ZEUS Results on Leading Baryons

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on behalf of ZEUS Collaboration

- Introduction
- Particle exchange model
- Rescattering model
- Results on neutron tagged PHP/DIS
- Results on neutron tagged D* PHP
- Conclusions

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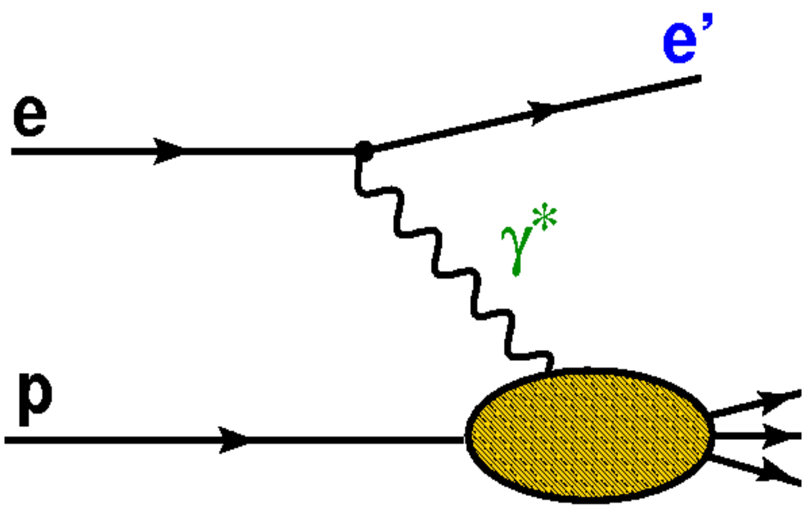
Introduction :

- Significant part of *ep* scattering at HERA contains a baryon in final state

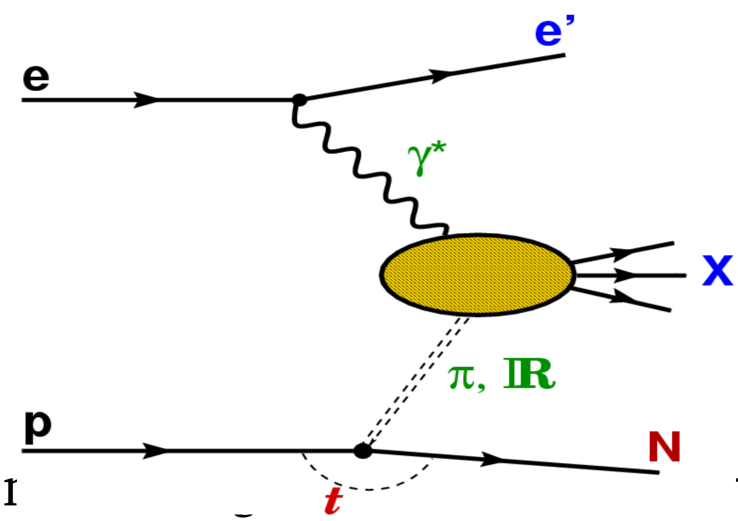
$$0.2 < x_L < 1. \quad , \quad x_L = E_{LB} / E_p$$

- Production mechanism not completely understood
- Exchange models are usually applied to describe data

(1)
STANDARD FRAGMENTATION



(2)
PARTICLE EXCHANGE



-one pio n -

Factorization :

Points of interest:

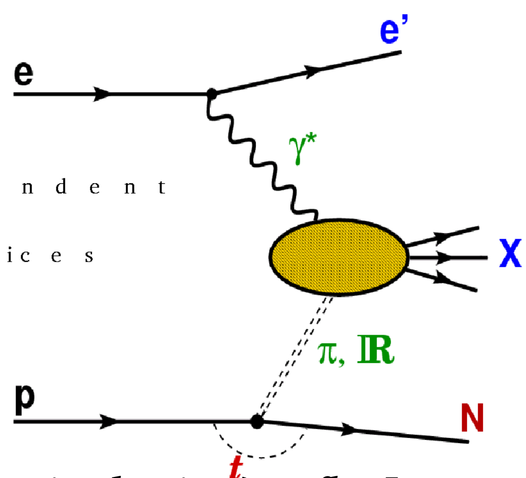
-Rel. between soft and hard interactions: (two scale physics)

- *hard* scale: m_c^2 for charm production, Q^2 for DIS
- *soft* scale: p_T of the neutron

-Factorization:

$$\frac{d\sigma_{\gamma p \to (charm,X)\,n}}{dx_L\,dt} = \underbrace{f_{\pi/p}(x_L,t)}_{(flux\ of\ pions)}\ \sigma^{\gamma\pi}_{charm,X}(s')$$

