Measurements of the Structure of Diffraction at HERA

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DESY

Moriond QCD 2005

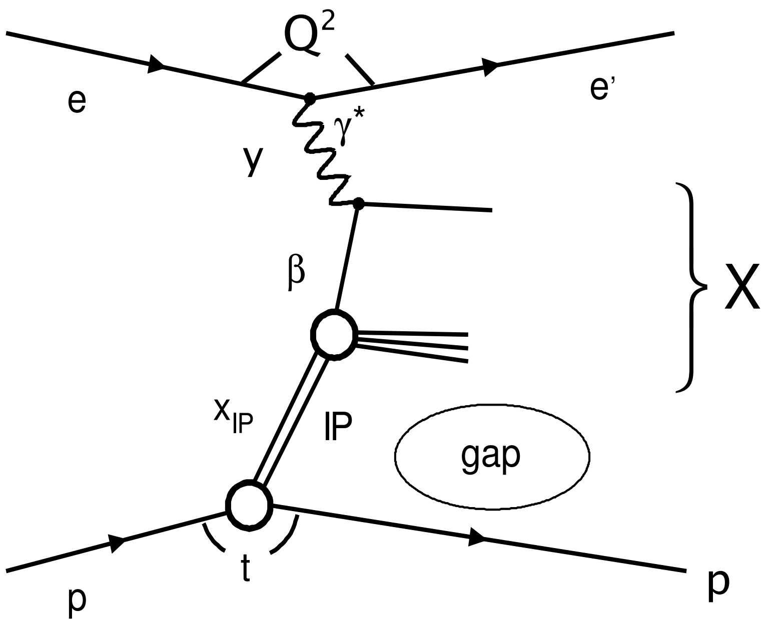
Diffractive Structure Function

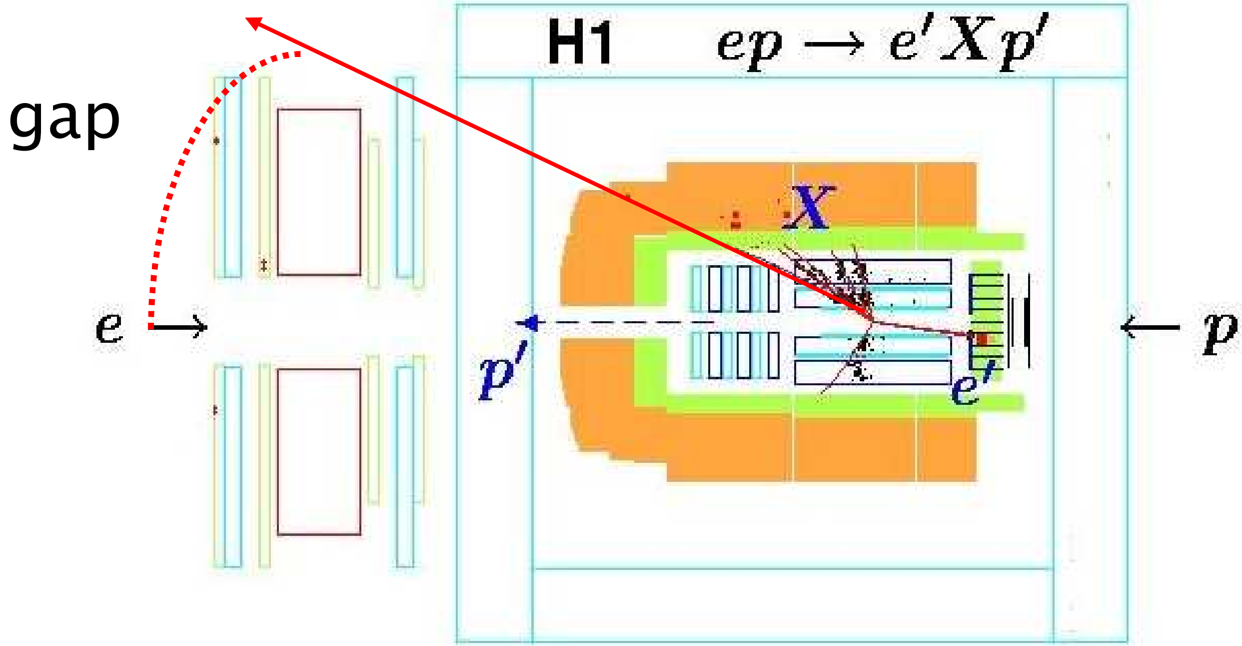
Parton Densities

Jet and charm production

Diffractive Charged Current events

Diffractive *ep* Scattering





***β* quark momentum fraction**

***x_{IP}* proton momentum loss**

Factorisation (J Collins): (for large Q^2)

$$\sigma_r^D \sim F_2^D = \sum_{\text{partons } i} f_{i/p}^D(x_{IP}, t, \beta, Q^2) \otimes \sigma^{\gamma^* i}$$

parton density

Diffractive Structure Function

Quarks measured directly:

$$F_2^D \propto \beta \sum_i e_i^2 q_i^D$$

Gluon from scaling violations:

