Diffractive DIS analysis and implications

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DESY

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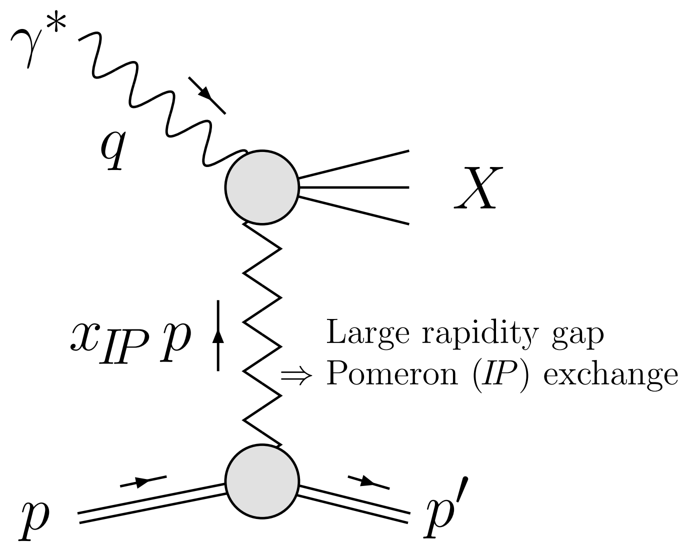
Goals of MRW analysis

1. Diffractive DIS data: Formulate new perturbative QCD description and extract reliable diffractive PDFs
2. Inclusive DIS data: Study effect of absorptive corrections due to parton recombination on conventional proton PDFs

Link between 1. and 2. is provided by AGK cutting rules

- Outline of talk:
  - Review work presented at June meeting
  - New plots made to clarify some aspects
  - Recent developments and outlook on future work

Diffractive DIS kinematics



- $q^2 \equiv -Q^2$
- $W^2 \equiv (q+p)^2 = -Q^2 + 2\,p\cdot q$
  $\Rightarrow \quad x_B \equiv \frac{Q^2}{2\,p\cdot q} = \frac{Q^2}{Q^2+W^2}$
  (fraction of proton's momentum carried by struck quark)
- $t \equiv (p-p')^2 \approx 0$, $(p-p') \approx x_{I\!P}\,p$
- $M_X^2 \equiv (q+p-p')^2 = -Q^2 + x_{I\!P}(Q^2+W^2)$
  $\Rightarrow \quad x_{I\!P} = \frac{Q^2+M_X^2}{Q^2+W^2}$
  (fraction of proton's momentum carried by Pomeron)
- $\beta \equiv \frac{x_B}{x_{I\!P}} = \frac{Q^2}{Q^2+M_X^2}$ (fraction of Pomeron's momentum carried by struck quark)

Diffractive structure function $F_2^{D(3)}$

- Diffractive cross section (integrated over t):

$$\frac{\mathrm{d}^3\sigma^D}{\mathrm{d}x_{I\!P}\,\mathrm{d}\beta\,\mathrm{d}Q^2} = \frac{2\pi\alpha_{\mathrm{em}}^2}{\beta\,Q^4}\,\left[1+(1-y)^2\right]\,\sigma_r^{D(3)}(x_{I\!P},\beta,Q^2),$$

where $y = Q^2/(x_B s)$, $s = 4E_eE_p$, and

$$\sigma_r^{D(3)} = F_2^{D(3)} - \frac{y^2}{1+(1-y)^2}\,F_L^{D(3)} \approx F_2^{D(3)}(x_{I\!P},\beta,Q^2),$$

for small y or assuming that $F_L^{D(3)} \ll F_2^{D(3)}$

- Measurements of $F_2^{D(3)}$ $\Rightarrow$ *diffractive* parton distribution functions (DPDFs)

$$a^D(x_{I\!P},\beta,Q^2) = \beta\Sigma^D(x_{I\!P},\beta,Q^2) \text{ or } \beta g^D(x_{I\!P},\beta,Q^2)$$

‘Traditional’ extraction of DPDFs

- Assume Regge factorisation [Ingelman-Schlein,1985]:

$$F_2^{D(3)}(x_{I\!P}, \beta, Q^2) = f_{I\!P}(x_{I\!P})\, F_2^{I\!P}(\beta, Q^2)$$

- Pomeron flux factor from Regge phenomenology:

$$f_{I\!P}(x_{I\!P}) = \int_{t_{\rm cut}}^{t_{\rm min}} {\rm d}t\, \frac{{\rm e}^{B_{I\!P}\, t}}{x_{I\!P}^{2\alpha_{I\!P}(t)-1}} \qquad (\alpha_{I\!P}(t) = \alpha_{I\!P}(0) + \alpha'_{I\!P}\, t)$$

Fits to $F_2^{D(3)}$ data give $\alpha_{I\!P}(0) > 1.08$ (value from soft hadron data) $\Longrightarrow$ significant perturbative QCD contributions to diffractive DIS

- Evaluate Pomeron structure function $F_2^{I\!P}(\beta, Q^2)$ from quark singlet $\Sigma^{I\!P}(\beta, Q^2)$ and gluon $g^{I\!P}(\beta, Q^2)$ Pomeron PDFs DGLAP-evolved from arbitrary polynomial input at scale Q_0^2

New perturbative QCD approach

- Pomeron singularity not a *pole* but a *cut* [Lipatov,1986]
  $\Rightarrow$ continuous number of components of size $1/\mu$:

$$F_{2,\mathrm{P}}^{D(3)}(x_{I\!P},\beta,Q^2) = \int_{Q_0^2}^{Q^2} \mathrm{d}\mu^2\; f_{I\!P}(x_{I\!P};\mu^2)\; F_2^{I\!P}(\beta,Q^2;\mu^2)$$

- Perturbative Pomeron represented by two t-channel gluons in colour singlet:

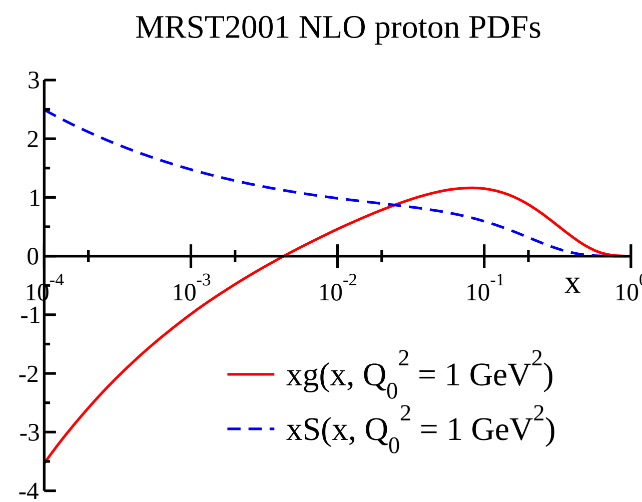
$$f_{I\!P=G}(x_{I\!P};\mu^2) = \frac{1}{x_{I\!P}}\left[\frac{\alpha_S(\mu^2)}{\mu^2}\, x_{I\!P}\, g(x_{I\!P},\mu^2)\right]^2$$

where $g(x_{I\!P},\mu^2)$ is the (integrated) gluon distribution of the proton

Problem: $x_{I\!P}\, g(x_{I\!P}, \mu^2)$ at low μ^2

- $f_{I\!P=G}(x_{I\!P}; \mu^2) \propto \left[x_{I\!P}\, g(x_{I\!P}, \mu^2)/\mu^2 \right]^2$ $\Rightarrow$ dominant contribution from low scales $\mu \sim Q_0 \sim 1$ GeV
- $F_2^{D(3)}$ data need $x_{I\!P} g(x_{I\!P}, \mu^2) \sim x_{I\!P}^{-\lambda}$ with $\lambda \simeq 0.17$

- But . . .



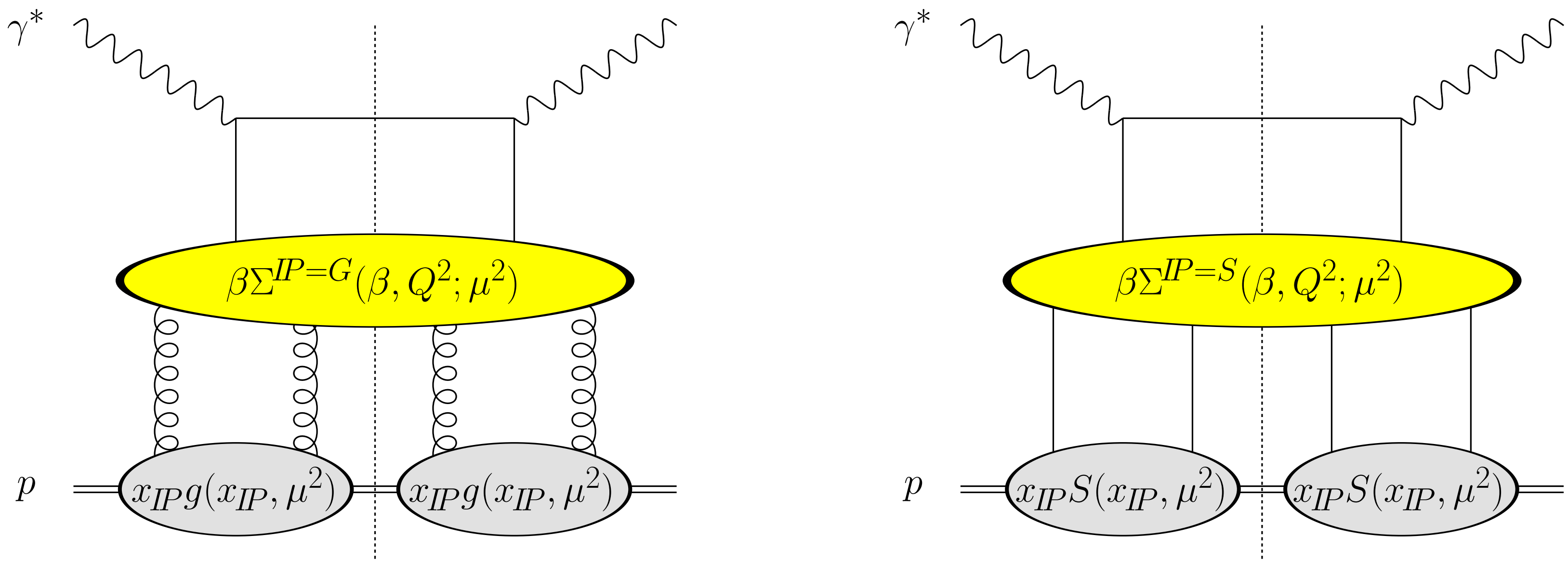
Solution:

