Diffractive Cross Sections and Parton Densities from Rapidity Gap and Leading Proton Measurements

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Measurement and QCD Analysis of the Diffractive Deep-Inelastic Scattering Cross Section at HERA

H1 Collaboration

Abstract

A detailed analysis is presented of the diffractive deep-inelastic scattering process $ep \rightarrow eXY$, where Y is a proton or a low mass proton excitation carrying a fraction $1-x_{I\!P} > 0.95$ of the incident proton longitudinal momentum and the squared four-momentum transfer at the proton vertex satisfies $|t| < 1\ \mathrm{GeV}^2$. Using data taken by the H1 experiment, the cross section is measured for photon virtualities in the range $3.5 \leq Q^2 \leq 1600\ \mathrm{GeV}^2$, triple differentially in $x_{I\!P}$, Q^2 and $\beta = x/x_{I\!P}$, where x is the Bjorken scaling variable. At low $x_{I\!P}$, the data are consistent with a factorisable $x_{I\!P}$ dependence, which can be described by the exchange of an effective pomeron trajectory with intercept $\alpha_{I\!P}(0) = 1.118 \pm 0.008\ (\mathrm{exp.})\ ^{+0.029}_{-0.010}\ (\mathrm{theory})$. Diffractive parton distribution functions and their uncertainties are determined from a next-to-leading order DGLAP QCD analysis of the Q^2 and β dependences of the cross section. The resulting gluon distribution carries an integrated fraction of around 70% of the exchanged momentum in the Q^2 range studied. Total and differential cross sections are also measured for the diffractive charged current process $e^+p \rightarrow \bar{\nu}_e XY$ and are found to be well described by predictions based on the diffractive parton distributions. The dynamics of the ratio of the diffractive to the inclusive neutral current ep cross sections are studied. Over most of the kinematic range studied, this ratio shows no significant dependence on Q^2 at fixed $x_{I\!P}$ and x or on x at fixed Q^2 and β fixed.

Diffractive Deep-Inelastic Scattering with a Leading Proton at HERA

H1 Collaboration

Abstract

The cross section for the diffractive deep-inelastic scattering process $ep \rightarrow eXp$ is measured, with the leading final state proton detected in the H1 Forward Proton Spectrometer. The data analysed cover the range $x_{I\!P} < 0.1$ in fractional proton longitudinal momentum loss, $0.08 < |t| < 0.5\ \mathrm{GeV}^{-2}$ in squared four-momentum transfer at the proton vertex, $2 < Q^2 < 50\ \mathrm{GeV}^2$ in photon virtuality and $0.004 < \beta = x/x_{I\!P} < 1$, where x is the Bjorken scaling variable. For $x_{I\!P} \lesssim 10^{-2}$, the differential cross section has a dependence of approximately $\mathrm{d}\sigma/\mathrm{d}t \propto e^{6t}$, independently of $x_{I\!P}$, β and Q^2 within uncertainties. The cross section is also measured triple differentially in $x_{I\!P}$, β and Q^2. The $x_{I\!P}$ dependence is interpreted in terms of an effective pomeron trajectory with intercept $\alpha_{I\!P}(0) = 1.110 \pm 0.018\ (\mathrm{stat.}) \pm 0.012\ (\mathrm{syst.})\ ^{+0.040}_{-0.020}\ (\mathrm{model})$ and a sub-leading exchange. The data are in good agreement with an H1 measurement for which the event selection is based on a large gap in the rapidity distribution of the final state hadrons, after accounting for proton dissociation contributions in the latter. Within uncertainties, the dependence of the cross section on x and Q^2 can thus be factorised from the dependences on all studied variables which characterise the proton vertex, for both the pomeron and the sub-leading exchange.

Final results, new for this conference. Everything shown is taken from these two closely related papers.

Contents

- Comparing proton-tagged and large rapidity gap data

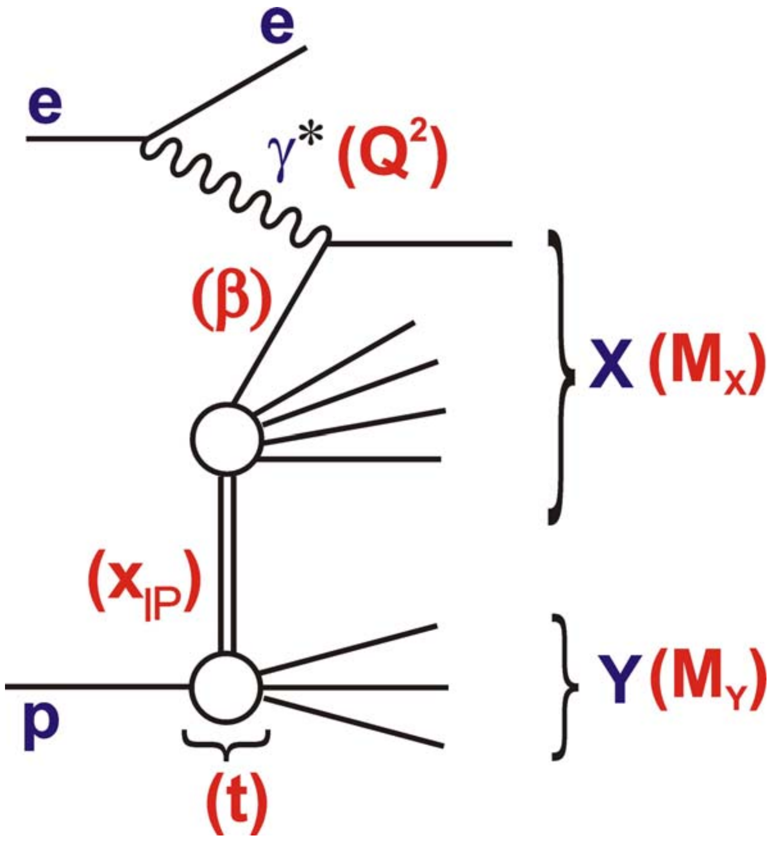
- Dependences on t

- Q^2 and β dependences and fits for diffractive parton densities (DPDFs)

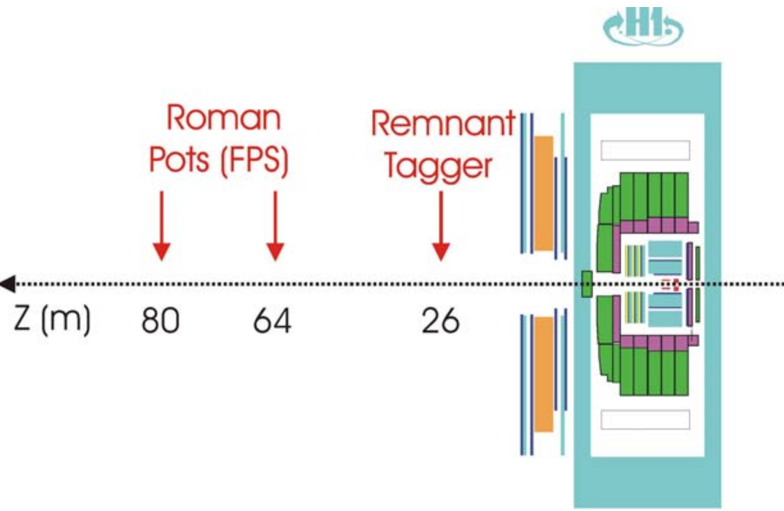
- x_{IP} dependences and effective pomeron intercept

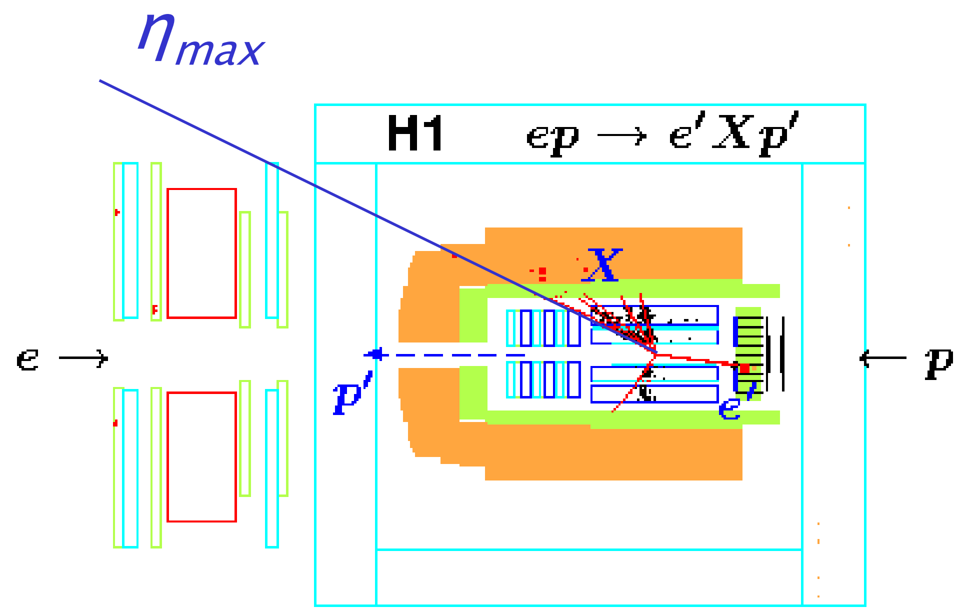
- Charged current diffraction

- Comparing diffractive and total cross sections



Event Selection Methods





1) Tag and measure final state proton in Forward Proton Spectrometer (FPS method)

- No proton dissociation
- Can measure t
- High x_{IP} accessible
- … but low Pot acceptance

2) Require Large Rapidity Gap spanning at least $3.3 < \eta <\sim 7.5$ and measure hadrons comprising X (LRG method)

- Some proton dissn $M_Y < 1.6$ GeV
- Near-perfect acceptance at low x_{IP}

Data Sets and Observables

- **FPS data sample** 1999-2000 data (28 pb^{-1})

$$x_{IP}\frac{\mathrm{d}^2\sigma^{ep\to eXp}}{\mathrm{d}x_{IP}\mathrm{d}t}$$ expressing t dependence

$$\sigma_r^{D(4)}(x,Q^2,x_{IP},t)=F_2^{D(4)}-\frac{y^2}{Y_+}F_L^{D(4)} \approx F_2^{D(4)}$$ obtained at $t=-0.25\ \mathrm{GeV}^2$ using ...

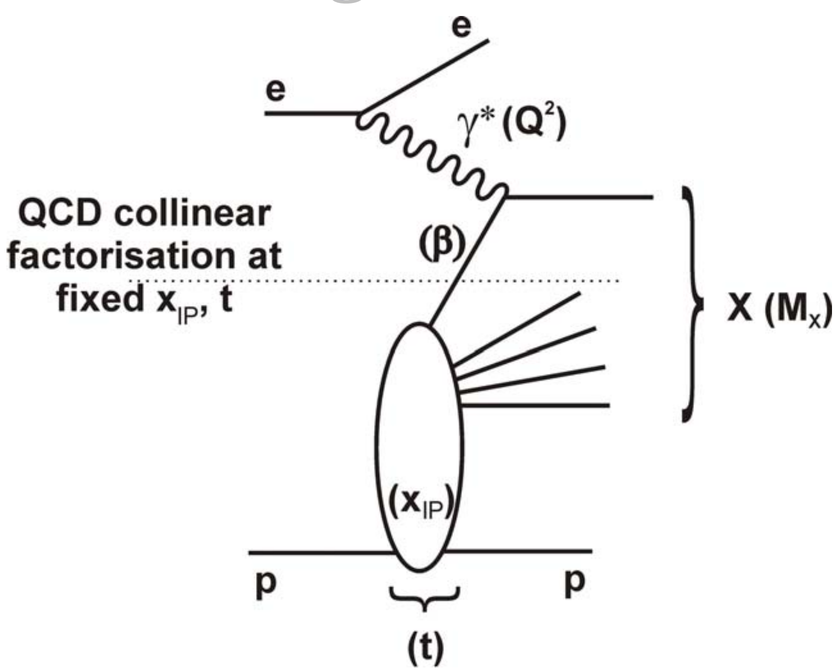
$$\frac{\mathrm{d}^4\sigma^{ep\to eXp}}{\mathrm{d}x\mathrm{d}Q^2\mathrm{d}x_{IP}\mathrm{d}t}=\frac{4\pi\alpha^2}{xQ^4}\ .\ Y_+\ .\ \sigma_r^{D(4)}(x,Q^2,x_{IP},t)$$ where $Y_+=1+(1-y)^2$.

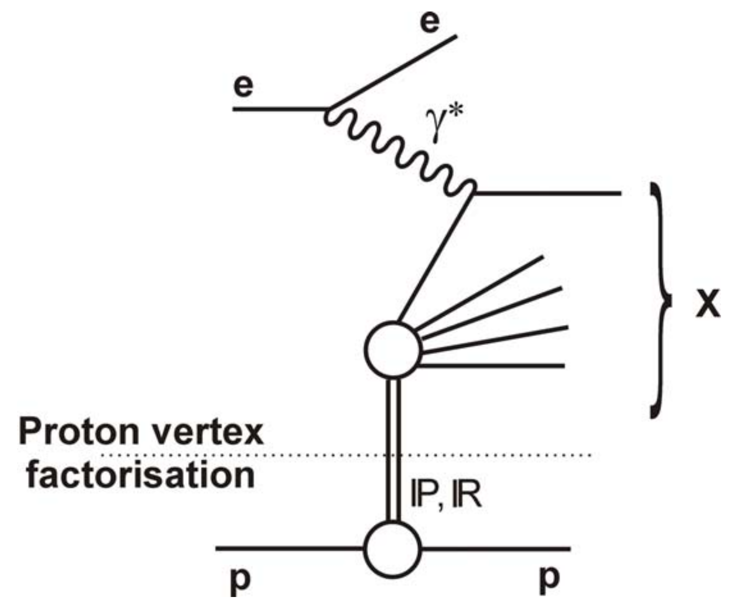
$$\sigma_r^{D(3)}(x,Q^2,x_{IP})=\int_{-1\mathrm{GeV}^2}^{t_{\min}}\sigma_r^{D(4)}(x,Q^2,x_{IP},t)\ \mathrm{d}t$$ which is also measured in ...

- **LRGdata sample** 1997 data (2 pb^{-1} for $Q^2 < 13.5$ GeV^2)
  1997 data (11 pb^{-1} for $13.5 < Q^2 < 105$ GeV^2)
  1999-2000 data (62 pb^{-1} for $Q^2 > 133$ GeV^2)

… used to measure $\sigma_r^{D(3)}$, also charged current cross section and ratio of diffractive $\sigma_r^{D(3)}$ to inclusive σ_r

Modelling the Data: Two levels of factorisation





QCD hard scattering collinear factorisation (Collins) at fixed x_{IP} and t

$$\boxed{\mathrm{d}\sigma_{\mathrm{parton}\ i}(ep \to eXY) = f_i^D(x, Q^2, x_{IP}, t) \otimes \mathrm{d}\hat{\sigma}^{ei}(x, Q^2)}$$

(applied after integration over measured M_Y and t ranges)

\`Proton vertex' factorisation of x and Q^2 from x_{IP}, t, and M_Y dependences

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

(separately for leading IP and sub-leading IR exchanges)

