Dijet production in diffractive DIS and photoproduction at ZEUS

DIS 2007

Diffraction and vector mesons parallel session

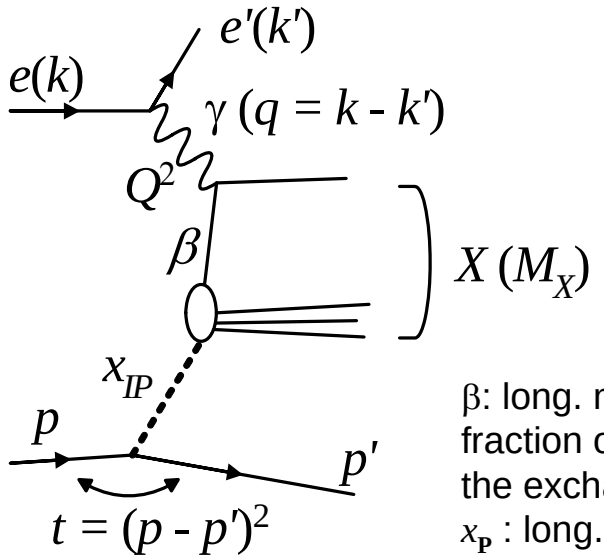
17 April 2007, Munich, Germany

Yuji Yamazaki (Kobe University, ZEUS)

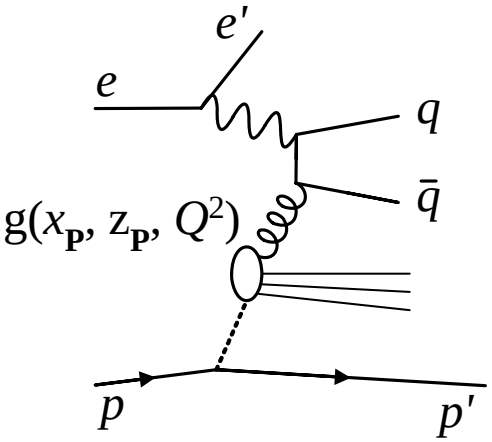
On behalf of the ZEUS collaboration

Introduction: why jets in diffraction

- Diffractive parton densities:
  - Extracted from $F_2^{D(3)}$ (DDIS) sensitive to quarks
  - Gluons from scaling violation, poorer constraint



β: long. momentum fraction of the parton in the exchange
$x_{\mathbf{P}}$: long. momentum fraction of the exchange in the proton



- Jets are produced mainly by BGF diagram
  - Directly sensitive to gluons
  - Dijet events allows to reconstruct $z_{\mathbf{P}}$, the longitudinal momentum fraction of the parton in the exchange.

Jet cross sections and factorisation

- Jet cross sections can be calculated in pQCD using the factorisation formula
  - Example: jet cross section $d\sigma/dE_T$ at given $x_{\mathbf{P}}$

$$\left.\frac{d\sigma_{\gamma^* p}}{dE_T}\right|_{x_{\mathbf{P}}} = \sum_i \int dt \int_x^{x_{\mathbf{P}}} [dz \frac{d\hat{\sigma}^{i\gamma^*}(z,\mu^2,x_{\mathbf{P}})}{dE_T} f_i^{\,D}(z,\mu^2,x_{\mathbf{P}},t)]$$

