Diffractive Processes at HERA

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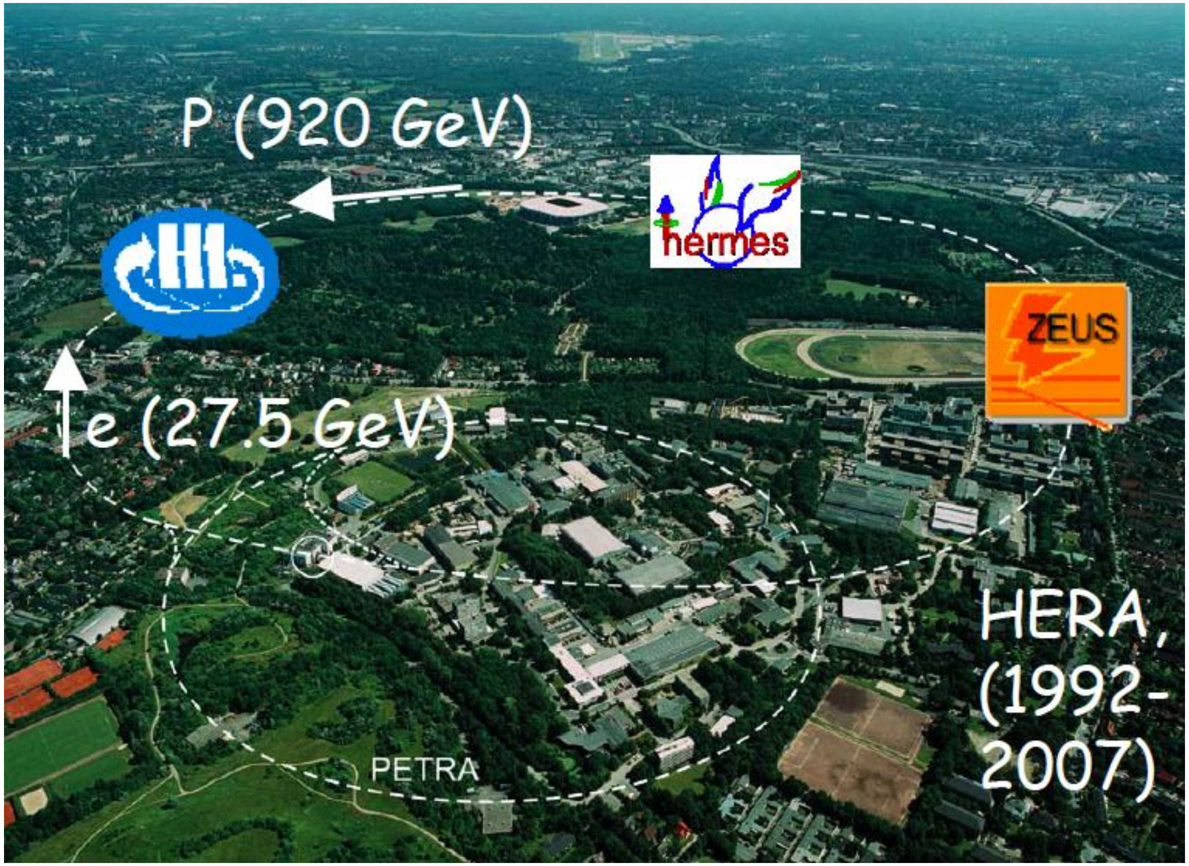
Outline:

- Diffraction in ep scattering
- Latest results on inclusive diffraction
- QCD fits and diffractive PDFs extraction
- Latest results on exclusive vector meson production

HERA experiments



HERA-I : 1992-2000

p : 820 GeV

920 GeV

HERA-II : 2001-2007

p : 920 GeV

575 GeV

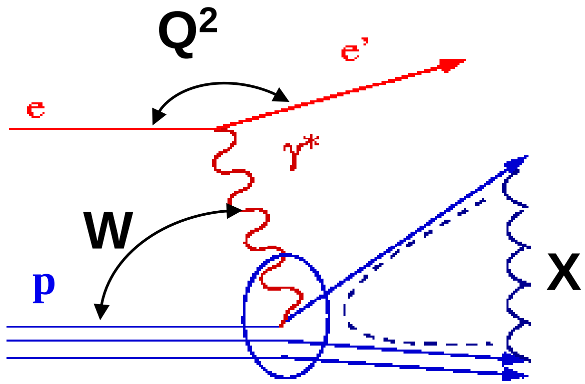
460 GeV

0.5 fb^{-1} collected by H1 and ZEUS experiments

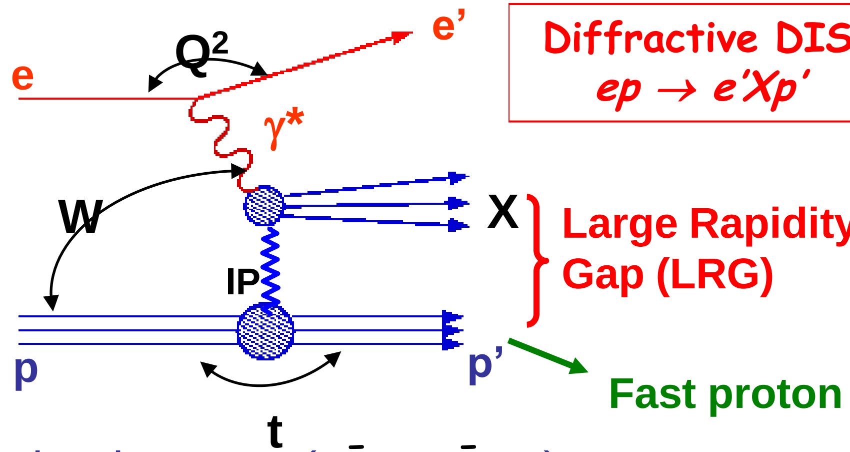
Final analyses of HERA data are underway

Diffraction at HERA

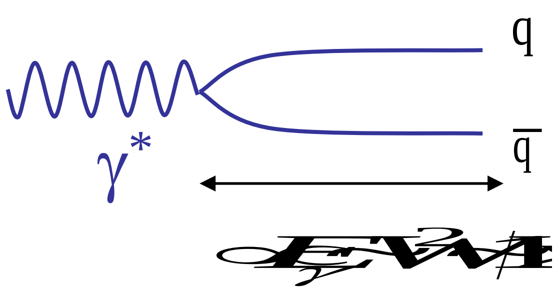
Standard DIS
ep → e'X



Diffractive DIS
ep → e'Xp'



Real and virtual photons can fluctuate in hadronic states ($q\bar{q}$, $qq\bar{g}$, ...)



$$\propto \frac{1}{\sqrt{Q^2 + M^2_{q\bar{q}}}}$$

(as seen in the proton rest-frame)

Q^2 = photon virtuality
x = Bjorken scaling variable

✓ Lifetime of $q\bar{q}$ dipole (hadron!) long because of large Lorentz boost (E_γ ~ 50 TeV at HERA)
→ Dipole interacts hadronically with the proton

✓ Transverse size proportional to $1/\sqrt{(Q^2+M_{qq}^2)}$
→ If dipole size is small, its interaction with the proton can be treated perturbatively

Diffractive events contribute up to 15% of the inclusive DIS cross section

Kinematics and cross sections

Q^2 = virtuality of exchanged photon

x = Bjorken scaling variable

y = inelasticity of virtual photon

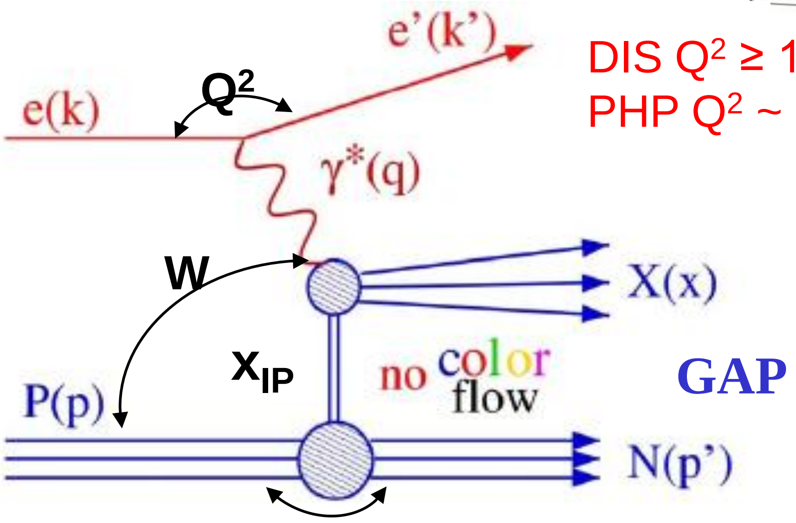
W = invariant mass of γ^*-p system

M_X = invariant mass of γ^*-IP system

x_{IP} = fraction of proton momentum carried by IP

$\beta = x/x_{IP}$ = fraction of IP momentum carried by struck parton

t = (4-momentum exchanged at p vertex)^2
typically: $|t| < 1$ GeV^2



DIS $Q^2 \geq 1$ GeV^2
PHP $Q^2 \sim 0$

- N = proton → Single Diffractive (SD) events
- N = proton dissociative system → Double Diffractive (DD) events

$$\frac{d^4\sigma^{ep\to e'Xp'}}{d\beta dQ^2 dx_{IP} dt} = \frac{2\pi\alpha^2}{\beta Q^4} Y_+ \underbrace{\left[F_2^{D(4)}(\beta,Q^2,x_{IP},t) - \frac{y^2}{Y_+} F_L^{D(4)}(\beta,Q^2,x_{IP},t)\right]}_{=\sigma_r^{D(4)}(\beta,Q^2,x_{IP},t)}$$

where $Y_+ = 1 + (1-y)^2$

$= \sigma_r^{D(4)}(\beta,Q^2,x_{IP},t)$ → Reduced cross section

When t is not measured $\sigma_r^{D(3)}(\beta, Q^2, x_{IP}) = \int \sigma_r^{D(4)}(\beta, Q^2, x_{IP}, t)\,dt$

Theoretical framework

pQCD framework as long as a hard scale is present :

QCD factorisation theorem, proven for DDIS by **J.Collins [PR D57 (1998) 3051]**

$$\sigma^D(\gamma^* p \to Xp) = \sum_i \hat{\sigma} \otimes f_i^D(x_{IP}, t, z, Q^2)$$

Hard subprocess ME

pQCD calculable

DPDFs = proton PDFs when a fast proton is in the final state, universal for diffractive DIS processes

Proton-vertex factorisation assumption, supported by H1 and ZEUS data

$$f_i^D(x_{IP}, t, z, Q^2) = f_{IP}(x_{IP}, t) f_i^{IP}(z, Q^2) + f_{IR}(x_{IP}, t) f_i^{IR}(z, Q^2)$$

Flux parametrisation

$$f(x_{IP}, t) = \frac{Ae^{Bt}}{x_{IP}^{2\alpha(t)-1}}$$

with $\alpha(t) = \alpha(0) + \alpha' t$

Pomeron PDFs

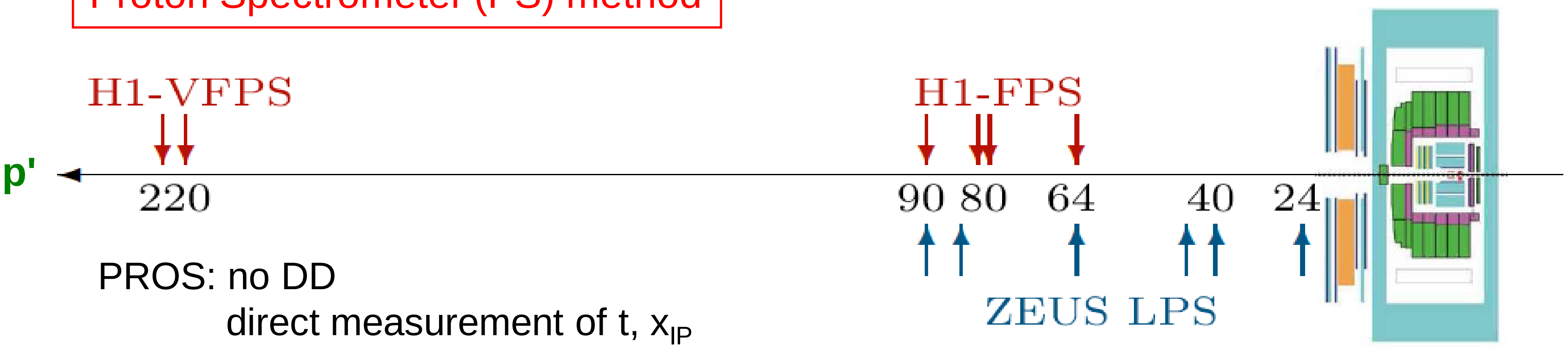
Reggeon PDFs taken from pion (GRV)

→ Use inclusive diffractive data to extract DPDFs via NLO QCD fits, fitting z and Q^2 dependence at fixed x_{IP} and t

(z = momentum fraction of the diffr exchange entering the hard scattering)

Signatures and selection methods

Proton Spectrometer (PS) method



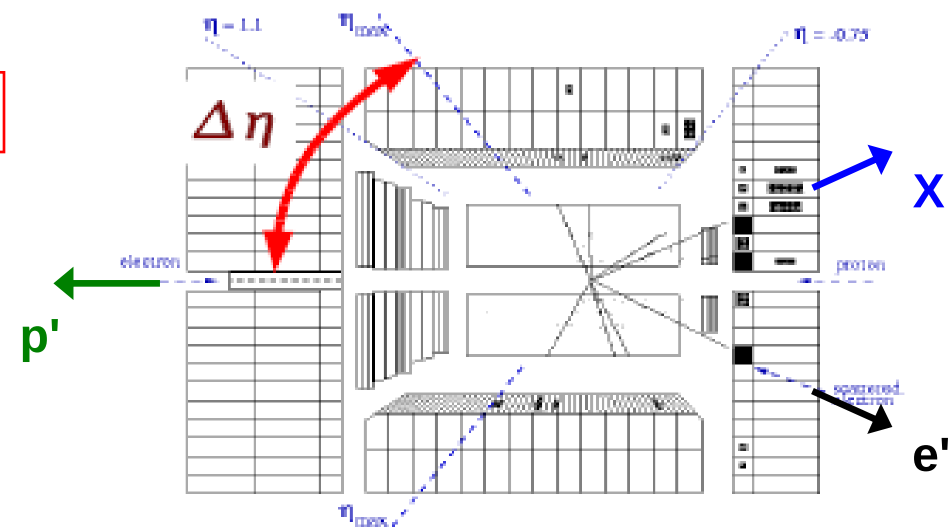
PROS: no DD
direct measurement of t, x_{IP}
high x_{IP} accessible