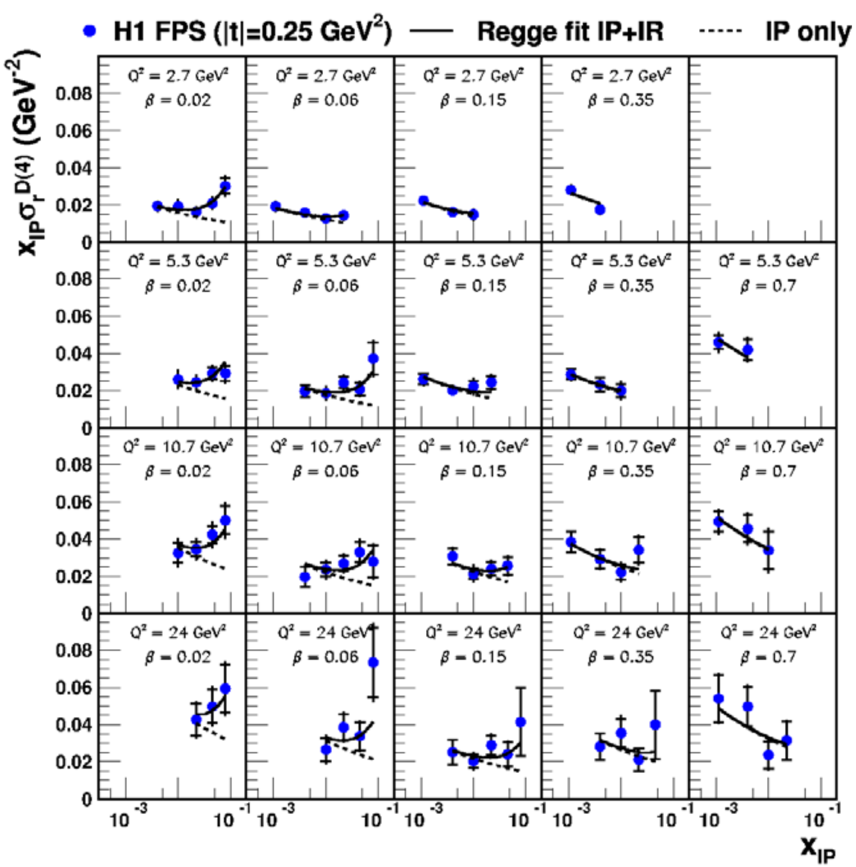
Data Overview

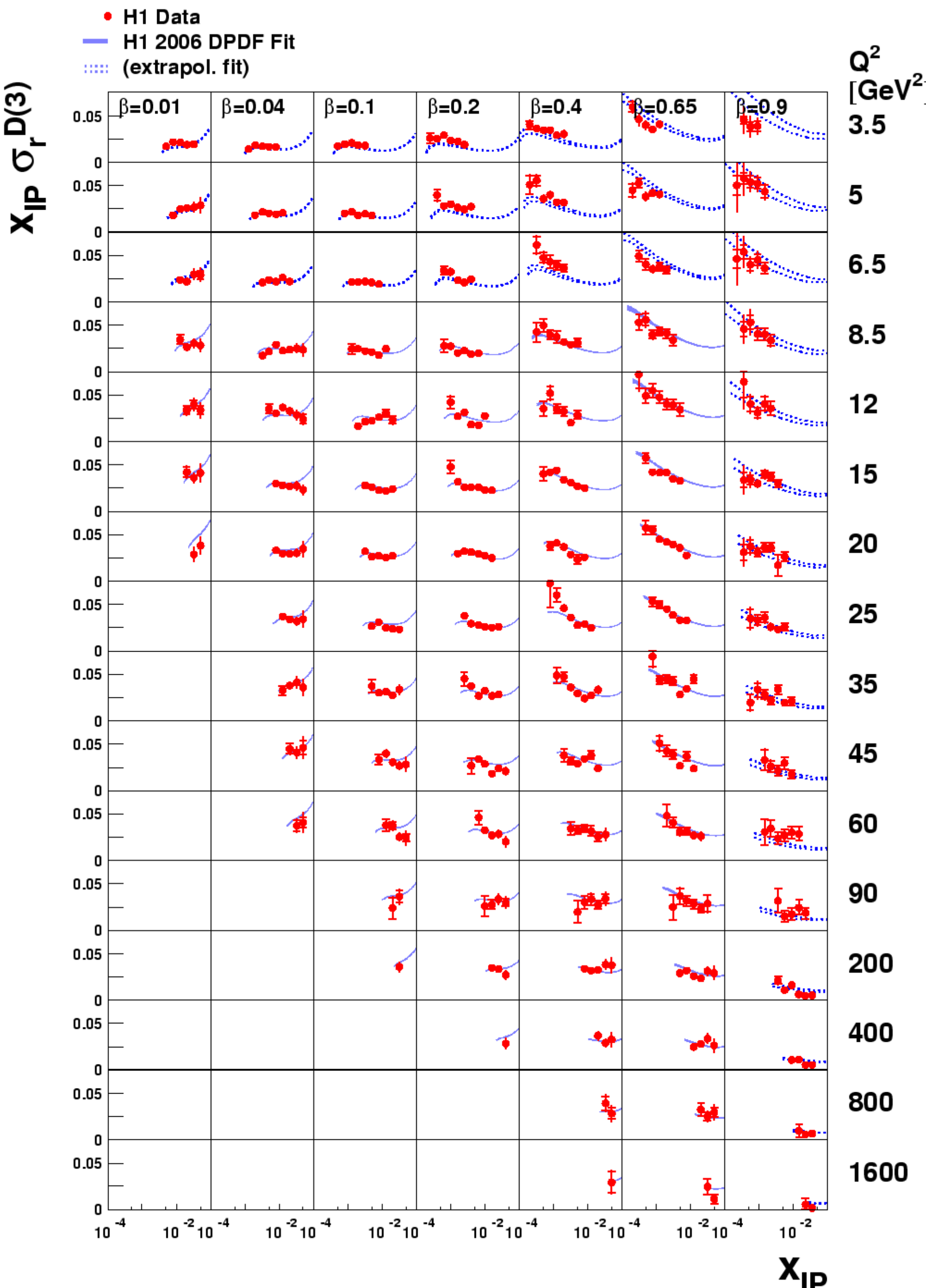
LRG: $M_Y < 1.6$ GeV

$$3.5 \le Q^2 \le 1600 \text{ GeV}^2$$

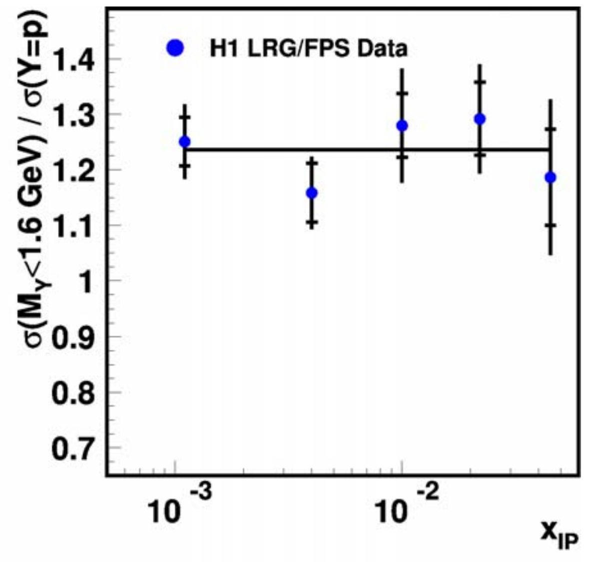
FPS: $Y=p$

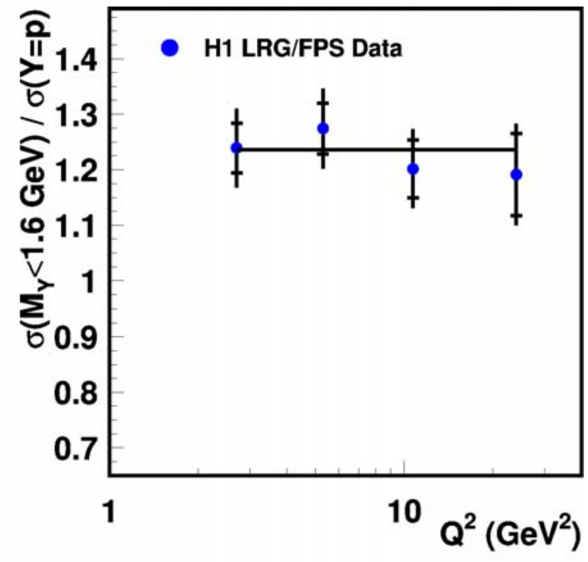
$$2.7 \le Q^2 \le 24 \text{ GeV}^2$$



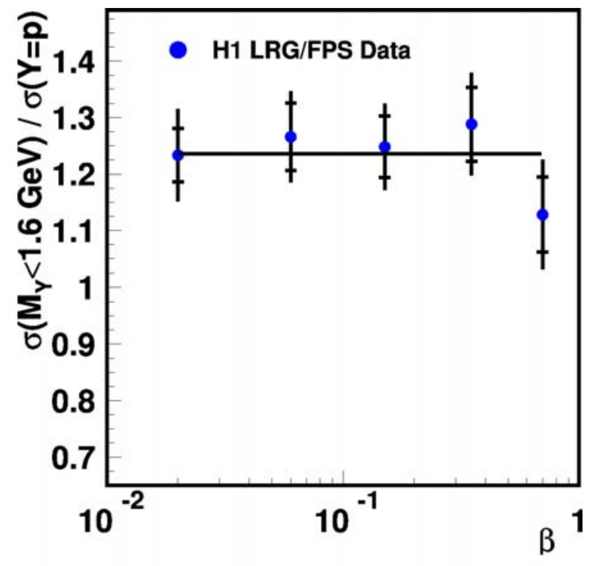


Detailed Comparison LRG v FPS





LRG measurement also done with FPS bins



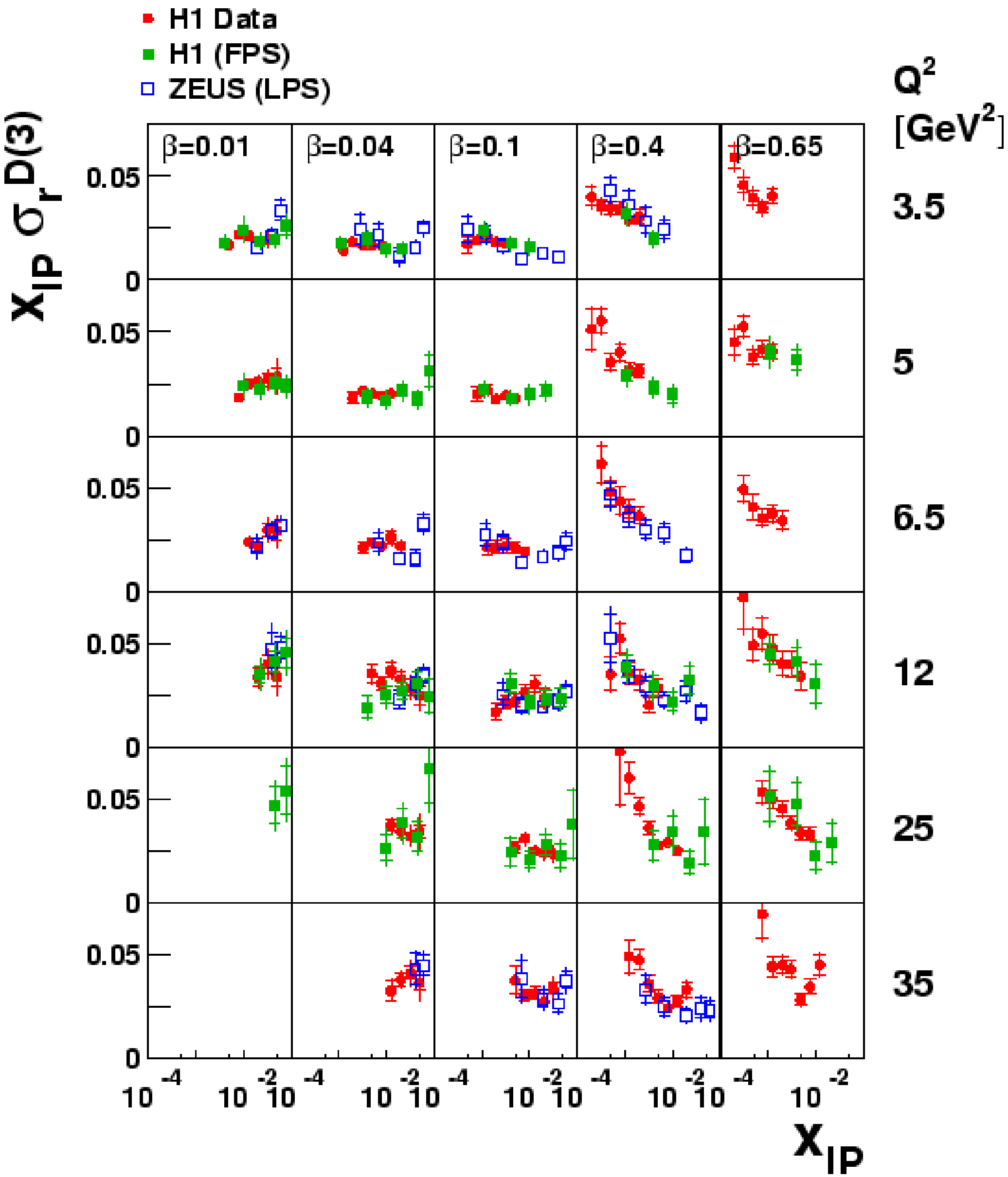
- Form ratio of measurements as a function of x_{IP}, β or Q^2 after integration over others

$$\frac{\sigma(M_Y < 1.6\ \text{GeV})}{\sigma(Y = p)} = 1.23 \pm 0.03\ (\text{stat.}) \pm 0.16\ (\text{syst.})$$

independently of kinematics within errors

- Agreement in detail between methods
- M_Y dependence factorises within (10%) (non-normalisation) errors

Comparison of H1 LRG, H1 FPS, ZEUS LPS Data



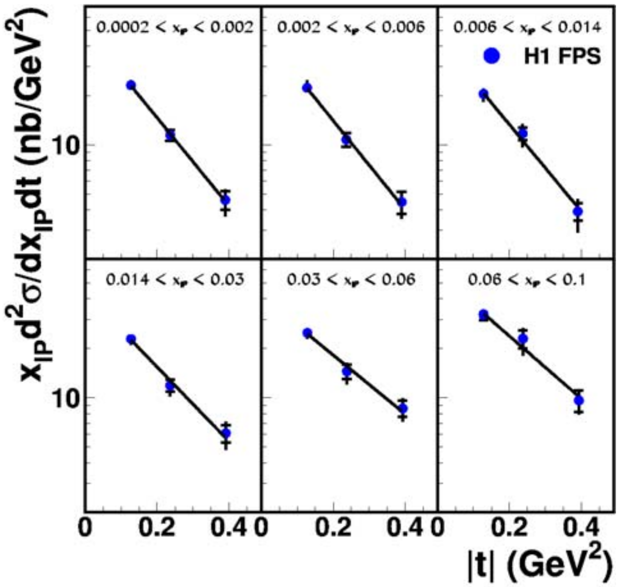
- ZEUS LPS and H1 FPS scaled by global factor of 1.23.

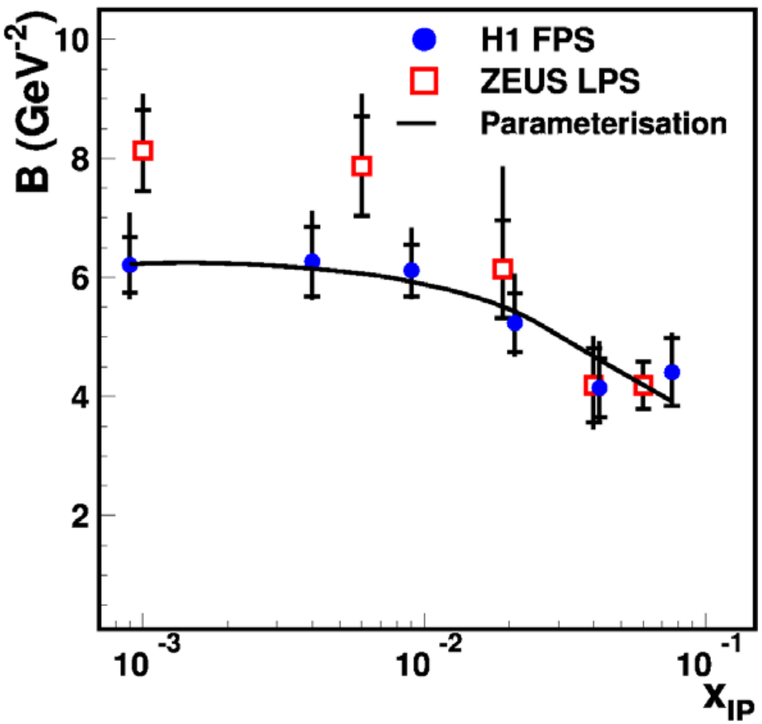
- ZEUS LPS and H1 FPS normalisations agree to 8% (cf 10% normalisation uncertainties each)

- Very good agreement between proton-tagging and LRG methods after accounting for proton dissociation

t Dependence from FPS Measurements

Fit to $exp(Bt)$ in bins of x_{IP}





$B(x_{IP})$ data constrain IP, IR flux factors in proton vertex fac^n model

Taking Regge motivated form

(similarly for IR)

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

$$\boxed{\alpha_{IP}(t) = \alpha_{IP}(0) + \alpha'_{IP}\, t}$$

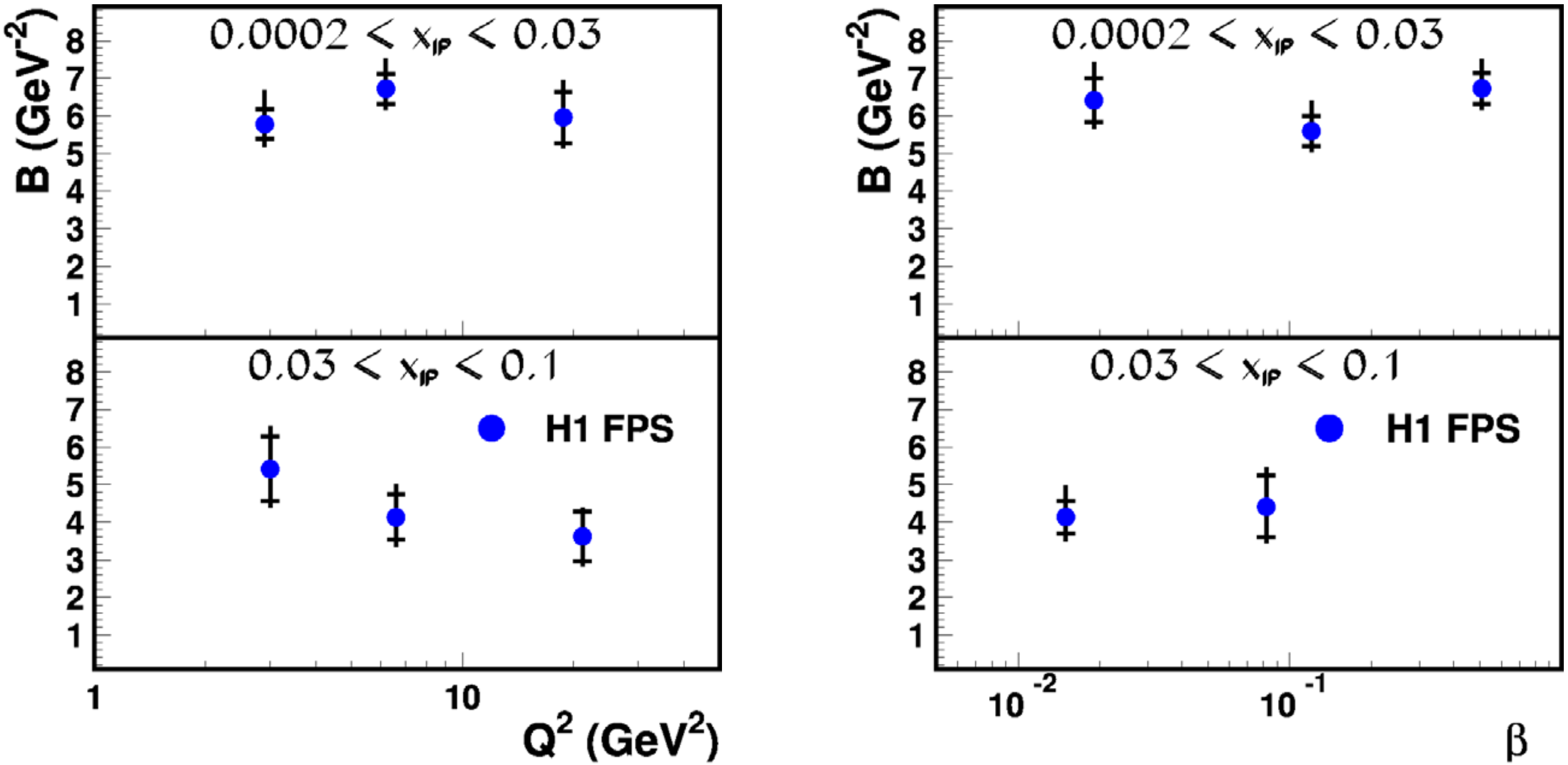
e.g. fitting low x_{IP} data to $B = B_{IP} + 2\alpha'_{IP}\ln(1/x_{IP})$ yields …

$$\boxed{\alpha'_{IP} = 0.06^{+0.19}_{-0.06}\ \text{GeV}^{-2}}$$

$$\boxed{B_{IP} = 5.5^{-2,0}_{+0.7}\ \text{GeV}^{-2}}$$

t Slope Dependence on β or Q^2?

