DIS charm cross sections through D* and D meson tagging by the ZEUS detector

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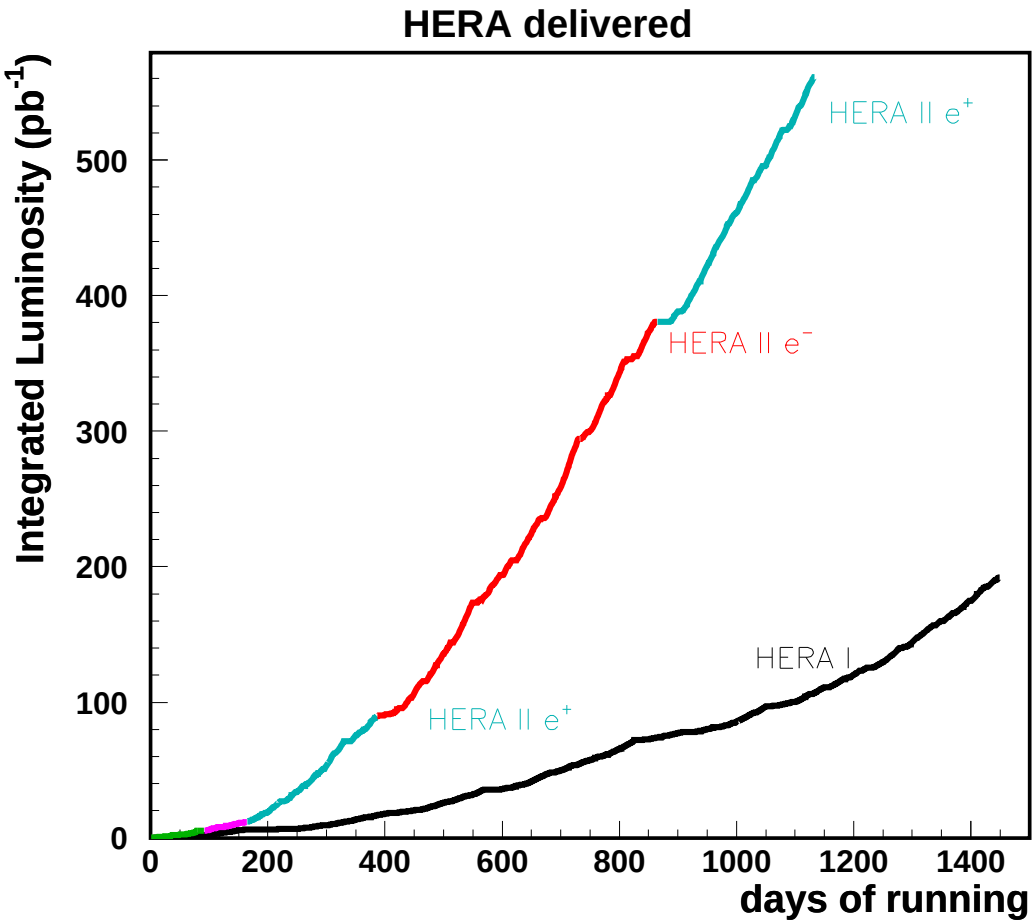
ZEUS in HERA II

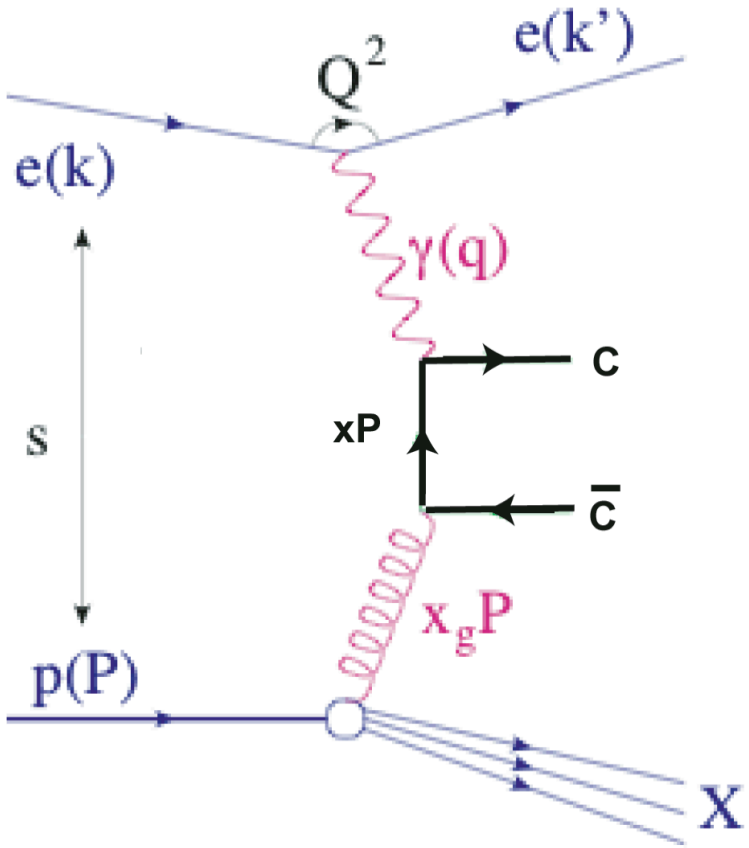
- HERA II luminosity upgrade
  - p 920 GeV
  - $e^{\pm}$ 27.6 GeV
  - $\sqrt{s} \approx 320$ GeV
- ZEUS detector upgrades
  - trigger
  - microvertex detector
  - forward tracking



Charm Production in DIS at HERA

Charm Production

- dominant process: boson gluon fusion
- large charm fraction
- can measure open charm contribution to F_2
- sensitive to proton gluon density
- $0.05 < Q^2 < 1000$ GeV; $p_T(D) > 1.5$ GeV



Covered Measurements

HERA I results

- Measurement of $D^{*\pm}$ Production in Deep Inelastic e^+p Scattering at HERA, Physical Review D 69 0120004(2004)
- Measurement of $D^{*\pm}$ Meson Production in e^+p Scattering at Low Q^2, published online in Physics Letters B
- Measurement of D Mesons Production in Deep Inelastic Scattering at HERA, paper almost ready

HERA II preliminary results

- Charm Production in DIS using HERA II Data (ICHEP06), ZEUS-prel-06-021
- $F_2^{c\bar{c}}$ from $D^{*\pm}$