CONS: low statistics

Large Rapidity Gap (LRG) method

PROS: near perfect acceptance
at low x_{IP}

CONS: DD included

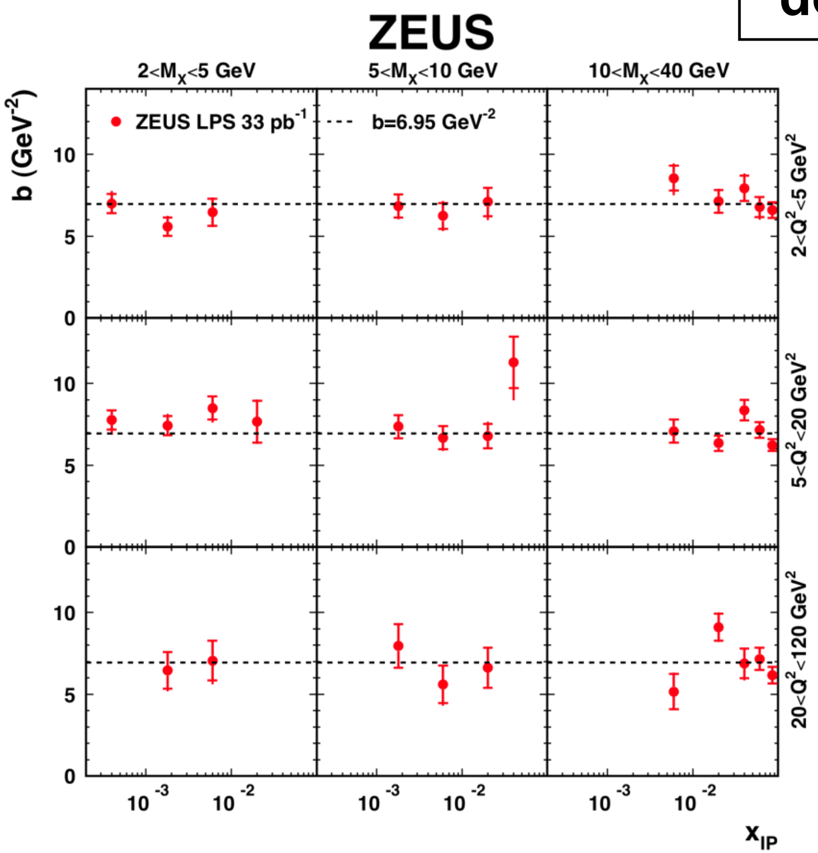


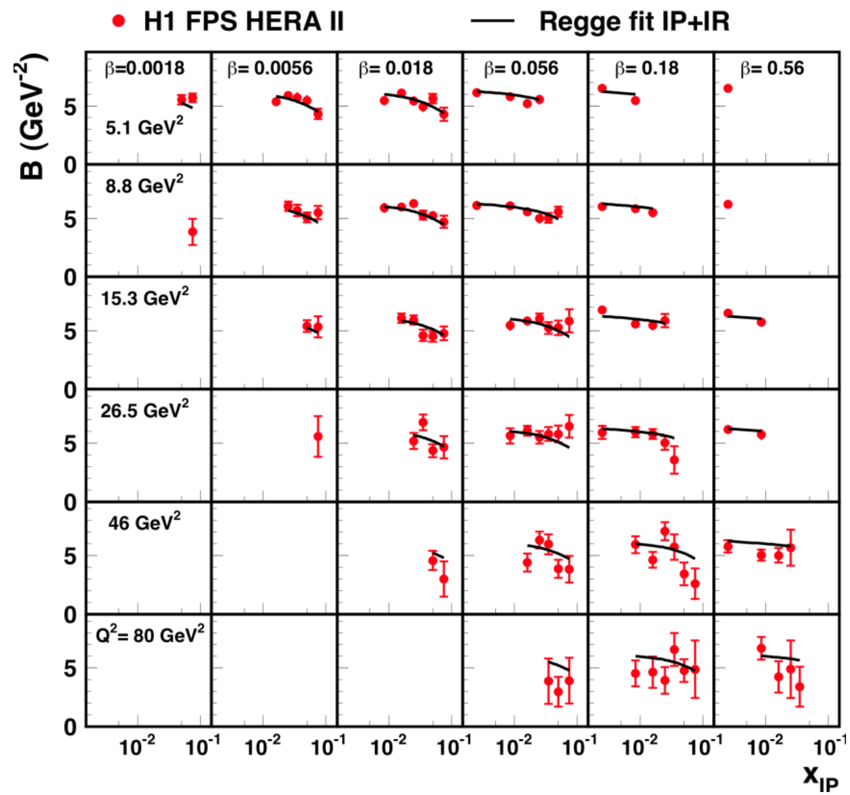
t dependence

ZEUS, NP B816 (2009) 1

$d\sigma/dt \sim e^{bt}$

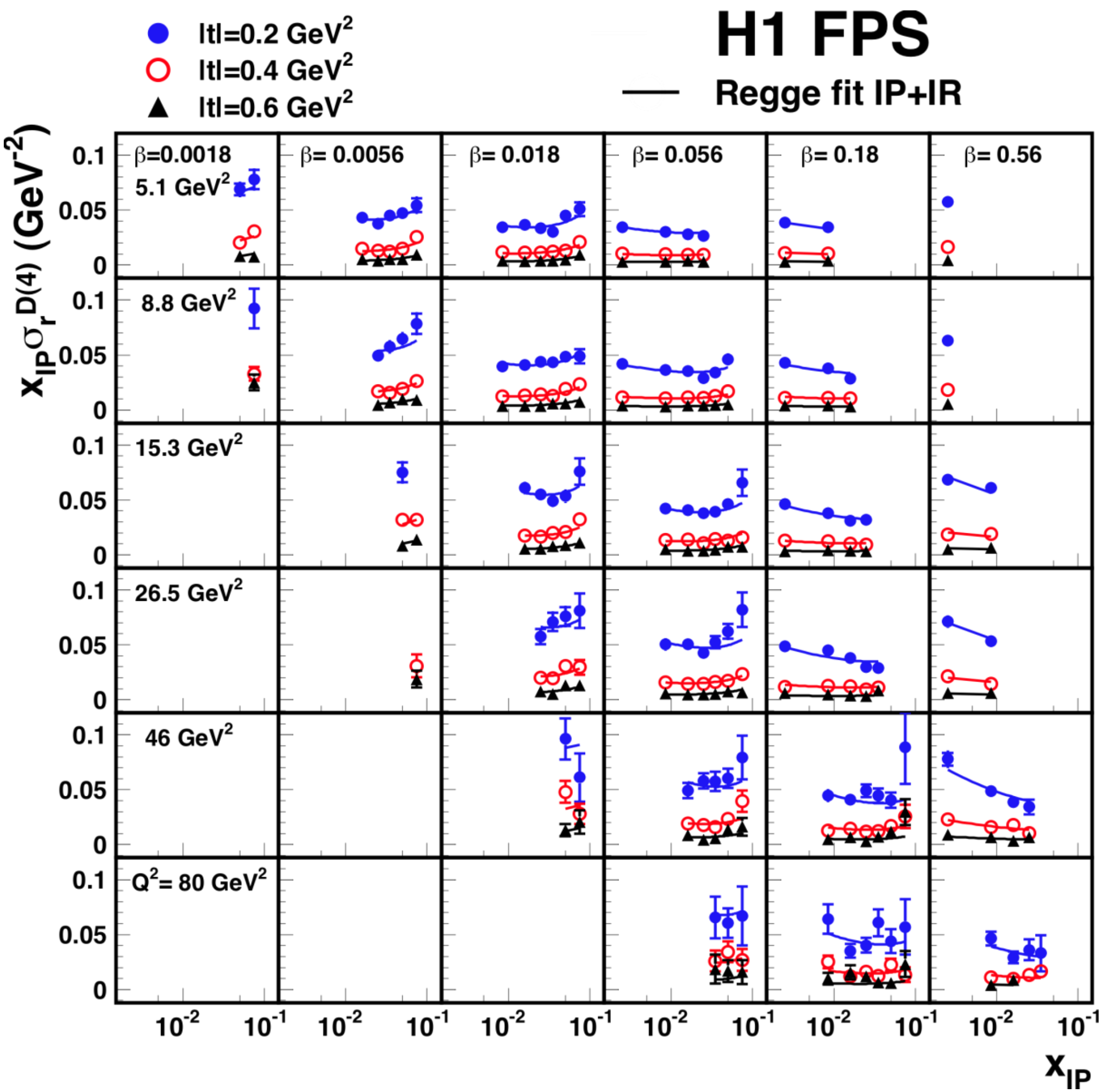
H1, EPJ C71 (2011) 1578





- t-slope does not change with Q^2 or M_X/β at fixed x_{IP}
  → data consistent with **proton-vertex factorization**
- H1 results exibit an x_{IP} dependence of the t-slope in (Q^2,β) bins
  → **IR contribution at high x_{IP}**

x_{IP} dependence of $\sigma_r^{D(4)}$

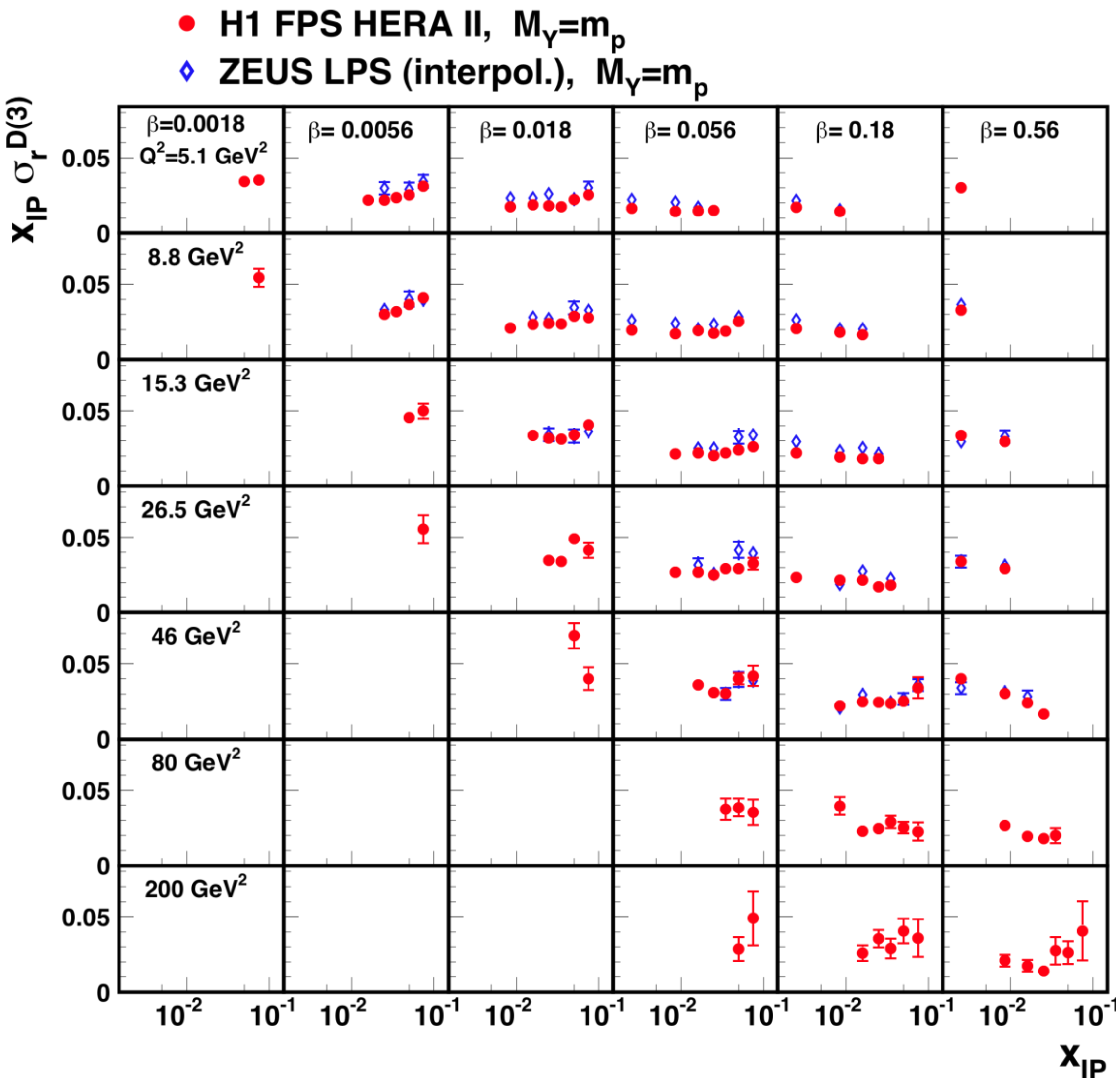


H1 HERA-II PS data
(156 pb^{-1}) improve stats by a factor of 20, allowing to :

→ measure three t bins
→ reach higher Q^2

syst uncertainty ~ 8%
norm uncertainty ~ 4.3%

x_{IP} dependence of $\sigma_r^{D(3)}$



All available **PS data** by both Collaborations (integrated over t)

Fair agreement in normalization between H1 and ZEUS

H1/ZEUS = 0.85 ± 0.01 (stat) ± 0.03(syst) + 0.09 – 0.12 (norm)

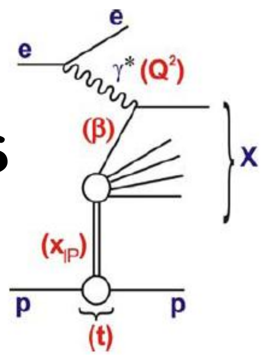
H1 FPS norm unc ~ ± 6%

ZEUS LPS norm unc ~ + 11% - 7%

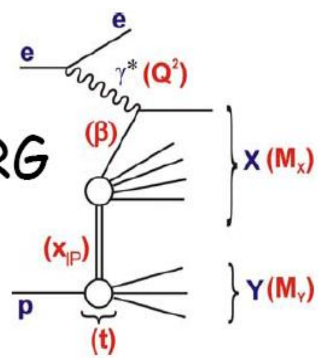
Reasonable agreement in shape between H1 and ZEUS