… B measured double differentially in (β or Q^2) and x_{IP}



- t dependence does not change with β or Q^2 at fixed x_{IP}
- Proton vertex factorisation working within errors for t dependence

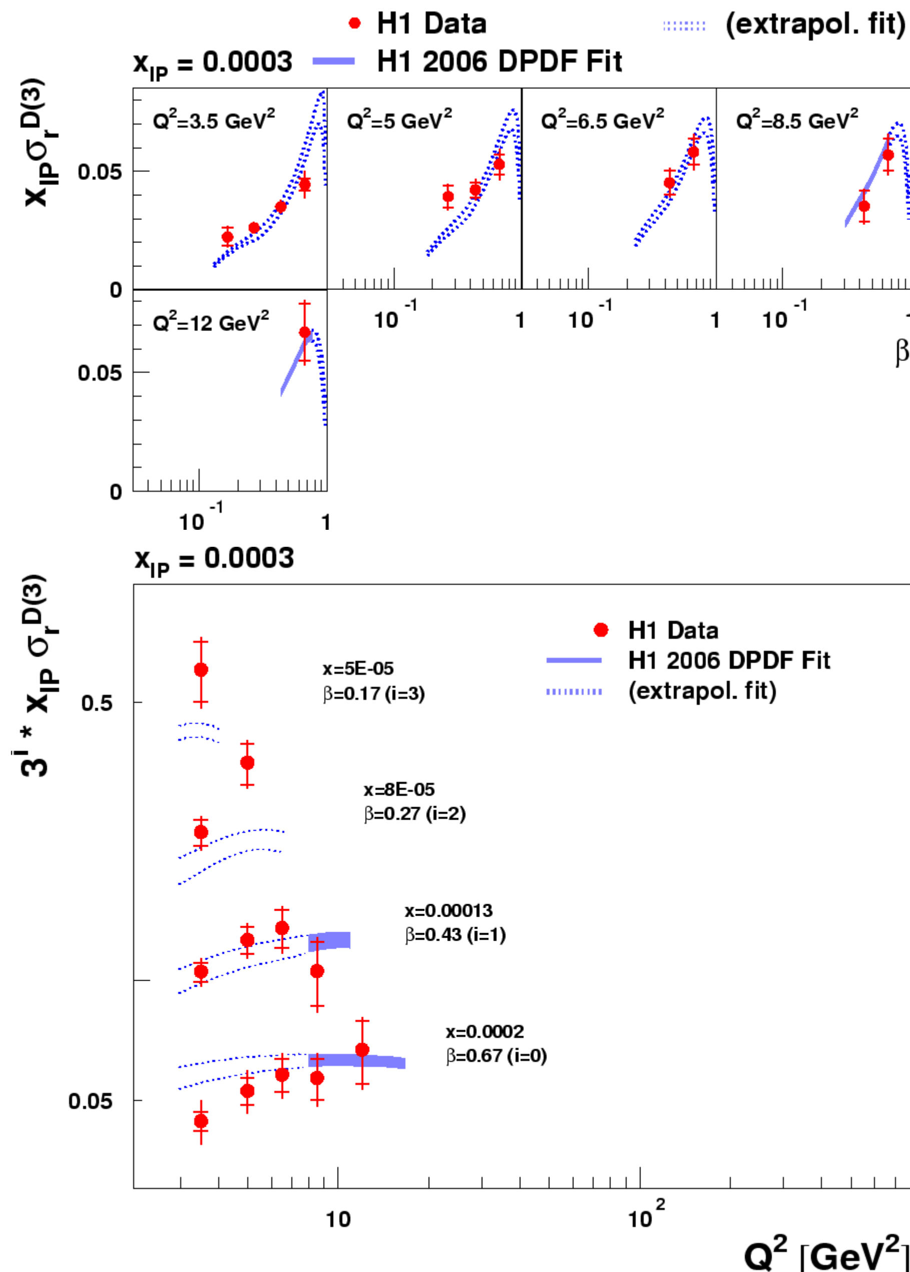
$\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ at $x_{IP} = 0.0003$

- Principal binning scheme for **LRG data** …
- Study Q^2 and x ($= \beta \,.\, x_{IP}$) dependences in detail at small number of fixed x_{IP} values.

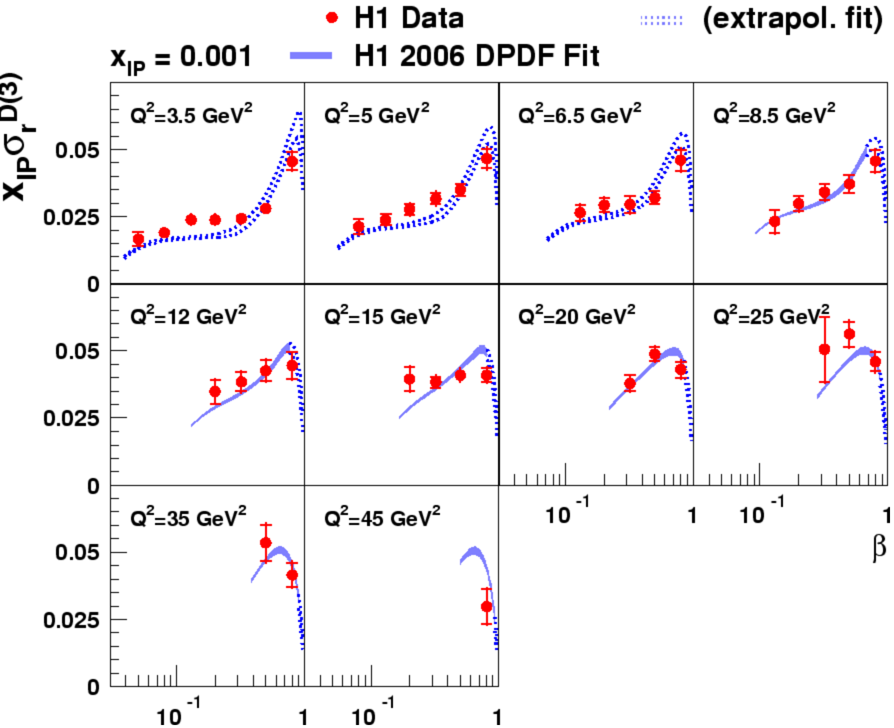
- Good precision – in best regions 5% (stat.), 5% (syst) 6% (norm)

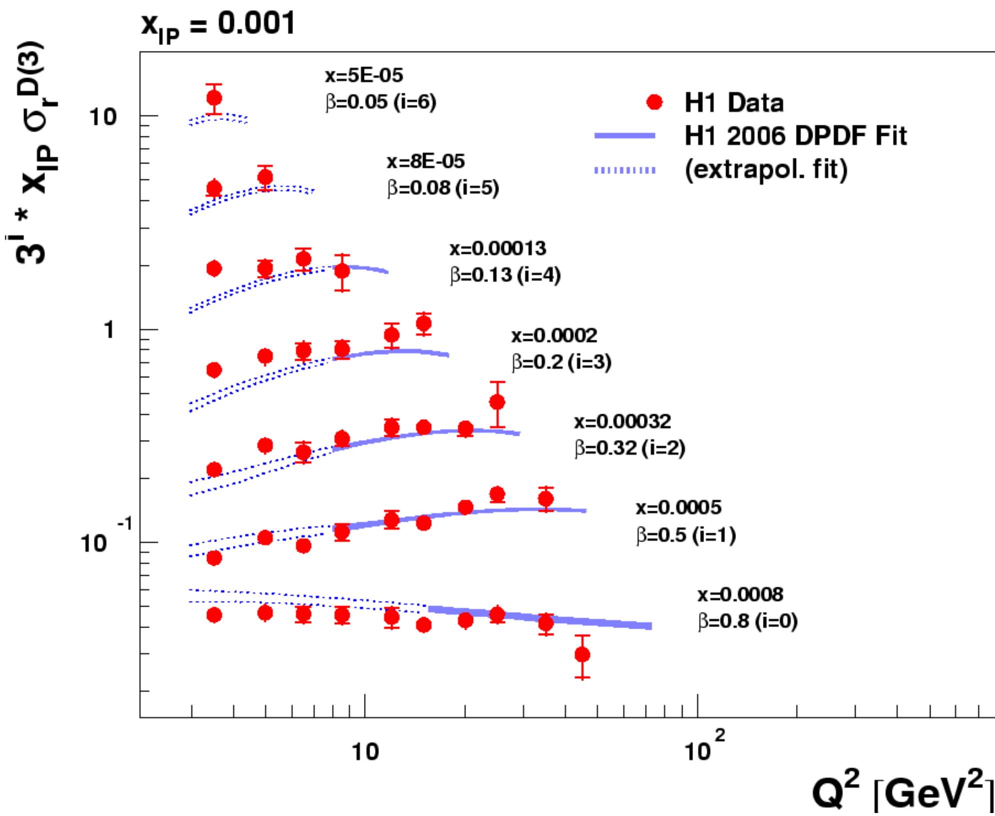
- Directly measures diffractive quark density at fixed x_{IP}

- Data compared with \`H1 2006 DPDF Fit' and its error band (assumes proton vertex factorisation - see later)



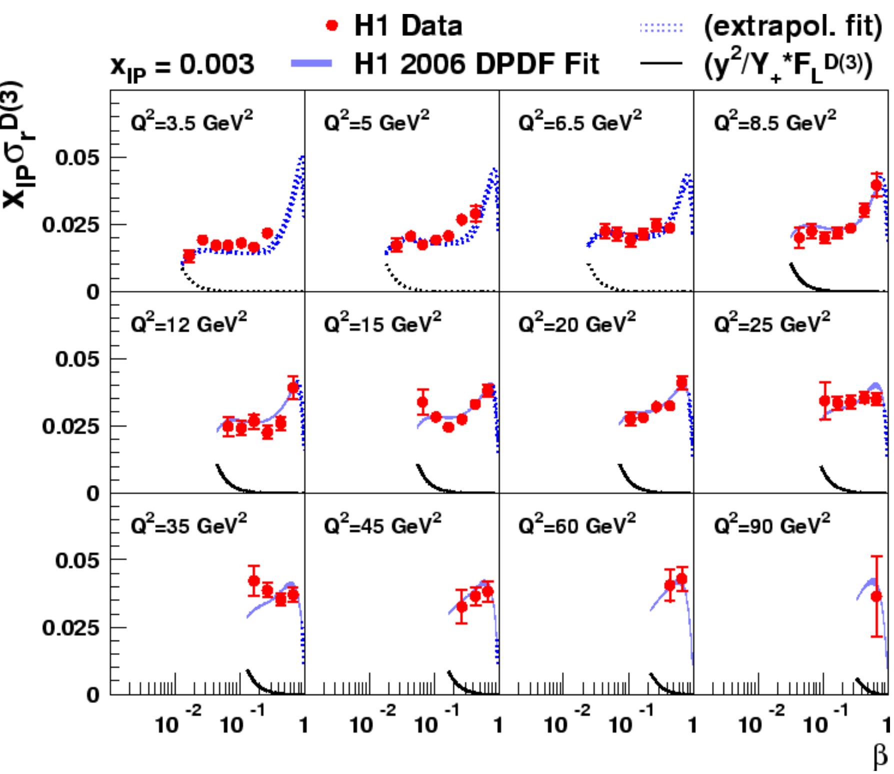
$\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ at $x_{IP} = 0.001$

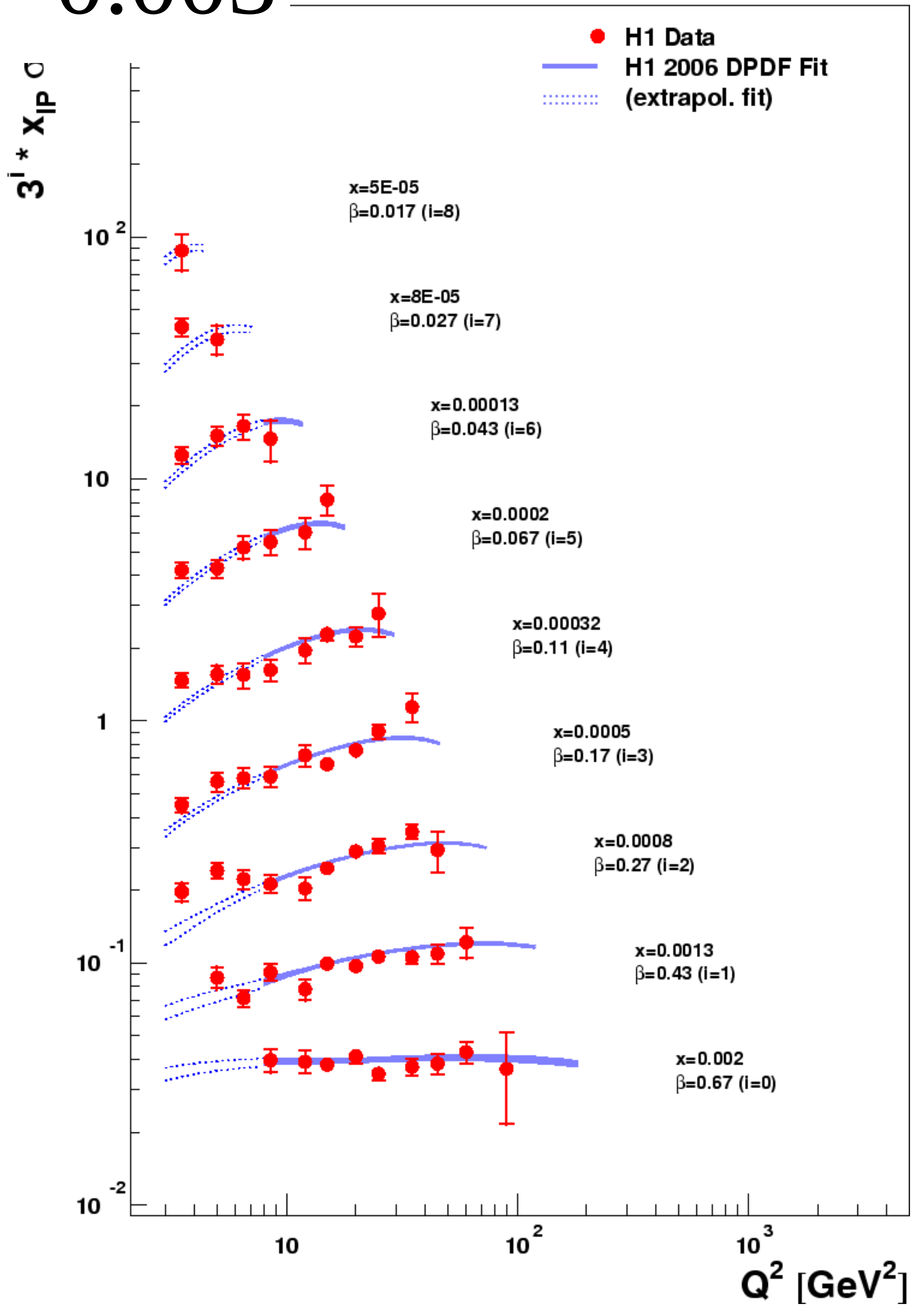




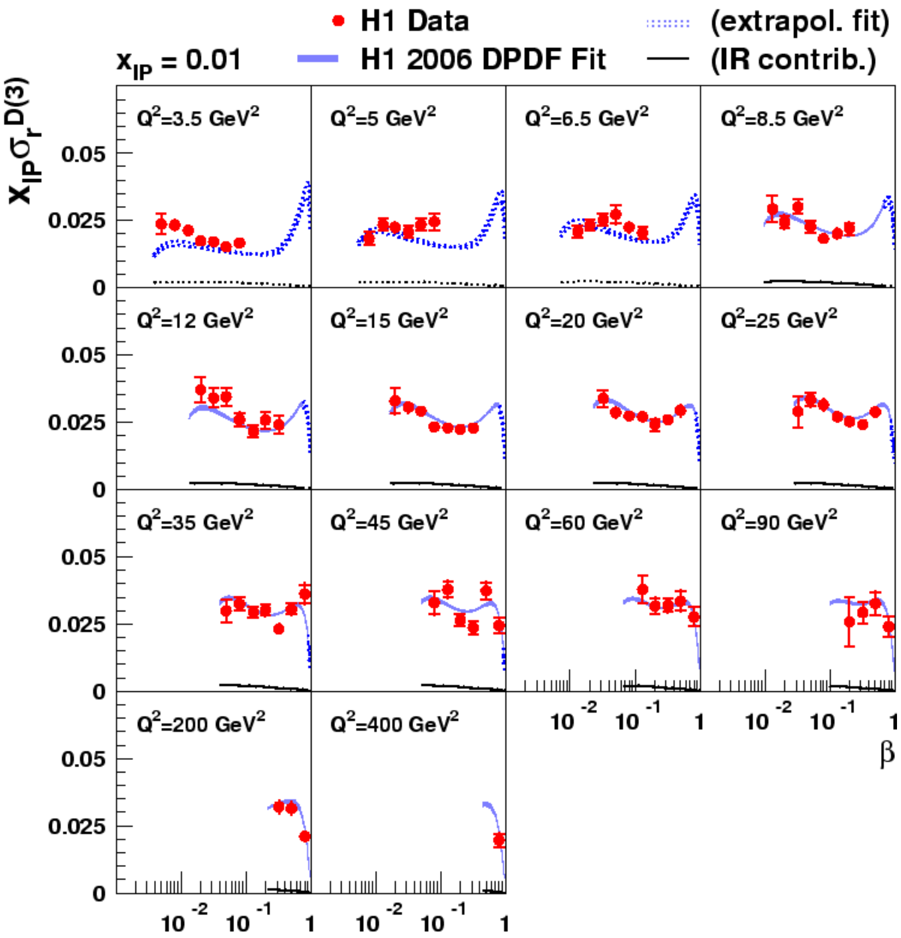
(Like an inclusive F_2 measurement at each value of x_{IP})

