Comparison of Diffractive Final States with LO and NLO QCD Predictions

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for the H1 Collaboration

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- Test of QCD Factorisation in NLO and LO
- Diffractive Production of Dijets and Charm in DIS
- Dijets in Diffractive Photoproduction and Gap Survival Probability

Factorisation in Diffraction

Hard Scattering Factorisation

$$\sigma^{D} = \sum_{partons\ i} f_i^{D}\left(x_{IP}, t, z, Q^2\right) \otimes \hat{\sigma}^{\gamma i}$$

diffractive PDF — partonic cross section

- proven for diffractive DIS (Collins)

Regge Factorisation (Pomeron exchange model)

- z, Q^2 evolution of diffractive PDFs independent of t and x_{IP}

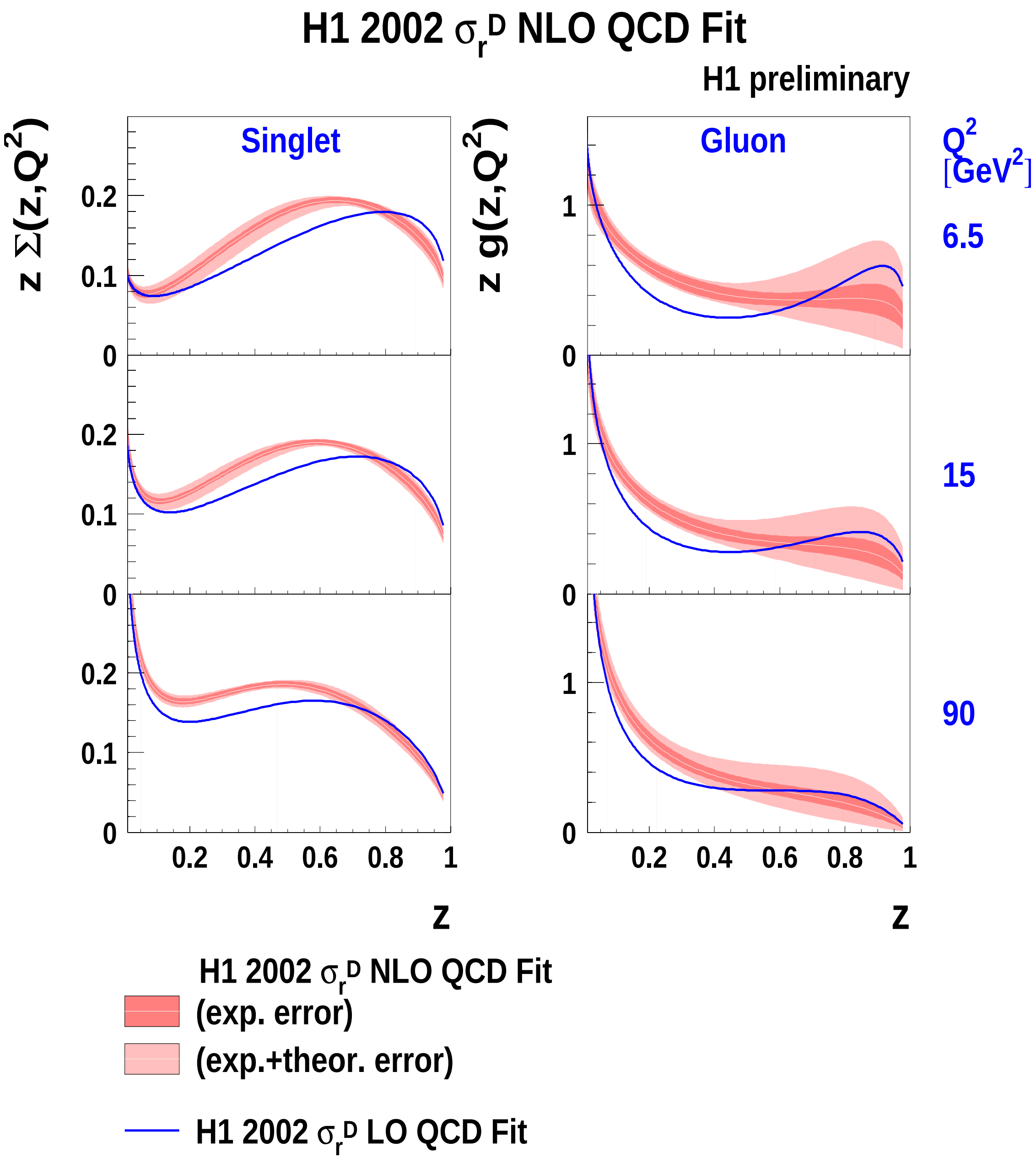
$$f_i^{D}\left(x_{\mathbb{P}}, t, z, Q^2\right) = f_{\mathbb{P}/p}\left(x_{\mathbb{P}}, t\right)\, f_{i/\mathbb{P}}\left(z, Q^2\right) + f_{\mathbb{R}/p}\left(x_{\mathbb{R}}, t\right)\, f_{i/\mathbb{R}}\left(z, Q^2\right)$$

flux factor — Pomeron PDF — Reggeon

- assumption, no proof
- compatible with inclusive diffr. measurements at present precision

Pomeron Parton Densities

- NLO (red) and LO (blue) PDFs from DGLAP fits to inclusive diffractive measurements (σ_r^D)
- Gluon dominant (75±15 %)
- large uncertainty at high z