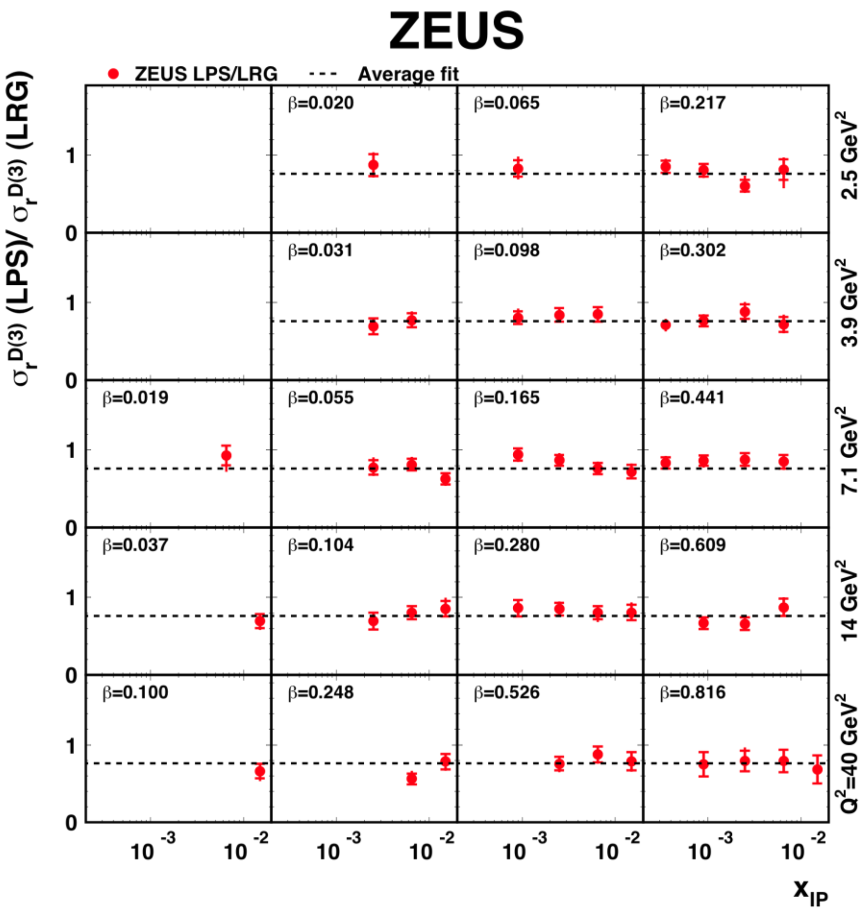
LRG vs PS

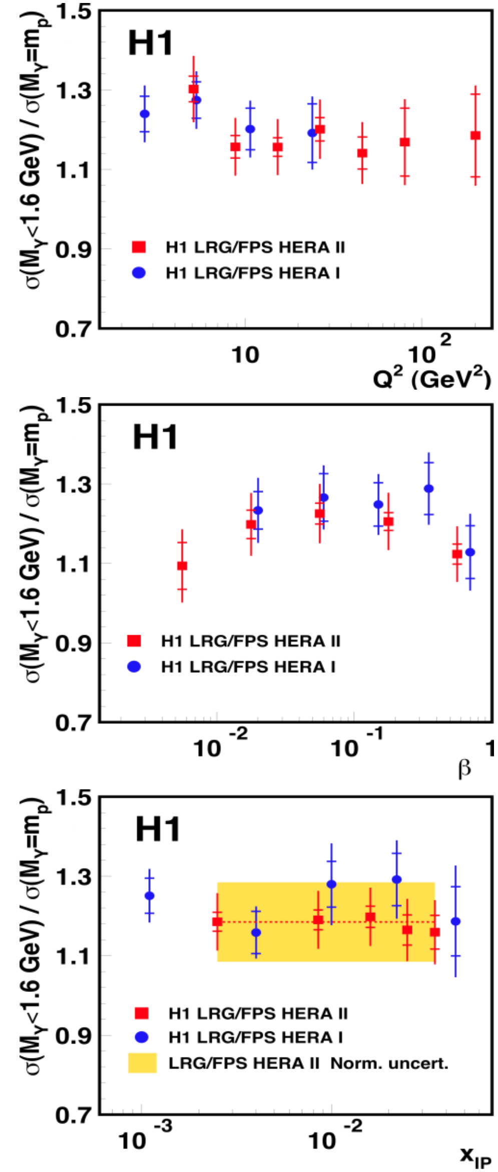
PS



LRG







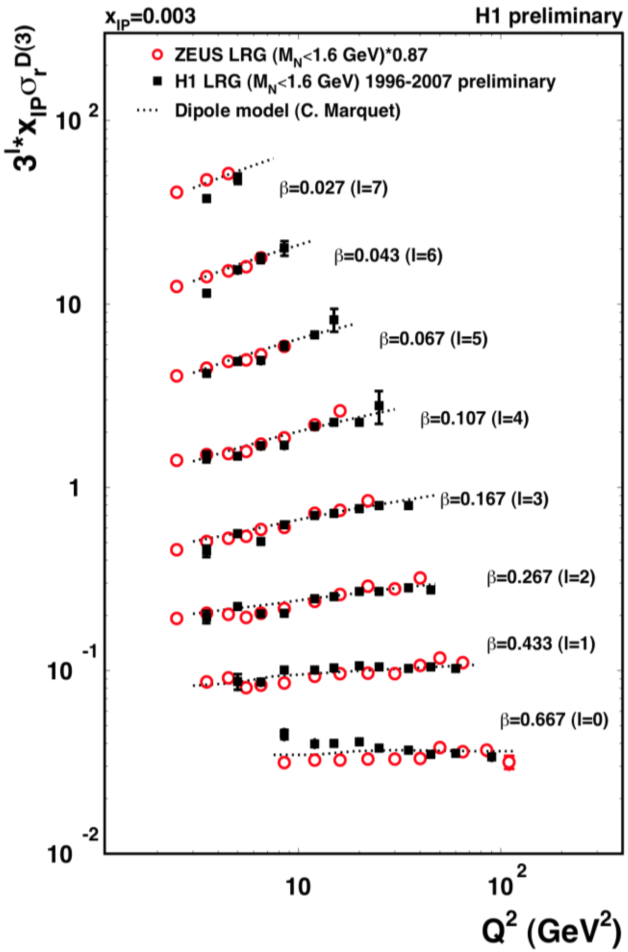
Estimation of **DD contribution** in LRG method

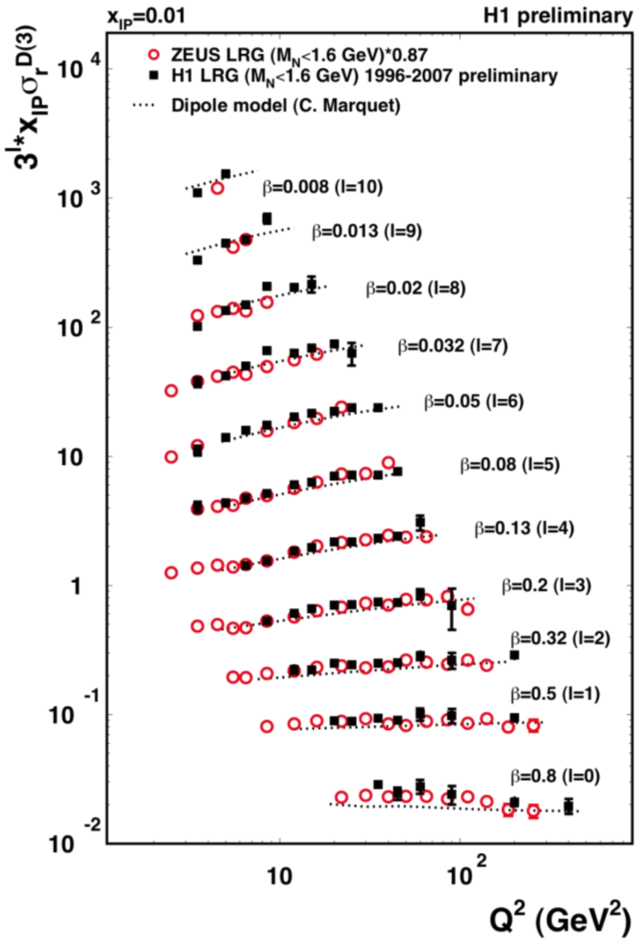
→ ratio flat both in ZEUS and H1

→ fraction of DD ~ 20%

Q^2 dependence of $\sigma_r^{D(3)}$

H1prelim 10-011 **ZEUS, NP B816 (2009) 1**





All available **LRG data** by both Collaborations

Very precise measurements of the **scaling violation** in diffractive DIS

Reduced cross sections constrain **quark densities**

ln Q^2 dependence constrains **gluon density**

⇨ QCD fits to data provide sets of diffractive PDFs

ZEUS corrected to M_N < 1.6 GeV with PYTHIA MC

Diffractive PDFs from NLO fits

Inclusive data : LRG + LPS

ZEUS, NP B831 (2010) 1

NLO QCD fits:

- assume proton-vertex factorization, fit z and Q^2 dependence at fixed x_{IP} and t
- parametrize IP PDFs at $Q^2_0 = 1.8\ GeV^2$

$$z\, f^{IP}_{u,d,s}(z,Q^2_0) = A_q\, z^{Bq}\, (1-z)^{Cq}$$
$$z\, f^{IP}_{g}(z,Q_0^2) = A_g\, z^{Bg}\, (1-z)^{Cg}$$

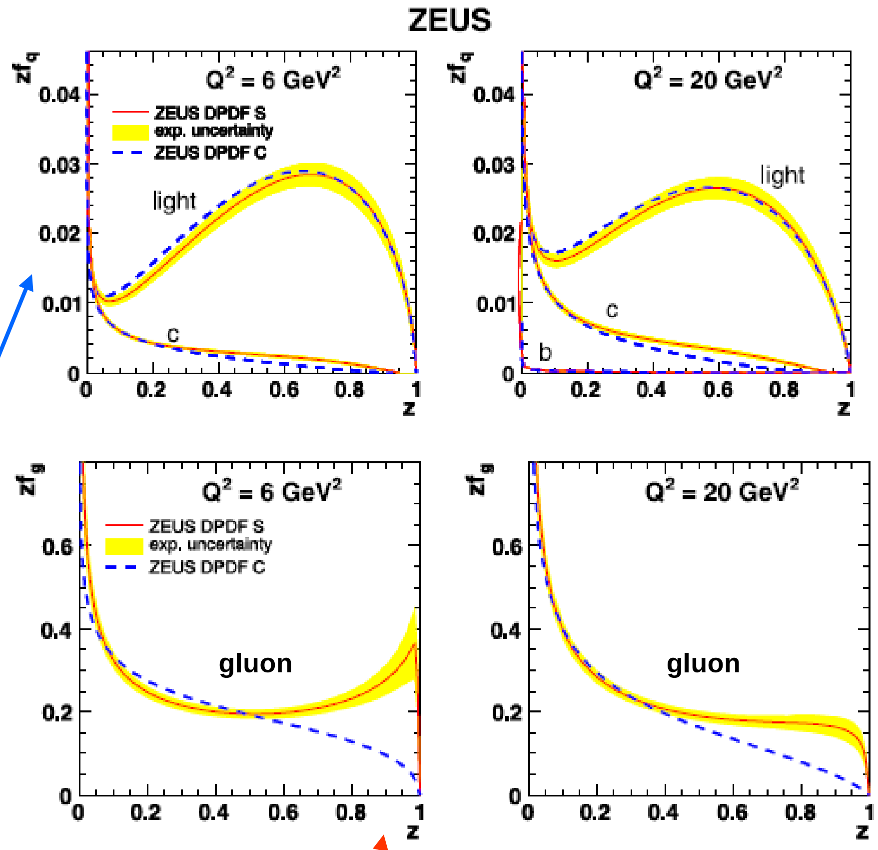
- evolve with NLO DGLAP

Different parametrizations:

- "Standard": **fit S** with B_g and C_g free
- "Constant": **fit C** with $B_g = C_g = 0$
  (as for **H1 2006 fit B** - **H1, EPJ C48 (2006) 715**)

Both fits give a comparably good description of inclusive data for $Q^2 > 5\ GeV^2$, but…

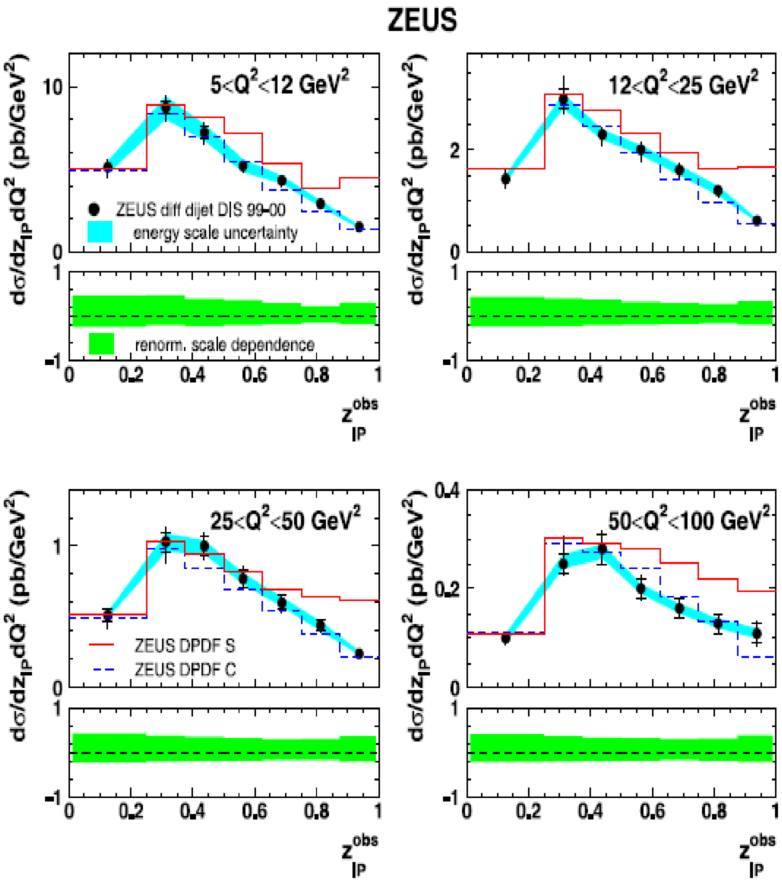
Quark densities well constrained by reduced cross sections



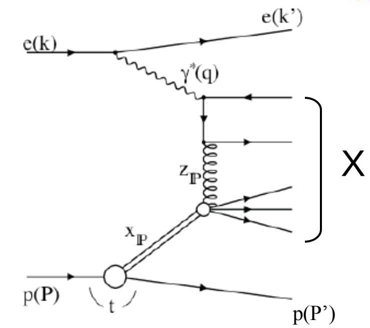
Gluon density weakly constrained in the high z_{IP} region (only indirectly by scaling violations)

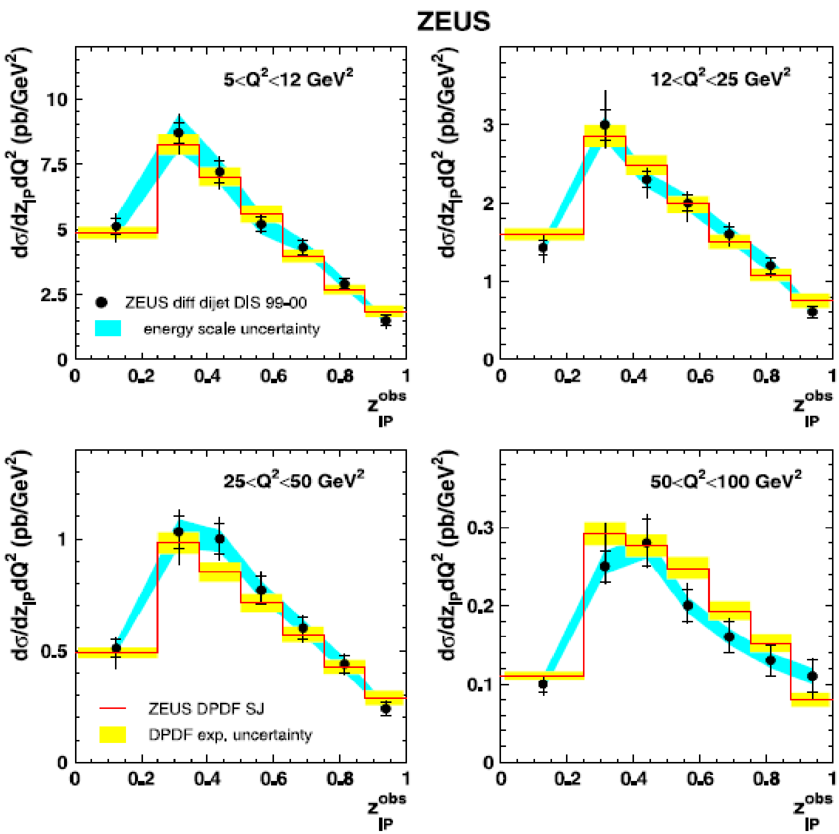
Comparison with DDIS dijet data

ZEUS, EPJ C52 (2007) 813



Use dijet data (photon-gluon fusion at LO) for a combined **fit S inclusive+dijets (SJ) :**

