].

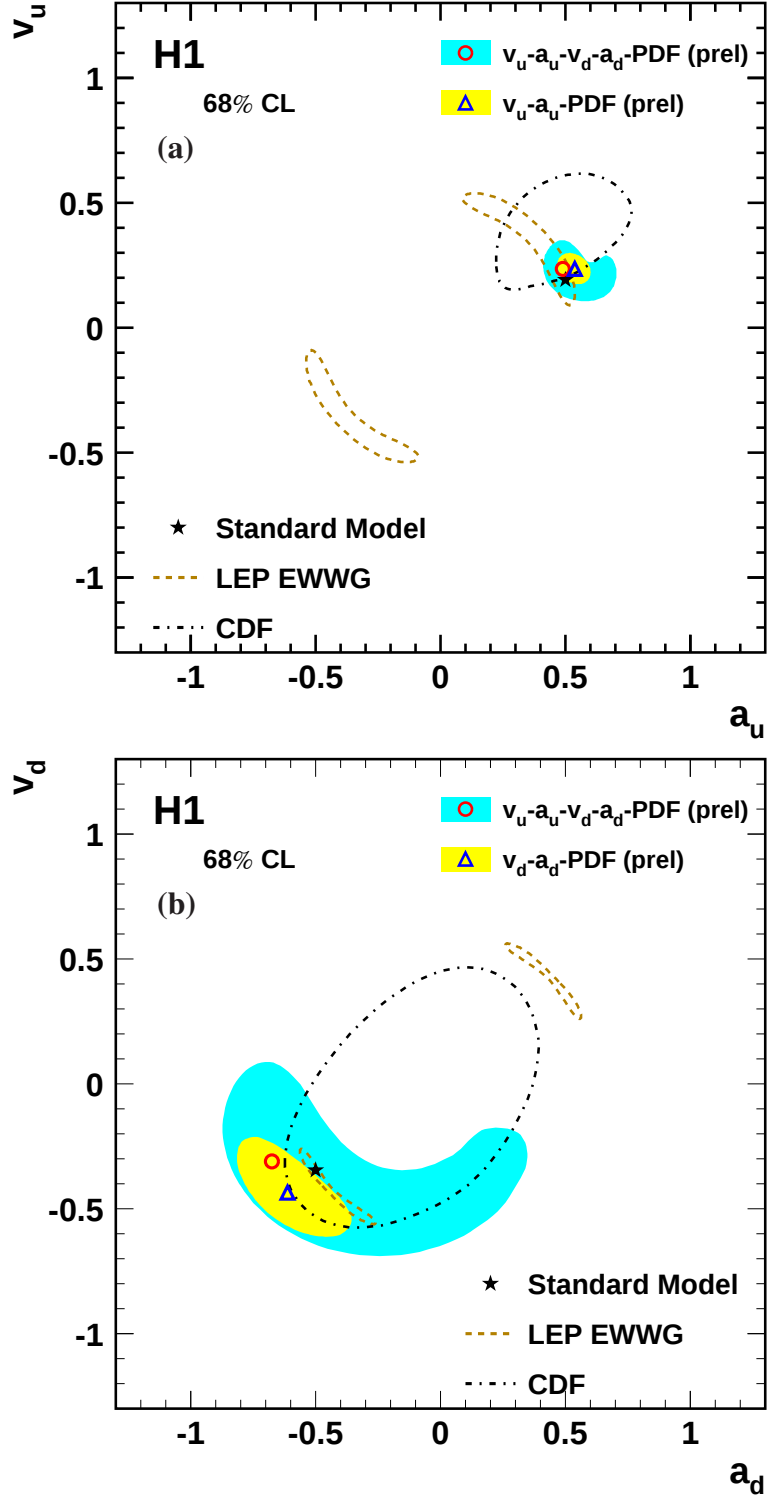


Figure 3: Results of a simultaneous fit of all four couplings (large-shaded contours) are compared with results of fits where either d or u quark couplings are fixed to their SM values (small-shaded contours) and those determined from LEP [2] and CDF [3].

