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D^* production in deep-inelastic Scattering at low Q^2

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Abstract. Inclusive production of D^* mesons in deep-inelastic scattering at HERA is studied in the range $5 < Q^2 < 100$ GeV^2 of the photon virtuality and $0.02 < y < 0.70$ of the inelasticity of the scattering process. The visible range for the D^* meson is $p_T(D^*) > 1.25$ GeV and $|\eta(D^*)| < 1.8$. The data were taken with the H1 detector in the years 2004 to 2007 and correspond to an integrated luminosity of 347 pb^{-1}. Single and double differential cross sections are measured. The results are compared to QCD predictions.

Keywords: HERA, H1, DIS, charm, D^*, differential cross section
PACS: 13,14

INTRODUCTION

HERA was the unique electron-proton (ep) accelerator colliding 27.6 GeV electrons (positrons) with 920 GeV protons providing a center-of-mass energy of $\sqrt{s} = 318$ GeV. The charm quark production in ep scattering is dominated by the boson-gluon-fusion (BGF) process ($\gamma p \to c\bar{c}$). This production process is directly sensitive to the gluon density in the proton and allows its universality to be tested. The kinematic region of deep-inelastic scattering (DIS) is defined by the four-momentum transfer squared (Q^2) of the exchanged photon: $Q^2 \gtrsim 5$ GeV^2. Due to the presence of a hard scale (m_c, Q^2 or p_T) perturbative Quantum Chromodynamics (pQCD) can be applied. If one of the other scales is much bigger than the mass, charm quarks can be treated as massless ("massless scheme"), otherwise the mass needs to be taken into account ("massive scheme"). The latter assumes no charm quark content of the proton.

D$^{*\pm}$ CROSS SECTION MEASUREMENTS IN DIS

Events containing charm quarks are efficiently identified reconstructing D^* mesons by the mass difference method. D^* production in DIS has been measured for photon virtualities of: $5 < Q^2 < 100$ GeV^2 and inelasticities of: $0.02 < y < 0.70$. The full HERAII data set corresponding to an integrated luminosity of 347 pb^{-1} has been analyzed. The visible phase space of the D^* meson is restricted to $p_T(D^*) > 1.25$ GeV and $|\eta(D^*)| < 1.8$ [2]. This measurement yields currently the largest phase space coverage at HERA for an inclusive D^* cross section measurement.

The D^* cross section as a function of Q^2 and x is depicted in Figure 1(left) and (right).

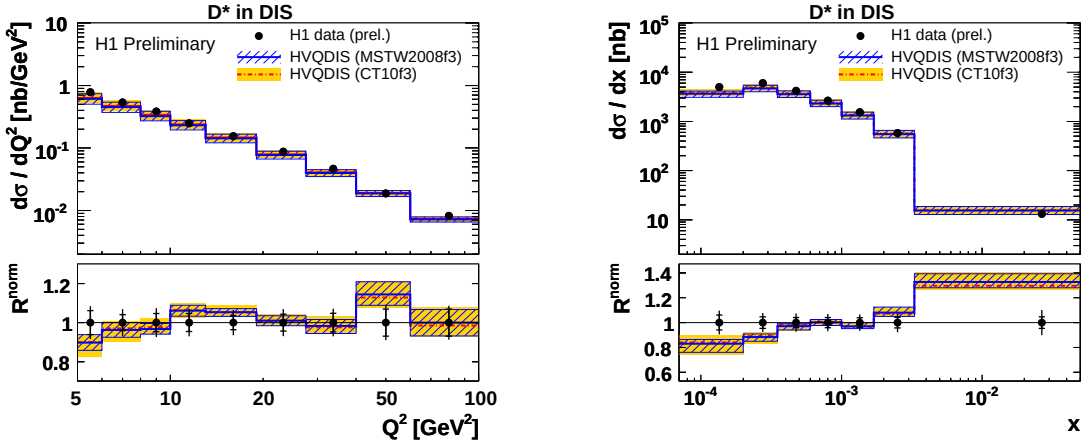

FIGURE 1. D^* cross section as a function of Q^2 (left) and x (right) compared to the massive NLO QCD calculation (HVQDIS) using two different proton PDFs: MRST2008f3 [4] or CT10f3 [5].

The data are compared to the massive NLO QCD calculation (HVQDIS) using two different proton parton density functions (PDFs): MRST2008f3 [4] or CT10f3 [5]. The Q^2 dependence of the data is well described, while the slope in x is not very well reproduced. Figure 2 shows the D^* cross section as a function of $p_T(D^*)$ (left) and $\eta(D^*)$

