Study of $D^{*\pm}$ Meson Production in Diffractive ep Scattering at HERA

Irina Korzhavina

Moscow State University - Московский Университет

on behalf of
the ZEUS Collaboration

O U T L I N E

1. Introduction
2. D^* diffractive signal
3. D^* diffractive cross sections
4. Summary

DIS2001
Bologna, April, 2001

1. Introduction

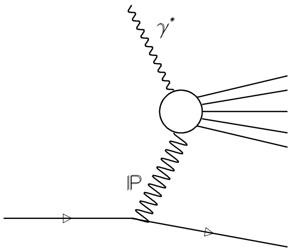
Diffractive Charm :

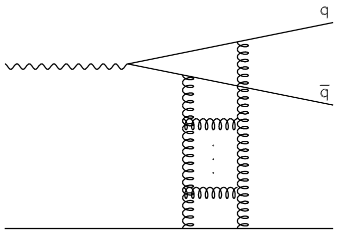
- to test pQCD $\Lambda_{QCD} << M_c$
  $\Longrightarrow$ charm mass gives a hard scale μ
  $\Longrightarrow$ pQCD expansion is valid

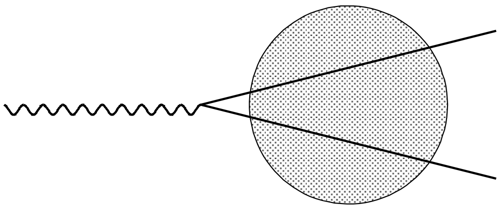
- to test
  partonic structure of diffraction
  $\Longrightarrow$ dominated by gluon-initiated processes

- to test diffractive dynamics
  $\Longrightarrow$ variety of models for diffractive interactions:

resolved $I\!P$ | 2-gluon exchange | SCI



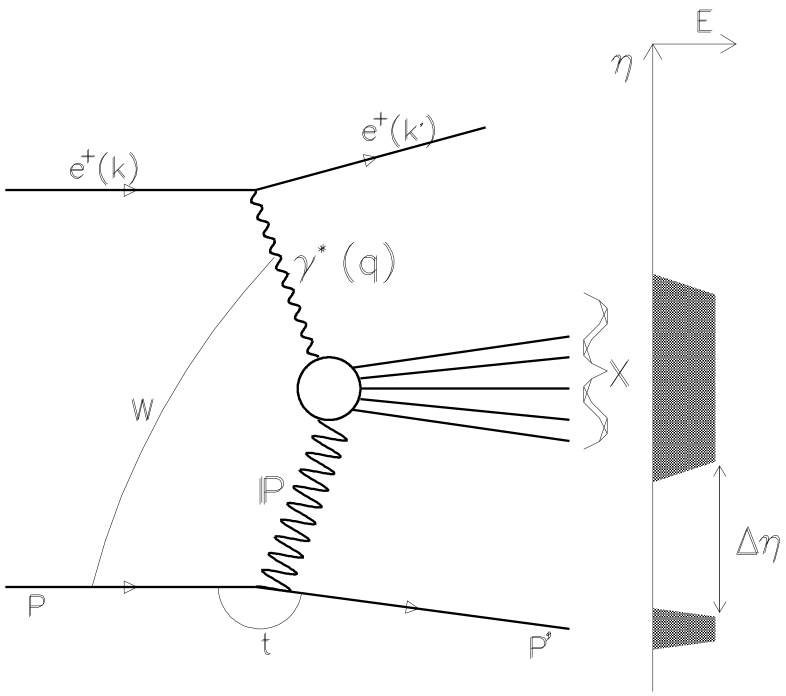




We measure:

$$e(k) + p(p) \rightarrow e'(k') + X + p'(p')$$

proceeds via $\gamma(q) + I\!P(P_{I\!P}) \rightarrow X$:



$$Q^2 = -q^2$$

PhP

$$Q^2 < 1 \text{ GeV}^2$$

DIS

$$Q^2 > 4 \text{ GeV}^2$$

$$M_X^2 = (P_{I\!P} + q)^2$$

$$x_{I\!P} = \frac{P_{I\!P} \cdot q}{p \cdot q} = \frac{M_X^2 + Q^2}{W^2 + Q^2}, \quad x_{I\!P} \simeq \frac{M_X^2}{W^2} \text{ in PhP}$$

$$\beta = \frac{Q^2}{Q^2 + M_X^2} \quad \text{(for DIS)}$$

$$\Delta\eta \;, \quad \eta^{D^*} = -ln(tan(\theta/2))$$

2. D^* Diffractive Signal

$\boxed{D^{*\pm}(2010)\ \text{Reconstruction :}}$

D^* was searched for by its decay mode:

$D^* \to D^0\ \pi_s$
$D^0 \to K\pi$

Both charged states $D^{*\pm}$ were detected

Decay branching ratio :

$B_{D^* \to (D^0 \to K\pi),\pi_s} = 0.0263 \pm 0.0010$

$\Delta M = M(D^*) - M(D^0)$ method was used to identify $D^{*\pm}$

$\Delta M \ = \ .14542 \pm .00005 \text{ GeV} \sim m_\pi$

phase space suppressed threshold region

Signature: signal in ΔM selecting $1.80 < M(D^0) < 1.92$ GeV

Diffractive reconstruction :