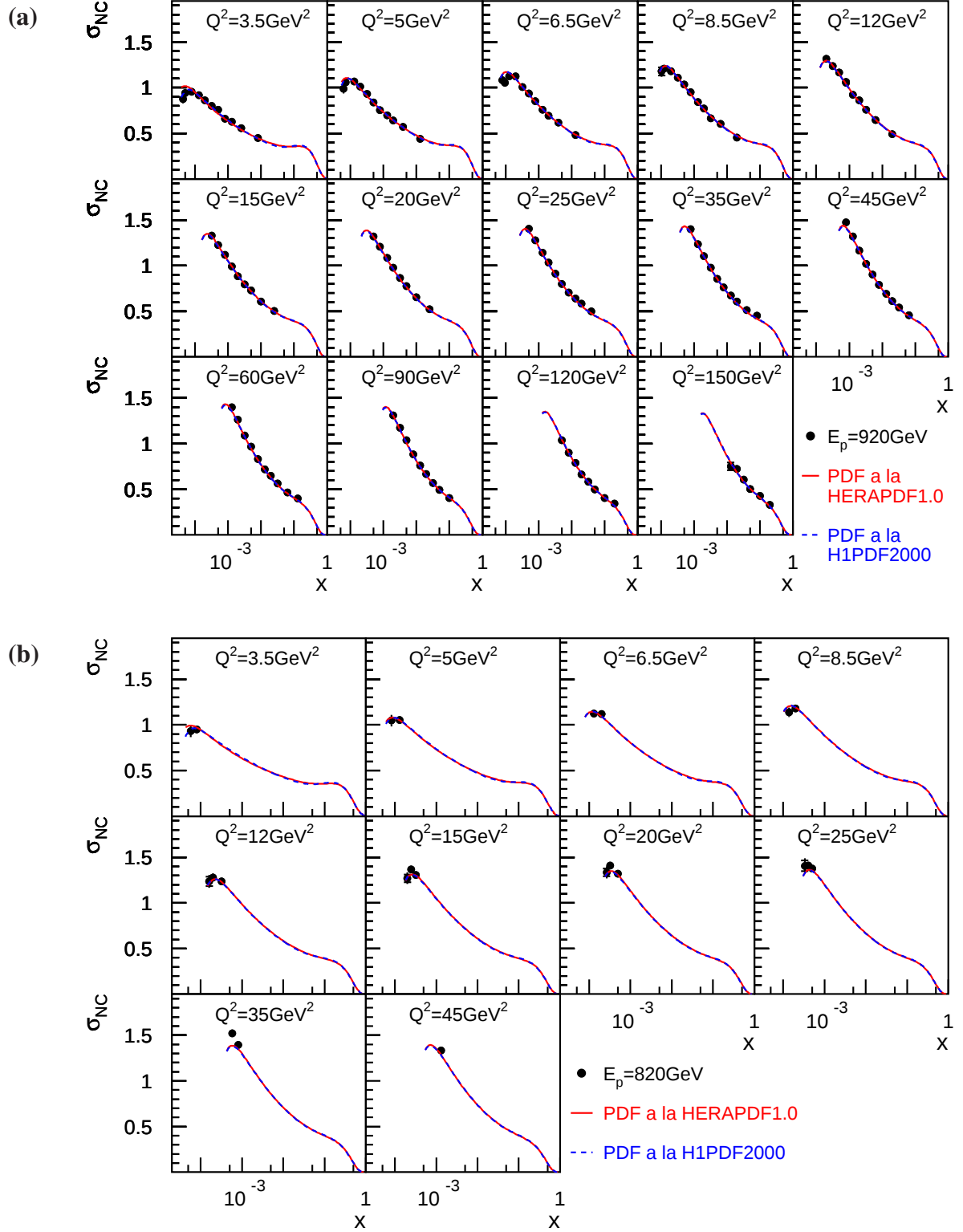


Figure 4: Low and medium Q^2 cross section data at $Q^2 \geq 3.5 \text{ GeV}^2$ measured at HERA-1 with proton beam energy $E_p = 920 \text{ GeV}$ (a) and $E_p = 820 \text{ GeV}$ (b) in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