- Introduce Pomeron composed of two sea quarks in a colour singlet:

$$f_{I\!P=S}(x_{I\!P}; \mu^2) = \frac{1}{x_{I\!P}} \left[\frac{\alpha_S(\mu^2)}{\mu^2}\, x_{I\!P}\, S(x_{I\!P}, \mu^2) \right]^2$$

and interference term with two-gluon Pomeron ($I\!P = GS$)
(set $x_{I\!P} g(x_{I\!P}, \mu^2) = 0$ if $-$ve)

New perturbative QCD approach



- $F_2^{I\!P}(\beta, Q^2; \mu^2)$ calculated from quark singlet $\Sigma^{I\!P}(\beta, Q^2; \mu^2)$ and gluon $g^{I\!P}(\beta, Q^2; \mu^2)$ DGLAP-evolved from an input scale μ^2 up to Q^2
- Get input Pomeron PDFs $\Sigma^{I\!P}(\beta, \mu^2; \mu^2)$ and $g^{I\!P}(\beta, \mu^2; \mu^2)$ from lowest-order Feynman diagrams. Calculate using light-cone wave functions of the photon [Wüsthoff,1997]

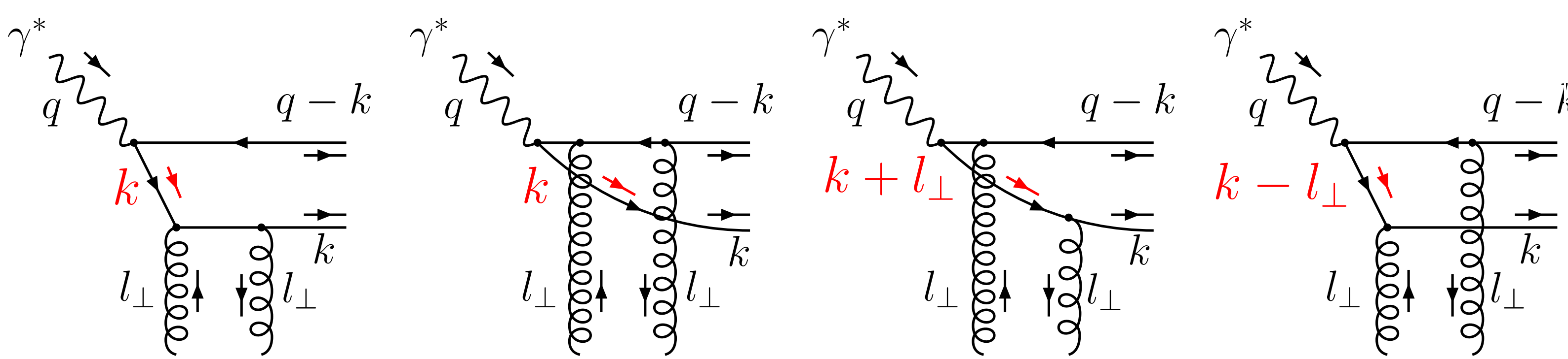
Example of dipole calculations

Two-gluon Pomeron, transversely-polarised photon, $\gamma^* \to q\bar{q}$:

$$\left.\frac{\mathrm{d}\sigma^{\gamma^* p}_{q\bar{q},T}}{\mathrm{d}t}\right|_{t=0} = \frac{N_C}{16\pi}\int_0^1 \mathrm{d}\alpha \int \frac{\mathrm{d}k_t^2}{2\pi} \sum_f e_f^2\, \alpha_{\mathrm{em}}\, \frac{1}{2} \sum_{\gamma=\pm 1} \sum_{h=\pm 1} \left| \int \frac{\mathrm{d}^2 \boldsymbol{l_t}}{\pi}\, D\Psi_h^\gamma\, \frac{\mathrm{d}\hat{\sigma}}{\mathrm{d}l_t^2} \right|^2$$

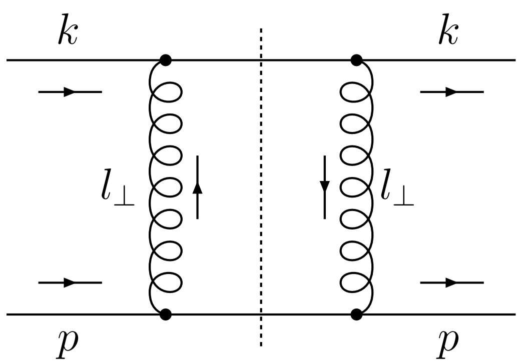
- Obtain four different permutations by simply shifting argument of wave functions:

$$D\Psi(\alpha, \boldsymbol{k_t}, \boldsymbol{l_t}) \equiv 2\Psi(\alpha, \boldsymbol{k_t}) - \Psi(\alpha, \boldsymbol{k_t} + \boldsymbol{l_t}) - \Psi(\alpha, \boldsymbol{k_t} - \boldsymbol{l_t})$$



Example of dipole calculations

- Obtain dipole cross section $\frac{d\hat{\sigma}}{dl_t^2}(qp \to qp)$ from $\frac{d\hat{\sigma}}{dl_t^2}(qq \to qq)$:



  - Make replacement

$$\frac{\alpha_S(l_t^2)}{2\pi} x_{I\!P} P_{gq}(x_{I\!P})\Big|_{x_{I\!P} \ll 1} \to f_g(x_{I\!P}, l_t^2, \mu^2)$$

where $\mu^2 \equiv k_t^2/(1-\beta)$ and $f_g(x_{I\!P}, l_t^2, \mu^2)$ is the *unintegrated* gluon distribution

- Work in strongly-ordered limit ($l_t \ll k_t \ll Q$):

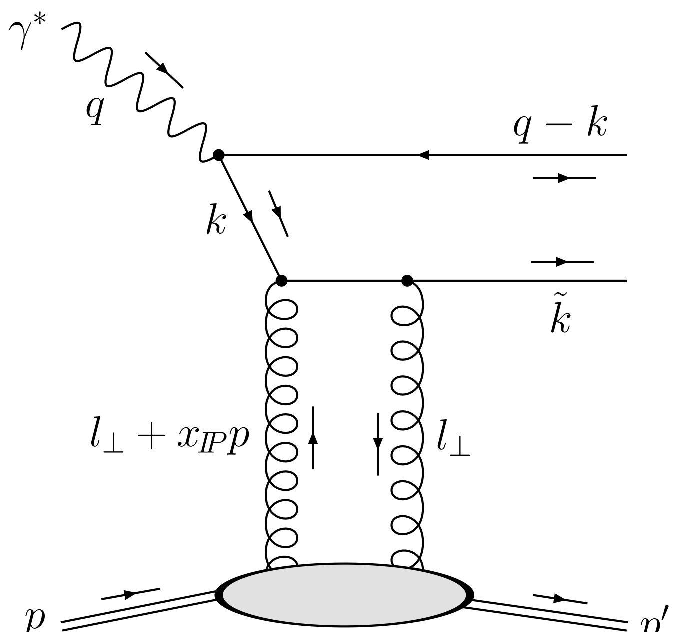
$$\int \frac{d^2 \boldsymbol{l_t}}{\pi} D\Psi_h^\gamma \frac{d\hat{\sigma}}{dl_t^2} \sim \int_0^{\mu^2} dl_t^2 \, l_t^2 \, \frac{1}{l_t^4} f_g(x_{I\!P}, l_t^2, \mu^2) = x_{I\!P} g(x_{I\!P}, \mu^2)$$

$D\Psi_h^\gamma$ gives the β dependence of $\Sigma^{I\!P=G}(\beta, \mu^2; \mu^2)$

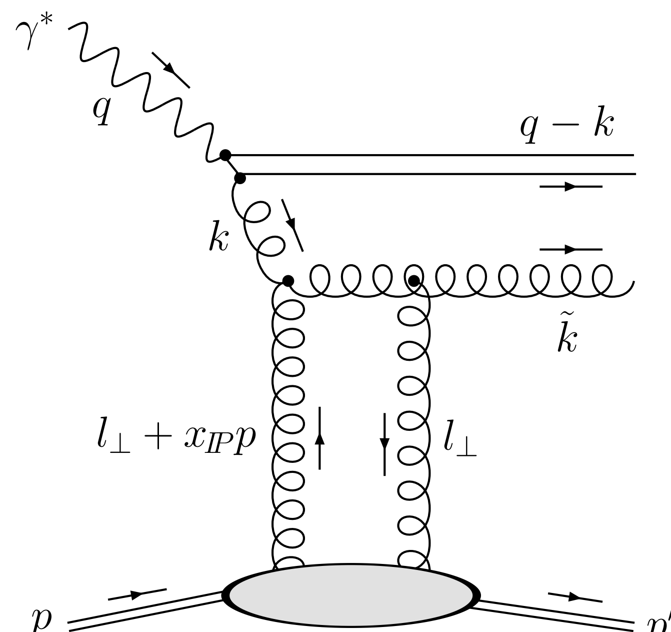
Two-gluon Pomeron

- Work in strongly-ordered limit: $l_t \ll k_t \ll Q$

Quark dipole



Effective gluon dipole



$$\beta\Sigma^{IP=G}(\beta,\mu^2;\mu^2) = c_{q/G}\,\beta^3\,(1-\beta)$$

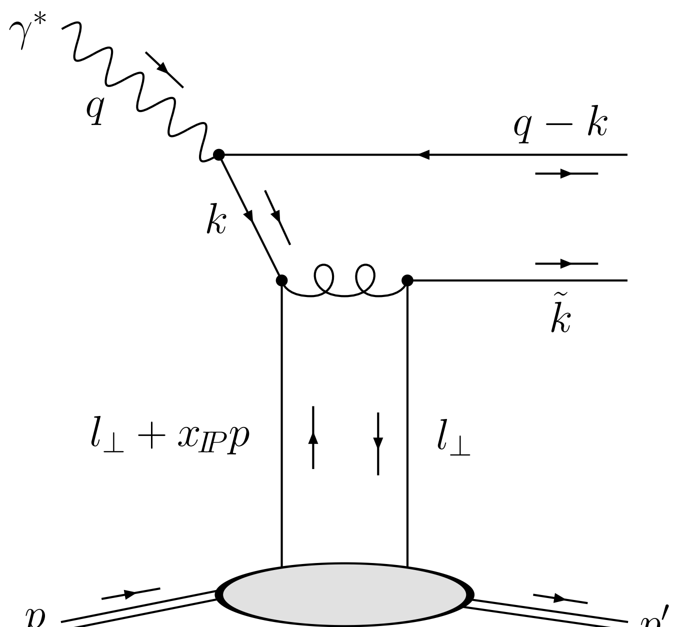
$$F_L^{IP=G}(\beta) = c_{L/G}\,\beta^3\,(2\beta-1)^2$$