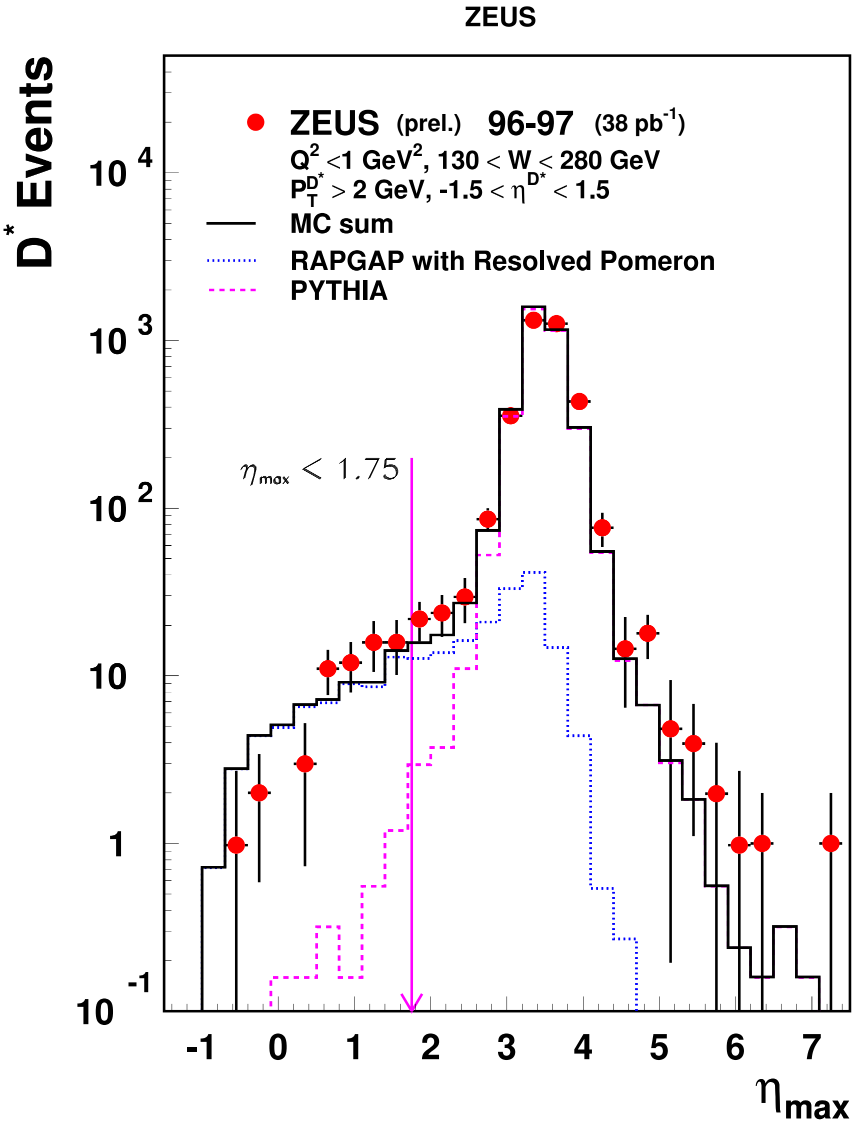
Diffractive event $\Longleftrightarrow$ LRG event

η_{max} method: most forward particle

$\Longrightarrow \eta_{max} < \eta_0 \Longrightarrow x_{I\!P}$ accessible range

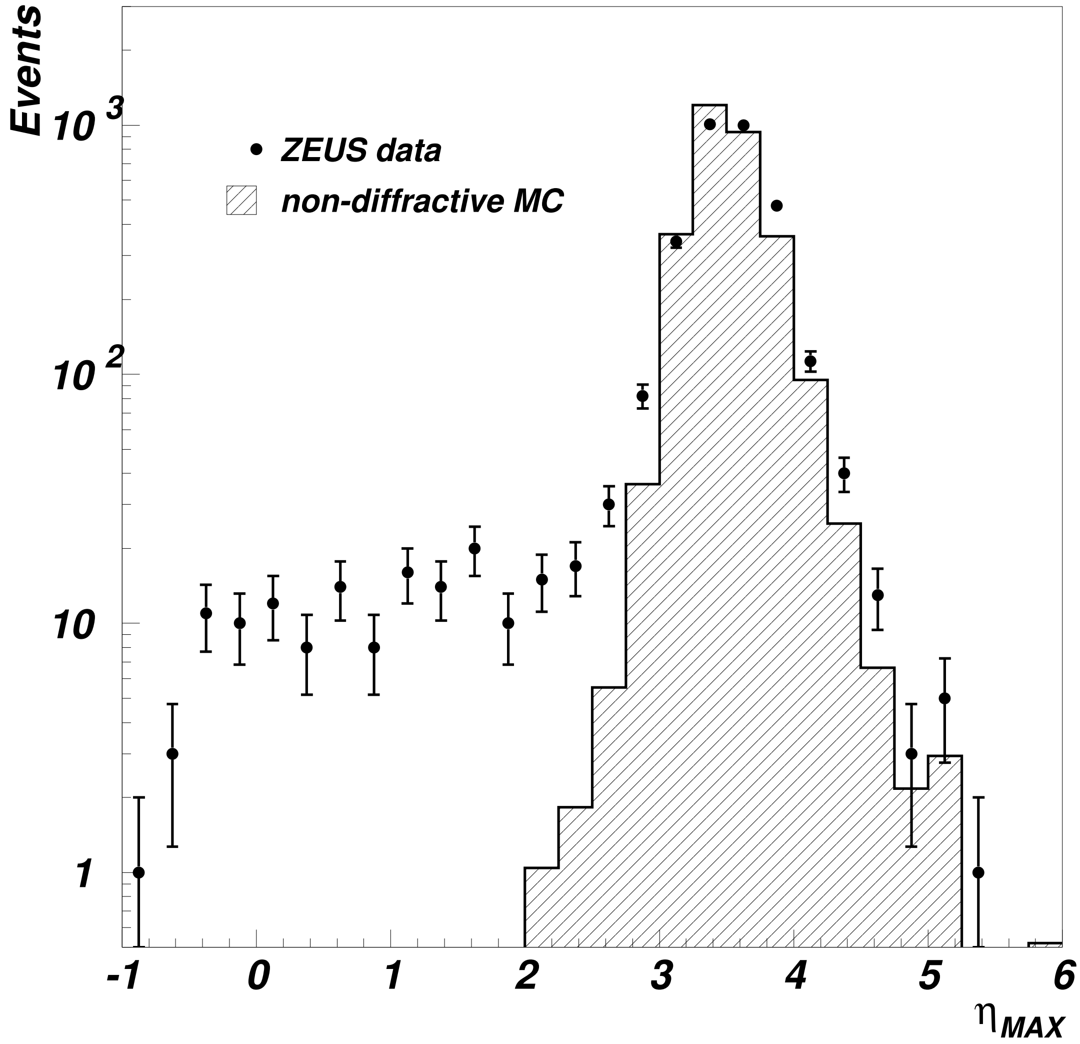
Diffractive PhP($Q^2 < 1$ GeV^2): $x_{I\!P} < 0.018$

