Dijets in Diffractive DIS and Photoproduction

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for the
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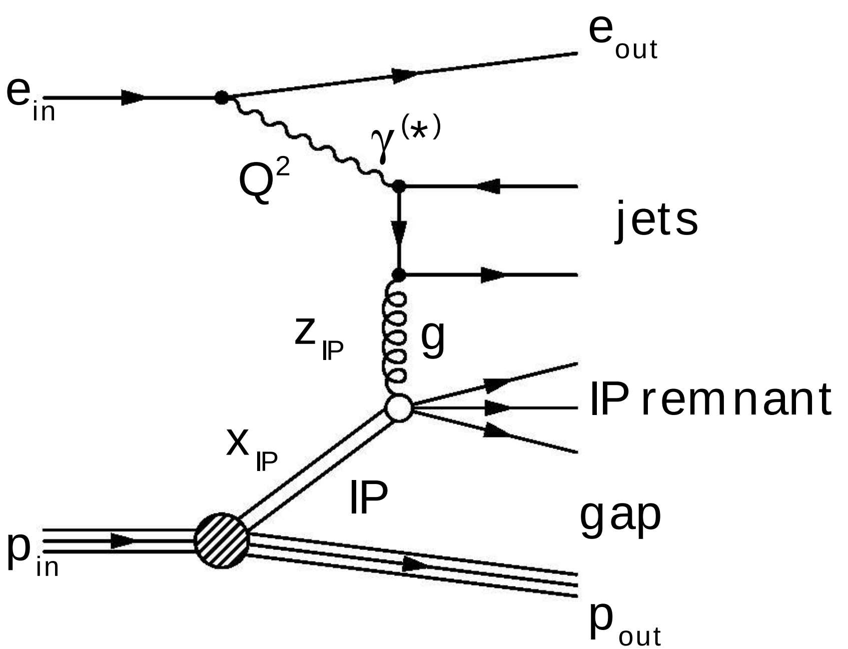
Introduction



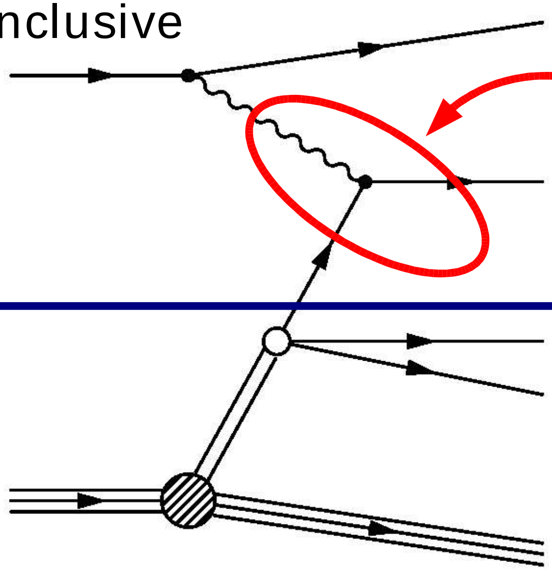
- compare DIS, γp in same kinematic range
- test QCD-factorization in γp and DIS
- direct access to gluon density of pomeron (IP)

important quantities:

Q^2: photon virtuality
x_{IP}: fractional proton momentum loss
z_{IP}: gluon momentum fraction

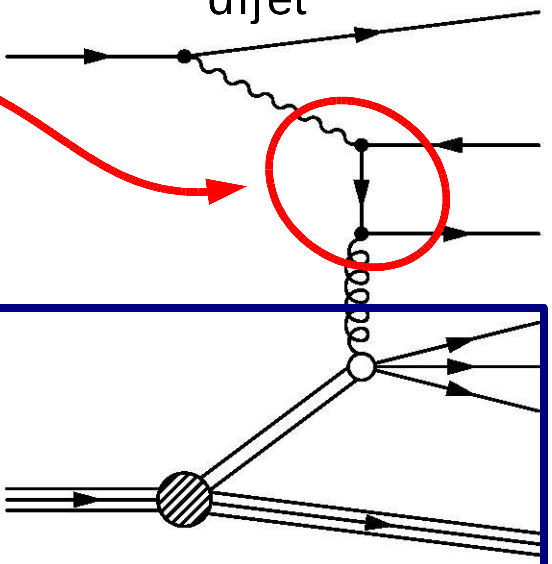
QCD- Factorization

inclusive



hard scattering
QCD- matrix element
perturbatively calculated
process- dependent

dijet



universal diffractive
parton densities
identical for all
processes

1) measure parton densities with inclusive diffraction
2) use to predict dijet cross section

- proven for DIS (J. Collins, Phys. Rev **D57** (1998) 3051, erratum ibid. **D61** (2000) 019902)
- not proven for photoproduction

Diffractive Parton Densities

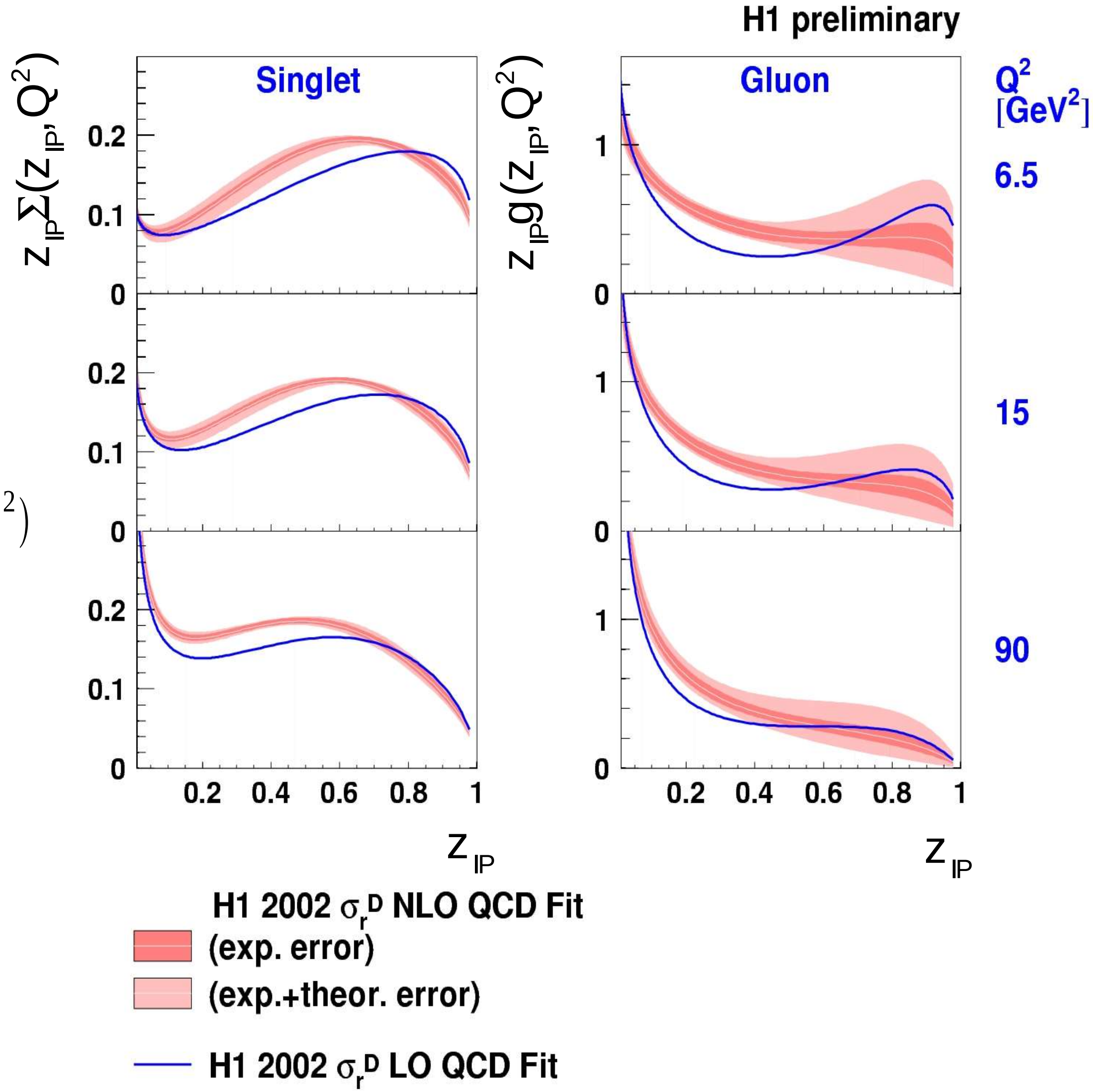
- determined from NLO-QCD- analysis of diffractive structure function