HERA II D^* Cross Section Measurement

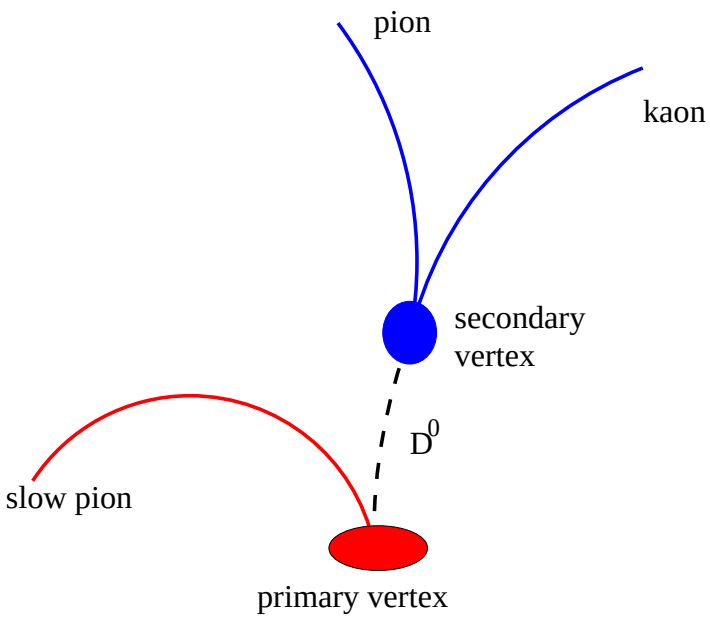
Kinematic Region

- $5 < Q^2 < 1000$ GeV^2
- $0.02 < y < 0.7$
- $|\eta(D^*)| < 1.5$
- $1.5 < p_T(D^*) < 15$ GeV

Selection of D^* candidates

$D^{*+}(2010) \rightarrow D^0\pi^+$ (BR: 67.7) % with $D^0 \rightarrow K^-\pi^+$ (BR: 3.8) %

- $|\eta| < 1.75$ (candidate tracks)
- $p_T > 0.4$ GeV (track from D^0)
- $p_T > 0.12$ GeV (slow pion from D^*)



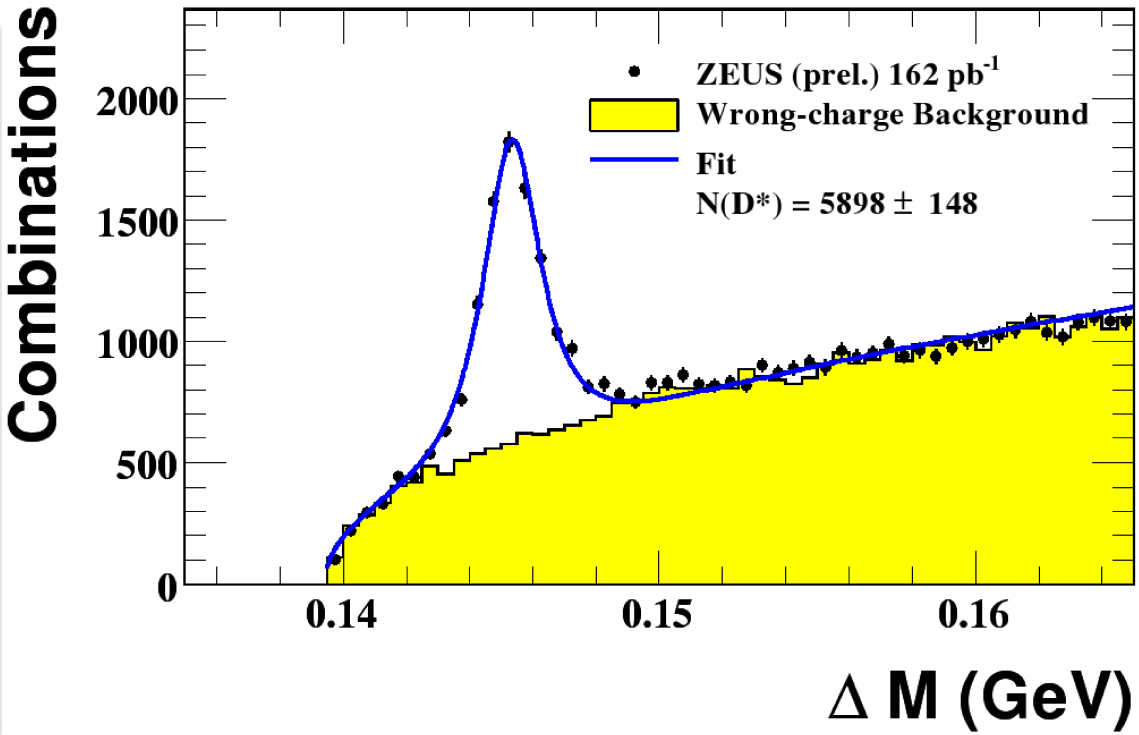
D Meson Tagging

D^0 tagging

- use ΔM, correlated errors cancel
- determine signal in window

$0.143 < \Delta M < 0.148$ GeV

- use wrong charge combinations to estimate background



HERA I D^* Cross Section Measurement at low Q^2

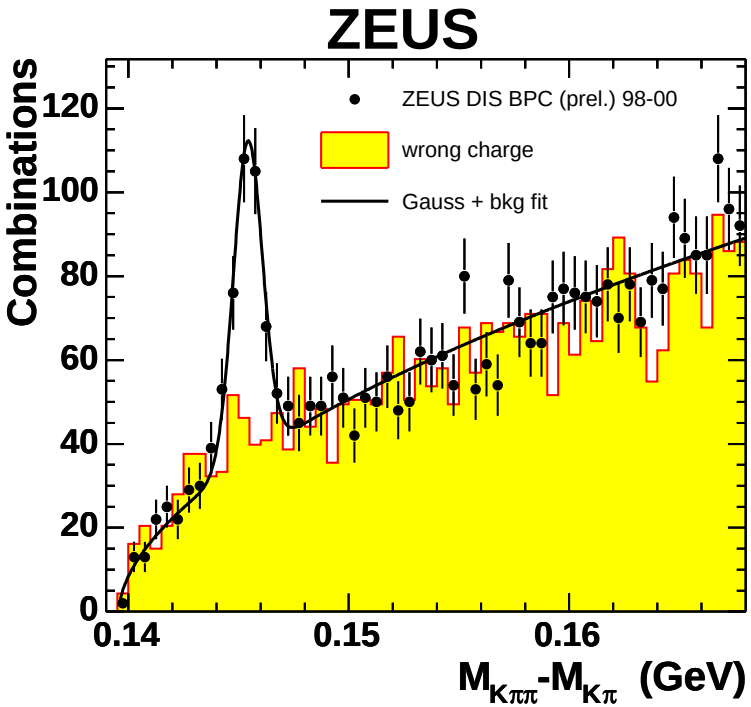
Kinematic Region

- $0.05 < Q^2 < 0.7$ GeV^2 using beampipe calorimeter
- $0.02 < y < 0.85$
- $|\eta(D^*)| < 1.5$
- $1.5 < p_T(D^*) < 9$ GeV