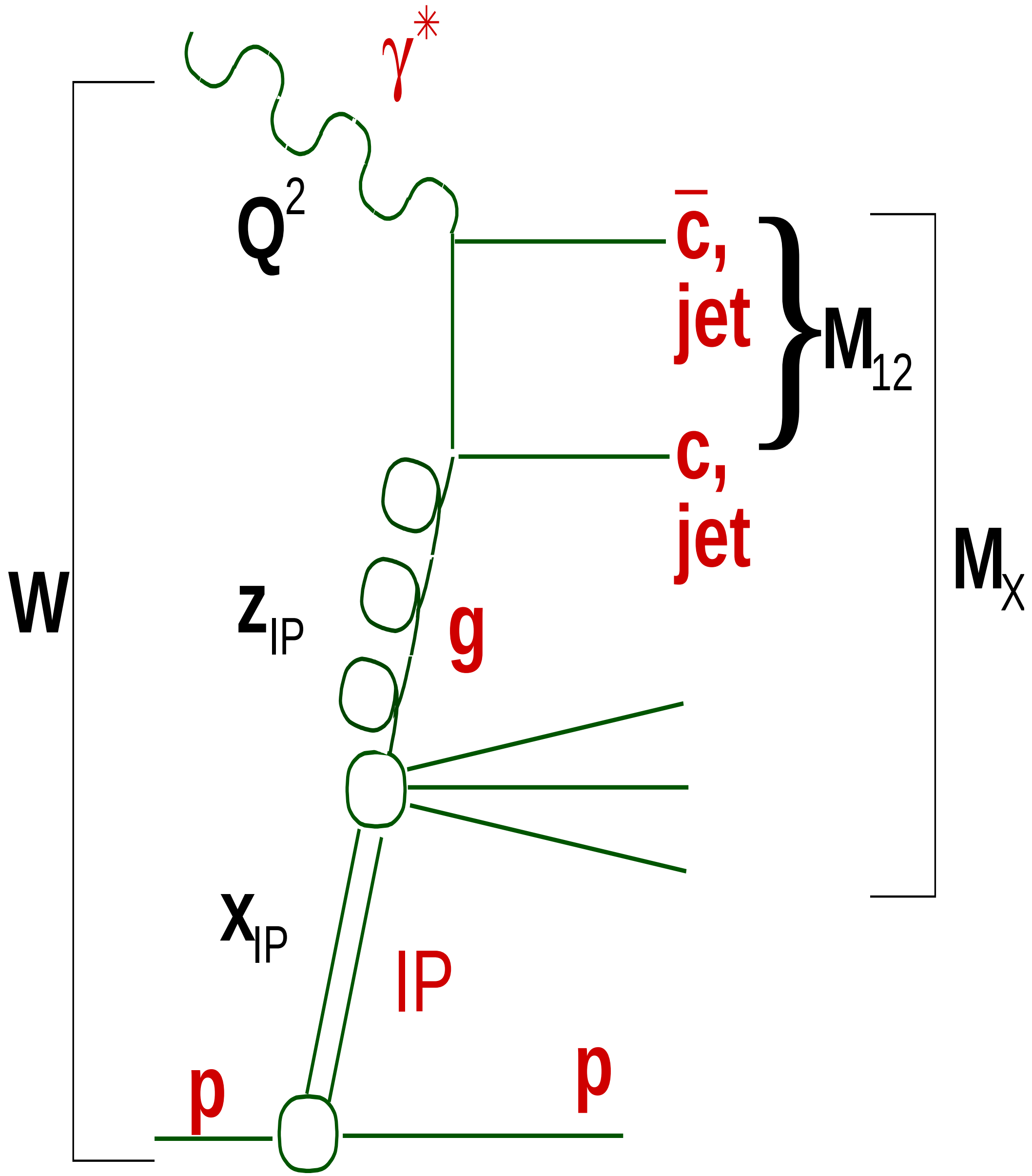
Diffractive Dijet and Heavy Flavour Production

- Sensitive to diffractive gluon through boson−gluon fusion

- fractional momenta

$$x_{IP} \approx \frac{Q^2 + M_X^2}{Q^2 + W^2}$$

$$z_{IP} \approx \frac{Q^2 + M_{12}^2}{Q^2 + M_X^2}$$



NLO Comparison with Diffractive Dijet Production

H1 Dijet Measurement Eur. Phys. J. C20 (2001) 29

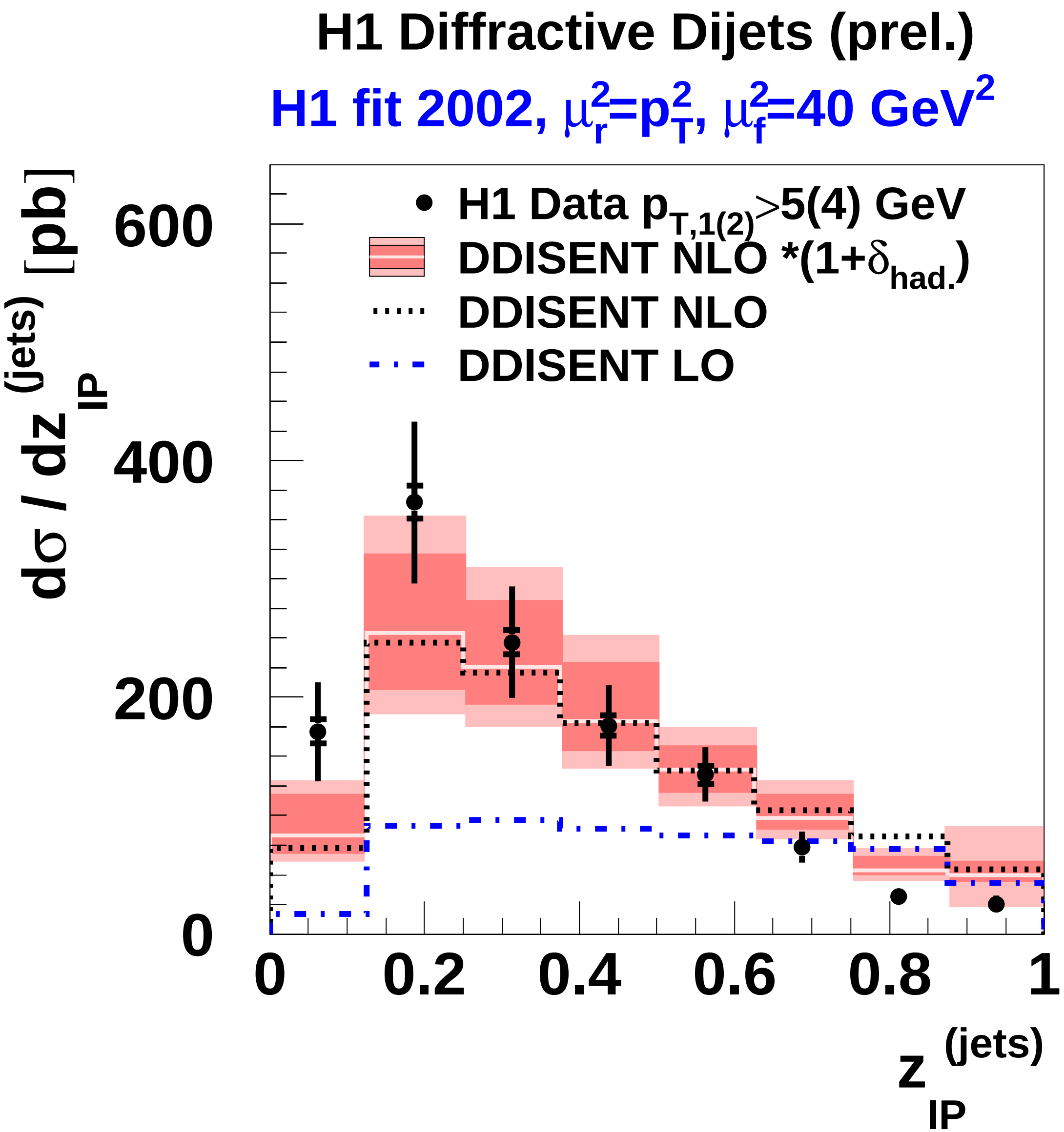
- $L=18/pb$; $4 < Q^2 < 80$ GeV^2, $0.1 < y < 0.7$, $x_{IP} < 0.05$, CDFcone algorithm, $p_T^{jet}(1,2) > 4$ GeV
- corrected to asymmetric cuts $p_T^{jet}(1) > 5$ GeV, $p_T^{jet}(2) > 4$ GeV using MC because NLO unstable for symmetric cuts