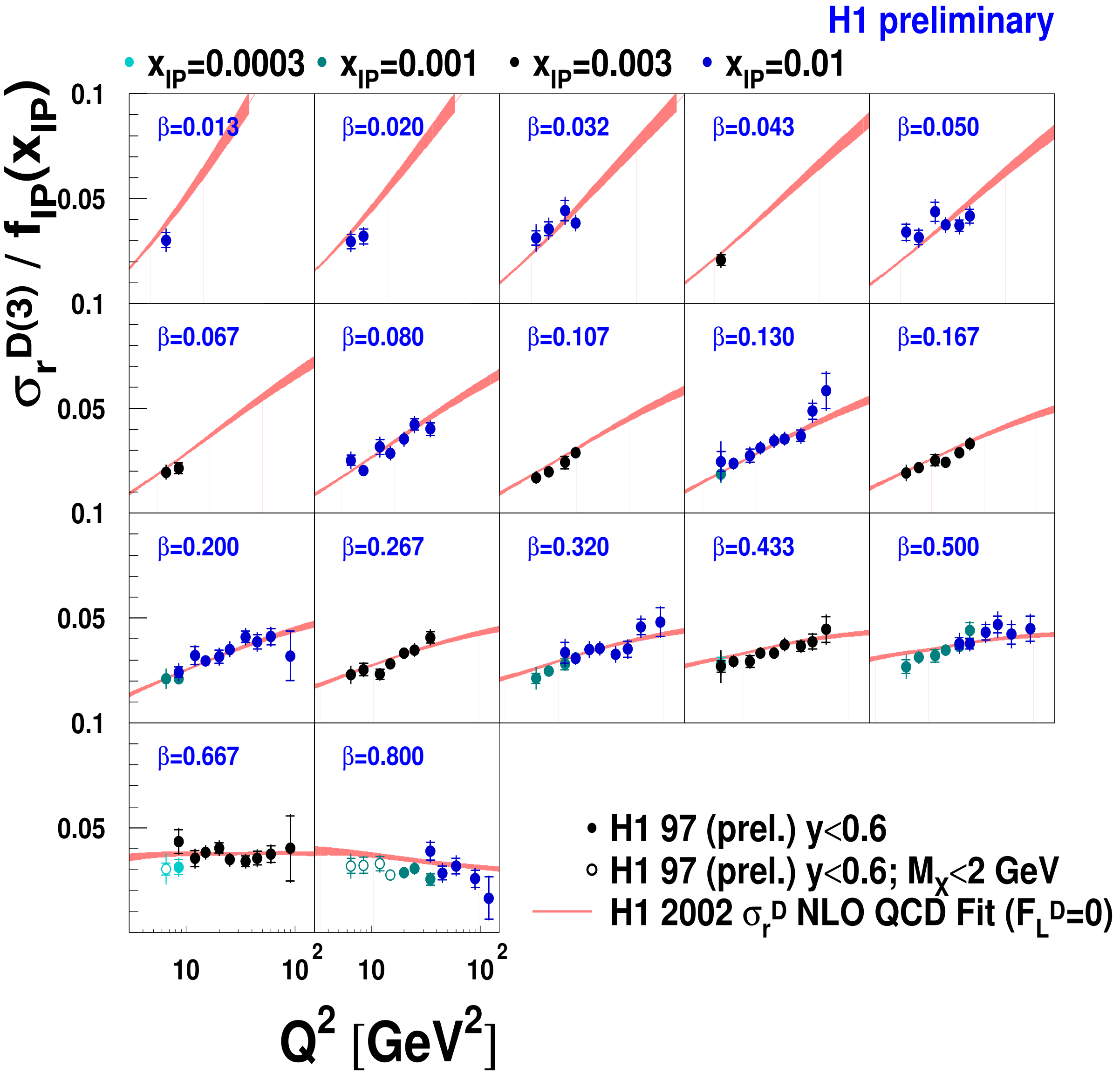
$$\frac{\partial F_2^D}{\partial \ln Q^2} \sim \alpha_s g^D$$

positive scaling violations up to $\beta \approx 2/3$

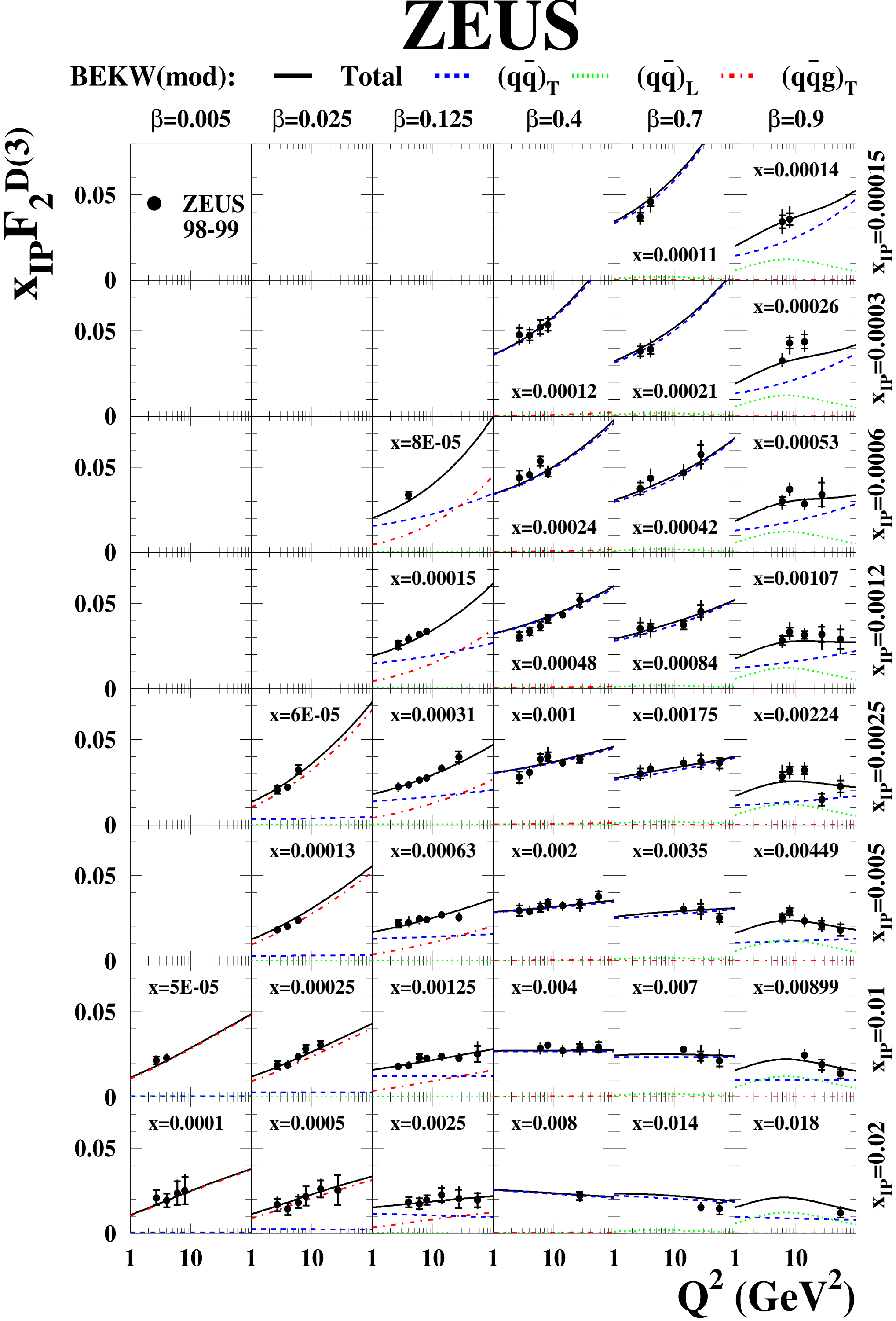
→ large gluon component

(standard F_2 rises only up to $x_{Bj} \approx 0.2$)