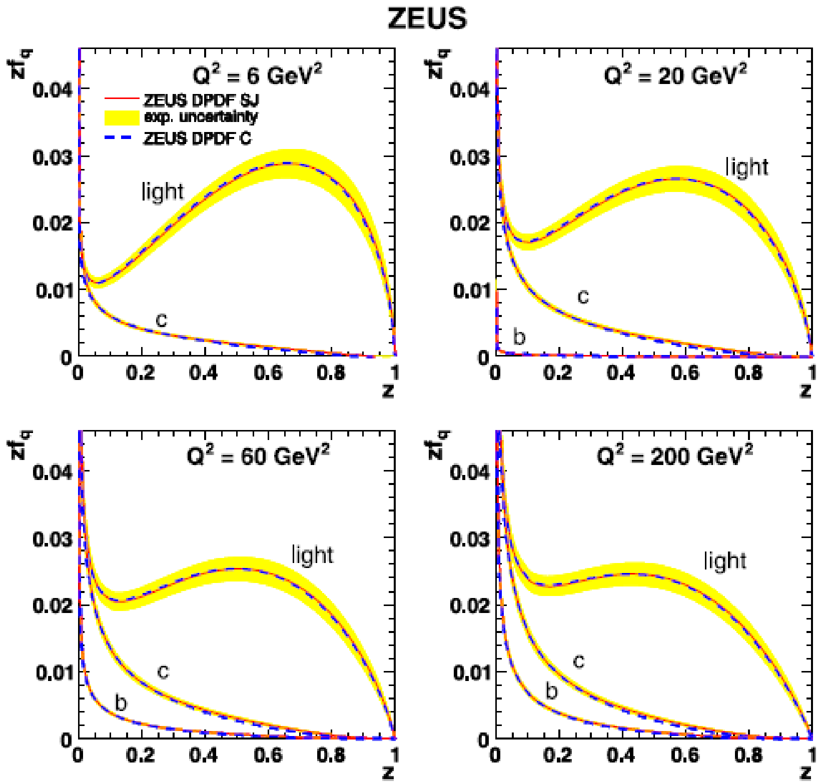


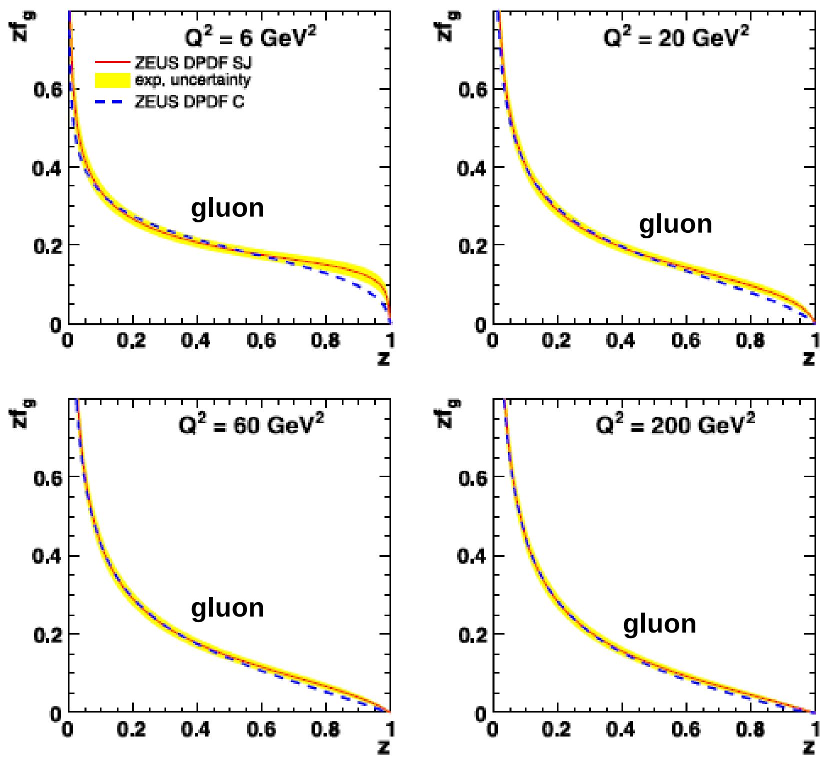


→ **QCD factorisation holds in DDIS!**

DPDFs from fit SJ

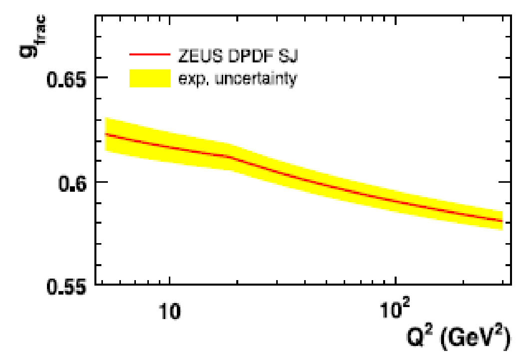
Inclusive + dijet data





Fit SJ and fit C give very similar results

Diffractive PDFs are **gluon dominated**: ~ 60%



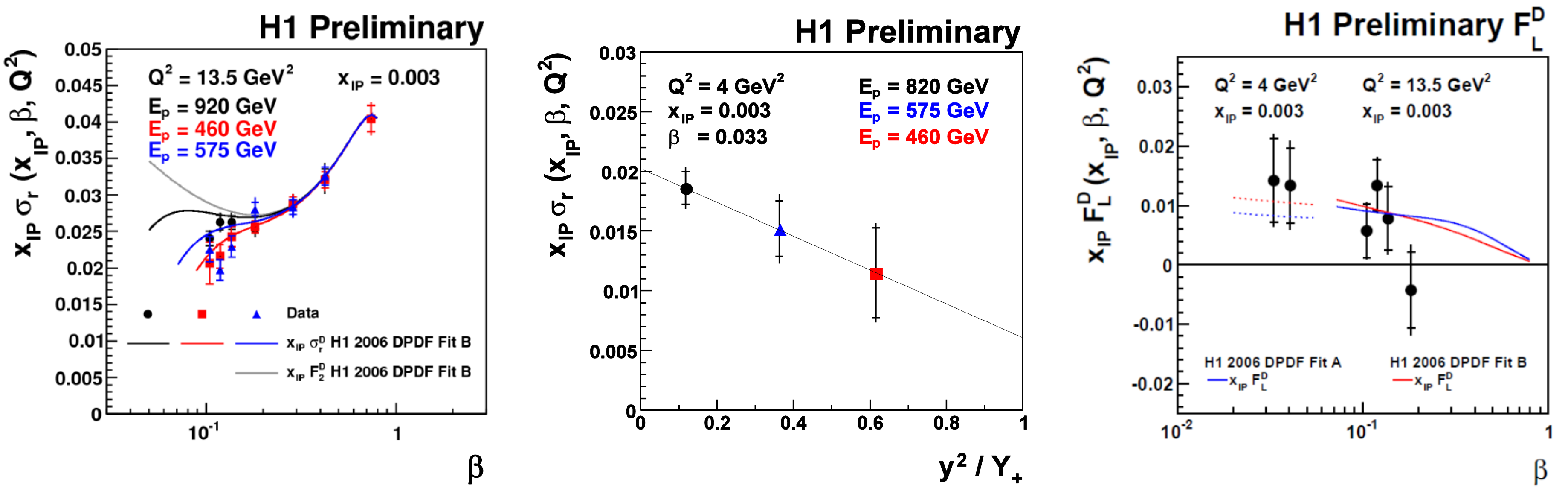
Direct measurement of F_L^D

H1prelim 09-011
H1prelim 10-017

$$\sigma_r^D = F_2^D - \frac{y^2}{Y_+} F_L^D \qquad F_L^D \sim \alpha_S \times g(x)$$

Challenging measurement, requires good understanding of the detector
Measurement is performed with data taken at **3 proton beam energies**:
920, 460 and 575 GeV

⇨ At fixed Q^2 and x_{IP}, high y corresponds to low β   ($Q^2 = sxy$, $x = \beta x_{IP}$)



→ **Data consistent with NLO predictions based on H1 2006 fit B**

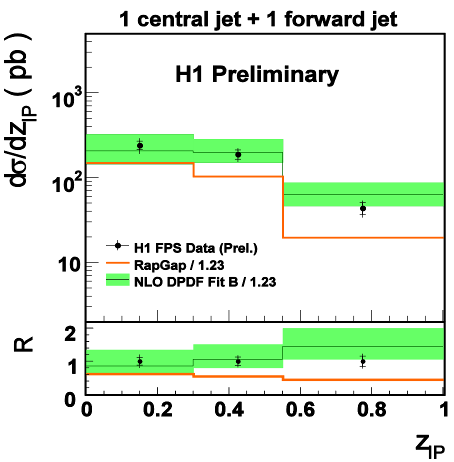
D* and dijets in diffractive DIS

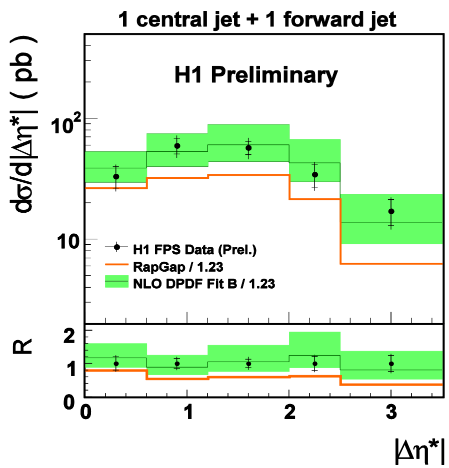
Open charm: **H1, EPJ C50 (2007) 1**
ZEUS, NP B672 (2003) 3

Dijets: **H1, JHEP 0710:042 (2007)**
ZEUS, EPJ C52 (2007) 813

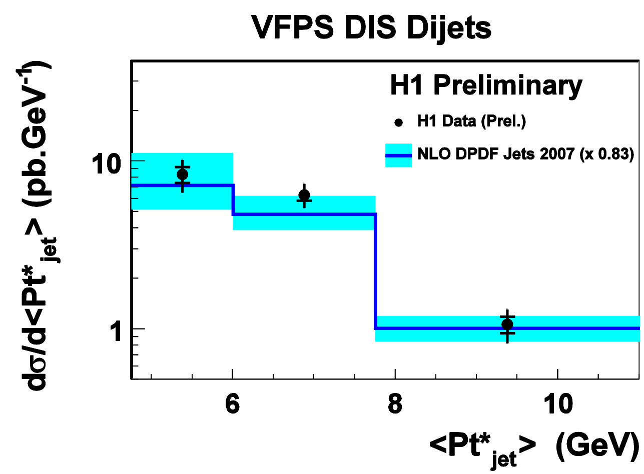
Universality of DPDFs has been successfully tested comparing with semi-inclusive final states like **open charm** and **dijets** in DIS where hard scales in the process ensure use of pQCD

DDIS dijets with a **tagged proton** in **FPS** - **H1prelim-10-013**



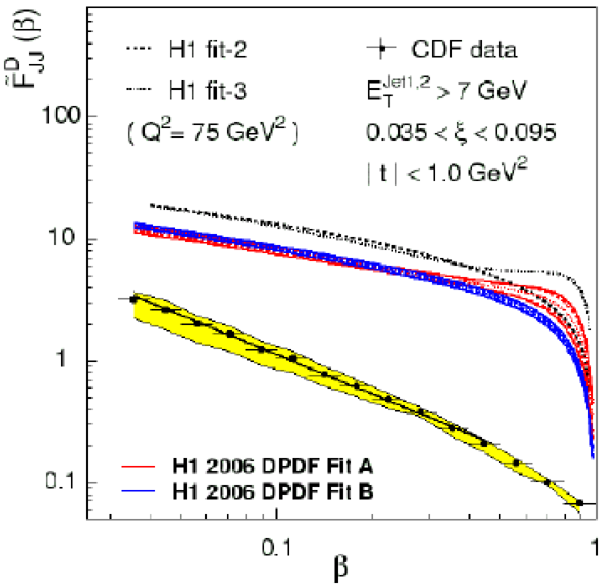


DDIS dijets with a **tagged proton** in **VFPS** - **H1prelim-10-013**



→ **NLO DGLAP with H1 DPDFs gives a good description of the data**

Factorization breaking at Tevatron and gap survival probability



CDF, PRL 84 (2000) 5043 + P.Newman/H1

Diffractive dijet measurement in ppbar by CDF

Comparison with NLO predictions with **HERA DPDFs as input**:

Significant **overestimation** (~ factor 10) of the data by NLO calculations and **different shape**

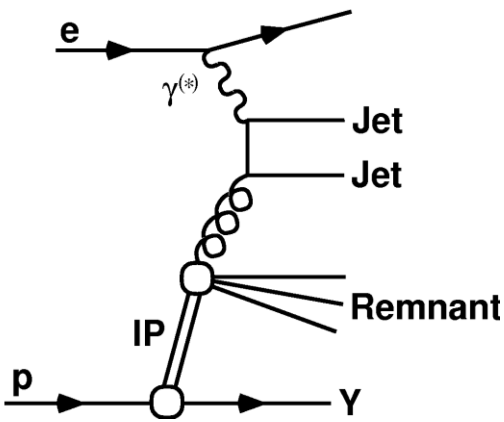
Factorisation not expected to hold for diffractive hadron-hadron collisions

- Violation of factorisation is understood in terms of (soft) rescattering between spectator partons, in initial and final states, suppressing the large rapidity gap: suppression ⟷ '**rapidity gap survival probability**'
- Models including rescattering corrections via multi-pomeron exchanges are able to describe the suppression observed [**KKMR, EPJ C21 (2001) 521**]
- **Of great interest for LHC!**

Hadron-hadron and photoproduction

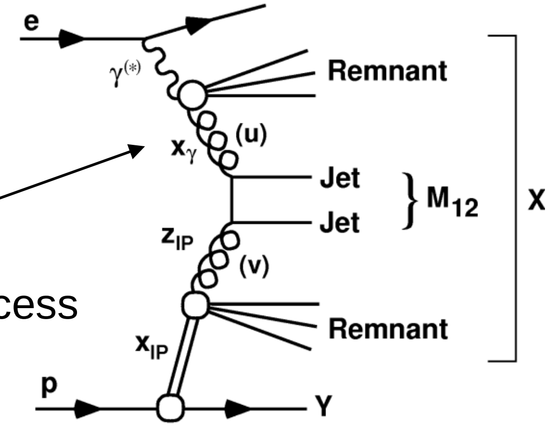
At HERA we have something similar to a hadron:
quasi-real photons ($Q^2 \sim 0$) can develop a **hadronic structure**

Direct photon ($x_\gamma \sim 1$) (at LO) **Resolved photon ($x_\gamma < 1$)**



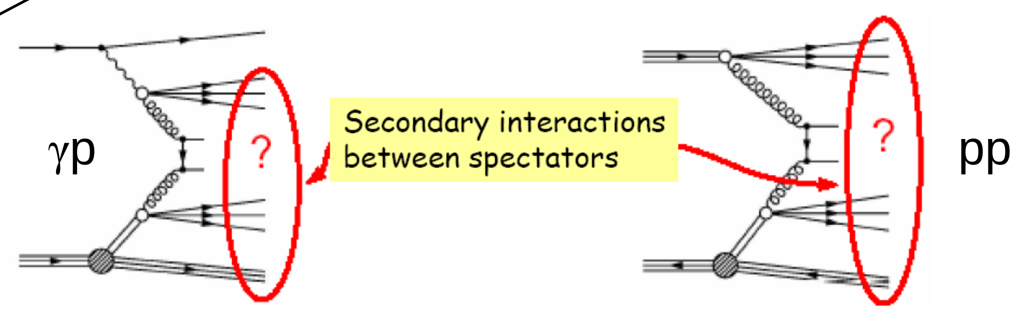
High E_T of the jets provides the hard scale

x_γ = fraction of photon's momentum in hard subprocess



QCD factorisation is expected to hold like in DIS

QCD factorisation is expected to break like in hadron-hadron:

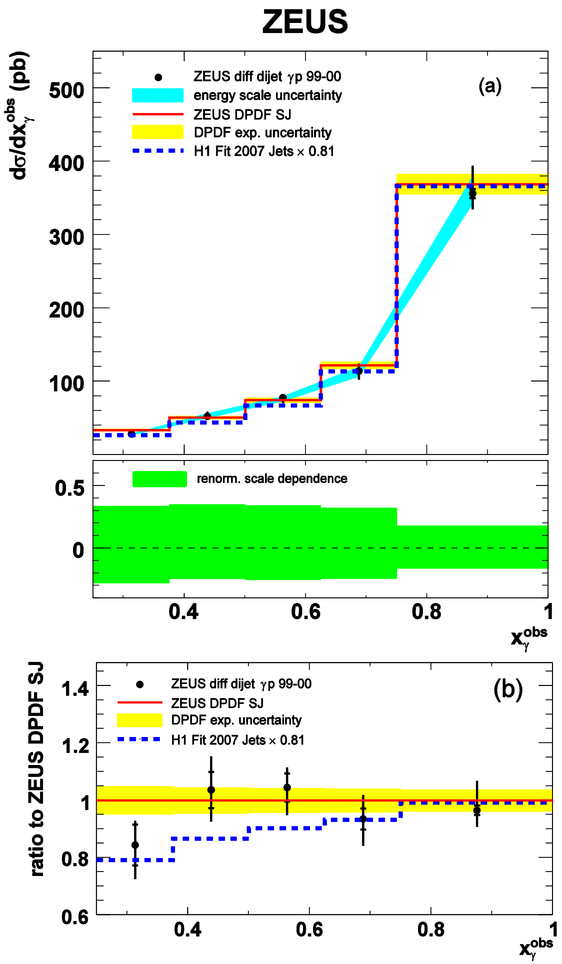


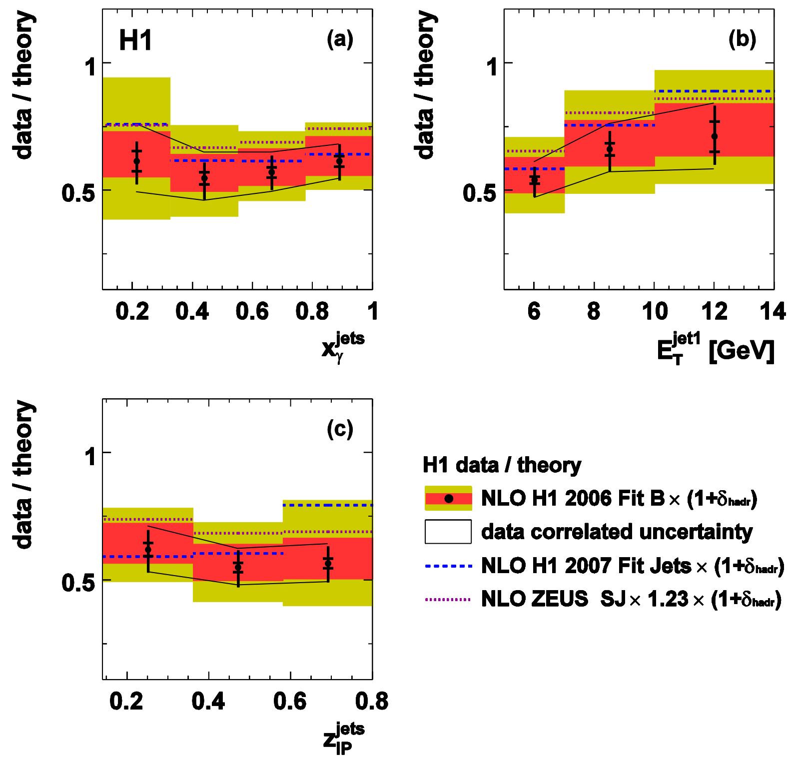
Expected suppression ~ 0.34 for resolved γ [KKMR, PL B567 (2003) 61]

Dijets in diffractive photoproduction

ZEUS, NP B831 (2010) 1

H1, EPJ C70 (2010) 15





Dependence on jet E_T ?

H1: data/NLO = 0.58 0.12(exp) ± 0.14(scale) ± 0.09(DPDF)

Both H1 and ZEUS see **no difference between direct and resolved regions** and prefer a global suppression factor

ZEUS: no evidence for a gap suppression

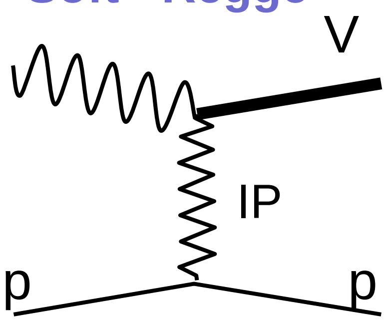
ZEUS has higher jet-E_T cuts than H1: $E_T^{1(2)}$ >7.5(6.5) GeV^2

Exclusive vector meson production

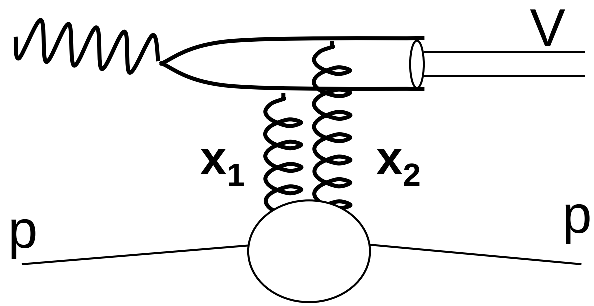
Soft - Regge

VM ($J^{PC} = 1^{--}$): ρ, ϕ, J/ψ, Υ, ...
DVCS: real γ

Hard - pQCD



IP exchange
(Regge trajectory)



2-gluon exchange
(LO realisation of vacuum quantum numbers in QCD)

Cross section proportional to probability of finding 2 gluons in the proton

$$\sigma \propto [x\,g]^2$$

$$\sigma \propto \left[H\left(x_1, x_2, t, Q^2\right)\right]$$

GPDs

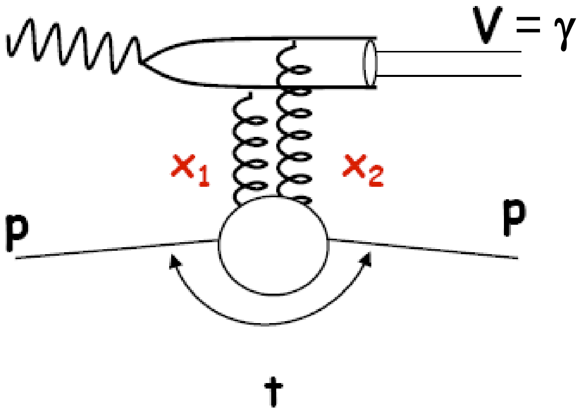
With increasing scale (Q^2, M_{VM}, t) :

$$\sigma(W) \propto W^{\delta}$$

$$\frac{d\sigma}{dt} \propto e^{-b|t|}$$

- Expect δ to increase from soft (~0.2, 'soft Pomeron' value) to hard (~0.8, reflecting large gluon density at low x)
- Expect b to decrease from soft (~10 GeV^{-2}) to hard (~4-5 GeV^{-2})

GPDs and DVCS

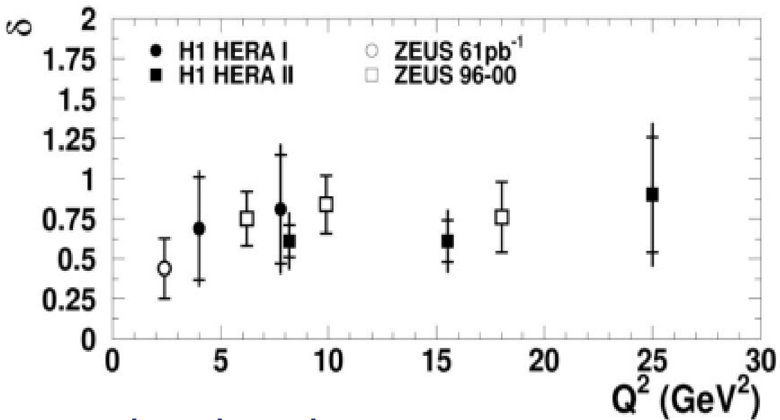


$\sigma \propto H(x_1,x_2,t,Q^2)$

Generalised PDFs (GPDs):

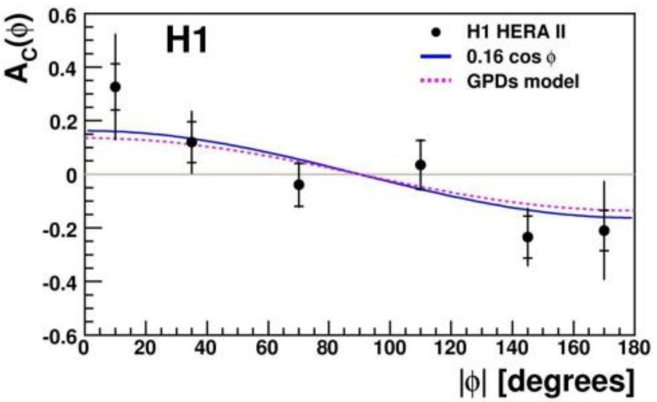
- sensitive to **parton-parton momenta correlation** in the proton
- t-dependence gives **2dim distribution of partons in the transverse plane**
- important ingredient for estimating **central exclusive production at LHC**

Deeply Virtual Compton Scattering (DVCS):



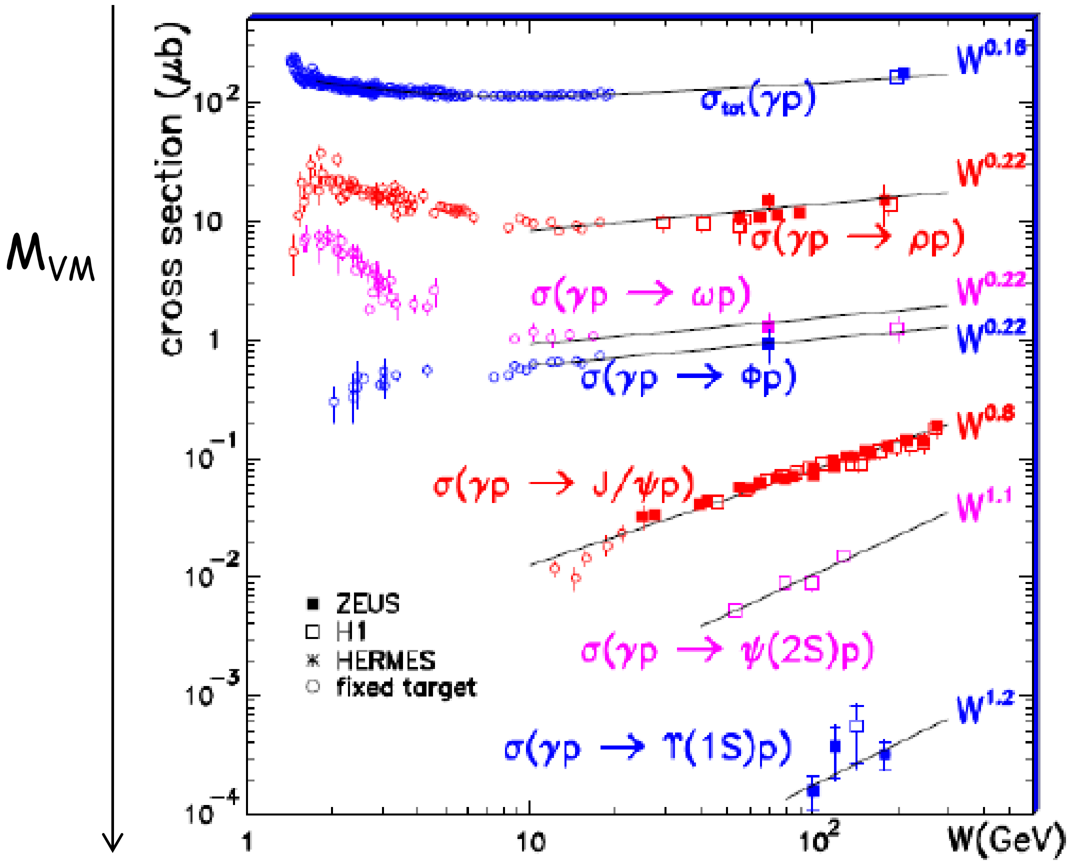
→ hard regime

Asimmetry amplidutes related to GPDs



→ Evidence of GPDs in DVCS

W dependence in photoproduction



$Q^2 = 0$

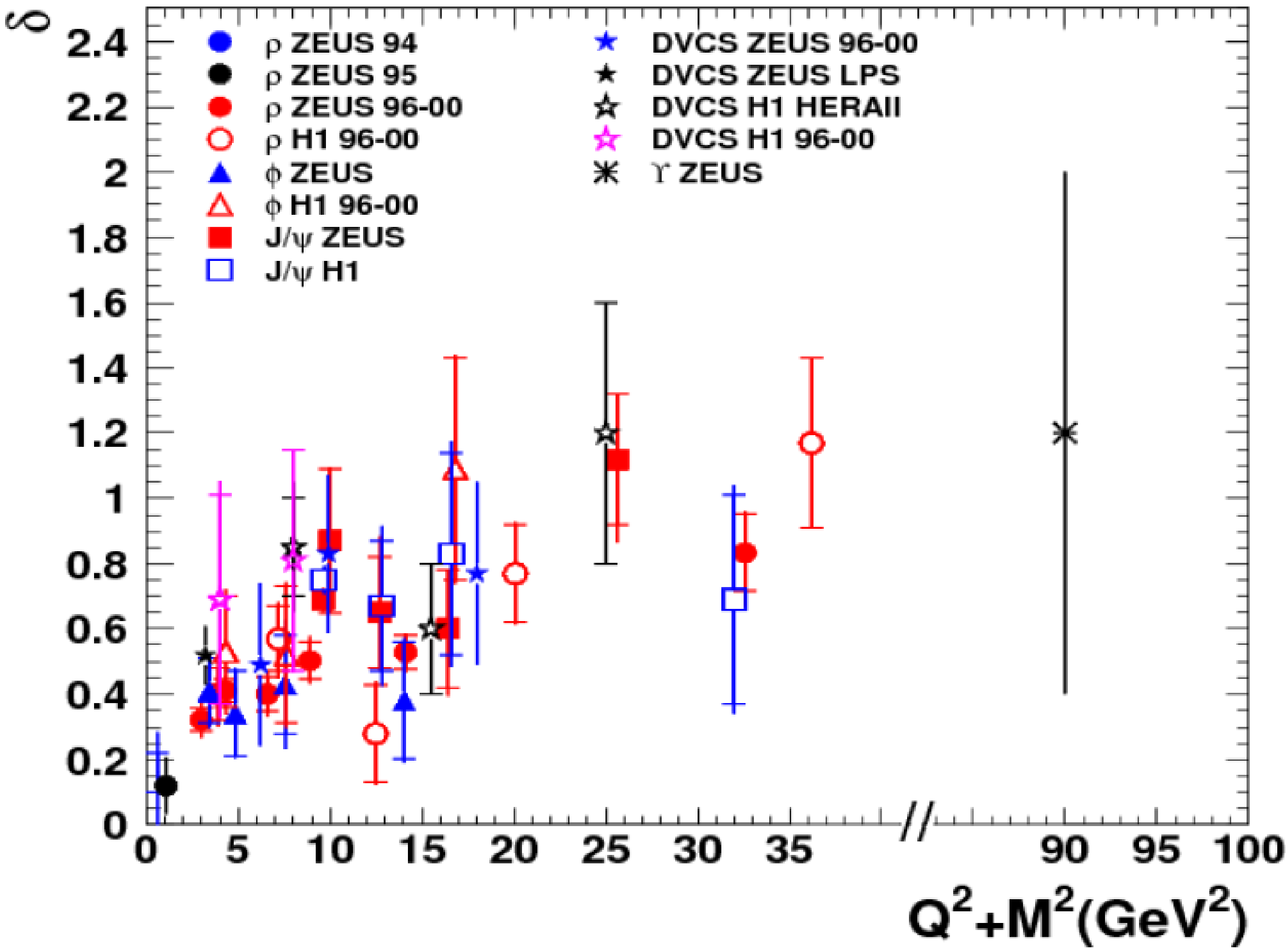
small M_{VM} (~ 1 GeV²): transverse size of dipole ~ size of proton

large M_{VM}: small dipole size
→ cross section much smaller (color screening)
→ dipole resolves partons in the proton
$\sigma \sim (xg)^2$ ⇨ large δ

⇨ VM data can help determine the gluon density!

