The Charm Contribution to the Structure Function of the Proton

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for the H1 and ZEUS collaborations

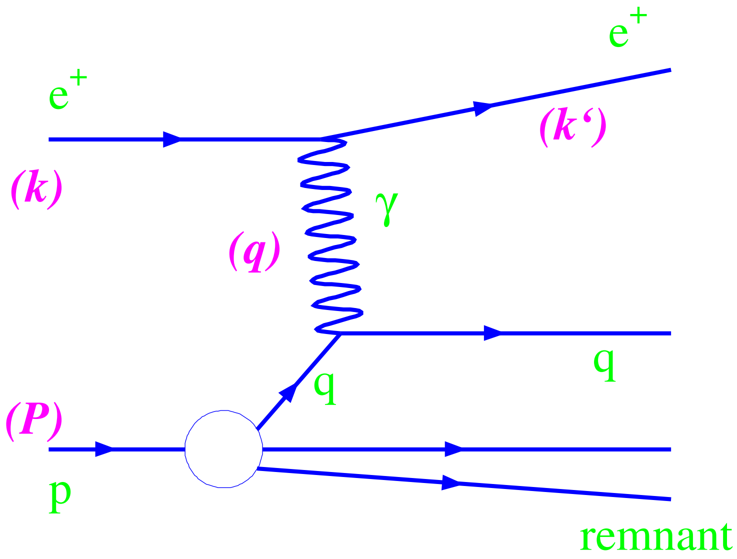
Outline of the Presentation

- **Introduction**
- **D^* cross sections**
- **F_2^c**
- **Summary**

abstracts: 853, 858, 983

Kinematics of Deep Inelastic Scattering

$27.5\ GeV\ e^{\pm} \longrightarrow \sqrt{s} = 300 GeV \longleftarrow p\ 820\ GeV$



$Q^2 = -q^2 = -(k - k')^2$ 4-momentum transfer^2

$x = Q^2/2P \cdot q$ fraction of p momentum carried by the struck quark

$y = (p \cdot q)/(p \cdot k)$ relative energy transfer in the p rest frame

$W^2 = (q + P)^2$ mass ^{2} of the hadronic final state

$$Q^2 = sxy$$

$$\eta = -ln(tan\frac{\theta}{2})$$

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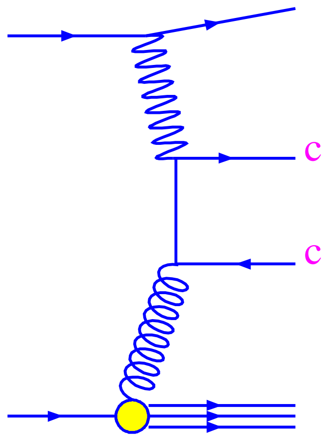
Charm Production



- charm production dominated by the Boson Gluon Fusion mechanism
- sensitive to the gluon density

Hard scale allows validity of pQCD calculations

Various calculation schemes based on

- the DGLAP evolution

  (Fixed Flavour Number Scheme (FFNS) massive and massless approach, Variable Flavour Number Scheme (VFNS))

- the CCFM evolution

  (Ciafaloni, Catani, Fiorani and Marchesini)

