The QCD analysis of F_2^D and Comparisons with Final States at HERA and theTevatron

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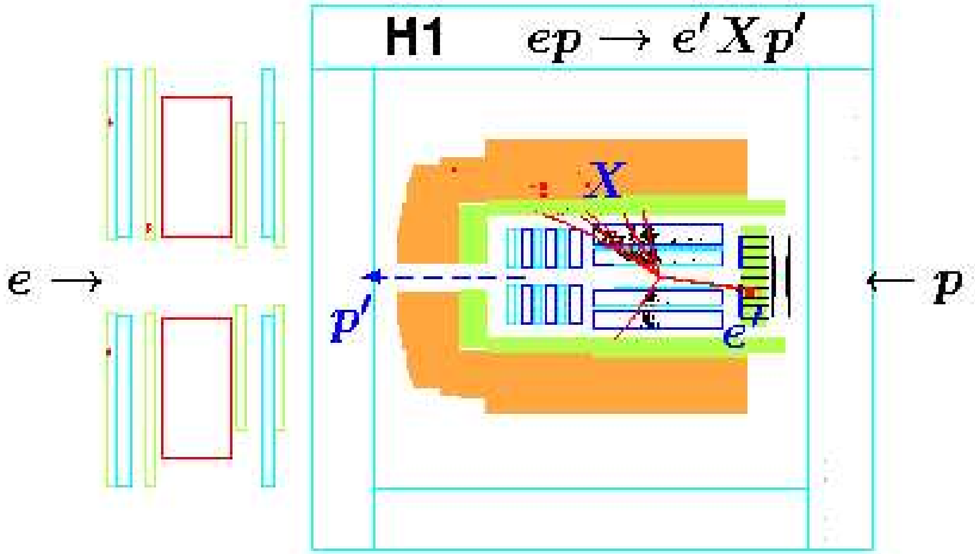
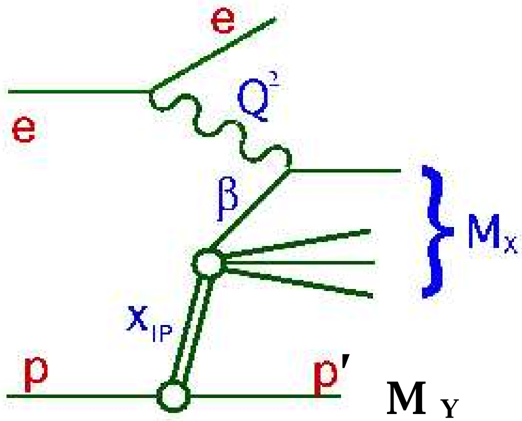
  - Diffractive reduced cross section
  - Factorisation in diffraction
- QCD fit to diffractive reduced cross section
- Diffractive final states
- Summary

Diffractive DIS at HERA

Large rapidity gap between leading proton *p'* and *X*





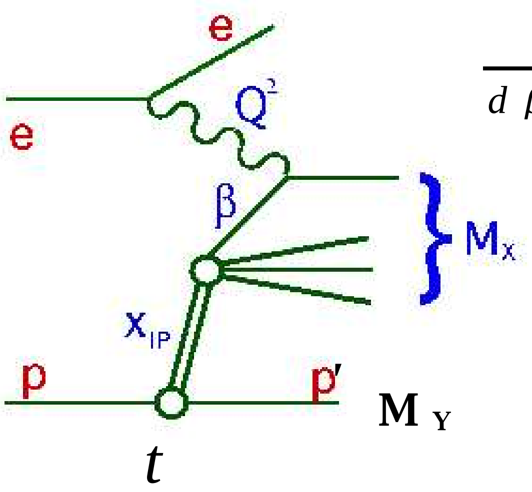
Momentum fraction of proton carried by colour singlet exchange:

$$x_{IP} = \frac{q \cdot (p - p')}{q \cdot p} \simeq \frac{Q^2 + M_x^2}{Q^2 + W^2}$$

Momentum fraction of colour singlet carried by struck quark:

$$\beta = \frac{x}{x_{IP}} \simeq \frac{Q^2}{Q^2 + M_x^2}$$

Diffractive Reduced Cross Section



$$\frac{d^4\sigma}{d\beta dQ^2 dx_{IP} dt} = \frac{4\pi\alpha^2}{\beta Q^4}\left(1-y+\frac{y^2}{2}\right)\sigma_r^{D(4)}(\beta, Q^2, x_{IP}, t)$$

Relation to F_2^D and F_L^D:

$$\sigma_r^{D(4)} = F_2^{D(4)} - \frac{y^2}{2(1-y+y^2/2)} F_L^{D(4)}$$

$\sigma_r^D \approx F_2^D$ at low y $\qquad$ $\sigma_r^D = F_2^D$ if $F_L^D = 0$

Integrate over t when proton is not tagged $\rightarrow$ $\sigma_r^{D(3)}$

Factorisation in Diffraction

QCD hard scattering factorisation:

$$\sigma^D(\gamma^* p \to Xp) = \sum_{parton\ i} f_i^D(x, Q^2, x_{IP}, t) \cdot \sigma^{\gamma^* i}(x, Q^2)$$

$\sigma^{\gamma^* i}$ – universal hard scattering cross section

f_i^D – diffractive parton distribution function $\rightarrow$ obey DGLAP,
universal for diffractive DIS (inclusive, dijets, charm)

Additional assumption $\rightarrow$ Regge factorisation:

$$f_i^D(x, Q^2, x_{IP}, t) = f_{IP/p}(x_{IP}, t) \cdot f_i^{IP}(\beta = x/x_{IP}, Q^2)$$

$f_{IP/p}$ – pomeron flux factor

f_i^{IP} – pomeron parton distribution function

Parameters of QCD Fit

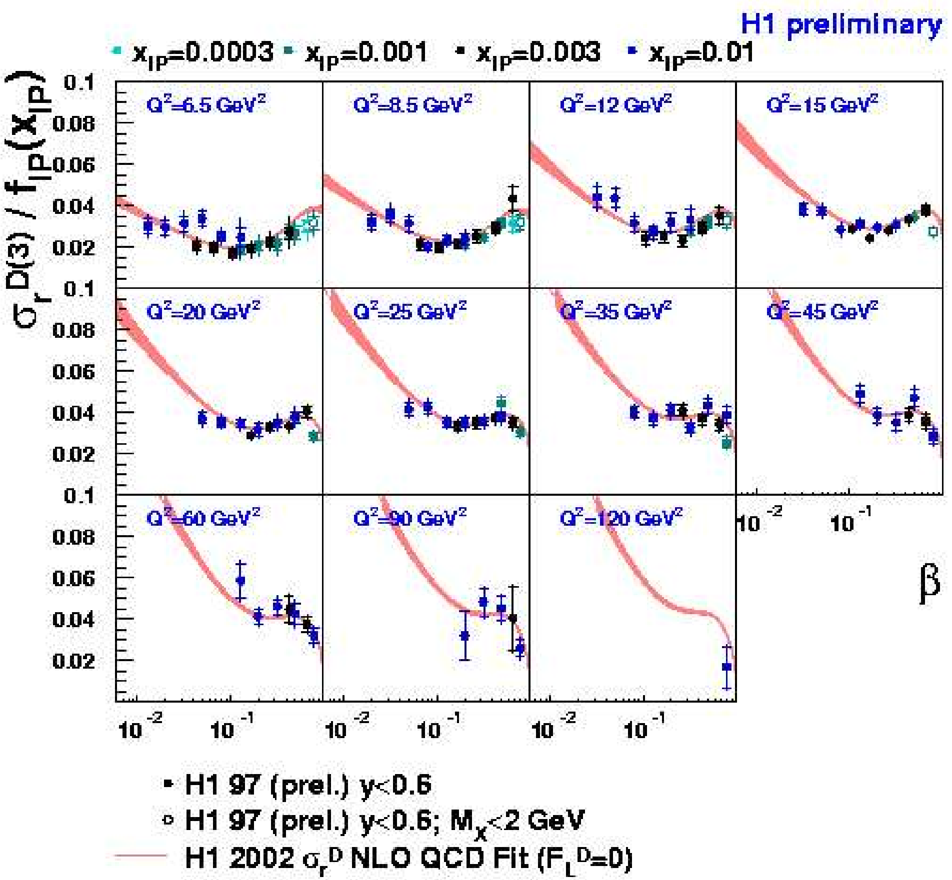
- Singlet quark and gluon parametrized at $Q_0^2 = 3$ GeV^2 by Chebychev polynomials, massive charm treatment via BGF