$$\beta'\,g^{IP=G}(\beta',\mu^2;\mu^2) = c_{g/G}(1+2\beta')^2(1-\beta')^2$$

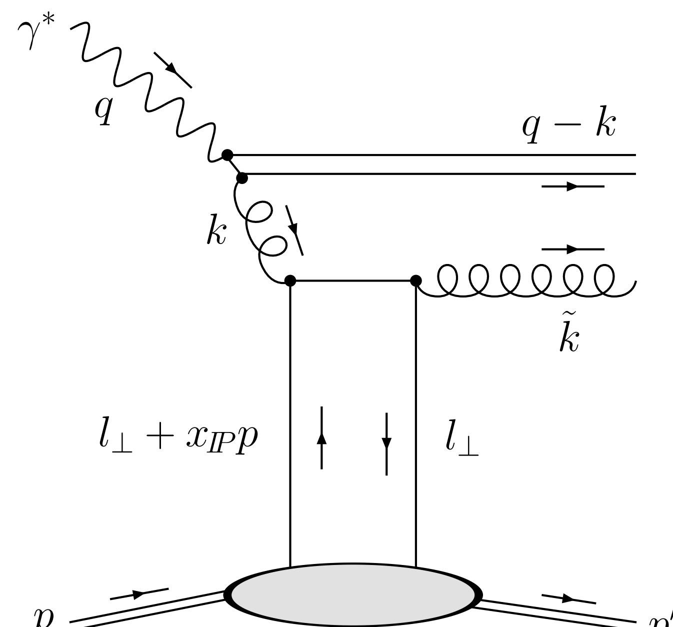
Two-quark Pomeron

- Work in strongly-ordered limit: $l_t \ll k_t \ll Q$

Quark dipole



Effective gluon dipole



$$\beta \Sigma^{I\!P=S}(\beta, \mu^2; \mu^2) = c_{q/S}\, \beta\, (1-\beta)$$

$$F_L^{I\!P=S}(\beta) = c_{L/S}\, \beta^3$$

$$\beta' g^{I\!P=S}(\beta', \mu^2; \mu^2) = c_{g/S}\, (1-\beta')^2$$

Other contributions to $F_2^{D(3)}$

$$F_2^{D(3)} = F_{2,\mathrm{P}}^{D(3)} + F_{2,\mathrm{NP}}^{D(3)} + F_{L,\mathrm{P}}^{D(3)} + F_{2,I\!R}^{D(3)}$$

- Non-perturbative contribution ($\mu < Q_0$, $\alpha_{I\!P}(0) = 1.08$):

$$F_{2,\mathrm{NP}}^{D(3)} = f_{I\!P=\mathrm{NP}}(x_{I\!P})\, F_2^{I\!P=\mathrm{NP}}(\beta, Q^2; Q_0^2)$$

$$\left[\beta\Sigma^{I\!P=\mathrm{NP}}(\beta, Q_0^2; Q_0^2) = c_{q/\mathrm{NP}}\,\beta\,(1-\beta), \quad \beta' g^{I\!P=\mathrm{NP}}(\beta', Q_0^2; Q_0^2) = 0\right]$$

- Twist-four contribution:

$$F_{L,\mathrm{P}}^{D(3)} = \sum_{I\!P=G,S,GS} \left(\int_{Q_0^2}^{Q^2} \mathrm{d}\mu^2\, \frac{\mu^2}{Q^2}\, f_{I\!P}(x_{I\!P}; \mu^2) \right) F_L^{I\!P}(\beta)$$

- Secondary Reggeon contribution ($\alpha_{I\!R}(0) = 0.50$):

$$F_{2,I\!R}^{D(3)} = c_{I\!R}\, f_{I\!R}(x_{I\!P})\, F_2^{\pi}(\beta, Q^2)$$

Description of $F_2^{D(3)}$ data

- Fit three different data sets simultaneously, allowing for *different* relative normalisations due to *proton dissociation*:

Data set	Points [a]	Proton dissociation	Normalisation
1997 ZEUS LPS	69	none	1
1998/99 ZEUS (prel.)	121	$M_Y < 2.3$ GeV	≈ 1.5
1997 H1 (prel.)	214	$M_Y < 1.6$ GeV	≈ 1.2

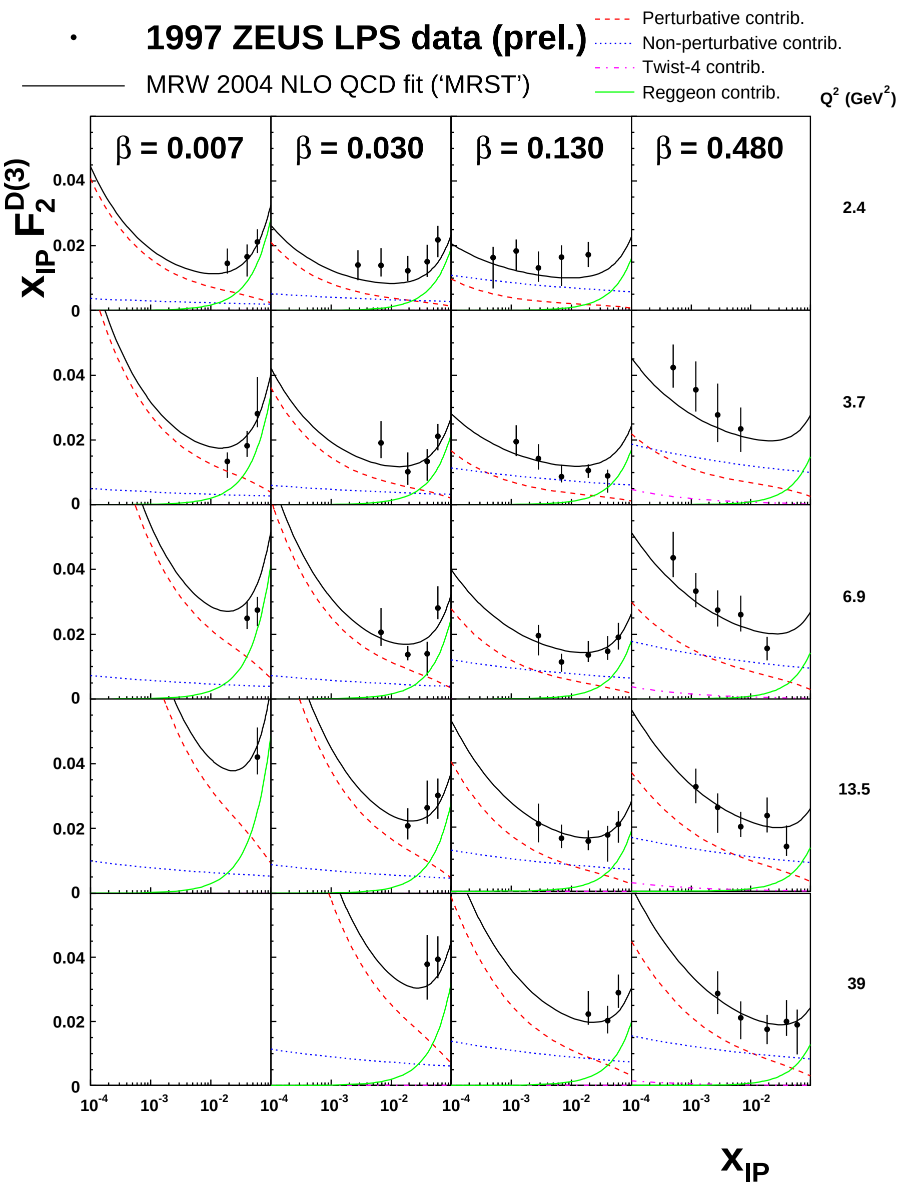
- Only other free parameters are *normalisations* (effective K-factors typically ~ 1–4) of the input Pomeron PDFs, the twist-four contributions and the secondary Reggeon contrib.:

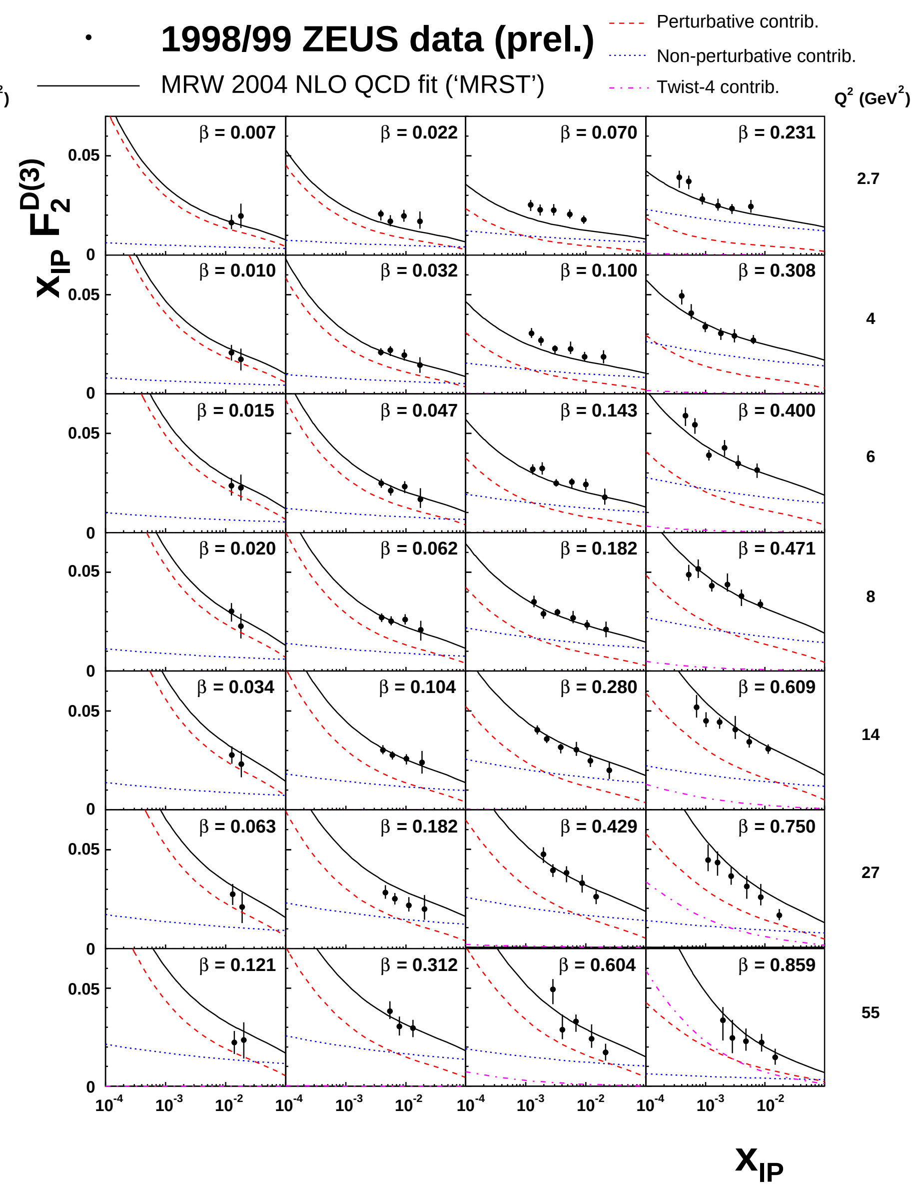
  $c_{q/G},\, c_{g/G},\, c_{L/G},\, c_{q/S},\, c_{g/S},\, c_{L/S},\, c_{q/\mathrm{NP}},\, c_{I\!R}$ $\quad$ ($Q_0 = 1$ GeV)