$\sigma^{i\gamma^*}$: photon - parton cross section

$f_i^{\,D}$: diffractive parton densities

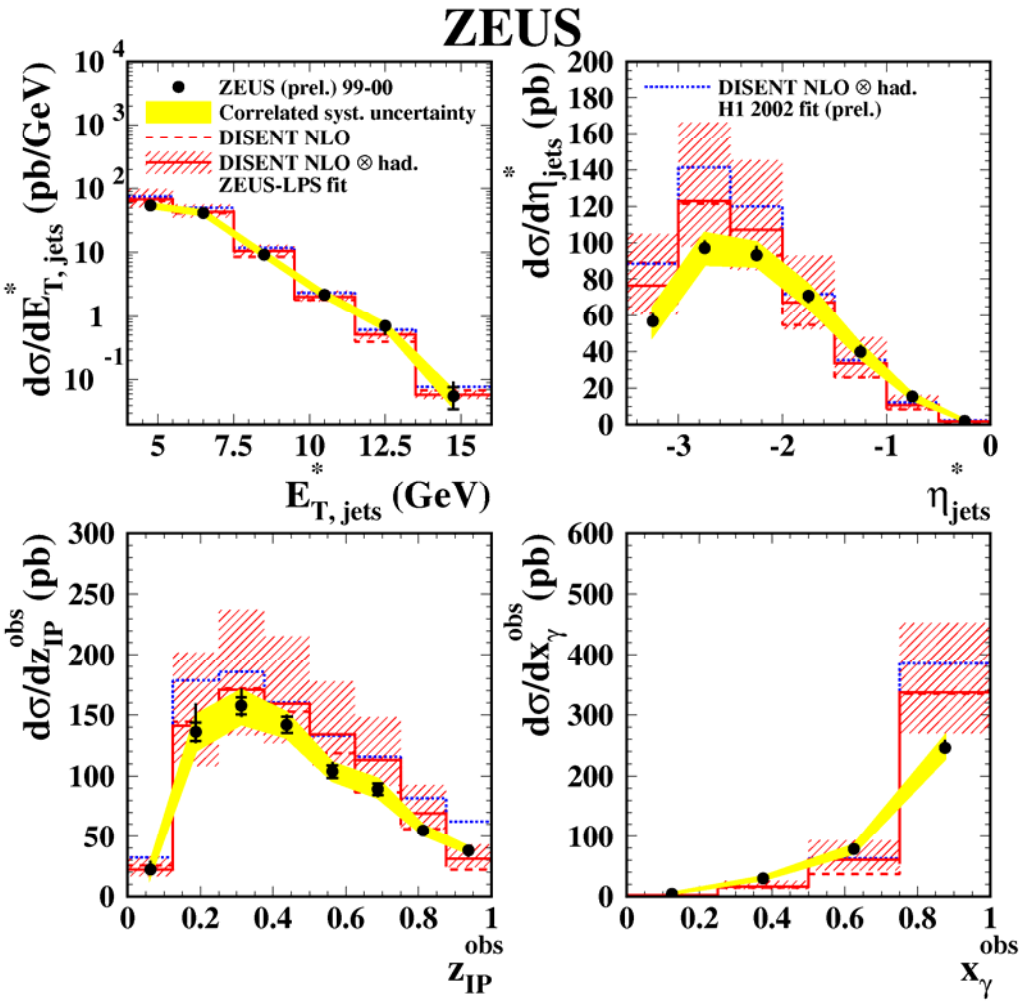
- They can give constraint to the gluons in the diffractive exchange, **assuming the factorisation**
  - OK for DIS, diffractive factorisation theorem proven
- In photoproduction, factorisation may not hold
  - Test of factorisation using the parton densities that describe the DIS dijet cross sections

Dijets in DIS – comparison with NLO

Preliminary in EPS05

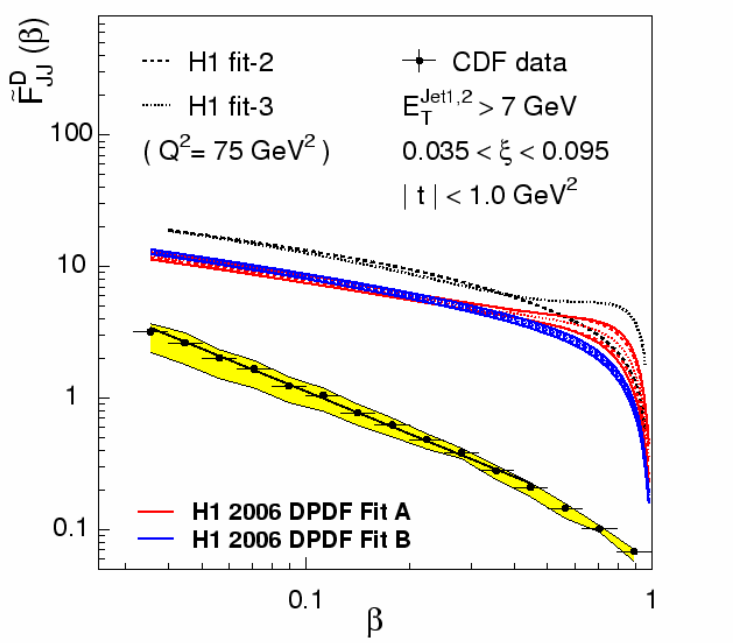
- Long. invariant k_T R = 1.0, γ*p frame
- $E_{T1} > 5$ GeV, $E_{T2} > 4$ GeV
- $5 < Q^2 < 100$ GeV^2, $100 < W < 250$
- $x_{\mathbf{P}} < 0.03$