- Assume Regge factorisation for $x_{\mathbb{P}}$ dependence, $\alpha_{\mathbb{P}}(0)$ extracted from data, GRV−π sub−leading contribution at high $x_{\mathbb{P}}$

- NLO and LO DGLAP evolution, fit data for $Q^2 > 6.5$ GeV^2 and $M_X > 2$ GeV, for LO fit: $y < 0.45$ to suppress F_L^D effect

- Full propagation of correlated experimental systematic and theoretical uncertainties

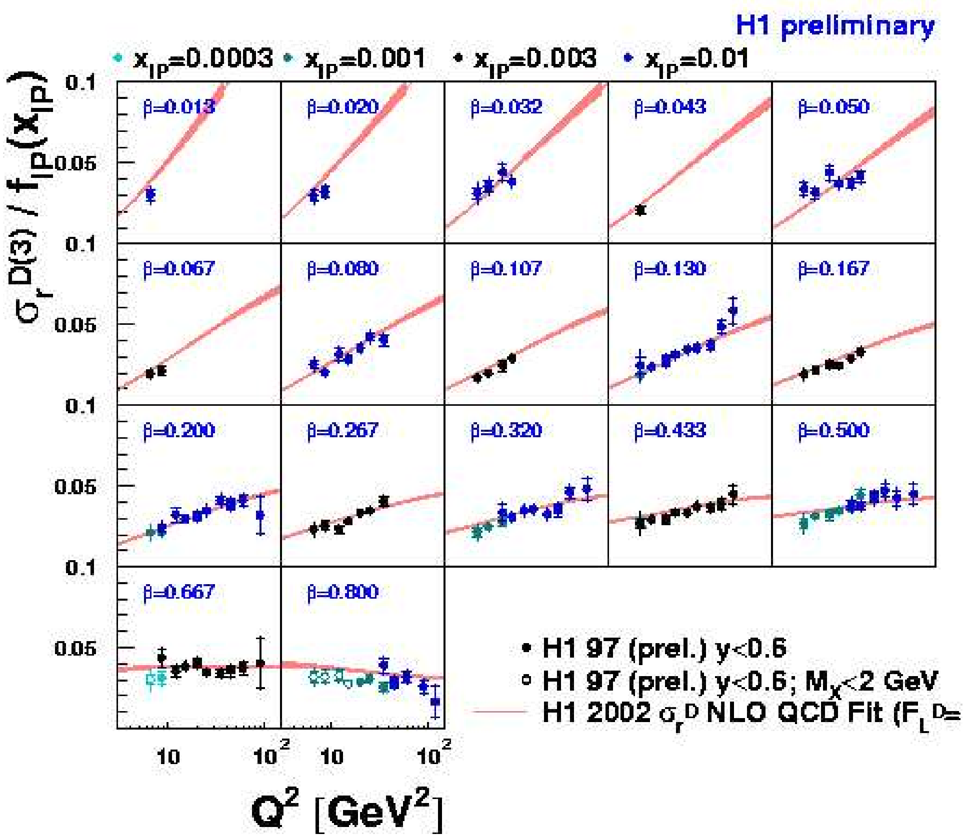
NLO DGLAP QCD Fit

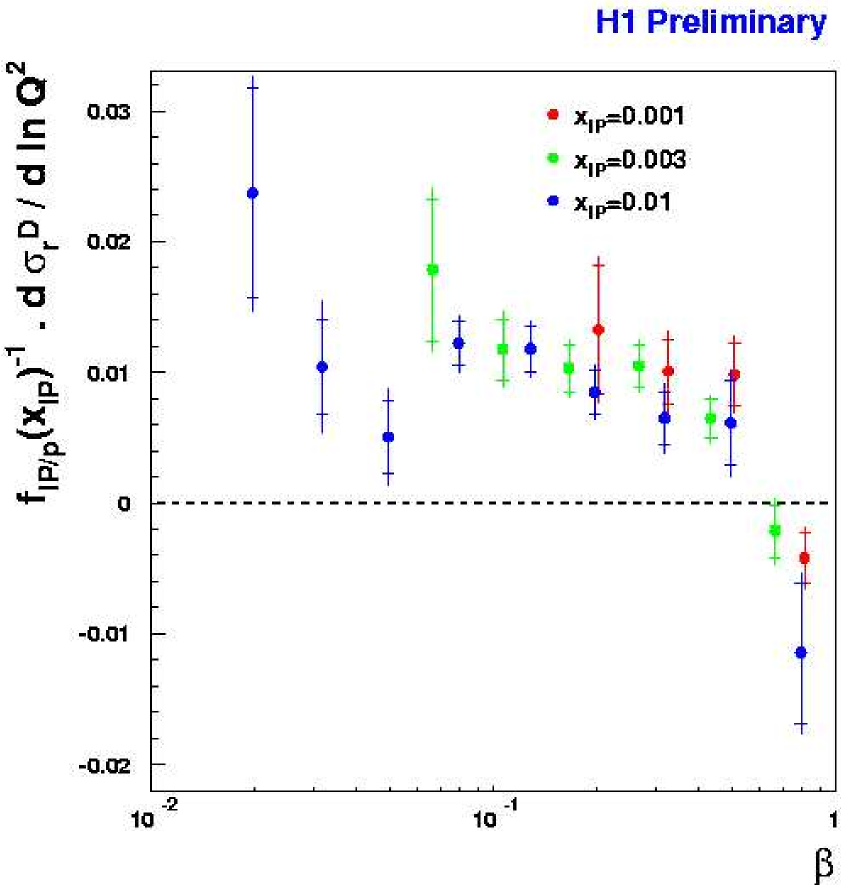


- β dependence well reproduced by NLO DGLAP fit
- σ_r from different $x_{\mathbb{P}}$ are in agreement