  (Fix $c_{i/GS} = \sqrt{c_{i/G}\, c_{i/S}}$ for $i = q, g, L$)

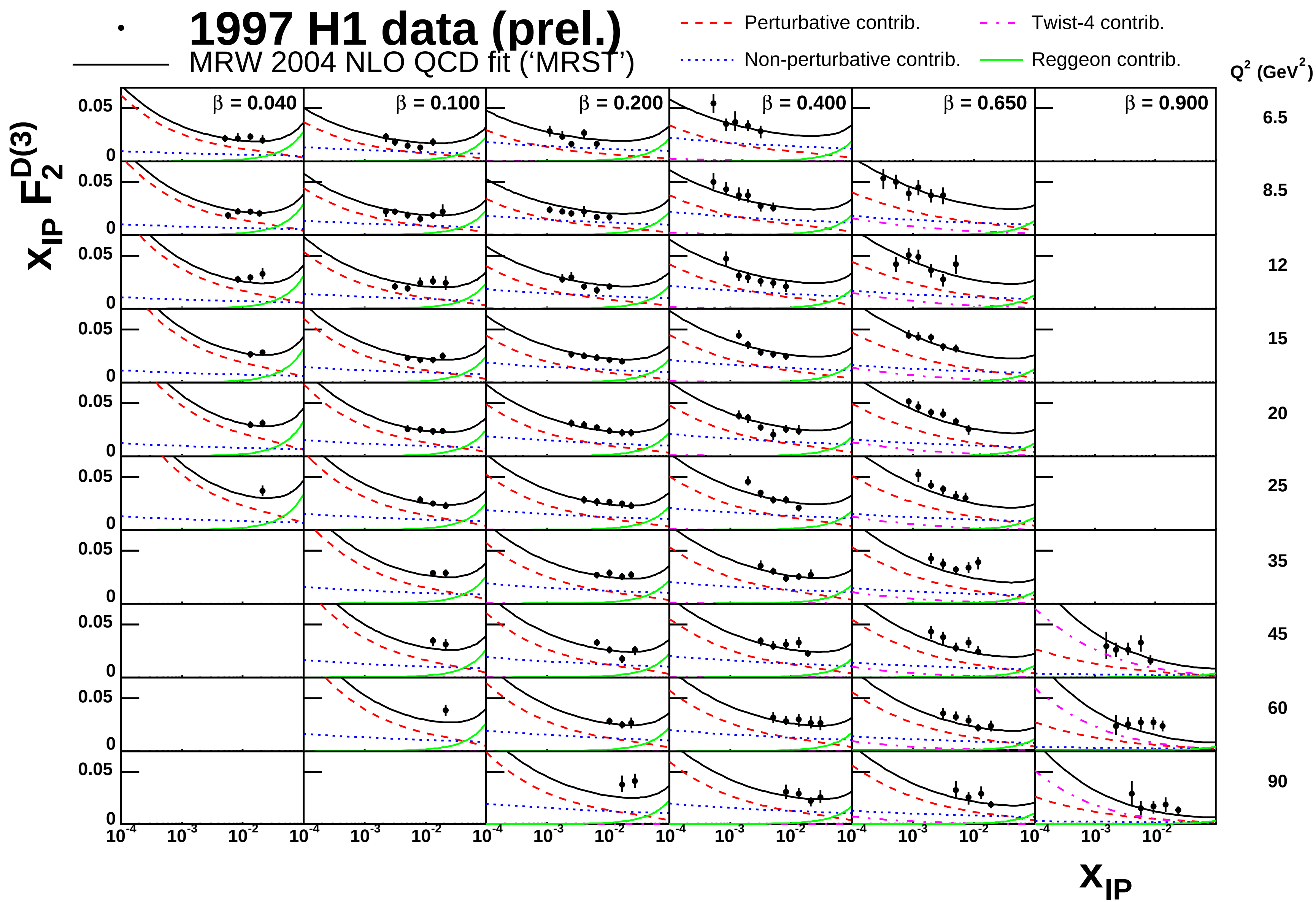
[a] Cuts: $M_X > 2$ GeV, $y < 0.45$

Fit to ZEUS + H1 $F_2^{D(3)}$

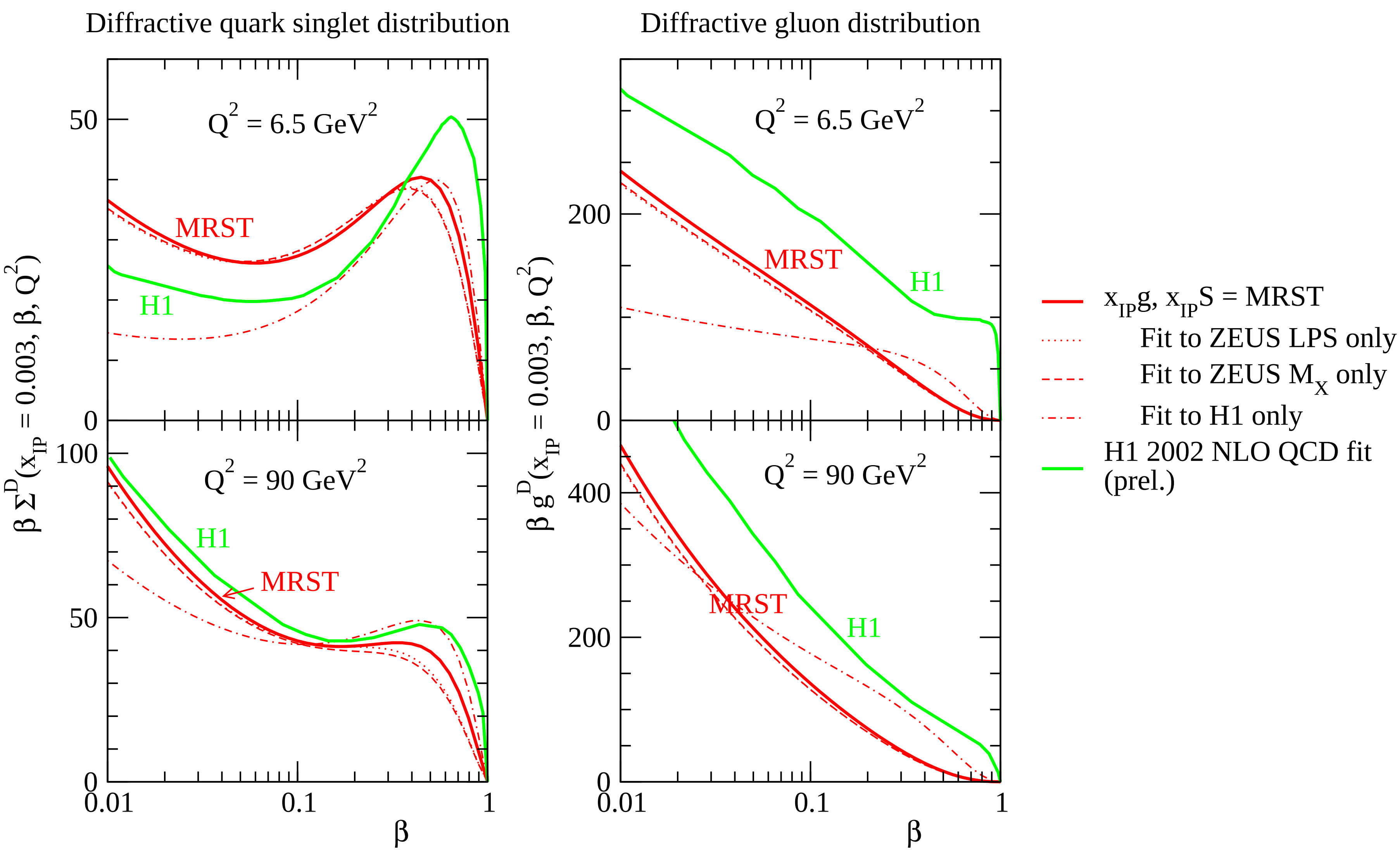




Fit to ZEUS + H1 $F_2^{D(3)}$



DPDFs compared to H1 fit

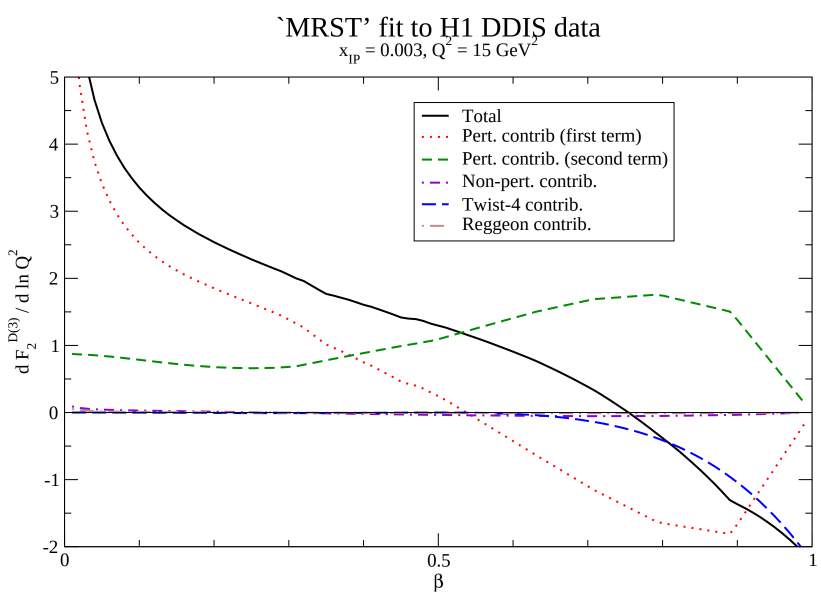


- H1 2002 NLO QCD fit has no twist-four contribution

Why is MRW g^D smaller than H1 ?