$$\sigma_r^D \sim F_2^D$$



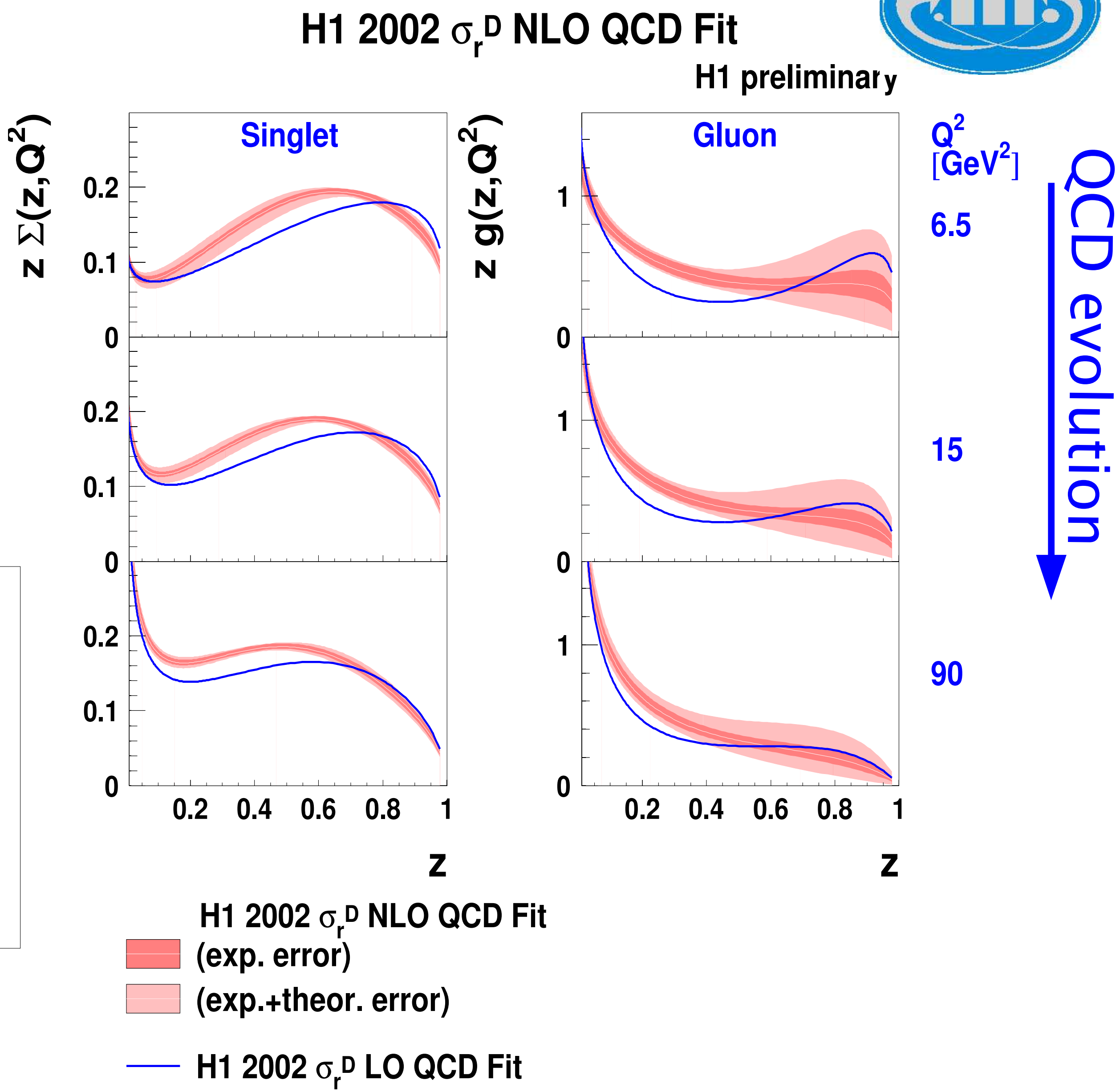
F_2^D from ZEUS



scaling violations
at low β

Parton Densities from Fit to F_2^D

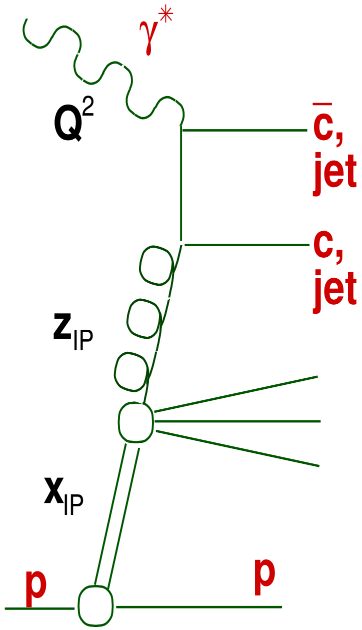
- DGLAP evolution fit
- gluon carries ≈80% of momentum
- large uncertainty at high fractional momentum



same structure in Jet and charm production?

