INCLUSIVE D^* MESON AND ASSOCIATED DIJET PRODUCTION IN DEEP-INELASTIC SCATTERING *

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Inclusive production of $D^{*\pm}$ mesons in deep inelastic scattering is studied with the H1 detector at HERA using an integrated luminosity of $47.0\,\mathrm{pb}^{-1}$. Differential cross sections are compared to perturbative calculations in the framework of the DGLAP and CCFM evolution schemes. The additional requirement is then made that at least two jets exist in the event. Cross sections for the production of dijet events with $D^{*\pm}$ mesons are presented and compared to QCD model predictions. Models which provide a good description of inclusive $D^{*\pm}$ production are found to provide a poorer description of dijet production with $D^{*\pm}$ mesons.

1 Introduction

Open heavy flavour production in deep-inelastic ep collisions (DIS) is described by pQCD assuming the heavy quark mass provides the necessary hard scale. To leading order (LO), photon gluon fusion ($\gamma g \to Q\bar{Q}$) is the dominant production process. The experimental results on inclusive $D^{*\pm}$ meson production are compared with predictions of two different pQCD approaches: (1) a next-to-leading order (NLO) calculation [1] based on collinear factorisation in the DGLAP evolution scheme implemented in the HVQDIS [2] program and (2) a calculation based on k_t factorisation and parton evolution according to the CCFM equations [3] as implemented in the CASCADE [4] program. In both approaches charm is produced perturbatively only via photon gluon fusion. CCFM is expected to provide a better description of gluon evolution at very low values of x.

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2 Measurement of $D^{*\pm}$ meson production

The measurement is confined in the kinematic region $2 \leq Q^2 \leq 100\,\mathrm{GeV}^2$ and $0.05 \leq y \leq 0.7$. A $D^{*\pm}$ meson is required to be fully reconstructed in the visible range of the detector, $1.5 \leq p_{t,D^*} \leq 15$ GeV and $|\eta_{D^*}| \leq 1.5$, in the decay chain $D^{*+} \longrightarrow D^0\pi_s^+ \longrightarrow K^-\pi^+\pi_s^+$. The reconstruction efficiency is estimated using the RAPGAP Monte Carlo program [5].

In this kinematic range the inclusive $D^{*\pm}$ meson production cross section is found to be $\sigma_{vis}(e^+p \rightarrow e^+D^{*\pm}X) = 7.72 \pm 0.23\,(\mathrm{stat.})\ \pm 1.09\,(\mathrm{syst.})$ nb.

The predictions of HVQDIS using the CTEQ5F3 proton parton densities [6] range from 4.90 nb for $m_c = 1.5$ GeV and Peterson fragmentation parameter $\epsilon_c = 0.1$, to 6.62 nb for $m_c = 1.3$ GeV and $\epsilon_c = 0.035$. Calculations with CASCADE yield cross sections of 6.79 nb and 8.82 nb, respectively, which is in better agreement with the measured value.

The inclusive differential $D^{*\pm}$ cross sections as a function of the kinematic variables x and Q^2 and as a function of the $D^{*\pm}$ observables p_t, η are shown in Fig. 1 in comparison with expectations from HVQDIS and CASCADE. The shaded bands indicate the uncertainties in the predictions due to the variations of m_c and ϵ_c. Although the predicted visible cross section for HVQDIS is smaller than experimentally observed, it describes well the shapes of the differential cross sections with the exception of the η distribution where the prediction falls below the data in the region $\eta > 0$. The CASCADE predictions agree better with the data, particularly in the positive η region.

In Fig. 2 the cross section is compared with the expectations of the RAPGAP Monte Carlo, which lies slightly below the data, when only direct processes are taken into account. Considering the contribution of resolved processes does not improve the prediction.

3 Measurement of associated dijet production

In order to define the jet sample within the events containing a $D^{*\pm}$ meson candidate, the k_t-cluster algorithm [7] in its inclusive mode is used in the Breit frame. The transverse energies of the leading jets in the Breit frame are required to be $E_{t,\,\mathrm{jet}\,1} \geq 4\,\mathrm{GeV}$, $E_{t,\,\mathrm{jet}\,2} \geq 3\,\mathrm{GeV}$ and their pseudorapidities in the laboratory frame $-1 \leq \eta_{\mathrm{jets,\,lab}} \leq 2.5$. The inclusive cross section for dijet