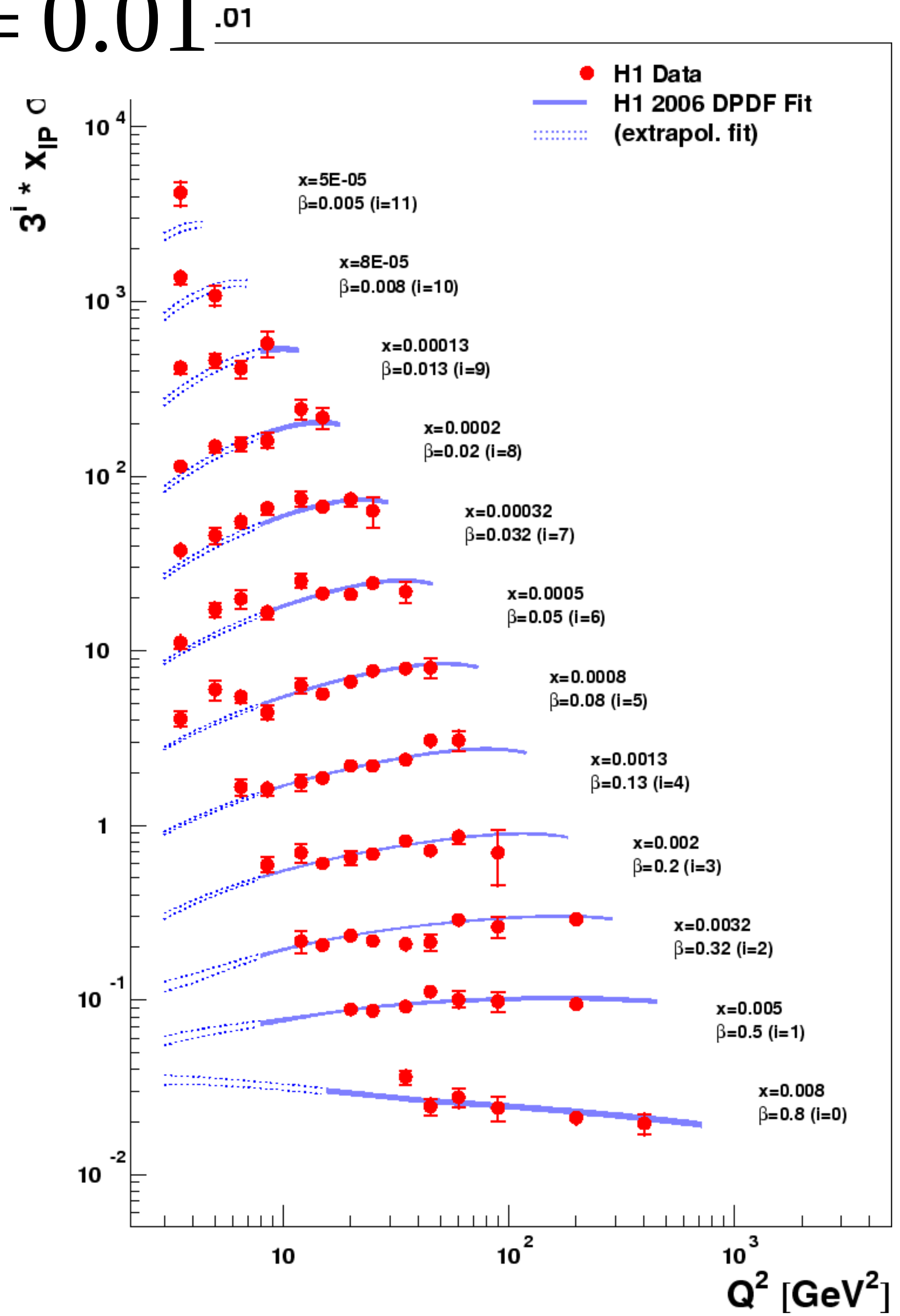
$\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ at $x_{IP} = 0.003$



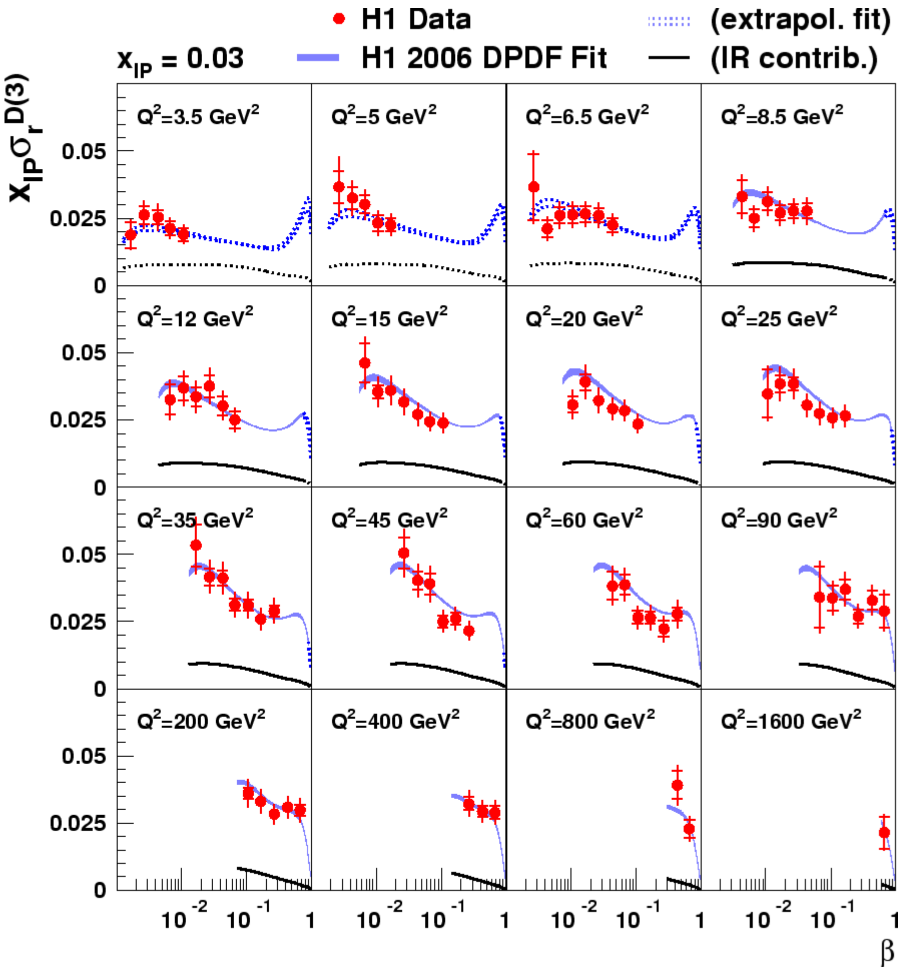


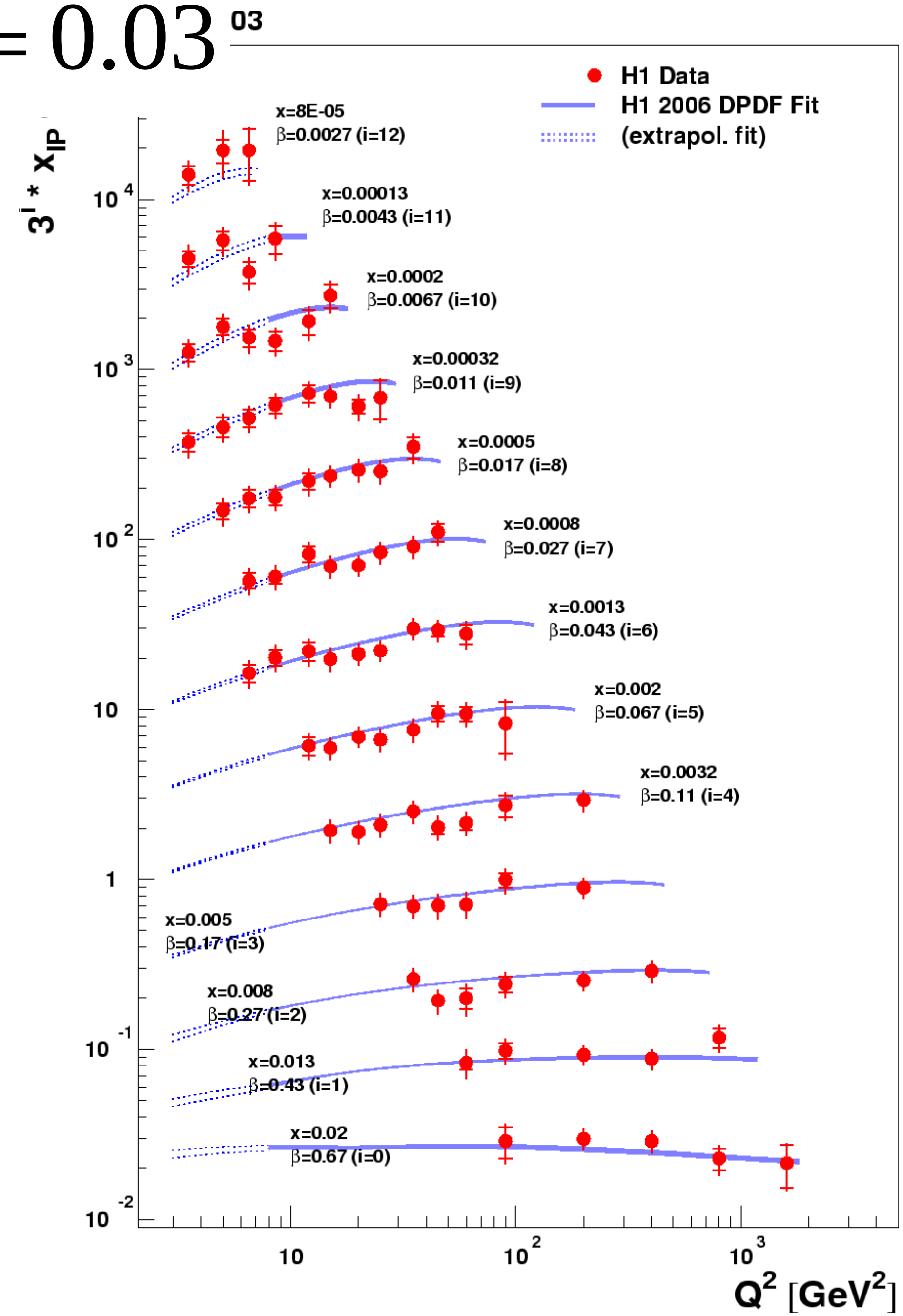
$\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ at $x_{IP} = 0.01$





$\sigma_r^{D(3)}(\beta, Q^2, x_{IP})$ at $x_{IP} = 0.03$





Q^2 Dependence in More Detail

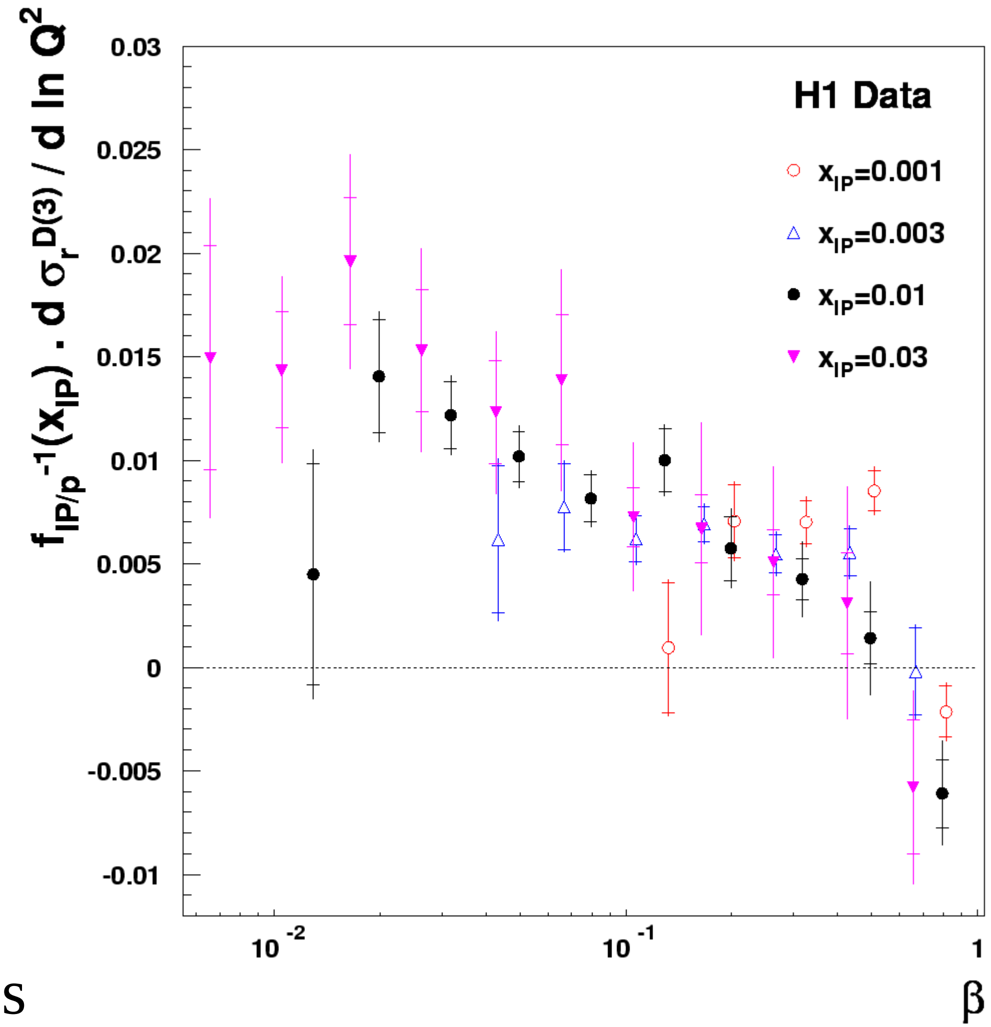
$\sigma_r^{D(3)}$ measures diffractive quark density.
Its dependence on Q^2 is sensitive to diffractive gluon density.

Fit data at fixed x, x_{IP} to

$$\sigma_r^D = A + B \ln Q^2$$

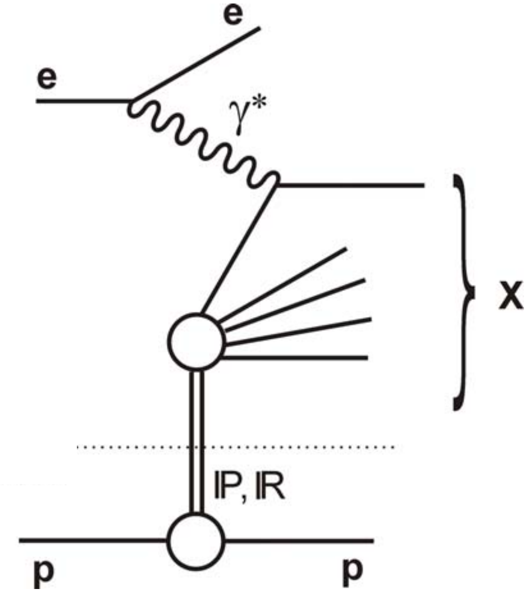
such that $$\boxed{B = \frac{\mathrm{d}\sigma_r^D}{\mathrm{d}\ln Q^2}}$$

Divide results by $f_{IP/p}(x_{IP})$ to compare different x_{IP} values



Derivatives large and positive at low β… suggests large gluon
Results independent of x_{IP} within errors

H1 2006 DPDF Fit, Overview



- Fit data from fixed x_{IP} binning, using NLO DGLAP evolution of DPDFs (massive charm) to describe x and Q^2 dependences.

- Proton vertex factorisation framework with Regge-motivated flux factors

$$f_{IP/p}(x_{IP},t) = \frac{e^{B_{IP}t}}{x_{IP}^{2\alpha_{IP}(t)-1}}$$ to relate data from different x_{IP} values with complementary x, Q^2 coverage.

- For IP, free parameters are $\alpha_{IP}(0)$ (describing x_{IP} dependence via flux factor) and parameters of DPDFs at starting scale Q^2_0 for QCD evolution. Fix B_{IP} and α'_{IP} using FPS data.

- For IR, all flux parameters taken from previous H1 data, parton densities taken from Owens-π. Single free parameter for normalisation

Kinematic Range and DPDF Parameterisation

• To ensure data fitted are compatible with chosen framework, test sensitivity of fit results to variations of kinematic boundaries…..
….. Results stable for most variations (β_{max}, β_{min}, $M_{x,min}$, $x_{IP,max}$)
….. Systematic variation of gluon density with minimum Q^2 of data included in fit for $Q^2_{min} < 8.5$ GeV^2. Stable for larger Q^2_{min}

• Fit all data with $Q^2 \geq 8.5\ \mathrm{GeV}^2$ (and $M_X > 2$ GeV, $\beta \leq 0.8$)

• Parameterise quark singlet $z\Sigma(z,Q_0^2)$ and gluon $zg(z,Q_0^2)$ densities, where z is parton momentum fraction (= β for QPM).

Parameterisation used is $\boxed{z\Sigma(z,Q_0^2) = A_q z^{B_q}(1-z)^{C_q}}$ and $\boxed{zg(z,Q_0^2) = A_g (1-z)^{C_g}}$
(gluon insensitive to B_g)

• Small numbers of parameters, so need to optimise Q_0^2 with respect to χ^2

• Results from this procedure reproducible with Chebyshev polynomials

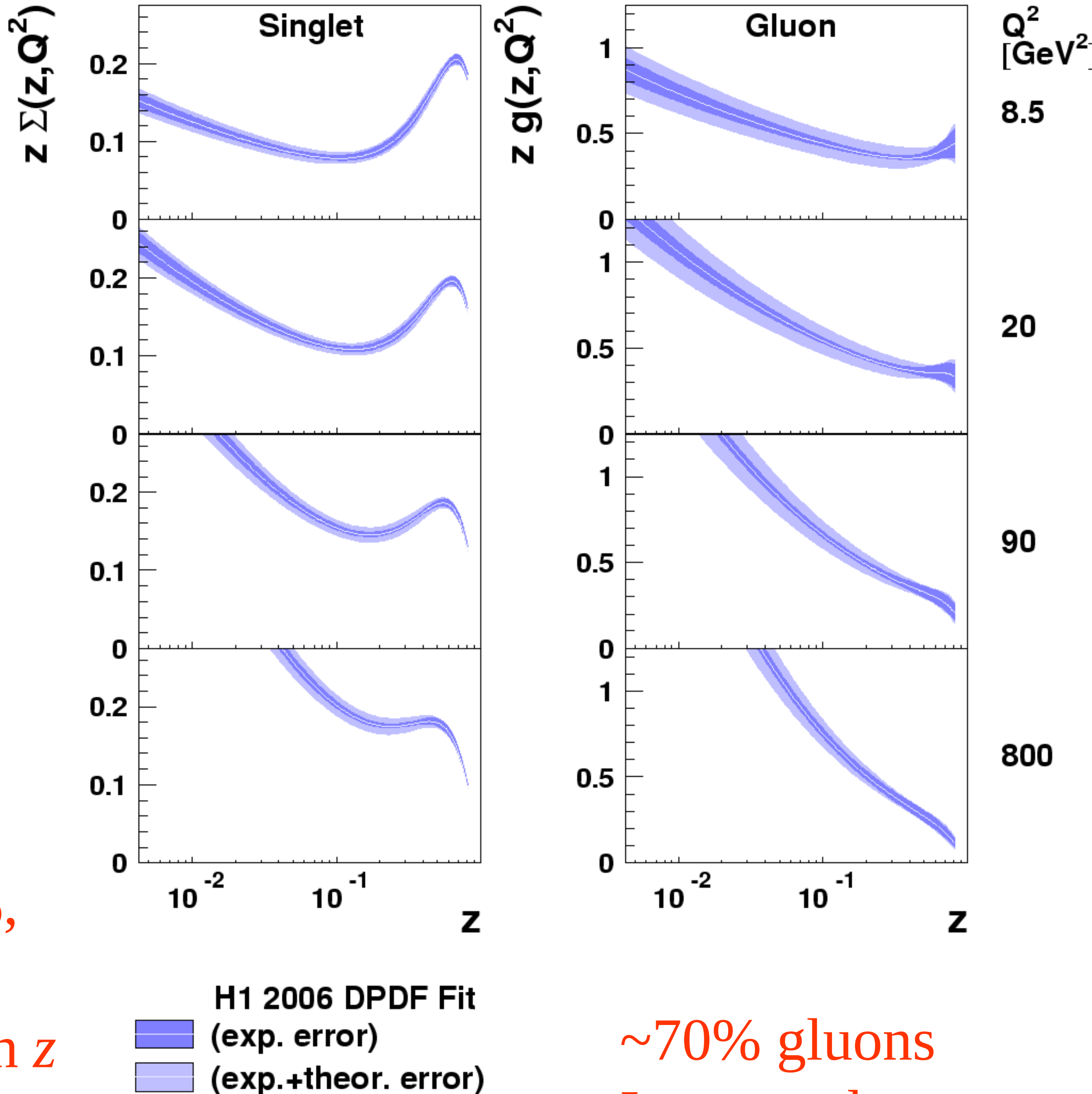
H1 2006 DPDF Fit Results (log z scale)

$Q_0^2 = 1.75\ \mathrm{GeV}^2$
$\chi^2 \sim 158 / 183$ d.o.f.