- Good agreement with the NLO within uncertainty, using
  - H1 fit 2002
  - ZEUS LPS – using D* in DIS in the fit
- Good sensitivity to the gluon density

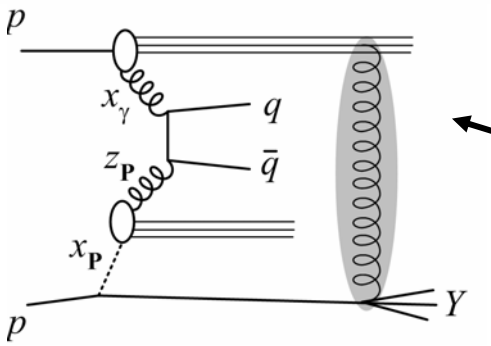


Photoproduction: testing factorisation

Paul Newman/H1

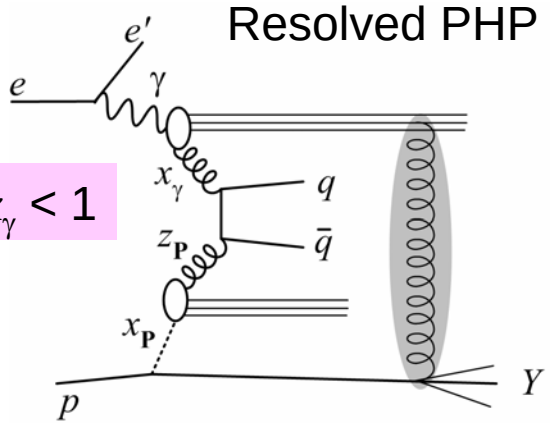


- The famous factorisation breaking in pp diffraction
  - Thought to be re-scattering effect
- It is claimed that …
  - The suppression should be in the hadron-like resolved photon
  - Not in direct events



Colour-octet filling the rapidity gap

Resolved PHP



$x_\gamma < 1$

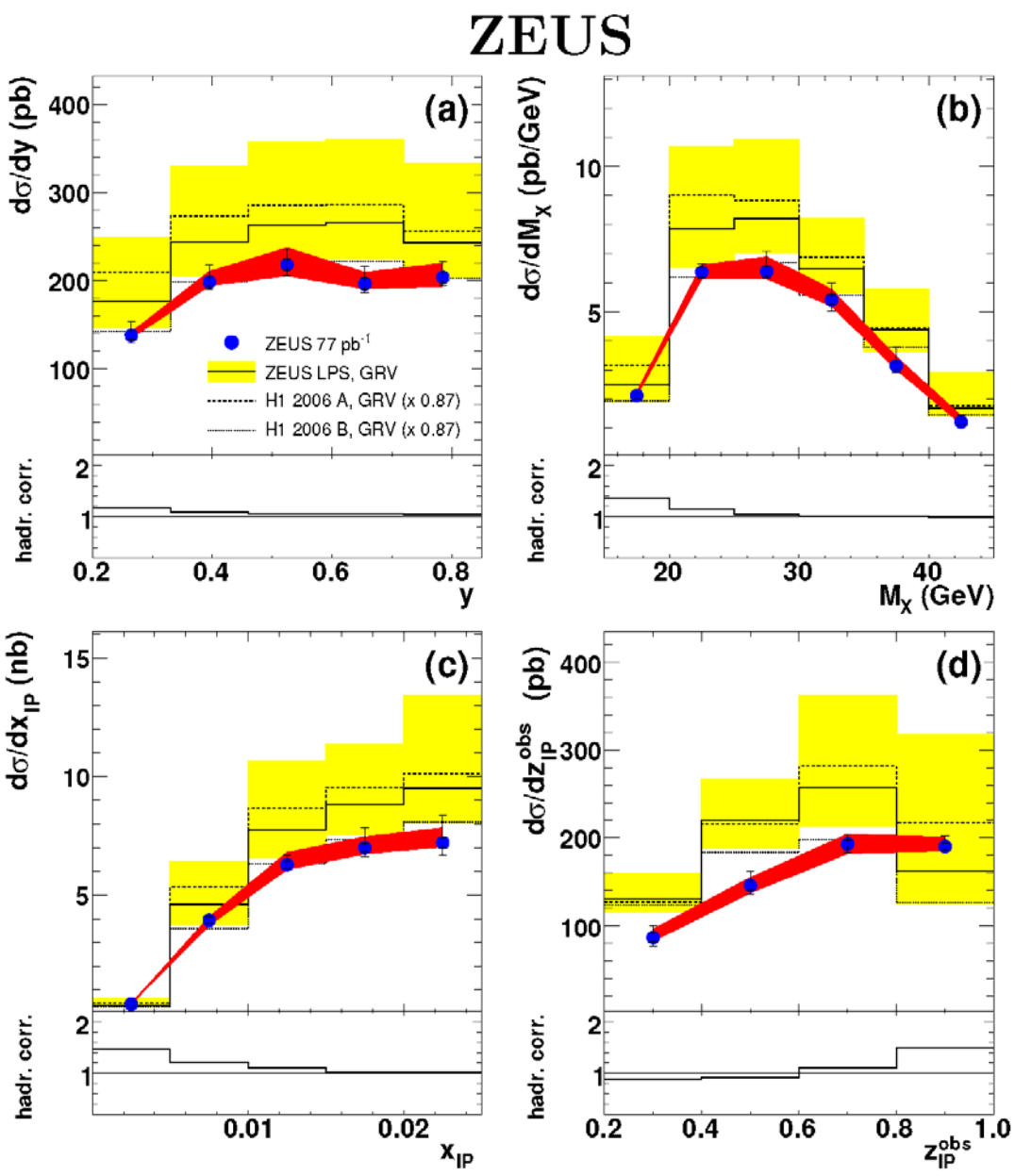
"Final" result on diffractive dijets in photoproduction