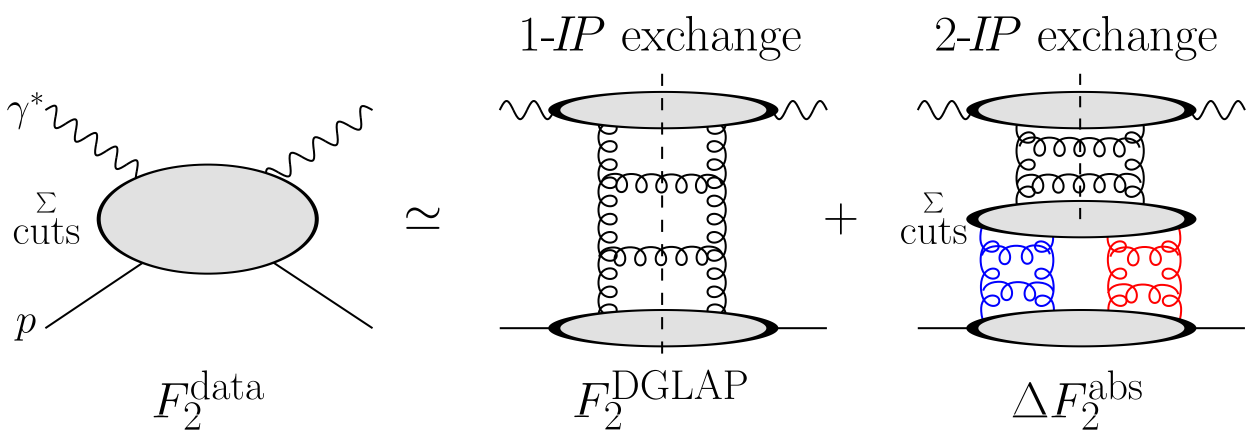
$$F_{2,\mathrm{P}}^{D(3)}(x_{I\!P},\beta,Q^2) = \sum_{I\!P=G,S,GS} \int_{Q_0^2}^{Q^2} \mathrm{d}\mu^2 \; f_{I\!P}(x_{I\!P};\mu^2)\; F_2^{I\!P}(\beta,Q^2;\mu^2)$$

$$\frac{\partial F_{2,\mathrm{P}}^{D(3)}}{\partial \ln Q^2} = \sum_{I\!P} \left[\int_{Q_0^2}^{Q^2} \mathrm{d}\mu^2 \; f_{I\!P}(x_{I\!P};\mu^2) \frac{\partial F_2^{I\!P}(\beta,Q^2;\mu^2)}{\partial \ln Q^2} + Q^2 f_{I\!P}(x_{I\!P};Q^2) F_2^{I\!P}(\beta,Q^2;Q^2) \right]$$

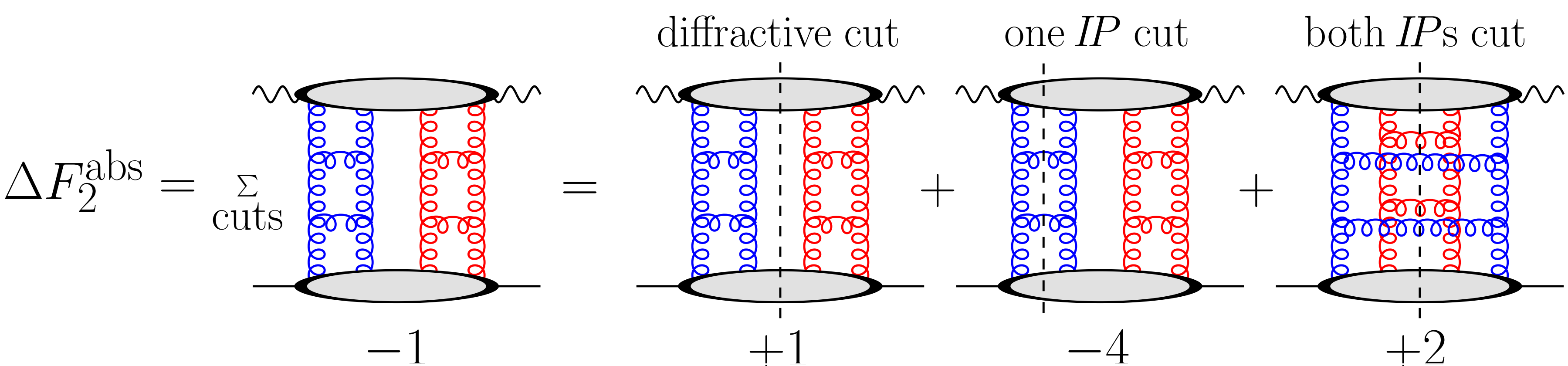


- Second term $\sim 1/Q^2$ but numerically significant
  $\therefore$ smaller g^D needed to reproduce Q^2 slope of DDIS data
- We use $\alpha_S(M_Z^2) = 0.1190$, cf. 0.1085 (H1), 0.1187 (PDG). Larger $\alpha_S \Rightarrow$ smaller g^D

Absorptive corrections to F_2



- **AGK cutting rules** [a] $\Longrightarrow$ diffractive events are intimately related to absorptive corrections to the inclusive structure function F_2:



[a] **A**bramovsky-**G**ribov-**K**ancheli (1973) ⟶ QCD: Bartels-Ryskin (1997)

Absorptive corrections to F_2

$$F_2^{\mathrm{data}}(x_B, Q^2) = F_2^{\mathrm{DGLAP}}(x_B, Q^2) + \Delta F_2^{\mathrm{abs}}(x_B, Q^2)$$

$$\Delta F_2^{\mathrm{abs}}(x_B, Q^2) = -\int_{Q_0^2}^{Q^2} \mathrm{d}\mu^2 \; F_2^D(x_B, Q^2; \mu^2)$$

- $F_2^D(x_B, Q^2; \mu^2)$ is the contribution to $F_2^{D(3)}$ (integrated over x_{IP}) originating from a perturbative component of the Pomeron of size $1/\mu$. The $\mu < Q_0$ contributions to the absorptive corrections are already included in the input parameterisations to the F_2 fit
- To fit F_2 using the DGLAP equation, first need to 'correct' the data for absorptive effects: [a]

$$F_2^{\mathrm{DGLAP}} = F_2^{\mathrm{data}} - \Delta F_2^{\mathrm{abs}} = F_2^{\mathrm{data}} + \left|\Delta F_2^{\mathrm{abs}}\right|$$

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[a] Aside: absorptive corrections $\sim$ non-linear effects, screening, shadowing, unitarity corrections, multiple scattering, multiple interactions, recombination, saturation effects, . . .

Compare to GLRMQ approach

- Gribov-Levin-Ryskin-Mueller-Qiu: original way of studying absorptive corrections to DGLAP (see e.g. talk by V. Kolhinen, October meeting). Non-linear DGLAP equation:

$$\frac{\partial xg(x,Q^2)}{\partial \ln Q^2} = \frac{\partial xg(x,Q^2)}{\partial \ln Q^2}\bigg|_{\mathrm{DGLAP}} - \frac{9}{2}\,\frac{\alpha_S^2(Q^2)}{R^2Q^2}\int_x^1 \frac{\mathrm{d}x'}{x'}\left[x'g(x',Q^2)\right]^2$$

  - Disadvantages: only DLLA, violation of momentum conservation, uncertainty in two-gluon distribution and in R parameter

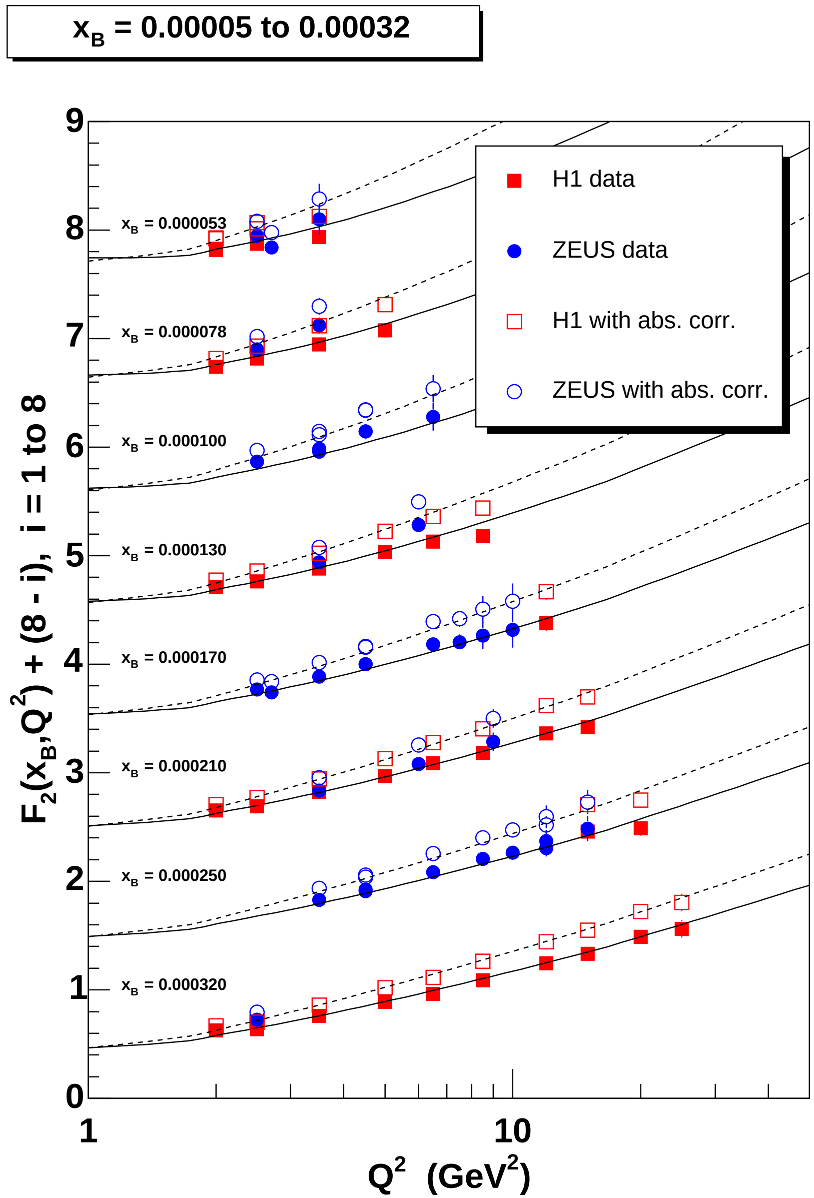
- MRW approach: ‘correct’ F_2 data for non-linear effects then fit using linear DGLAP evolution
  - Advantages: goes beyond DLLA, include sea quark recombination in addition to gluon recombination, allows use of standard NLO DGLAP evolution codes, parameters are fitted to DDIS data