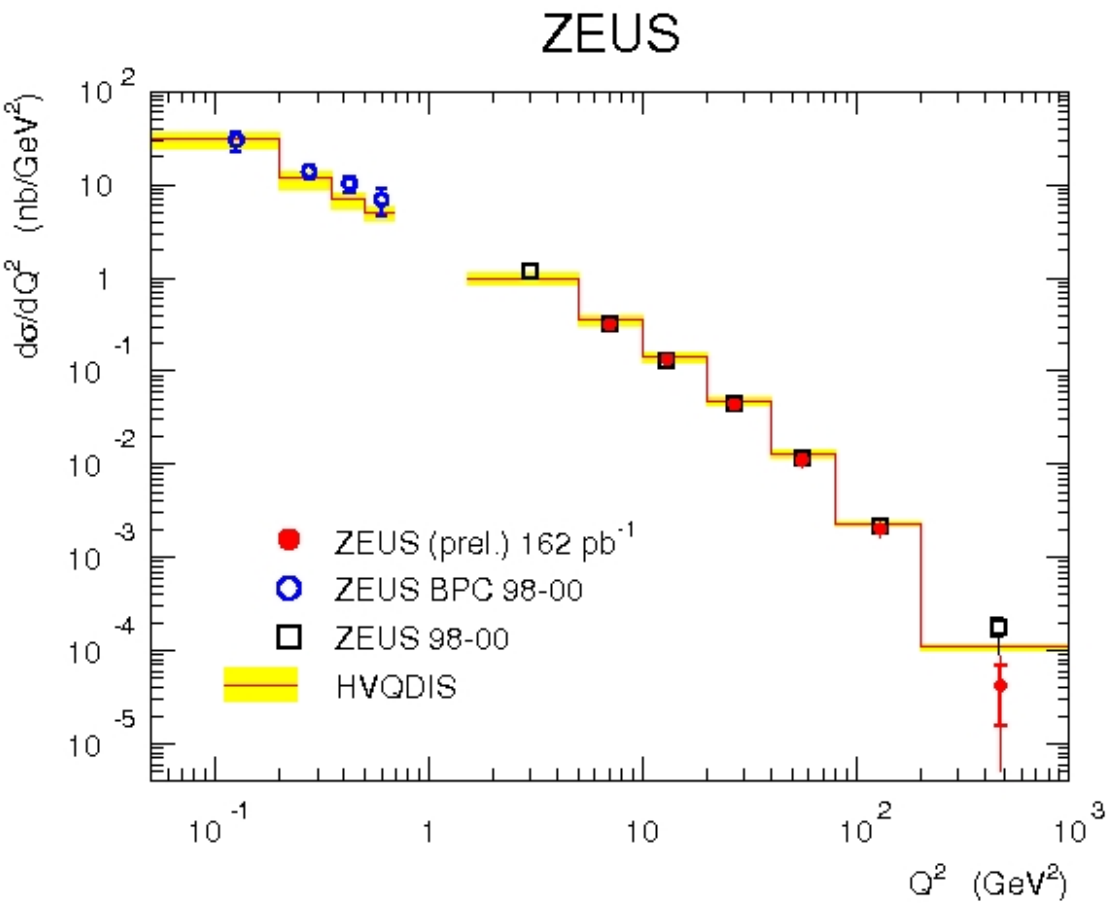
Selection of D^* candidates

$D^{*+}(2010) \rightarrow D^0\pi^+$ (BR: 67.7) % with $D^0 \rightarrow K^-\pi^+$ (BR: 3.8) %

- $p_T > 0.45$ GeV (track from D^0)
- $p_T > 0.12$ GeV (slow pion from D^*)