$$\sigma^D = \sum_{partons\,i} f_i^D(x_{IP}, z_{IP}, Q^2) \otimes \sigma^{\gamma i}$$

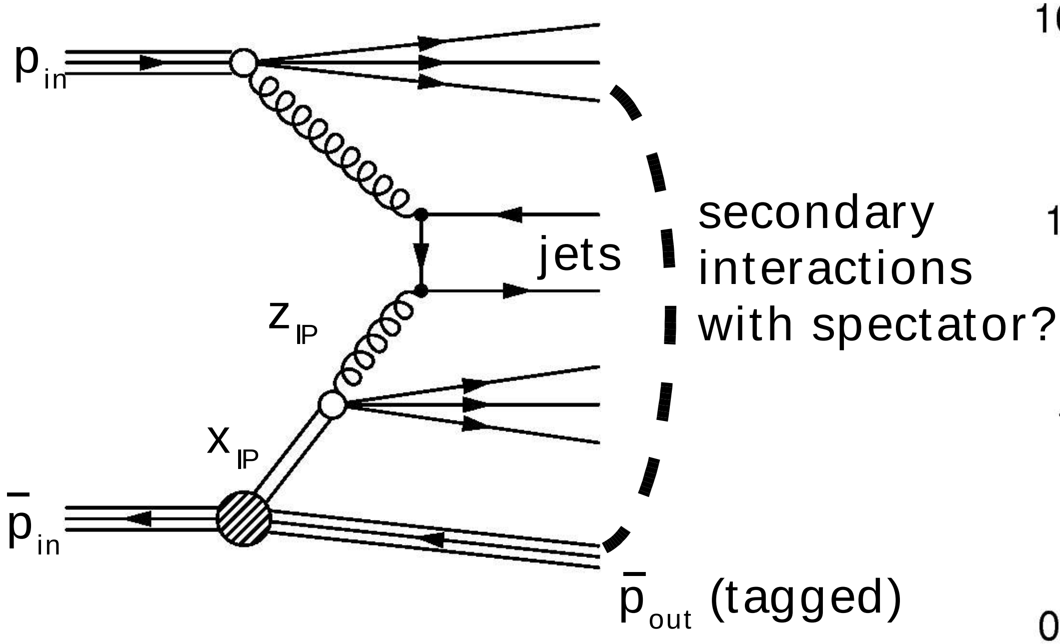
- parametrized as

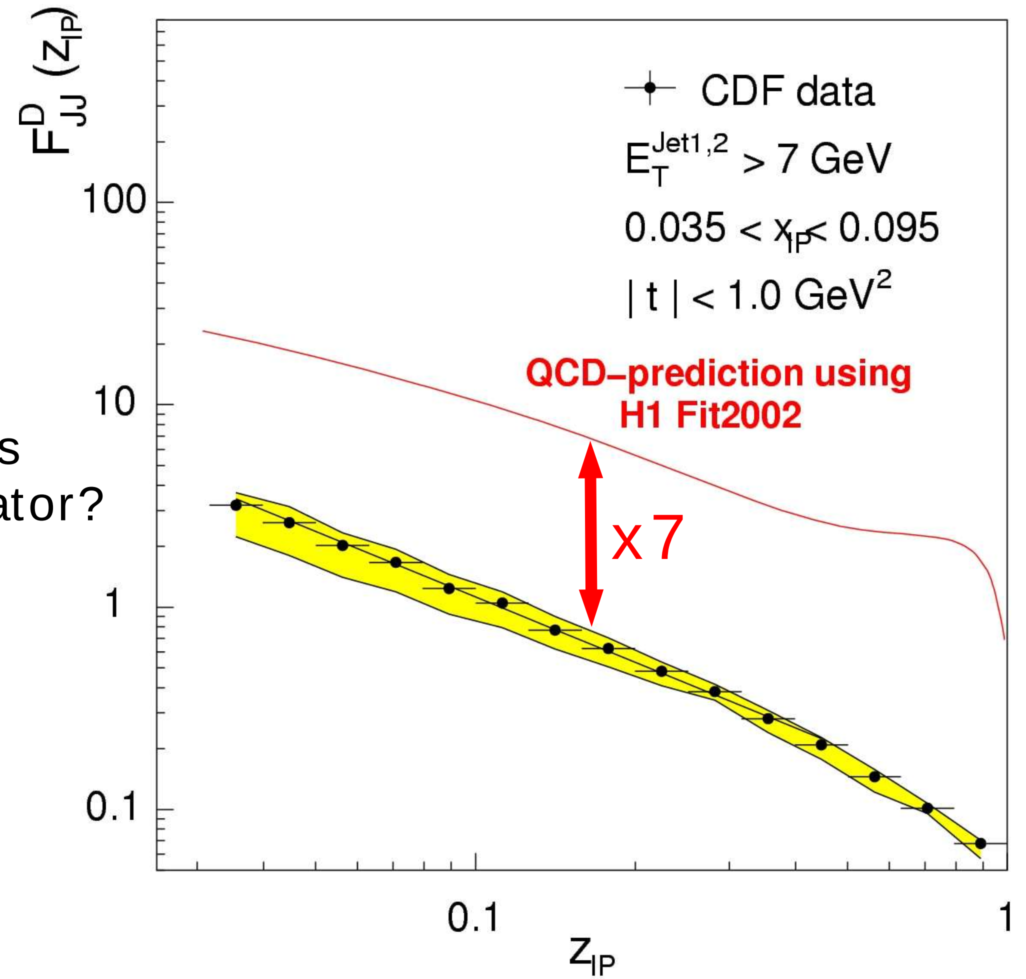
$$f_i^D(x_{IP}, z_{IP}, Q^2) = f_{IP\,flux}(x_{IP}) \cdot f_{IP\,PDF}(z_{IP}, Q^2)$$

- gluon carries 75%of pomeron momentum
- large uncertainty at high z_{IP}



Single- Diffractive Dijets at the Tevatron

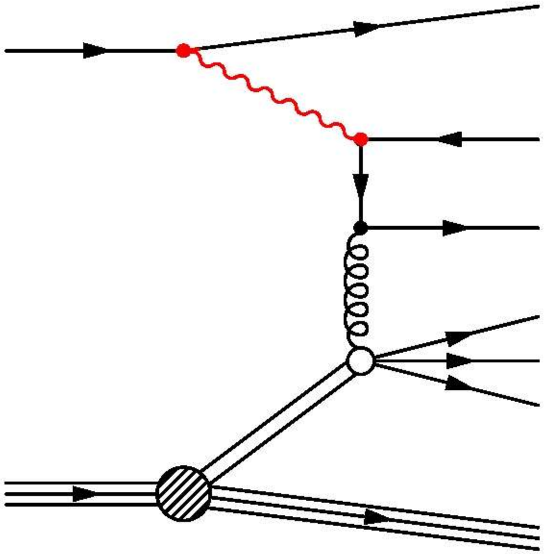




HERA PDFs don't work! why?