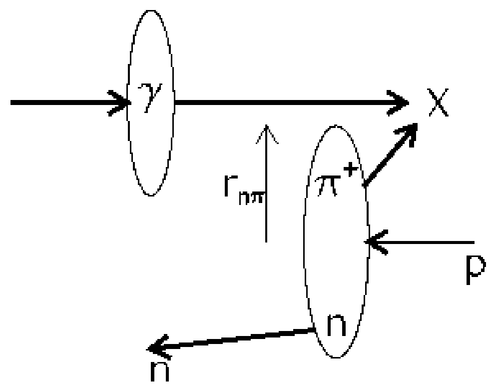
independent vertices



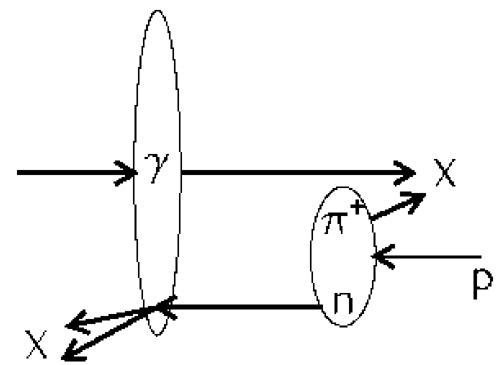
[if it holds: ratios (dσ/dY neutron tagged) / (dσ/dY inclusive) ~flat]
Y kinematical variables of the event

Rescattering :
[U.D'Alesio, H.J.Pirner, Eur.Phys.J A7:109 (2000)]

However
even within exchange picture factorization violation can be observed:



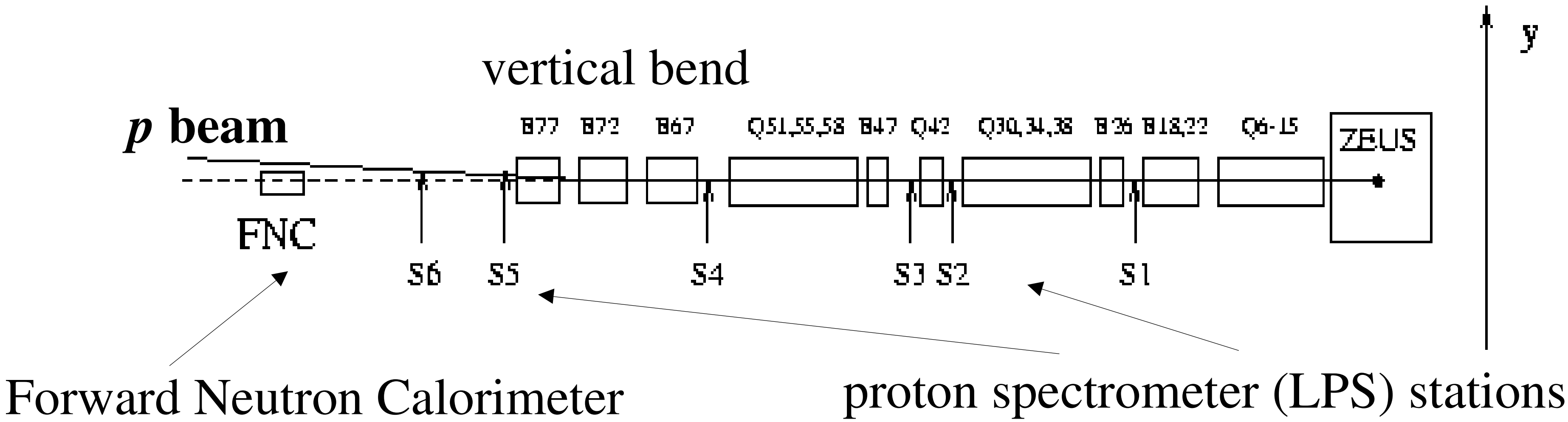
No rescattering,
neutron detected



rescattering, neutron lost
(lower x_L, higher p_T)

- In π exchange models, $\langle r_{\pi n}\rangle$ smaller at lower x_L ---more rescattering
- γ size $\sim 1/Q$ --- more rescattering at lower Q^2

Neutron detector



Leading neutron measurement:

$x_L > 0.2$ $\quad$ $(x_L = E_n/E_{beam})$

$\theta_n < 0.8\ mrad$ $\quad$ (limited by the magnets aperture)