→ Factorisation Tests at NLO

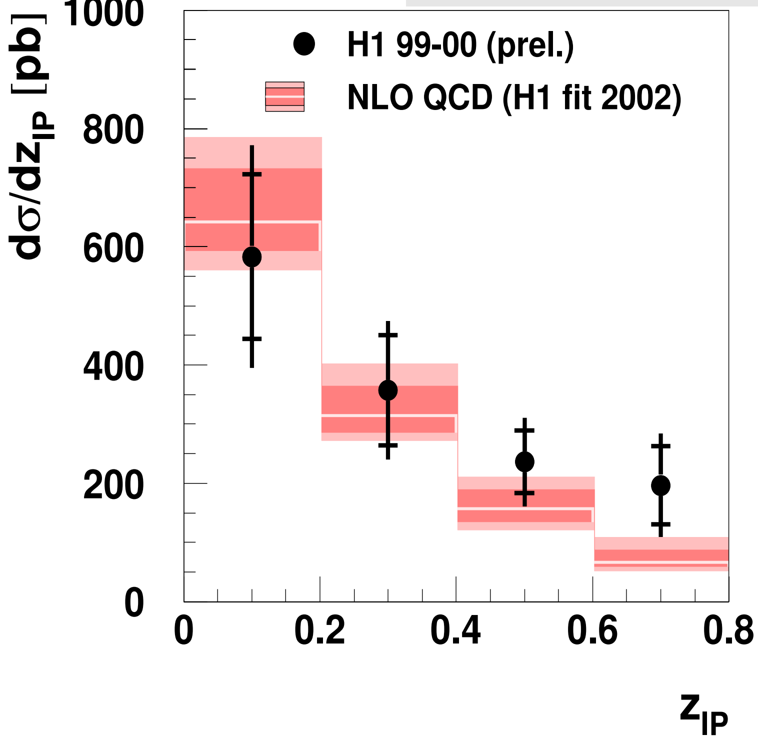
Open Charm Production (D*) in DIS



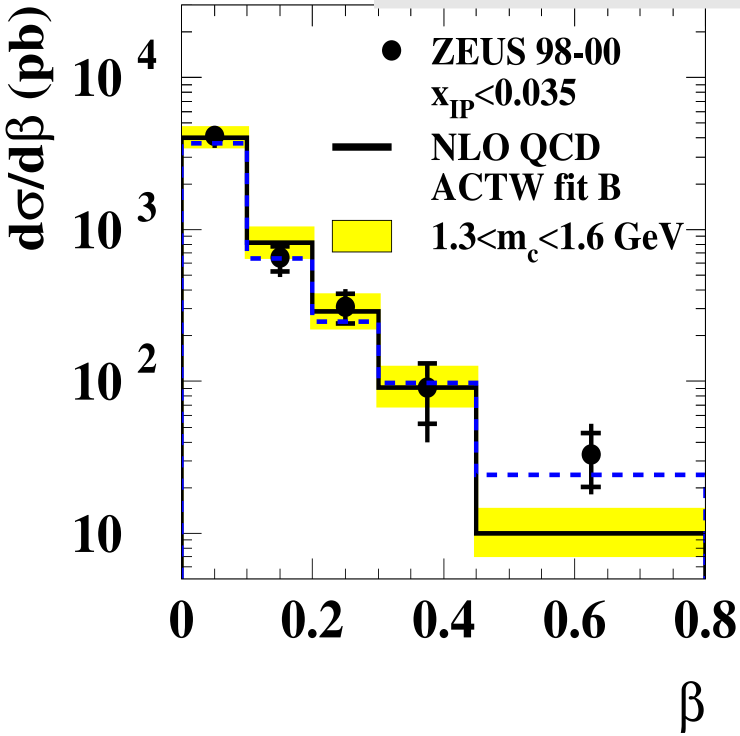
sensitive
to gluon

NLO:
HVQDIS
program

$Q^2 > 2$ GeV^2
$x_{IP} < 0.04$
$p_T^{D^*} > 2$ GeV/c



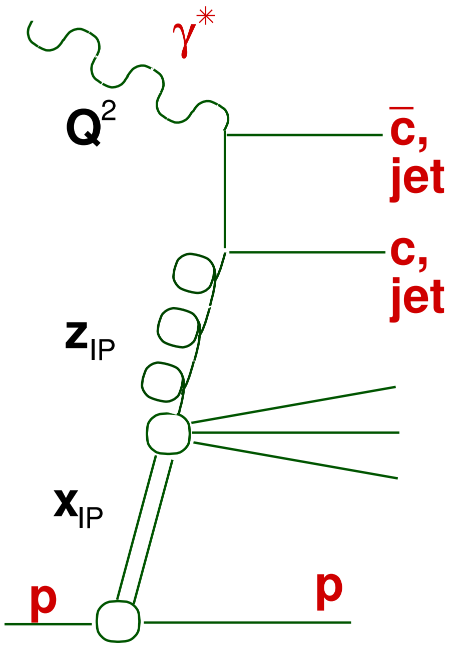
$Q^2 > 1.5$ GeV^2
$x_{IP} < 0.035$
$p_T^{D^*} > 1.5$ GeV/c

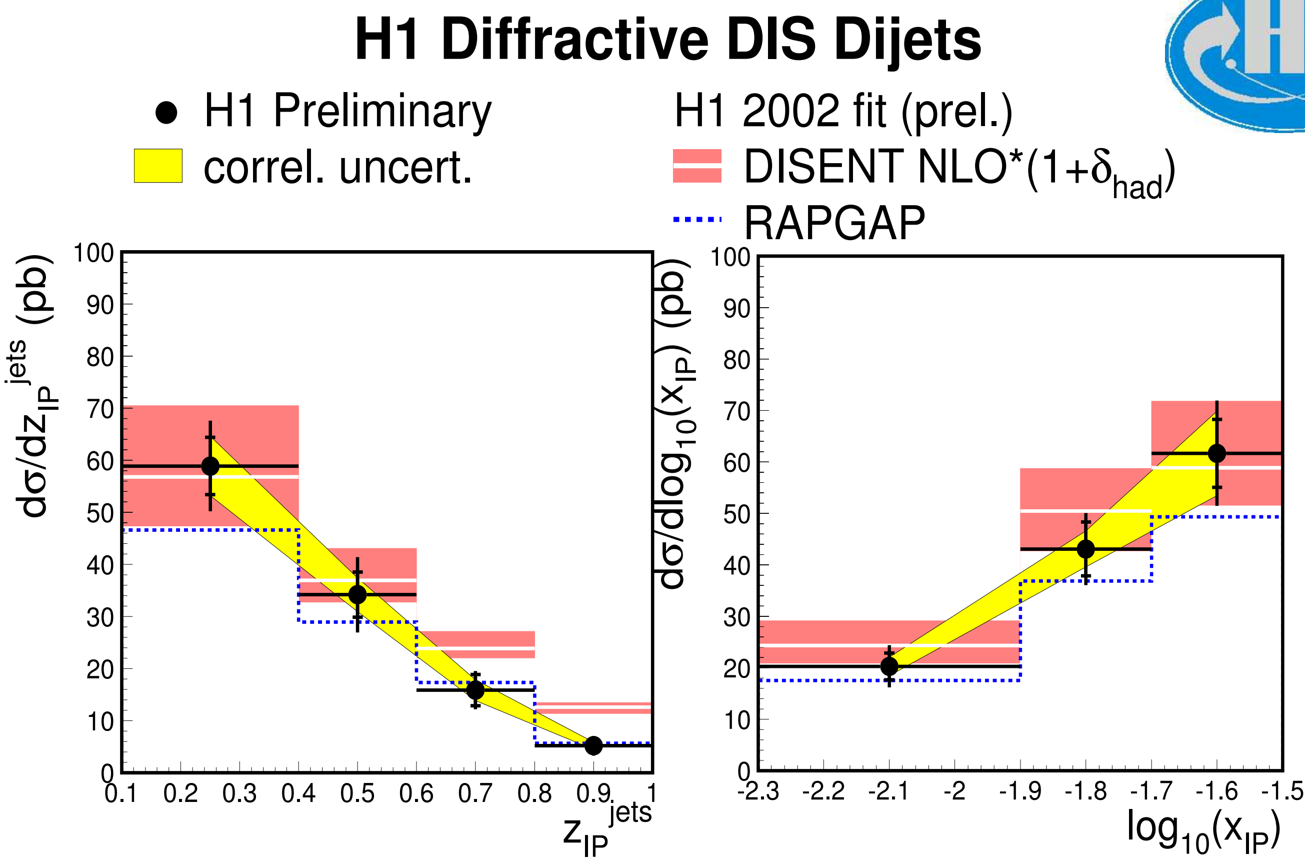


NLO calculations w/diffr. PDFs from F_2^D

✔ good description
✔ Factorisation holds

Jet Production in DIS





$4 < Q^2 < 80$ GeV^2
$x_{IP} < 0.03$
$E_T^{jet}(1) > 5$ GeV
$E_T^{jet}(2) > 4$ GeV
k_T jet algorithm