Charm Cross Section over Q^2

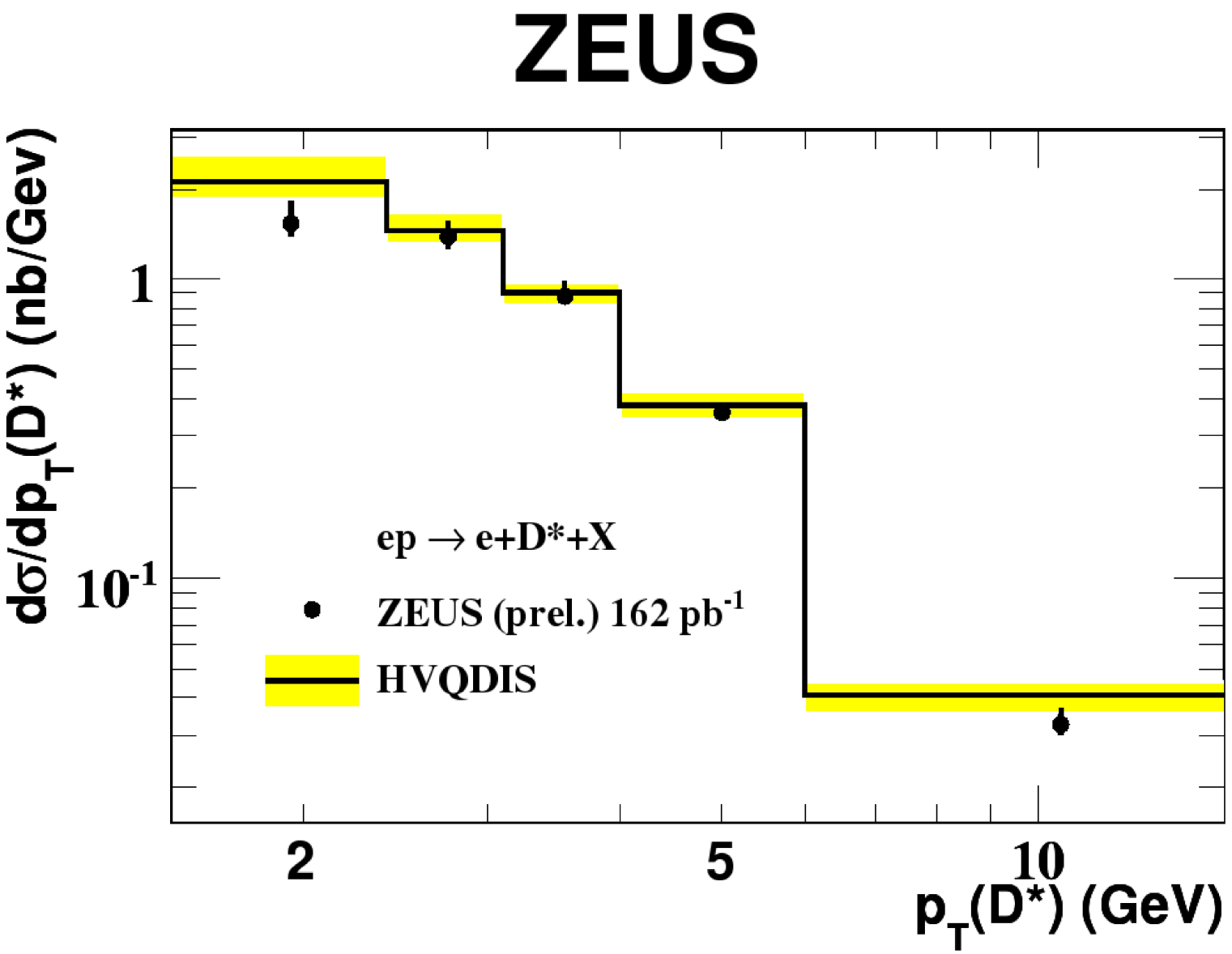


Theory

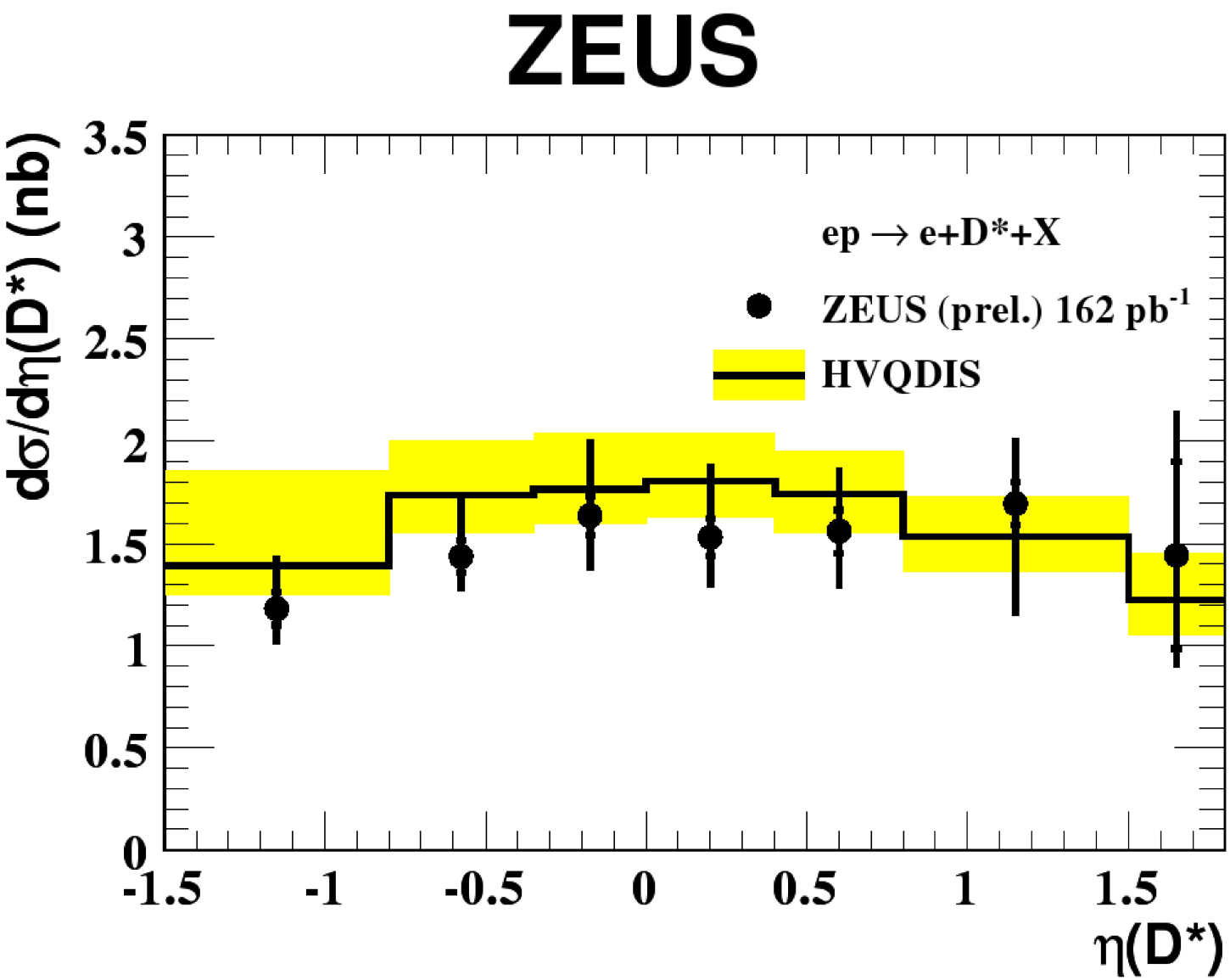
- NLO QCD: HVQDIS (B.W. Harris, J. Smith)
- fixed-flavor-number-scheme
- two scales: m_c and Q^2
- $\mu = \sqrt{Q^2 + 4m_c^2}$

Large Q^2 region covered
Good agreement with HERA I measurement and massive theory HVQDIS