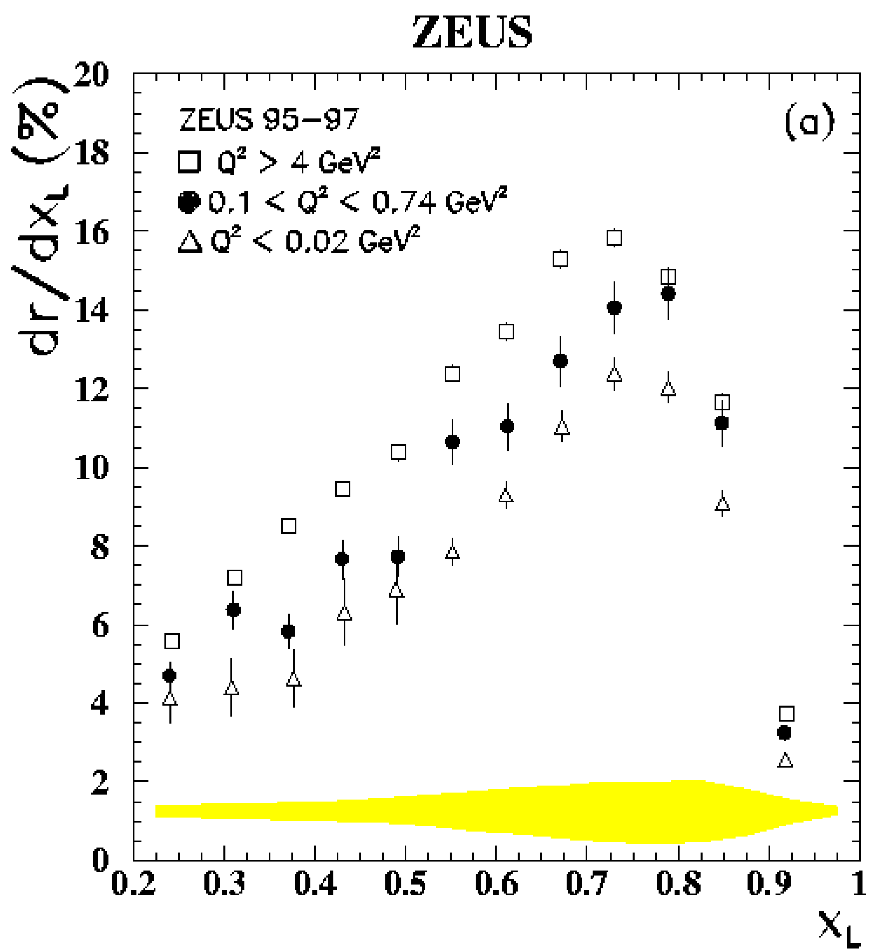
Results on neutron tagged PHP/DIS

Event selection:

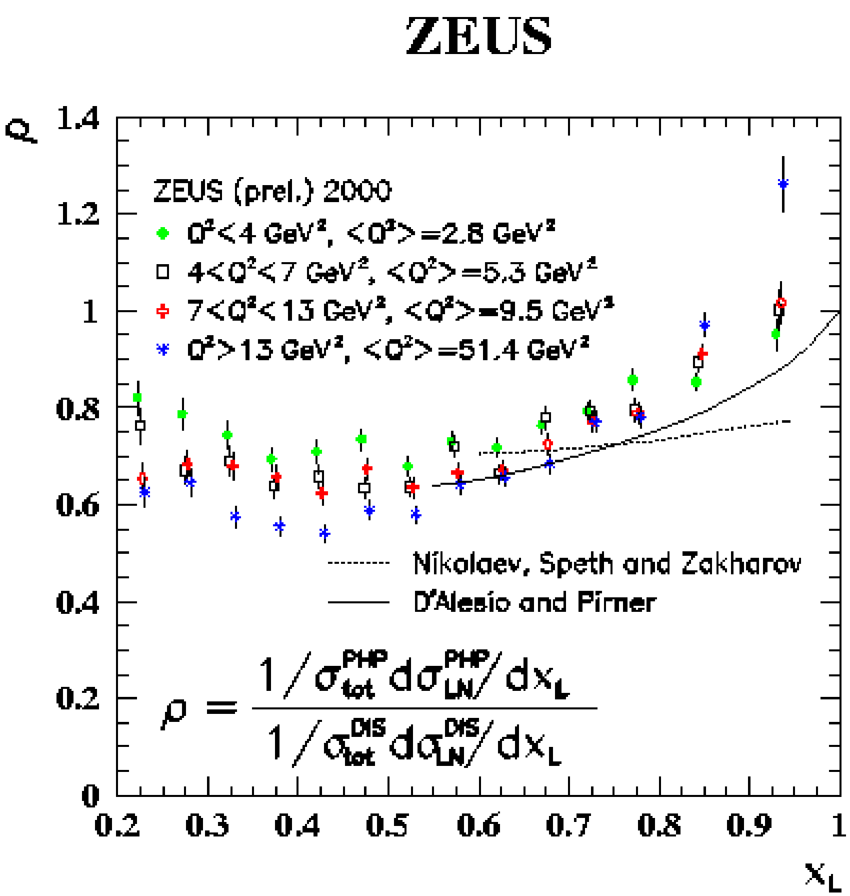
- ZEUS running period: *2000 ~ 9. pb* $^{-1}$
- neutron with (x_L > 0.2) detected in ZEUS forward neutron calorimeter
- PhP : $Q^2 \sim 0$ GeV^2
- DIS : Q^2 > a few GeV^2