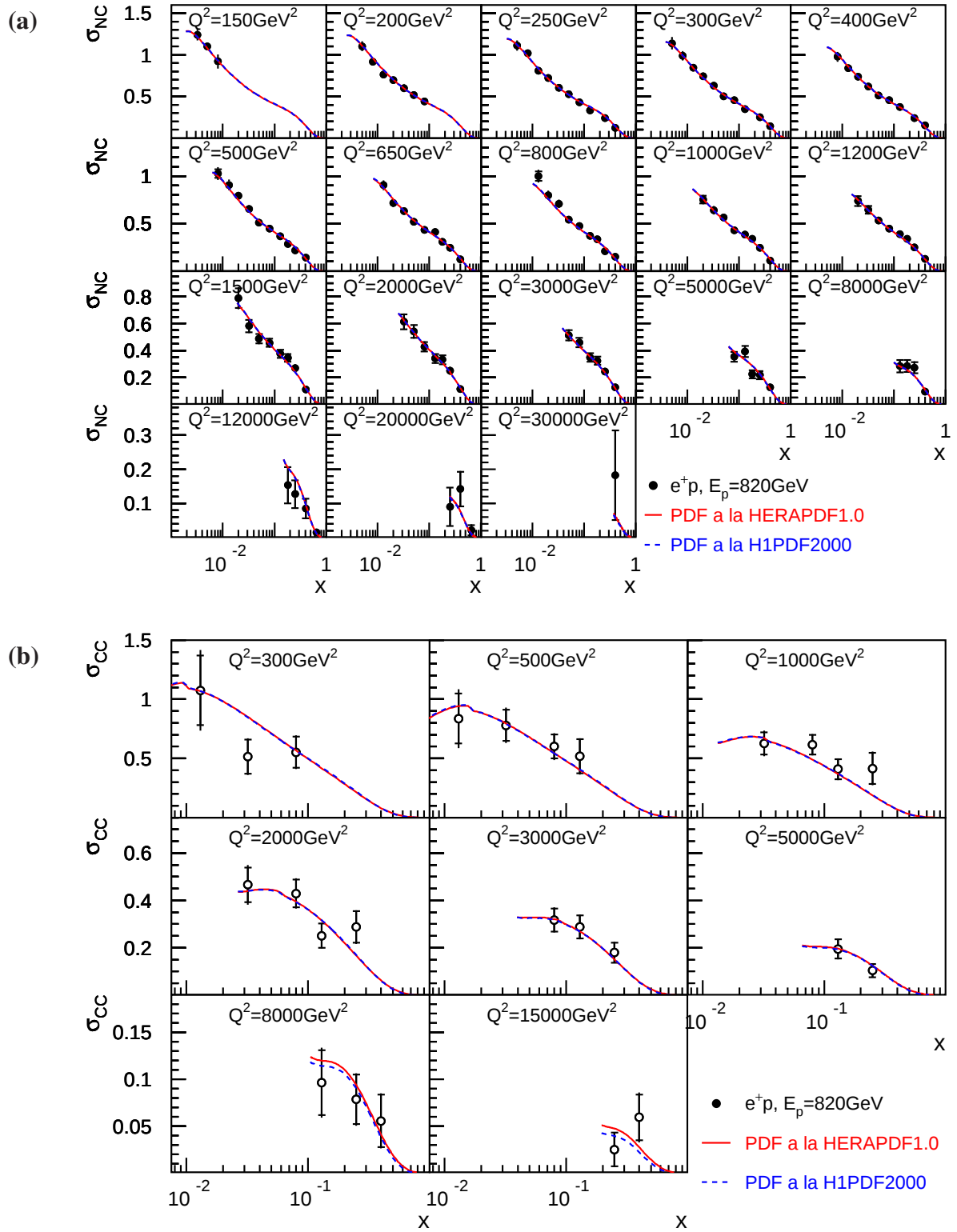


Figure 5: High Q^2 NC (a) and CC (b) e^+p cross section data measured at HERA-1 with $E_p = 820$ GeV in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