CDF Collaboration, T. Affolder *et al.*, Phys. Rev. Lett. **84** (2000) 5043

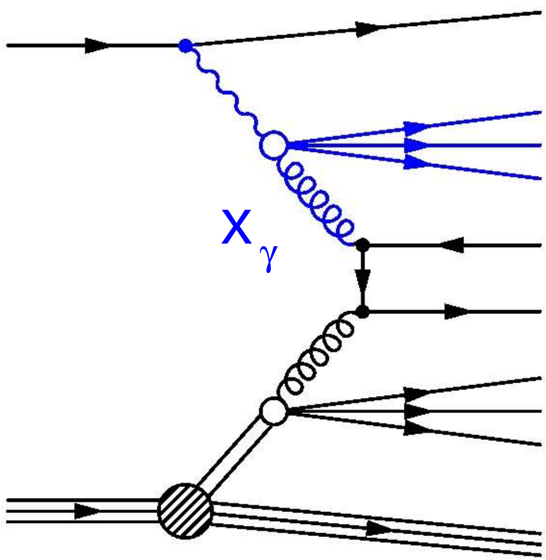
Direct and Resolved Processes at HERA



DIS ($Q^2 > 4$) and
direct photoproduction ($Q^2 \cong 0$):

- photon directly involved in hard scattering process
- $x_\gamma = 1$

x_γ: momentum fraction of hard scattered parton in γ

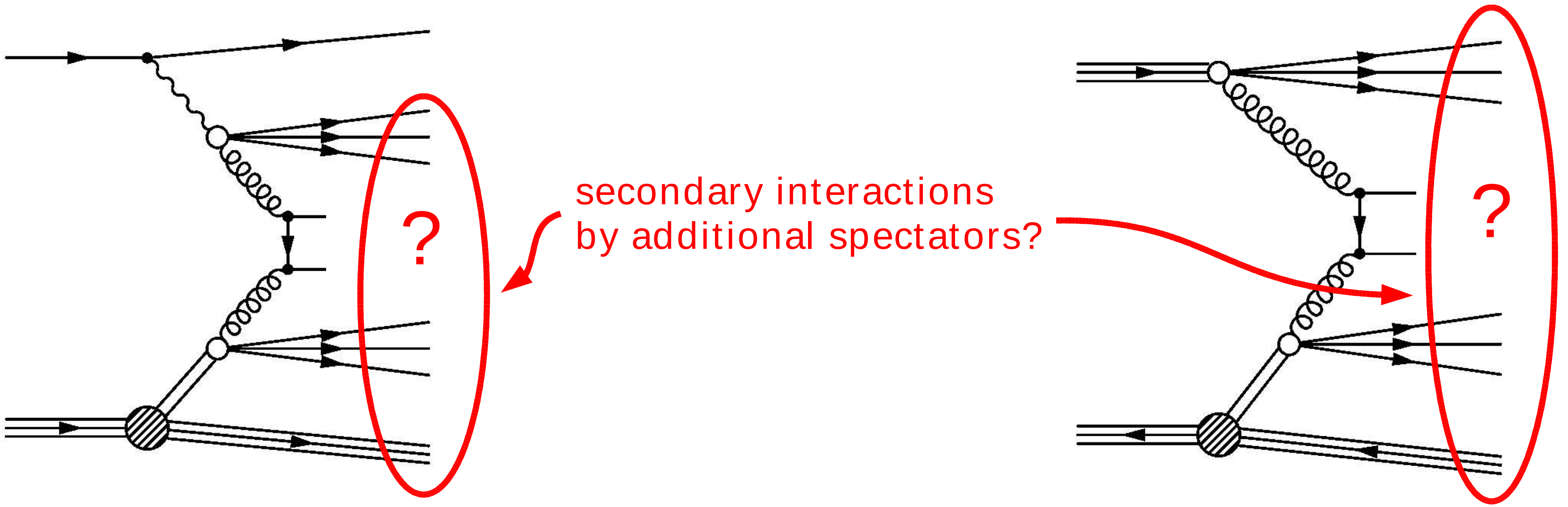


resolved photoproduction:

- photon fluctuates into hadronic system, which takes part in the hard scattering
- contributes at low Q^2, large contribution in γp
- $x_\gamma < 1$

Photoproduction as Hadronic Interaction

HERA Tevatron



typical models that describe suppression at Tevatron assume secondary interactions of spectators as the cause

$\Rightarrow$ resolved contribution expected to be suppressed by factor 0.34 (Kaidalov, Khoze, Martin, Ryskin, Phys. Lett **B567** (2003) 61)

Data Sample and QCD predictions

DIS

$4 < Q^2 < 80\ GeV^2$

DISENT
Catani, Seymour,
Nucl. Phys. **B485** (1997) 29
[erratum-ibid. **B510** (1997) 503]

$\mu_r = E_T{}^*(jet1)$
$\mu_f = 6.2 GeV = \langle E_T{}^*(jet1) \rangle$

$L = 18 pb^{-1}$ (96/97)
$165 < W < 242 GeV$
$x_{IP} < 0.03$
k_t-algorithm
$p_{t,jet1} > 5\ GeV$
$p_{t,jet2} > 4\ GeV$