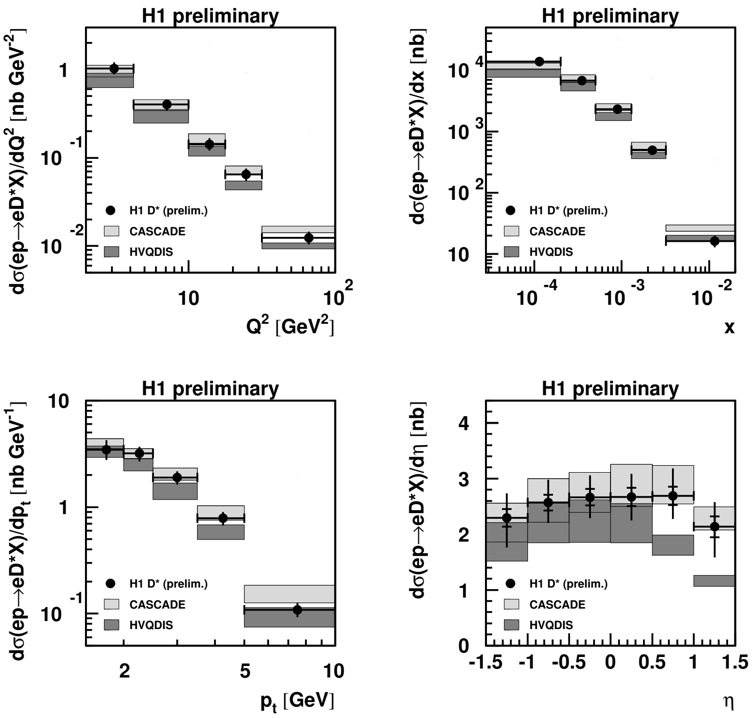

Figure 1: Differential $D^{*\pm}$ meson production cross sections versus Q^2, x, p_{tD^*}, η_{D^*} compared to calculations from the HVQDIS and CASCADE programs.

production associated with a $D^{*\pm}$ meson in this kinematic region is found to be $\sigma_{vis}(e^+p \rightarrow e^+D^{*\pm}\text{dijet } X) = 1.63 \pm 0.10\,(\text{stat.}) \pm 0.25\,(\text{syst.})$ nb.

In Fig. 2 the dijet production cross section associated with a $D^{*\pm}$ meson is presented as a function of Q^2, in Fig. 3 as a function of the maximum transverse jet energy $E_t^{\max} = E_{t,\text{ jet 1}}$ and the rapidity difference of the dijets, $\Delta\eta = |\eta_{\text{jet 1}} - \eta_{\text{jet 2}}|$, the latter two being measured in the Breit frame. The data are compared with the expectations from CASCADE and RAPGAP with $m_c = 1.4$ GeV and $\epsilon_c = 0.078$ for direct and the sum of direct and resolved processes. RAPGAP predictions for direct processes are below the measured cross sections particularly for small x (not shown here), large $E_t^{\max}$ and small $\Delta\eta$. RAPGAP with direct and resolved contributions is closer to the data,

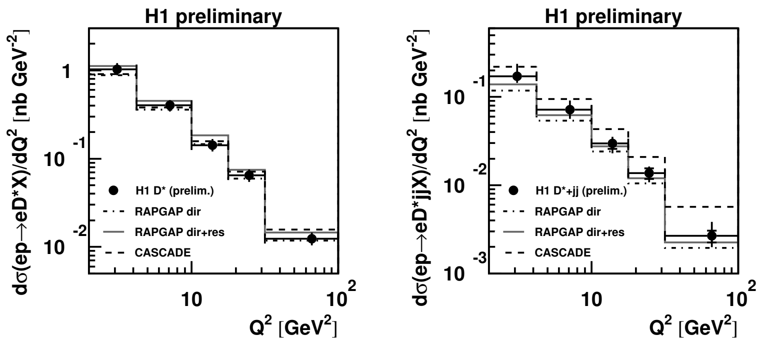

Figure 2: The cross section for $D^{*\pm}$ meson production (left) and for dijet production with an associated $D^{*\pm}$ meson (right) is shown as a function of Q^2. The data are compared with expectations from CASCADE and RAPGAP for direct processes and for the sum of direct and resolved processes.

while the expectation from CASCADE is above the measured cross section particularly for large Q^2.

4 Conclusions

New measurements of differential cross sections for inclusive $D^{*\pm}$ production in DIS are presented. The predictions of the CCFM based model, implemented in CASCADE, provide a better description of the data in the positive pseudo-rapidity region, than those based on the NLO DGLAP formalism.

Measurements of the differential cross sections for associated dijet and $D^{*\pm}$ meson production are presented and compared with the RAPGAP and CASCADE expectations. Even though the inclusive $D^{*\pm}$ meson production cross section is described reasonably well, the associated dijet cross section is found to be less well described by both models.

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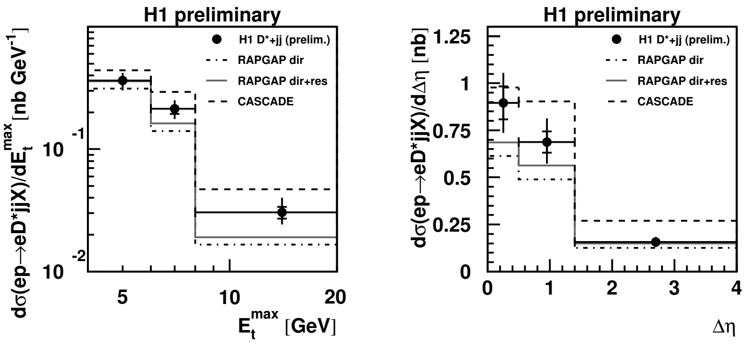

Figure 3: Differential dijet production cross section with associated $D^{*\pm}$ meson as a function of $E_t^{\max}$ and $\Delta\eta$. The data are compared with expectations from CASCADE and RAPGAP for direct processes and for the sum of direct and resolved processes.

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