$\eta_{max} < 1.75$

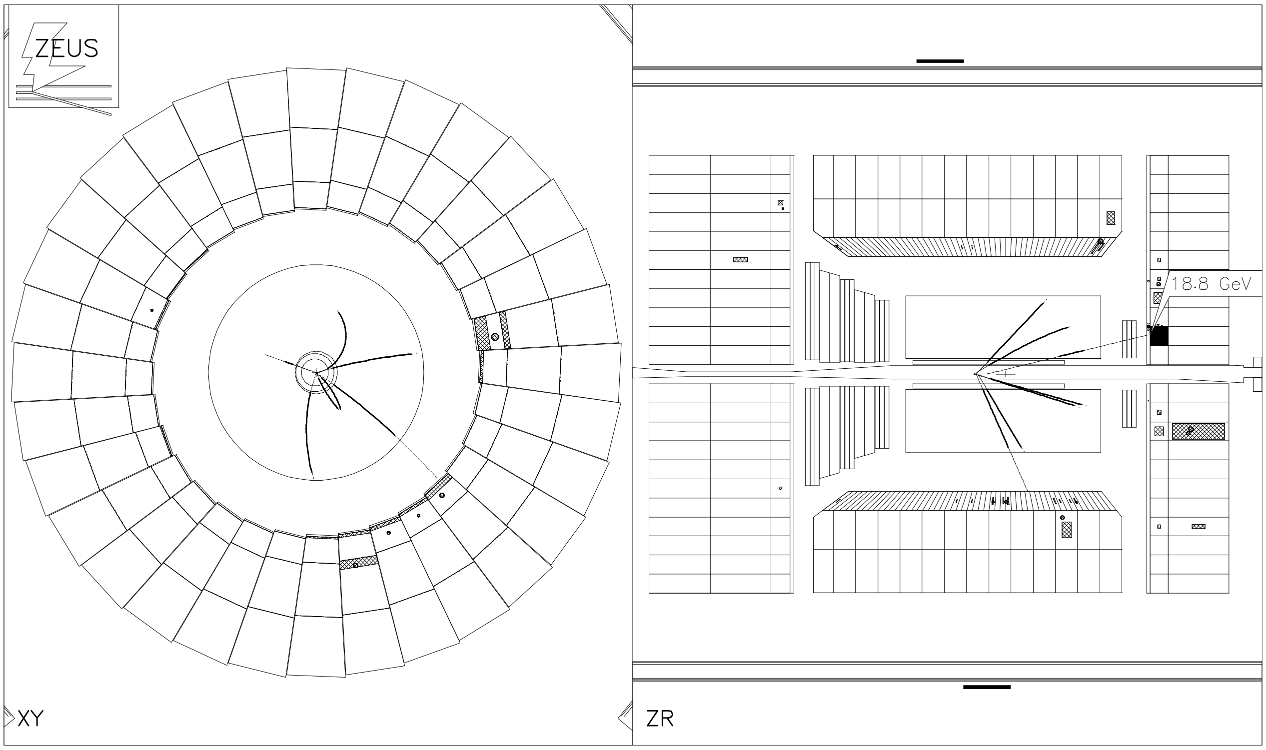


Diffractive DIS($Q^2 > 4$ GeV^2): $x_{I\!P} < 0.016$

$\eta_{max} < 2.0$



Diffractive reconstruction :