Test of universality of the gluon distribution

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Charm Tagging in DIS

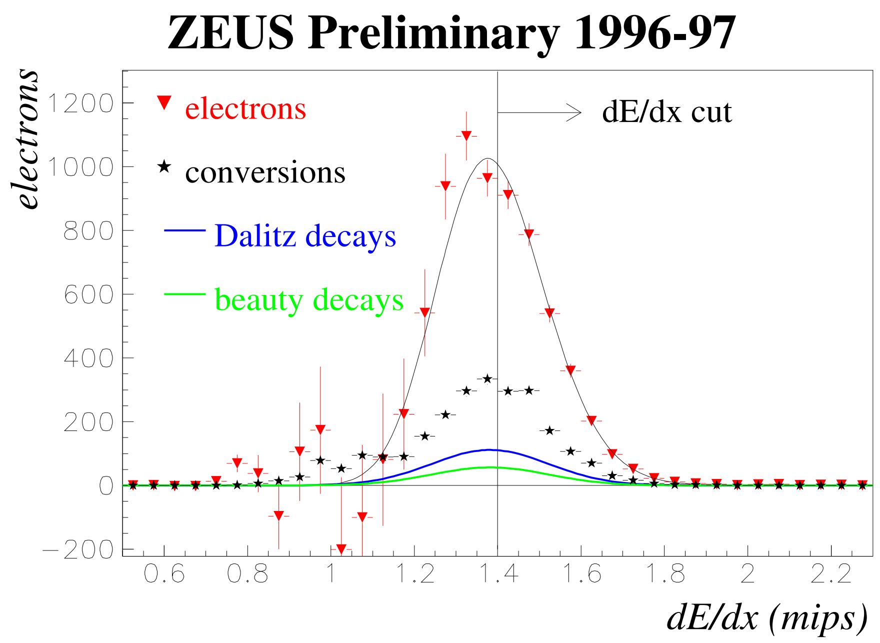
- D^{*+} mesons

$D^{*+} \rightarrow D^0 \pi^+$

$\quad \hookrightarrow K^- \pi^+$ — H1 and ZEUS

$\quad \hookrightarrow K^- \pi^+ \pi^+ \pi^-$ — ZEUS

- semileptonic decays of charm into electrons — ZEUS



definition of "visible" range in terms of

$p_t(D^{*+}, e)$ and $\eta(D^{*+}, e)$

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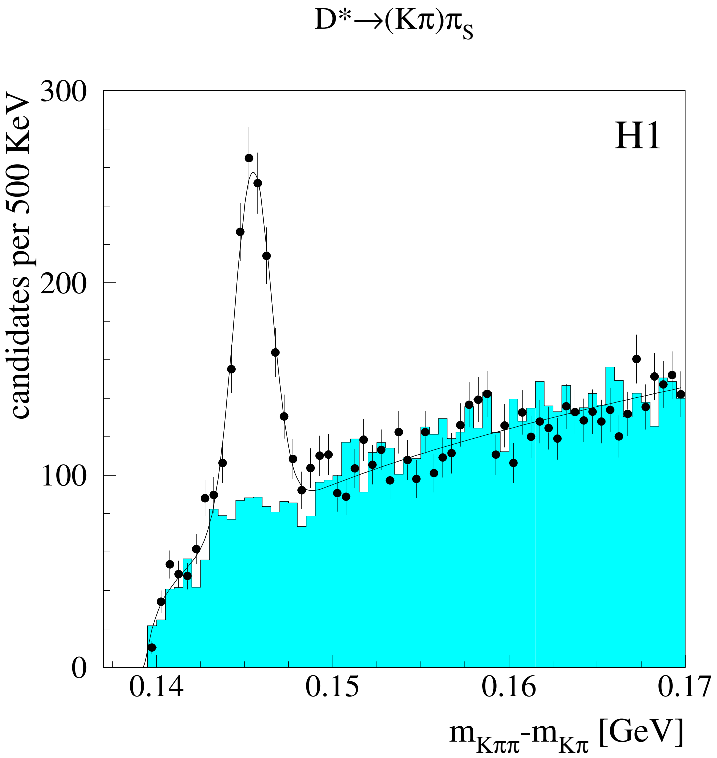
Inclusive D^* Cross Sections



kinematic region

$$1 < Q^2 < 100 \; GeV^2$$

$$0.05 < y < 0.7$$

$$p_{T\ D^*} > 1.5 \; GeV/c$$

$$|\eta_{D^*}| < 1.5$$

H1

$$\sigma(e^+p \to e^+D^{*\pm}X) = 8.37 \pm 0.41(stat.)^{+1.11}_{-0.82}(syst.)^{+0.64}_{-0.39}(theo.) \; nb$$

ZEUS

$$1 < Q^2 < 600 \; GeV^2, \quad 0.02 < y < 0.7$$

$$1.5 < p_{T\ D^*} < 15. \; GeV/c, \quad |\eta_{D^*}| < 1.5$$

$$\sigma(e^+p \to e^+D^{*\pm}X) = 8.31 \pm 0.31(stat.)^{+0.3}_{-0.5}(syst.) \; nb$$

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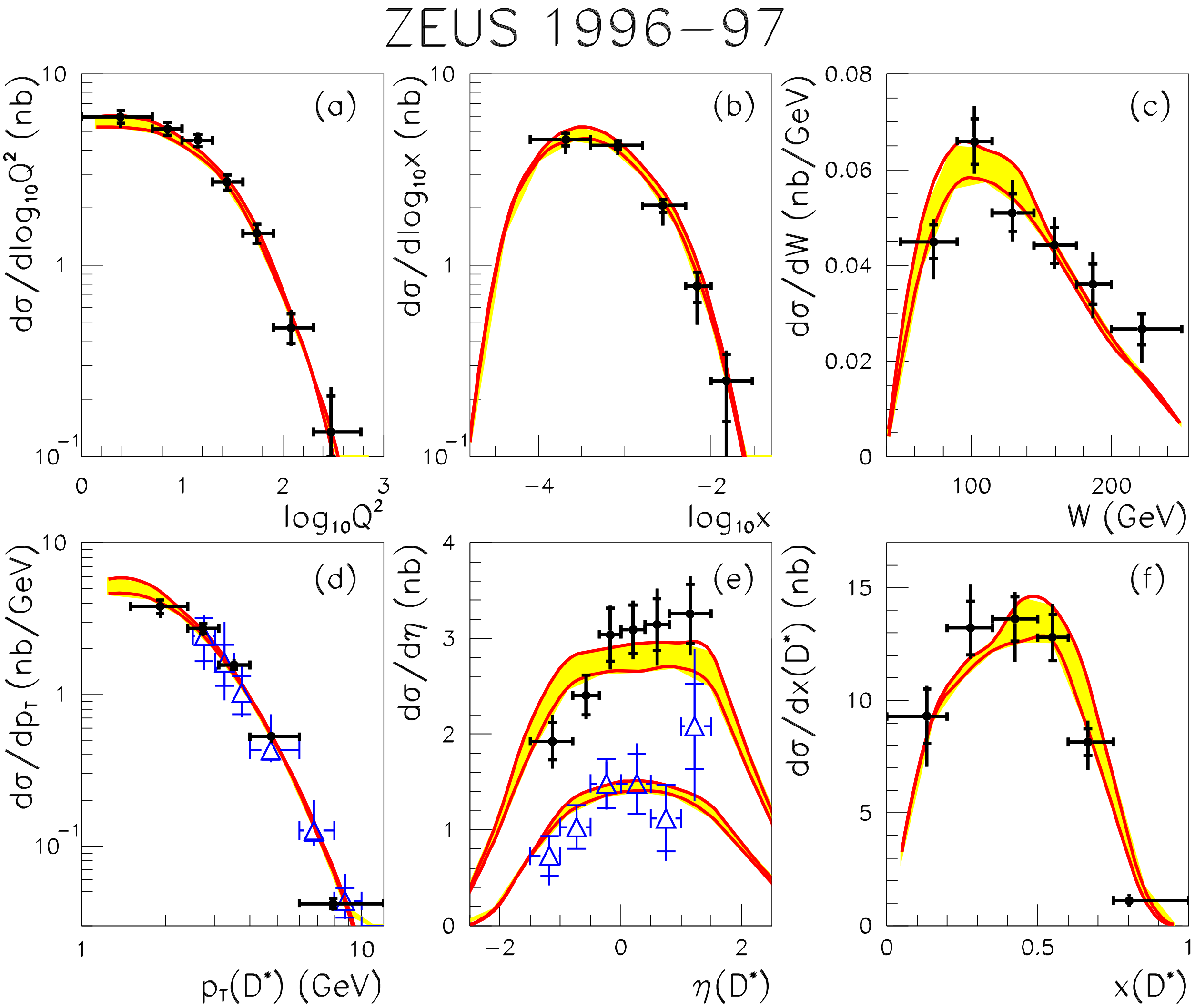
Differential Cross Sections