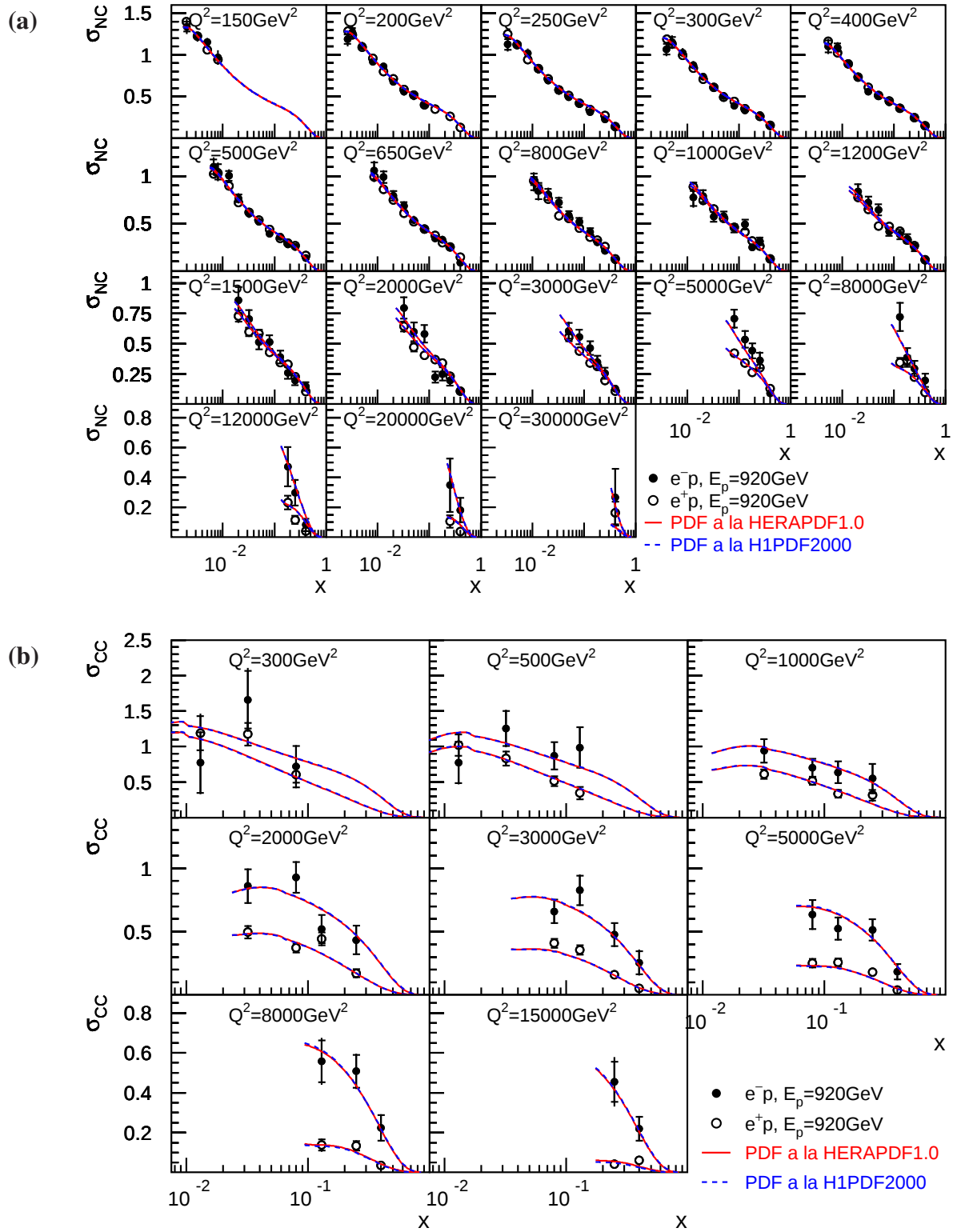


Figure 6: High Q^2 NC (a) and CC (b) $e^\pm p$ cross section data measured at HERA-1 with $E_p = 920$ GeV in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