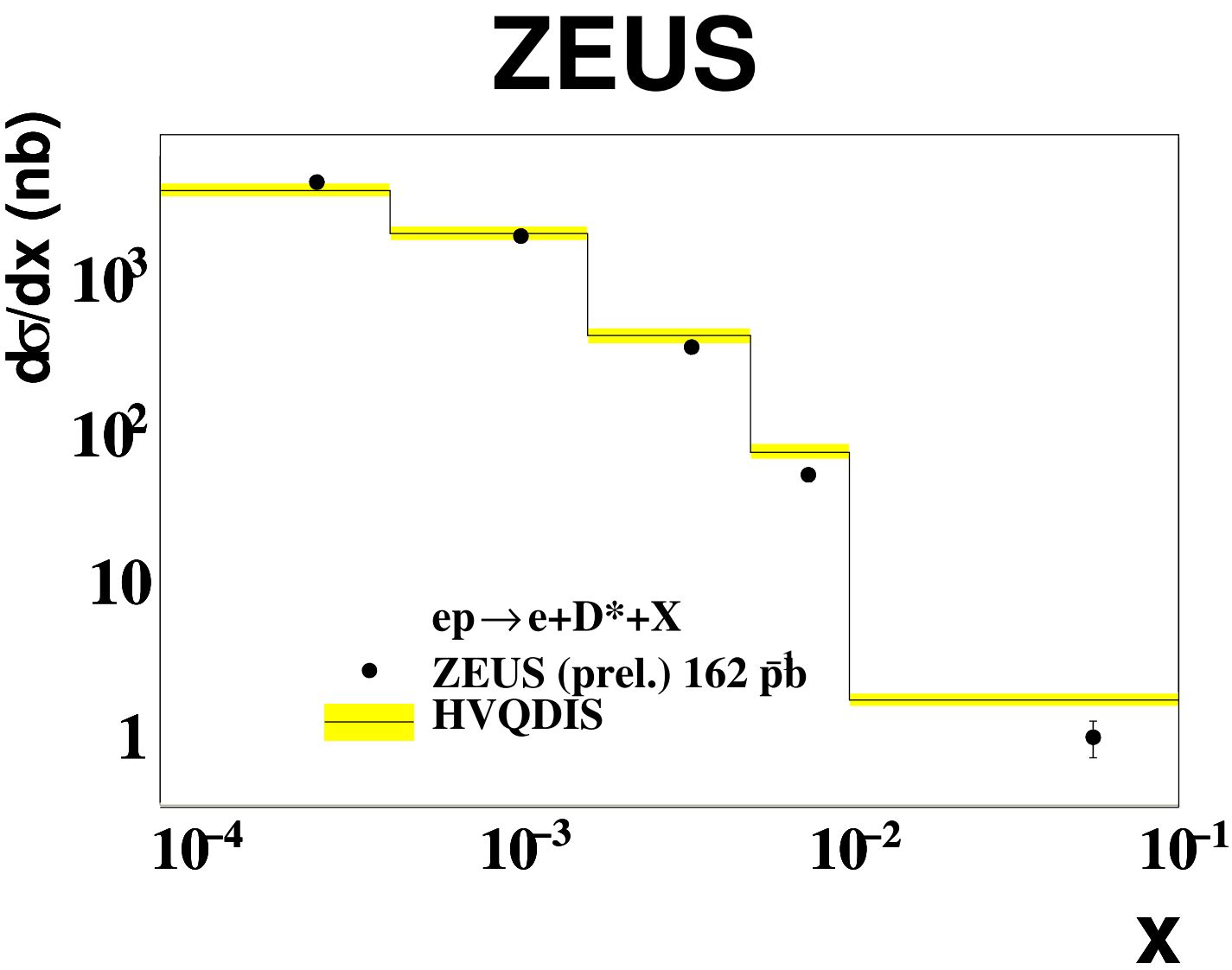
Differential Cross Sections: p_T



Differential Cross Sections: η



Differential Cross Sections: x



HERA I D Meson Cross Section Measurements

Decay Modes

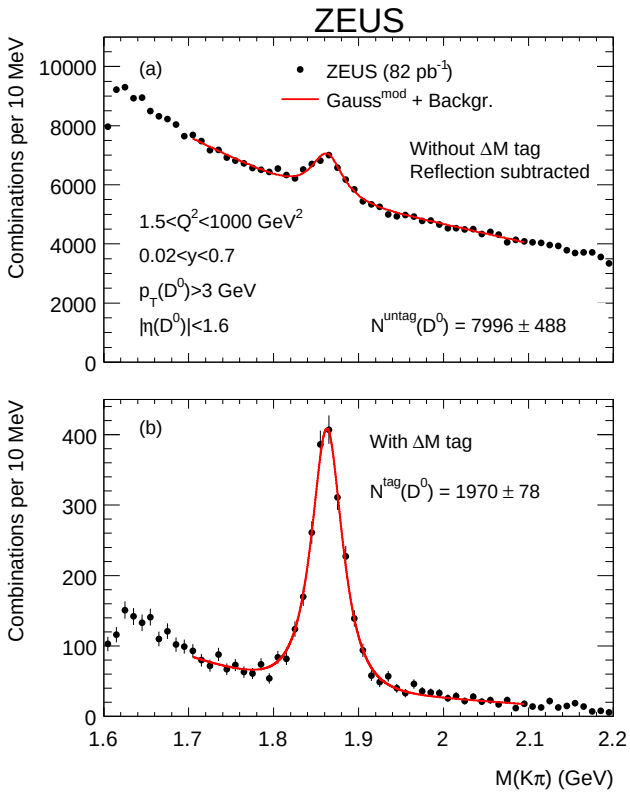
- $D^0 \rightarrow K^- \pi^+$
- $D^+ \rightarrow K^- \pi^+ \pi^+$
- $D_s^+ \rightarrow \Phi \pi^+$ with $\Phi \rightarrow K^+ K^-$

Kinematic Region

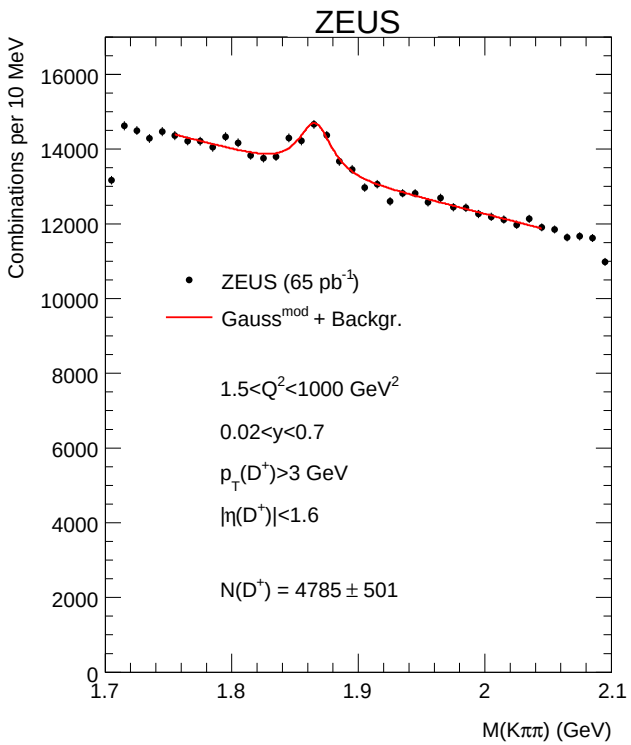
- $1.5 < Q_e^2 < 1000$ GeV^2
- $0.02 < y < 0.7$
- $|\eta(D)| < 1.6$
- $p_T(D^0, D^\pm) > 3$ GeV, $p_T(D_s^\pm) > 2$ GeV

