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Precision DIS Measurements at HERA

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A measurement of the inclusive deep inelastic neutral current e^+p scattering cross section is reported in the region of four-momentum transfer squared, $12 \text{ GeV}^2 < Q^2 < 150 \text{ GeV}^2$, and Bjorken x , $2 \times 10^{-4} < x < 0.1$. The results are based on data collected by the H1 Collaboration at the ep collider HERA at positron and proton beam energies of $E_e = 27.6 \text{ GeV}$ and $E_p = 920 \text{ GeV}$, respectively. The data are combined with previously published data, taken at $E_p = 820 \text{ GeV}$. The accuracy of the combined measurement is typically in the range of 1.3-2%. A QCD analysis at next-to-leading order is performed to determine the parton distributions in the proton based on H1 data.

A measurement of the inclusive ep scattering cross section is presented in the region of low momentum transfers, $0.2 < Q^2 < 12 \text{ GeV}^2$, and low Bjorken x , $5 \times 10^{-6} < x < 0.02$. The result is based on two data sets collected in dedicated runs by the H1 Collaboration at HERA at beam energies of 27.6 GeV and 920 GeV for positrons and protons, respectively. A combination with data previously published by H1 leads to a cross section measurement of a few percent accuracy. A kinematic reconstruction method exploiting radiative ep events extends the measurement to lower Q^2 and larger x . The data are compared with theoretical models which apply to the transition region from photoproduction to deep inelastic scattering.

The inclusive single differential cross section $d\sigma/dQ^2$ and the reduced double differential cross section $\tilde{\sigma}(x, Q^2)$ are presented for the charged current process, $e^{\pm}p \rightarrow \nu X$, in interactions with longitudinally polarised lepton beams using the complete HERA-II data set. The cross sections are measured in the region of large negative four-momentum transfer squared $Q^2 \geq 200 \text{ GeV}^2$ and inelasticity $y < 0.9$. In addition the total cross section for $Q^2 > 400 \text{ GeV}^2$ and inelasticity $y < 0.9$ is measured. Together with the corresponding cross section obtained from the previously published unpolarised data, the polarisation dependence of the charged current cross section is measured and found to be in agreement with the Standard Model prediction.

The inclusive single differential cross section $d\sigma/dQ^2$ and the reduced double differential cross section $\tilde{\sigma}(x, Q^2)$ are presented for the neutral current process, $e^{\pm}p \rightarrow e^{\pm}X$, in interactions with longitudinally polarised lepton beams using the complete HERA-II data set. The cross sections are measured in the region of large negative four-momentum transfer squared $Q^2 \geq 200 \text{ GeV}^2$ and inelasticity $y < 0.9$. The data are consistent with the expected Q^2 dependence of polarised cross sections. The data are compared to predictions of the Standard Model which is able to provide a good description of the data.

A measurement is presented of the longitudinal proton structure function $F_L(x, Q^2)$ derived from inclusive deep inelastic ep scattering cross section measurements with the H1 detector at HERA. The data were taken in the year 2007 at a positron beam energy of $E_e = 27.5 \text{ GeV}$ and proton beam energies E_p of 920 GeV, 575 GeV and 460 GeV. The measurements of F_L use different parts of the H1 detector covering when combined a range of four-momentum transfers squared $5 \leq Q^2 \leq 800 \text{ GeV}^2$ and Bjorken x between 0.0001 and 0.035. The data are compared with higher order QCD predictions.

The energy dependence of the total photon-proton cross-section is determined using data of three different proton beam energies collected with the ZEUS detector at HERA. These measurements correspond to centre-of-mass energies of 225 GeV, 250 GeV and 320 GeV.

The charm contribution F_2^{cc} to the proton structure function F_2 is determined. The results of D meson production cross section measurements are combined with the measurements using semi-leptonic decays into muons as well as inclusive track measurements. The correlations of the systematic uncertainties between different measurements are taken into account. The data cover the kinematic range of photon virtuality $2 < Q^2 < 1000 \text{ GeV}^2$ and Bjorken scaling variable $10^{-5} < x < 10^{-1}$.

A combination of the inclusive deep inelastic cross sections measured by the H1 and ZEUS Collaborations for ep scattering with nominal and reduced proton-beam energies, $E_p=920$ GeV, $E_p=460$ GeV and 575 GeV, is presented. The combination method used takes the correlations of systematic uncertainties into account, resulting in improved accuracy. From the combined data the proton structure function, F_L , is extracted in the region of $2.5 < Q^2 < 800 \text{ GeV}^2$.