ZEUS Data compared with HVQDIS



$$x_{D^*} = \left(\frac{2|\vec{p}^{\,*}_{D^*}|}{W}\right)$$

HVQDIS predictions for m_c 1.3 - 1.5GeV , using the ZEUS 1994 PDF
$p_t(c \to D^*)$, drag effect correction

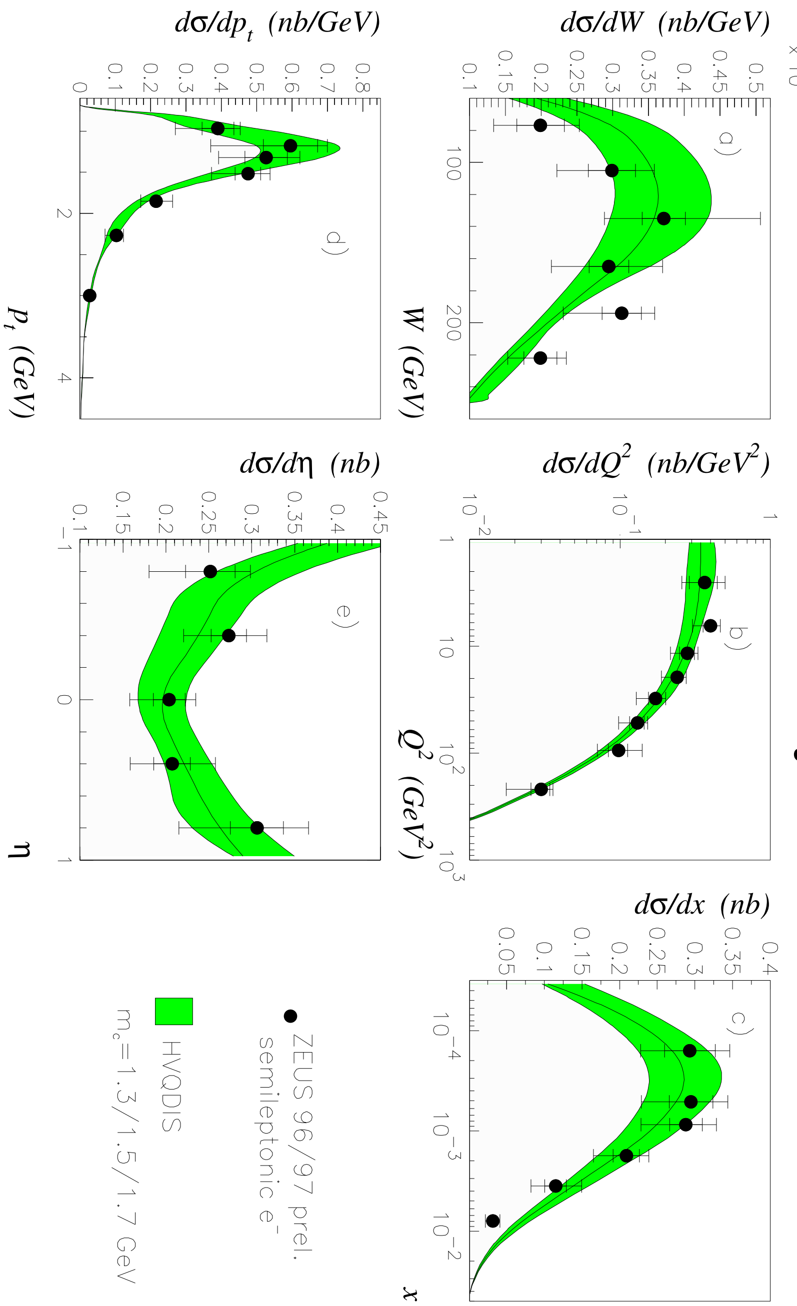
Differential Cross Sections

$c \to e\nu X$

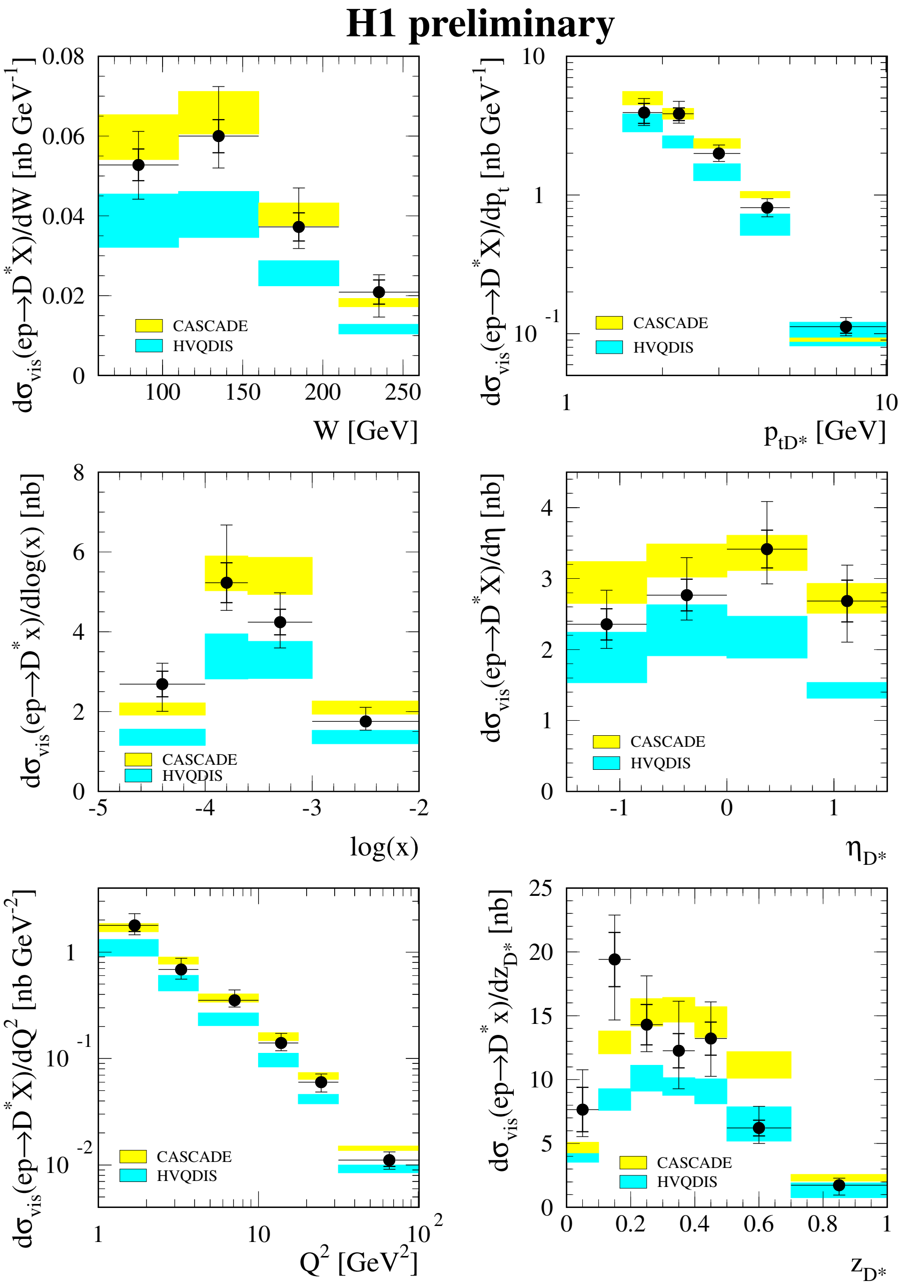
$1 < Q^2 < 1000\ GeV^2, \quad 0.03 < y < 0.7$