➔ Regge factorisation holds

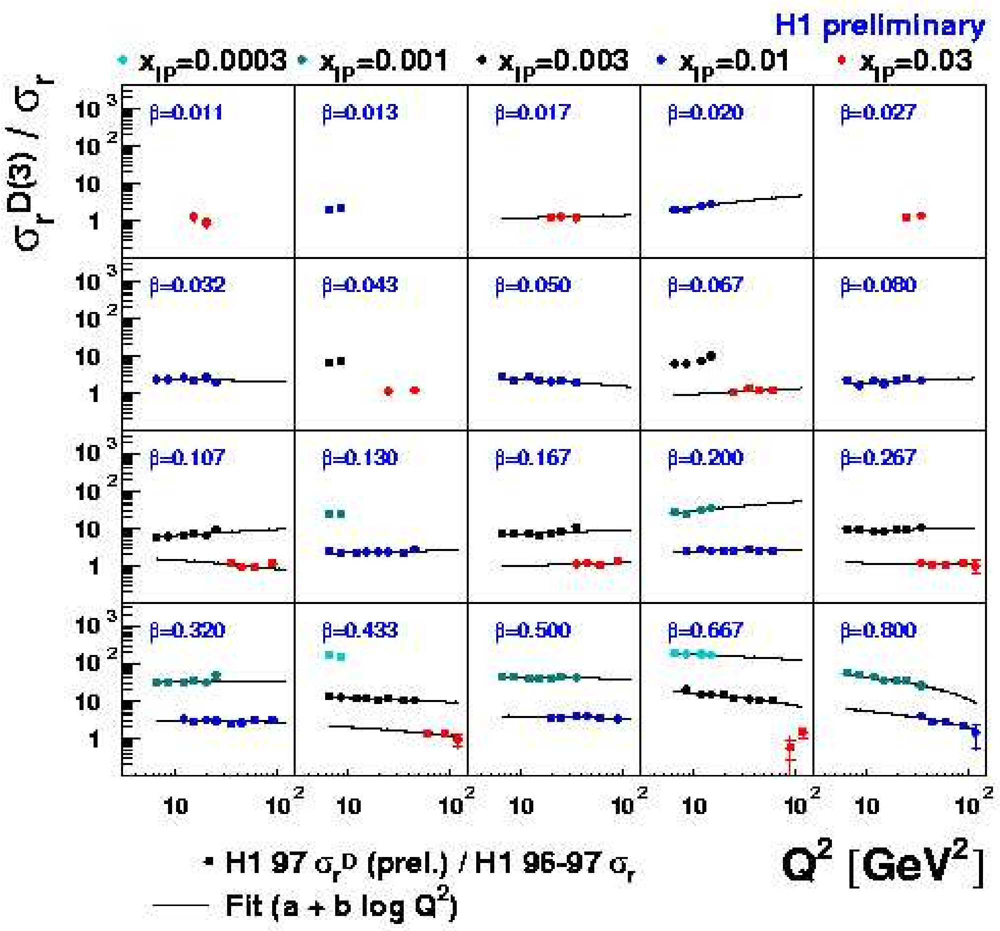
NLO DGLAP QCD Fit





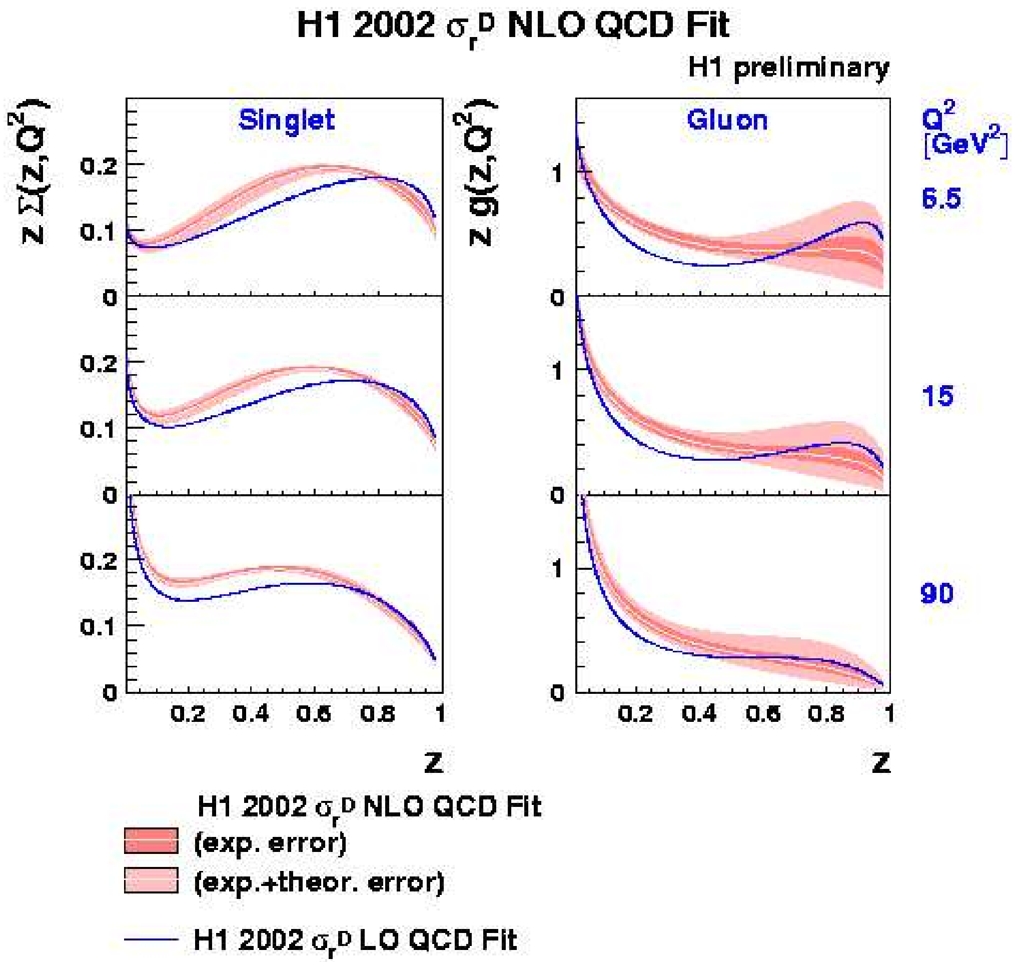
- Positive scaling violations in most of the β range reproduced by NLO DGLAP fit → gluon dominance

Ratio of Diffractive to Inclusive σ_r



Ratio is flat in most of the β range $\rightarrow$ same scaling violations in diffractive and inclusive DIS

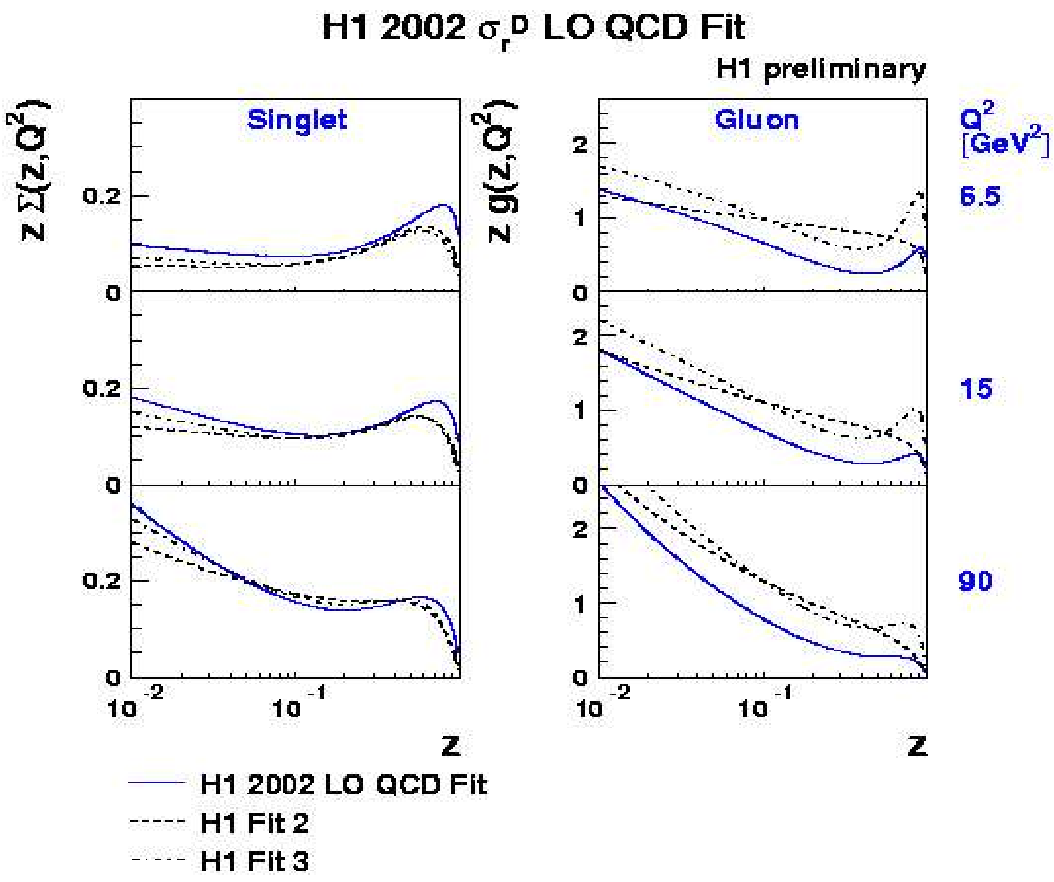
Diffractive Parton Distributions



- NLO vs LO DGLAP fit
- PDFs extending to large fractional momentum z
- Precise measurement of quark singlet distribution
- Hard gluon distribution