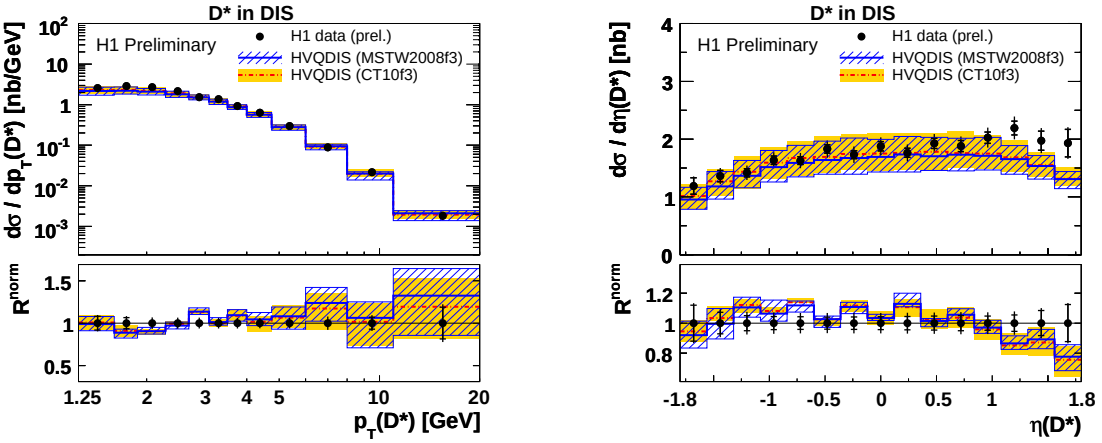

FIGURE 2. D^* cross section as a function of $p_T(D^*)$ (left) and $\eta(D^*)$ (right) compared to the massive NLO QCD calculation (HVQDIS) using two different proton PDFs: MRST2008f3 or CT10f3.

(right) compared to the massive NLO QCD predictions by HVQDIS. With either proton PDFs the massive NLO calculation describes the data nicely, except for the high $\eta(D^*)$ region (forward direction) where it slightly undershoots the data. The two-dimensional cross section reveals this to be located at low p_T of the D^* (see Figure 3). Otherwise the data are reasonable described by the NLO calculation. In order to allow comparisons with the massless NLO calculation (ZM-VFNS) [7] an additional transverse momentum cut in the photon-proton rest frame of $p_T^*(D^*) > 2$ GeV is applied. The ZM-VFNS calculation uses the CTEQ6.6 proton PDF [1] together with the fragmentation function

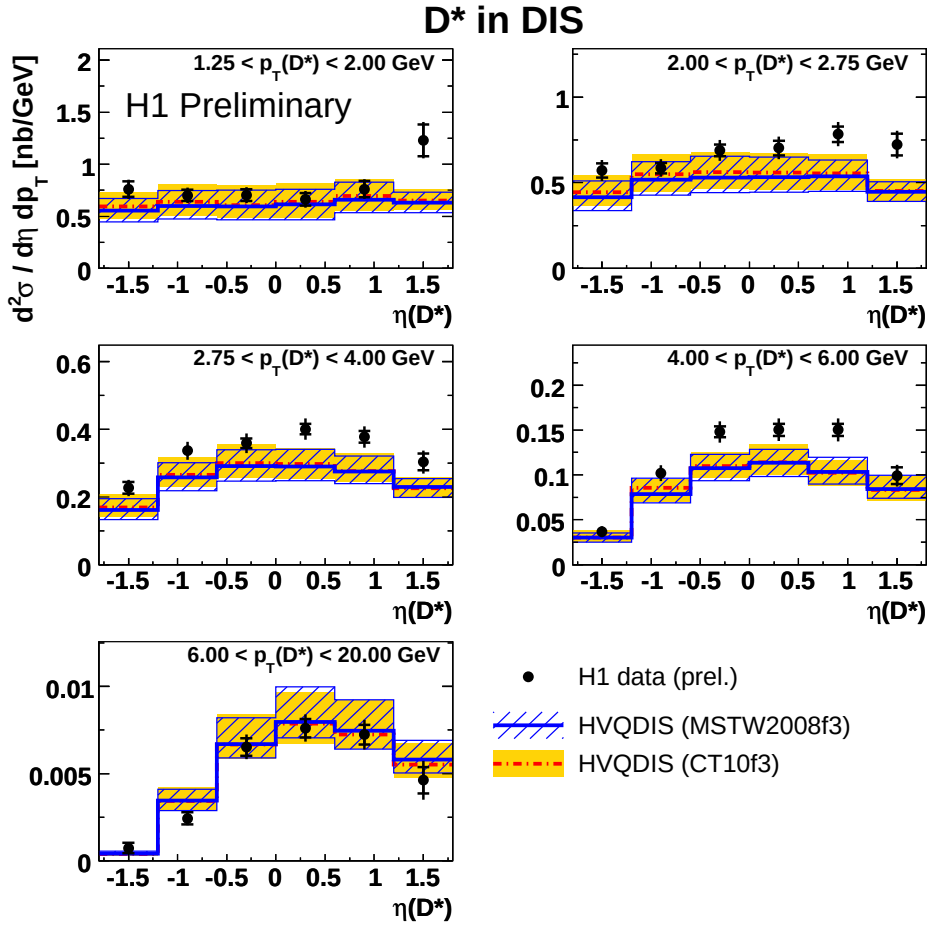

FIGURE 3. Two dimensional D^* cross section as a function of $\eta(D^*)$ and $p_T(D^*)$ compared to the massive NLO QCD calculation (HVQDIS) using two different proton PDFs: MRST2008f3 or CT10f3.