$1.2 < p_e < 5.0\ GeV, \quad 0.65 < \theta_e < 2.5\ rad$

ZEUS Preliminary 1996-97



Differential Cross Sections



HVQDIS and CASCADE

GRV98HO, $m_c 1.3 - 1.5$GeV

$p_t(c \to D^*)$, ϵ $0.035 - 0.1$

gluon from F_2 fit, $m_c 1.3 - 1.5$GeV

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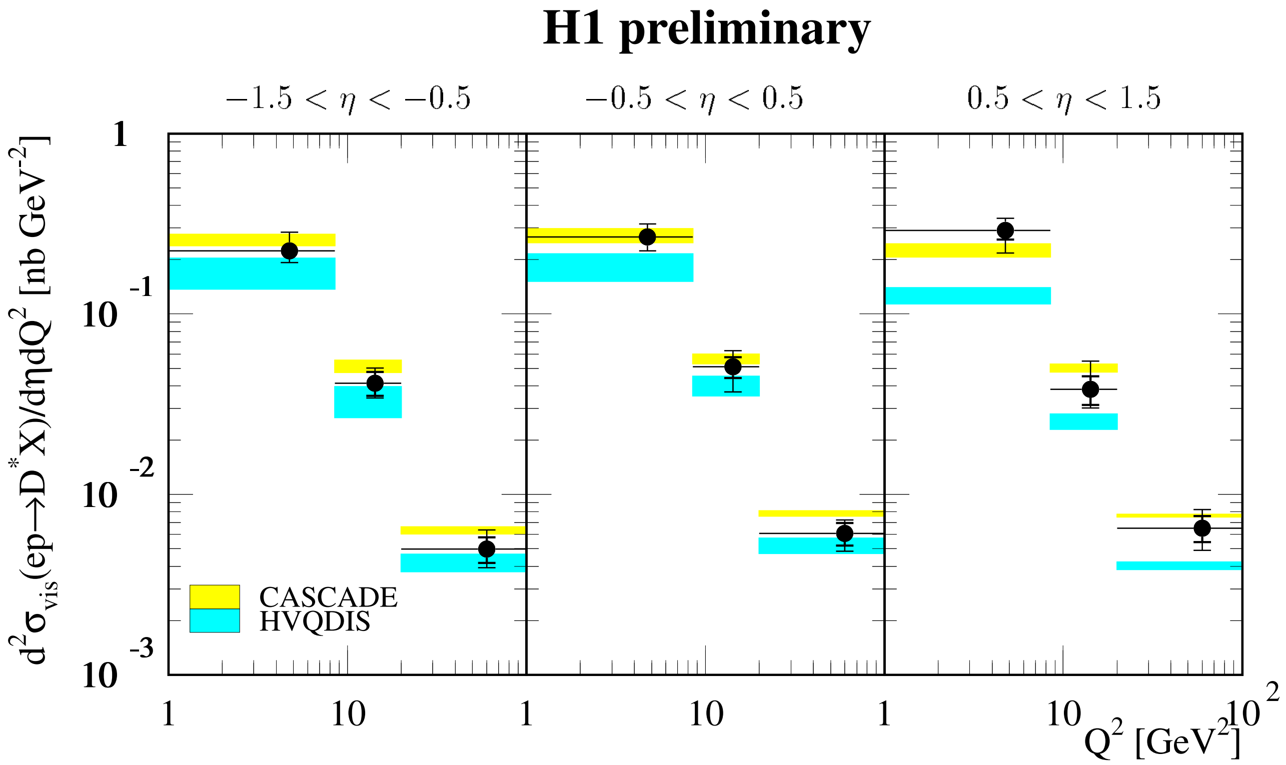
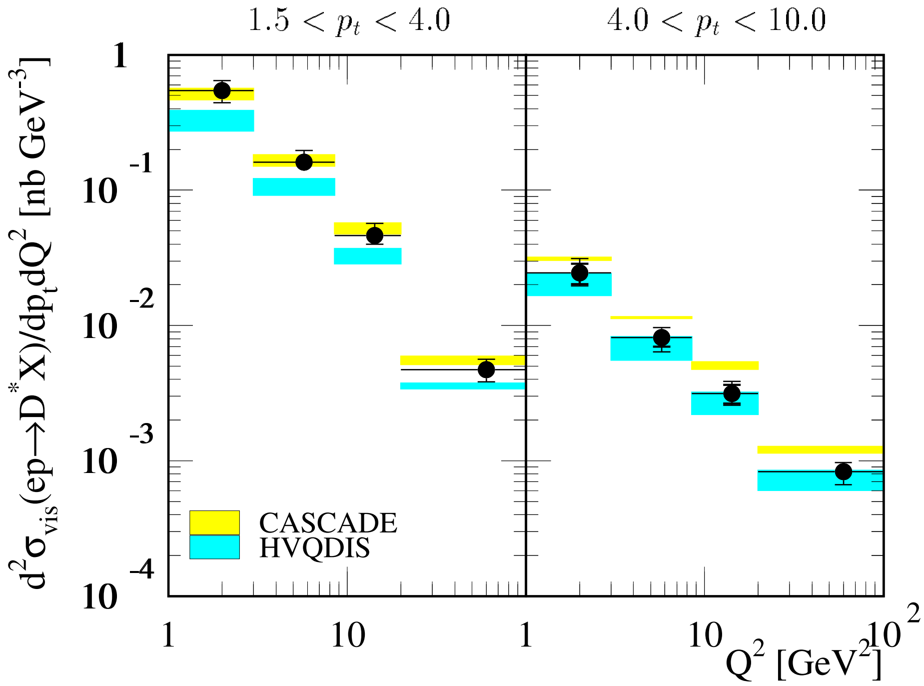
Double Differential Cross Sections