Measurements of the neutral current cross sections for deep inelastic scattering in e-p collisions at HERA with a longitudinally polarised electron beam are presented. The single-differential cross-sections $d\sigma/dQ^2$, $d\sigma/dx$ and $d\sigma/dy$ and the double-differential cross sections in Q^2 and x are measured in the kinematic region $y < 0.9$ and $Q^2 > 185 \text{ GeV}^2$ for both positively and negatively polarised electron beams and for each polarisation state separately. The measurements are based on an integrated luminosity of 169.9 pb^{-1} taken with the ZEUS detector in 2005 and 2006 at a centre-of-mass energy of 318 GeV. The structure functions xF_3 and $xF_3^{\gamma Z}$ are determined by combining the e-p results presented in this paper with previously measured e+p neutral current data. The asymmetry parameter A_- is used to demonstrate the parity violating effects of electroweak interactions at large spacelike photon virtuality. The measurements agree well with the predictions of the Standard Model.

A combination is presented of the inclusive deep inelastic cross sections measured by the H1 and ZEUS Collaborations in neutral and charged current unpolarised ep scattering at HERA during the period 1994-2000. The data span six orders of magnitude in negative four-momentum-transfer squared, Q^2 , and in Bjorken x . The combination method used takes the correlations of systematic uncertainties into account, resulting in an improved accuracy. The combined data are the sole input in a NLO QCD analysis which determines a new set of parton distributions, HERAPDF1.0, with small experimental uncertainties. This set includes an estimate of the model and parametrisation uncertainties of the fit result.

Measurements of the cross sections for charged current deep inelastic scattering in e-p collisions with longitudinally polarised electron beams are presented. The measurements are based on a data sample with an integrated luminosity of 175 pb^{-1} collected with the ZEUS detector at HERA at a centre-of-mass energy of 318 GeV. The total cross section is given for positively and negatively polarised electron beams. The differential cross-sections $d\sigma/dQ^2$, $d\sigma/dx$ and $d\sigma/dy$ are presented for $Q^2 > 200 \text{ GeV}^2$. The double-differential cross-section $d^2\sigma/dx dQ^2$ is presented in the kinematic range $280 < Q^2 < 30000 \text{ GeV}^2$ and $0.015 < x < 0.65$. The measured cross sections are compared with the predictions of the Standard Model.

Measurements of the cross sections for charged current deep inelastic scattering in e+p collisions with a longitudinally polarised positron beam are presented. The measurements are based on a data sample with an integrated luminosity of 132 pb^{-1} collected with the ZEUS detector at HERA in 2006 and 2007 at a centre-of-mass energy of 318 GeV. The total cross section is presented at positive and negative values of the longitudinal polarisation of the positron beams. The single-differential cross sections $d\sigma/dQ^2$, $d\sigma/dx$ and $d\sigma/dy$ are presented for $Q^2 > 200 \text{ GeV}^2$. The reduced double-differential cross section is presented in the kinematic range $280 < Q^2 < 30000 \text{ GeV}^2$ and $0.0078 < x < 0.42$. The cross section measurements agree well with the predictions of the Standard Model. In addition, a linear fit is applied to the total cross section as a function of polarisation. The fit is extrapolated to determine the upper limit on the cross section for a fully left-handed positron beam. The lower limit on the mass of a hypothetical W boson which couples to right-handed particles is then extracted.

A new method is employed to measure the neutral current cross section up to Bjorken- x values of one with the ZEUS detector at HERA using an integrated luminosity of 187 pb^{-1} of e-p collisions at $\sqrt{s} = 318 \text{ GeV}$. Cross sections have been extracted for $Q^2 \geq 575 \text{ GeV}^2$. A much improved precision with respect to the previous ZEUS publication, which only used 16.7 pb^{-1} of e-p collisions, is achieved, owing to the larger data sample and improved kinematic reconstruction methods. The measurement is well described by predictions based on the CTEQ6D PDFs.

The reduced cross sections for ep deep inelastic scattering have been measured with the ZEUS detector at HERA at three different centre-of-mass energies, 318, 251 and 225 GeV. From the cross sections, measured double differentially in Bjorken x and the virtuality, Q^2 , the proton structure functions F_L and F_2 have been extracted in the region $0.0005 < x < 0.007$ and $20 < Q^2 < 130 \text{ GeV}^2$.

The measurements of the reduced cross sections for e+p deep inelastic scattering at high inelasticities y for three different centre-of-mass energies, 318, 251 and 225 GeV have been extended to lower momentum transferred squared, Q^2 . The analysis of satellite vertex events allows to extend the cross section measurement at high y down to $Q^2 = 5 \text{ GeV}^2$, substantially lower than the previously published cross section measurements from which the longitudinal structure function, F_L , was extracted.

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