- Long. invariant k_T R = 1.0, LAB frame
- $E_{T1} > 7.5$ GeV, $E_{T2} > 6.5$ GeV
- $Q^2 < 1$ GeV^2, $0.2 < y < 0.85$
- $x_{\mathbf{P}} < 0.025$

- **Data are final,**
  In comparison with the NLO calculation using the program from Klasen+Kramer
- Note on the NLO calculation
  - We implemented recent DPDFs in the program
  - However, the code could not exactly reproduce the H1 cross section predictions from Frixione+Ridolfi
    - Agreeing by ~ 10%, shape slightly different
  - Asking for cross-check to Michael Klasen
- NLO calculations in the plots are **preliminary**
  Following discussion assumes they are correct by ~10%.

PHP dijets – entire x_γ^{OBS} range

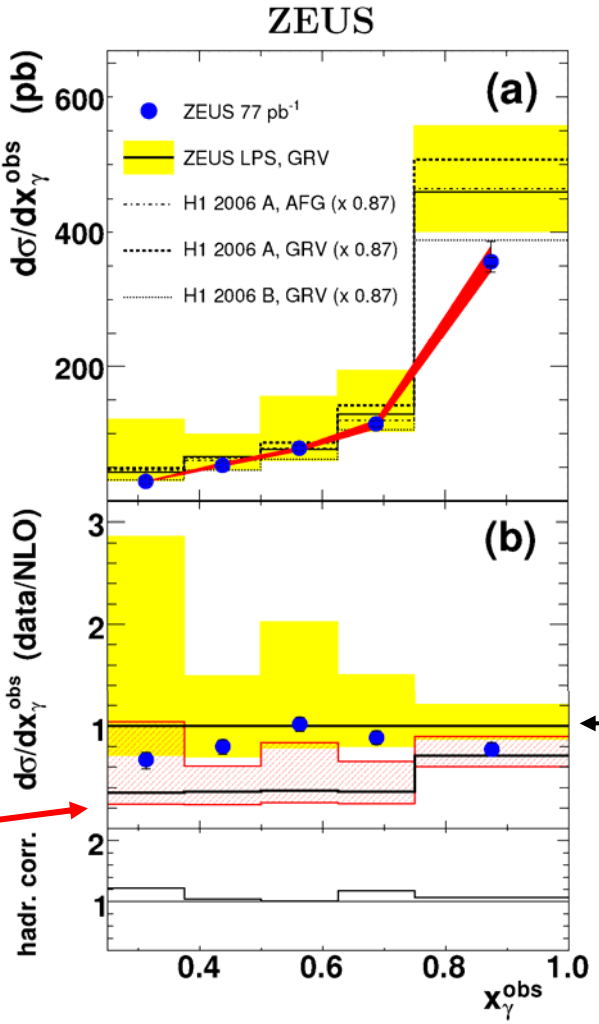
- **No strong evidence of the cross section suppression**
- Good agreement with H1 2006 fit B PDF
  - H1 2006 Fit A and ZEUS LPS: ~ 20 % higher, but within uncertainty



Direct / resolved ?