NLO Calculation

- DISENT (Catani, Seymour) NLO program for standard DIS, interfaced to diffractive PDFs (suggested by F. Hautmann, JHEP 0210 (2002) 025)
- $\mu_r = \frac{p_T(1) + p_T(2)}{2}$, $\mu_f^2 = 40$ GeV^2, $\Lambda^{(4)}_{QCD} = 0.2$ GeV (as in PDFs)
- scale uncertainty: 20% (μ_r varied by factors 2 and 0.5) $\rightarrow$ inner band
- hadronisation correction uncertainty from MC: ~10% $\rightarrow$ outer band

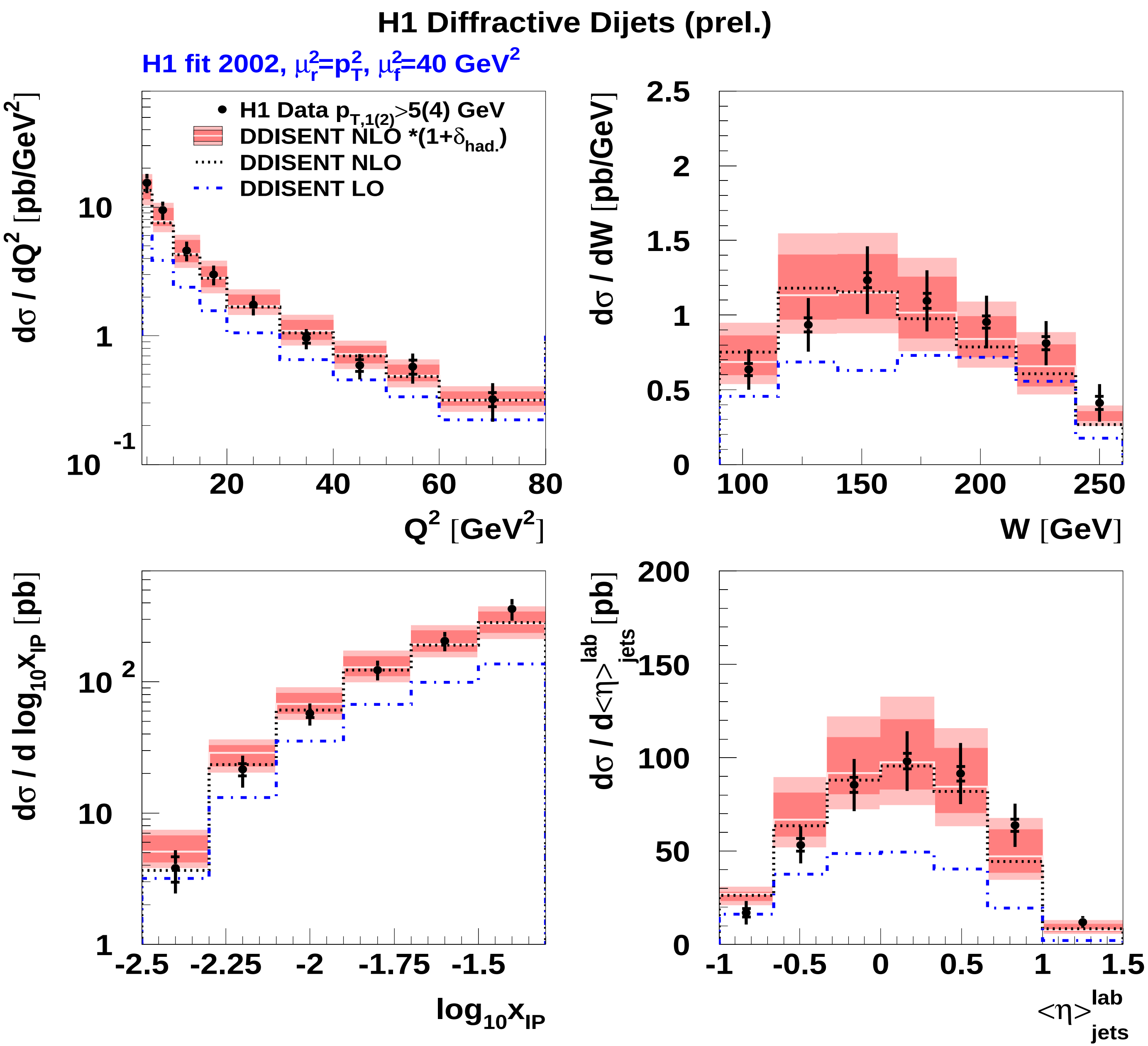
Momentum Fraction of Diffractive Exchange

- NLO calculation gives reasonable description of shape and normalisation
- LO result too low, shape not described
- size of NLO correction: factor ~2 (large because low p_T of jets)
- not shown: gluon uncertainty at large z_{IP} (~25%)