➔ Momentum fraction carried by gluons: 75±15%

Comparison with previous H1 Fits



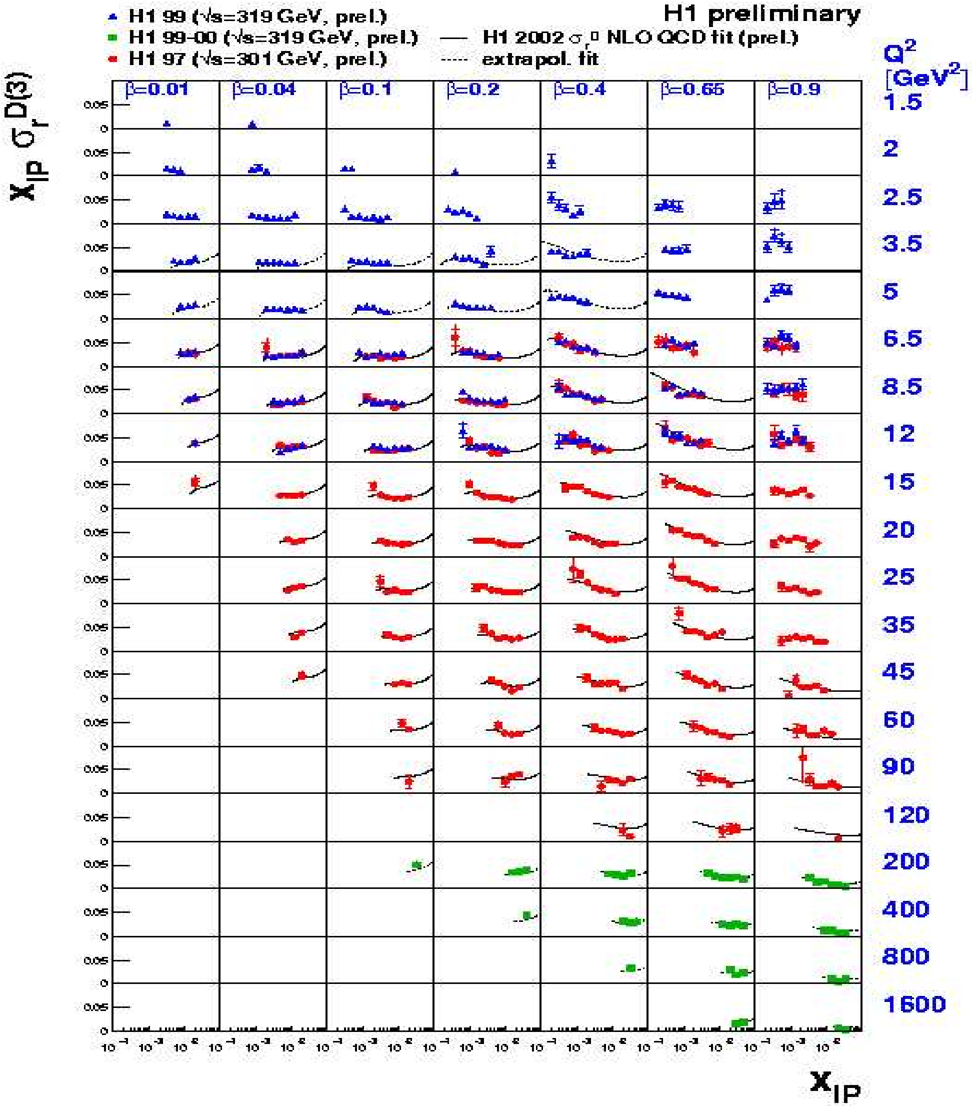
- Previous LO QCD fits to H1 1994 data:

- H1 Fit 2 ("flat gluon")
- H1 Fit 3 ("peaked gluon")

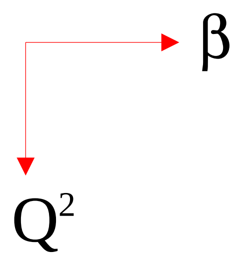
- Reasonable agreement of quark singlet distributions