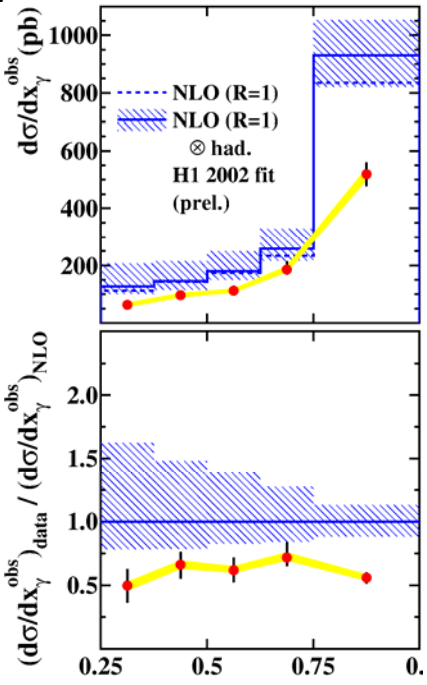
Cross section vs. x_γ^{OBS}

- Good agreement in shape and normalisation
- Update from our preliminary:
  - Data changed but within systematic error
  - Proton dissociation was subtracted for the data, but not for the H1 2002 fit, used in the NLO calculation. Now it is subtracted (13 % for the H1 DPDFs).
  - We used to compare with H1 2002 (prel.) fit. The ZEUS LPS (left plot) gives smaller cross sections (~ 10%)



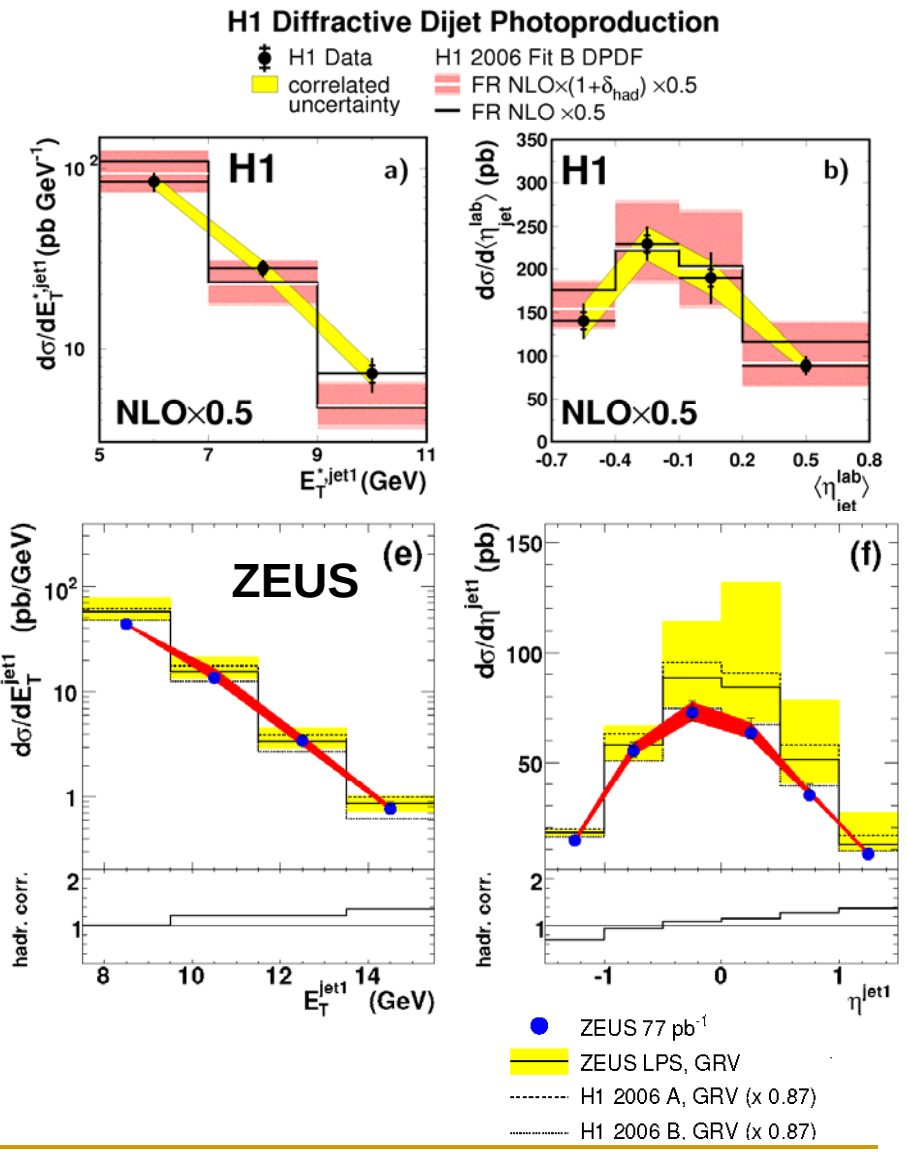
NLO, resolved suppressed by R = 0.34 (factor calculated from the CDF-H1 comparison by Kaidalov et al.)

