

Measurements of charmed hadrons production in deep inelastic scattering with ZEUS

Roberval Walsh

On behalf of the ZEUS Collaboration

McGill University, Physics Department, 3600 University Street, Montreal, Quebec H3A 218

Abstract.

Charm production in deep inelastic scattering has been measured with the ZEUS detector at HERA using an integrated luminosity of approximately 82 pb^{-1} . Charm has been tagged by reconstructing $D^{*\pm}$, D^0 , D^\pm , D_s^\pm and Λ_c^\pm charm hadrons in the kinematic region $1.5 < Q^2 < 1000 \text{ GeV}^2$, $0.02 < y < 0.7$, $p_T(D, \Lambda_c) > 3 \text{ GeV}$ and $|\eta(D, \Lambda_c)| < 1.6$. The charm fragmentation ratios and fractions are measured in the kinematic range considered.

Keywords: Heavy flavour, charm fragmentation, ZEUS, HERA

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INTRODUCTION

This paper presents the measurements of charm production in DIS using D^0 , D^\pm , D_s^\pm and $D^{*\pm}$ mesons and Λ_c^\pm baryons. Measurements of the charm fragmentation ratios and fractions were performed in ep scattering at HERA in the DIS regime with $1.5 < Q^2 < 1000 \text{ GeV}^2$.

The data presented in this analysis were collected with the ZEUS detector at HERA. The data sample corresponds to an integrated luminosity of 82 pb^{-1} . A detailed description of the ZEUS detector can be found elsewhere [1].

EVENT SELECTION AND RECONSTRUCTION OF HADRONS

An event was selected if it satisfied the following criteria: a scattered electron was identified with energy $E'_e > 10 \text{ GeV}$; $y_e \leq 0.95$; $y_{\text{JB}} \geq 0.02$; $1.5 < Q_\Sigma^2 < 1000 \text{ GeV}^2$; $40 < E - p_z < 65 \text{ GeV}$; a reconstructed primary vertex with $|Z_{\text{vertex}}| < 50 \text{ cm}$ is required; the impact point (X, Y) for the scattered lepton in the RCAL must lie outside the region $26 \times 14 \text{ cm}^2$ centred on $X = Y = 0$. The selected kinematic region was $1.5 < Q^2 < 1000 \text{ GeV}^2$ and $0.02 < y < 0.7$.

The charm hadrons were reconstructed in the kinematic region $p_T(D, \Lambda_c) > 3.0 \text{ GeV}$ and $|\eta(D, \Lambda_c)| < 1.6$. Details of the reconstruction of the charm hadrons¹ can be found in [2]. Figure 1 shows the mass distributions of the charm hadrons.

¹ Additionally to the cuts in [2], a cut $p_T > 0.25 \text{ GeV}$ on the soft pion in the reconstruction of D^0 tag and additional D^* candidates is applied for a data subsample, for which the track reconstruction efficiency at low-momentum was smaller due to the operating conditions of the CTD [3].