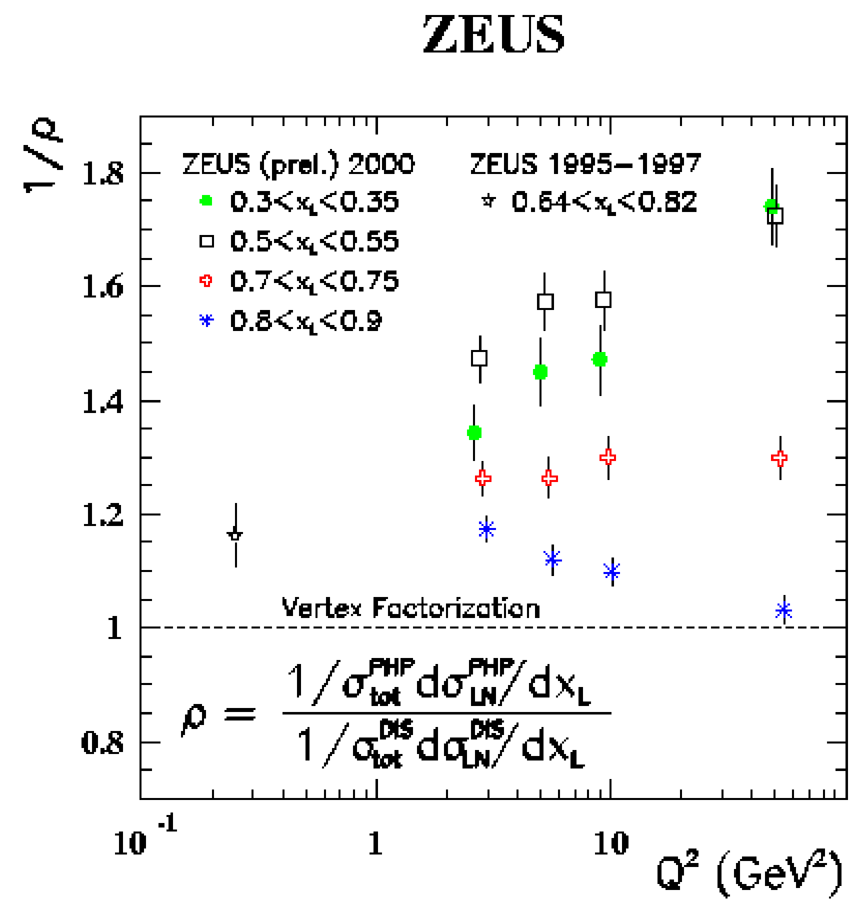
$$\rho(x_L) = \frac{\dfrac{1}{\sigma(\gamma p \to X)} \dfrac{d\sigma(\gamma p \to nX)}{dx_L}}{\dfrac{1}{\sigma(\gamma^* p \to X)} \dfrac{d\sigma(\gamma^* p \to nX)}{dx_L}}$$