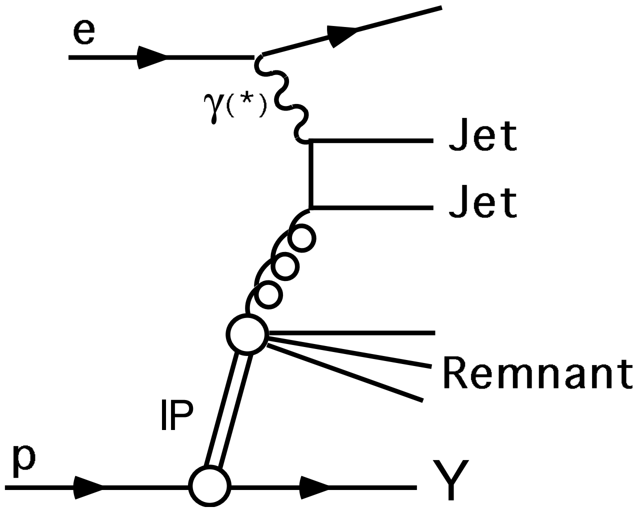
PDF uncertainty not shown
(important at high z_{IP})

NLO: DISENT w/
diffractive PDFs

✔ good description
✔ Factorisation holds

Real Photon – Proton Scattering

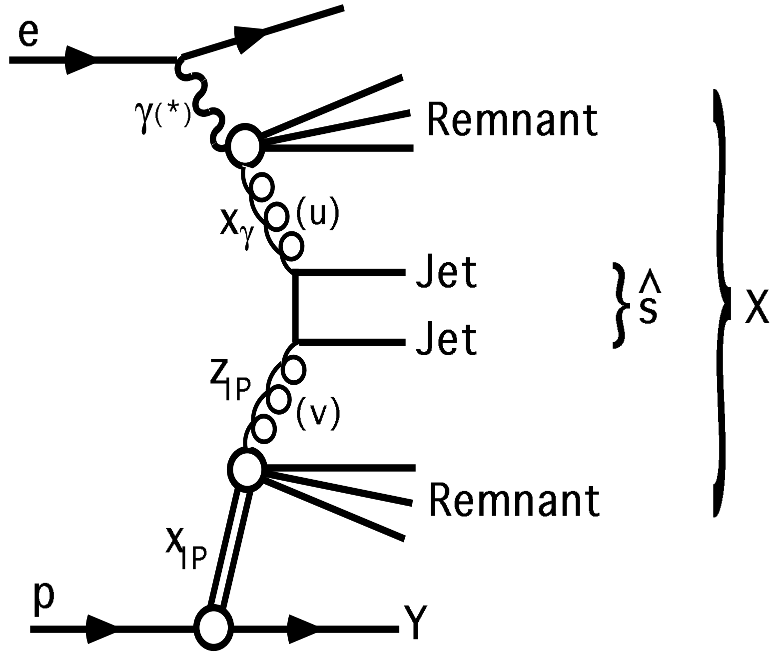
"direct" ($x_\gamma = 1$)



x_γ = photon momentum fraction transferred to jets

"resolved" ($x_\gamma < 1$)