NLO Diffractive Dijet Cross Sections

reasonable description of all distributions



Evolving Structure of Diffractive Exchange

z_{IP} in bins of

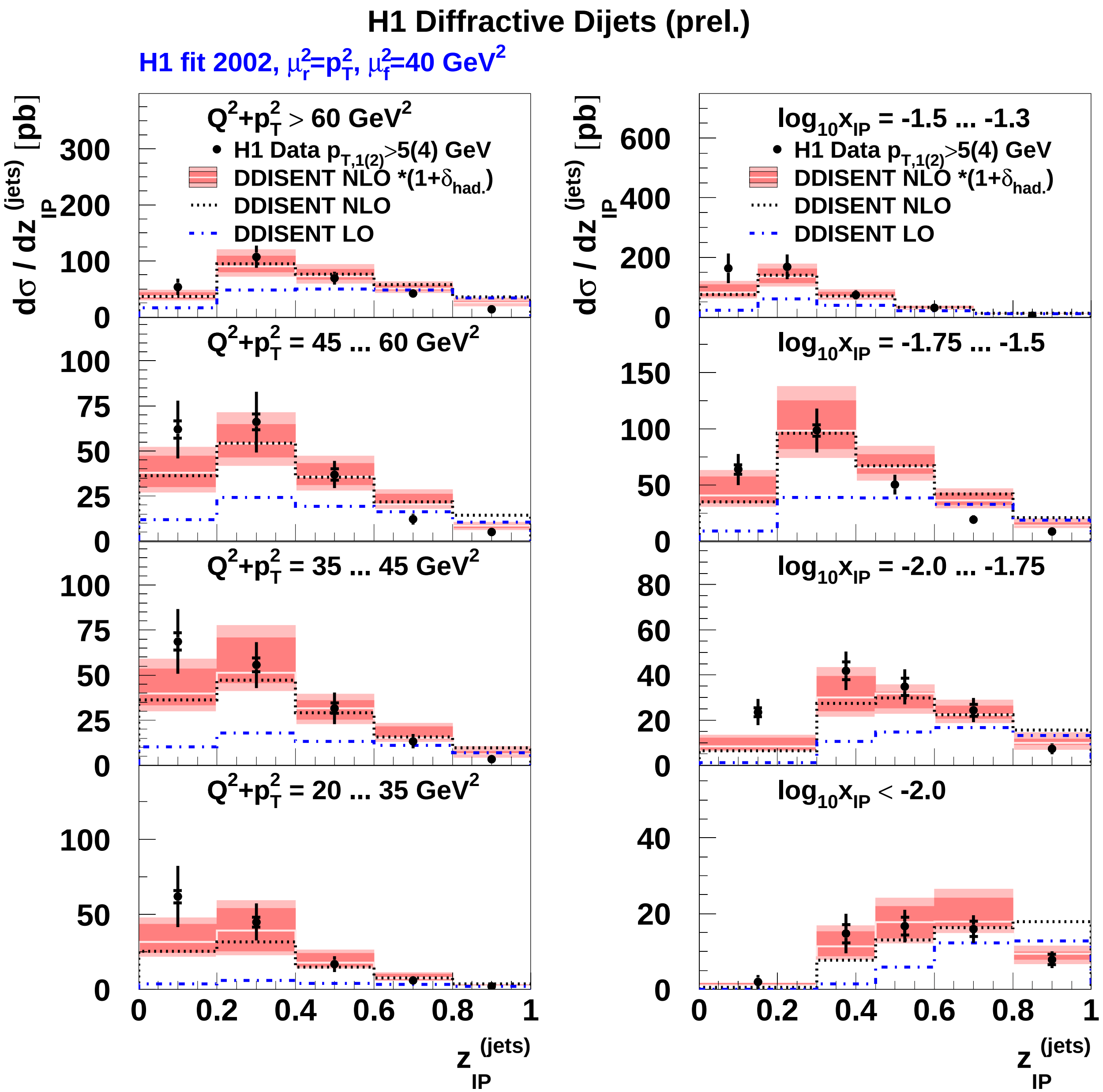
$Q^2+p_T^{\ 2}$

change with scale

x_{IP}

- test of Regge factorisation
- kinematic effect: $x_{IP}\ z_{IP} = x_g \approx$ const

evolution reasonably well described



NLO Comparison with D* Production

H1 D* measurement Phys. Lett. B520 (2001) 191

- L=19/pb, $2<Q^2<100$ GeV^2, $0.05<y<0.7$, $x_{IP}<0.04$, $p_T^{D*}>2$ GeV, $|\eta_{D*}| < 1.5$