Ratio to ZEUS LPS +GRV γ



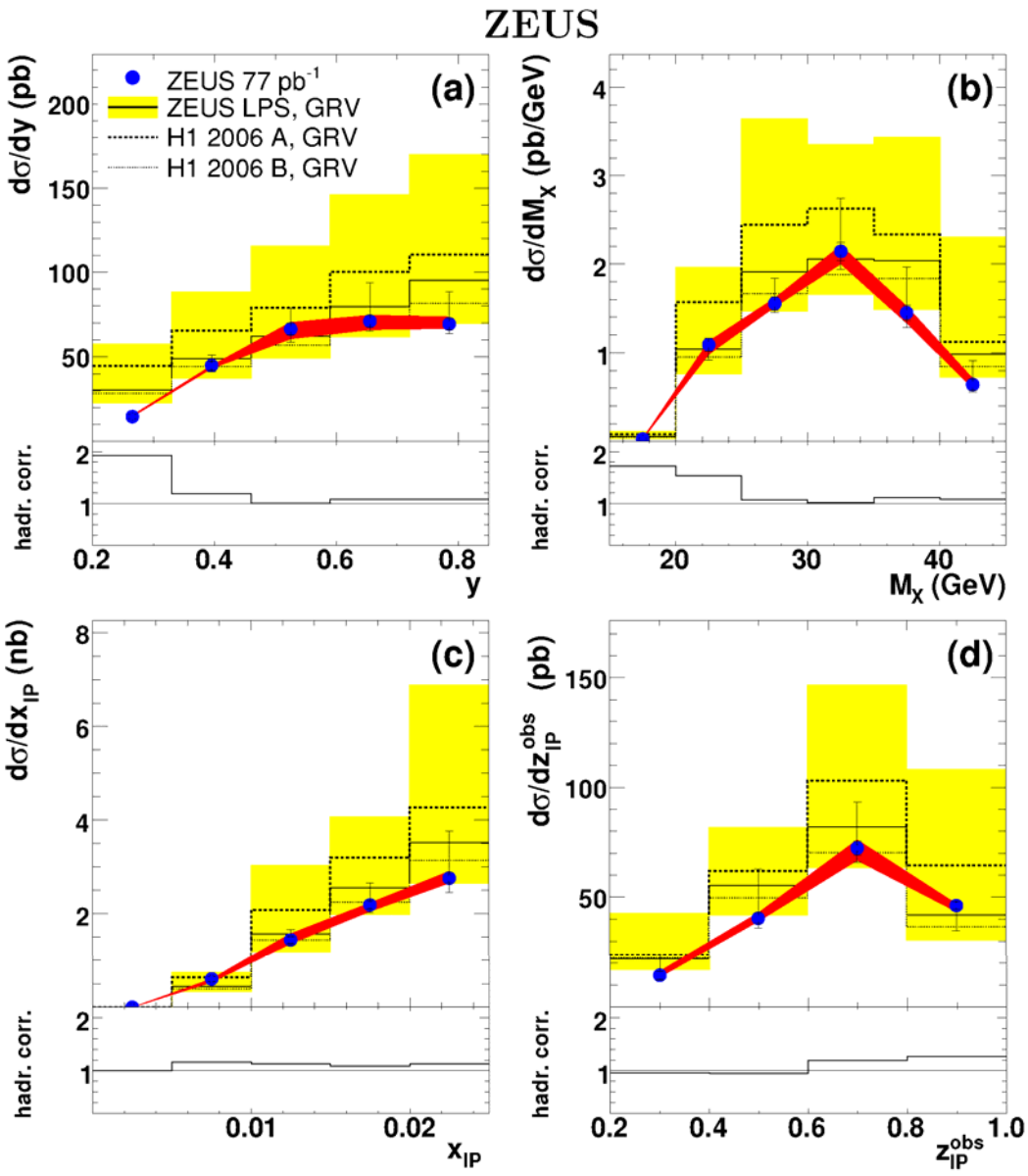
Message inconsistent with H1? No!