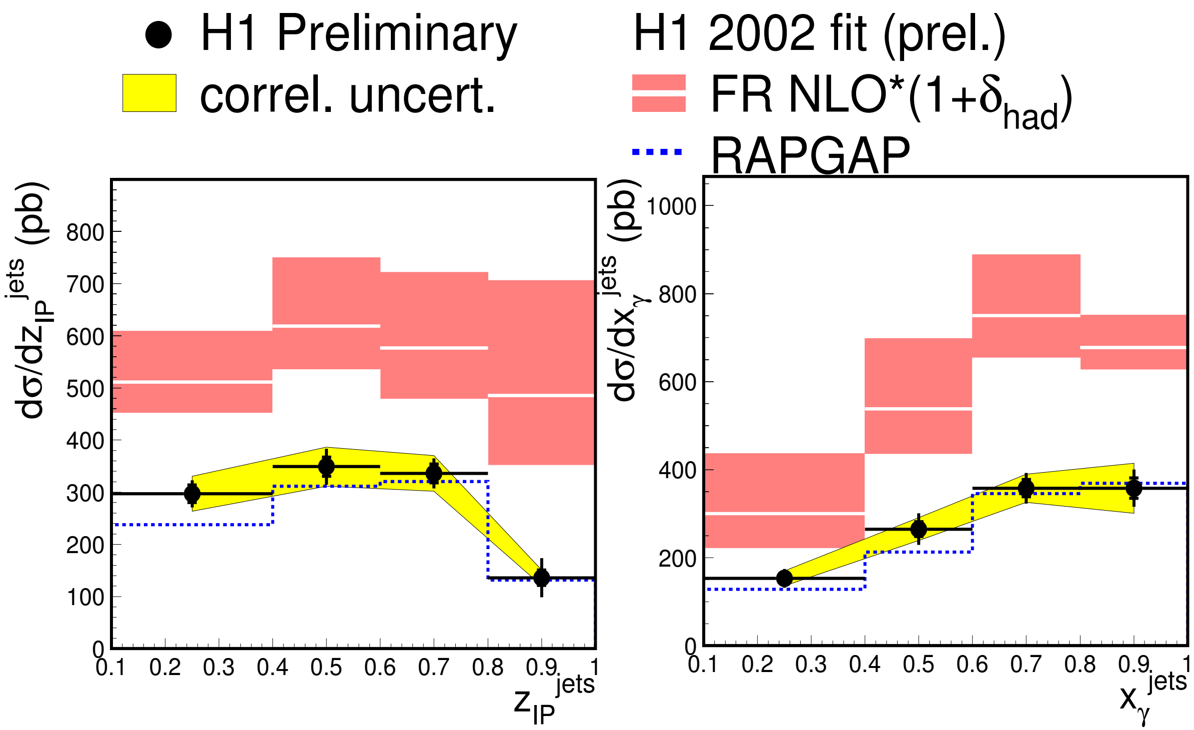
photon fluctuates into hadronic system

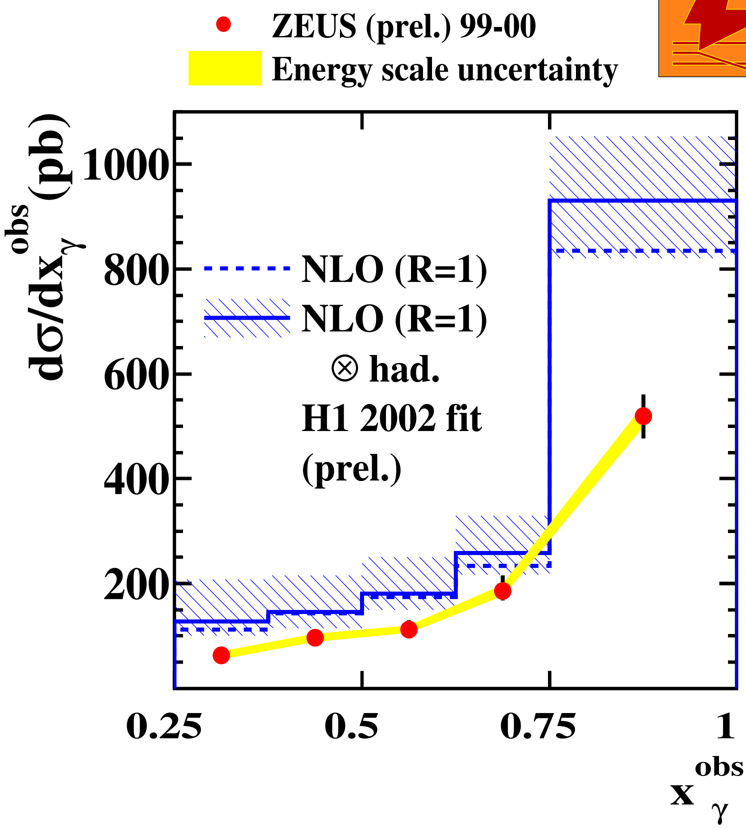


Factorisation breaking due to rescattering?

γp Dijet Factorisation Breaking

H1 Diffractive γp Dijets





$Q^2 < 0.01$ GeV^2
$x_{IP} < 0.03$
$E_T^{jet}(1) > 5$ GeV
$E_T^{jet}(2) > 4$ GeV
k_T jet algorithm

NLO: Frixione program

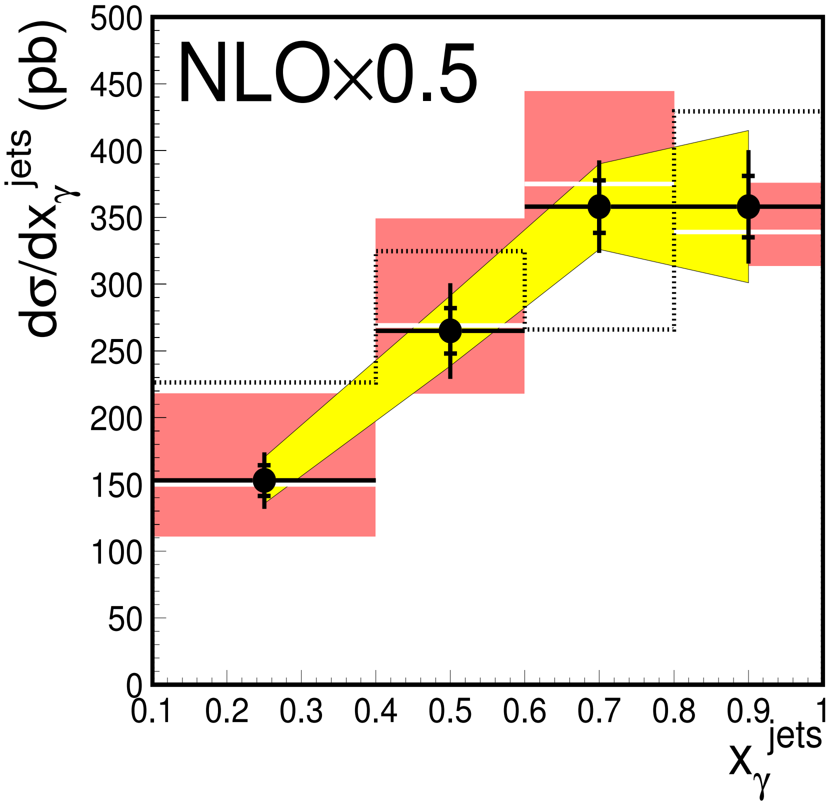
✗ NLO factor 2 above data
✗ Factorisation broken

$Q^2 < 1$ GeV^2
$x_{IP} < 0.035$
$E_T^{jet}(1) > 7.5$ GeV
$E_T^{jet}(2) > 6.5$ GeV
k_T jet algorithm