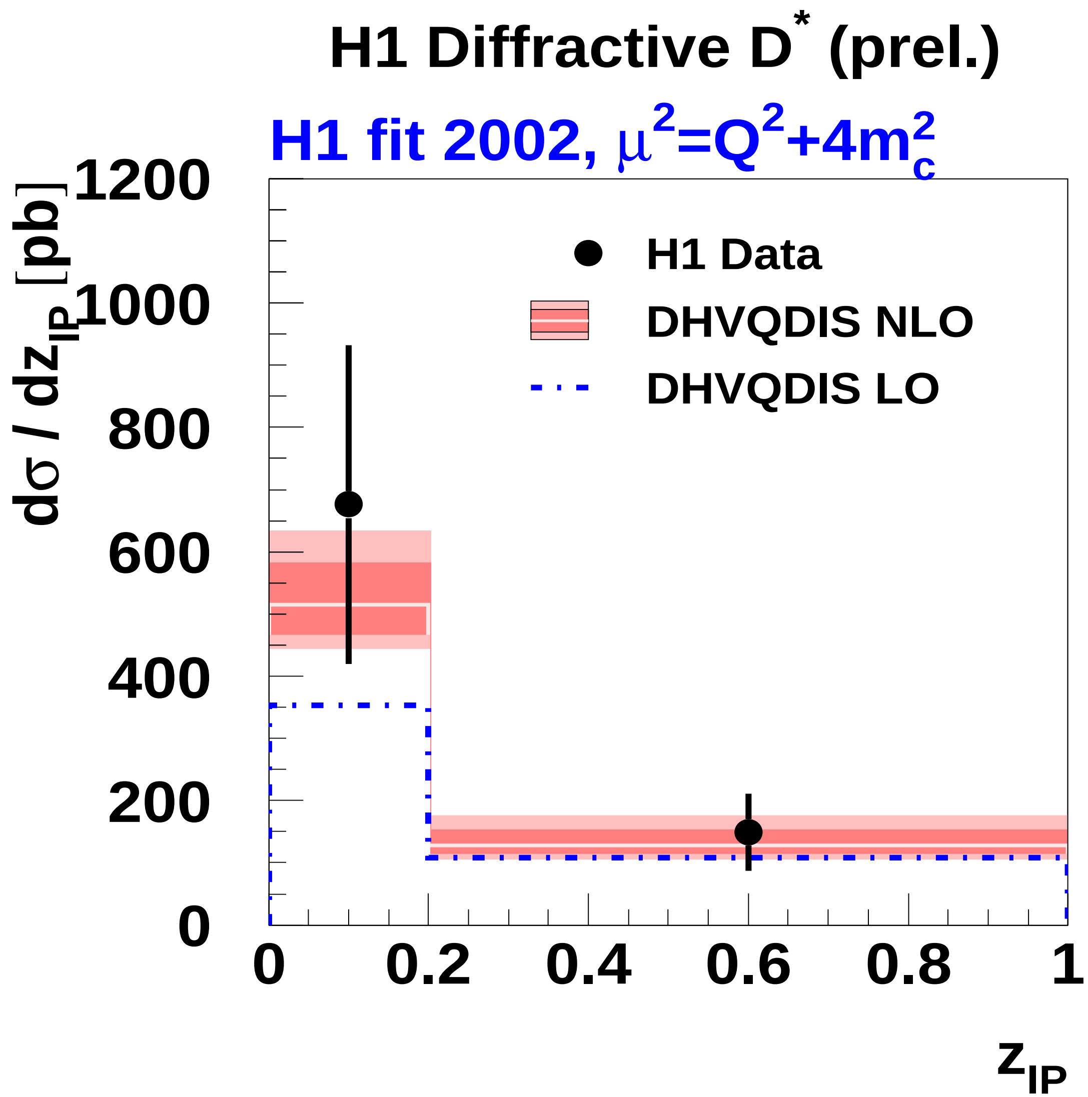
NLO Calculation

- HVQDIS (Harris, Smith), diffractive extension by Alvero, Collins, Whitmore hep−ph/9806340
- hadronisation fraction $f(c\rightarrow D^*)=0.233$
- Peterson fragmentation: $\varepsilon=0.078$, varied between 0.035..0.100 $\rightarrow$ outer band (+21 / −7 %)
- $m_c=1.5$ GeV, varied between 1.35..1.65 GeV $\rightarrow$ outer band (±12%)
- $\Lambda^{(4)}_{QCD}= 0.2$ GeV, $\mu_r^2 = \mu_f^2 = Q^2 + 4\, m_c^2$
- scale uncertainty (μ_r varied by factors 2 and 0.5) $\rightarrow$ inner band: (+14/−10%)

Momentum Fraction of Diffractive Exchange

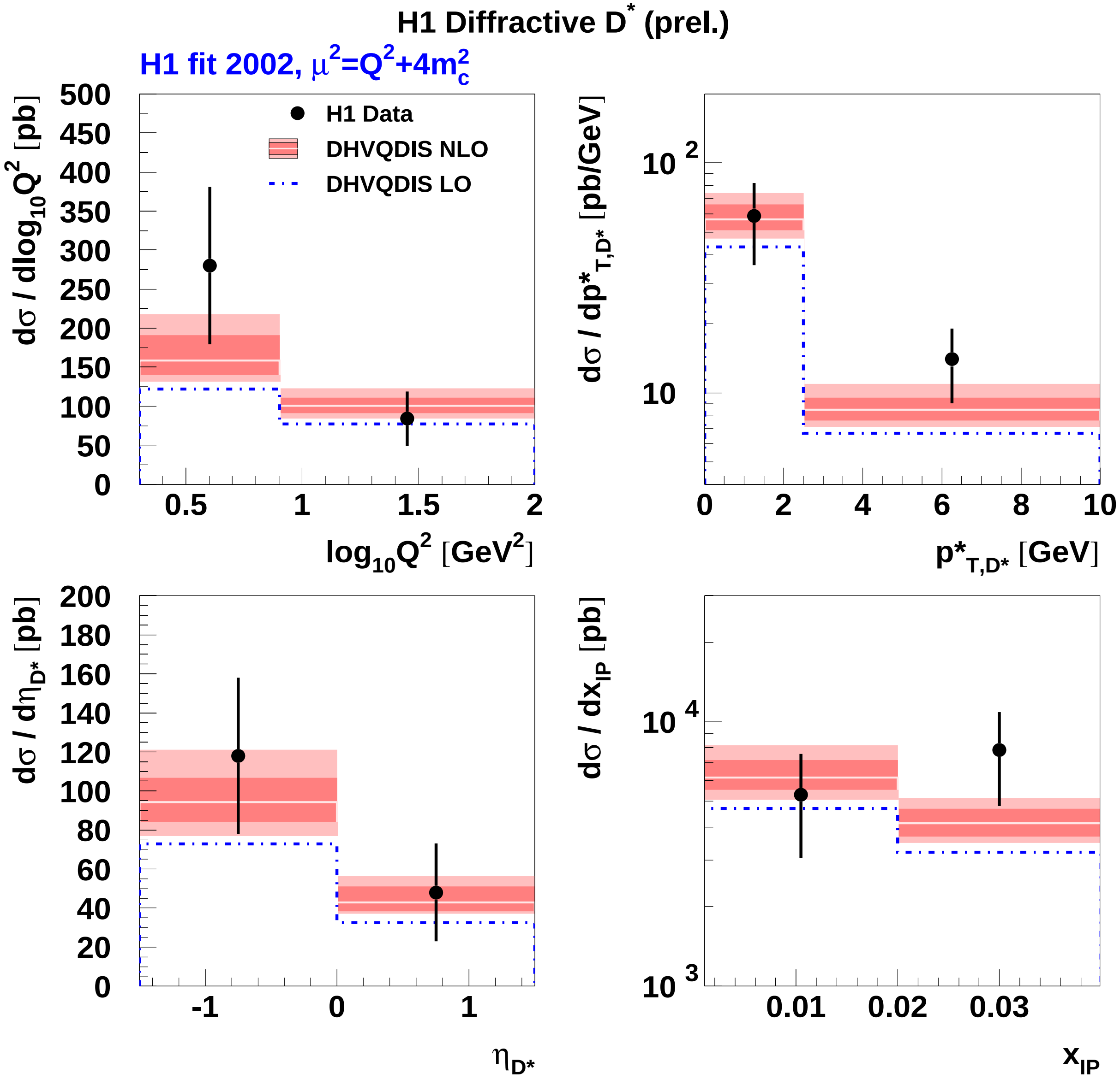
- NLO calculation gives good description within large uncertainties of measurement

- size of NLO correction is smaller than for dijet production



NLO Diffractive D* Cross Sections

good description for all distributions within large uncertainties of measurement



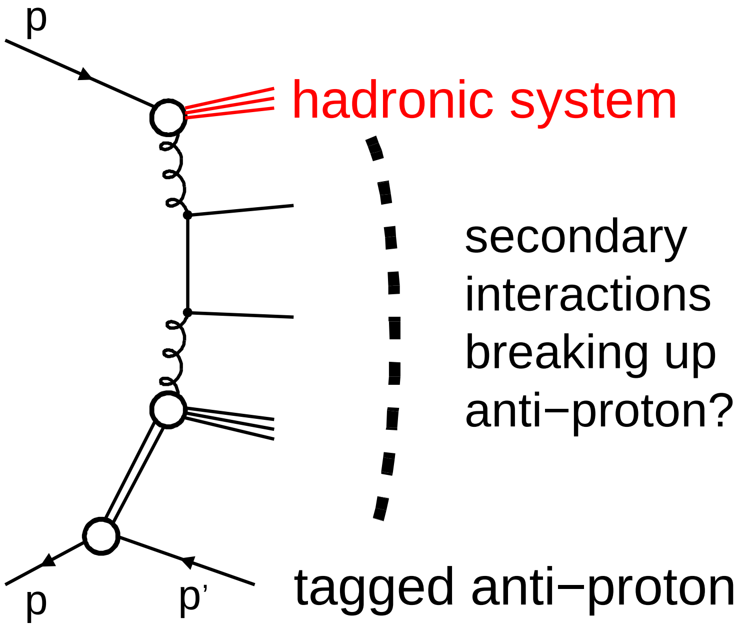
Summary Dijet and D* Production in DIS

- Within uncertainties (theoretical and experimental):