- New gluon distribution smaller by 30% , but within combined errors of two fits

New σ_r^D measurements

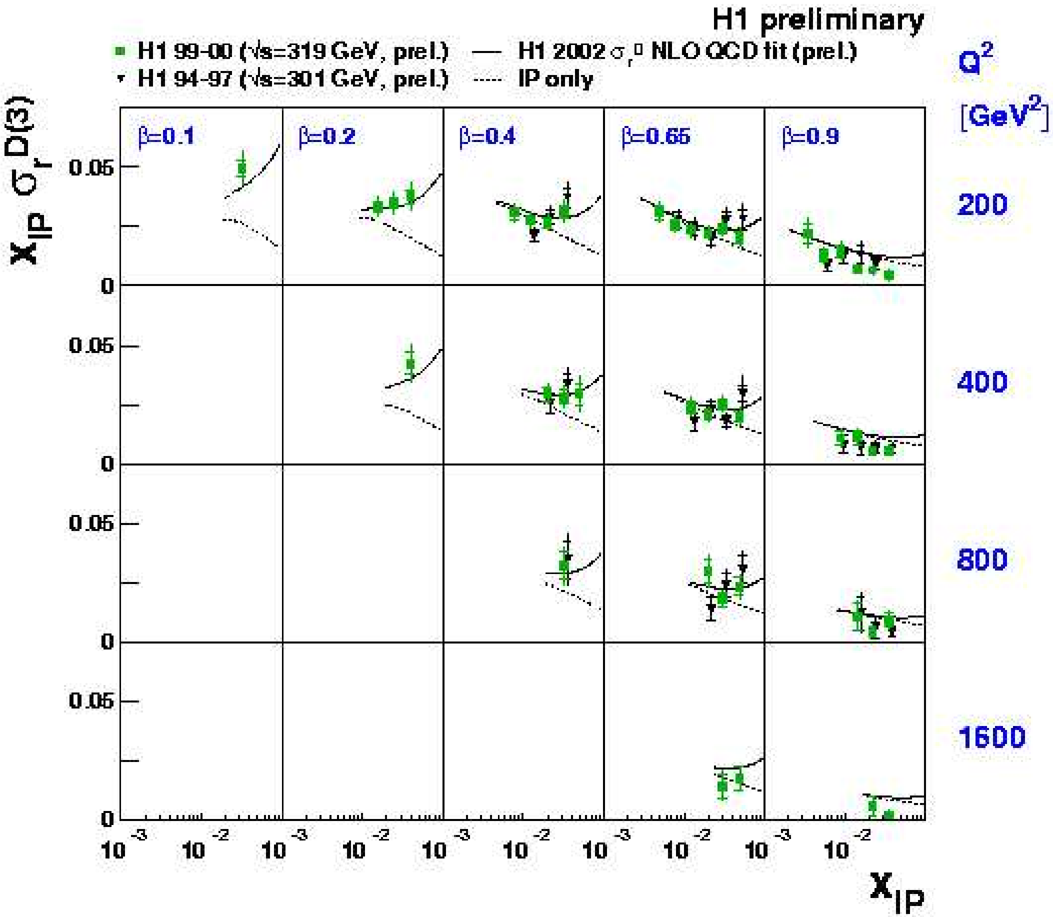


New low Q^2 points



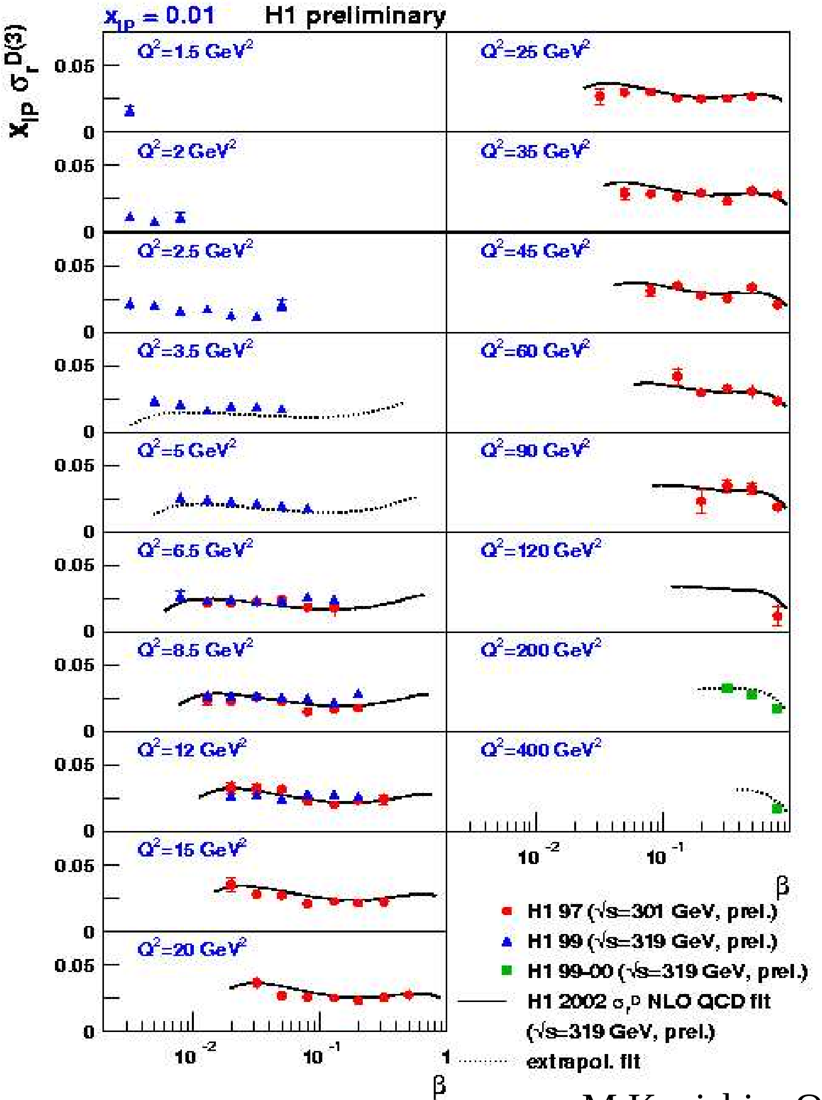
New high Q^2 points

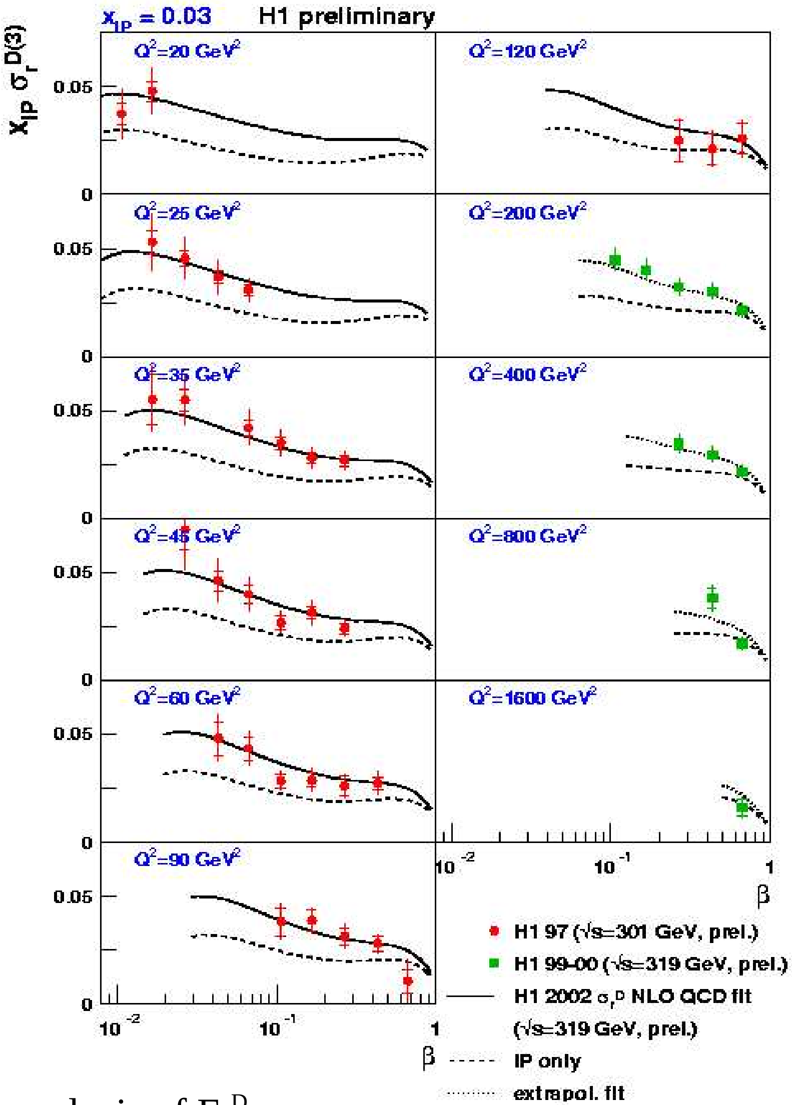
New measurement at high Q^2



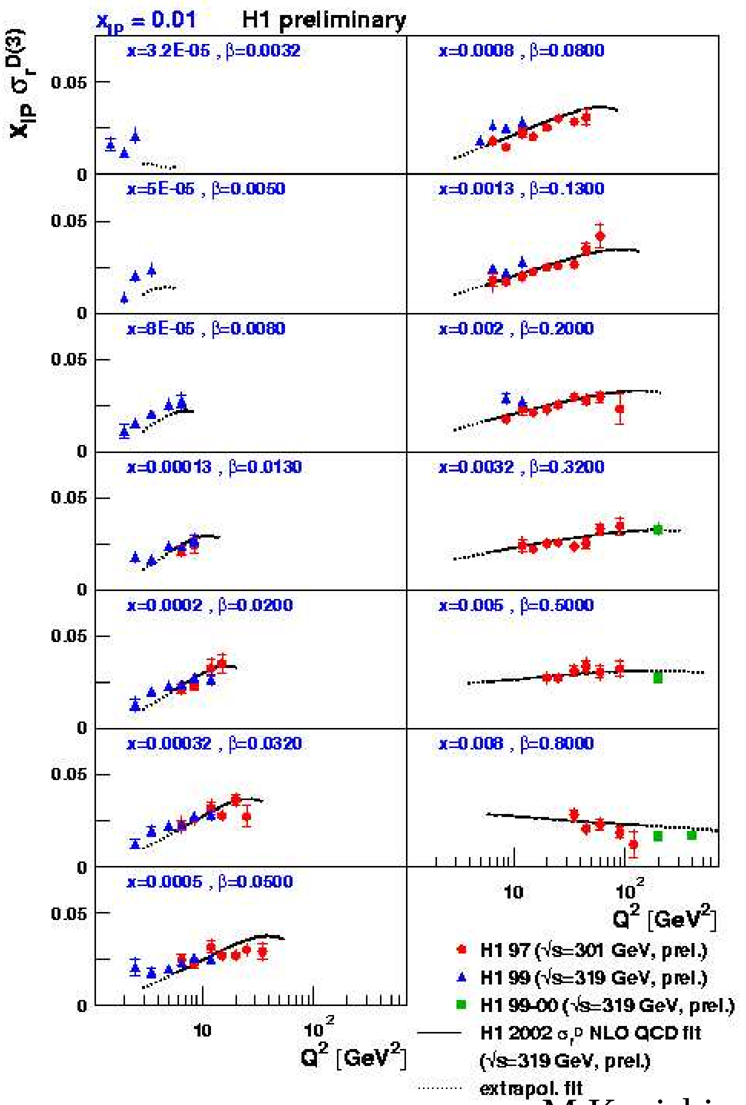
- Good agreement with NLO DGLAP fit to the medium Q^2 data
- Sub−leading trajectory contribution becomes important at low β