NLO: Klasen/Kramer

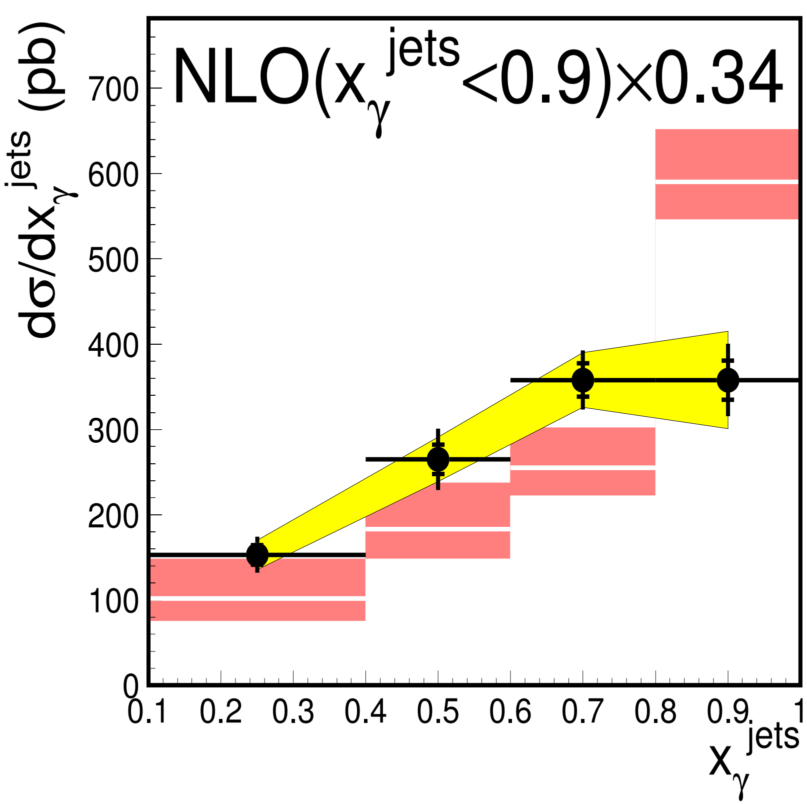
Suppression independent of kinematics

global suppression



good description

direct unsuppressed



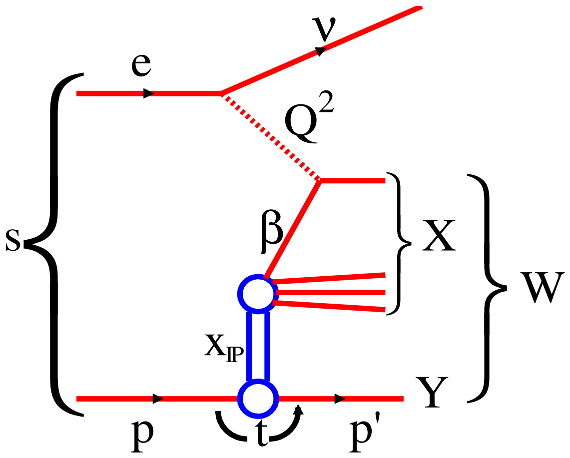
disfavoured

Factor 0.34 from Kaidalov et al.
Phys.Lett. B567 (2003) 61

(same model describes factor ≈10 Tevatron suppression)

same conclusion from ZEUS

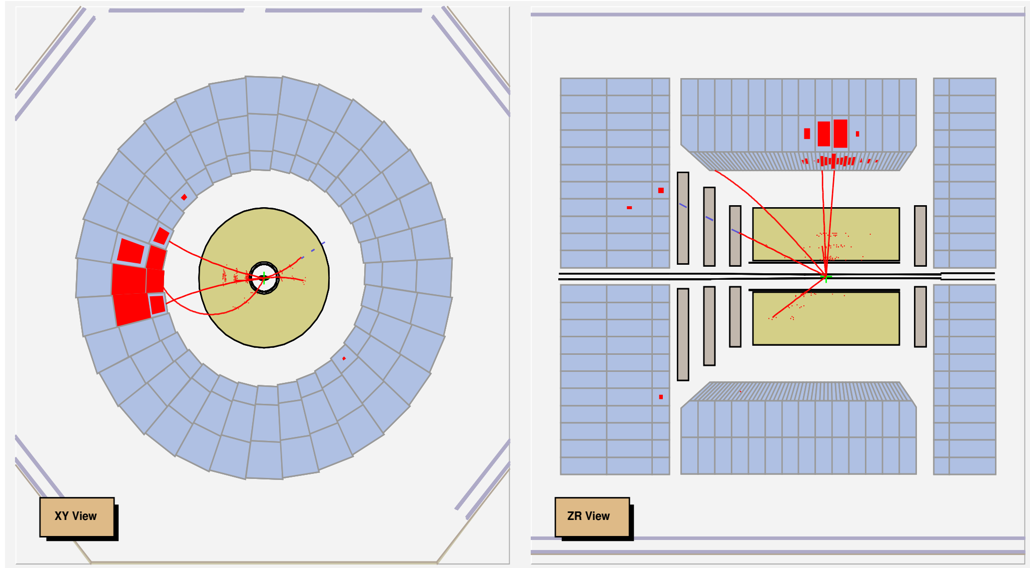
Diffractive Charged Current Events

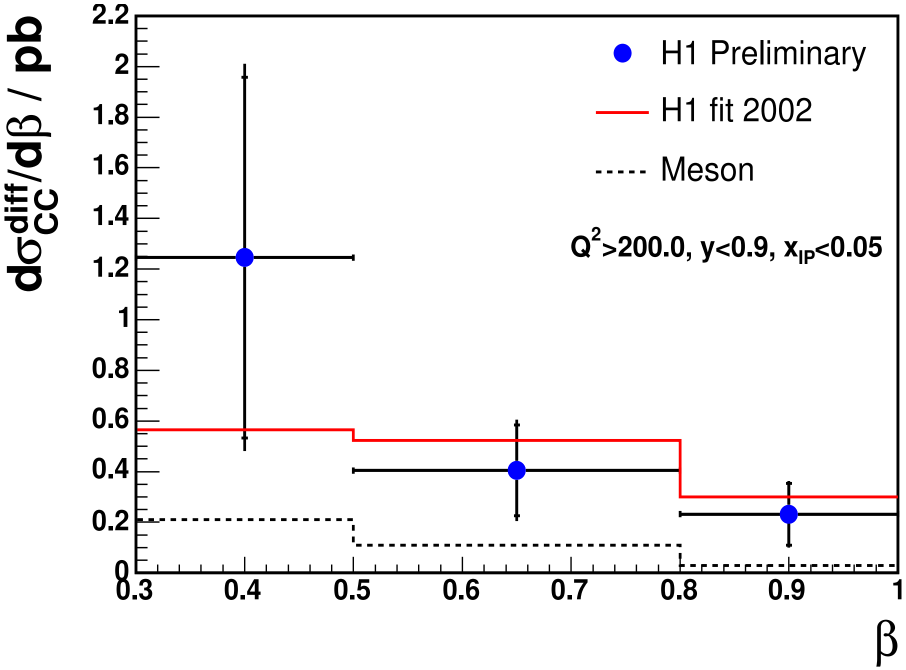


- process $ep \to \nu XY$

$p_T^{miss} > 12$ GeV/c
$Q^2 > 200$ GeV^2
$x_{IP} < 0.05$

- H1: 14 events
- ZEUS: 9 events





- described by LO Monte Carlo w/diffractive PDFs from neutral current F_2^D

- diffr. CC/all CC:

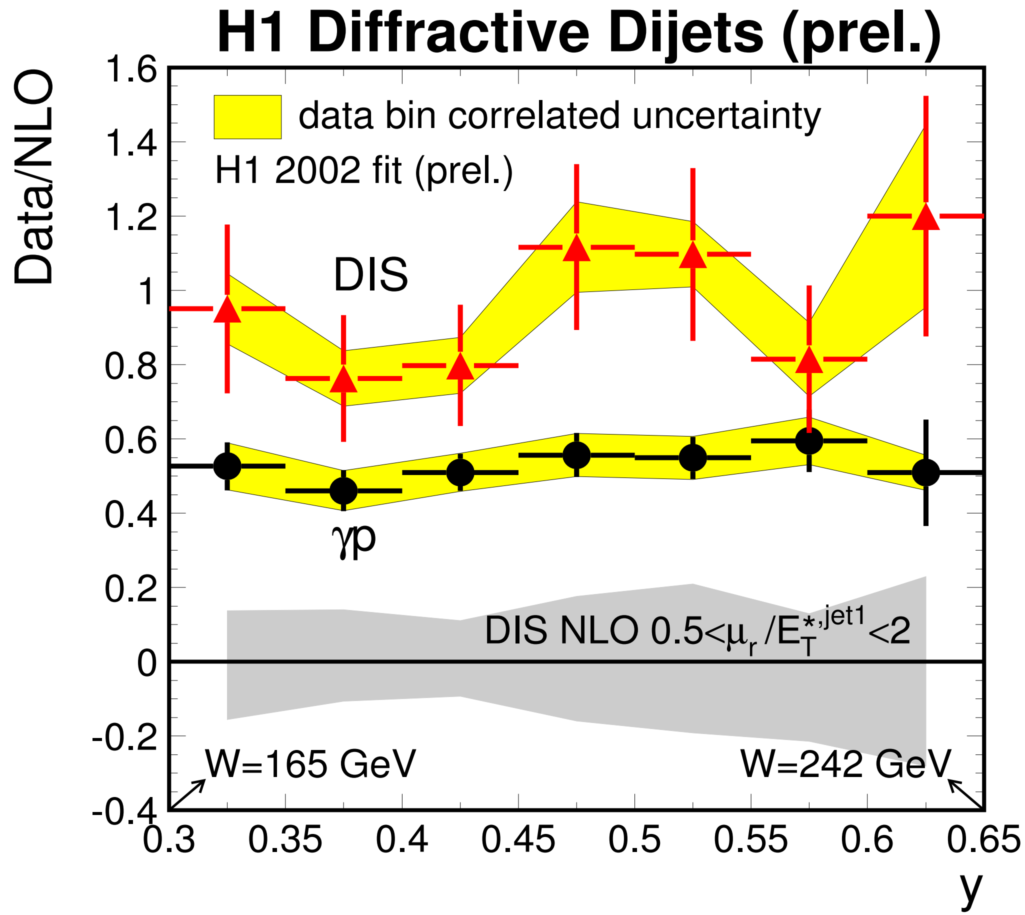
$$\text{H1: } 2.5 \pm 0.8(\textbf{stat}) \pm 0.6(\textbf{syst})\ \%$$
$$\text{ZEUS: } 2.9 \pm 1.2(\textbf{stat}) \pm 0.8(\textbf{syst})\ \%$$

Summary

- Universal diffractive structure in deep-inelastic ep scattering (NC, CC, jets, charm)

- Factorisation breaking for real photons:

  global suppression 0.5



Backup

Parameterisation of x_{IP},t dependence

- not enough data to fit β,Q^2 dependence at fixed x_{IP},t (ideal case)
- Ansatz:

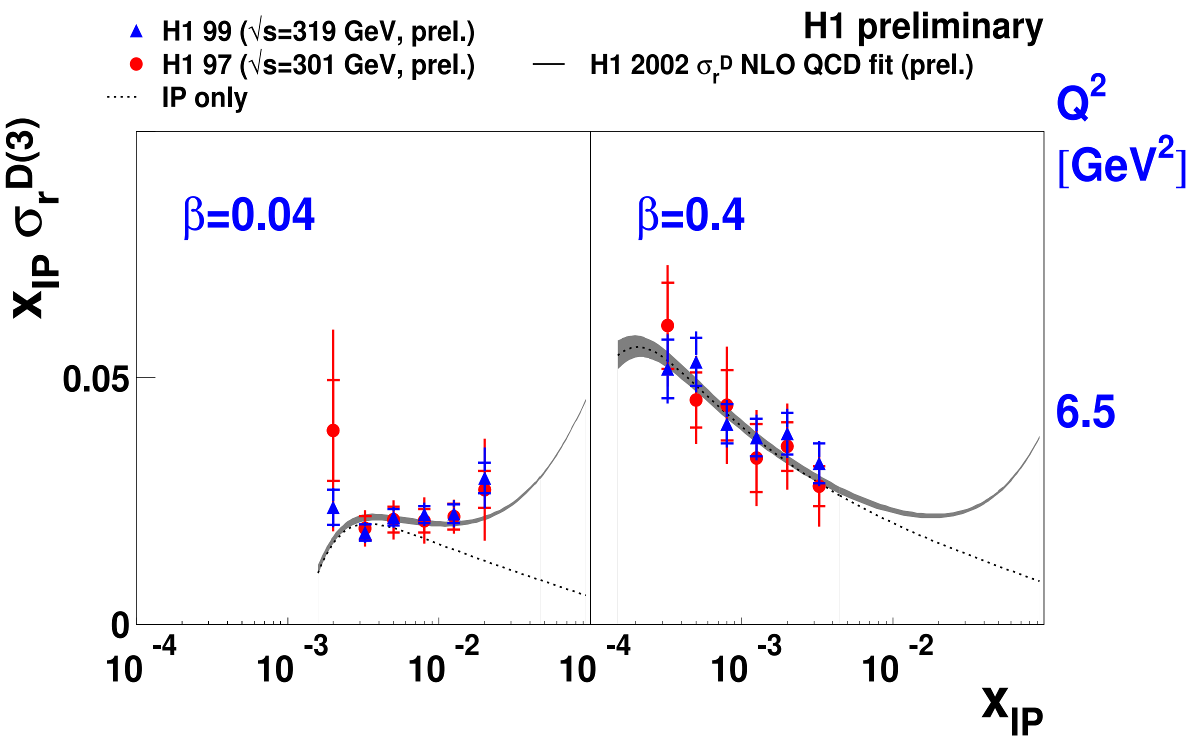
$$f^D_{i/p}(x_{IP},t,\beta,Q^2) = f_{IP/p}(x_{IP},t) \times f_{i/IP}(\beta,Q^2) \quad \text{"Pomeron"}$$
$$+ f_{IR/p}(x_{IP},t) \times f_{i/IR}(\beta,Q^2) \quad \text{"Reggeon"}$$

for $x_{IP}>0.01$

- x_{IP},t dependence parameterised in Regge form:

$$f_{IP/p}(x_{IP},t) = \int dt \frac{e^{B_{IP}t}}{x_{IP}^{2\alpha_{IP}(t)-1}}$$

$$\alpha_{IP}(0) = 1.17^{+0.07}_{-0.05}$$ from fit to data



- Reggeon contribution small for jets (≈7%)