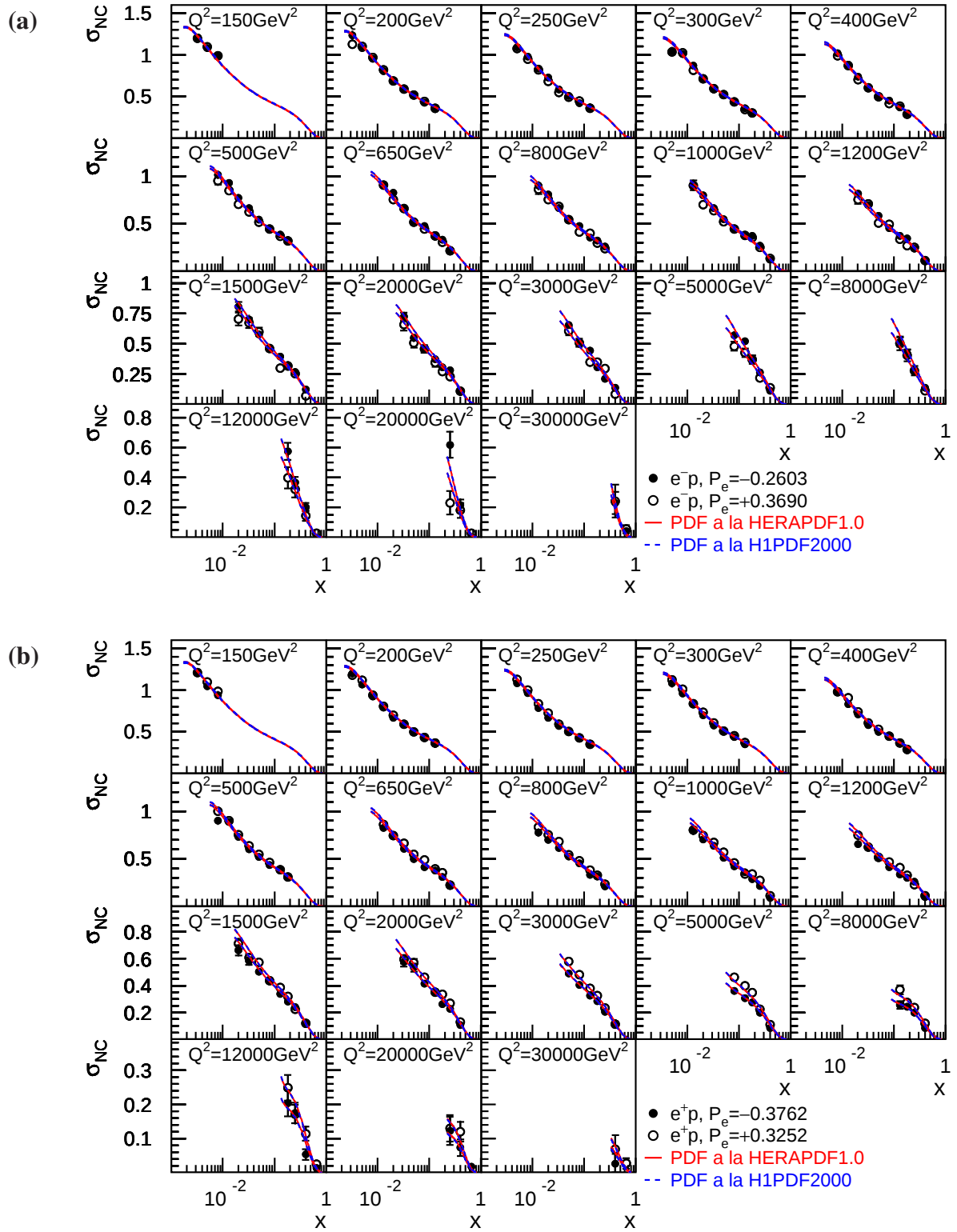


Figure 7: High Q^2 NC e^-p (a) and e^+p (b) cross section data measured at HERA-2 in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