$$= \frac{dr/dx_L(\mathrm{PhP})}{dr/dx_L(\mathrm{DIS})}$$

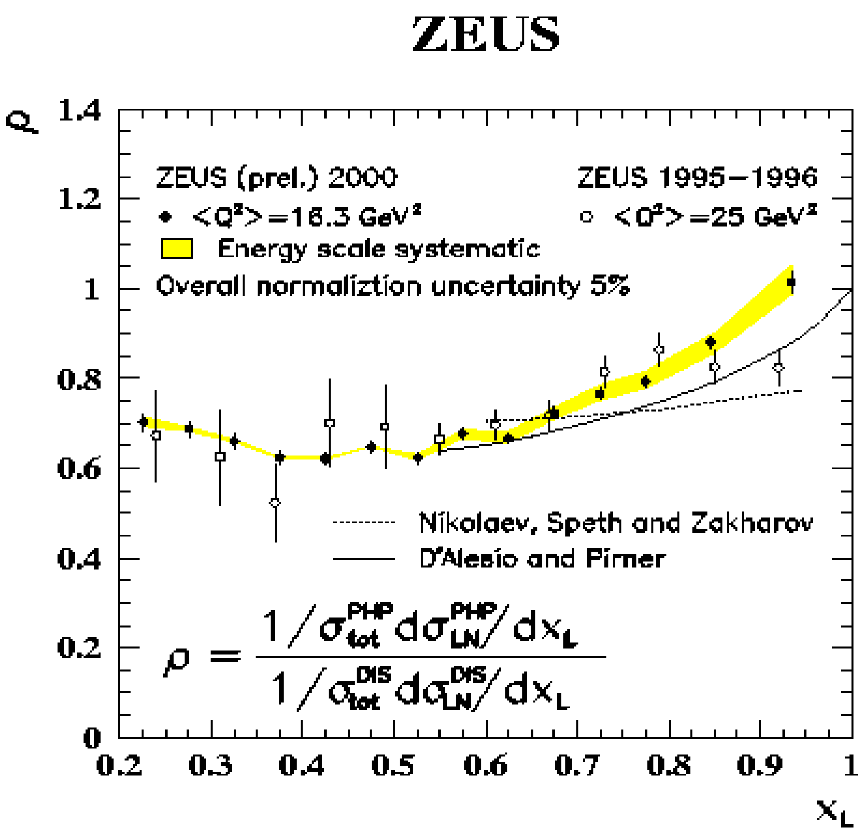


Results on neutron tagged PHP/DIS





- ratios depend weakly on x_L and Q^2
- qualitative agreement with D'Alesio and Pirner



Message from LN in PhP and DIS:

-Particle exchange models describe rate of baryons

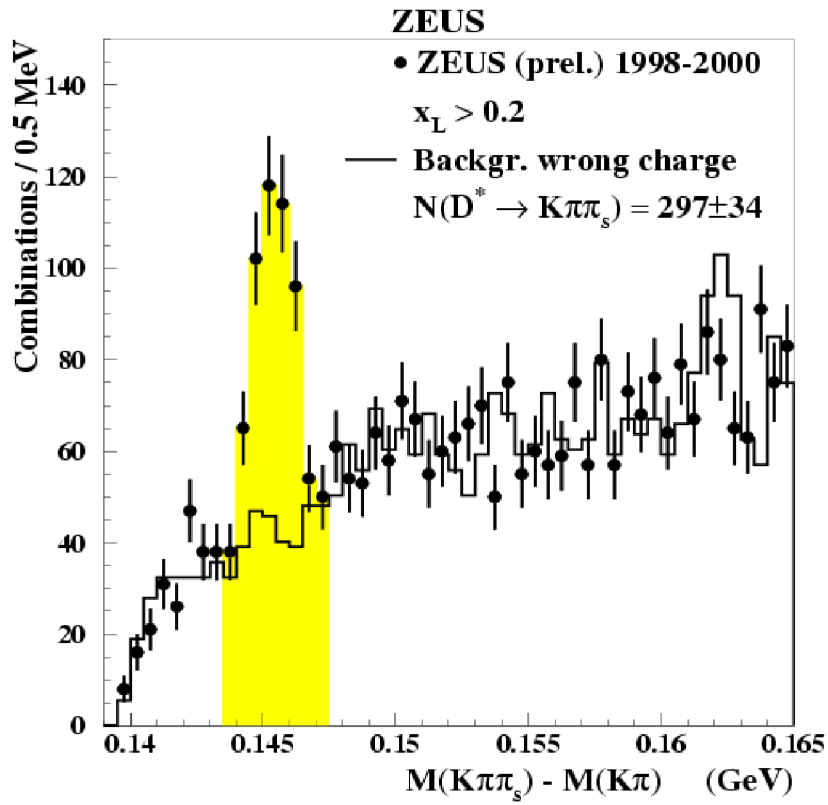
-Vertex factorization broken at low Q^2, form of violation varies with x_L

-Violation consistent with particle exchange, rescattering

Results on neutron tagged D PHP*

Event selection:

- ZEUS running period: *1998 to 2000 ~ 80.17 pb^{-1}*
  - Photoproduction events
  - *$117.3 < W < 274.3$ GeV*
  - Neutron in detected in ZEUS Forward Neutron Calorimeter
  - $0.2 < x_L < 1$, $\theta_n < 0.8$ mrad