Simultaneous F_2 + $F_2^{D(3)}$ analysis

- Procedure:
  1. Start by fitting ZEUS + H1 F_2 data (279 points) [a] with no absorptive corrections $\sim$ MRST2001 NLO
  2. Fit ZEUS + H1 $F_2^{D(3)}$ data, using $g(x_{I\!P}, \mu^2)$ and $S(x_{I\!P}, \mu^2)$ from previous F_2 fit
  3. Fit $F_2^{\rm DGLAP} = F_2^{\rm data} + \left|\Delta F_2^{\rm abs}\right|$, with $\Delta F_2^{\rm abs}$ from previous $F_2^{D(3)}$ fit
  4. Go to 2.
- Only a few iterations needed for convergence

[a] Cuts: $x_B < 0.01$, $2 < Q^2 < 500$ GeV^2, $W^2 > 12.5$ GeV^2; match to MRST xg, xS at $x = 0.2$

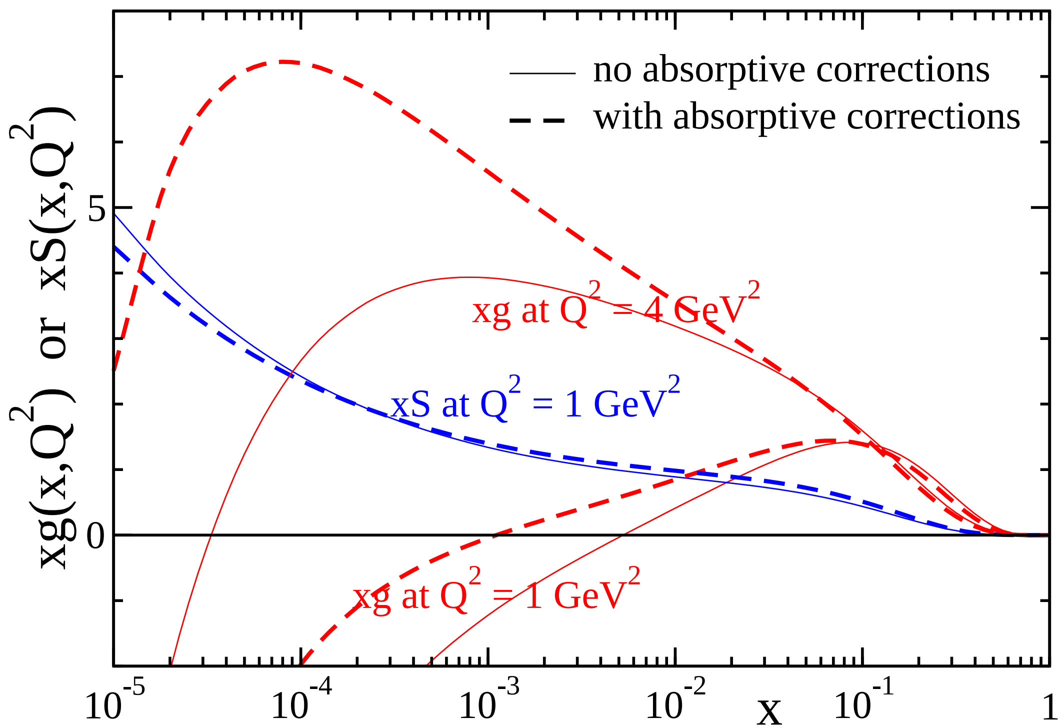
Fit to ZEUS + H1 F_2 data



Gluon and sea quark PDFs

$$xg(x,Q^2=1\text{ GeV}^2) = A_g\, x^{-\lambda_g}\,(1-x)^{3.7}\,(1+\epsilon_g x^{0.5}) - A_-\, x^{-\delta_-}\,(1-x)^{10}$$

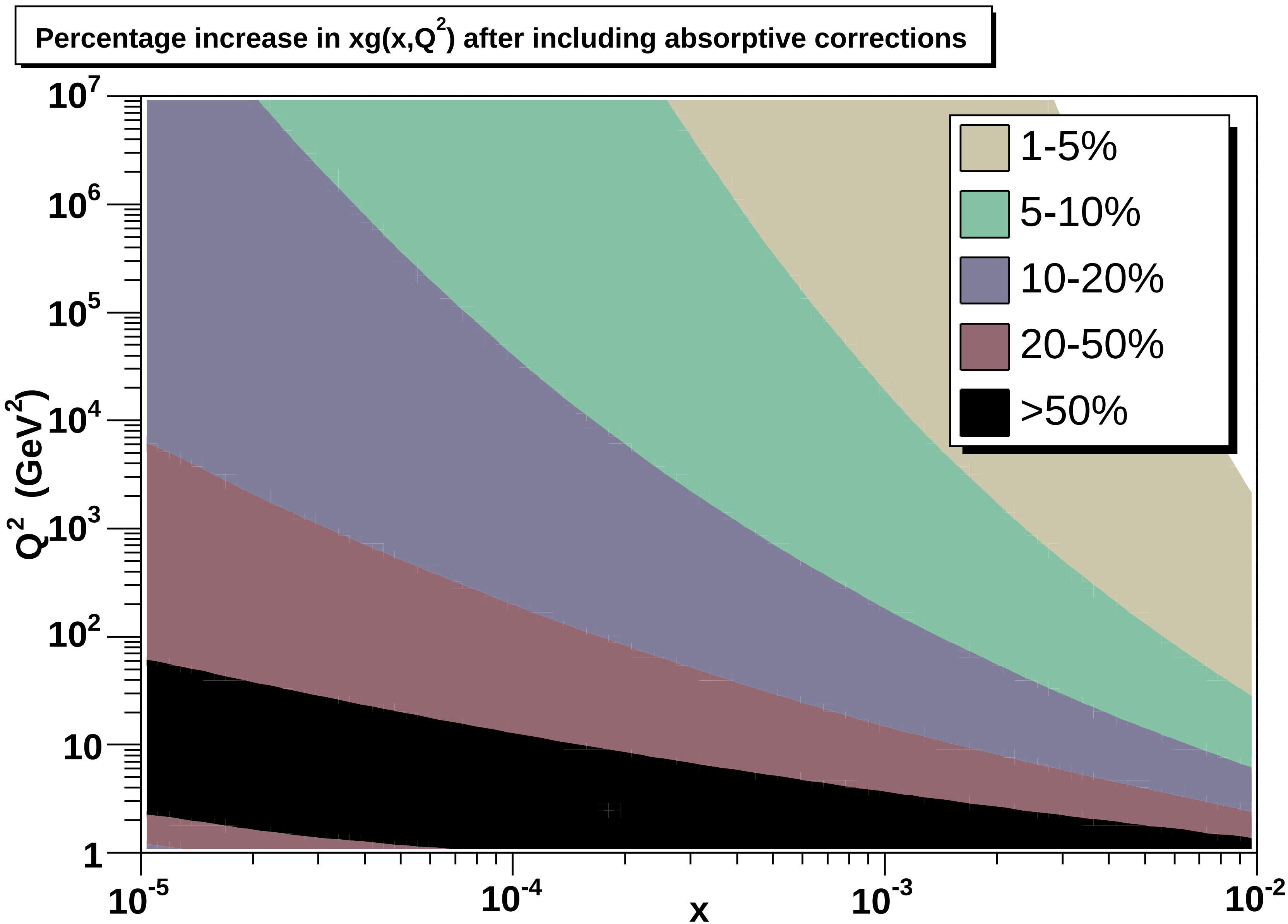
$$xS(x,Q^2=1\text{ GeV}^2) = A_S\, x^{-\lambda_S}\,(1-x)^{7.1}\,(1+\epsilon_S x^{0.5})$$



χ^2/d.o.f.	
F_2	$F_2^{D(3)}$
1.15	1.14
1.09	1.15

- Take +ve input gluon parameterisation ($A_- = 0$):
  - no absorptive corrections $\chi^2/\text{d.o.f.} = 1.57$ for F_2, 1.17 for $F_2^{D(3)}$
  - with absorptive corrections $\chi^2/\text{d.o.f.} = 1.11$ for F_2, 1.14 for $F_2^{D(3)}$

Percentage increase in gluon distribution



‘Pomeron-like’ xS but ‘valence-like’ xg ?