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Extraction of $F_2^c(x, Q^2)$

The $c\bar{c}$ production cross section described by $F_2^{c\bar{c}}(x, Q^2)$

$$\frac{d^2\sigma^{c\bar{c}}}{dxdQ^2} = \frac{2\pi\alpha^2}{xQ^4}(1 + (1-y)^2) \cdot F_2^{c\bar{c}}(x, Q^2)$$

assumptions $\quad F_L^c \sim 0$

extrapolate outside the "visible" region in p_T and η

$$F_2^{c\ \ meas}(x, Q^2) = \sigma_{vis}^{meas}(x, Q^2) \cdot \frac{F_2^{c\ \ theo}(x,Q^2)}{\sigma_{vis}^{theo}(x,Q^2)}$$

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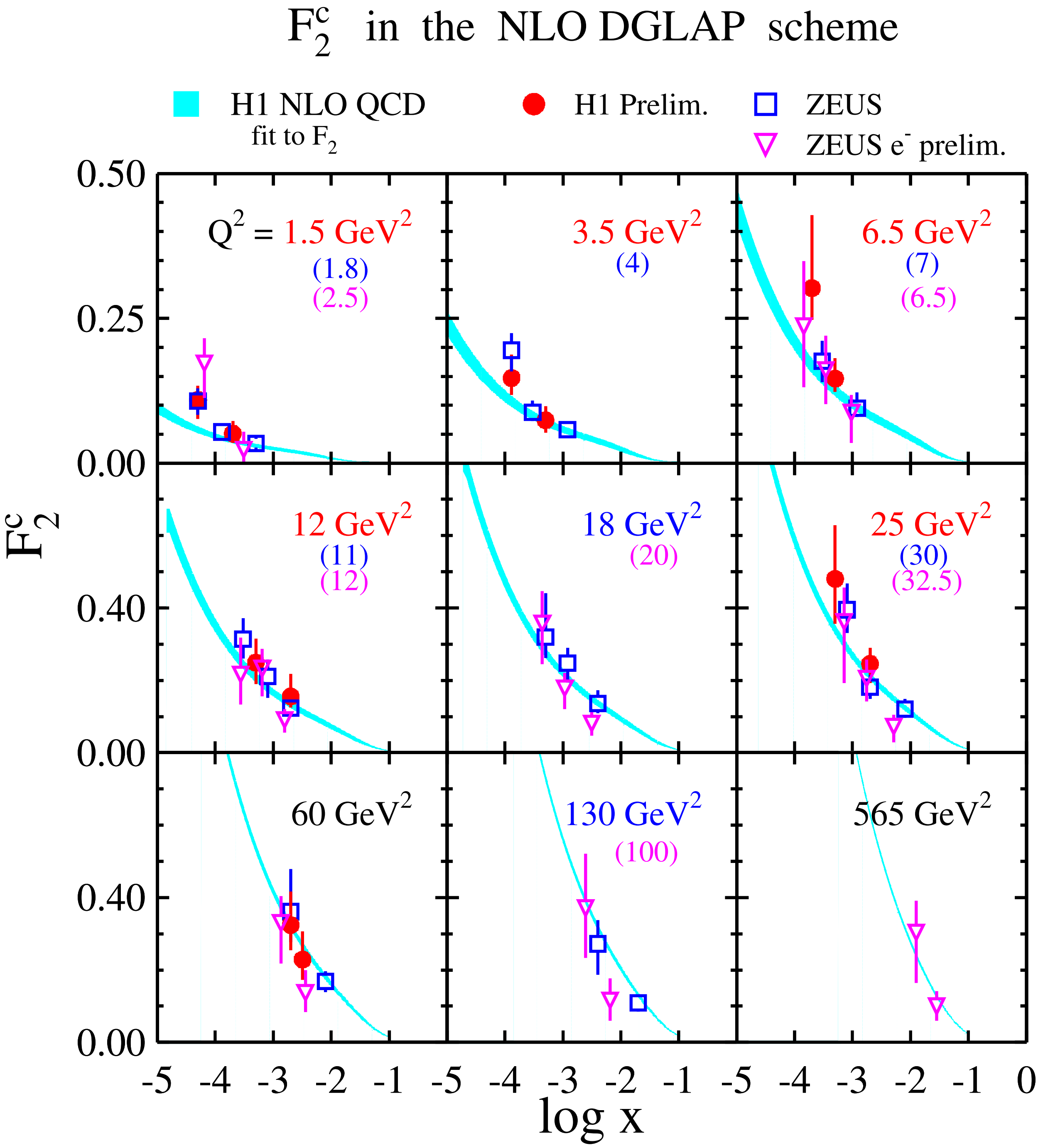
$F_2^c(x, Q^2)$