• Experimental uncertainty obtained by propagating errors on data through χ^2 minimisation procedure

• Theoretical uncertainty by varying fixed parameters of fit and Q^2_0 (s.t. $\Delta\ \chi^2 = 1$)

• Singlet constrained to ~5%, gluon to ~15% at low *z*, growing considerably at high *z*

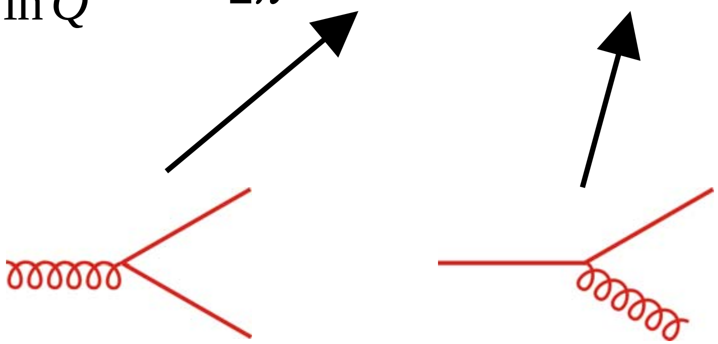


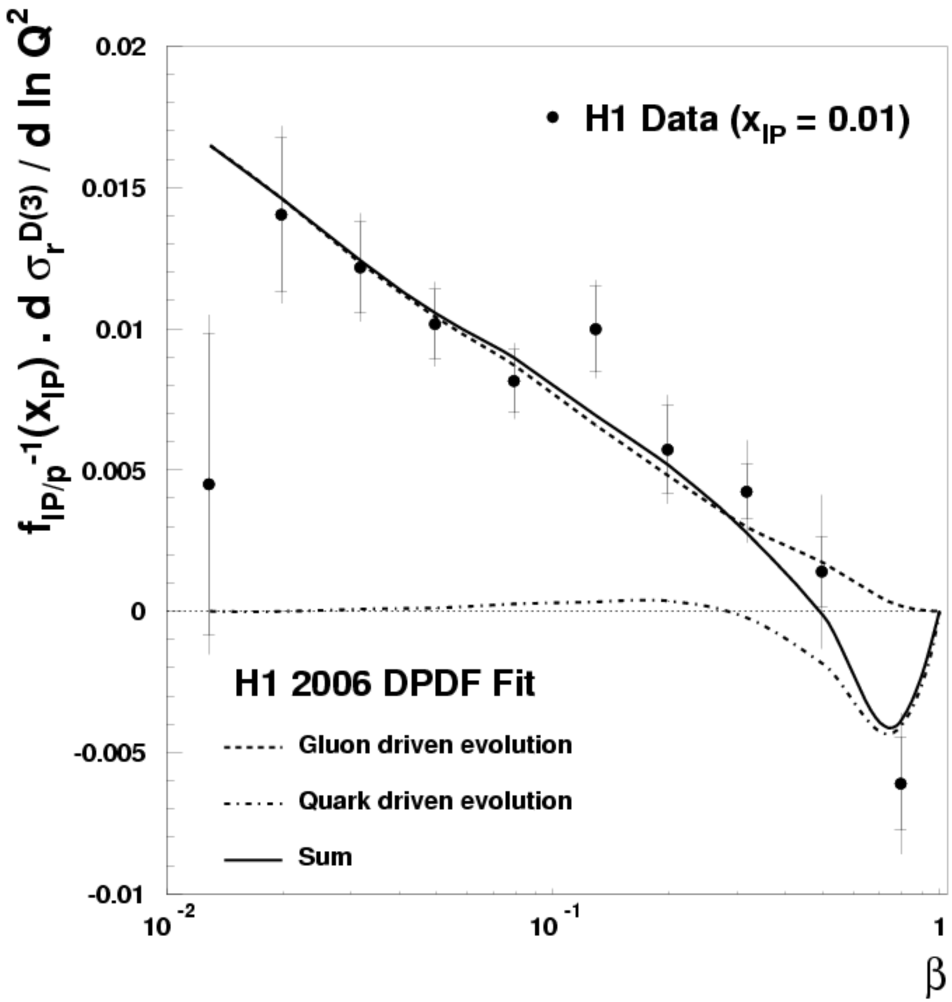
~70% gluons
Integrated over *z*

A Closer Look at the High z Region

We have only singlet quarks, so DGLAP evolution equation for F_2^D ....

$$\frac{dF_2^D}{d\ln Q^2} \sim \frac{\alpha_s}{2\pi}\left[P_{qg}\otimes g + P_{qq}\otimes\Sigma\right]$$





- At low β, evolution driven by $g \to q\bar{q}$ … strong sensitivity to gluon
- At high β, relative error on derivative grows, $q \to qg$ contribution to evolution becomes important … sensitivity to gluon is lost

DPDFs (linear z scale)

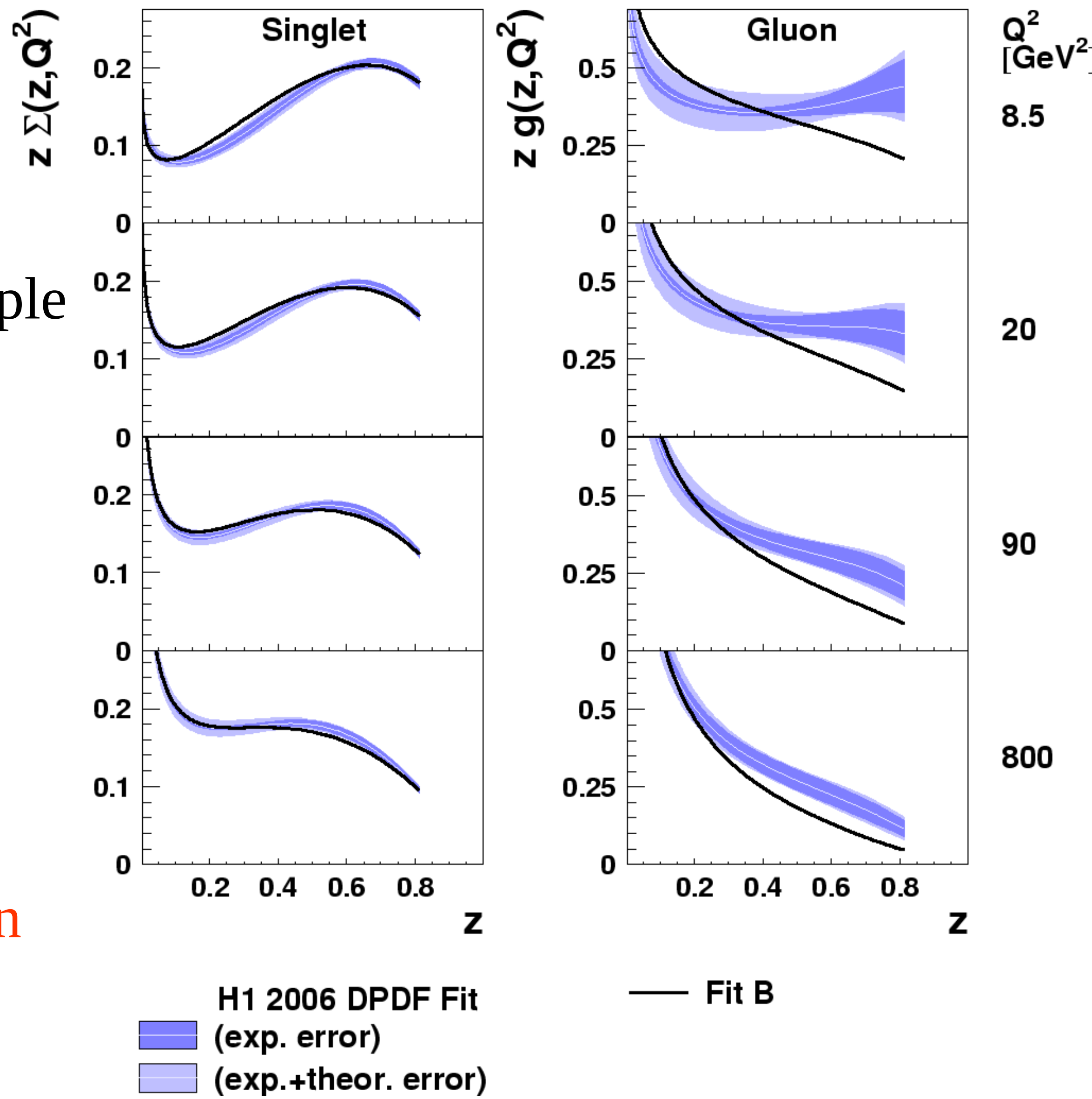
- Lack of sensitivity to high z gluon confirmed by dropping (high z) C_g parameter, so gluon is a simple constant at starting scale!

•Fit B

χ^2 ~164 / 184 d.o.f.

Q_0^2 = 2.5 GeV^2

- Quarks very stable
- Gluon similar at low z
- Substantial change to gluon at high z

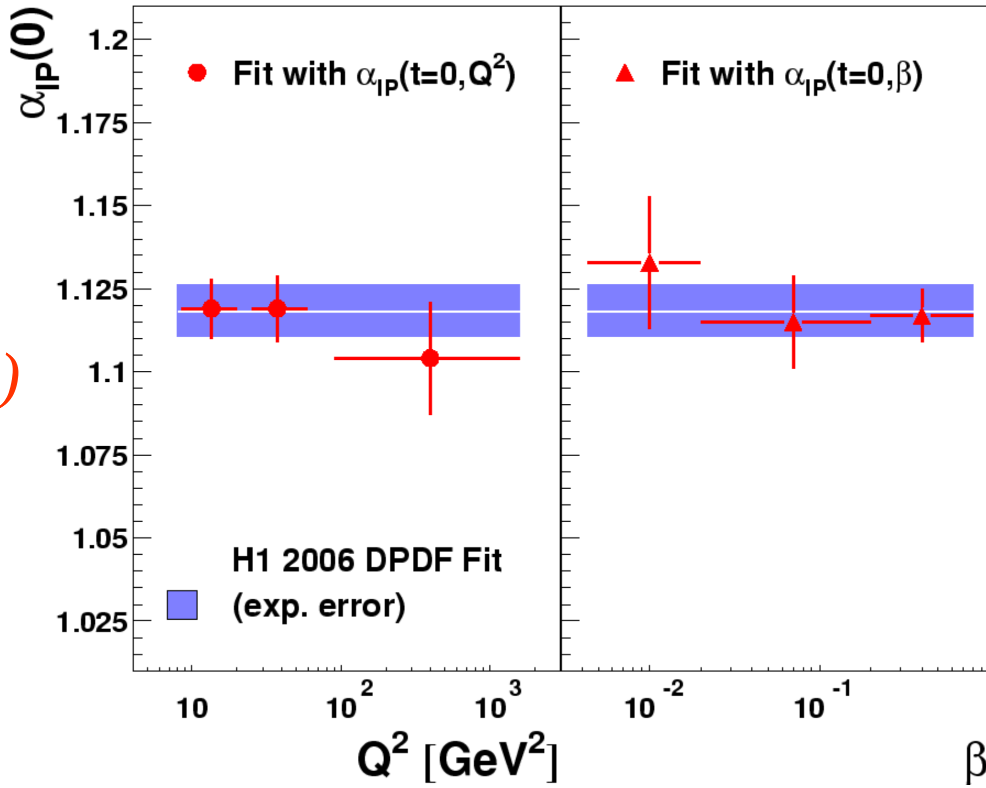


Effective Pomeron Intercept

From QCD fit to LRG data $\alpha_{IP}(0) = 1.118 \pm 0.008\ (\text{exp.})\ ^{+0.029}_{-0.010}\ (\text{theory})$

- Dominant uncertainty from strong correlation with α'_{IP}.
…taking $\alpha'_{IP} = 0.25\ \text{GeV}^{-2}$ instead of $0.06\ \text{GeV}^{-2}$ yields $\alpha_{IP}(0) \sim 1.15$

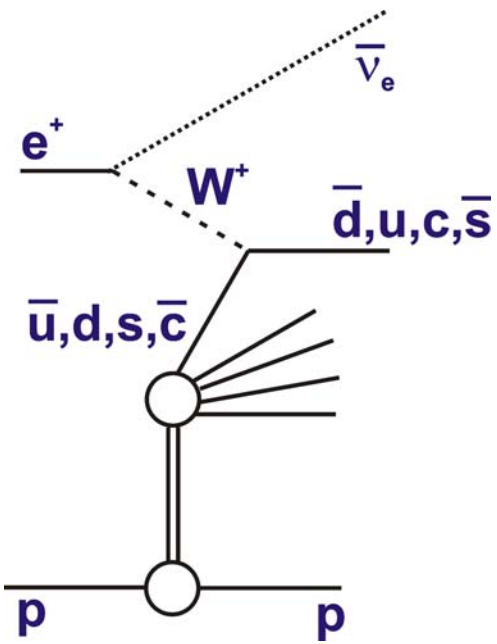
- Adding extra parameters for $\alpha_{IP}(0)$ in different Q^2 or β regions shows no significant variation (as required for proton vertex factorisation)

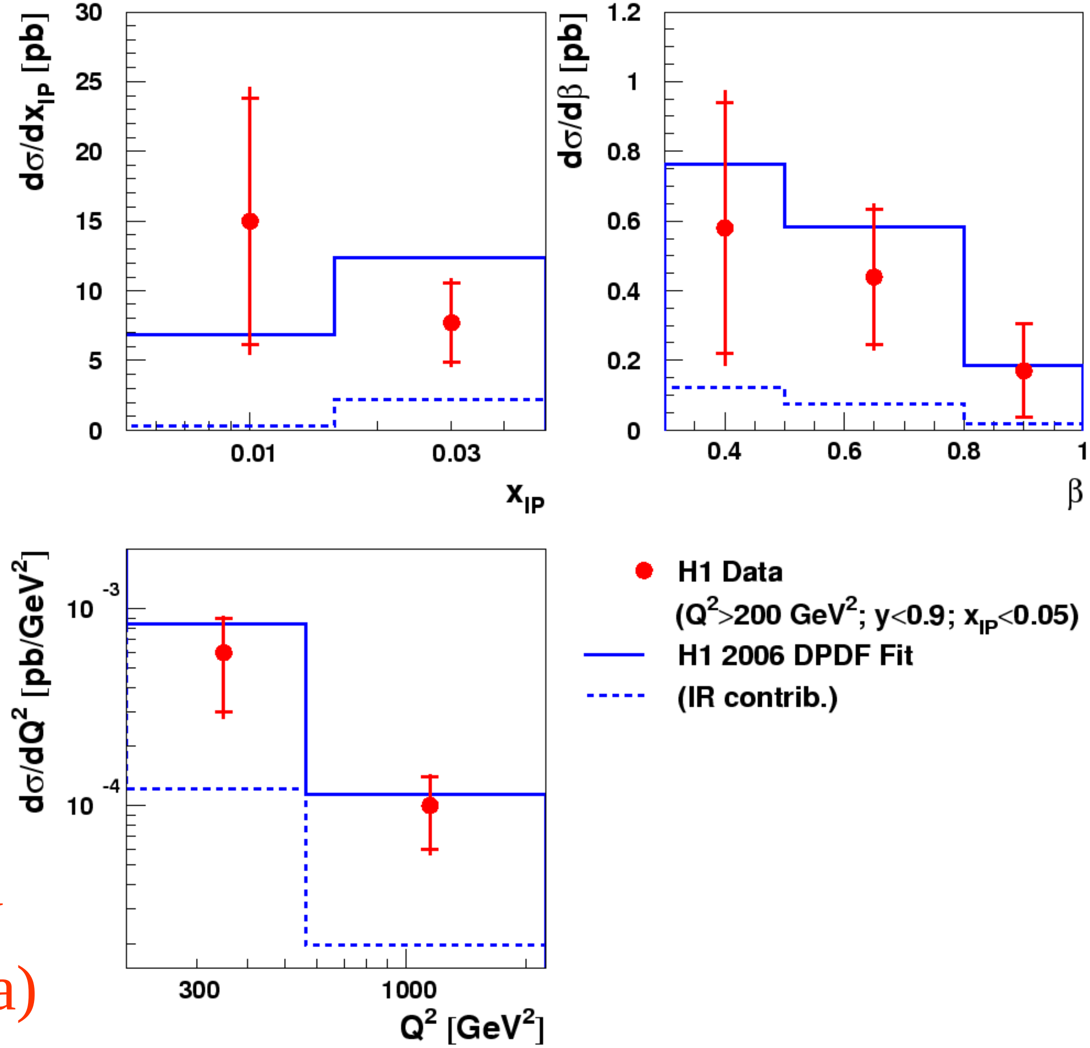


Consistent result from similar fit to x_{IP} dependence of FPS data:

$$\alpha_{IP}(0) = 1.114 \pm 0.018\ (\text{stat.}) \pm 0.012\ (\text{syst.})\ ^{+0.040}_{-0.020}\ (\text{theory})$$