NLO-predictions

H1-Fit2002
Diffractive PDFs

Photoproduction

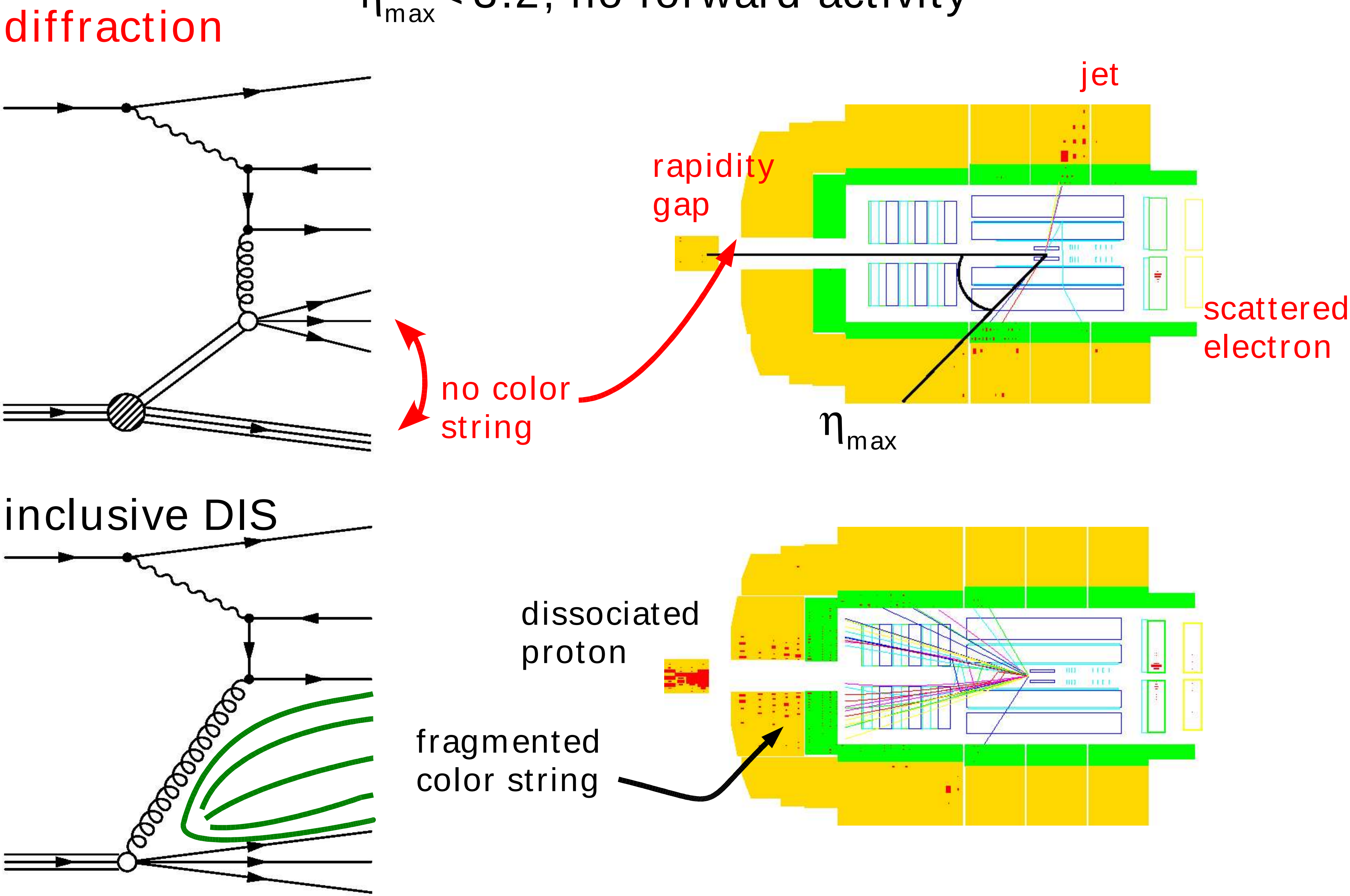
$Q^2 < 0.01\ GeV^2$

Frixione Program
Frixione, *et al.*
Nucl. Phys. **B467** (1996) 339
Frixione, Nucl. Phys. **B507** (1997) 295