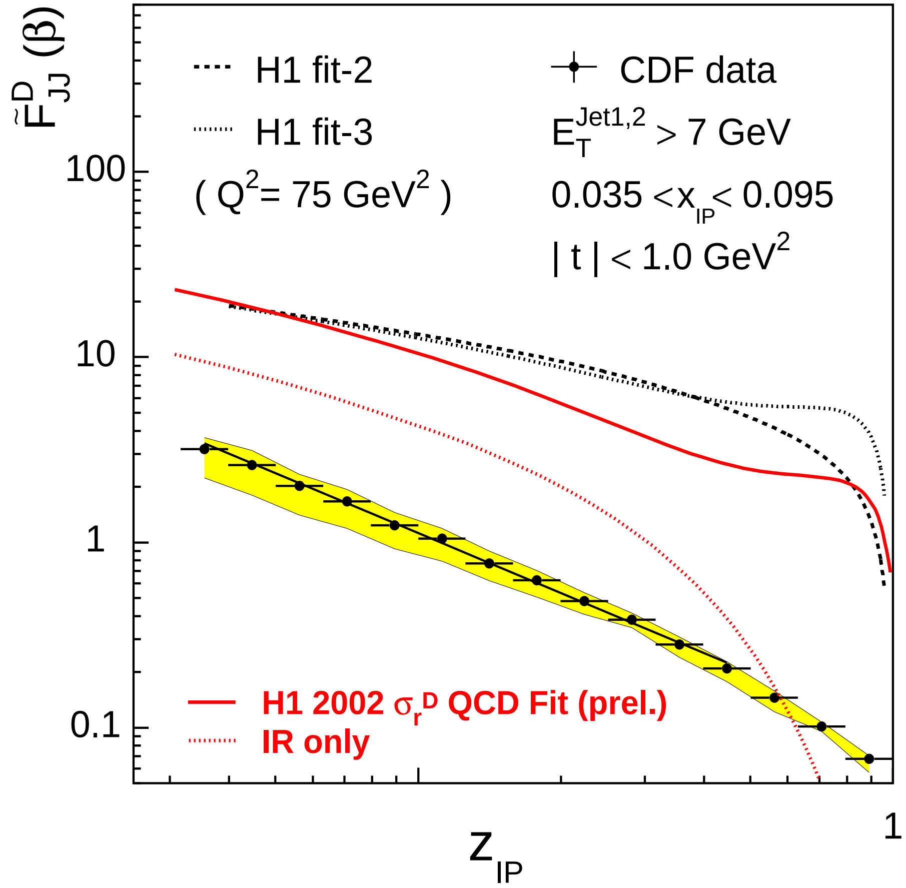
QCD Factorisation holds in diffractive DIS, tested to NLO

- consistent description at NLO of both dijet and D* production using diffractive PDFs from inclusive diffractive measurements

Single−Diffractive Dijets at the Tevatron



Diffractive Structure Function of Antiproton



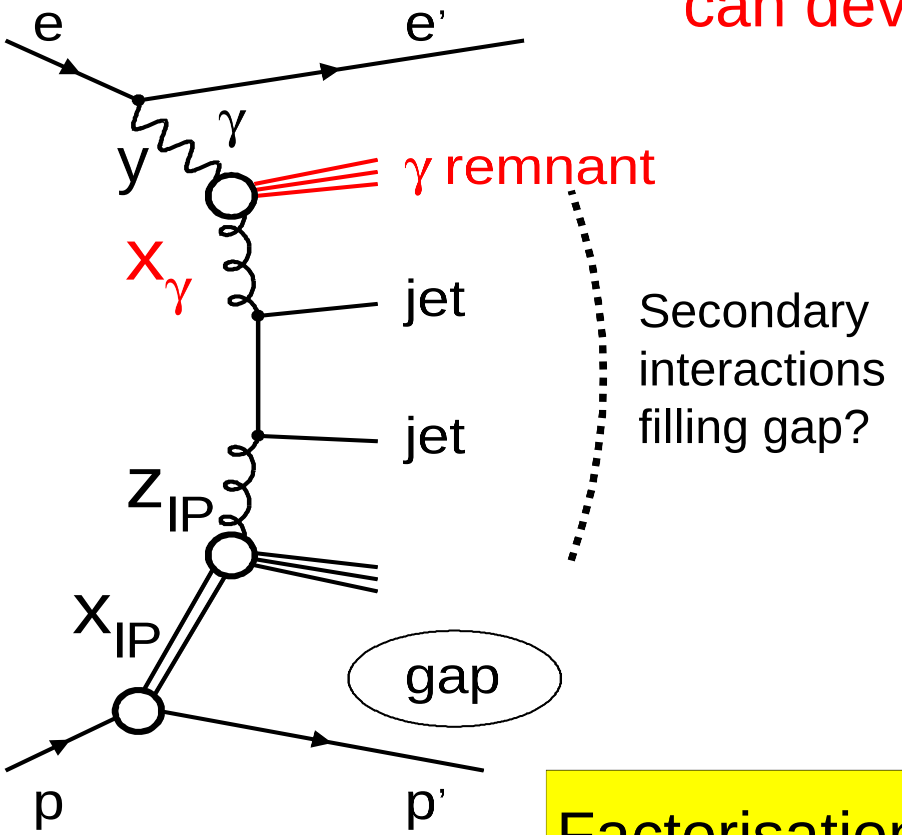
LO Comparison to diffr. Parton Densities from HERA

→ **Breakdown of Factorisation!**

- rate overestimated by factor ≈10
- secondary interactions due to hadronic system?