- H1 starts at lower E_T^{jet}
  - H1: $E_T^{\text{jet1}} > 5$ GeV
  - ZEUS > 7.5 GeV
- x_P range:
  - H1: < 0.03, ZEUS < 0.025
- E_T^{jet1} in the data seems harder than the NLO
  - Both in H1 and ZEUS
  - Seems the reason to have more suppression at low E_T^{jet} i.e. the H1 result
- Problem in the NLO? Or, suppression only at low-E_T^{jet} events?



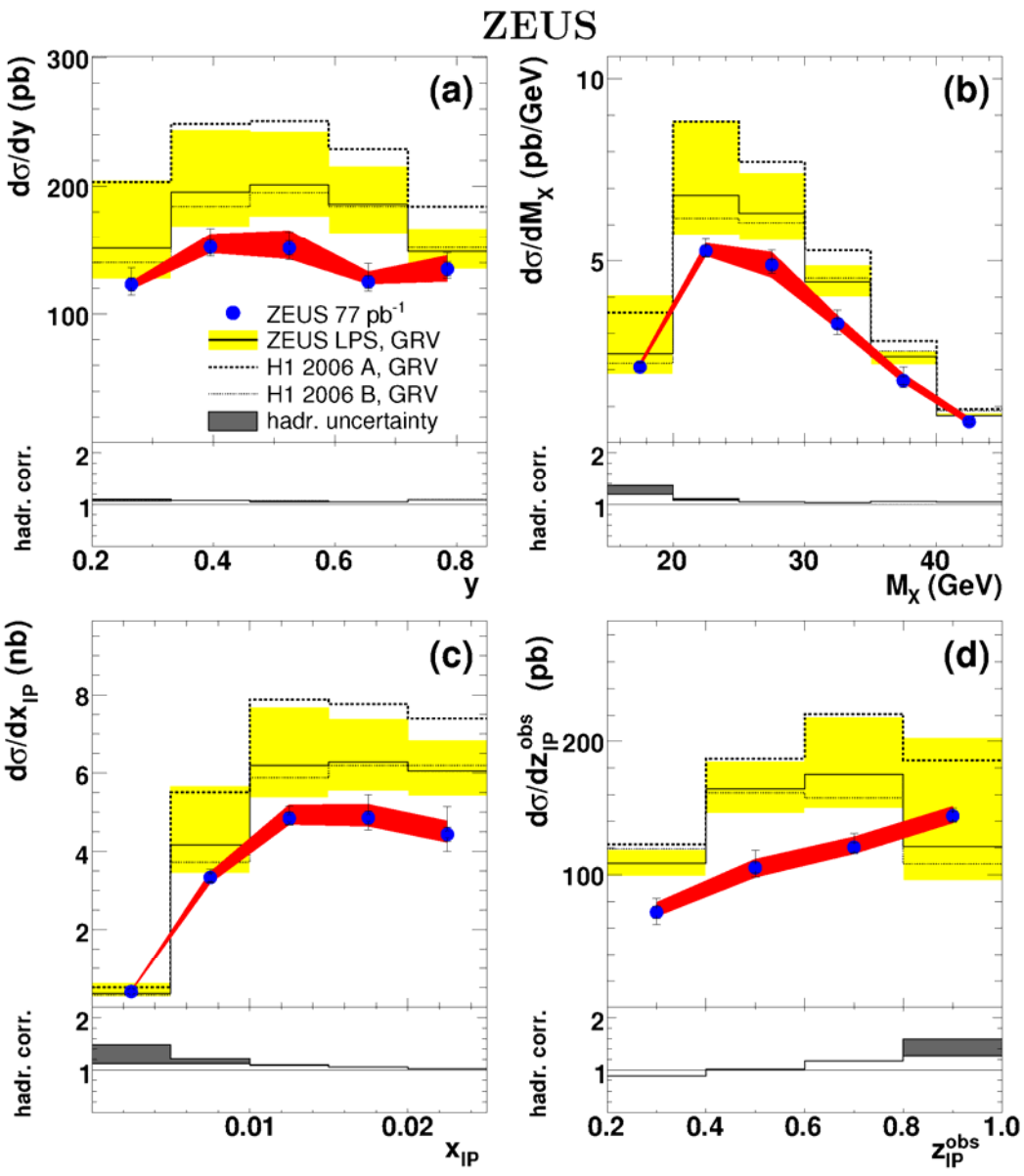
More in detail: $x_\gamma^{OBS} < 0.75$ (resolved enriched)

