Charm production in DIS and diffraction

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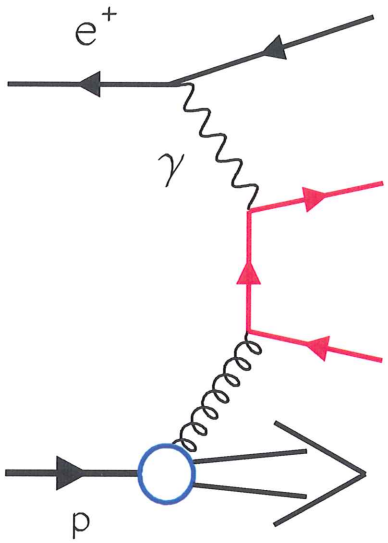
representing H1 and ZEUS

- Introduction
- charm production in DIS
  - $D^{*\pm}$ in e^+p, double differential (H1)
  - $D^{*\pm}$ in e^+p,e^-p (Zeus)
  - semileptonic charm (Zeus)
  - $F_2^c(x, Q^2)$
- $D^{*\pm}$ in diffraction
  - photoproduction
  - DIS
- summary

charm production in ep scattering

dominant at HERA: Boson Gluon Fusion



LO:

- $Q^2 = -q^2$
  Momentum transfer
  DIS: $Q^2 > 1GeV^2$
- $x_B = \frac{Q^2}{2P \cdot q}$
  Bjorken scaling variable
- $y = \frac{P \cdot q}{P \cdot k}$
  inelasticity

q=p(e')-p(e), P=p(p)

BGF probes directly the gluon content of the proton (or IP).

approaches in pQCD:

- NLO + DGLAP
- LO + CCFM

predictions depend on

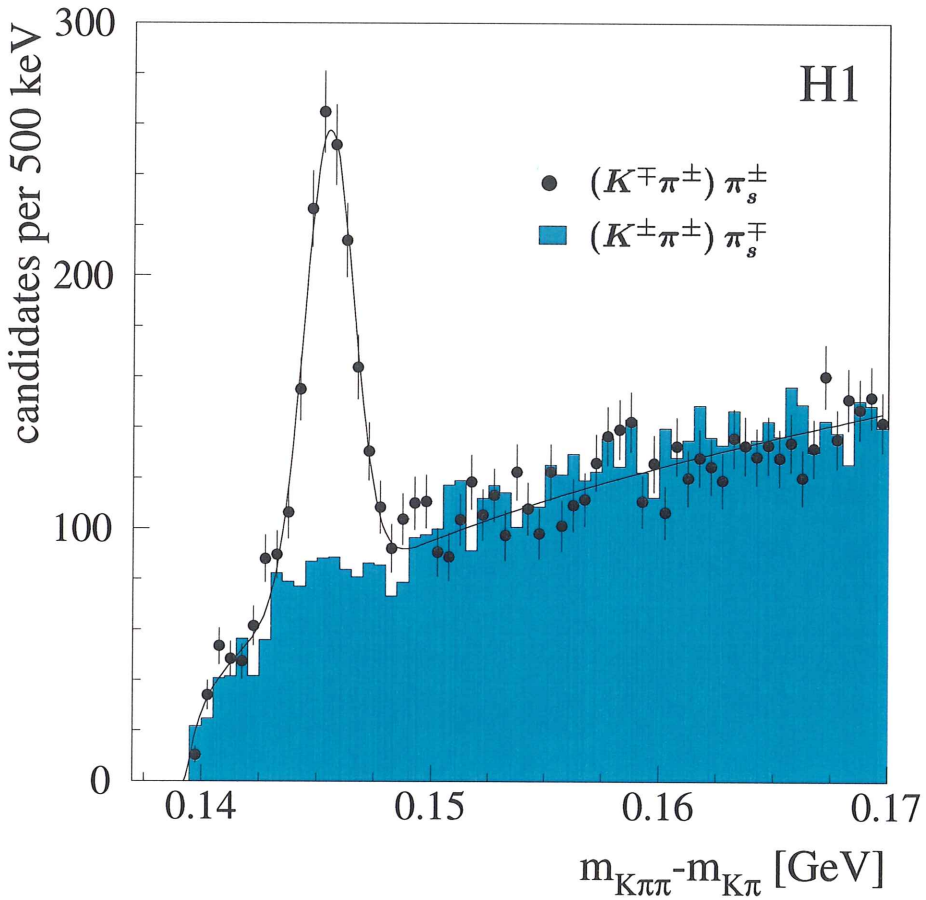
- structure functions
- value of the charm quark mass m_c
- hadronization

charm tagging I

Work horse:

$D^{*+} \to D^0 \pi_s^+ \qquad \mathcal{B} = 67.7\%$

$\hookrightarrow K^- \pi^+ \pi_s^+ \qquad \mathcal{B} = 3.38\%$



$$\left|M(K^-\pi^+) - M(D^0)\right| < 70\text{MeV}$$

$$N = 973 \pm 40$$

- $f(c \to D^{*+}) = 0.233 \pm 0.010 \pm 0.011$ (Aleph)
  (changed by 16% wrt previous H1 publication)

$D^{*\pm}$ in DIS: total cross section

H1 1996 – 1997 e^+p, $\mathcal{L} = 18.6\text{pb}^{-1}$ (hep-ex/0108039, subm. to Phys. Lett. B)

Kinematic region

$$1 < Q^2 < 100\text{GeV}^2 \quad \text{(new backward ECAL)}$$
$$0.05 < y < 0.7$$
$$E(e') > 8\text{GeV}$$

visible: $p_t(D^*) > 1.5\text{GeV}$ and $|\eta(D^*)| < 1.5$

$$\sigma_{vis}(e^+p \to e^+D^{*\pm}X) =$$
$$8.50 \pm 0.42(\text{stat.})^{+1.02}_{-0.76}(\text{syst.}) \pm 0.65(\text{mod.})nb$$

syst.: tracking efficiency, signal extraction

QCD

NLO DGLAP	$5.17nb$	–	$7.02nb$	HVQDIS, GRV98
CCFM	$8.04nb$	–	$10.77nb$	CASCADE, H1 Fit

Ranges: (m_c, ϵ_c)=(1.3GeV , 0.100)–(1.5GeV , 0.035)

good agreement with published Zeus result.

(Eur. Phys. J. C12, 35-52(2000)).

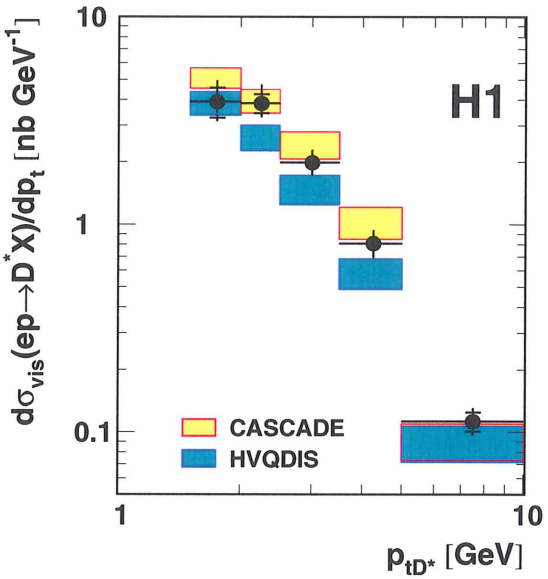
similar kinematic region:

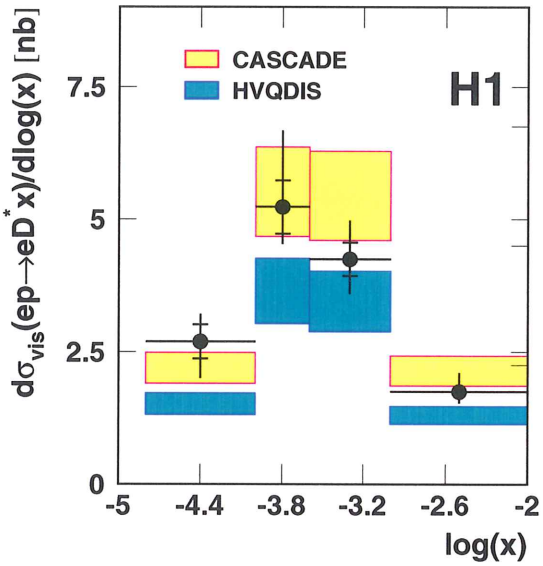
$$1 < Q^2 < 600\text{GeV}^2$$
$$0.02 < y < 0.7$$