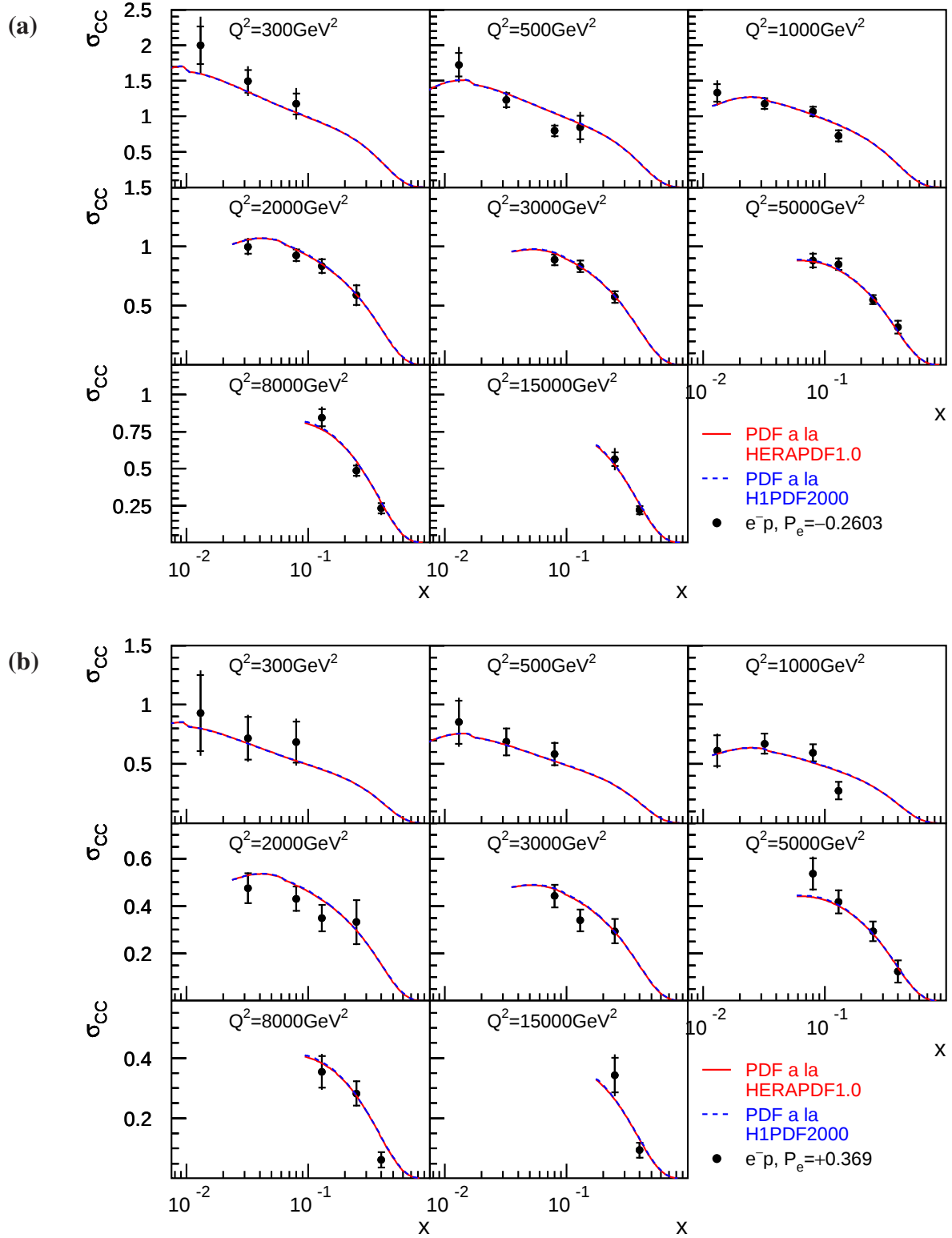


Figure 8: High Q^2 CC e^-p cross section data measured at HERA-2 with left- (a) and right-handed (b) polarised electron beam in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