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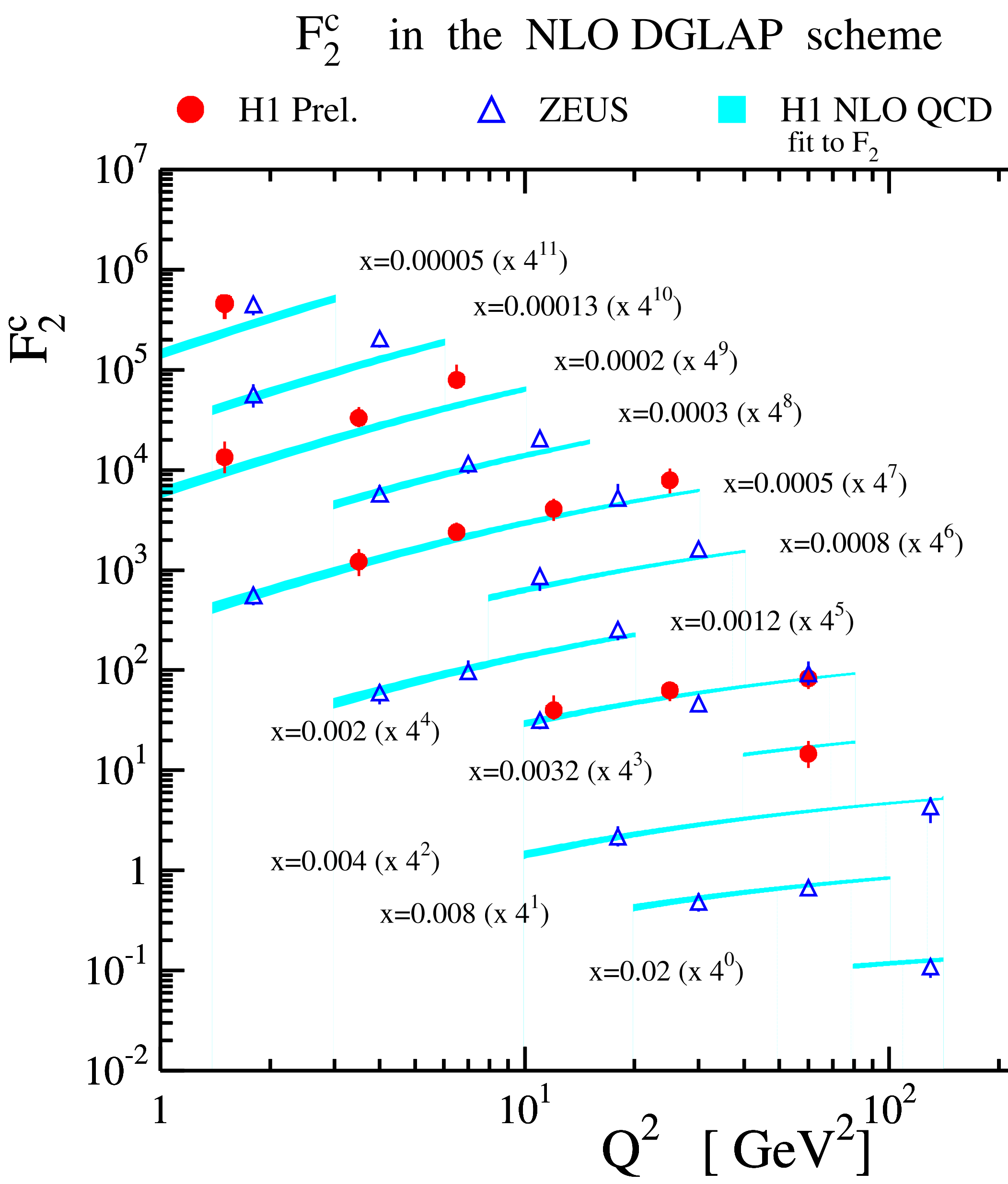
$F_2^c(x, Q^2)$