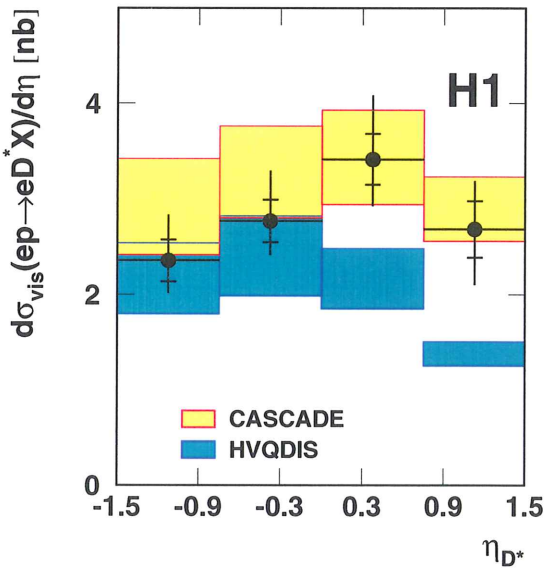
visible: $1.5\text{GeV} < \text{p}_\text{t}(\text{D}^*) < 15\text{GeV}$ and $|\eta(D^*)| < 1.5$

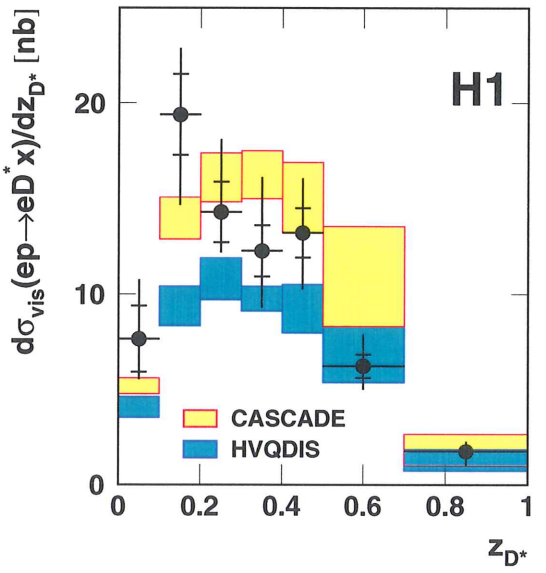
$$\sigma_{vis}(e^+p \to e^+D^{*\pm}X) = 8.31 \pm 0.31(\text{stat.})^{+0.30}_{-0.50}(\text{syst})nb$$