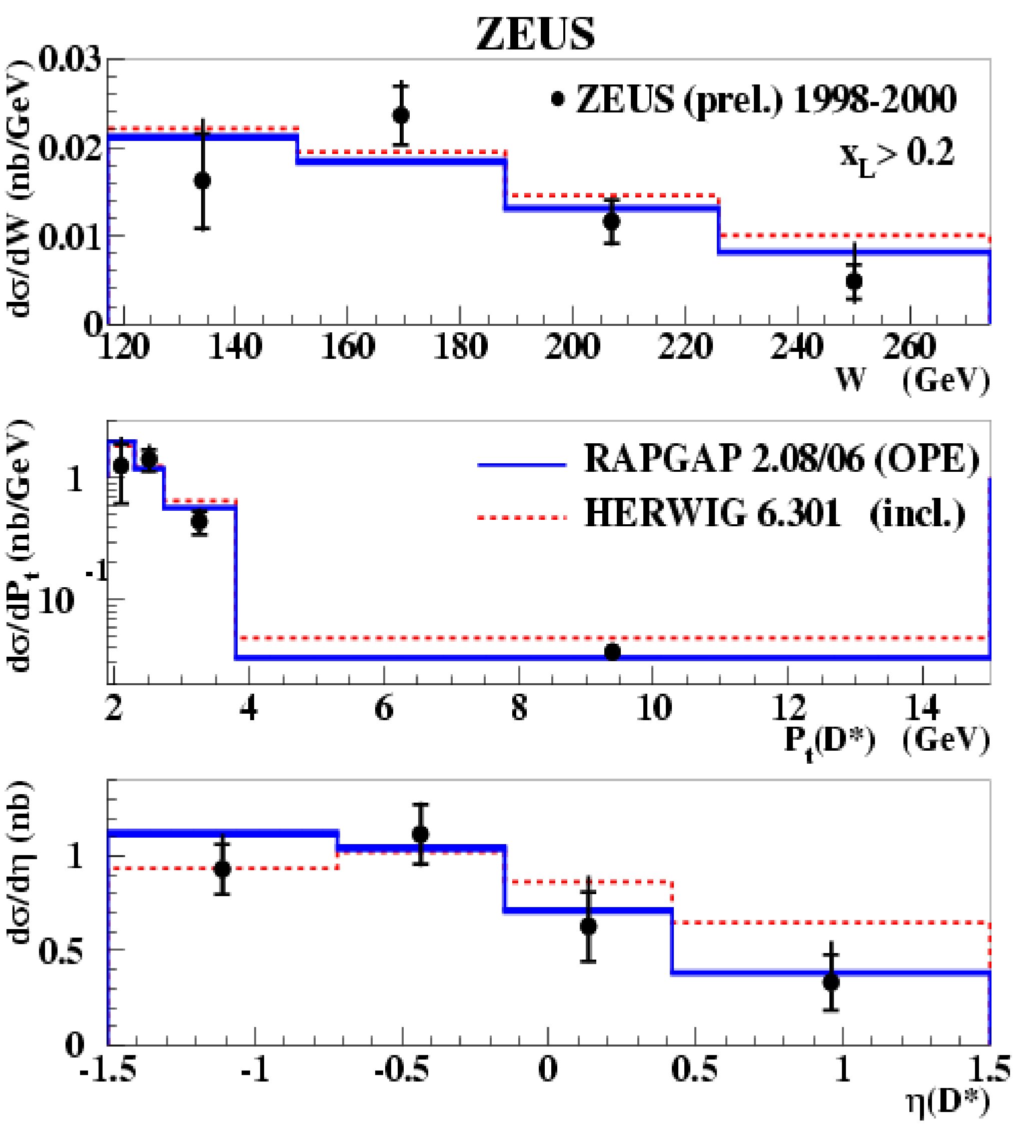


- D* decay mode: $D^{*\pm} \to D_0 \pi_s^{\pm} (\to K \pi^{\pm})$
- $P_t(D^*) > 1.9$ GeV
- $-1.5 < \eta(D^*) < 1.5$
- For the daughters:

  $P_t(\pi) > 0.120, 0.45$ (from D_0)

  $P_t(K) > 0.45$ (from D_0)