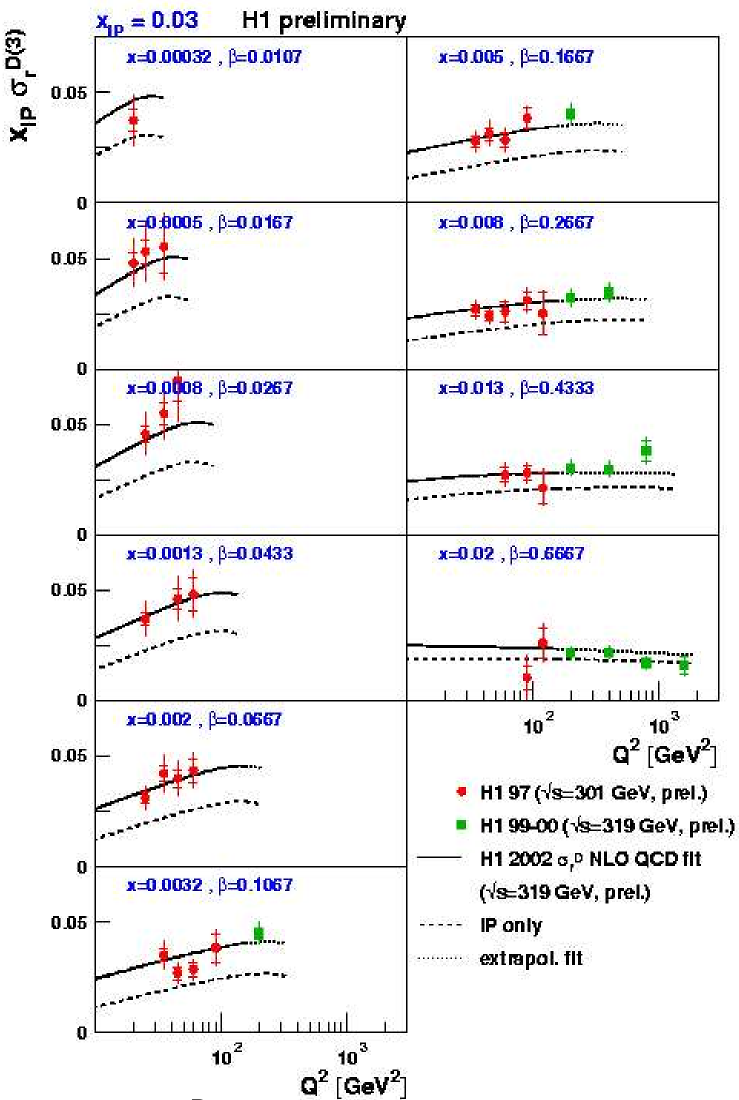
β dependence





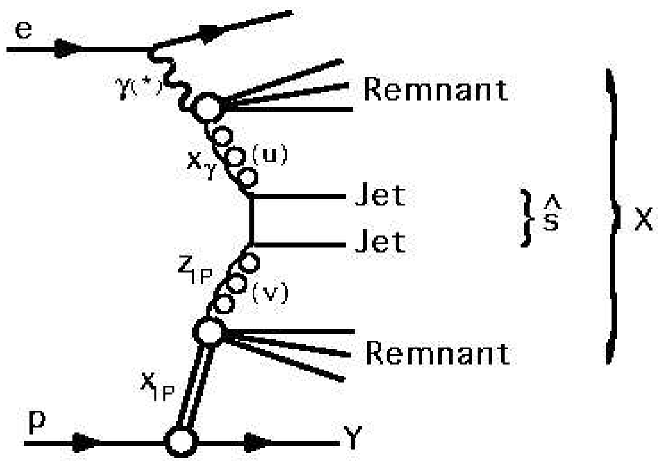
Q^2 dependence

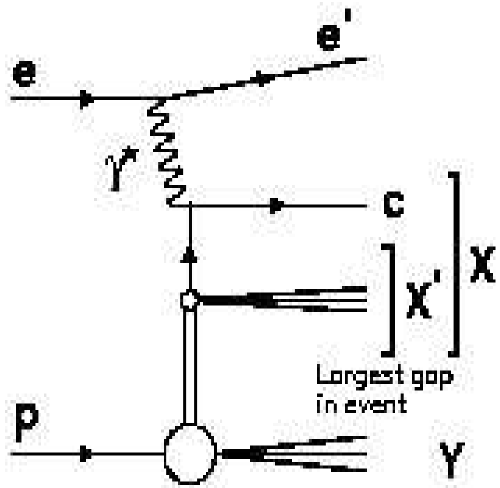


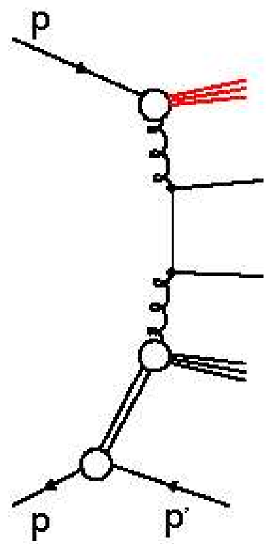


Diffractive Final States

dijet production | open charm | dijets in pp collisions



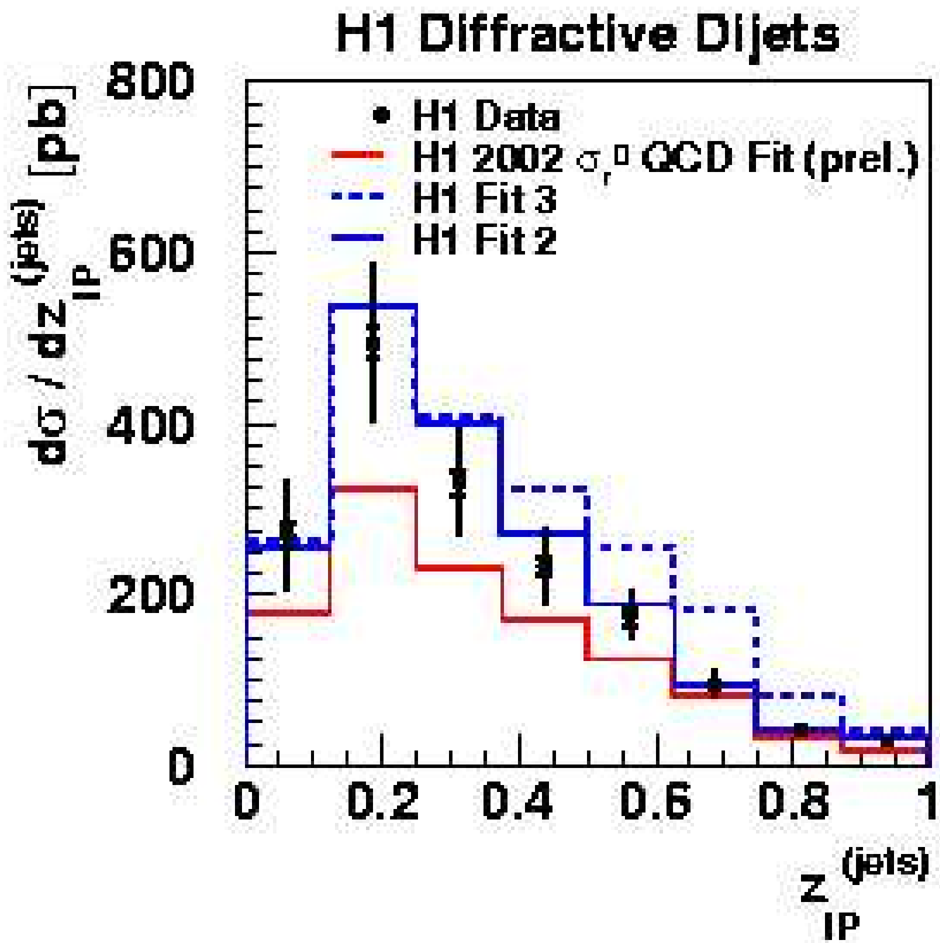




- Apply diffractive LO PDF's extracted from DGLAP fit to the inclusive diffractive cross sections

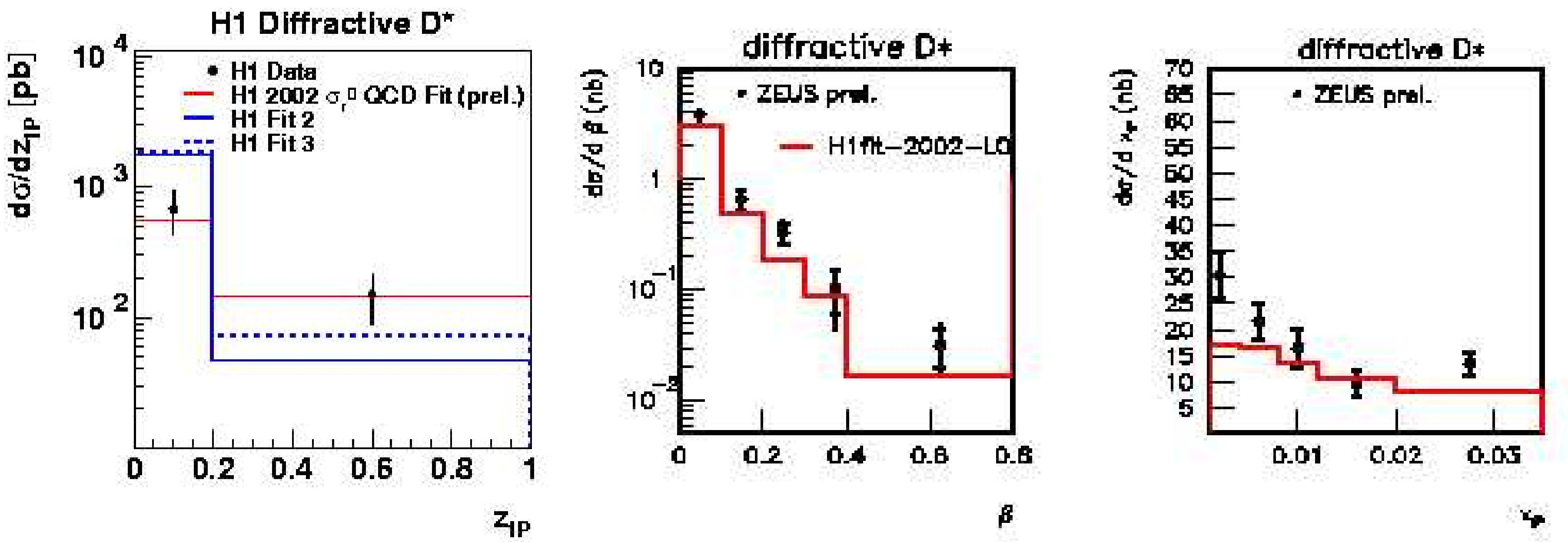
➔ Test QCD factorisation in Diffractive Final States (dijets in ep DIS, photo−production, pp, open charm production)