Photoproduction — Transition from DIS to $p\bar{p}$

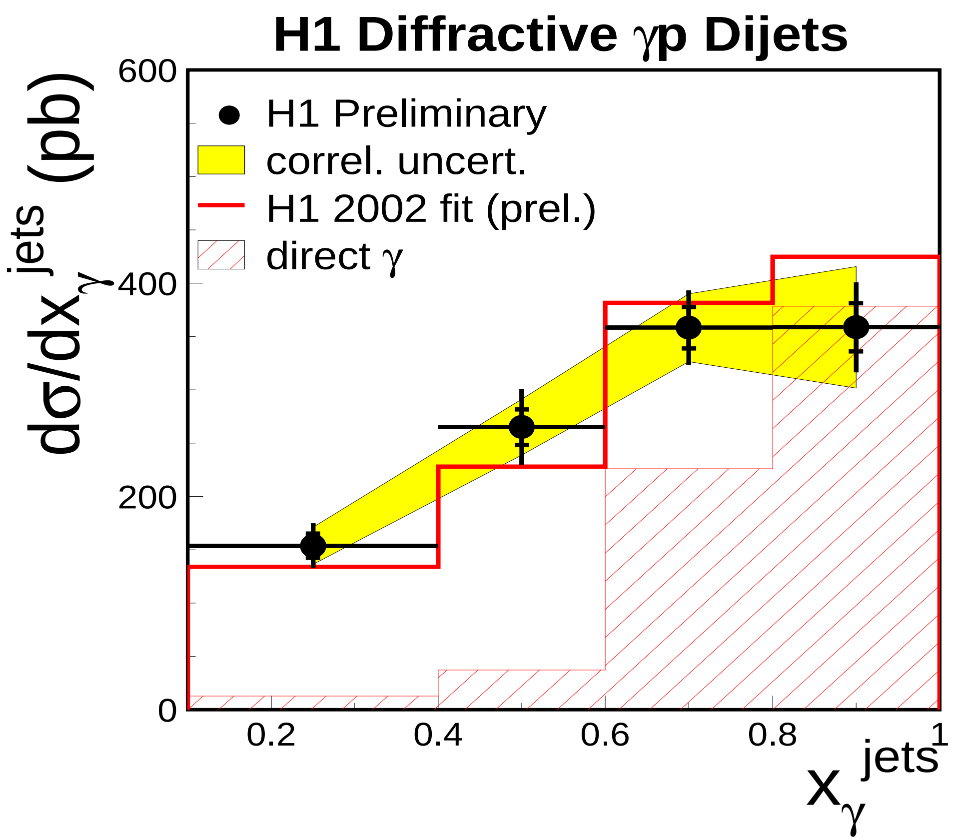
quasi−real photon ($Q^2 \approx 0$)
can develop hadronic structure



- $x_\gamma = 1$: direct photon coupling, DIS−like
- $x_\gamma < 1$: resolved photon, hadron−like
- photon remnant energy $\propto 1 - x_\gamma$

Factorisation breaking in diffr. photoproduction
Suppression dependent on photon remnant ?

x_γ : Momentum Fraction of Photon



H1 Preliminary measurement

L=18/pb, Q^2<0.01 GeV^2,
165<W<240 GeV, x_{IP}<0.03,
incl. k_T jet algorithm, $p_T^{jet}(1,2)$>5,4 GeV

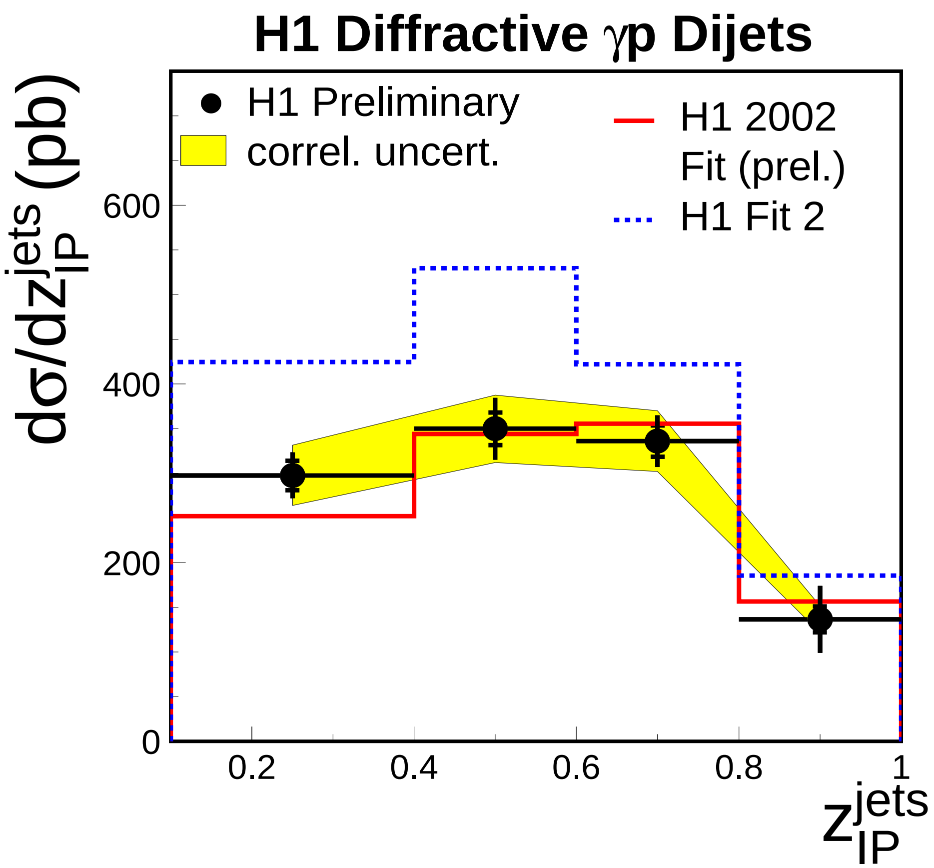
Monte Carlo comparison:

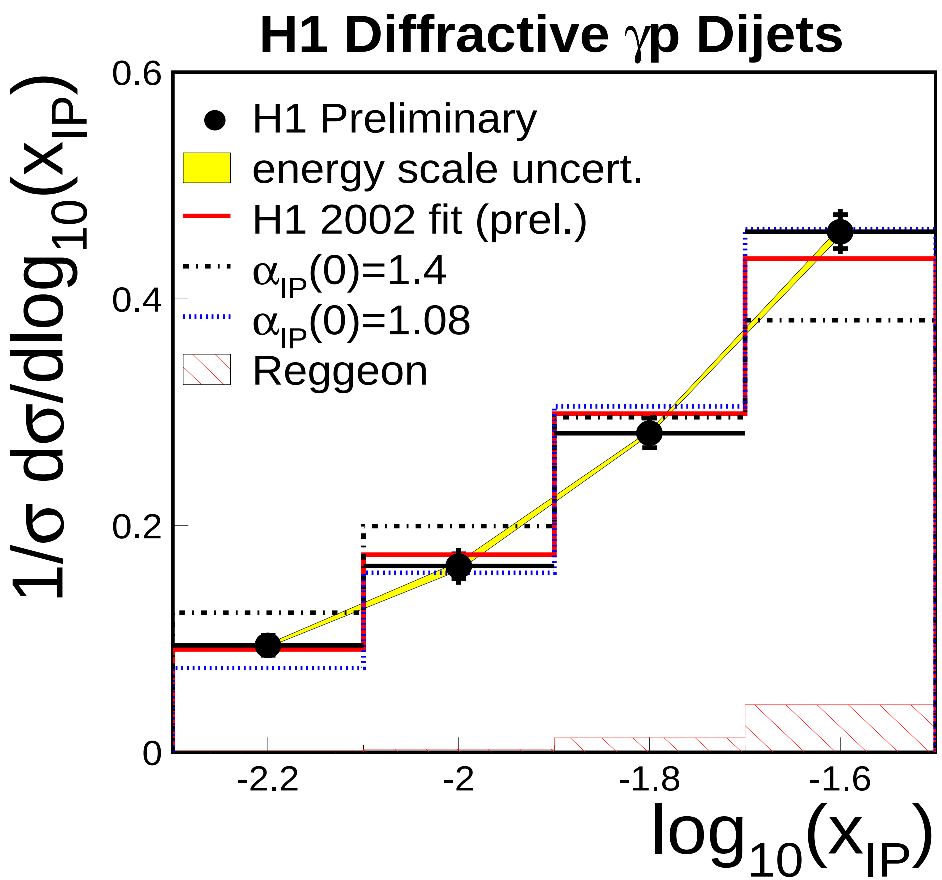
- LO Matrix Elements + Parton Showers
- scale $\mu_r = \mu_f = p_T$ (uncertainty: 25%)