$\eta_{max} < \eta_0 \Longrightarrow ep \rightarrow e'XN^*$

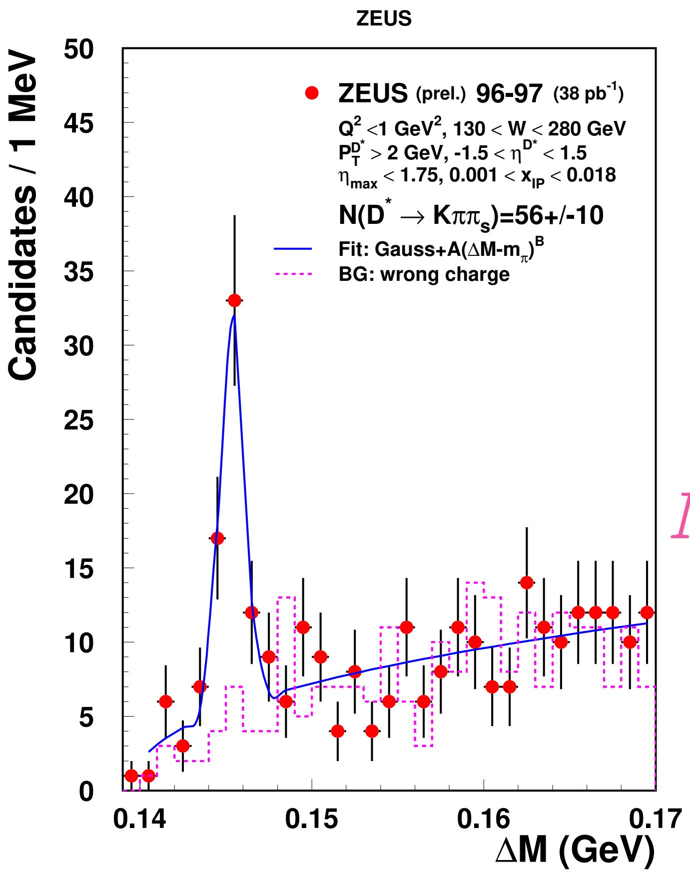
proton dissociative hadronic system N^* may fit the cut.

Its contribution of 0.31 ± 0.15

subtracted from

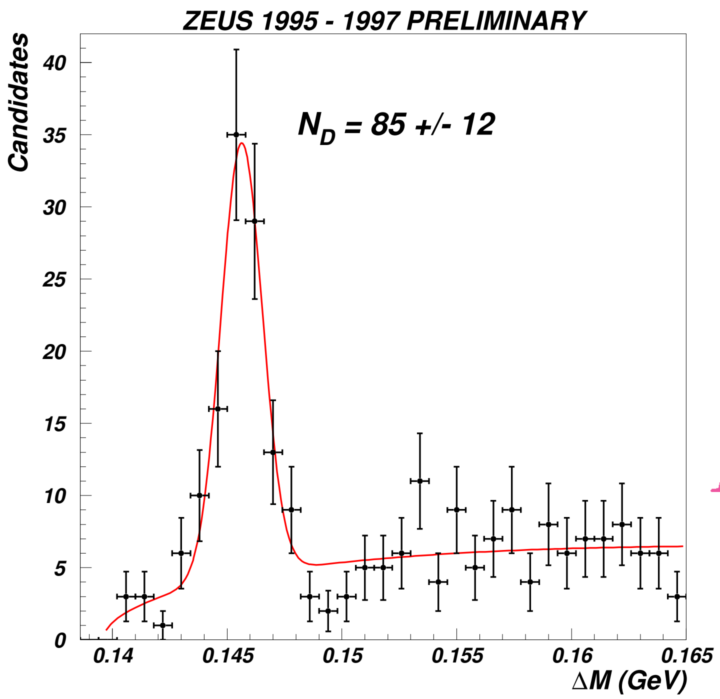
all measured cross sections.

Diffractive D* PhP Signal



$$Q^2 < 1 \text{ GeV}^2$$
$$x_{I\!P} < 0.018$$
$$N_{D^*} = 56 \pm 10$$

Diffractive D* in DIS Signal



$$Q^2 > 4 \text{ GeV}^2$$
$$\beta < .8$$
$$x_{I\!P} < 0.016$$
$$N_{D^*} = 85 \pm 12$$

3. Diffractive Cross Sections

Preliminary data with D^* in
PhP(RAS2000) at $\mathcal{L} = 38$ pb $^{-1}$ and
DIS(ICHEP2000) at $\mathcal{L} = 44$ pb $^{-1}$,
collected by the ZEUS detector
during 1995-1997 in beams
e^+ 27.5 GeV and p 820 GeV

Integrated Cross Sections:

Diffractive PhP:

$$Q^2 < 1 \text{ GeV}^2 \text{ , } 130 < W < 280 \text{ GeV}$$
$$p_T^{D^*} > 2 \text{ GeV , } |\eta^{D^*}| < 1.5$$
$$0.001 < x_{I\!P} < 0.018$$

$\sigma^{diff}_{ep\to D^*Xp} =$

$$\boxed{0.74 \pm 0.21(stat.)^{+0.27}_{-0.18}(syst.) \pm 0.16(p.diss.) \text{ nb}}$$

$\sim$ 4 % of inclusive D^* PhP cross section while only a fraction of the diffractive contribution

Resolved $I\!P$ model predictions:

–with H1 FIT2

$$\sigma^{diff}_{ep\to D^*Xp} = 1.42 \text{ nb}$$

– with BKL:

$$\sigma^{diff}_{ep\to D^*Xp} \simeq 0.56 - 0.77 \text{ nb}$$

Integrated Cross Sections:

Diffractive DIS:

$$4 < Q^2 < 400 \text{ GeV}^2 \;,\; 0.02 < y < 0.7 \text{ GeV}$$
$$p_T^{D^*} > 1.5 \text{ GeV} \;,\; |\eta^{D^*}| < 1.5$$
$$x_{I\!P} < 0.016 \;,\; \beta < .8$$

$$\boxed{\sigma^{diff}_{ep\to D^*Xp} = 0.281 \pm 0.041(stat.)^{+0.079}_{-0.073}(syst.) \text{ nb}}$$

$$\boxed{\mathcal{R_D}^{DIS} = 6.1 \pm 0.9(stat.)^{+1.5}_{-1.4}(syst)\%}$$

being independent on Q^2 and W

Resolved $I\!P$ model predictions for ACTW:

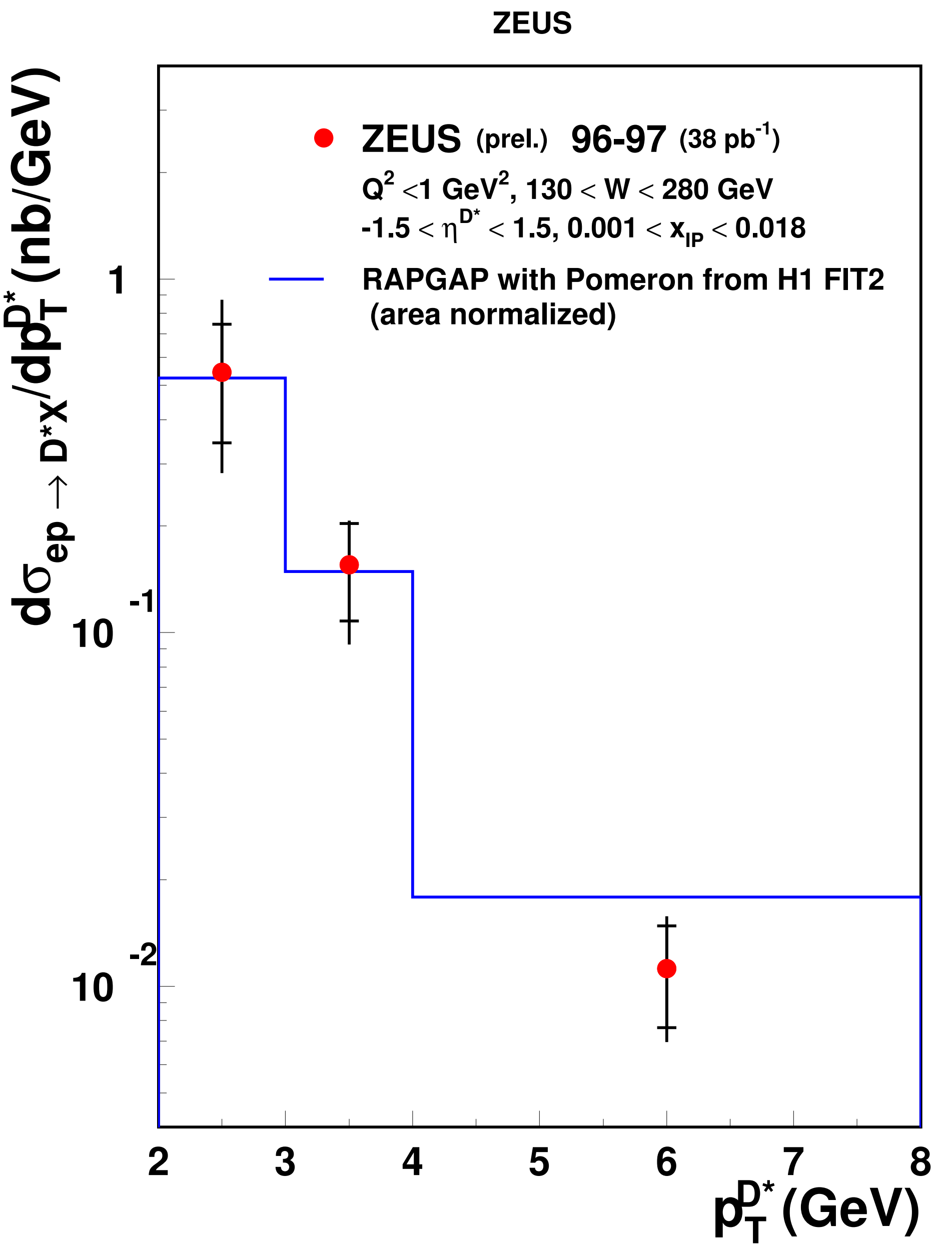
– gluon dominated parametrization:

$$\sigma^{diff}_{ep\to D^*Xp} \simeq 0.19 - 0.40 \text{ nb}$$

– quark dominated parametrization underestimates cross section by factor of ~ 100.