Diffractive Charged Current Cross Section





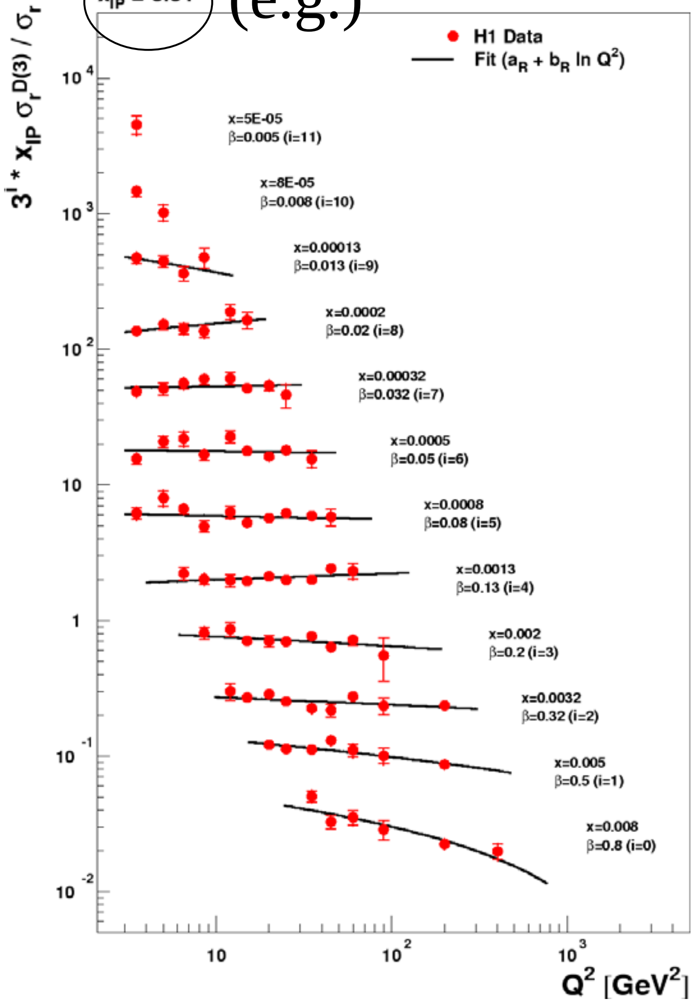
Sensitive to flavour decomposition of quark singlet (completely unconstrained by NC data)

Good agreement with 2006 DPDF fit (assumes $u = d = s = \bar{u} = \bar{d} = \bar{s}$ and c from BGF) though statistical precision very limited so far

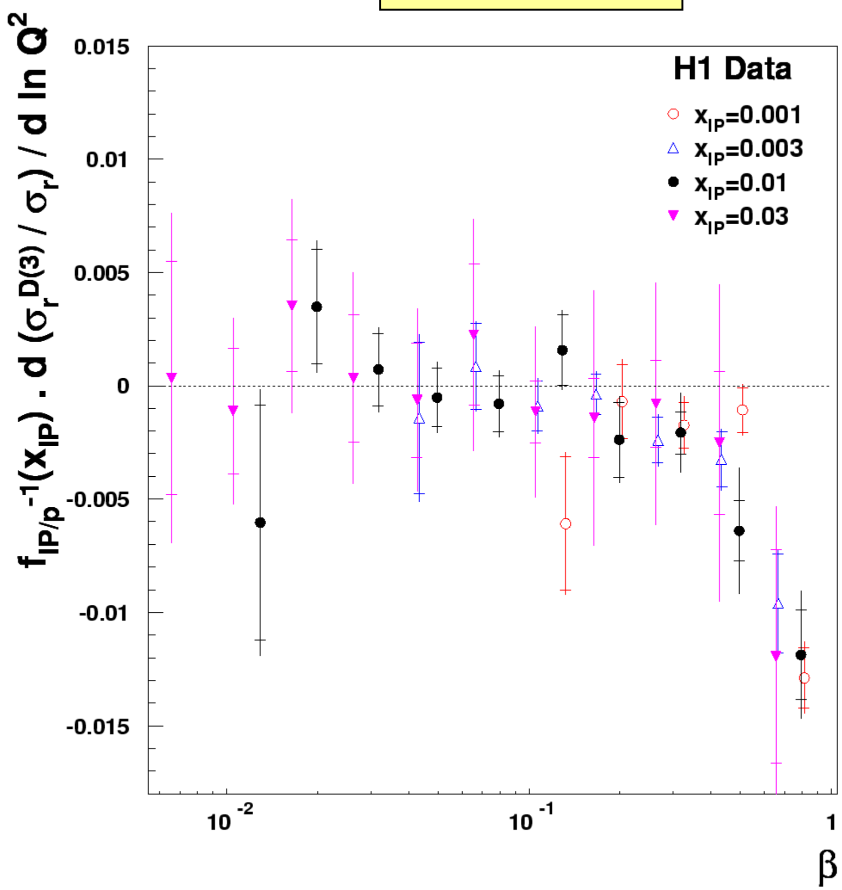
Q^2 dependence of diffractive/inclusive ratio

Make ratio at fixed x_{IP} and x and fit to $\sigma_r^D / \sigma_r = A + B \ln Q^2$

$x_{IP} = 0.01$ (e.g.)



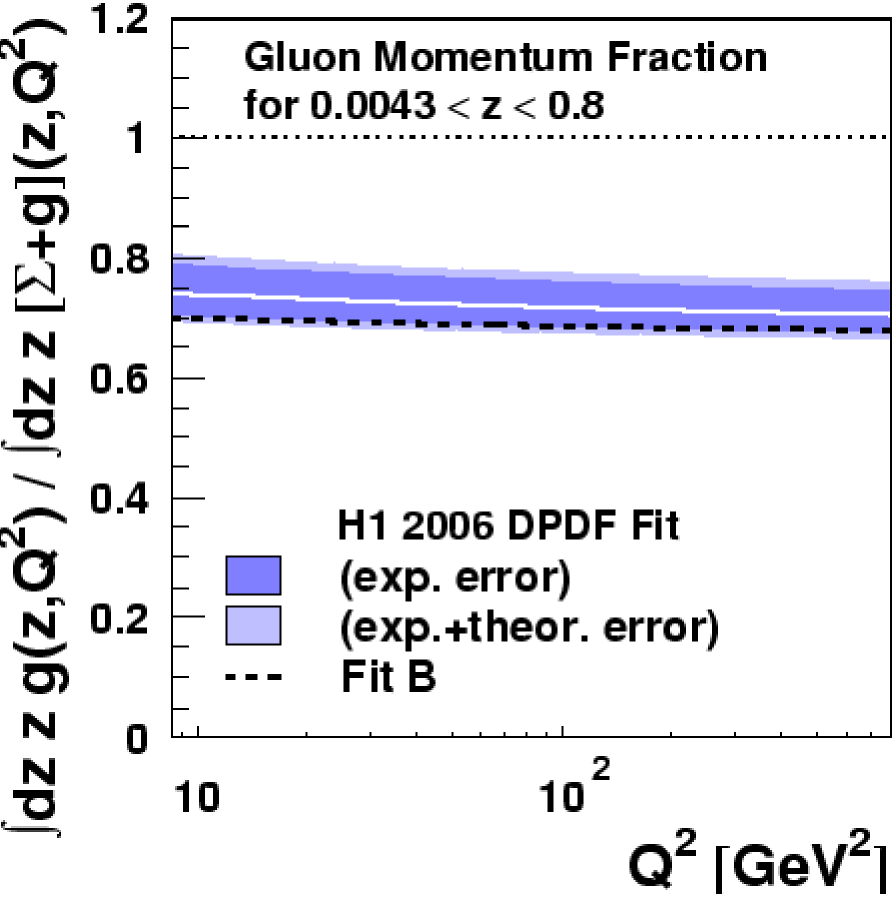
such that $$B = \frac{d\left(\sigma_r^D / \sigma_r\right)}{d \ln Q^2}$$

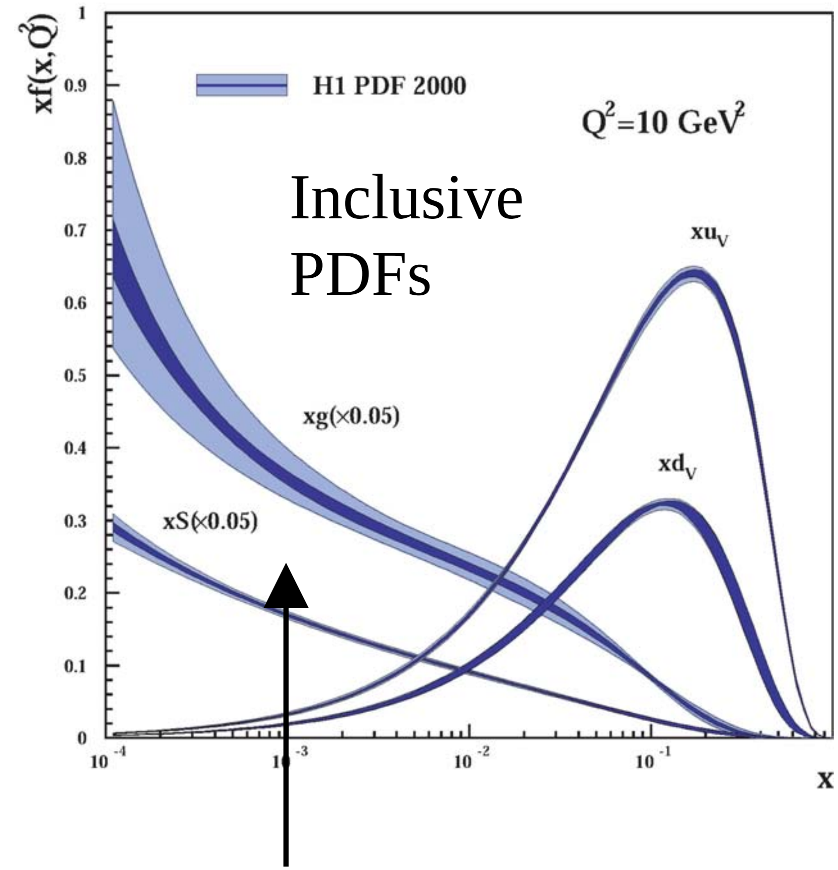


Ratio remarkably flat (derivative ~ 0) except at high β

Q^2 Derivative and Quark to Gluon Ratios

If $\frac{d\left(\sigma_r^D/\sigma_r\right)}{d\ln Q^2} \sim 0$, then $\frac{1}{\sigma_r^D}\frac{d\sigma_r^D}{d\ln Q^2} \approx \frac{1}{\sigma_r}\frac{d\sigma_r}{d\ln Q^2}$ and $\boxed{\frac{g^D}{q^D} \approx \frac{g^I}{q^I}}$





At low x, ratio of quark:gluon = 70% : 30% common to diff. and incl.

x Dependence of Ratio

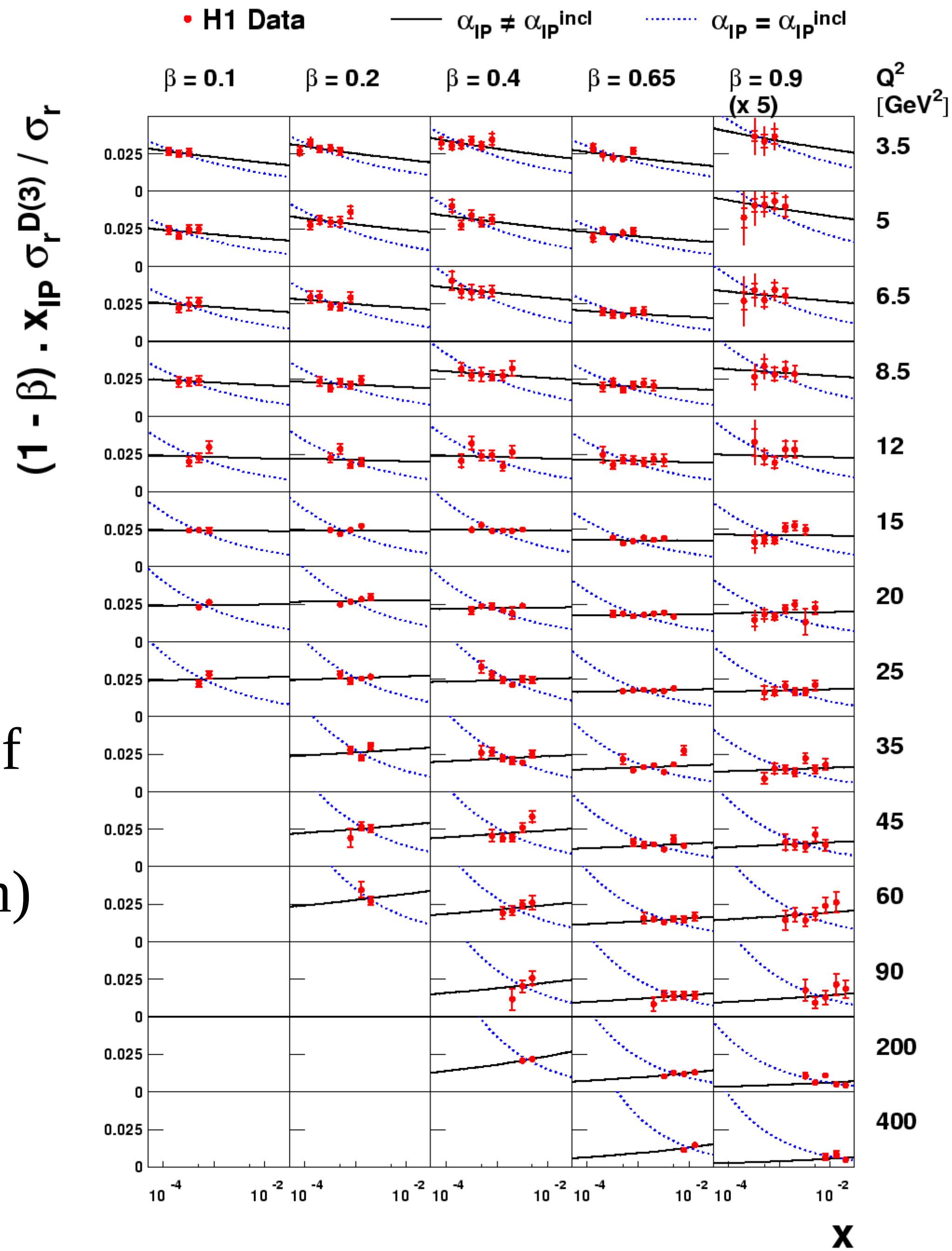
- Plot $\sigma_r^{D(3)}$ / σ_r at fixed β and Q^2 (hence fixed M_x) as a function of x (~$1/W^2$)

- i.e. (with appropriate factors)

$$\boxed{M_X^2 \cdot \frac{d\,\sigma_r^D}{d\,M_X^2} \Big/ \sigma_{tot}}$$

- Remarkably flat v x over most of kinematic range (bins with large F_L^D or IR contributions not shown)

- Diffractive and inclusive cross sections cannot be described with the same $\alpha_{IP}(0)$, even if it is Q2 dependent



Summary

• FPS and LRG measurements to be published. New level of precision and kinematic range. Agreement in detail between the two methods

• Slope parameter B~6 GeV^{-2} at low x_{IP}, independently of x_{IP} , β and Q^2

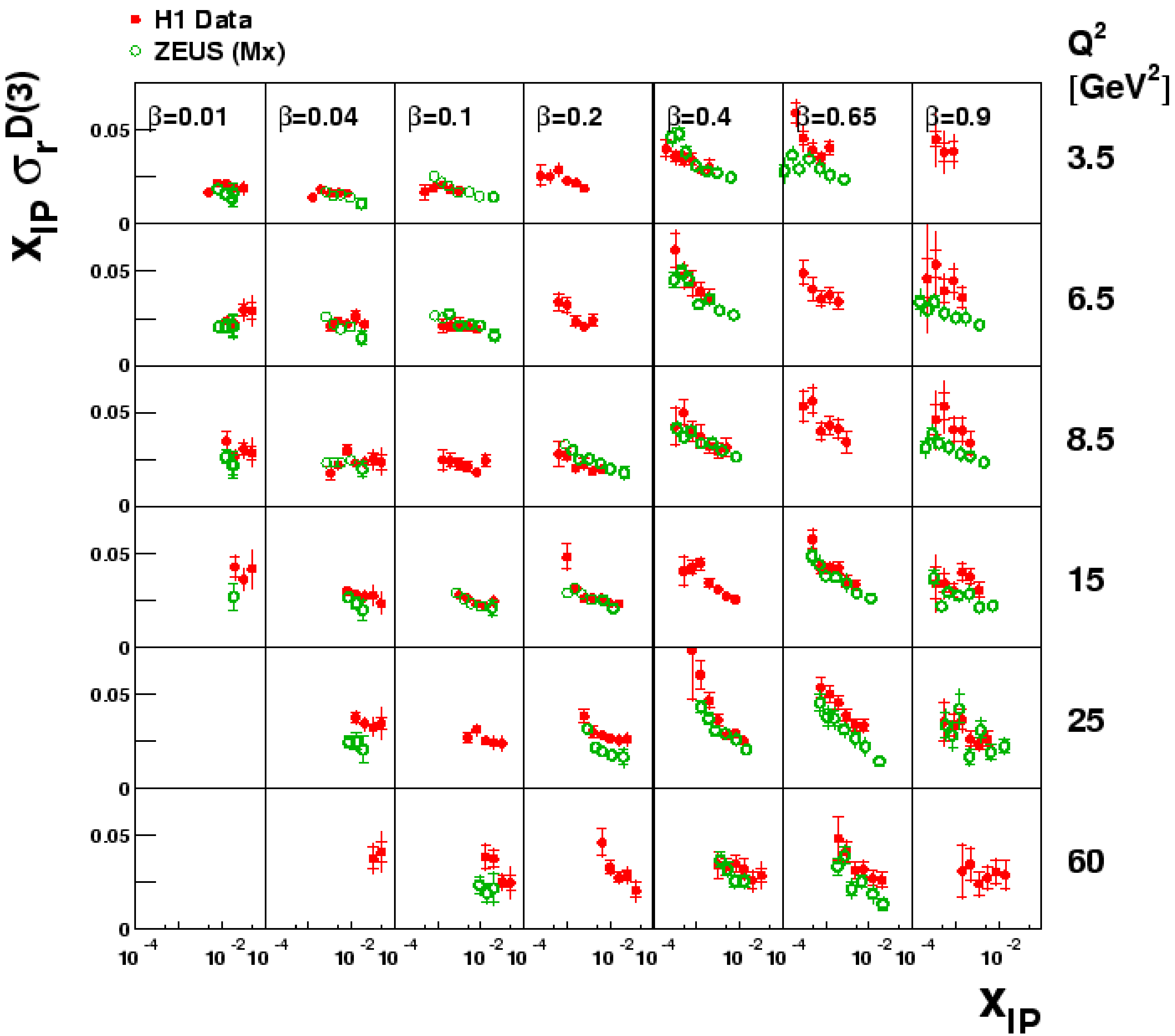
• Proton vertex factorisation with Reggeon exchanges continues to provide a good model for the x_{IP} dependence: $\alpha_{IP}(t) \sim 1.118 + 0.06\,t$