- Strong Scaling violations

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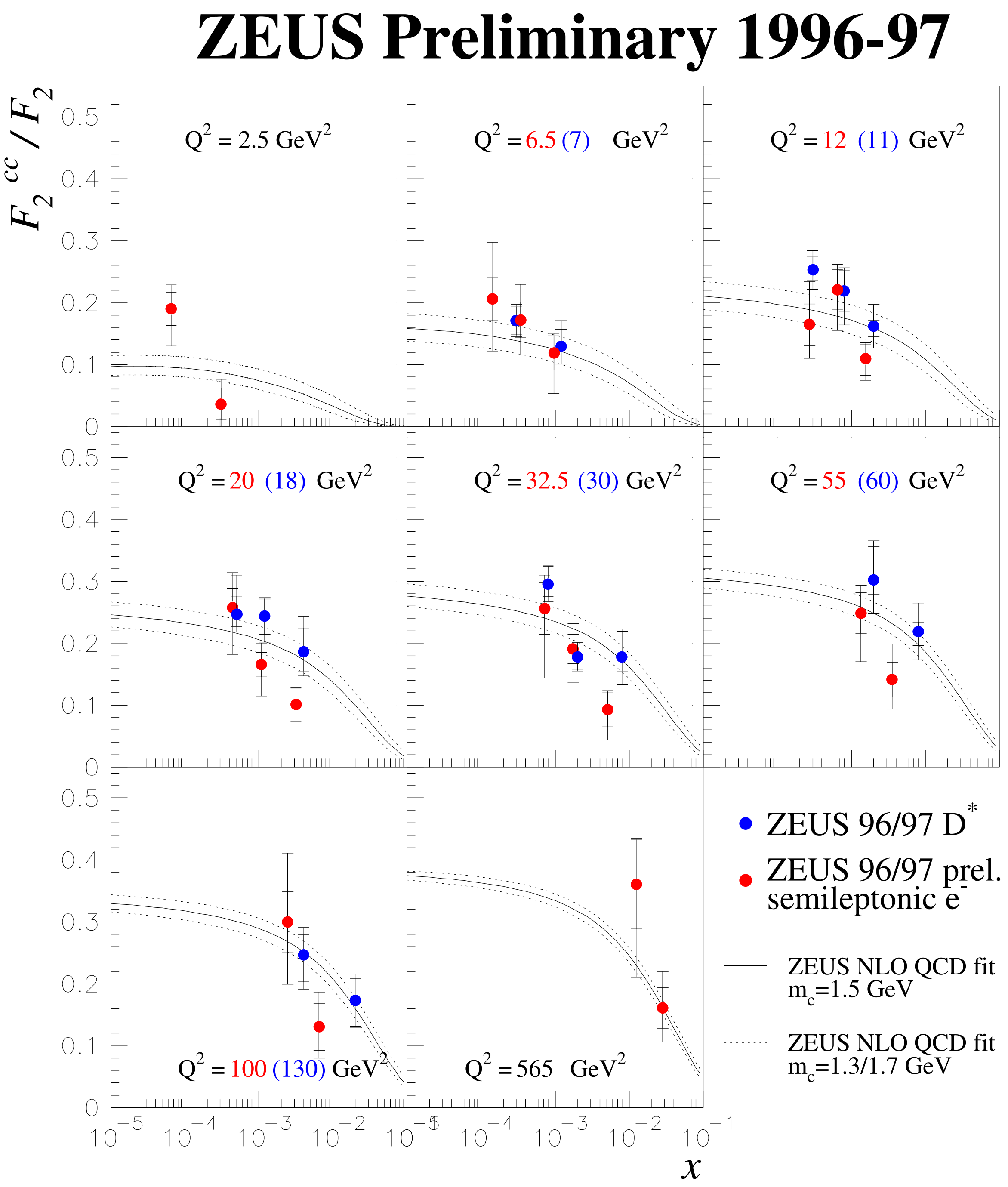
$F_2^c(x,Q^2)/F_2(x,Q^2)$



- Ratio $F_2^{c\bar{c}}/F_2$ is large $\sim 25-30\%$

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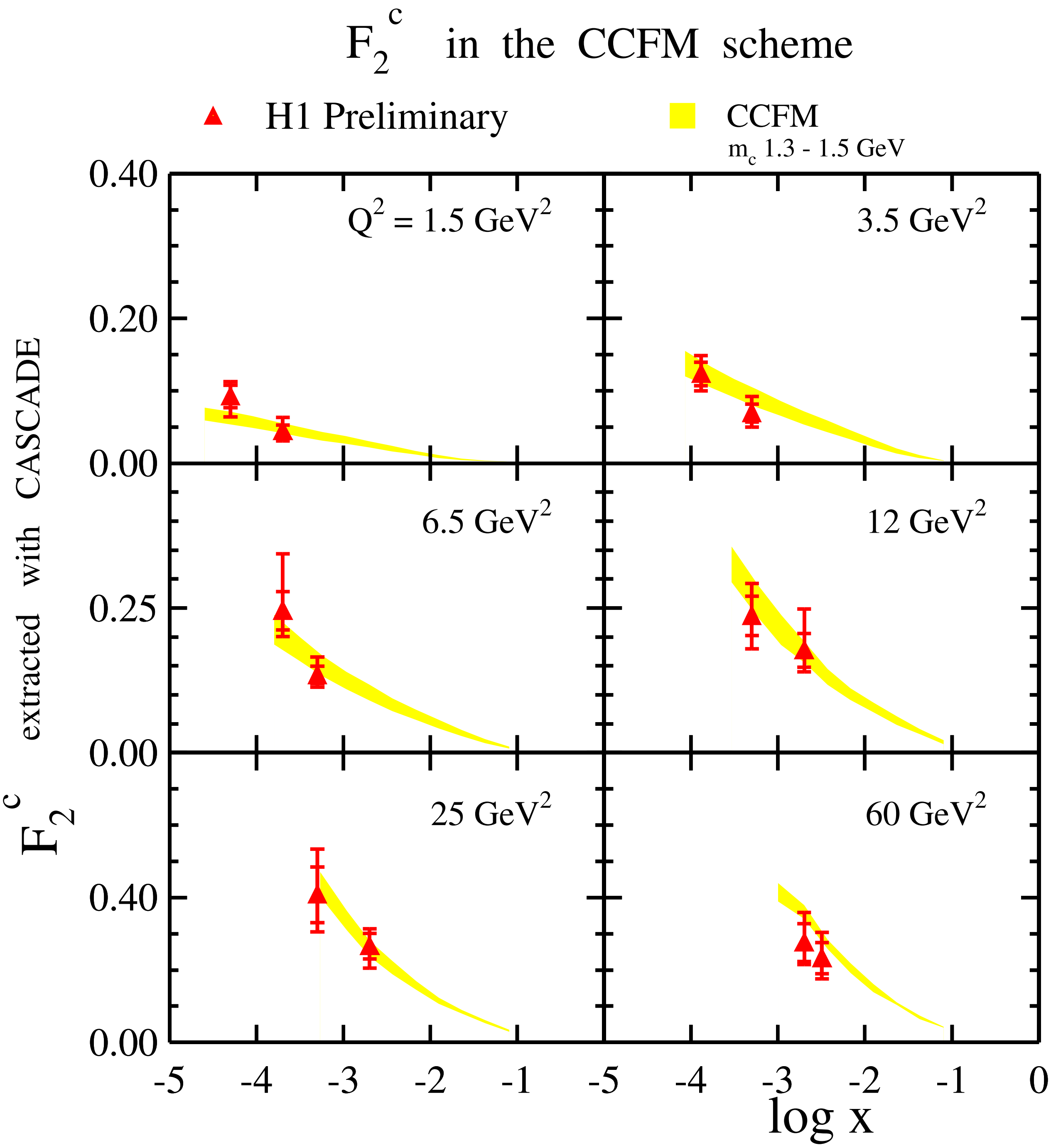
$F_2^c(x, Q^2)$