$D^{*\pm}$ in DIS: differential cross section



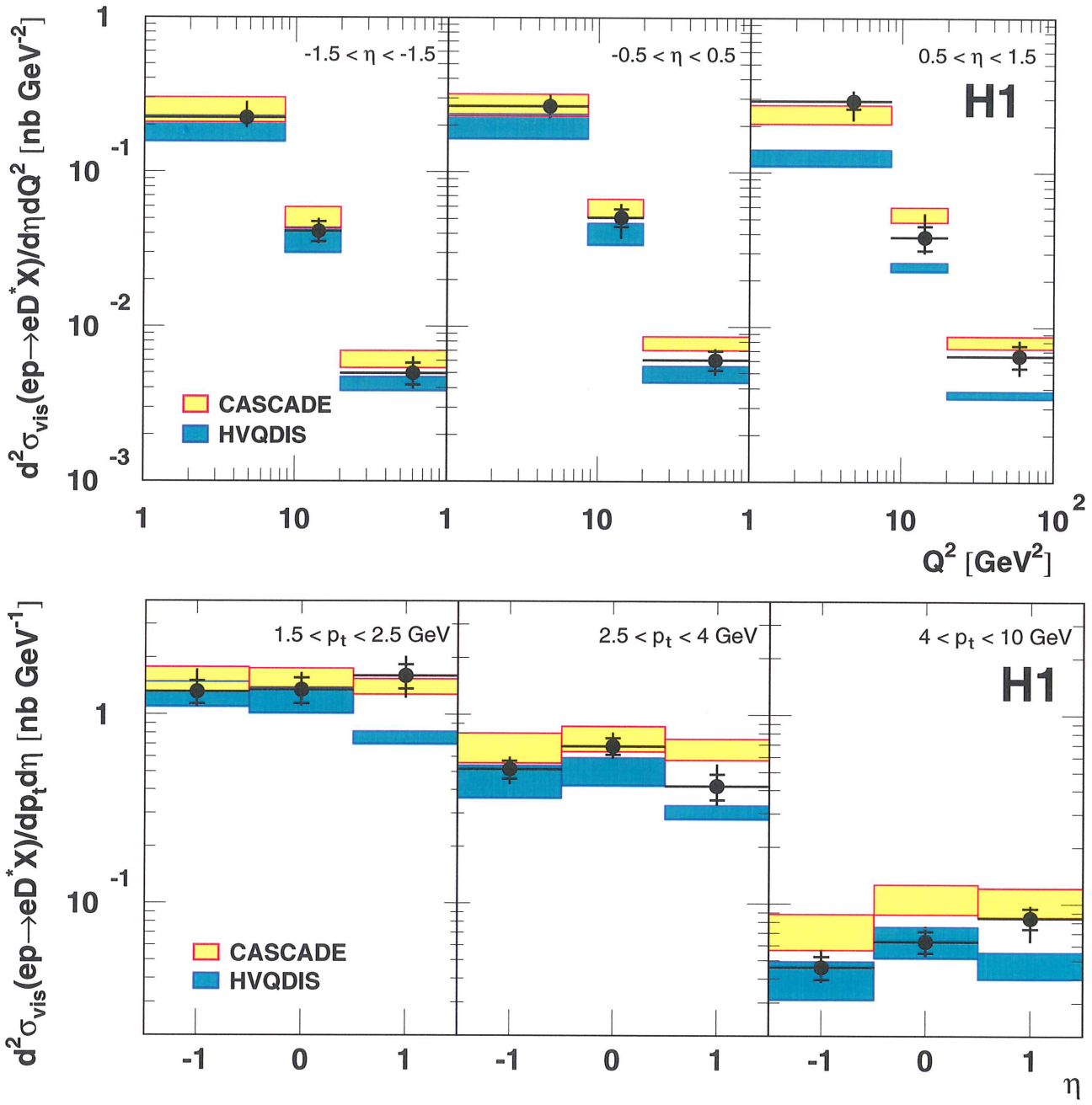






- HVQDIS = NLO+DGLAP, CASCADE = LO+CCFM
- bands: $(m_c, \epsilon_c) = (1.3\text{GeV}\ , 0.035) \to (1.5\text{GeV}\ , 0.100)$
- shapes in $pt(D^*), Q^2, x$ well described

double differential cross sections



- $\eta > 0$ deviation not confined to a certain Q^2 region (no breakdown of "massive" approach for high Q^2)
- most prominent at very low transverse momenta

$D^{*\pm}$ in e^+p and e^-p

- 1998: Hera beam energy 820GeV $\rightarrow$ 920GeV
  expected cross section increase 5% (HVQDIS).
- 1998-1999: e^-p running ($\mathcal{L}_{\rm Zeus} = 16.7{\rm pb}^{-1}$)
- 1999-2000: e^+p running ($\mathcal{L}_{\rm Zeus} = 65.2{\rm pb}^{-1}$)

larger Q^2 range

$$1 < Q^2 < 1000{\rm GeV}^2$$
$$0.02 < y < 0.8$$

Zeus preliminary:

$$\sigma_{vis}(e^-p \rightarrow e^+D^{*\pm}X) = 10.20 \pm 0.48({\rm stat.})^{+0.34}_{-0.54}({\rm syst})n{\rm b}$$
$$\sigma_{vis}(e^+p \rightarrow e^+D^{*\pm}X) = 8.94 \pm 0.24({\rm stat.})^{+0.27}_{-0.51}({\rm syst})n{\rm b}$$

- no lepton charge dependence expected from BGF

- no systematic effect identified

  – rates of random background 1.01 ± 0.05

  – no difference observed in photoproduction