- Good news: Absorptive corrections remove the need for a negative input gluon distribution when fitting inclusive F_2 data
- Bad news: Still have ‘Pomeron-like’ sea quarks but ‘valence-like’ gluons at small x and low Q^2:

$$xg \sim x^{-\lambda_g}, xS \sim x^{-\lambda_S} \quad \text{with} \quad \lambda_g < 0 \text{ and } \lambda_S > 0$$

- Reminder:
  - Regge theory $\Longrightarrow \lambda_g = \lambda_S$
  - Resummed NLL BFKL $\Longrightarrow \lambda_g = \lambda_S \simeq 0.3$
  - Soft hadron data $\Longrightarrow \lambda \simeq 0.08$
- Must be some large non-perturbative effect causing the observed behaviour. One possibility: mimic unknown power corrections by shifting scale in F_2 and $F_2^{D(3)}$ fits by ≈ 1 GeV^2. Fix $\lambda_g = \lambda_S = 0$

Multi-$I\!P$ exchange (approximately)

- s-channel unitarity relation in impact parameter ($\boldsymbol{b_t}$) basis:

$$2\,\mathrm{Im}\,T_{\mathrm{el}}(s,\boldsymbol{b_t}) = |T_{\mathrm{el}}(s,\boldsymbol{b_t})|^2 + G_{\mathrm{inel}}(s,\boldsymbol{b_t})$$

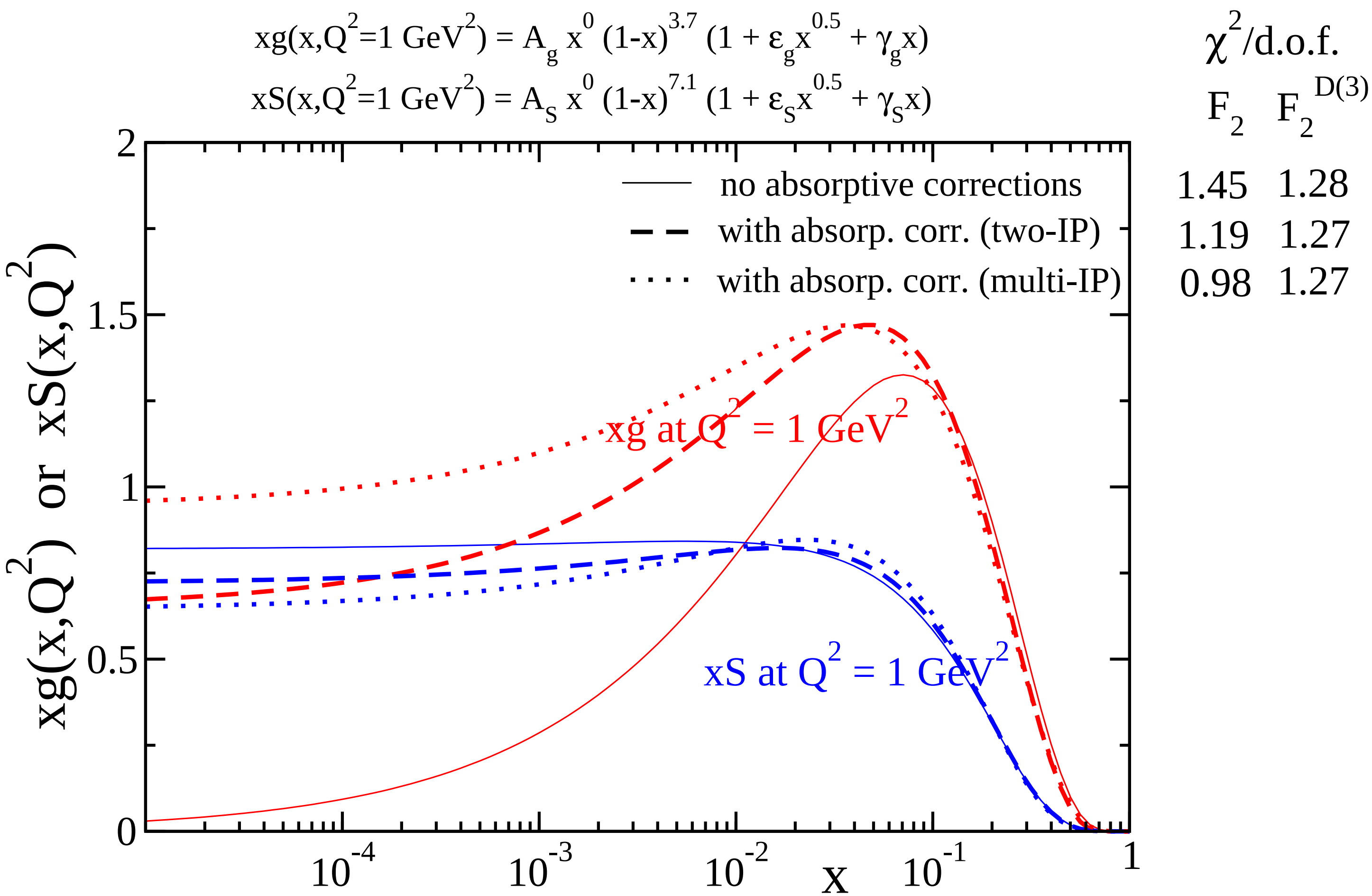
- Assume $\mathrm{Re}\,T_{\mathrm{el}} \ll \mathrm{Im}\,T_{\mathrm{el}}$, then $T_{\mathrm{el}} = \mathrm{i}[1-\exp(-\Omega/2)]$ where $\Omega(s,\boldsymbol{b_t})$ is the opacity (optical density) or eikonal
- Let $F_2^D \equiv \left|\Delta F_2^{\mathrm{abs}}\right|$ ($\mu > Q_0$, two-$I\!P$ exch.), then, for some $\langle \boldsymbol{b_t}\rangle$:

$$\boxed{\frac{F_2^D}{F_2^{\mathrm{data}}} = \frac{|T_{\mathrm{el}}(s,\langle\boldsymbol{b_t}\rangle)|^2}{2\mathrm{Im}\,T_{\mathrm{el}}(s,\langle\boldsymbol{b_t}\rangle)} = \frac{1}{2}(1-\exp(-\Omega/2))} \quad \Rightarrow \text{Solve for } \Omega/2$$

- To fit F_2 with DGLAP equation, need one-$I\!P$ exchange:

$$\boxed{F_2^{\mathrm{DGLAP}} = F_2^{\mathrm{data}}\,\frac{\Omega/2}{1-\exp(-\Omega/2)}}$$

Gluon and sea quark PDFs

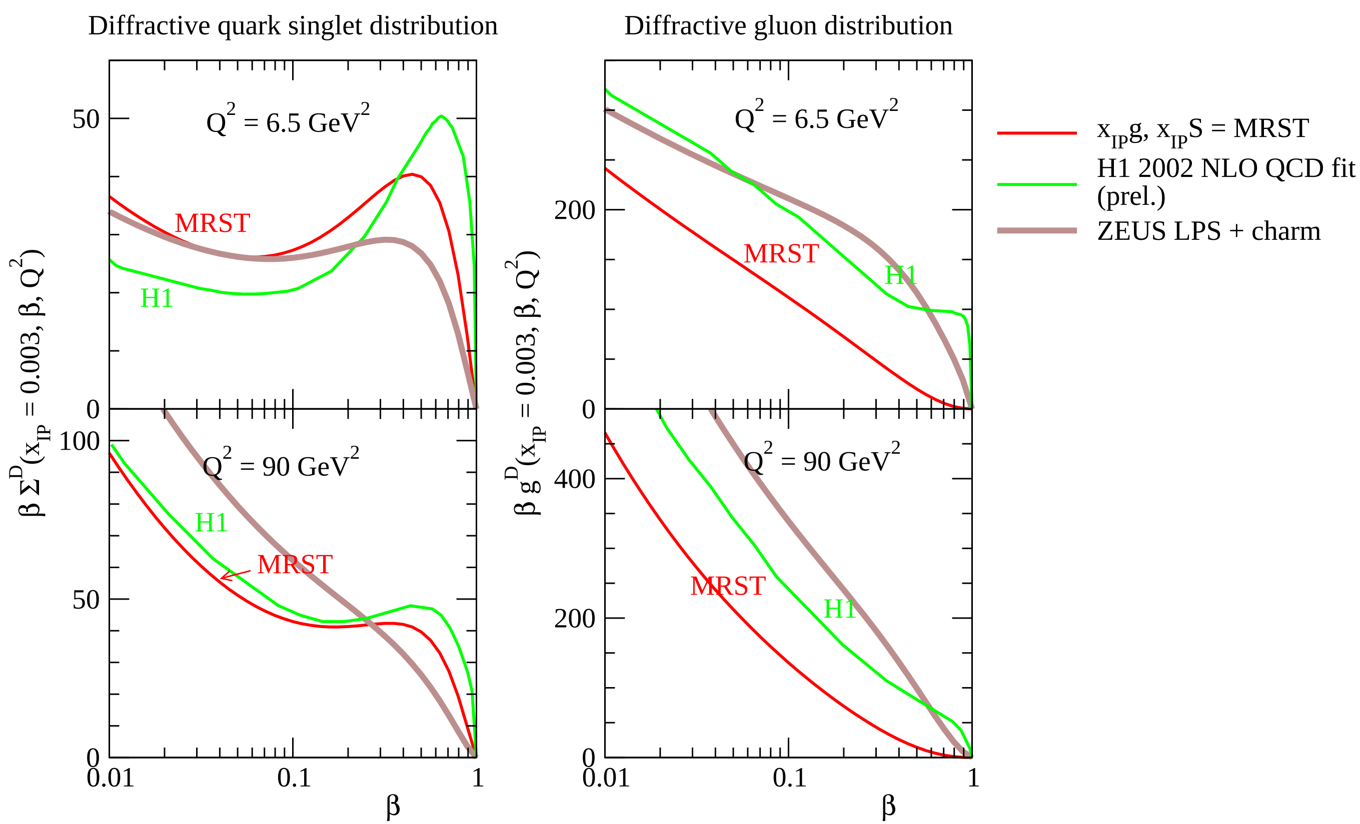


- Good description of F_2 and $F_2^{D(3)}$ data with 'flat' asymptotic behaviour ($x \to 0$) of input xg, xS