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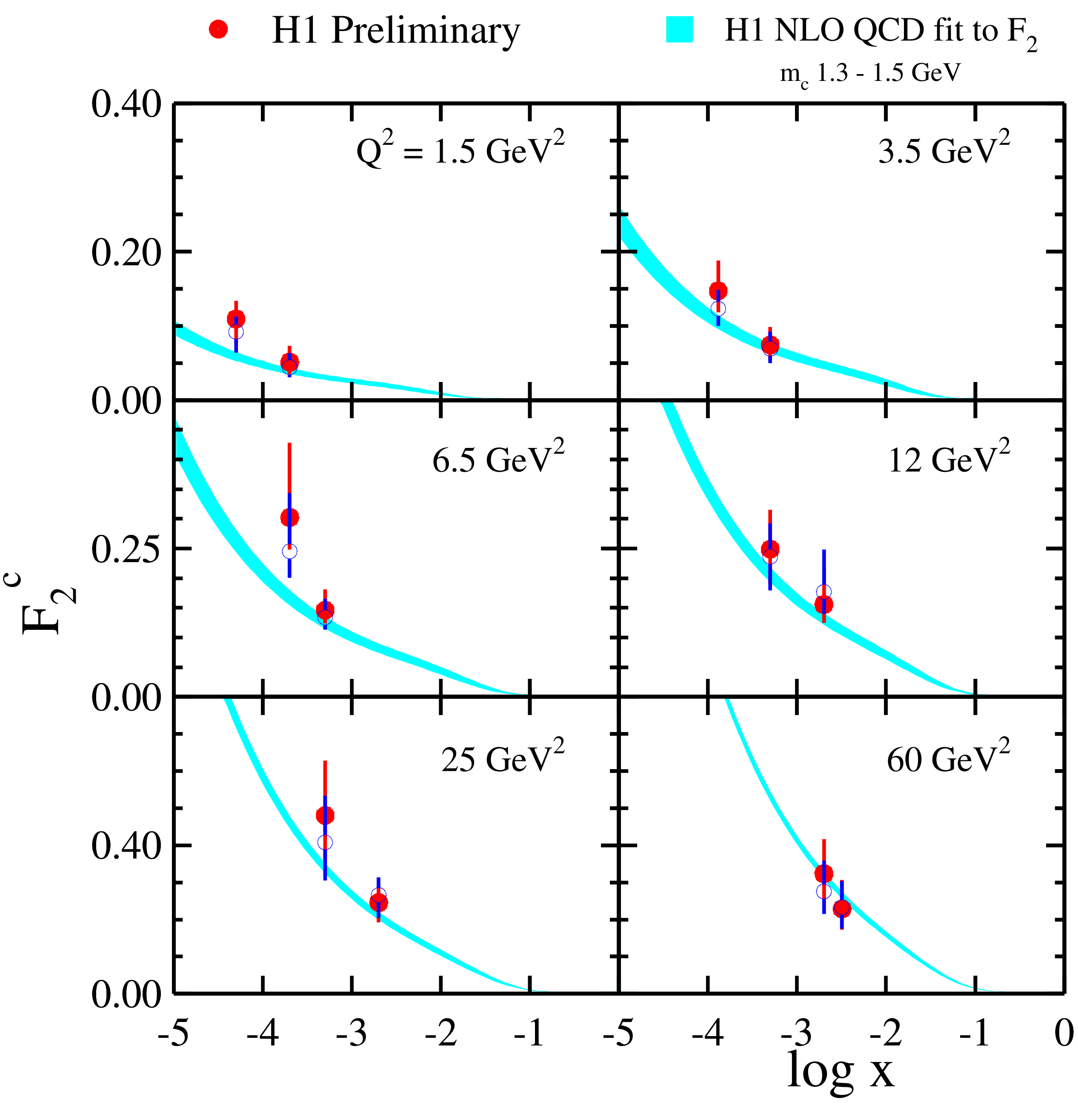
$F_2^c(x, Q^2)$



F_2^c extracted with HVQDIS

F_2^c extracted with CASCADE

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Conclusions

- D^* production cross sections
  - measured with improved precision
  - also double differentially
  - compared to NLO calculations

- F_2^{charm}
  - strong rise to lower x for increasing Q^2
  - large scaling violations
  - F_2^{charm}/F_2 reaches $\sim 30\%$
    at low x and high Q^2

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