• DPDFs extracted from fits to β and Q^2 dependences at Q^2>=8.5GeV^2
Singlet quarks very well constrained (~5%).
Gluon to ~15% at low-to-moderate z, but poorly known at high z

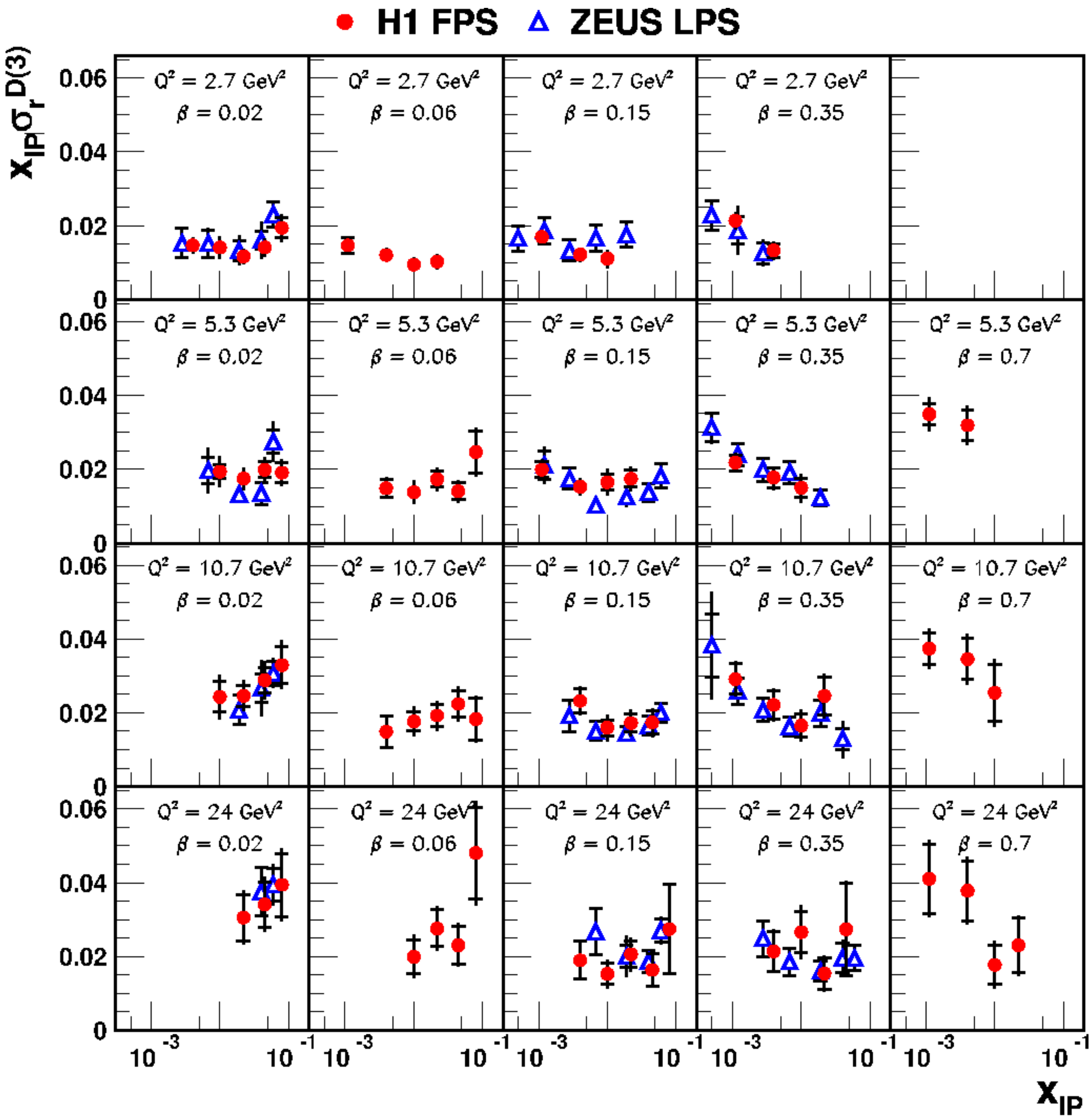
• DPDFs predict charged current OK. Many more comparisons to follow

• Over much of measured range, ratio of diffractive to inclusive cross sections shows no significant dependence on Q^2 at fixed x, x_{IP} or on W at fixed Q^2 and M_X

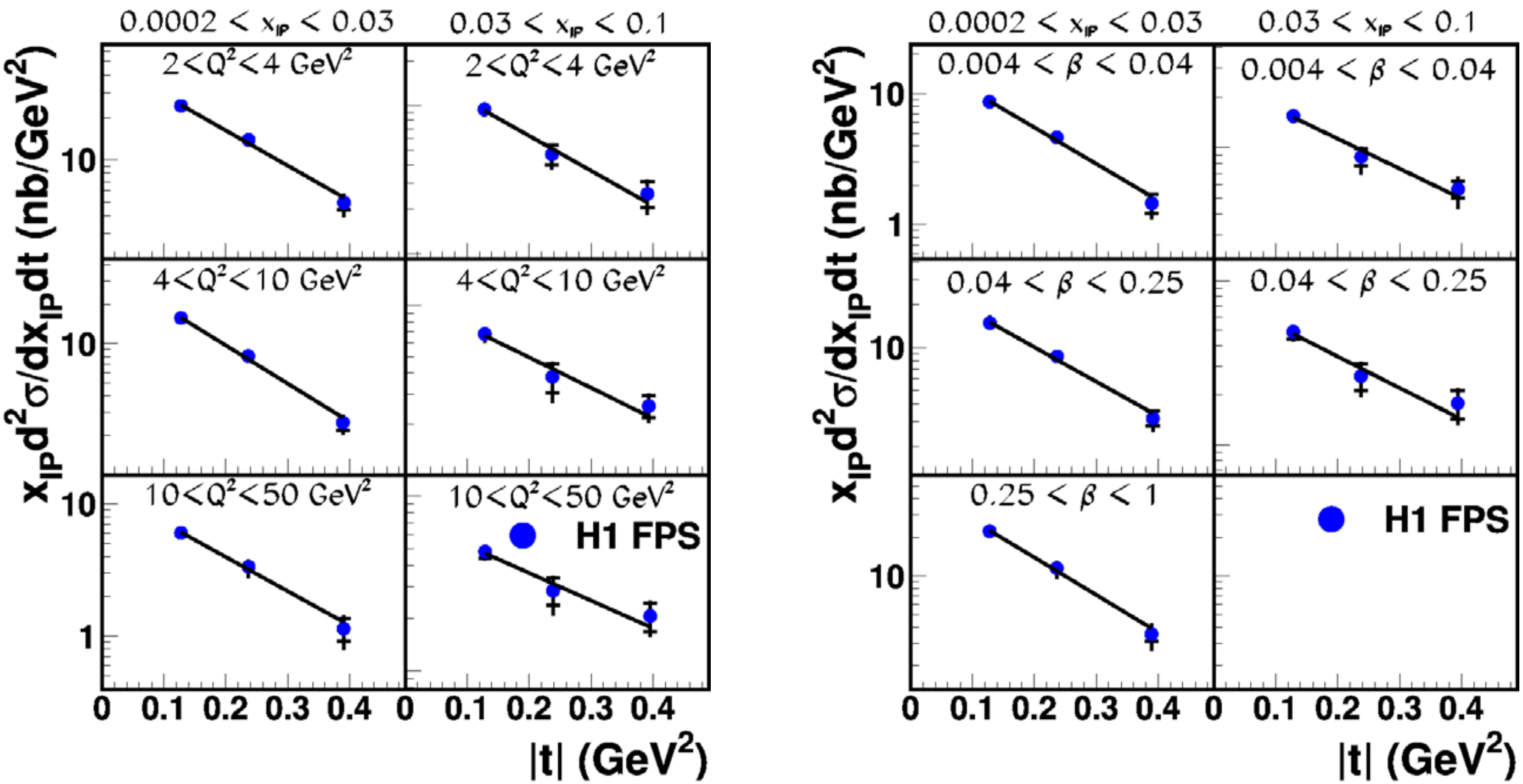
BACK-UP SLIDES FOLLOW



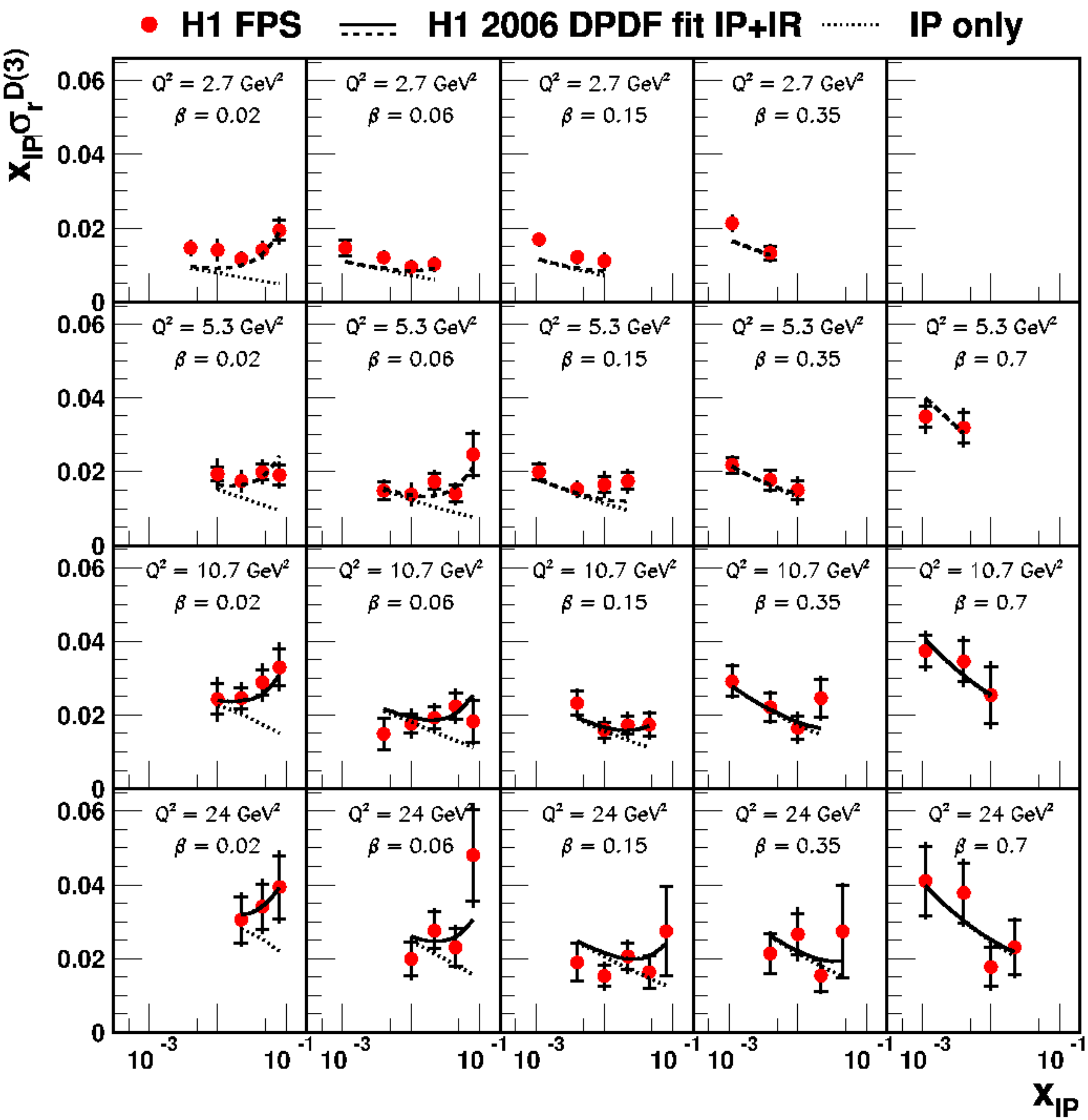
H1 Data
ZEUS (Mx)
$x_{IP}\,\sigma_r^{D(3)}$
Q^2 [GeV^2]
β=0.01
β=0.04
β=0.1
β=0.2
β=0.4
β=0.65
β=0.9
3.5
6.5
8.5
15
25
60
0.05
0
10^{-4}
10^{-2}
x_{IP}



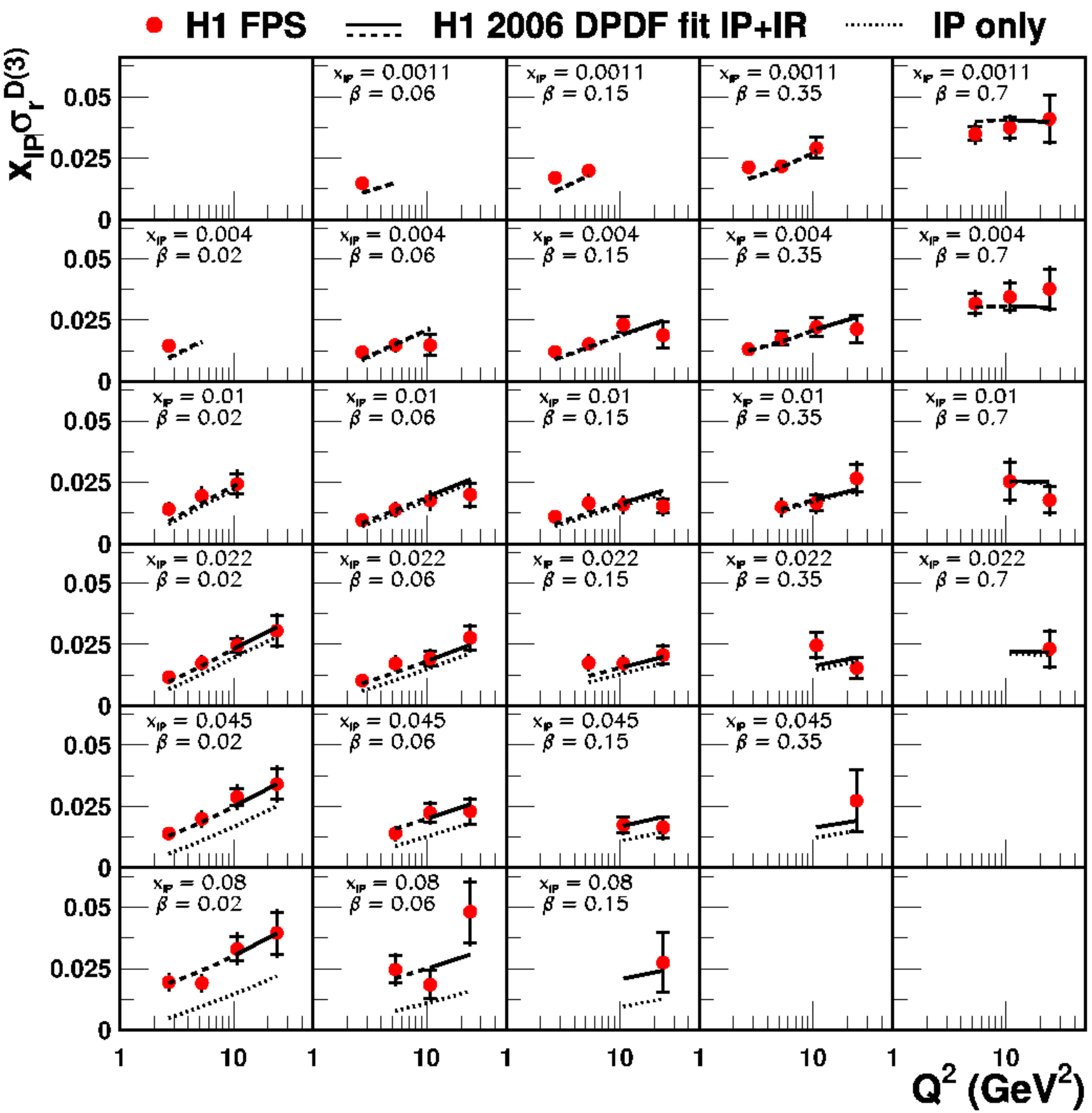
H1 FPS
ZEUS LPS
$x_{IP}\sigma_r^{D(3)}$
Q^2 = 2.7 GeV^2 β = 0.02
Q^2 = 2.7 GeV^2 β = 0.06
Q^2 = 2.7 GeV^2 β = 0.15
Q^2 = 2.7 GeV^2 β = 0.35
Q^2 = 5.3 GeV^2 β = 0.02
Q^2 = 5.3 GeV^2 β = 0.06
Q^2 = 5.3 GeV^2 β = 0.15
Q^2 = 5.3 GeV^2 β = 0.35
Q^2 = 5.3 GeV^2 β = 0.7
Q^2 = 10.7 GeV^2 β = 0.02
Q^2 = 10.7 GeV^2 β = 0.06
Q^2 = 10.7 GeV^2 β = 0.15
Q^2 = 10.7 GeV^2 β = 0.35
Q^2 = 10.7 GeV^2 β = 0.7
Q^2 = 24 GeV^2 β = 0.02
Q^2 = 24 GeV^2 β = 0.06
Q^2 = 24 GeV^2 β = 0.15
Q^2 = 24 GeV^2 β = 0.35
Q^2 = 24 GeV^2 β = 0.7
0 0.02 0.04 0.06
10^{-3} 10^{-1}
x_{IP}