HERA I D Meson Signals

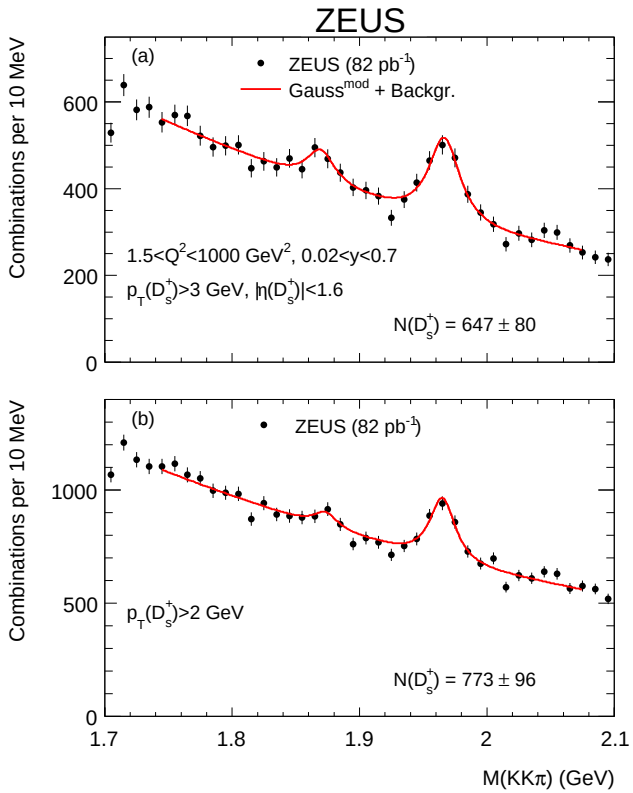
$D^0 \rightarrow K^-\pi^+$



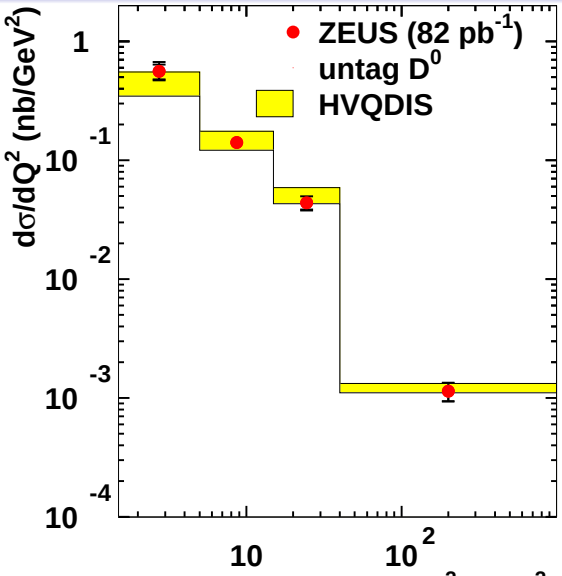
$D^+ \rightarrow K^-\pi^+\pi^+$

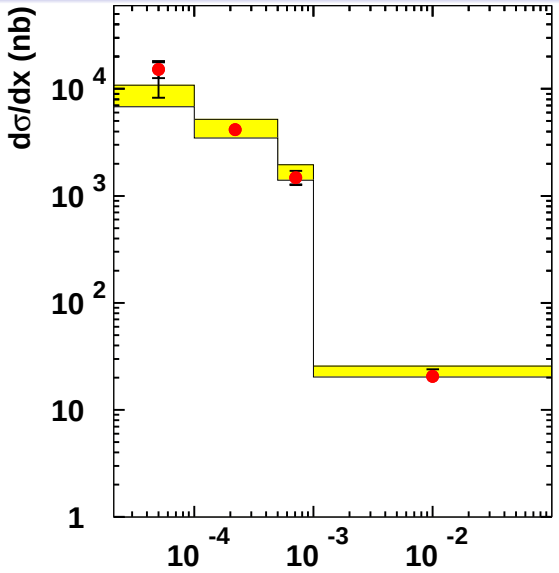


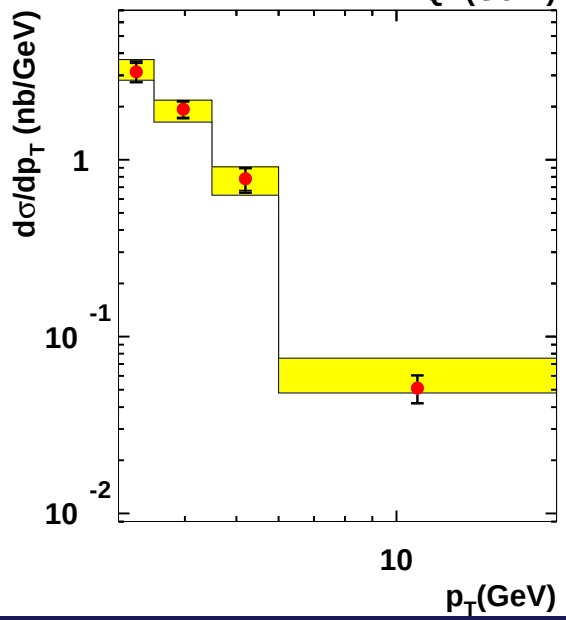
$D_s^+ \rightarrow \Phi\pi^+$

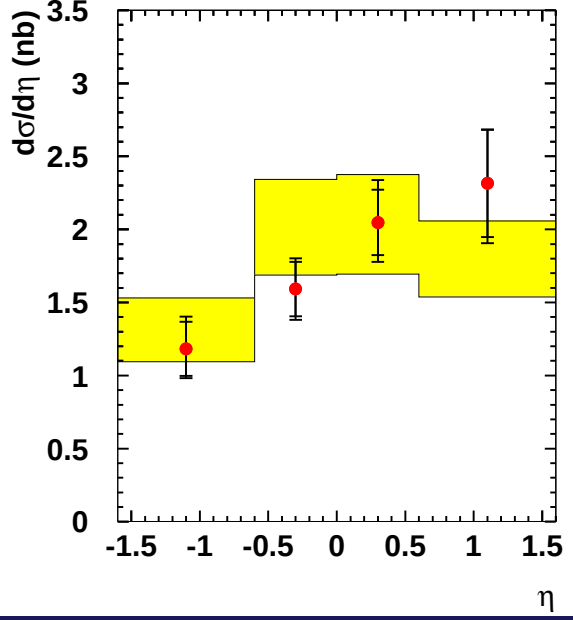


Untagged D^0 in HERA I

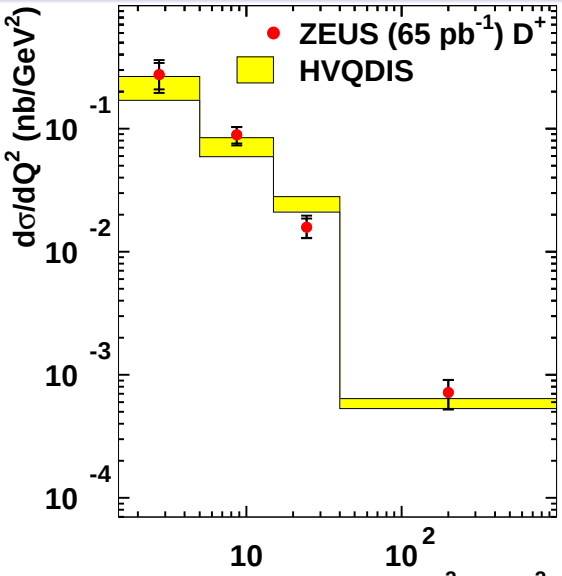