Results on neutron tagged D : cross sections*



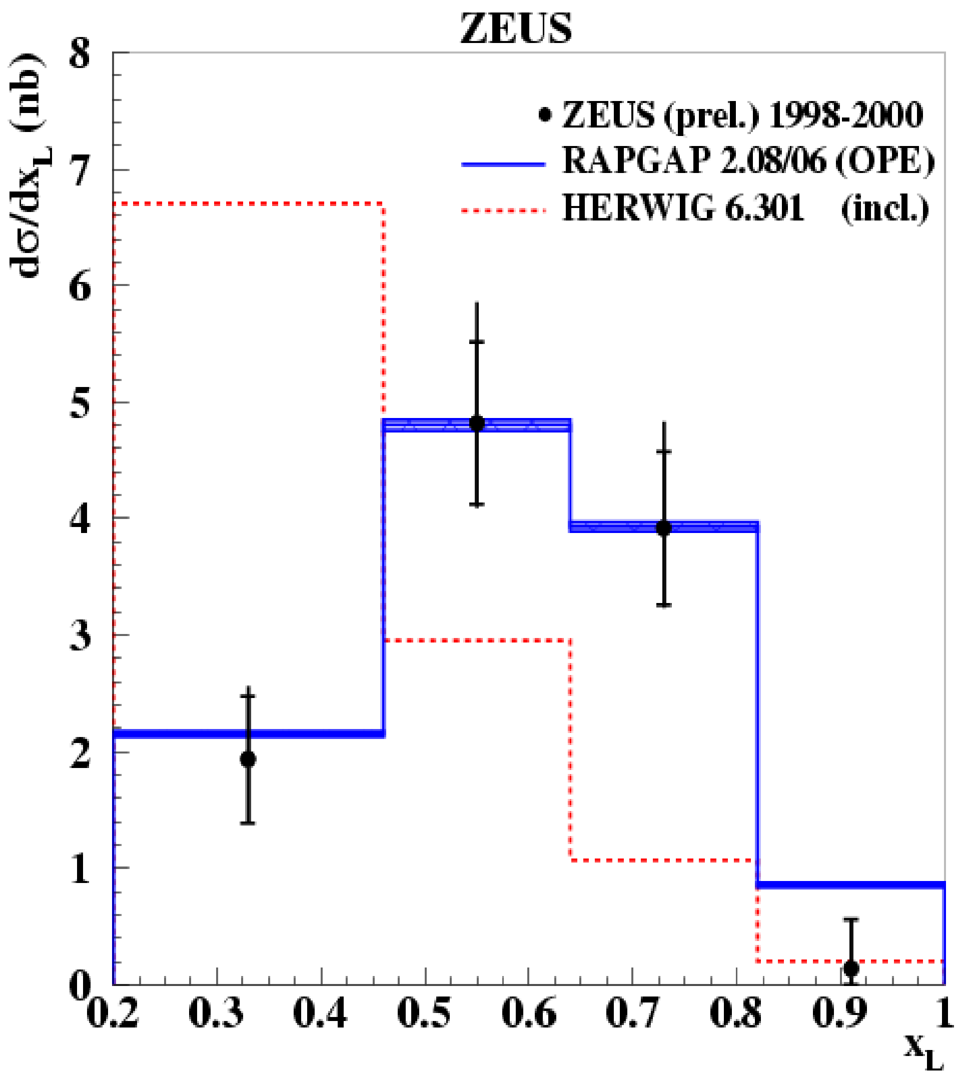
☛ **For W, η, P_t, both**

One Pion Exchange
(RAPGAP)

standard fragmentation
(HERWIG)