$\mu_r = E_T{}^*(jet1)$
$\mu_f = E_T{}^*(jet1)$

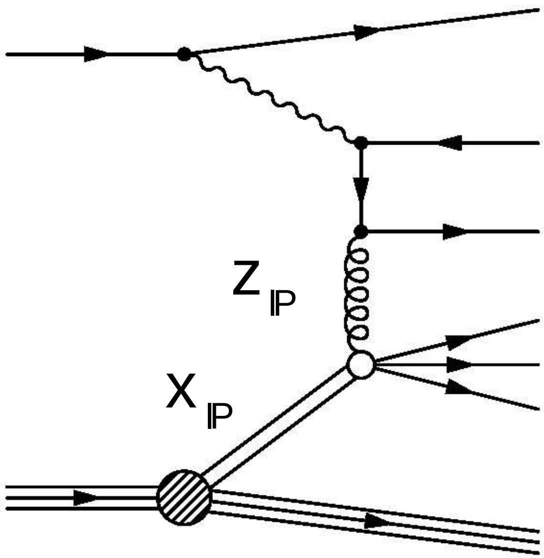
Diffractive Selection

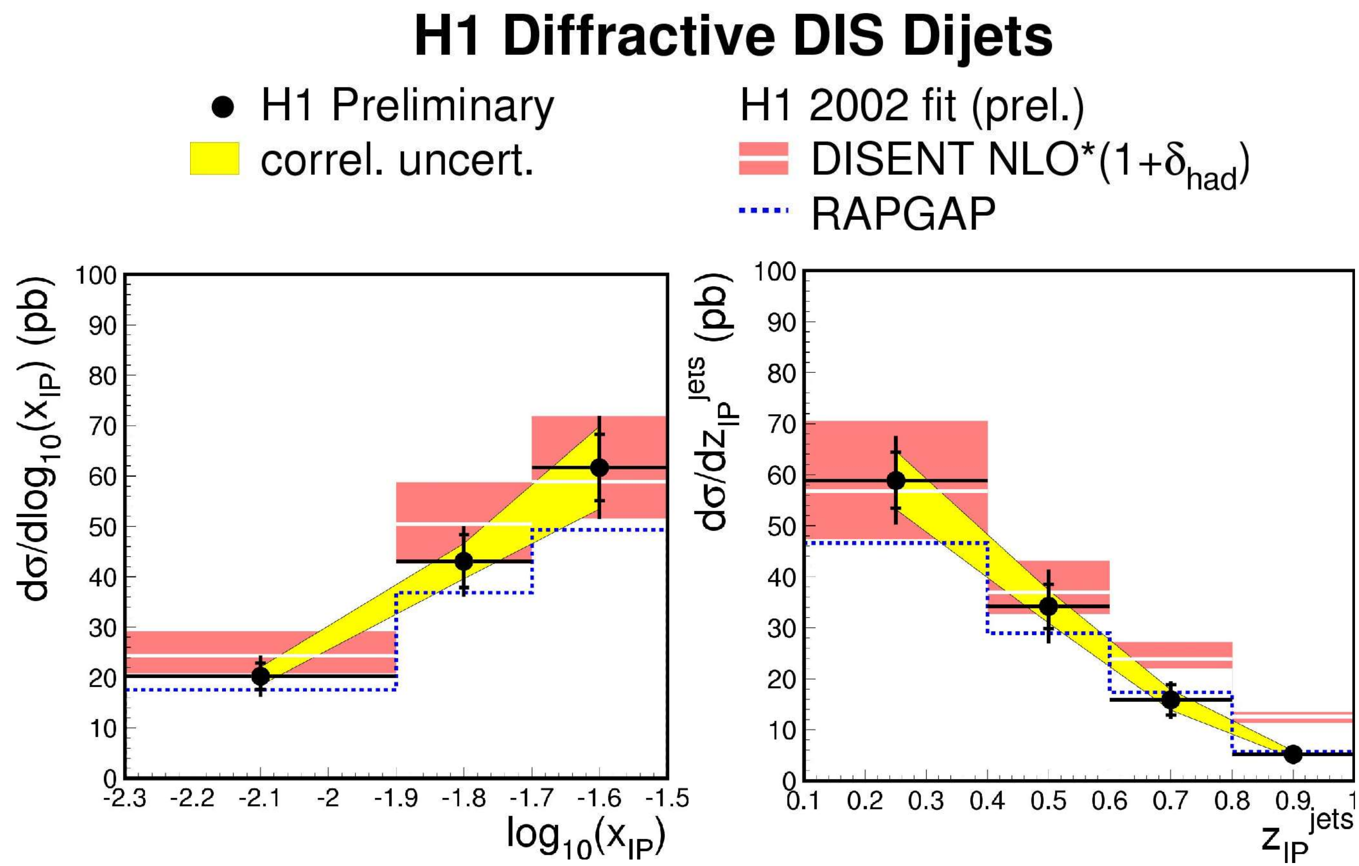
$\eta_{max} < 3.2$, no forward activity



Dijet Cross Sections in DIS

$(Q^2 > 4\ \mathrm{GeV}^2)$





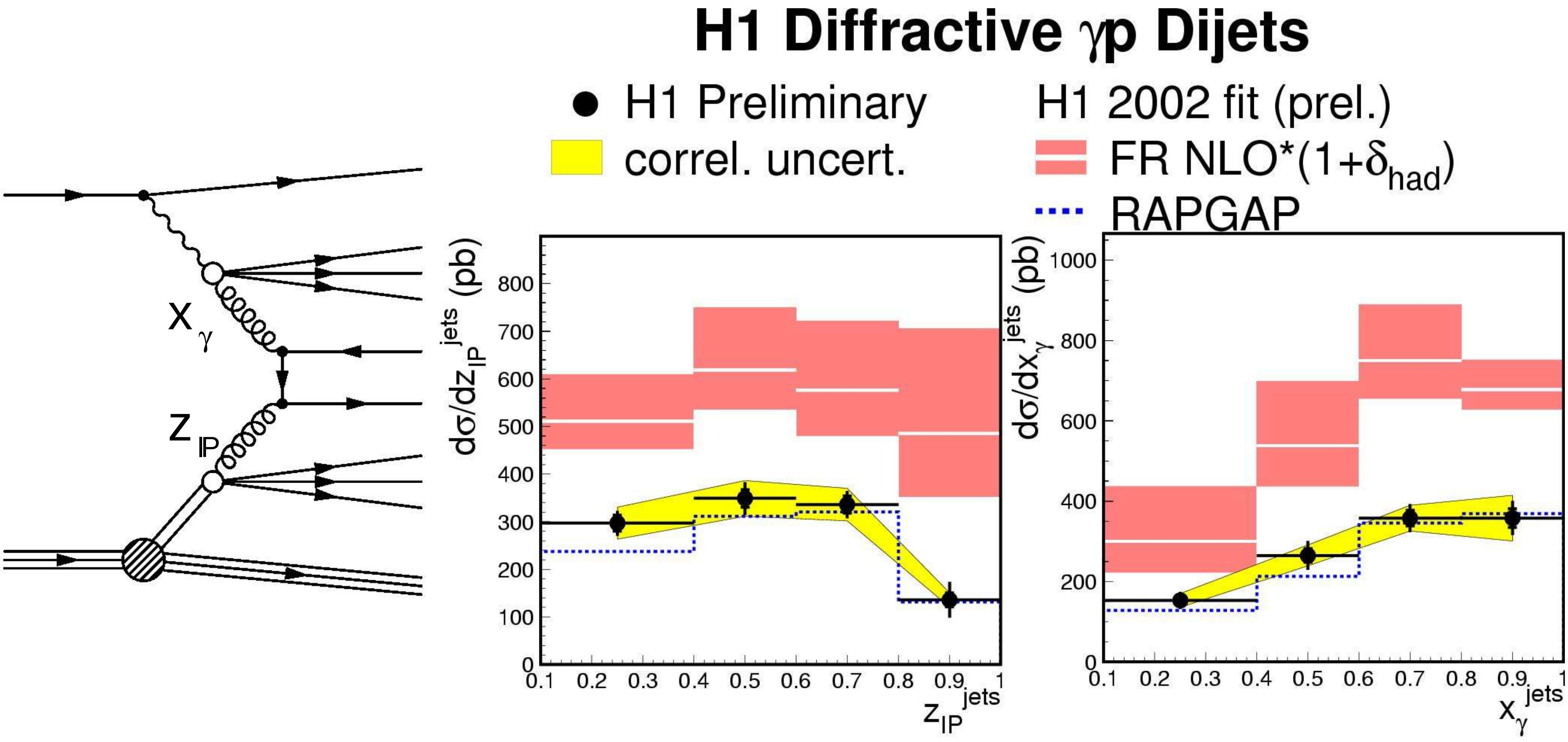
reasonable agreement
⇒factorization holds

NLO- errorbands: μ_r, μ_f x0.5/ 2

not included:

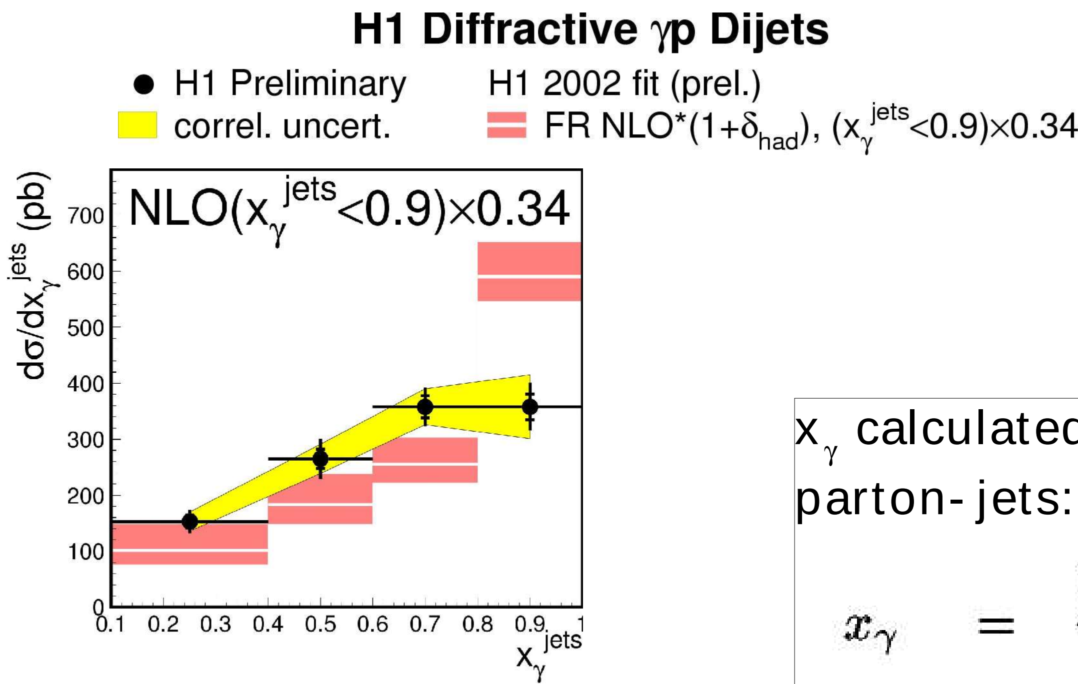
- hadronization uncertainty
- structure function uncertainty

Diffractive Dijets in γp



QCD- prediction overestimates cross sections by factor 2
factorization broken!