Shape and normalisation well described within uncertainties:

- Result consistent with QCD Factorisation in Photoproduction
- no difference between direct and resolved photon processes

Dependence on z_{IP} and x_{IP}



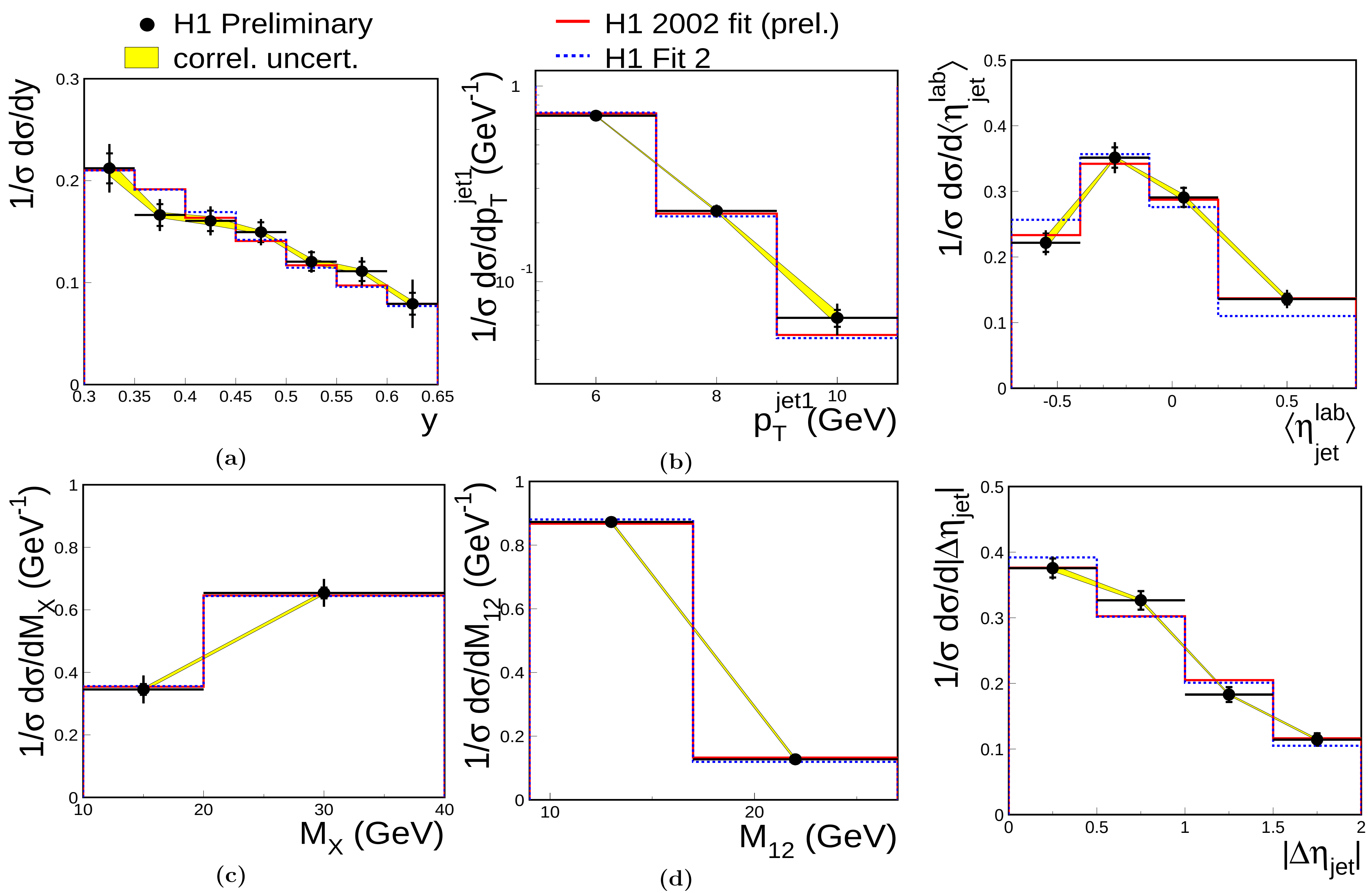


- pomeron intercept 1.4 excluded
- 1.08 and 1.17 both compatible

distributions well described!

More well described Cross Sections

H1 Diffractive γp Dijets



Survival Probability in Diffractive Photoproduction

- comparison of diffractive dijet cross sections in DIS and photoproduction
- need MC to correct for different acceptance (phase space effect)
- no dependence on $x_\gamma \rightarrow$ overall factor

$$S = \frac{\left(\frac{\mathrm{MC}}{\mathrm{data}}\right)_{\gamma p}}{\left(\frac{\mathrm{MC}}{\mathrm{data}}\right)_{\mathrm{DIS}}} = 1.3 \pm 0.3 \text{ (exp.)}$$

uncertainty is quadratic sum of experimental errors

No significant suppression found in photoproduction relative to DIS

Summary

Diffractive Dijet and D* Production in DIS

- NLO comparisons with diffractive PDFs from inclusive diffractive measurements
- Results consistent with QCD Factorisation at NLO

Diffractive Dijet Photoproduction

- comparisons with Monte Carlo (LO + Parton Showers)
- Results consistent with QCD Factorisation in diffractive photoproduction
- no significant suppression observed in photoproduction relative to DIS