Modifications to original MRW analysis

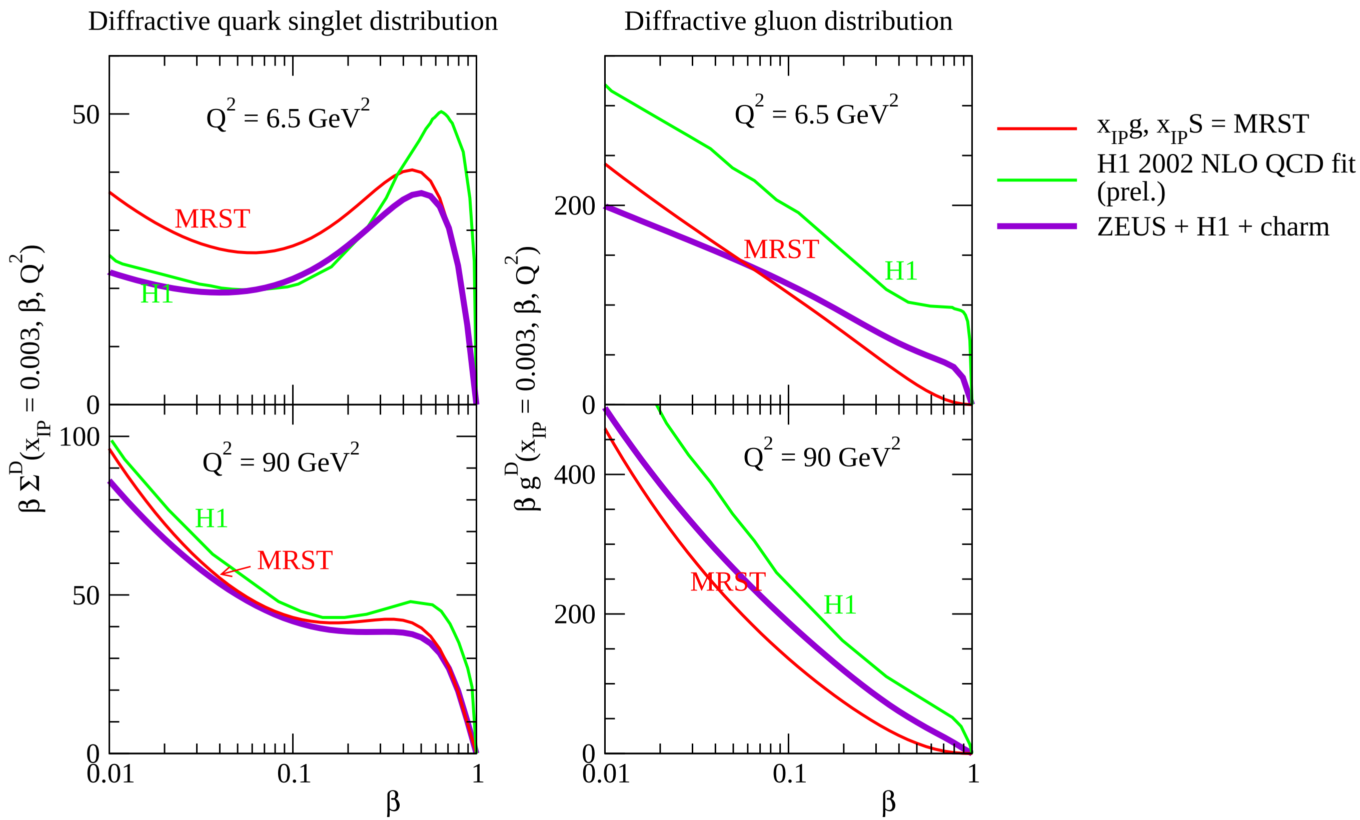
- Shift scale in F_2 and $F_2^{D(3)}$ fits: $Q^2 \to Q^2 + 1$ GeV^2 and $\mu^2 \to \mu^2 + 1$ GeV^2. Fix $\lambda_g = \lambda_S = 0$ in F_2 fit
- Use eikonal formula to approximately include absorptive corrections from multi-Pomeron exchange in F_2 fit
- Take $\beta' g^{I\!P=\mathrm{NP}}(\beta', Q_0^2; Q_0^2) = c_{g/\mathrm{NP}}\, \beta'$ (previously zero)
- Parameterise input $g^{I\!P}$ in DIS scheme, then transform to $\overline{MS}$ scheme (cf. MRST2004 PDFs)
- Include ZEUS diffractive open charm data, $F_2^{D(3),c\bar{c}}$, at $x_{I\!P} = 0.004$. In addition to $\gamma^* g^{I\!P} \to c\bar{c}$, include diagrams where the two gluons comprising the Pomeron couple directly to the two charm quarks [Levin-Martin-Ryskin-Teubner,1997]

Fit ZEUS LPS + charm DDIS data



- Very good fit to DDIS data ($x_{IP} < 0.01$, $c_{IR} = 0$, stat. errors only):
  $\chi^2 = 19$ for 37 $F_2^{D(3)}$ points, $\chi^2 = 4$ for 5 $F_2^{D(3),c\bar{c}}$ points
- ...but large $\left|\Delta F_2^{\rm abs}\right| / F_2^{\rm data} > 0.5 \Rightarrow$ violates unitarity
  (very poor $\chi^2/{\rm d.o.f.} = 2.00$ for F_2 fit)

Fit ZEUS + H1 + charm DDIS data

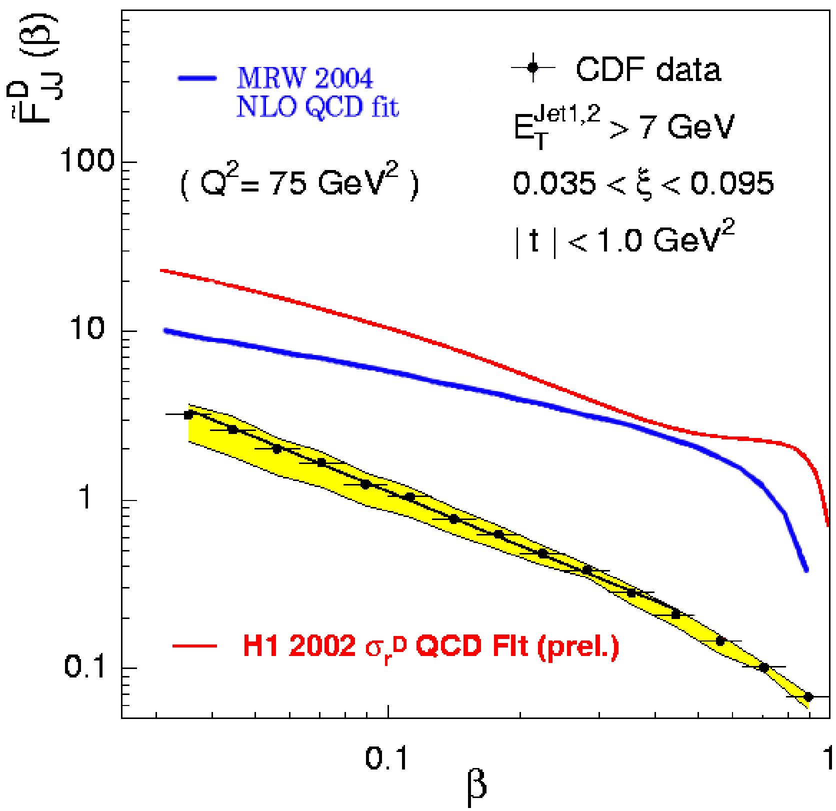


- Good fit to ZEUS + H1 DDIS data ($\chi^2 = 484$ for 408 $F_2^{D(3)}$ points), reasonable fit to ZEUS charm data ($\chi^2 = 19$ for 4 $F_2^{D(3),c\bar{c}}$ points)
- Very good fit to F_2 ($\chi^2/\mathrm{d.o.f.} = 0.98$, unitarity not violated)
- Currently, this is our 'best' fit

CDF diffractive dijets

- Diffractive structure function of the antiproton:

$$\tilde{F}^D_{JJ}(\beta) = \frac{1}{\xi_{\max} - \xi_{\min}} \int_{\xi_{\min}}^{\xi_{\max}} \mathrm{d}\xi \left[\beta g^D(\xi, \beta, Q^2) + \frac{4}{9} \beta \Sigma^D(\xi, \beta, Q^2) \right]$$



- Fairly close to result presented by M. Arneodo (October meeting)
- Results for 'survival probability' of the rapidity gap do not contradict calculation by Kaidalov-Khoze-Martin-Ryskin, 2000/1: $S^2 \simeq 0.12\text{–}0.28$

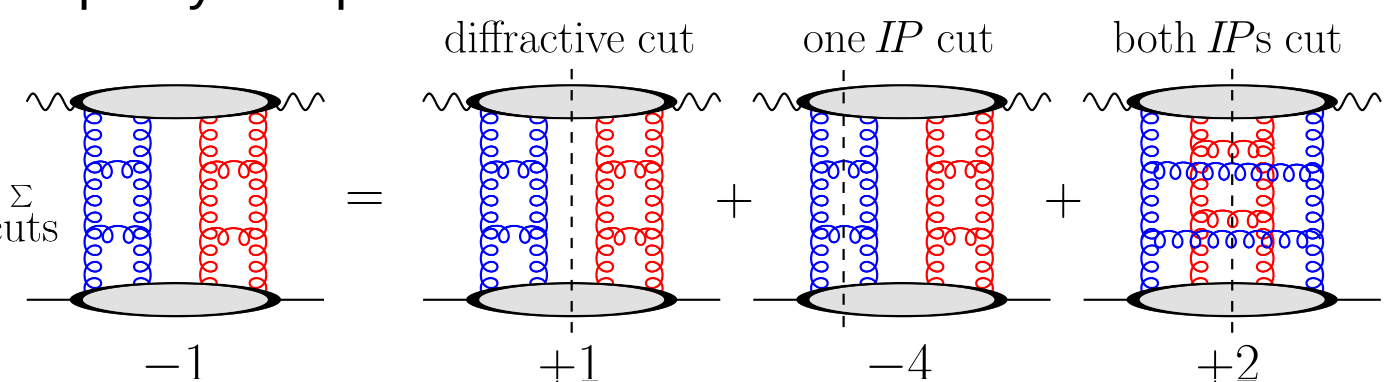
Future work: Diffractive PDFs

- After ZEUS + H1 DDIS data finally published, expect public release of MRW DPDFs
- Test by calculating final state observables in DDIS, e.g. dijet and D^* meson production cross sections (as already done by H1)
- DPDFs needed for calculating background to exclusive diffractive Higgs production at LHC. Test formalism using exclusive dijet production in double Pomeron exchange measured by CDF at Tevatron

Future work: Absorptive corrections

- Absorptive corrections are significant and should be incorporated into global parton analyses (MRST, CTEQ, ...)
- Test corrected PDFs using observables sensitive to small-x, e.g. production of forward Drell-Yan pairs
- Size of colour octet exchange contribution?
- Exclusive observables? Want Monte Carlo program with two parton chains compatible with AGK cutting rules (see talk by J. Bartels, October meeting), e.g. if both ladders cut, naïvely expect double the particle multiplicity compared to one cut ladder:

$\Delta F_2^{\rm abs} = \sum_{\rm cuts}$



Important for understanding multiple interactions at the LHC

Conclusions

- **New perturbative QCD description of $F_2^{D(3)}$**
  - Pomeron singularity not a *pole* but a *cut*
    $\Rightarrow$ Integral over Pomeron scale μ
  - Input Pomeron PDFs from lowest-order QCD diagrams
  - Two-quark Pomeron in addition to two-gluon Pomeron
- **Absorptive corrections to F_2 from AGK cutting rules**
  - Good news: remove need for negative gluon input
  - Dilemma: still have 'Pomeron-like' sea quarks but 'valence-like' gluons at small x and low Q^2
    1. Non-perturbative Pomeron doesn't couple to gluons, secondary Reggeon couples more to gluons than sea quarks ?
    2. Unknown non-perturbative power corrections slow down DGLAP evolution at low Q^2 ?