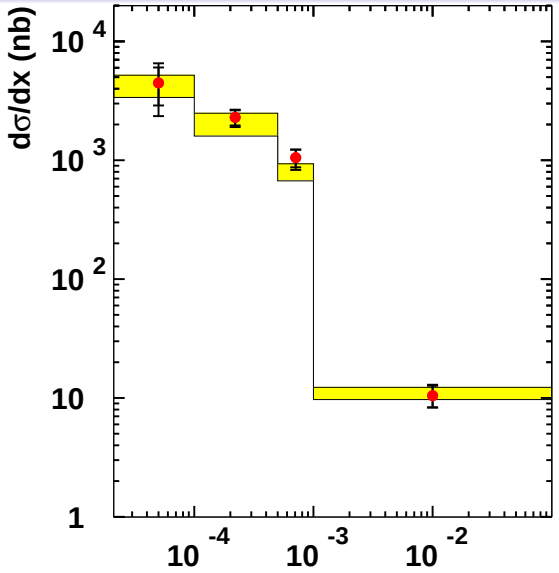


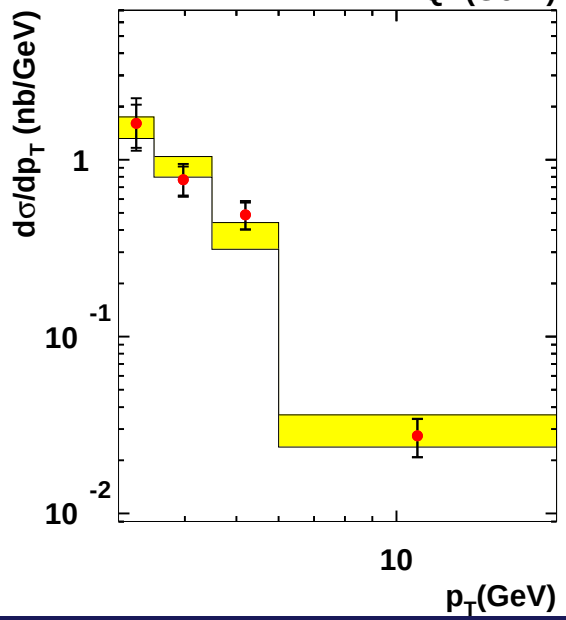


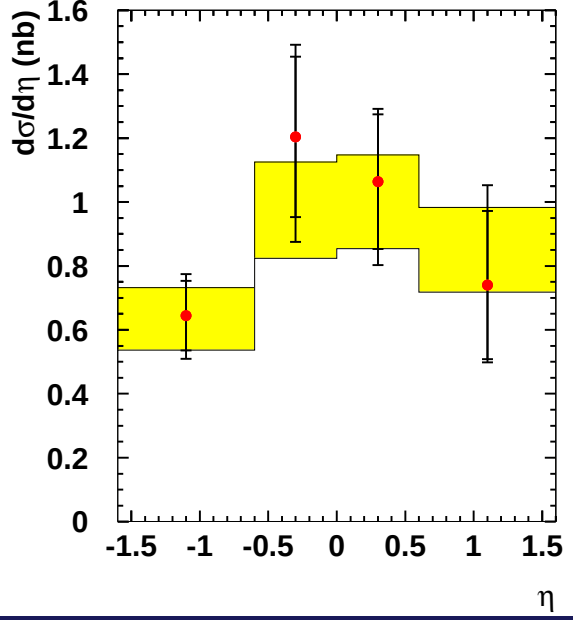


$D^{\pm}$ in HERA I

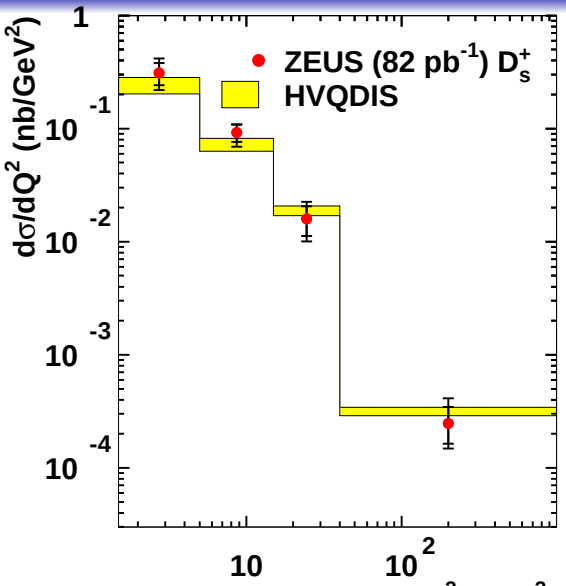

ZEUS (65 pb^{-1}) D$^+$
HVQDIS
dσ/dQ^2 (nb/GeV^2)
Q^2 (GeV^2)

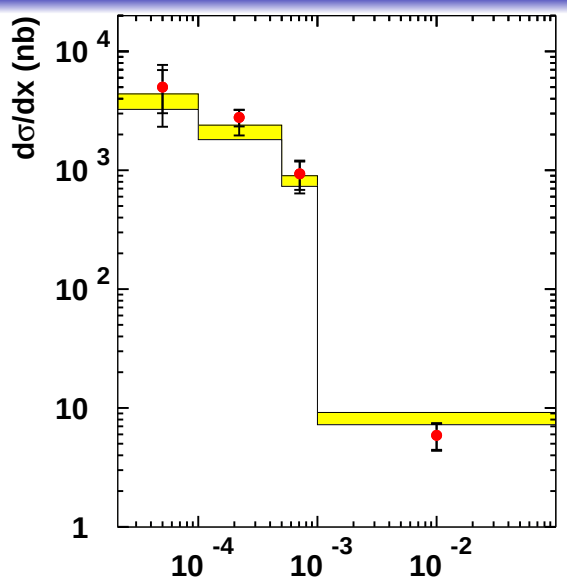

dσ/dx (nb)
x

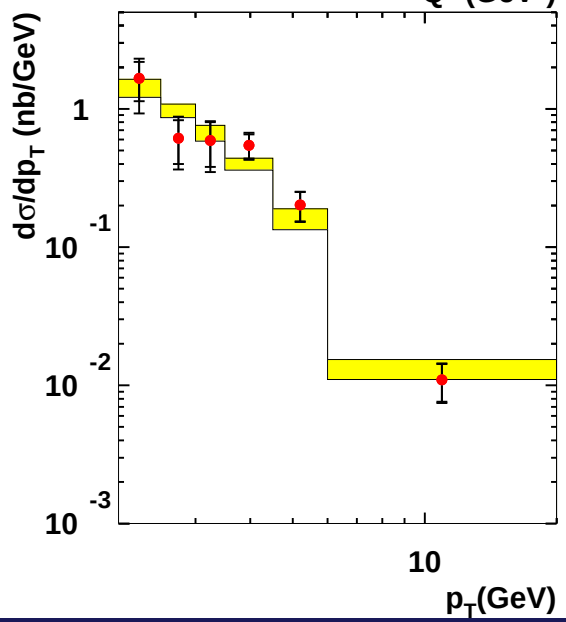

dσ/dp$_T$ (nb/GeV)
p$_T$(GeV)