Suppression in γp



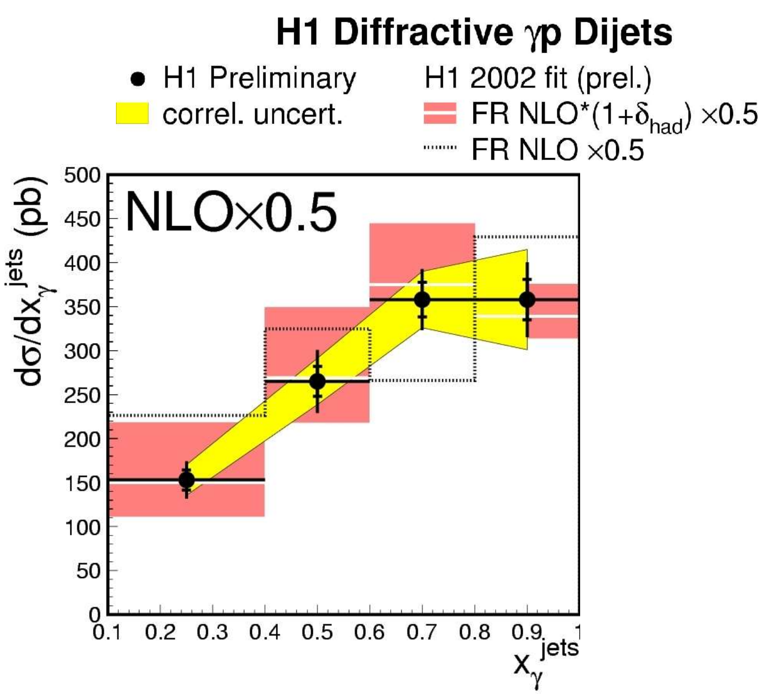
<u>direct unsuppressed:</u>

does not describe x_γ shape

x_γ calculated from parton-jets:

$$x_\gamma = \frac{\sum_{jets}(E-p_z)}{2yE_e}$$

$x_\gamma > 0.9$ contains
90% direct
10% resolved



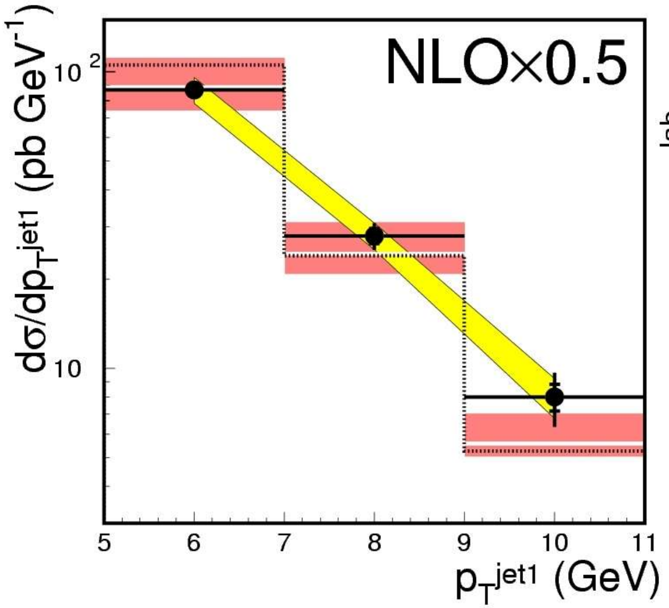
<u>global suppression:</u>

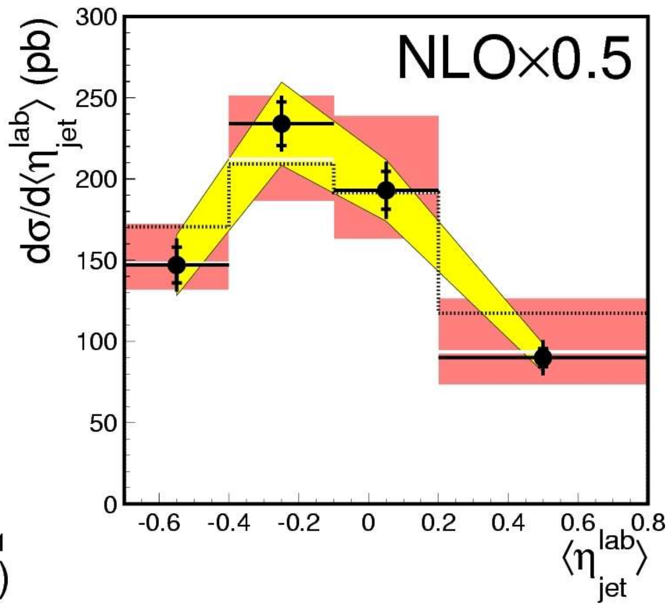
describes data within uncertainties

Dijet Cross Sections in γp

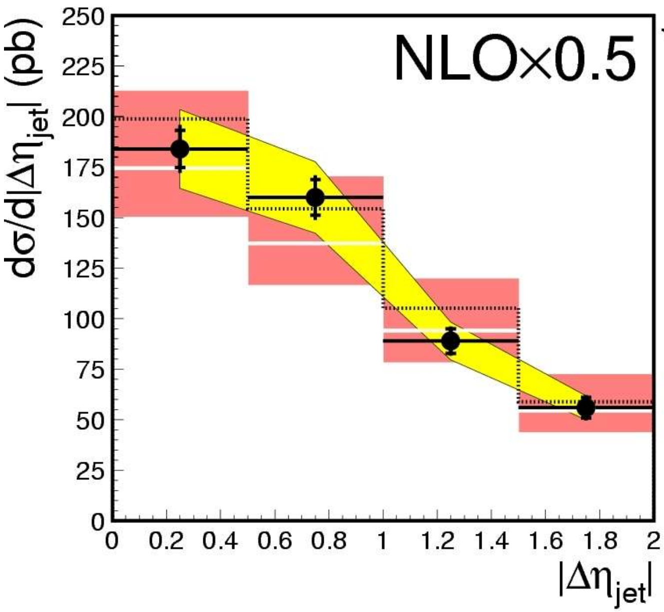
● H1 Preliminary
correl. uncert.

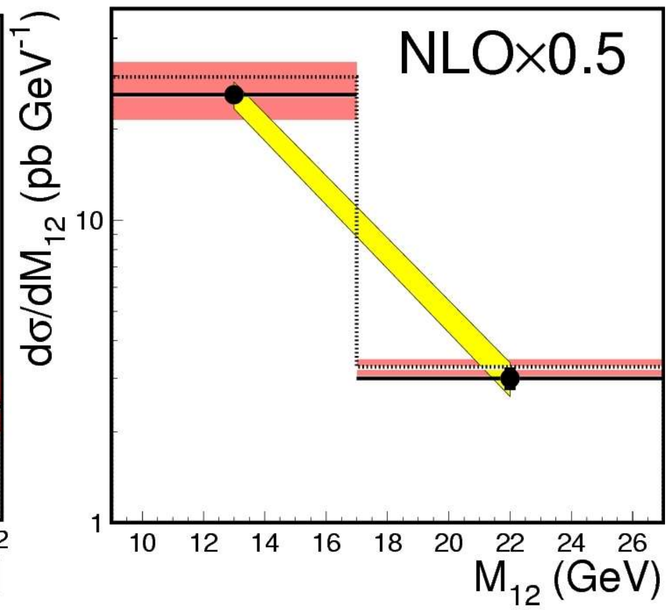
H1 2002 fit (prel.)
FR NLO*$(1+\delta_{had}) \times 0.5$
FR NLO $\times 0.5$