do a similar job

Results on neutron tagged D : cross sections*

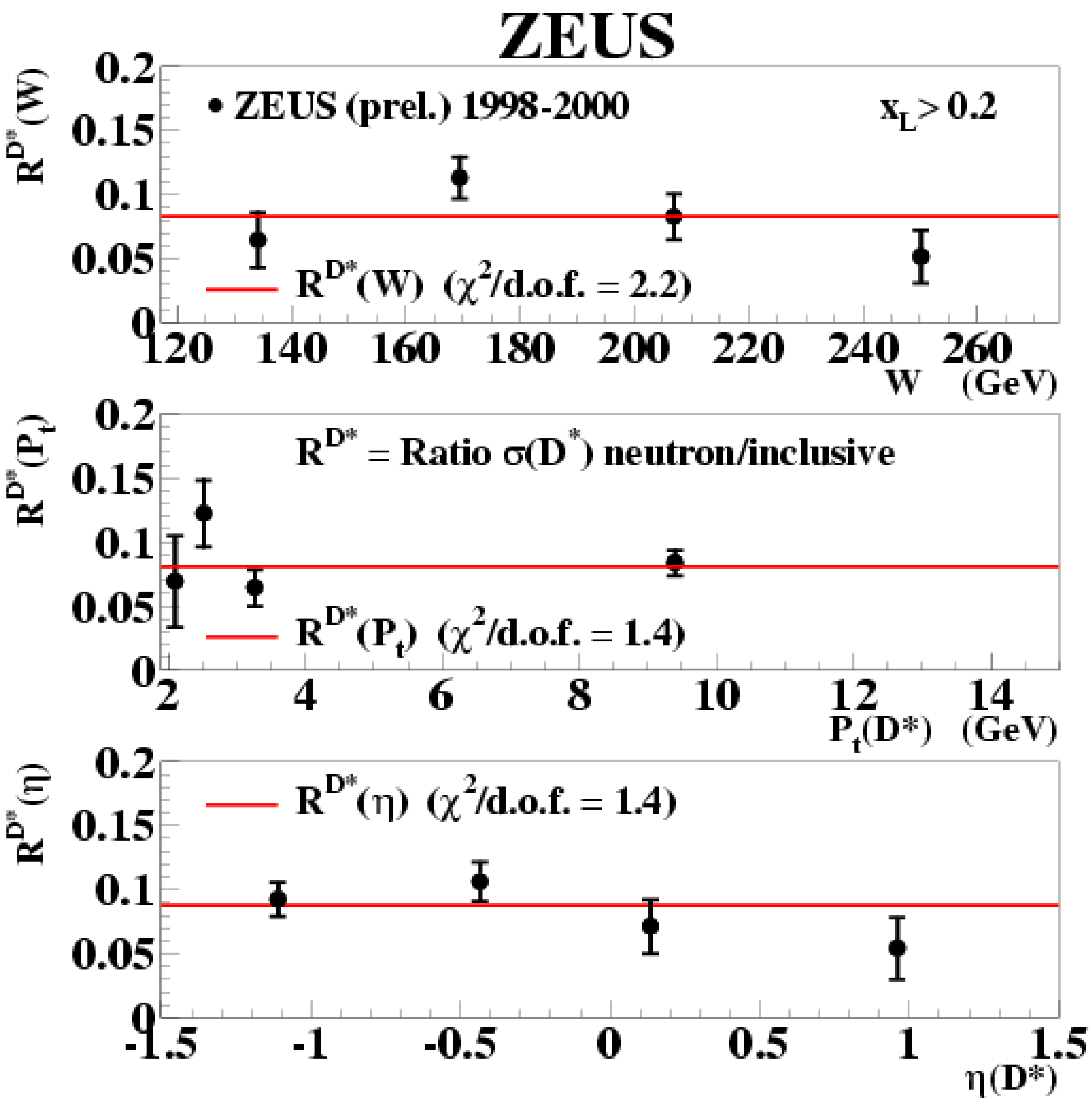


For x_L :

☛ *One Pion Exchange* (RAPGAP) describes the data

☛ *Standard fragmentation* (HERWIG) does not describe the data

Results on neutron tagged D : ratios tagged/inclusive*



Fits: R^{D^*} = constant
☛ Ratios are compatible with flat

Results on neutron tagged D : ratios tagged/inclusive*

ZEUS 98-00 (prel.)

$0.2 < x_L < 1$, $P_t(D^*) > 1.9$ GeV, $|\eta(D^*)| < 1.5$, $117.3 < W < 274.3$ GeV, PhP:

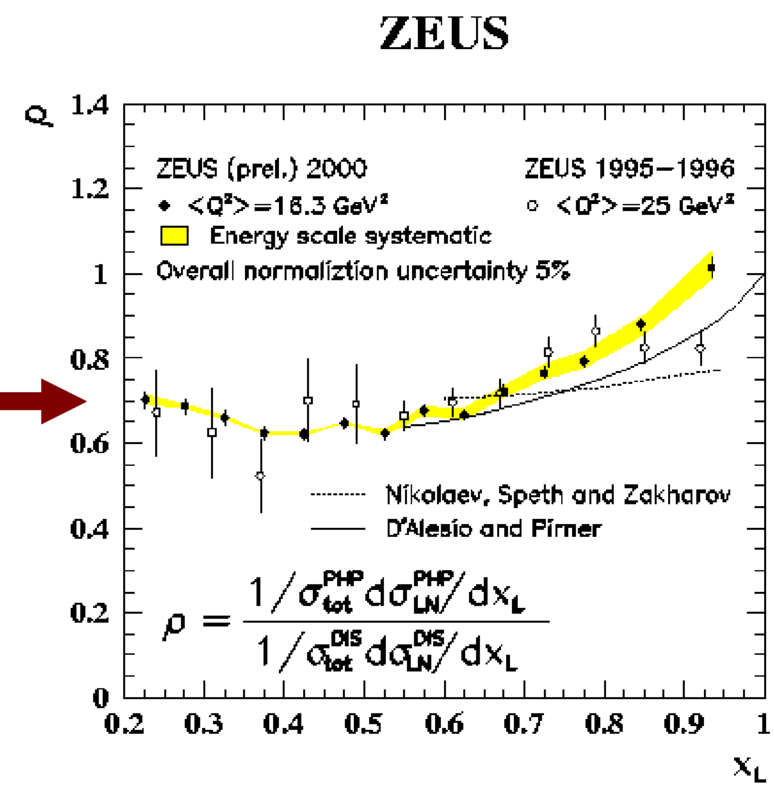
$$R^{D^*} = (\sigma^{D^*}_{LN} / \sigma^{D^*}_{inc}) = 8.1 \pm 0.9\ (\text{stat.}) \pm 0.3\ (\text{sys.})\ \%$$

ZEUS 95-97:

$R^{DIS} = (\sigma^{DIS}_{LN} / \sigma^{DIS}_{tot}) = 8.03 \pm 0.04\ \%$

$R^{incl} = (\sigma^{PhP}_{LN} / \sigma^{PhP}_{tot}) = 5.7 \pm 0.4\ \%$

$\rho = R^{incl} / R^{D^*} \sim 0.7$



$R^{DIS} = R^{D^*}$

For charm: hard scale $= m_c^2$

For DIS: hard scale $= Q^2$

Conclusions:

-Leading neutron production in DIS vs. PhP was studied at ZEUS

-Neutron tagged charm PhP was measured for the first time

-Neutron energy spectra and ratios ($\sigma^{D^*}_{\text{neutron tagged}}/\sigma^{D^*}_{\text{inclusive}}$) ~flat suggestive of particle exchange hypothesis

-D* ratio larger than inclusive PhP indicates factorization violation

- DIS results in agreement with charm results (hard scale)

hard scale: $Q^2 \sim m_c^2$

-Small vertex factorization violation observed

- All results are compatible with particle exchange models