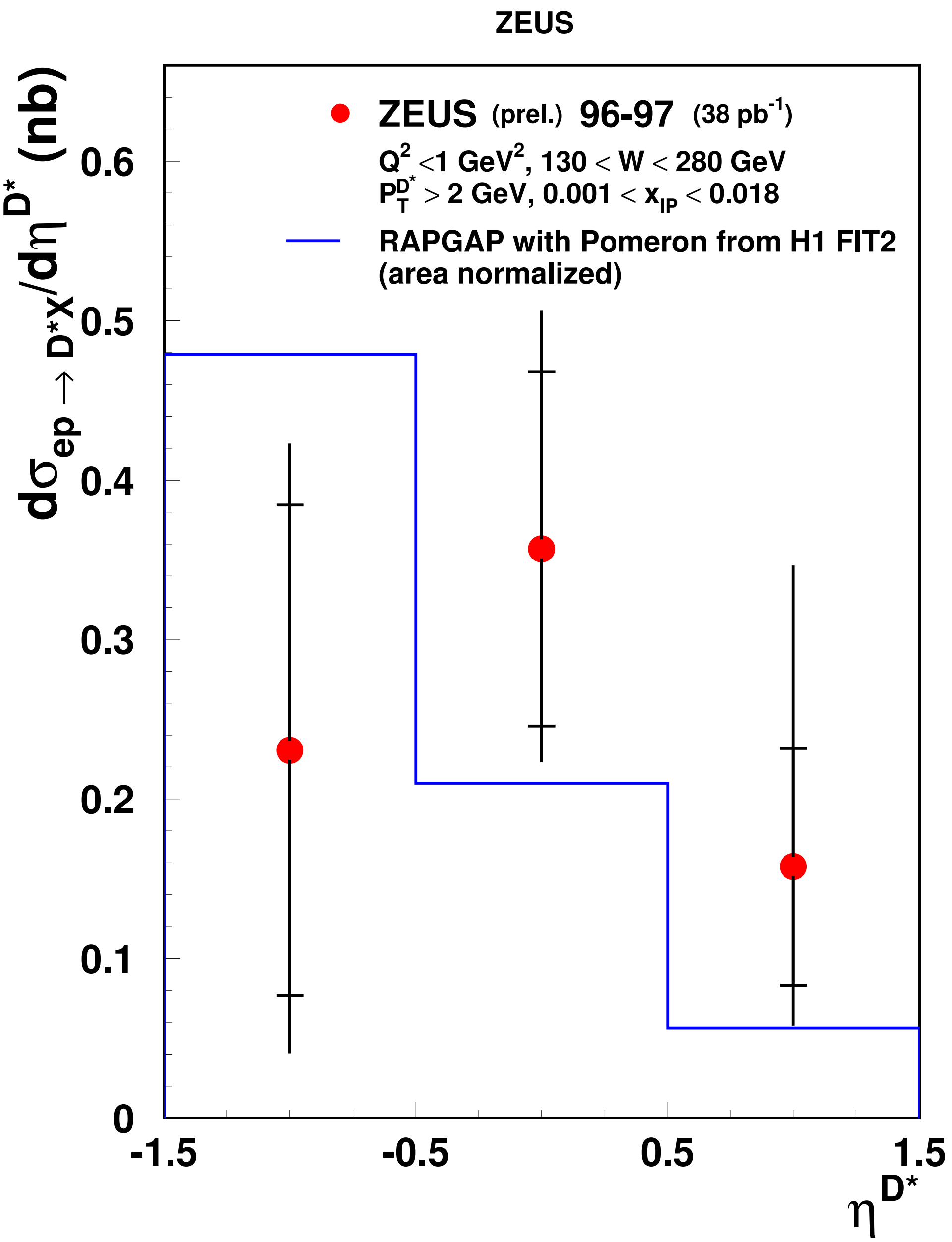
Differential Cross Sections:

Diffractive PhP($Q^2 < 1$ GeV^2):$x_{I\!P} < 0.018$



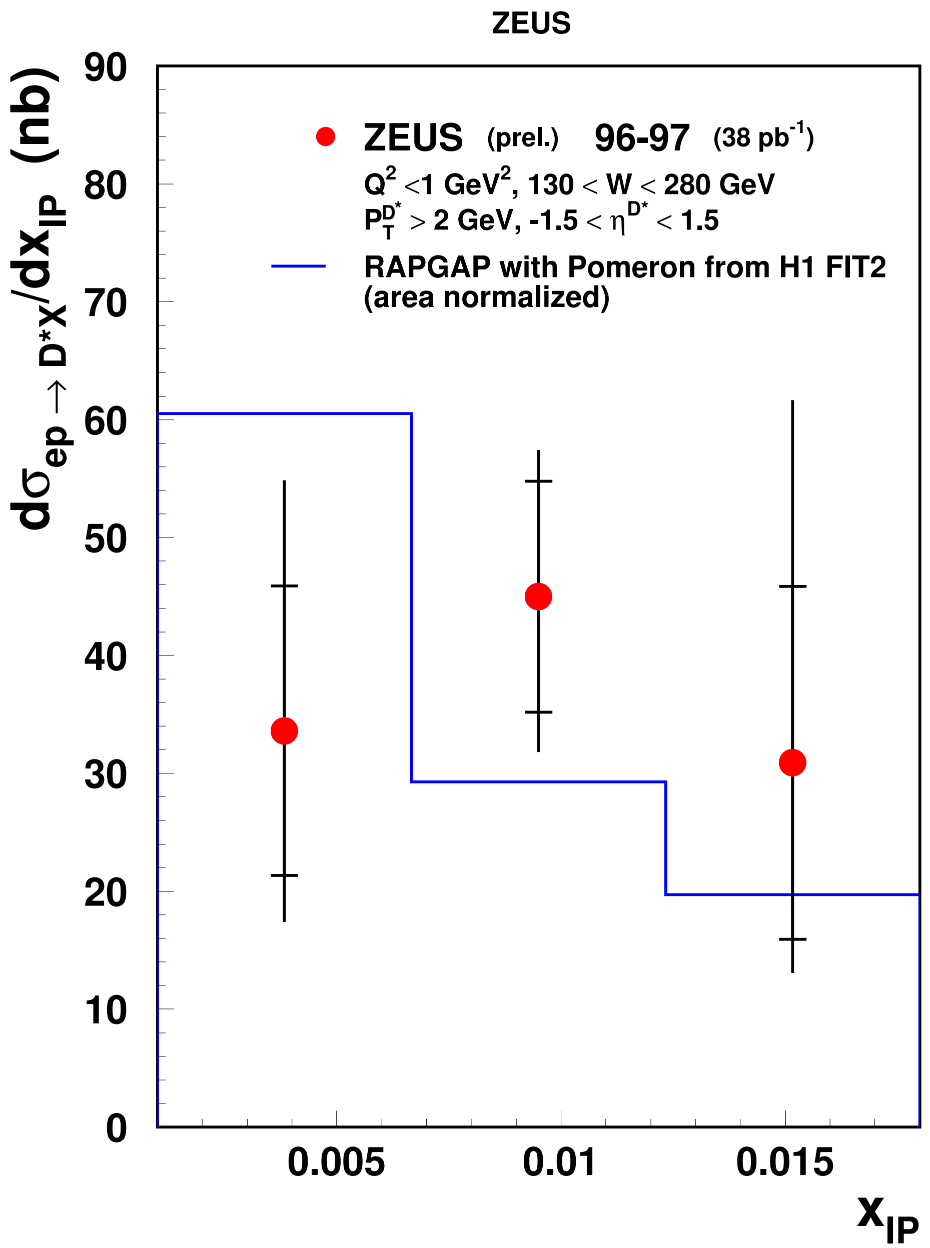
Differential Cross Sections:

Diffractive PhP($Q^2 < 1$ GeV^2):$x_{I\!P} < 0.018$



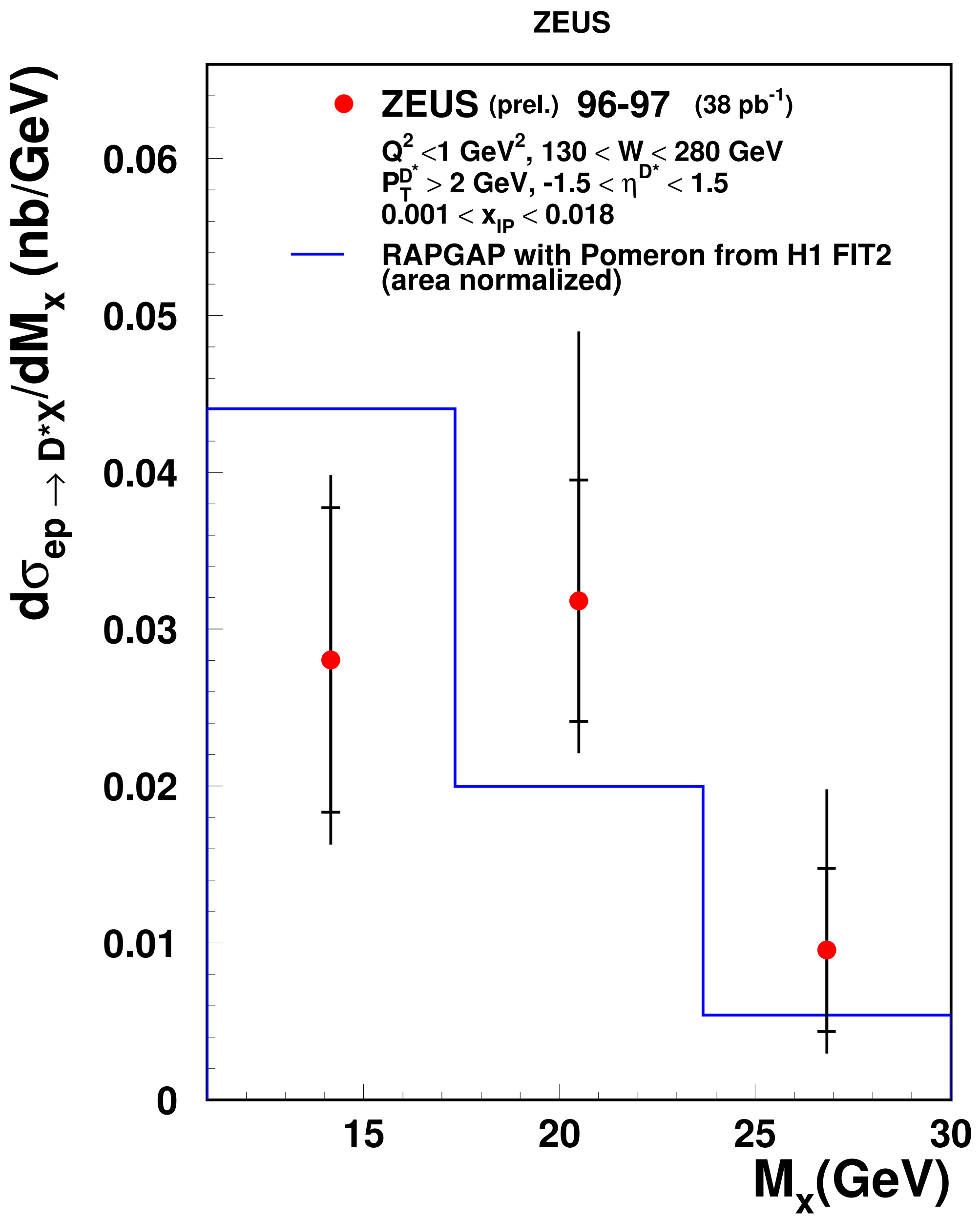
Differential Cross Sections:

Diffractive PhP($Q^2 < 1$ GeV^2):$x_{I\!P} < 0.018$



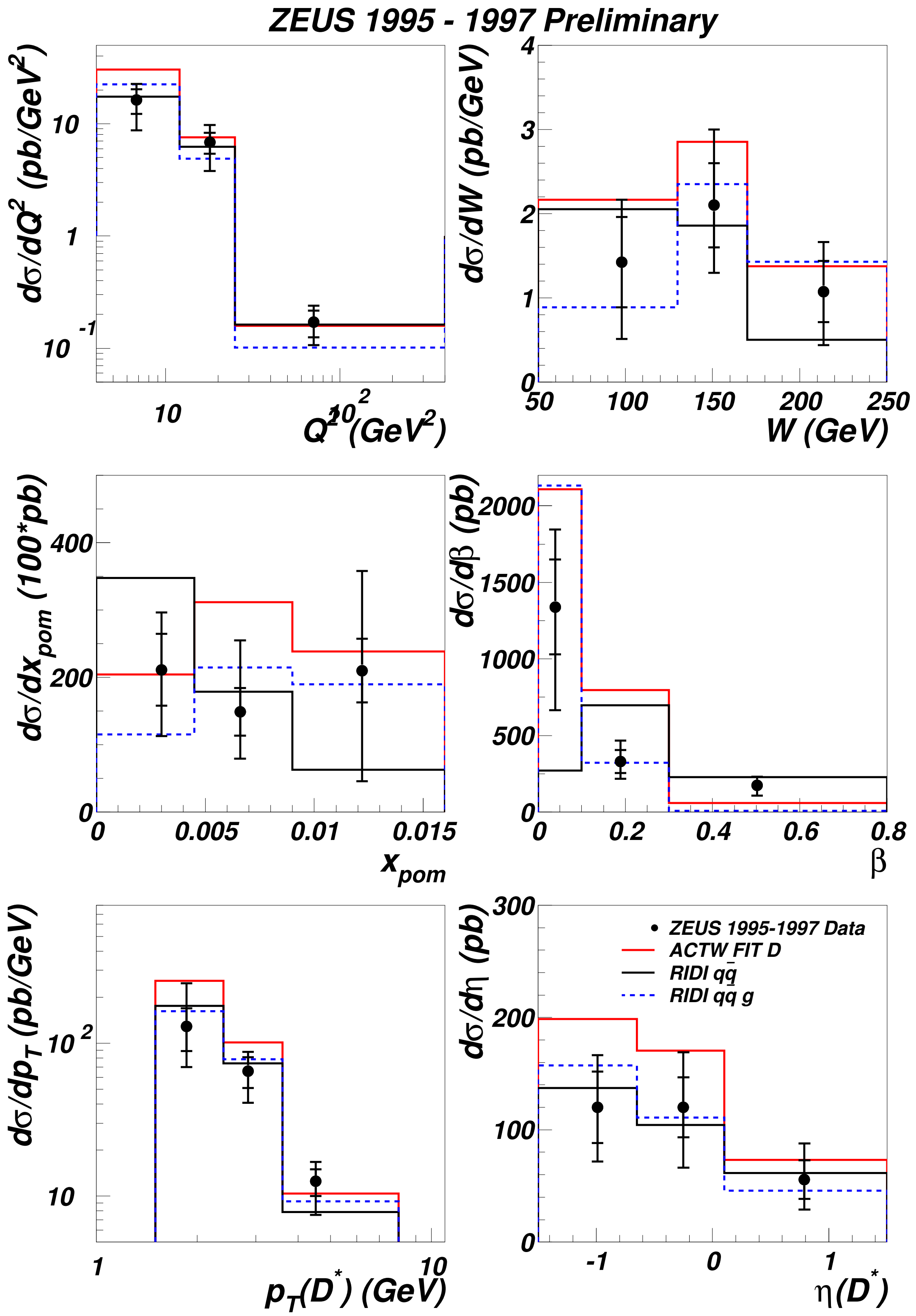
Differential Cross Sections:

Diffractive PhP($Q^2 < 1$ GeV^2):$x_{I\!P} < 0.018$



Differential Cross Sections:

Diffractive DIS($Q^2 > 4$ GeV^2):$x_{I\!P} < 0.016$



4. Summary

- D^* diffractive cross sections were measured (ZEUS prel.) at HERA:
  in PhP for the 1st time
  $\sigma^{diff}_{ep \to D^* X p} =$
  $0.74 \pm 0.21(stat.)^{+0.27}_{-0.18}(syst.) \pm 0.16(p.diss.)$ nb
  in DIS
  $\sigma^{diff}_{ep \to D^* X p} = 0.281 \pm 0.041(stat.)^{+0.079}_{-0.073}(syst.)$ nb

- For both sets of data qualitative agreement with resolved $I\!P$ model is observed within measurement errors, regarding gluon dominated $I\!P$ structure.

- The ratio of diffractive to inclusive D^* production is found to be consistent with the corresponding ratio for light quark production, indicating that diffractive charm production is not suppressed in diffractive processes.
  PhP: $> \sim 4$ % (a fraction of the diffractive contribution)
  $\mathcal{R_D}^{DIS} = 6.1 \pm 0.9(stat.)^{+1.5}_{-1.4}(syst)\%$

Perspective

- **Larger amount of data (>80pb^{-1}) with Forward Plug Calorimeter information has been taken by the ZEUS in 1998-2000. More precise results on charm diffractive production will come soon.**
- **New theoretical predictions are welcome**