M_{VM} is the scale
→ same observed when varying Q^2 for a given VM

Soft to hard – σ(W)



⇨ **Process becomes hard as the scale ($Q^2 + M^2$) becomes larger**

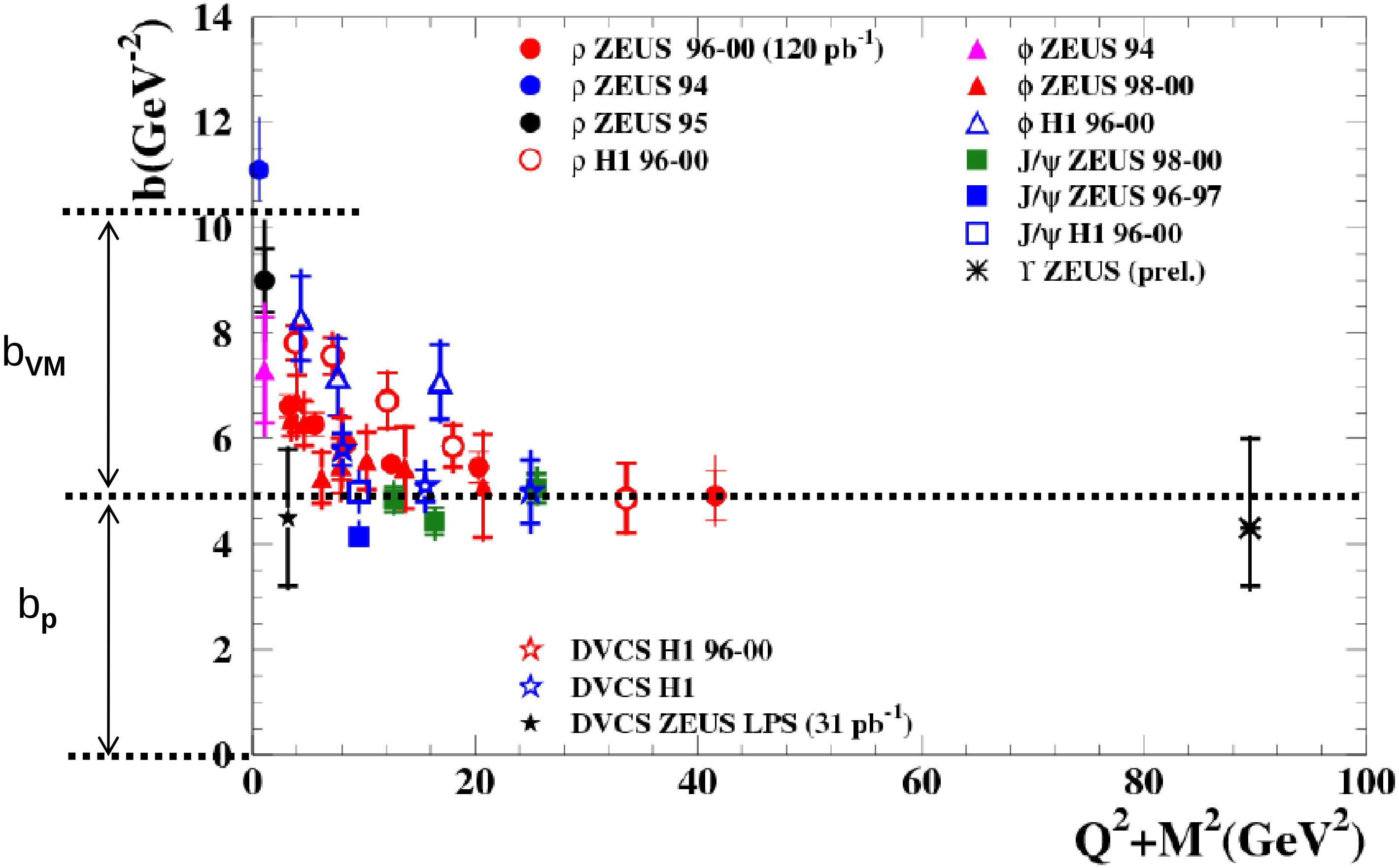
Soft to hard – t-slope

$$\frac{d\sigma}{dt} \propto e^{-b|t|}$$

Slope b smaller as scale increases

Size of diffractive cone related to size of interacting objects (as in optical diffraction)

$b \sim b_{VM} + b_p$



$\langle r^2 \rangle = b(\hbar c)^2$

$r_{gluons} \sim 0.6$ fm - radius of gluon density in proton

$r_{proton} \sim 0.8$ fm - charge density in the proton

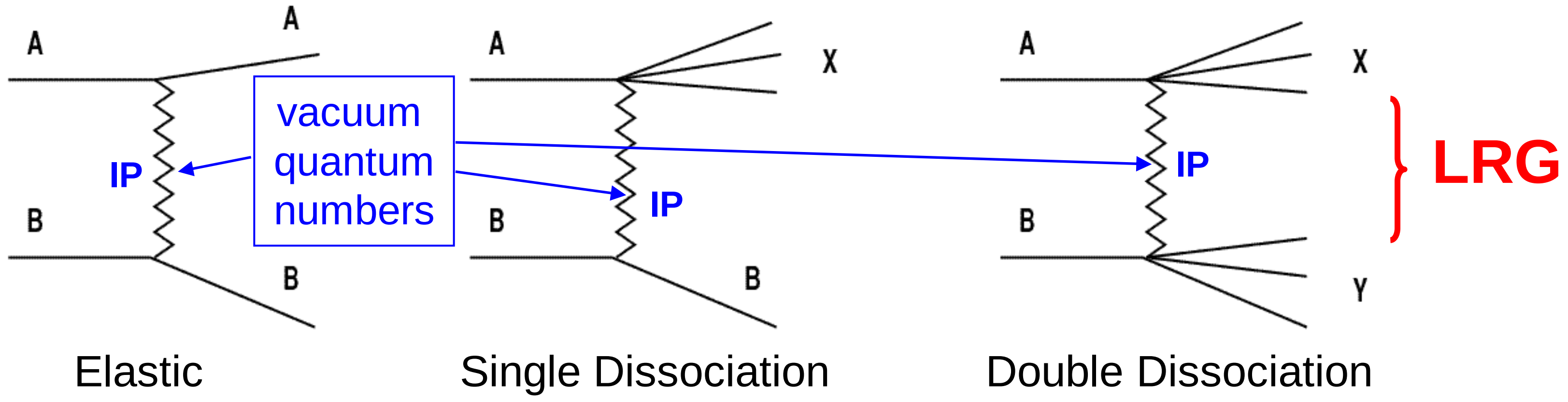
Summary

- ✓ Unique diffractive data continue to arrive from H1 and ZEUS
- ✓ Consistency reached between different experiments, methods and data sets
  - ⇨ Ready to combine inclusive cross sections between experiments
- ✓ Well constrained DPDFs can be obtained from a combined fit to inclusive and dijet data and used to predict other processes in diffractive DIS, proving QCD factorisation
  - ⇨ DPDFs are gluon dominated
- ✓ Direct measurement of F_L^D
  - ⇨ Independent test of the diffractive gluon density
- ✓ Diffractive dijet photoproduction has been studied to test possible factorisation breaking as in proton-antiproton collisions at Tevatron
  - ⇨ Progress in understanding rapidity gap survival probability
- ✓ Lot of inputs from exclusive vector meson production and DVCS
  - ⇨ Transition from soft to hard regime is visible
  - ⇨ Precision measurements can constrain the gluon density
  - ⇨ Sensitivity to the GPDs

Backup slides

Diffraction in hadron scattering

Diffraction is a feature of hadron-hadron interactions (30% of σ_{tot})



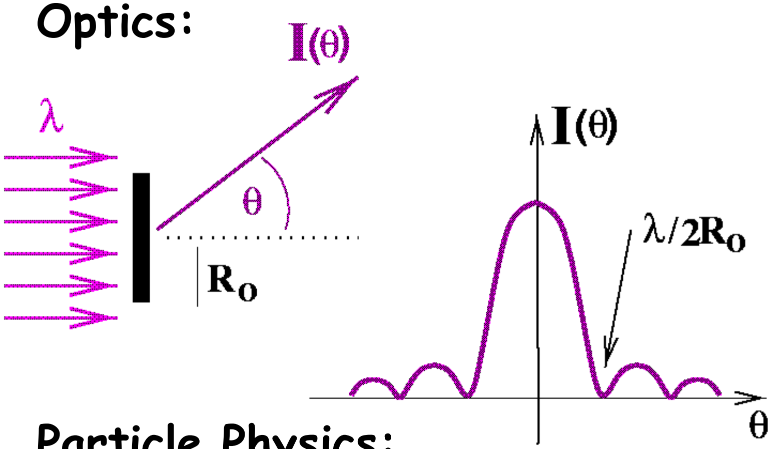
⇨ Beam particles emerge intact or dissociated into low-mass states
→ Very small fractional momentum losses (within a few %)

⇨ Final-state systems separated by large polar angle
(or pseudorapidity $\eta = -\ln[\tan(\theta/2)]$)
→ Large Rapidity Gap (LRG)

⇨ Interaction mediated by t-channel exchange of an object with vacuum quantum numbers (no colour)
→ Pomeron (IP)

Why diffraction?

Optics:



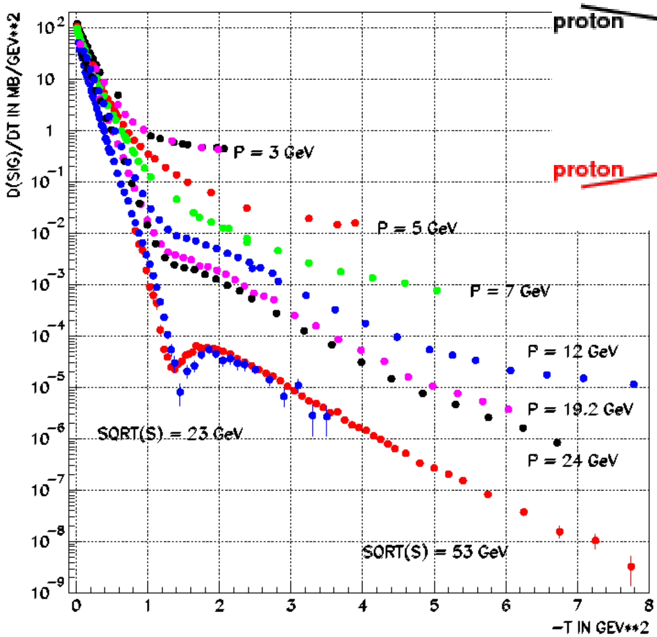
$$\frac{I(\theta)}{I(0)} \approx 1 - \frac{R_0^2}{4}(k\theta)^2 \qquad k = 2\pi/\lambda$$

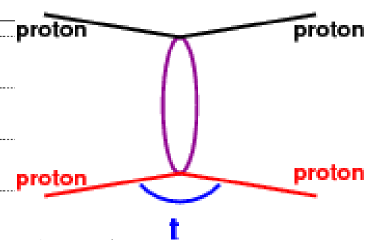
Forward peak for q=0 (diffractive peak)

Diffraction pattern related to size of target and wavelength of beam

Particle Physics:

Propagation/interaction of a a hadron ⇨ absorption of its wave function





$$\frac{d\sigma}{dt} = \frac{d\sigma}{dt}(t=0)\, e^{-b|t|}$$

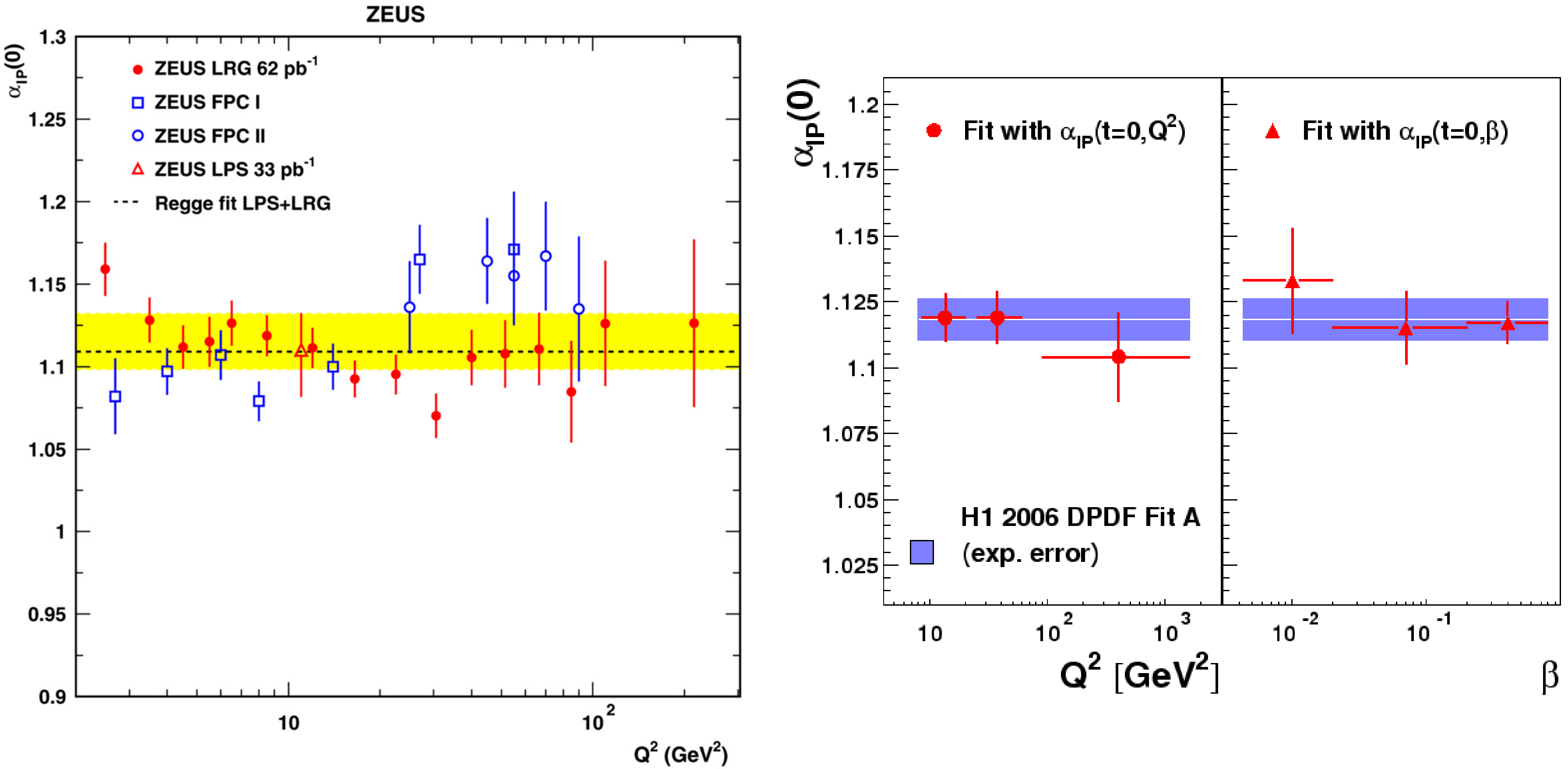
$|t| \approx (p\theta)^2$ 4-momentum transfer