- Good description by the NLO in general
- H1 2006 fitB and ZEUS LPS are preferred
  - Within the scale uncertainty, though



$x_\gamma^{OBS} \geq 0.75$ (direct enriched)

- NLO giving fair description of the data

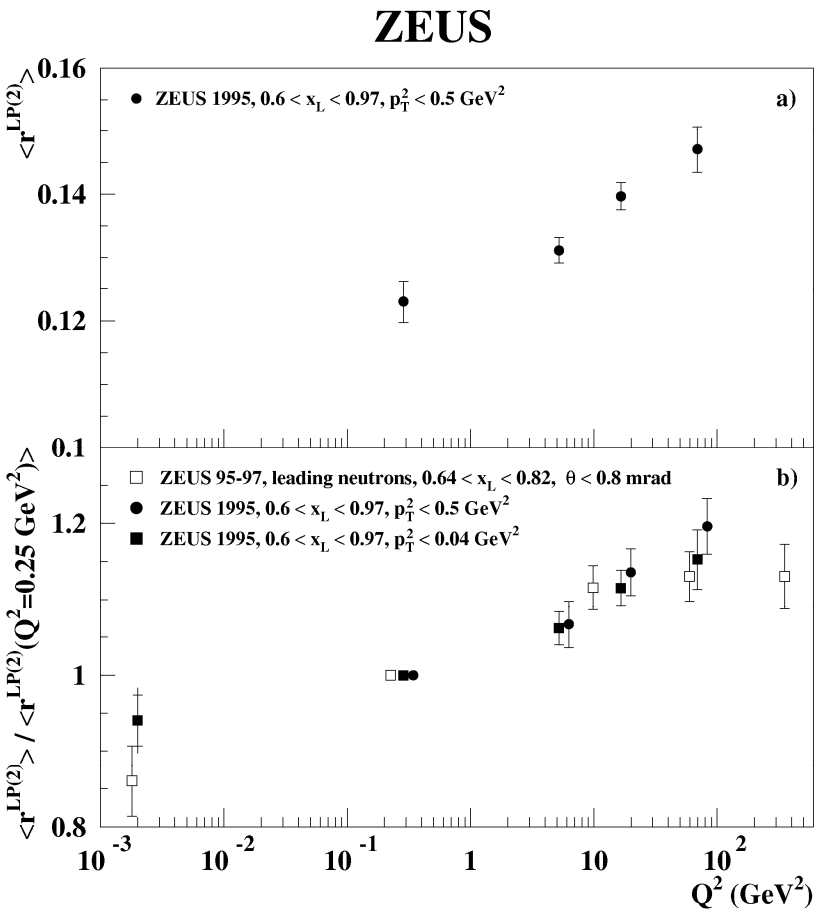


Conclusions on the ZEUS dijet data

- DIS dijet agrees with the DPDFs (H1 2002(prel.), LPS+D*)
- ZEUS PHP measurement for Et > 7.5 GeV :
  - fairly good agreement with the NLO prediction with the recent parton densities, which describe the DIS jet data
  - No strong factorisation breaking
- No conflicting message with H1
  - H1 measures at lower E_T, higher $x_{\boldsymbol{P}}$
  - E_T distribution may not be well reproduced by NLO: Low-E_T cross section tend to be low, for both H1 and ZEUS

Small suppression at PHP: déjà vu?

- Example: leading baryons
  - $0.6 < x_L < 0.97$ for proton
  - $0.6 < x_L < 0.82$ for neutron
- About 20% suppression in photoproduction
- Explained by absorption models: more in W. Schmidke's talk
  - Models say suppression of small configuration = high-Pt events → Suppression depending on B-slopes



Discussion

- There seems no large suppression in the PHP cross sections but for small-E_T^{jet} events (H1).
- The suppression is both in direct and resolved, if any.

- Is the HERA PHP data consistent with the re-scattering models explaining the Tevatron suppression?
  Apparently not, both in quality and quantity.

- We need more direct comparison between Tevatron and HERA
  - Measure in the same $x_{\boldsymbol{P}}$ range (Pomeron vs Reggeon)
    Tevatron data are 0.035 < ξ ($x_{\boldsymbol{P}}$) < 0.095, HERA ~ 0.02
  - B-slope, the same between Tevatron and HERA?