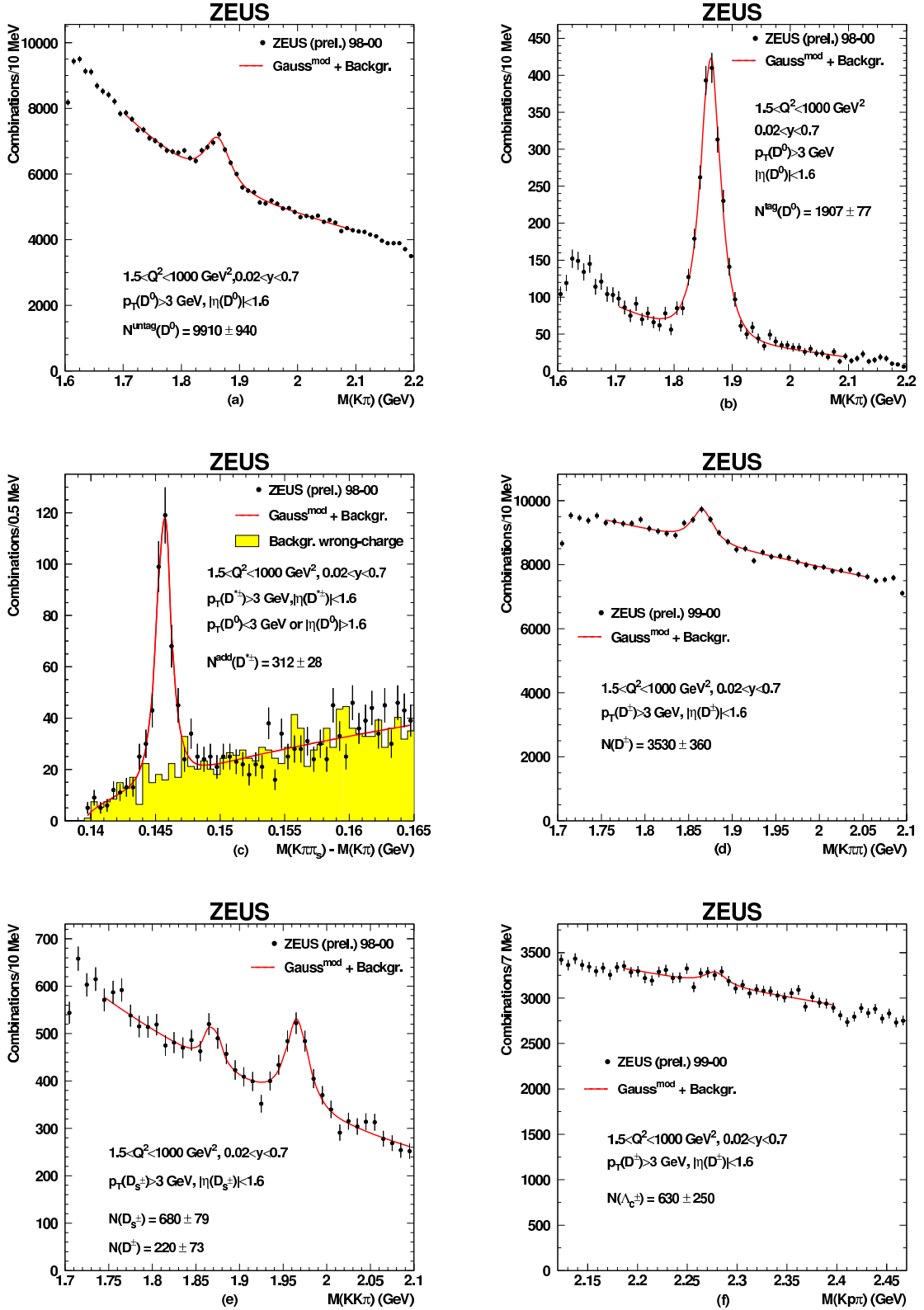


FIGURE 1. The mass distributions for the (a) untagged D^0 , (b) tagged D^0 , (c) additional $D^{*\pm}$, (d) D^\pm , (e) D_s and (f) Λ_c candidates. The solid curves represent fits to the sum modified Gaussian functions and a background functions.

CHARM FRAGMENTATION RATIOS AND FRACTIONS

The ratio of neutral and charged D meson production rates $R_{u/d}$ is the ratio of the sum of direct neutral mesons (D^{*0}, D^0) production cross sections to the sum of the charged mesons ($D^{*\pm}, D^\pm$) production cross sections. The measured ratio is

$$R_{u/d} = 1.46 \pm 0.17^{+0.10}_{-0.34}.$$

The measured ratio is consistent with one. The large systematic effect comes mainly from the signal extraction procedure which also affects the other measurements of ratios and fractions.

The strangeness suppression factor γ_s is the ratio of twice the cross sections for charmed meson containing a strange quark divided by the cross sections for those containing an up or down quark. The strangeness suppression factor obtained is

$$\gamma_s = 0.265 \pm 0.035^{+0.039}_{-0.048}.$$

The fraction of D mesons produced in a vector state is given by the ratio of vector charm-meson production cross sections to the sum of vector and direct pseudoscalar charm-meson production cross sections. The measured fractions for charged P_V^d and for charged and neutral P_V charm-mesons are, respectively,

$$P_V^d = 0.590 \pm 0.037^{+0.022}_{-0.018}, \quad P_V = 0.490 \pm 0.032^{+0.071}_{-0.019}.$$

It can be seen from the measured fractions P_V^d and P_V that naive spin counting, which predicts a value of 0.75, does not hold for charm production.

The fraction of c quarks hadronising into a particular charm hadron, $f(c \rightarrow D, \Lambda_c)$, is the ratio of the charmed-hadron production rate to the sum of the production rate of all charm ground states. The measured fragmentation fractions are shown in Table 1.