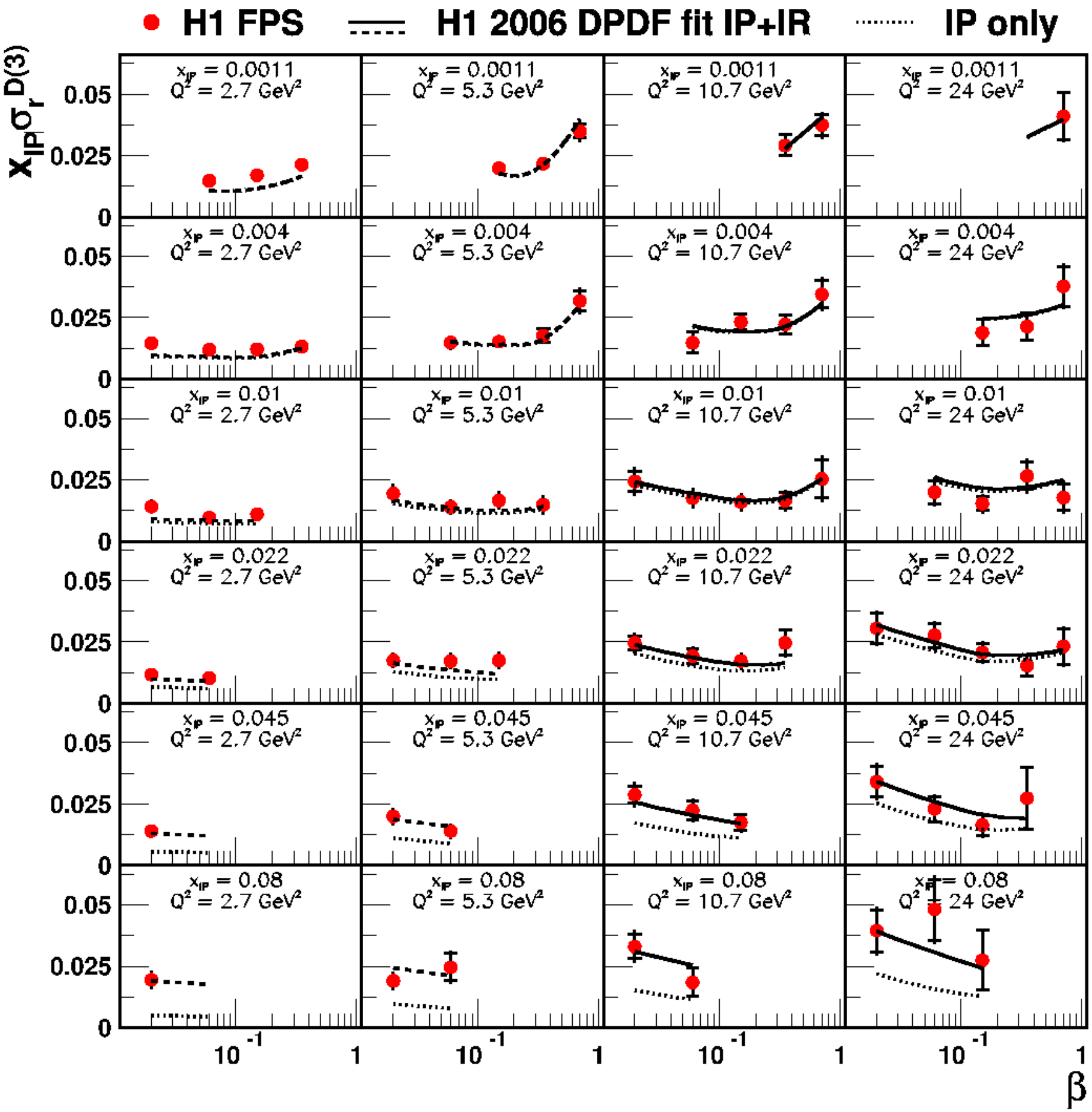
0.0002 < x_IP < 0.03
0.03 < x_IP < 0.1
2<Q²<4 GeV²
4<Q²<10 GeV²
10<Q²<50 GeV²
0.004 < β < 0.04
0.04 < β < 0.25
0.25 < β < 1
H1 FPS
x_IP d²σ/dx_IP dt (nb/GeV²)
|t| (GeV²)



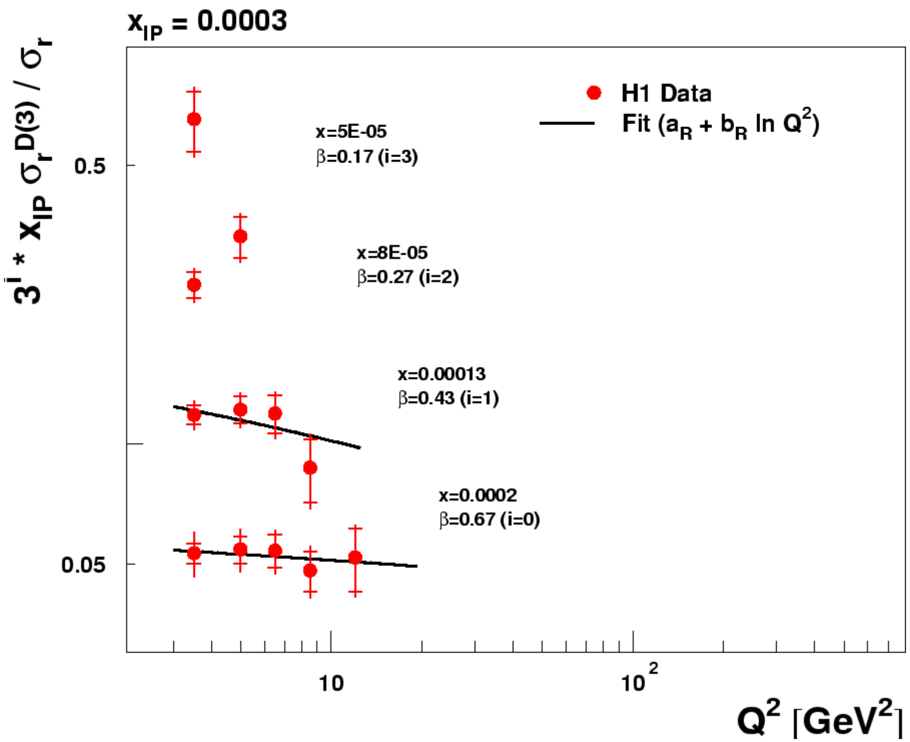
H1 FPS
H1 2006 DPDF fit IP+IR
IP only
$x_{IP}\sigma_r^{D(3)}$
Q^2 = 2.7 GeV^2 β = 0.02
Q^2 = 2.7 GeV^2 β = 0.06
Q^2 = 2.7 GeV^2 β = 0.15
Q^2 = 2.7 GeV^2 β = 0.35
Q^2 = 5.3 GeV^2 β = 0.02
Q^2 = 5.3 GeV^2 β = 0.06
Q^2 = 5.3 GeV^2 β = 0.15
Q^2 = 5.3 GeV^2 β = 0.35
Q^2 = 5.3 GeV^2 β = 0.7
Q^2 = 10.7 GeV^2 β = 0.02
Q^2 = 10.7 GeV^2 β = 0.06
Q^2 = 10.7 GeV^2 β = 0.15
Q^2 = 10.7 GeV^2 β = 0.35
Q^2 = 10.7 GeV^2 β = 0.7
Q^2 = 24 GeV^2 β = 0.02
Q^2 = 24 GeV^2 β = 0.06
Q^2 = 24 GeV^2 β = 0.15
Q^2 = 24 GeV^2 β = 0.35
Q^2 = 24 GeV^2 β = 0.7
0 0.02 0.04 0.06
10^{-3} 10^{-1}
x_{IP}



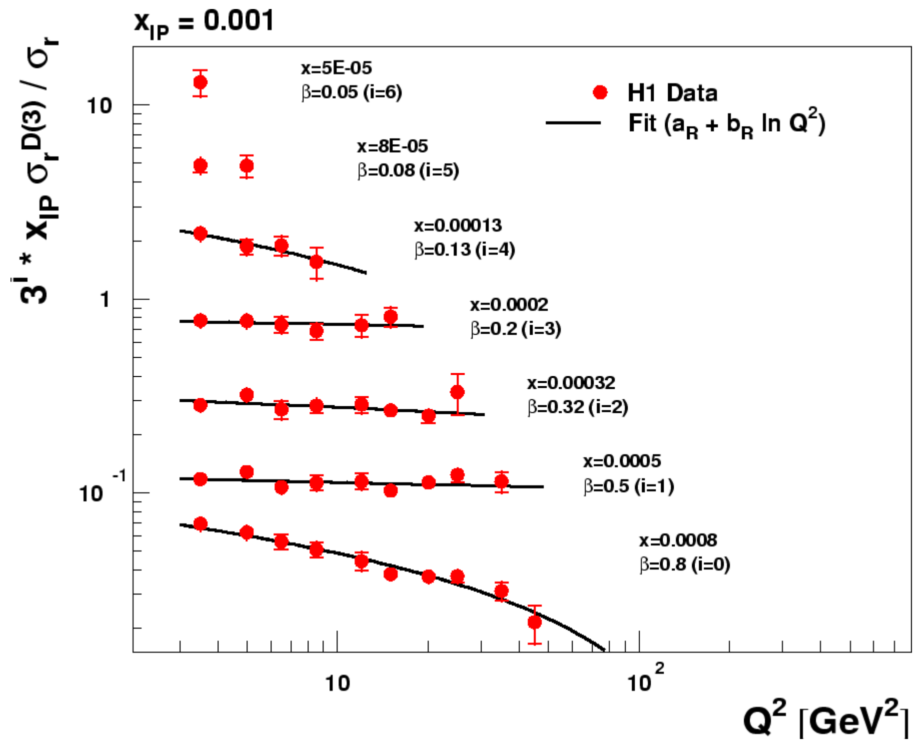
H1 FPS
H1 2006 DPDF fit IP+IR
IP only
$x_{IP}\sigma_r^{D(3)}$
Q^2 (GeV^2)
x_{IP} = 0.0011, β = 0.06
x_{IP} = 0.0011, β = 0.15
x_{IP} = 0.0011, β = 0.35
x_{IP} = 0.0011, β = 0.7
x_{IP} = 0.004, β = 0.02
x_{IP} = 0.004, β = 0.06
x_{IP} = 0.004, β = 0.15
x_{IP} = 0.004, β = 0.35
x_{IP} = 0.004, β = 0.7
x_{IP} = 0.01, β = 0.02
x_{IP} = 0.01, β = 0.06
x_{IP} = 0.01, β = 0.15
x_{IP} = 0.01, β = 0.35
x_{IP} = 0.01, β = 0.7
x_{IP} = 0.022, β = 0.02
x_{IP} = 0.022, β = 0.06
x_{IP} = 0.022, β = 0.15
x_{IP} = 0.022, β = 0.35
x_{IP} = 0.022, β = 0.7
x_{IP} = 0.045, β = 0.02
x_{IP} = 0.045, β = 0.06
x_{IP} = 0.045, β = 0.15
x_{IP} = 0.045, β = 0.35
x_{IP} = 0.08, β = 0.02
x_{IP} = 0.08, β = 0.06
x_{IP} = 0.08, β = 0.15
0
0.025
0.05
1
10



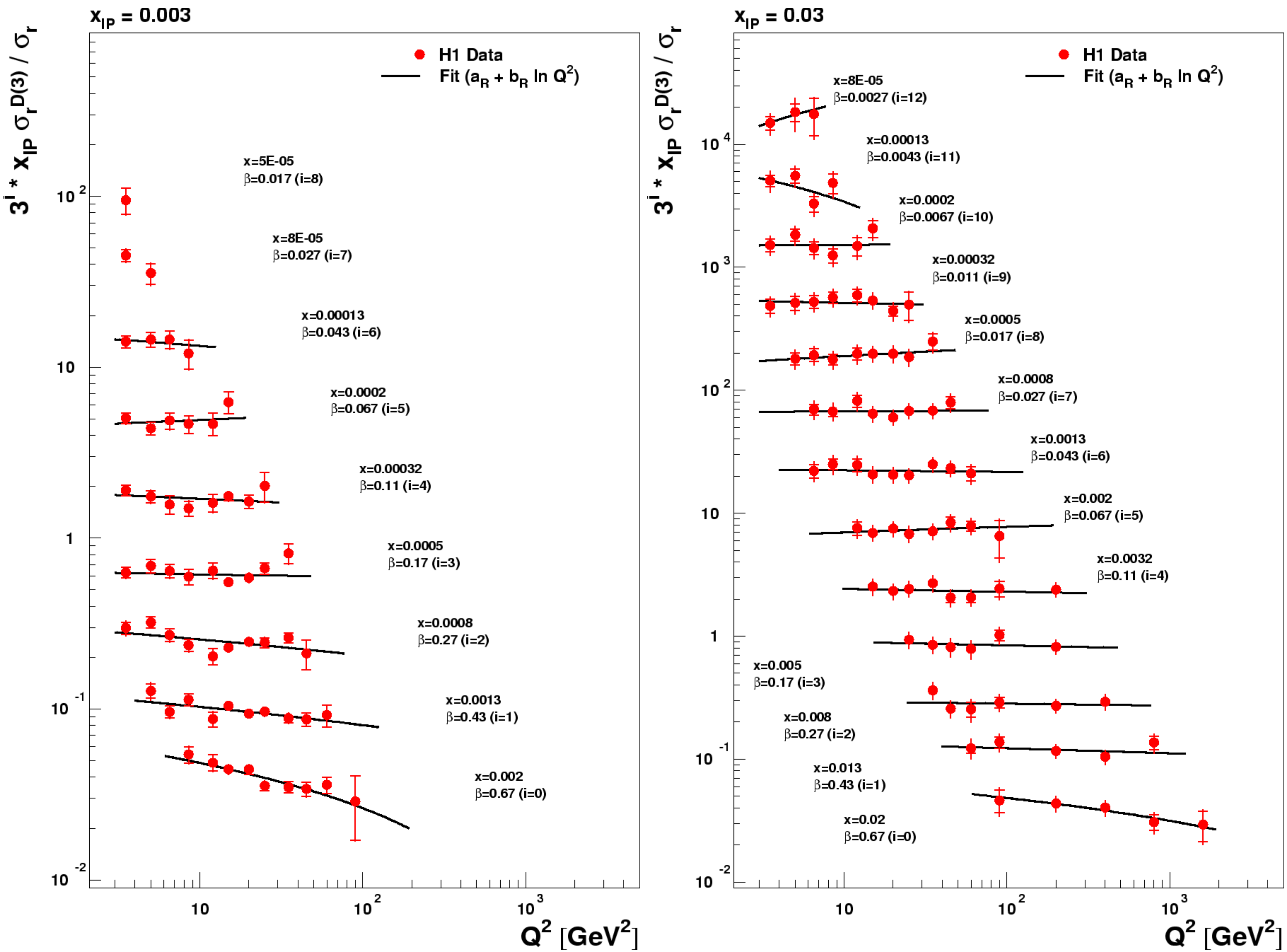
H1 FPS
H1 2006 DPDF fit IP+IR
IP only
$x_{IP}\sigma_r^{D(3)}$
β
x_{IP} = 0.0011, Q^2 = 2.7 GeV²
x_{IP} = 0.0011, Q^2 = 5.3 GeV²
x_{IP} = 0.0011, Q^2 = 10.7 GeV²
x_{IP} = 0.0011, Q^2 = 24 GeV²
x_{IP} = 0.004, Q^2 = 2.7 GeV²
x_{IP} = 0.004, Q^2 = 5.3 GeV²
x_{IP} = 0.004, Q^2 = 10.7 GeV²
x_{IP} = 0.004, Q^2 = 24 GeV²
x_{IP} = 0.01, Q^2 = 2.7 GeV²
x_{IP} = 0.01, Q^2 = 5.3 GeV²
x_{IP} = 0.01, Q^2 = 10.7 GeV²
x_{IP} = 0.01, Q^2 = 24 GeV²
x_{IP} = 0.022, Q^2 = 2.7 GeV²
x_{IP} = 0.022, Q^2 = 5.3 GeV²
x_{IP} = 0.022, Q^2 = 10.7 GeV²
x_{IP} = 0.022, Q^2 = 24 GeV²
x_{IP} = 0.045, Q^2 = 2.7 GeV²
x_{IP} = 0.045, Q^2 = 5.3 GeV²
x_{IP} = 0.045, Q^2 = 10.7 GeV²
x_{IP} = 0.045, Q^2 = 24 GeV²
x_{IP} = 0.08, Q^2 = 2.7 GeV²
x_{IP} = 0.08, Q^2 = 5.3 GeV²
x_{IP} = 0.08, Q^2 = 10.7 GeV²
x_{IP} = 0.08, Q^2 = 24 GeV²
0
0.025
0.05
10^{-1}
1



x_IP = 0.0003
3^i * x_IP σ_r^D(3) / σ_r
0.5
0.05
H1 Data
Fit (a_R + b_R ln Q^2)
x=5E-05
β=0.17 (i=3)
x=8E-05
β=0.27 (i=2)
x=0.00013
β=0.43 (i=1)
x=0.0002
β=0.67 (i=0)
10
10^2
Q^2 [GeV^2]



x_IP = 0.001
3^i * x_IP σ_r^D(3) / σ_r
10
1
10^-1
H1 Data
Fit (a_R + b_R ln Q^2)
x=5E-05
β=0.05 (i=6)
x=8E-05
β=0.08 (i=5)
x=0.00013
β=0.13 (i=4)
x=0.0002
β=0.2 (i=3)
x=0.00032
β=0.32 (i=2)
x=0.0005
β=0.5 (i=1)
x=0.0008
β=0.8 (i=0)
10
10^2
Q^2 [GeV^2]



x_{IP} = 0.003
$3^i * x_{IP}\,\sigma_r^{D(3)} / \sigma_r$
H1 Data
Fit ($a_R + b_R \ln Q^2$)
x=5E-05 β=0.017 (i=8)
x=8E-05 β=0.027 (i=7)
x=0.00013 β=0.043 (i=6)
x=0.0002 β=0.067 (i=5)
x=0.00032 β=0.11 (i=4)
x=0.0005 β=0.17 (i=3)
x=0.0008 β=0.27 (i=2)
x=0.0013 β=0.43 (i=1)
x=0.002 β=0.67 (i=0)
10^{-2}
10^{-1}
1
10
10^2
10
10^2
10^3
Q^2 [GeV^2]
x_{IP} = 0.03
$3^i * x_{IP}\,\sigma_r^{D(3)} / \sigma_r$
H1 Data
Fit ($a_R + b_R \ln Q^2$)
x=8E-05 β=0.0027 (i=12)
x=0.00013 β=0.0043 (i=11)
x=0.0002 β=0.0067 (i=10)
x=0.00032 β=0.011 (i=9)
x=0.0005 β=0.017 (i=8)
x=0.0008 β=0.027 (i=7)
x=0.0013 β=0.043 (i=6)
x=0.002 β=0.067 (i=5)
x=0.0032 β=0.11 (i=4)
x=0.005 β=0.17 (i=3)
x=0.008 β=0.27 (i=2)
x=0.013 β=0.43 (i=1)
x=0.02 β=0.67 (i=0)
10^{-2}
10^{-1}
1
10
10^2
10^3
10^4
10
10^2
10^3
Q^2 [GeV^2]