good description by global suppression 0.5

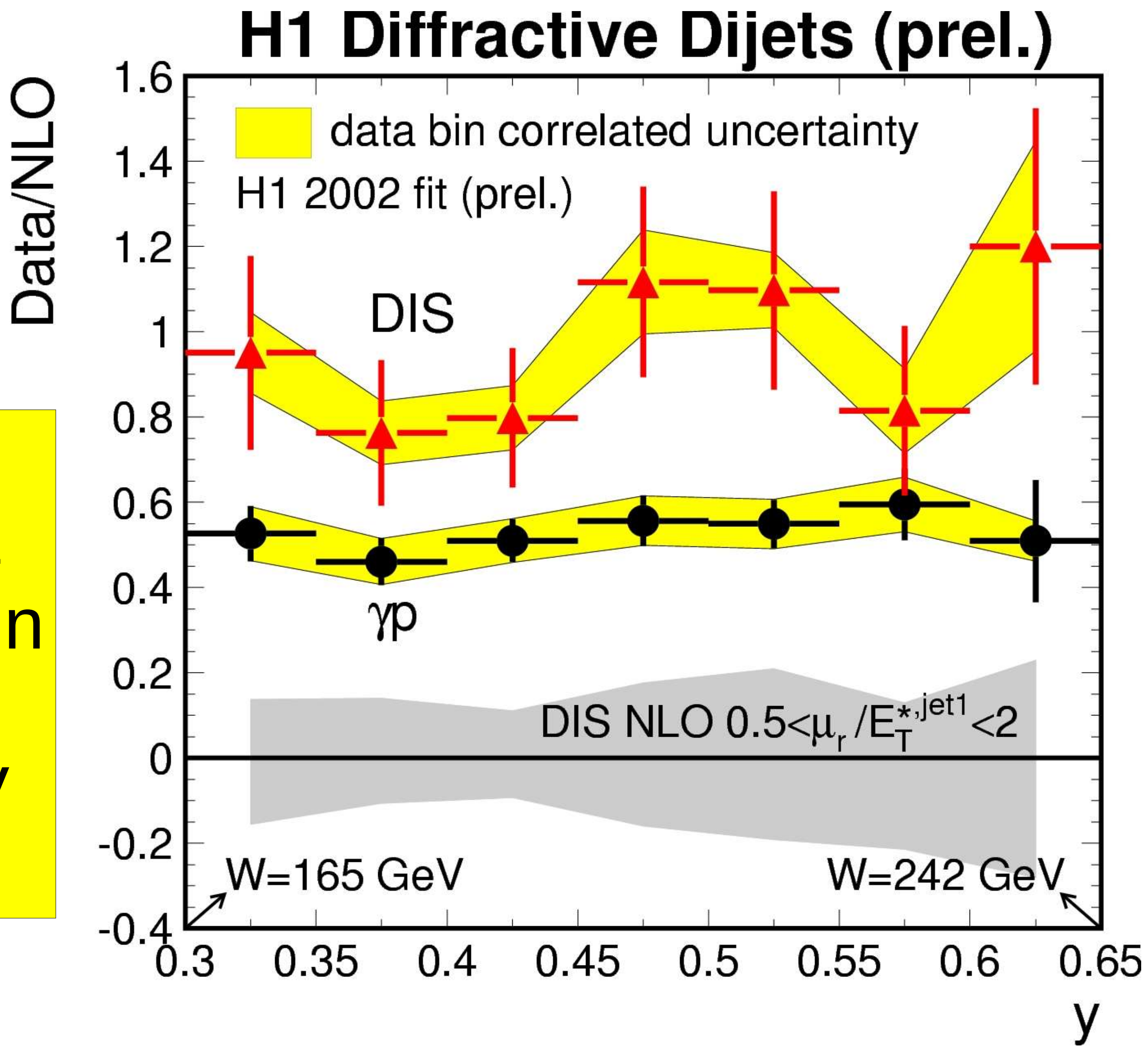




Dependence on CMS Energy

suppression depends on CMS-energy?
Tevatron: factor 7
HERA: factor 2

no significant dependence on CMS-energy 165-242 GeV



Summary

DIS:

- dijet cross sections agree with NLO-QCD predictions
- factorization holds as predicted
- all DIS processes at HERA consistently described using diffractive PDFs, see talks by Matthew Beckingham (D*), Paul Laycock (F2D)

Photoproduction:

- NLO-QCD-prediction significantly overestimates γp cross section for both direct and resolved contributions
- shapes described, global suppression 0.5
- factorization broken
- reasons for discrepancy at high x_γ unclear

Reconstruction of Kinematic Variables

DIS:

$$y = 1 - \frac{E'_e}{E_e}\sin^2\frac{\theta_e}{2}$$

$$Q^2 = 4E_eE'_e\cos^2\frac{\theta_e}{2}$$

$$x_\gamma = \frac{\sum_{jets}(E-p_z)^\star}{\sum_X (E-p_z)^\star}$$

$$z_{I\!P} = \frac{Q^2+M_{12}^2}{Q^2+M_X^2}$$

$$M_x^2 = (\textstyle\sum_X E)^2 - (\sum_X \vec{p})^2$$

$$x_{I\!P} = \frac{Q^2+M_X^2}{Q^2+W^2}$$

Photoproduction:

$$y = 1 - \frac{E'_e}{E_e}$$

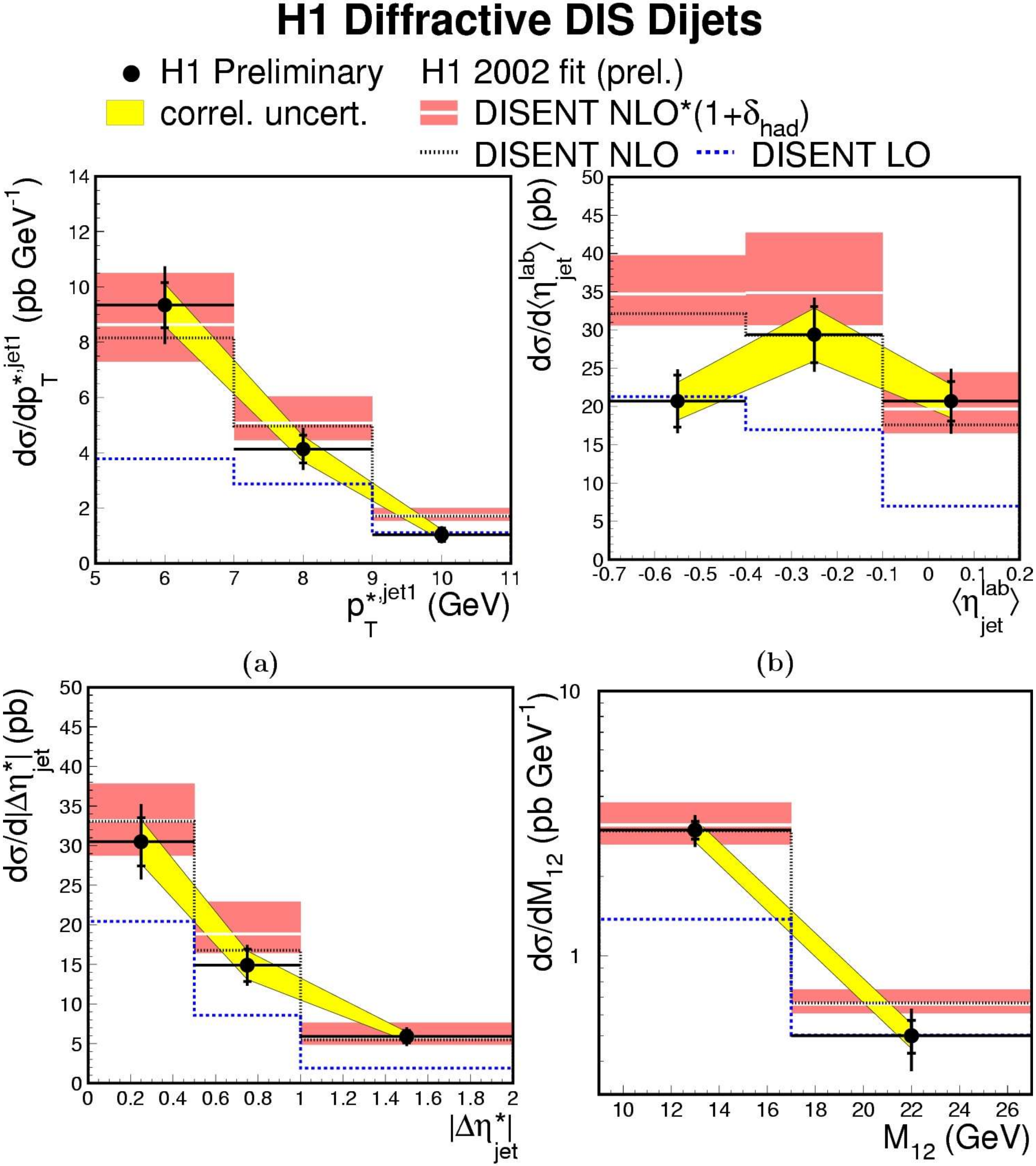
$$Q^2 < 0.01\,(\approx 0)$$

$$x_\gamma = \frac{\sum_{jets}(E-p_z)}{2yE_e}$$

$$z_{I\!P} = \frac{\sum_{jets}(E+p_z)}{2x_{I\!P}E_p}$$

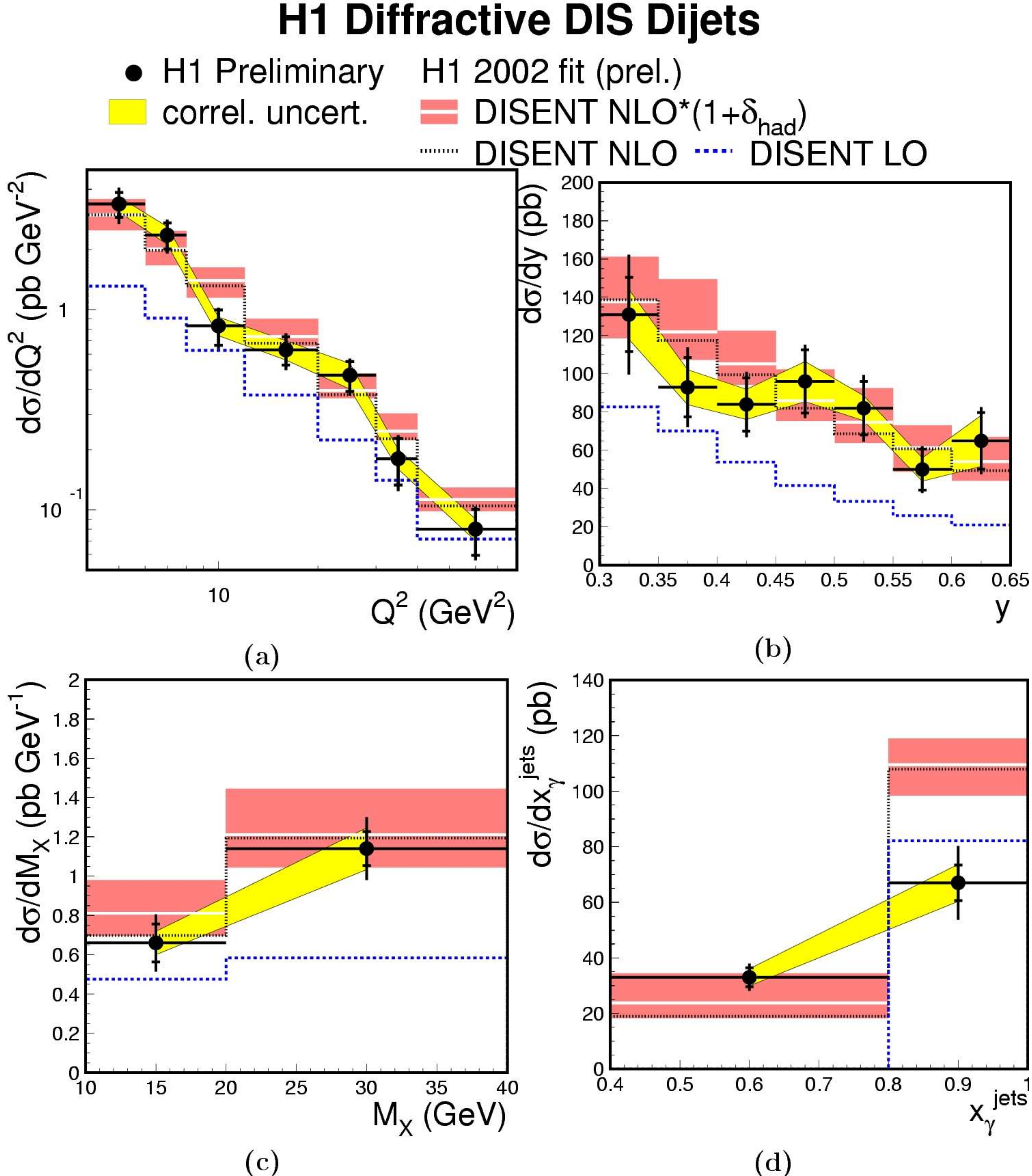
$$M_x^2 = \frac{M_{12}^2}{z_{I\!P}x_\gamma}$$

$$x_{I\!P} = \frac{\sum_X(E+p_z)}{2E_p}$$


H1 Diffractive DIS Dijets
H1 Preliminary
correl. uncert.
H1 2002 fit (prel.)
DISENT NLO*(1+δ_had)
DISENT NLO
DISENT LO
dσ/dp*,jet1_T (pb GeV^-1)
p*,jet1_T (GeV)
dσ/d⟨η^lab_jet⟩ (pb)
⟨η^lab_jet⟩
dσ/d|Δη*_jet| (pb)
|Δη*_jet|
dσ/dM_12 (pb GeV^-1)
M_12 (GeV)

(a) (b)

(c) (d)


H1 Diffractive DIS Dijets
H1 Preliminary
correl. uncert.
H1 2002 fit (prel.)
DISENT NLO*(1+δhad)
DISENT NLO
DISENT LO
dσ/dQ² (pb GeV⁻²)
Q² (GeV²)
dσ/dy (pb)
y
dσ/dM_X (pb GeV⁻¹)
M_X (GeV)
dσ/dx_γ^jets (pb)
x_γ^jets
(a)
(b)
(c)
(d)

H1 Diffractive γp Dijets