Dijets in Diffractive DIS at HERA



- Diffractive LO PDF's from σ_r QCD fit $\rightarrow$ predict diffractive dijets
- BGF process directly sensitive to gluons
- New fit:
  $\rightarrow$ dijet shape reproduced,
  $\rightarrow$ normalisation below, but within errors (30%)
- Consistent with QCD factorisation within errors

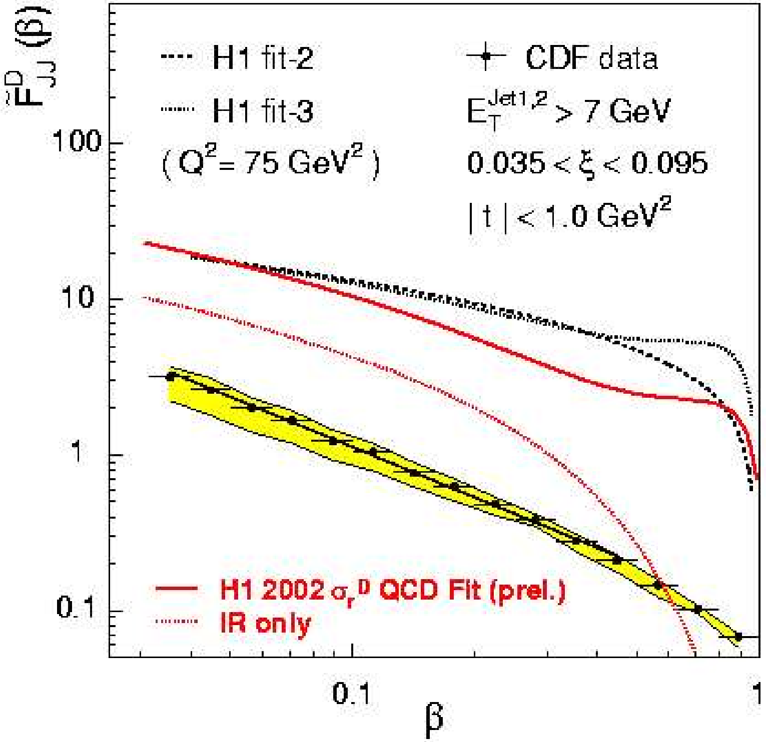
Diffractive D^* production



- Sensitive to gluon content of the pomeron through boson−gluon fusion
- Agreement between σ_r LO QCD fit prediction and D^* data