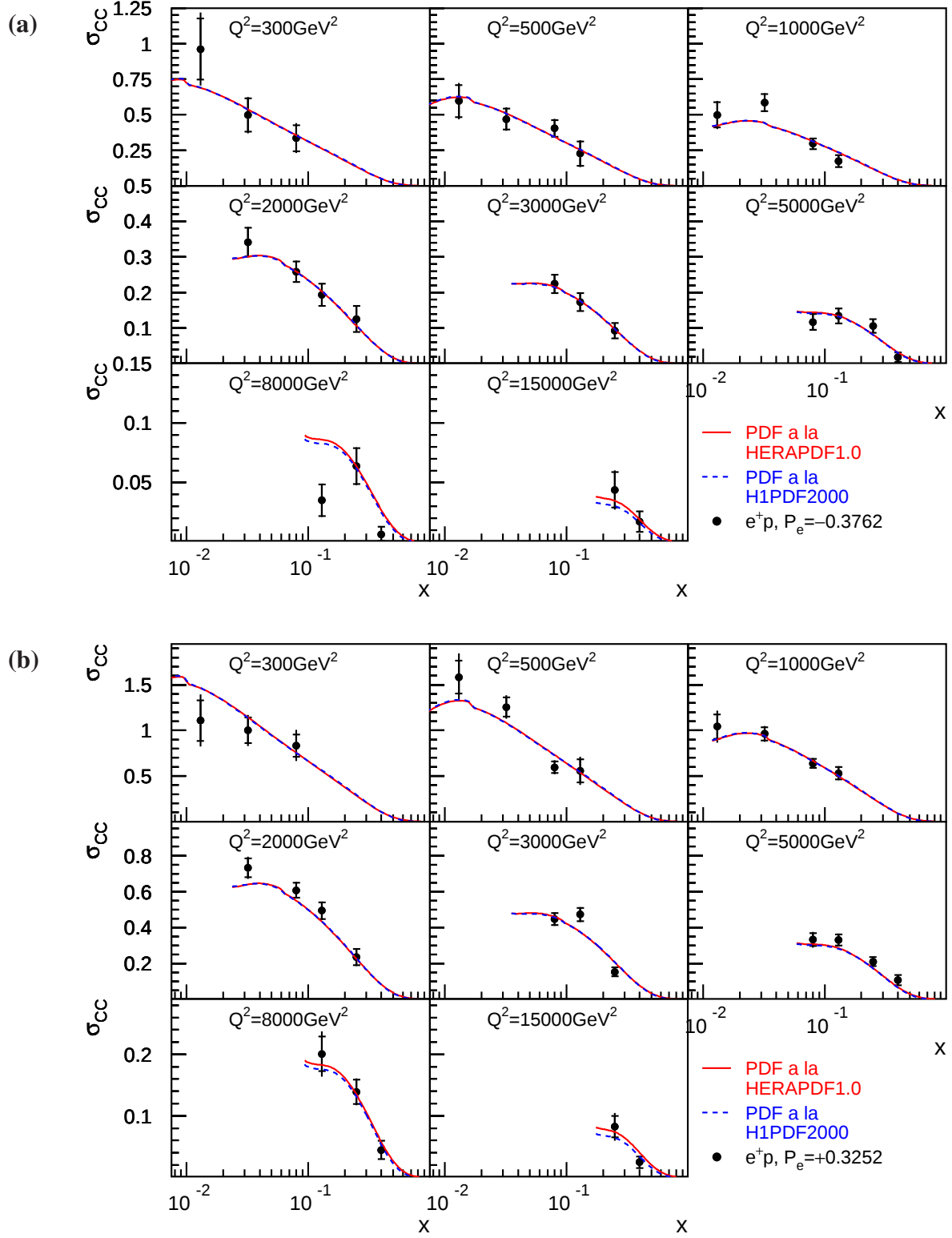


Figure 9: High Q^2 CC e^+p cross section data measured at HERA-2 with left- (a) and right-handed (b) polarised electron beam in comparison with predictions based on the fitted PDFs using parameterisation forms either as HERAPDF1.0 [5] or as H1PDF2000 [6].

References

- [1] A. Aktas *et al.* [H1 Collaboration], Phys. Lett. B **632**, 35 (2006) [arXiv:hep-ex/0507080].
- [2] [ALEPH Collaboration and DELPHI Collaboration and L3 Collaboration and], Phys. Rept. **427**, 257 (2006) [arXiv:hep-ex/0509008].
- [3] D. E. Acosta *et al.* [CDF Collaboration], Phys. Rev. D **71**, 052002 (2005) [arXiv:hep-ex/0411059].
- [4] ZEUS Collaboration, ZEUS-prel-07-027.
- [5] F.D. Aaron *et al.* [H1 Collaboration and ZEUS Collaboration], JHEP **1001**, 109 (2010) [arXiv:0911.0884 [hep-ex]].
- [6] C. Adloff *et al.* [H1 Collaboration], Eur. Phys. J. C **30**, 1 (2003) [arXiv:hep-ex/0304003].