The measurements are compared with other values obtained at HERA [2, 4, 5] and with those from e^+e^- annihilations [6, 7, 8, 9] in Figure 2. All measurements agree within experimental uncertainties.

SUMMARY

The production of D^0, D^\pm, D_s^\pm and $D^{*\pm}$ charm mesons and Λ_c^\pm charm baryons has been measured in DIS at HERA in the kinematic region $1.5 < Q^2 < 1000 \text{ GeV}^2$, $0.02 < y < 0.7$, $p_T(D, \Lambda_c^\pm) > 3.0 \text{ GeV}$ and $|\eta(D, \Lambda_c^\pm)| < 1.6$ with the ZEUS detector.

TABLE 1. Fractions of c quarks hadronising as a particular charm hadron.

	ZEUS prel. (DIS)		ZEUS prel. (DIS)
$f(c \rightarrow D^0)$	$0.584 \pm 0.039^{+0.024}_{-0.050}$	$f(c \rightarrow D^{*\pm})$	$0.190 \pm 0.014^{+0.023}_{-0.009}$
$f(c \rightarrow D^\pm)$	$0.194 \pm 0.020^{+0.023}_{-0.011}$	$f(c \rightarrow D_s^\pm)$	$0.103 \pm 0.013^{+0.012}_{-0.017}$
$f(c \rightarrow \Lambda_c^\pm)$	$0.104 \pm 0.048^{+0.018}_{-0.010}$		

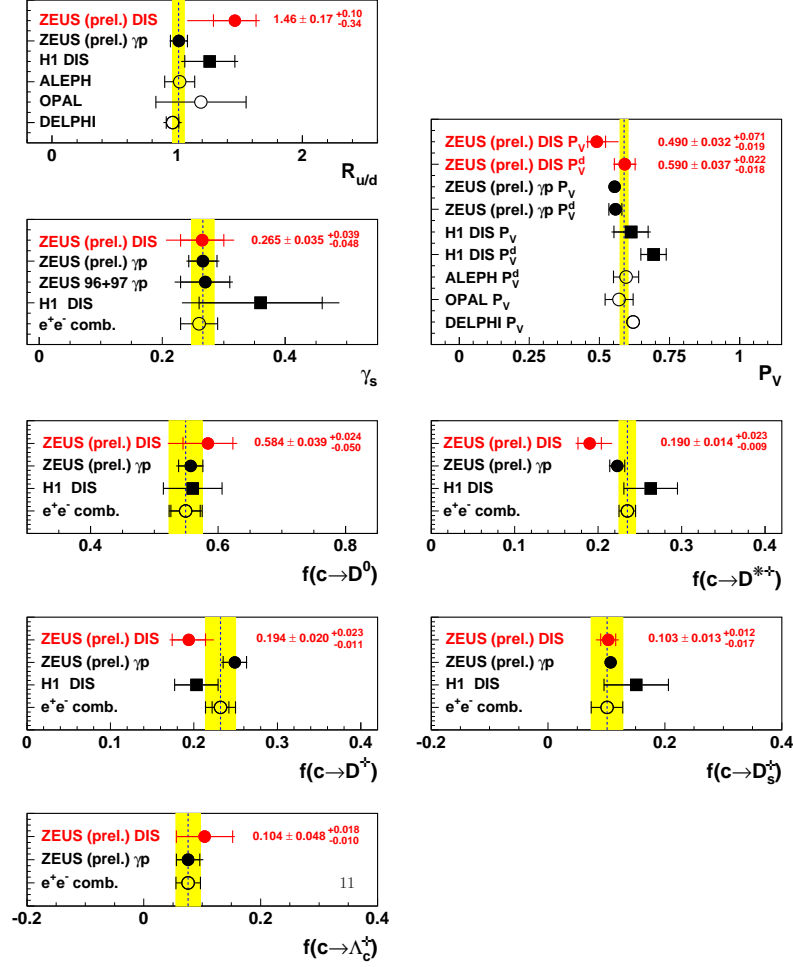


FIGURE 2. Comparison of the charm fragmentation ratios and fractions measurements with those obtained in other experiments.

Charm fragmentation ratios and fractions were determined in the above kinematic range. All fragmentation ratios and fractions agree with those obtained in charm production at HERA and in e^+e^- annihilations, confirming the universality of charm fragmentation.

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