➔ Consistent with QCD factorisation within errors

Diffractive Dijets at the Tevatron



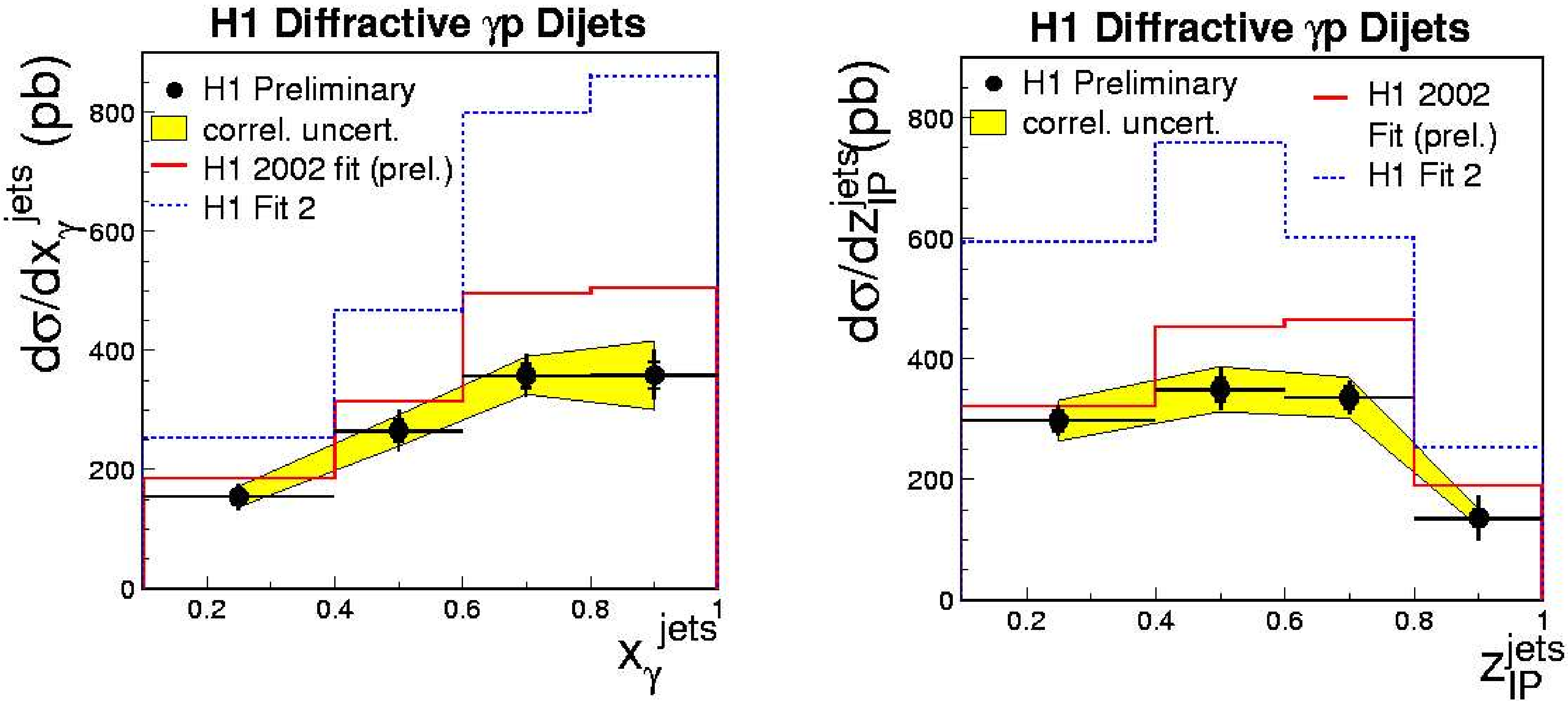
- Comparison with diffractive LO PDFs from HERA

➔ Overestimation by factor ~10

➔ Breakdown of factorisation

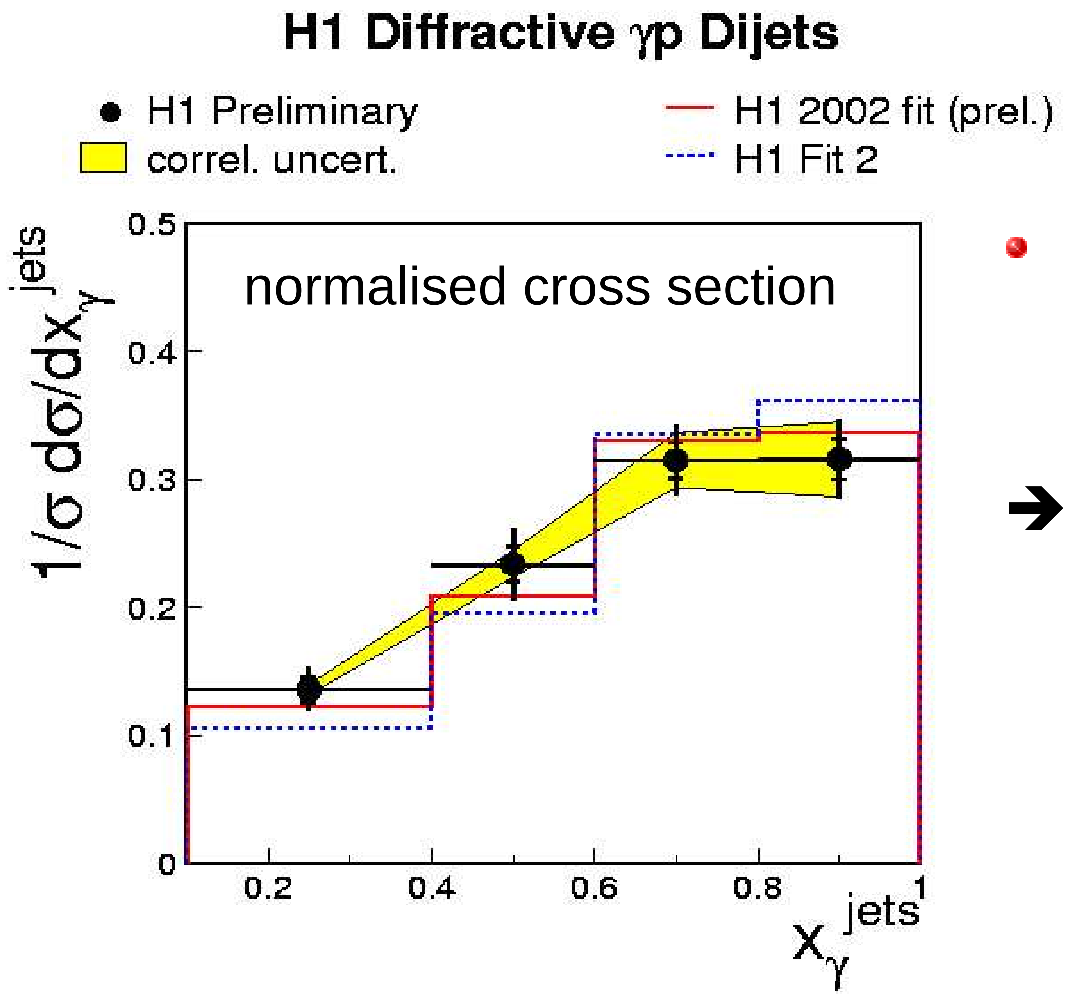
➔ Secondary interactions between remnants in *pp* collisions

Diffractive Dijet photo−production



- Suppression factor relative to dijets in ep DIS: 1.8±0.45
- Transition from ep DIS to pp collisions → secondary interactions between proton and photon dipole fields ?

Direct and Resolved Photon Processes



- Same suppression factor for direct and resolved processes

➔ Suppression does not depend on photon remnant energy

Summary

- NLO DGLAP fit to the high precision medium Q^2 inclusive diffractive DIS data
- diffractive parton distributions (quark singlet and gluon)
- gluon distribution dominates (75±15%)
- New high Q^2 measurement in agreement with NLO QCD fit
- Test QCD factorisation in Diffractive Final States:
- dijet and open charm in DIS consistent with factorisation
- strong breakdown of factorisation in pp scattering (~10)
- dijet photo−production suppressed relative to dijet in DIS by factor 1.8±0.45