θ scattering angle

$b = R^2/4$

R transverse distance projectile-target

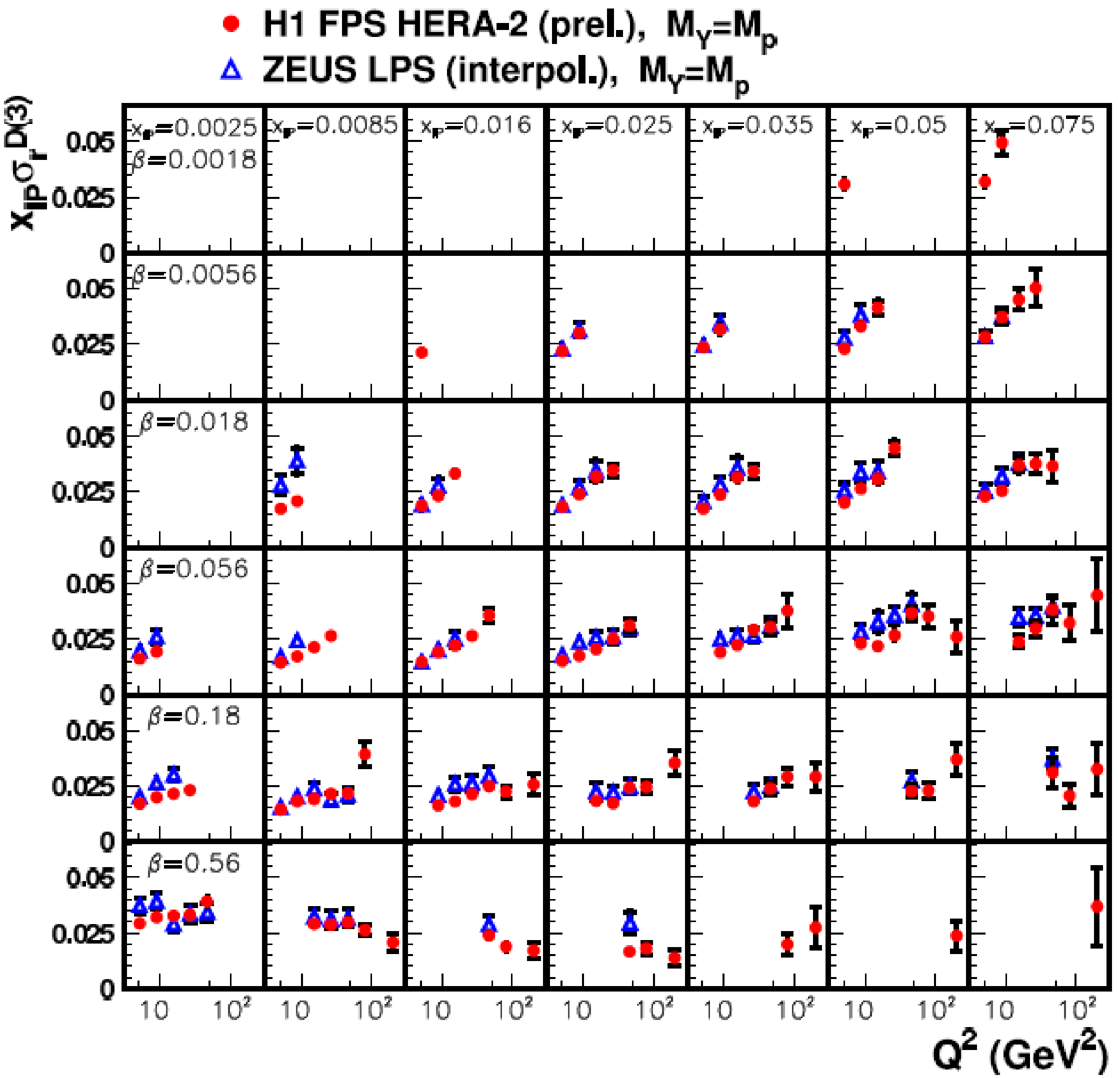
Proton vertex factorisation



Measure the x_{IP} dependence of the data as a function of β and Q^2

The proton vertex factorisation approximation holds within the experimental precision ⟶ allow NLO QCD analysis of the β and Q^2 dependences

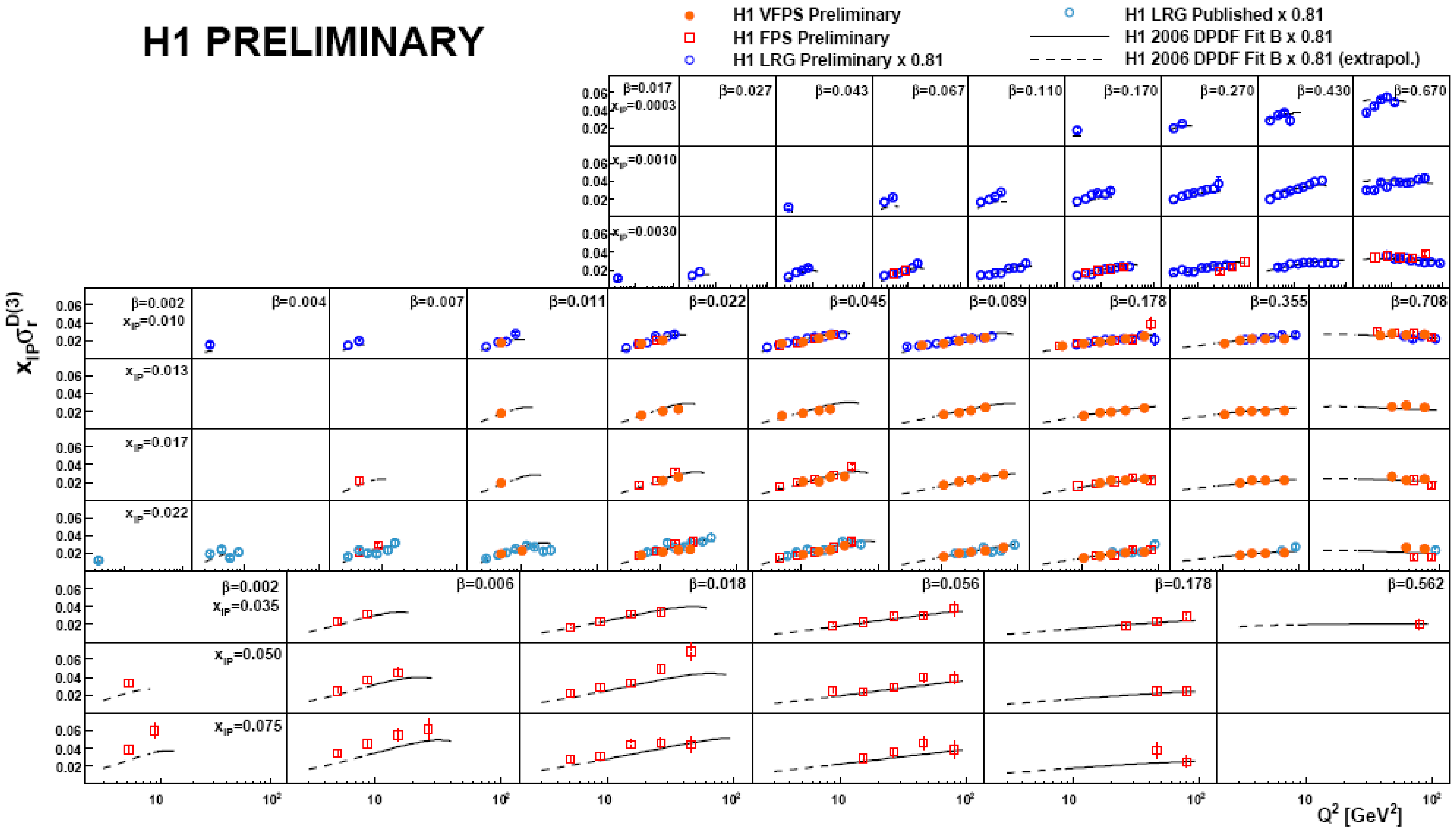
Q^2 dependence of $\sigma_r^{D(3)}$ from PS data



Reasonable agreement between H1-FPS and ZEUS-LPS

Positive scaling violation for $\beta < 0.2$

H1 $\sigma_r^{D(3)}$ summary plot



Fitting procedure and data sets

Pomeron PDFs parametrised at initial $Q_o^2 = 1.8$ GeV^2, Q^2 evolution with DGLAP :

$$zf_k^{IP}(z,Q^2) = A_k z^{B_k}(1-z)^{C_k}$$ with k = g,S

- for all flavours q = qbar
- assume d = u = s
- heavy quarks dynamically generated above thresholds: $m_c = 1.35$ GeV, $m_b = 4.3$ GeV using the General-Mass Variable-Flavour-Number-Scheme of Thorne and Roberts

⟶ 6 parameters + $\alpha_{IP}(0)$, $\alpha_{IR}(0)$, A_{IR} (b and α' fixed by Regge fits to ep and pp data)

Gluons expected to be poorly constrained by inclusive data (lnQ^2 dependence of F_2^D)

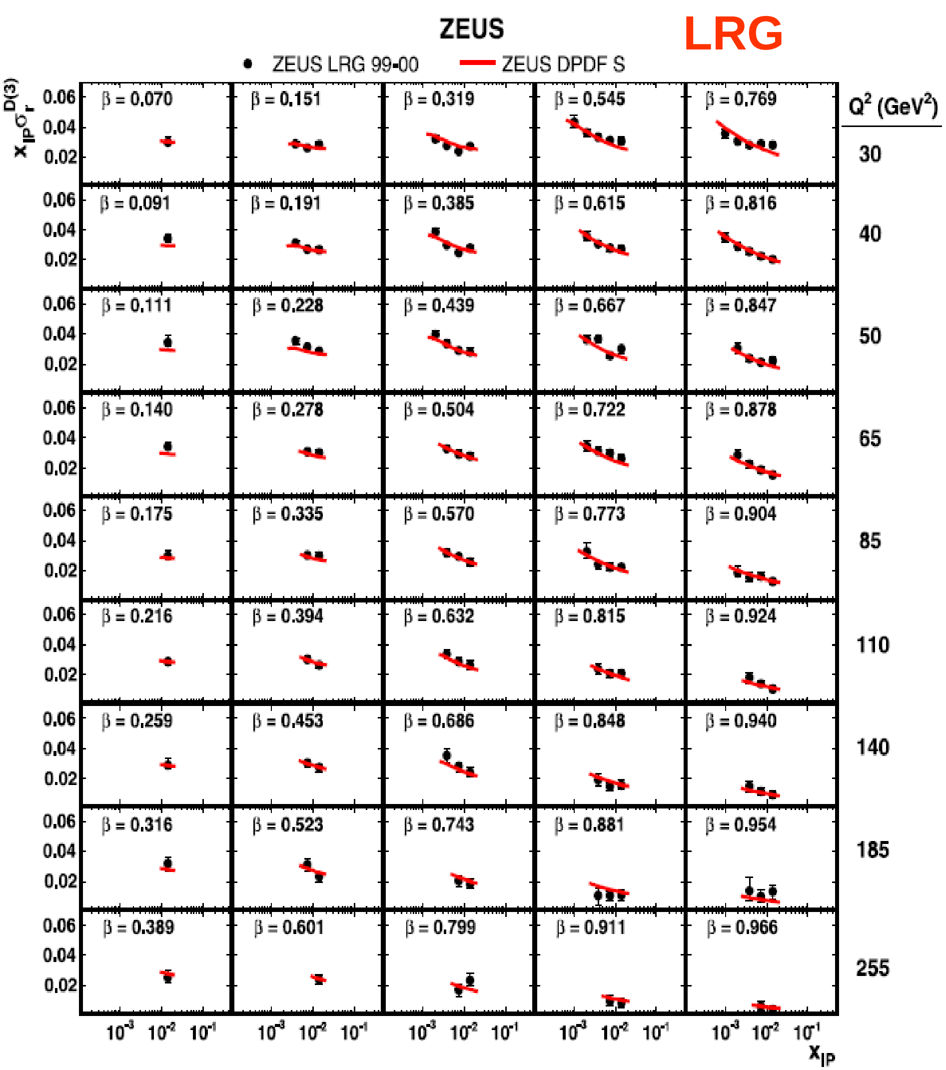
⟶ two cases: "Standard": fit S with B_g and C_g free
"Constant": fit C with $B_g = C_g = 0$ (as for H1 2006 fit B)

Latest inclusive ZEUS data: - LRG and LPS (229 + 36 points)
ZEUS, NP B816 (2009) 1 - only data with $Q^2 > 5$ GeV^2 used
- overlapping LPS data not used

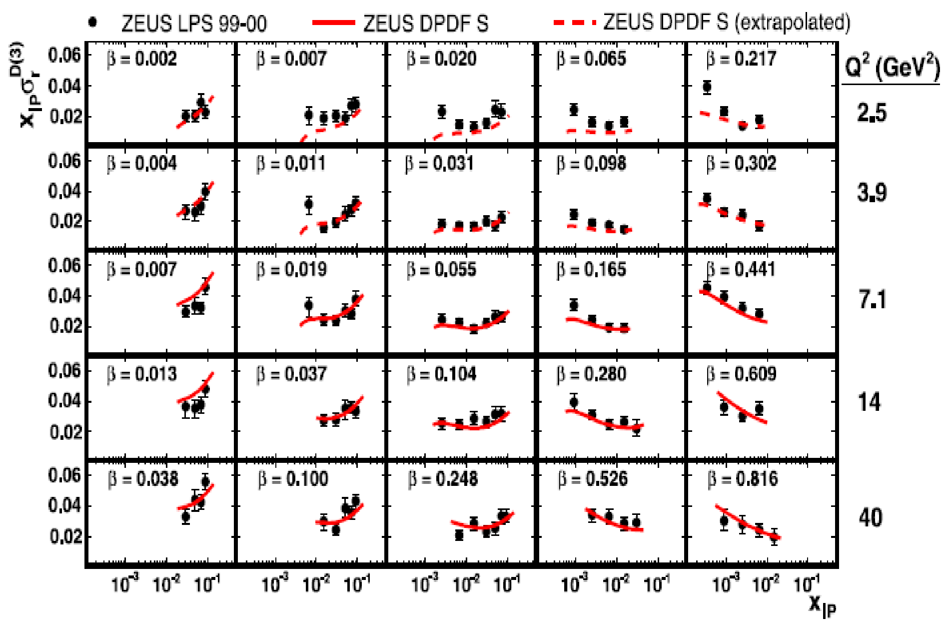
Fit vs data

ZEUS, NP B831 (2010) 1

LRG



LPS



Both fits give a comparably good description of inclusive data for $Q^2 > 5$ GeV^2

Values of $\alpha_{IP}(0)$, $\alpha_{IR}(0)$, A_{IR} are consistent with Regge fits

Fit parameters and χ^2/ndf

Table 3

Parameters obtained with the different fits and their experimental uncertainties.