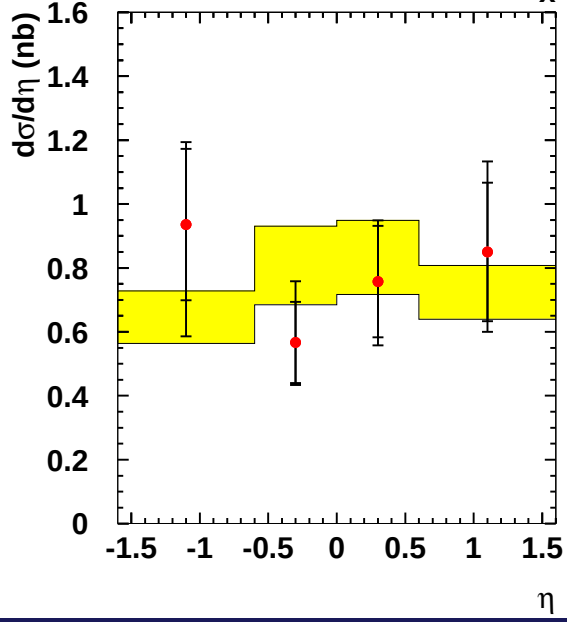

dσ/dη (nb)
η

$D_s^{\pm}$ in HERA I









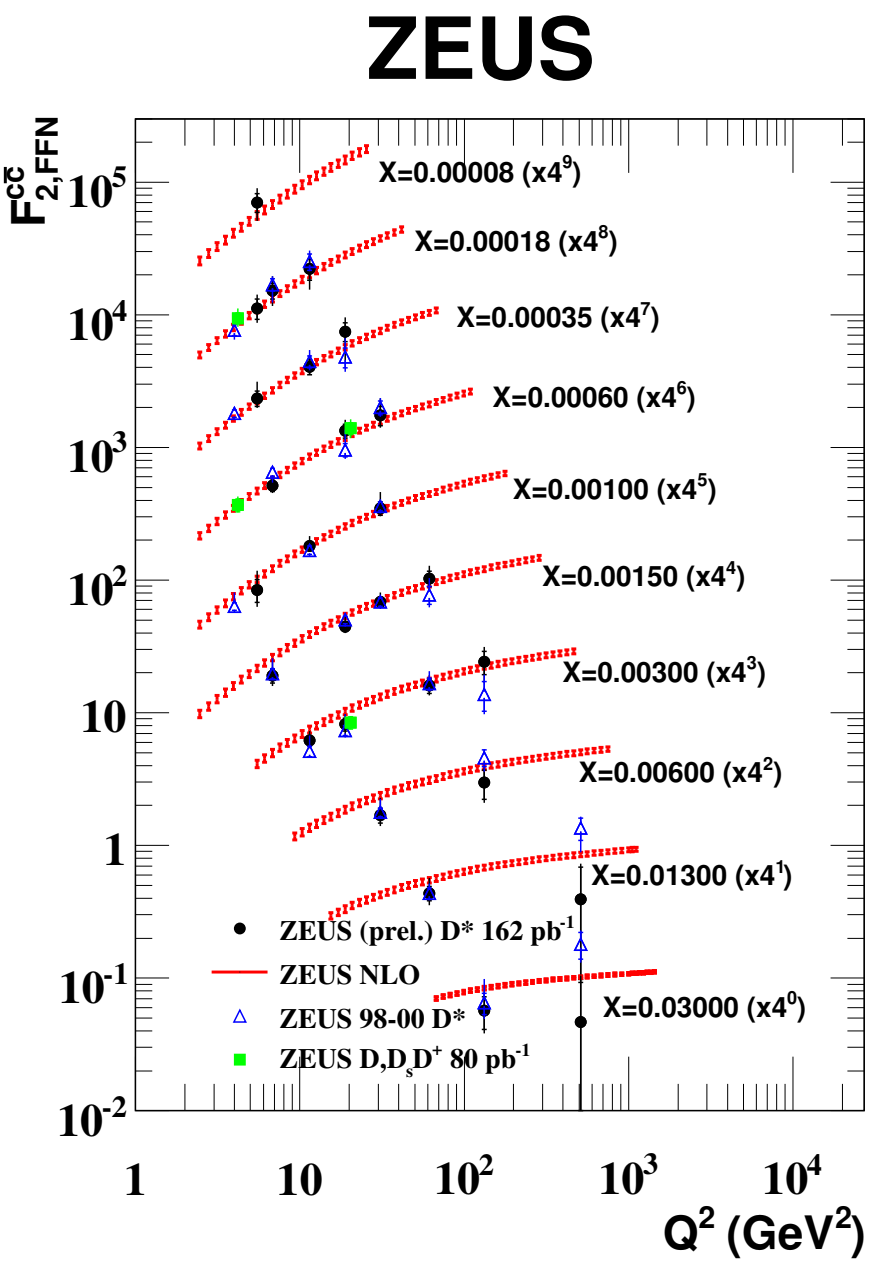
Extraction of $F_2^{c\bar{c}}$

Inclusive double-differential $c\bar{c}$ cross section

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

Extract Open Charm Contribution

- charm cross section extrapolated from D meson measurement (known fragmentation fraction)
- $F_{2,meas}^{c\bar{c}}(x,Q^2) = \frac{\sigma_{meas}(ep\rightarrow DX)}{\sigma_{theo}(ep\rightarrow DX)} F_{2,theo}^{c\bar{c}}(x,Q^2)$
- cross sections from D meson measurement region extrapolated to full p_T and η phase space using HVQDIS



Good agreement between HERA I and HERA II and with and NLO

Conclusions and Outlook

Conclusions and Outlook

- charm production in DIS measured over large range of Q^2
- first ZEUS $F_2^{c\bar{c}}$ measurement using HERA II data via D^* with larger statistics than HERA I
- overall good agreement between HERA I and HERA II and with massive theory HVQDIS
- working on combination of HERA I and II results for $F_2^{c\bar{c}}$