KKKS08 [6]. The massless calculation fails completely to describe the data as a function of x (see Fig. 4(left)), whereas the data are reasonably well described by the massive NLO QCD calculation provided by HVQDIS. Figure 4(right) shows the D^* cross section as a function of y which also shows the bad description of the data by the massless NLO calculation at low values of y. Differential D^* cross sections have also been measured for a restricted D^* phase space region: $|\eta(D^*)| < 1.5$ and $p_T(D^*) > 1.5$ GeV [2]. Figure 5 shows these restricted cross section data as a function of Q^2 together with the data from the measurement of D^* cross sections at high Q^2: $100 < Q^2 < 1000$ GeV^2 [8]. Data are compared to the massive NLO QCD calculation which describes the data well with either proton PDFs, also the Q^2 slope is nicely described.

CONCLUSION

New measurements using the full H1 HERAII data sample have been analyzed for D^* production in ep scattering. The measurement in the DIS regime at medium Q^2 has

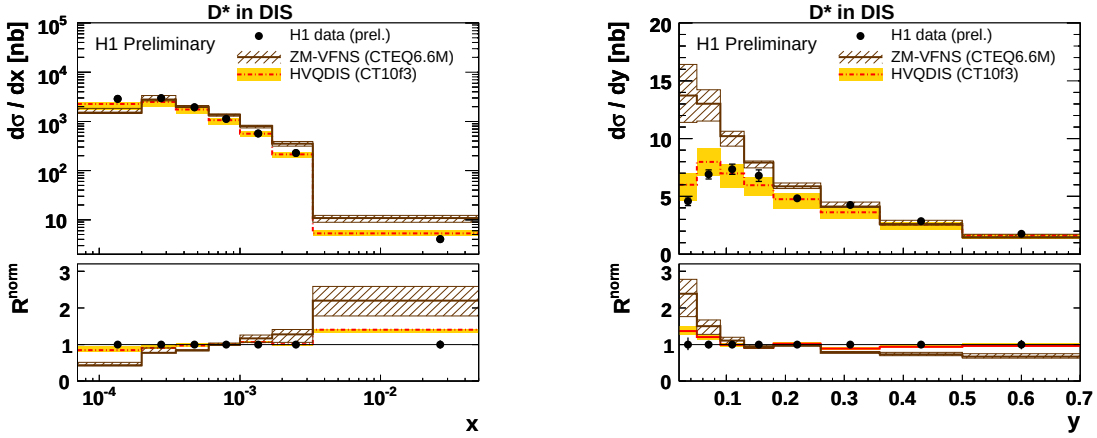

FIGURE 4. D^* cross section as a function of x (left) and y (right) for $p_T^* > 2$ GeV compared to the massive NLO QCD calculation (HVQDIS) using the proton PDF: CT10f3 and to the massless (ZM-VFNS) NLO QCD calculation using CTEQ6.6M [1].

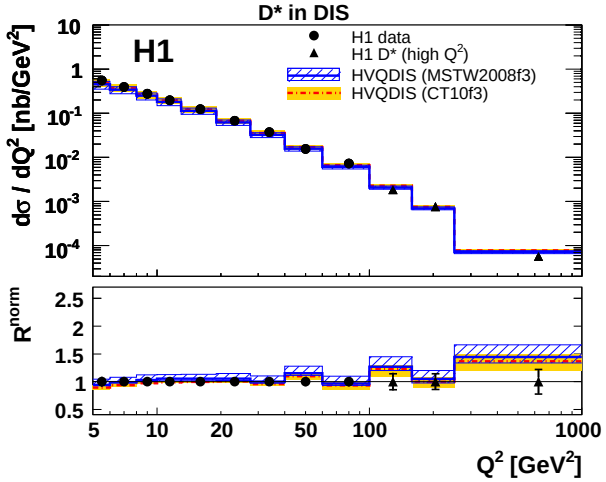

FIGURE 5. D^* cross section as a function of Q^2 with the additional cuts: $|\eta(D^*)| < 1.5$ and $p_T(D^*) > 1.5$ GeV are shown together with the results from the high Q^2 D^* publication [2]. Data are compared to the massive NLO QCD calculation (HVQDIS) using two different proton PDFs: MRST2008f3 or CT10f3.

been carried out in the largest phase space at HERA for inclusive D^* cross section measurements. The data are reasonable described by the massive NLO QCD calculation. However, the NLO calculation undershoots the data slightly at high $\eta(D^*)$ and low $p_T(D^*)$ for either PDFs. The slope in x is not very well reproduced for the massive NLO QCD calculation, whereas the massless one fails completely to describe the x and y slopes. A restricted D^* phase space region allows to compare the data from $5 < Q^2 < 1000$ GeV^2 - this includes the high Q^2 D^* data - to the massive NLO QCD predictions which describes the data nicely in slope and normalization.

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