Parameter	Fit value DPDF S	Fit value DPDF C	Fit value DPDF SJ
A_q	0.135 ± 0.025	0.161 ± 0.030	0.151 ± 0.020
B_q	1.34 ± 0.05	1.25 ± 0.03	1.23 ± 0.04
C_q	0.340 ± 0.043	0.358 ± 0.043	0.332 ± 0.049
A_g	0.131 ± 0.035	0.434 ± 0.074	0.301 ± 0.025
B_g	-0.422 ± 0.066	0	-0.161 ± 0.051
C_g	-0.725 ± 0.082	0	-0.232 ± 0.058
$\alpha_{\mathbb{P}}(0)$	1.12 ± 0.02	1.11 ± 0.02	1.11 ± 0.02
$\alpha_{\mathbb{R}}(0)$	0.732 ± 0.031	0.668 ± 0.040	0.699 ± 0.043
$A_{\mathbb{R}}$	2.50 ± 0.52	3.41 ± 1.27	2.70 ± 0.66
χ^2/ndf	$315/265 = 1.19$	$312/265 = 1.18$	$336/293 = 1.15$

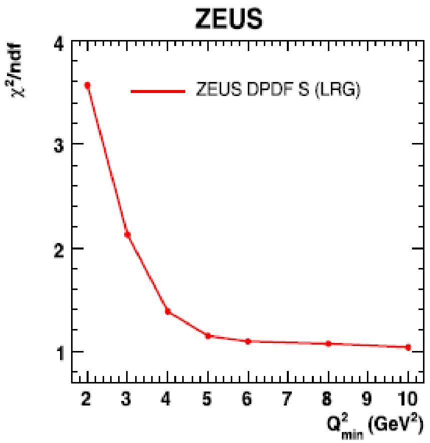


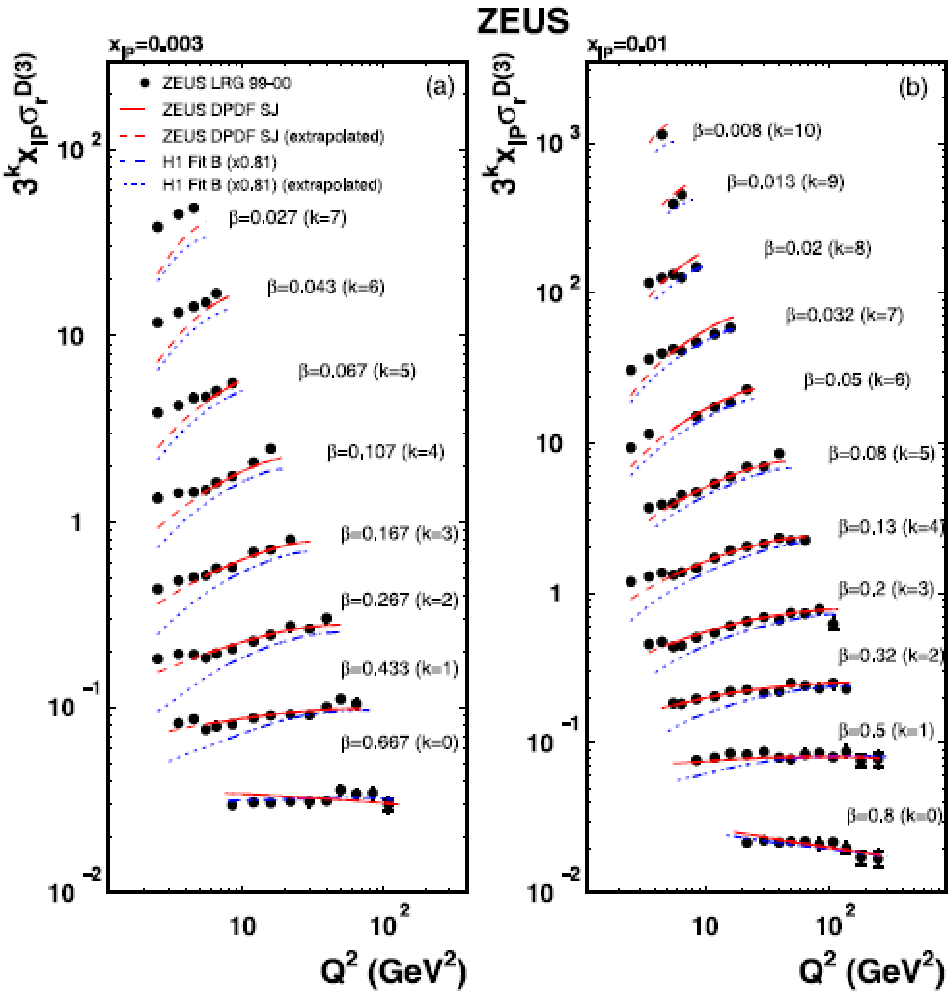
Table 1

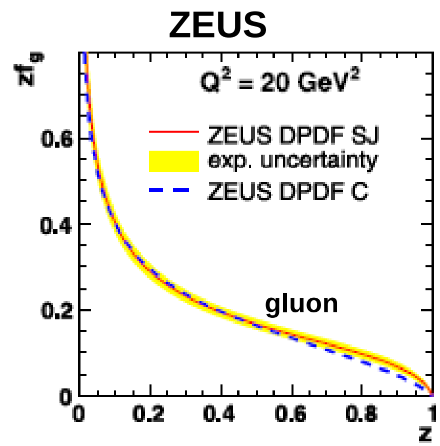
The values of the parameters fixed in the fits and the measurements providing this input.

Parameter	Fixed to (GeV^{-2})	Measurement (GeV^{-2})	Ref.
$\alpha'_{\mathbb{P}}$	0	-0.01 ± 0.06 (stat.)$^{+0.04}_{-0.08}$ (syst.) ± 0.04 (model)	[10]
$\alpha'_{\mathbb{R}}$	0.9	0.90 ± 0.10	[32]
$B_{\mathbb{P}}$	7.0	7.1 ± 0.7 (stat.)$^{+1.4}_{-0.7}$ (syst.)	[10]
$B_{\mathbb{R}}$	2.0	2.0 ± 2.0	[32]

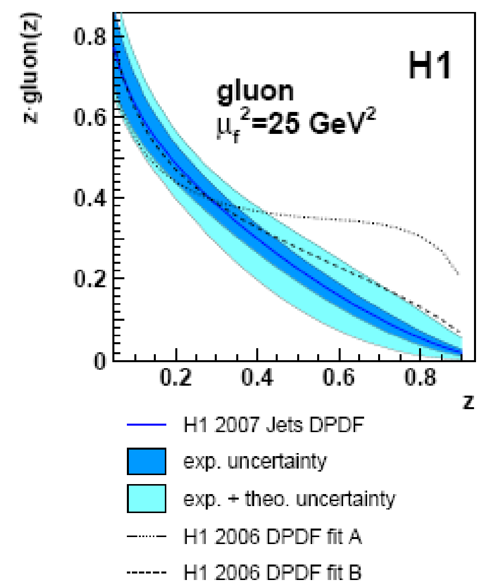
Comparison with H1 2006 fit B

H1, EPJ C48 (2006) 715





H1, JHEP 0710:042 (2007)



Plan to extract HERA DPDFs from H1+ZEUS final combined data

H1 predictions corrected to $M_Y = M_P$ as for ZEUS via the scaling factor 0.81

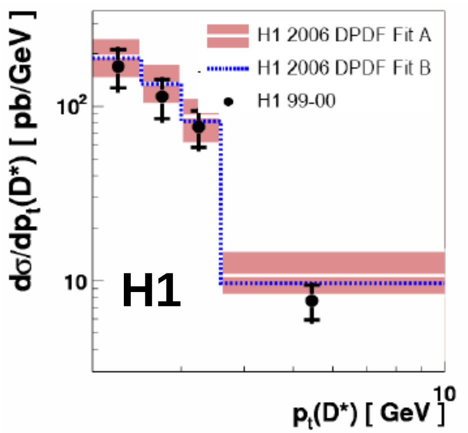
D* and dijets in diffractive DIS

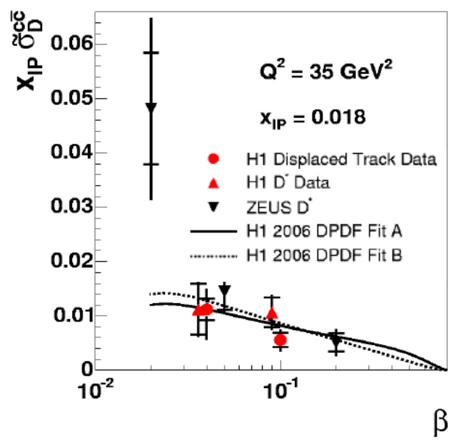
Use DPDFs extracted from inclusive DDIS for calculating NLO predictions to semi-inclusive final states: **test universality of DPDFs**

→ Open charm and dijets in DIS: hard scales in the process ensure use of pQCD

Open charm:

H1, DESY 06-164
ZEUS, NP B672 (2003) 3

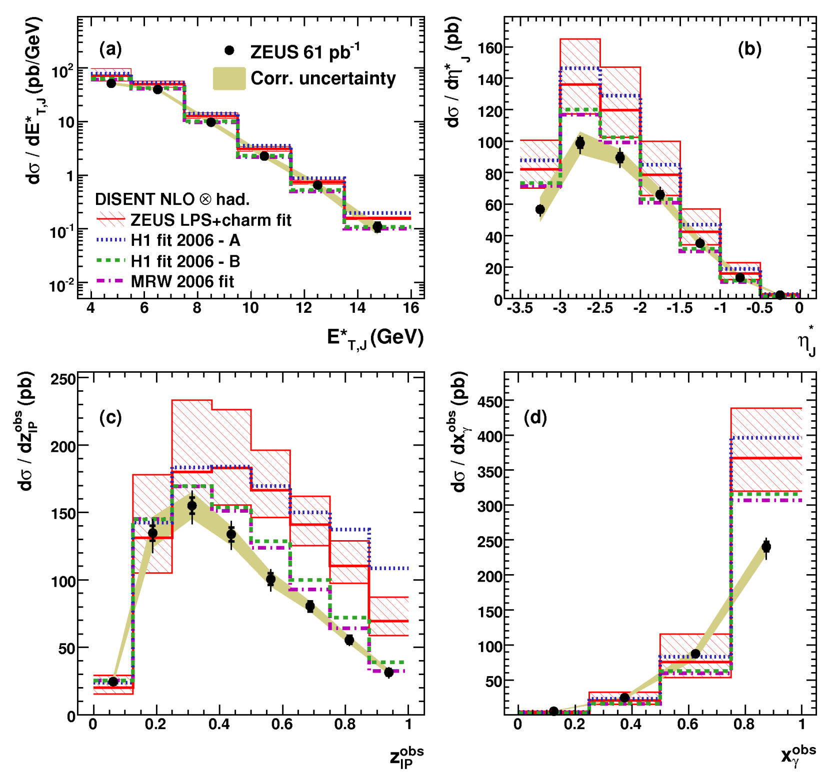




Dijets:

H1, JHEP 0710:042 (2007)
ZEUS, EPJ C52 (2007) 813

ZEUS



H1 and ZEUS data agree with NLO predictions within uncertainties

→ **QCD factorization holds in DDIS!**

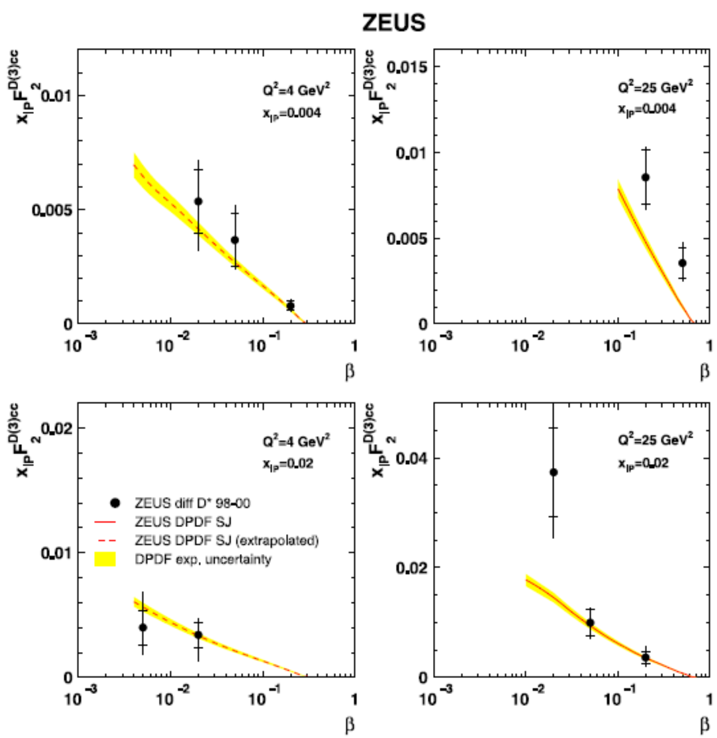
Use D* and jet data to better constrain DPDFs

D* and dijets in diffractive DIS

Use DPDFs extracted from inclusive DDIS for calculating NLO predictions to semi-inclusive final states: **test universality of DPDFs**

→ Open charm and dijets in DIS: hard scales in the process ensure use of pQCD

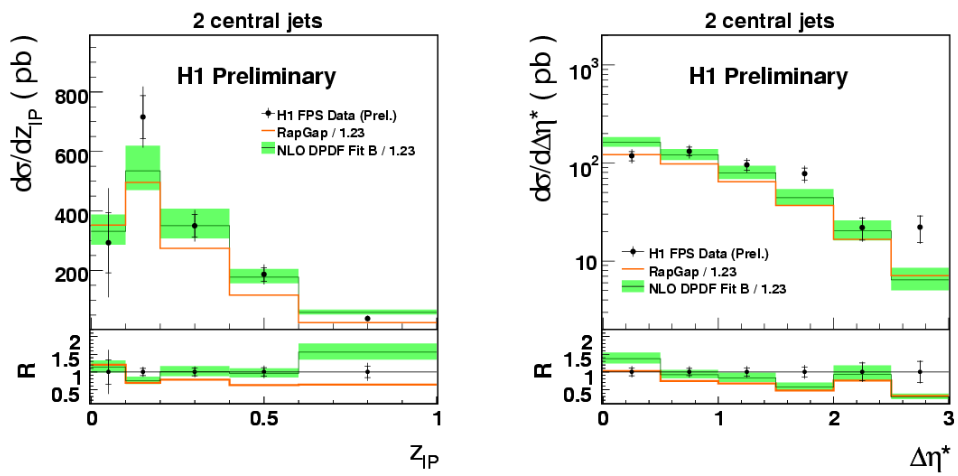
Open charm: H1, EPJ C50 (2007) 1
ZEUS, NP B672 (2003) 3



→ QCD factorisation holds in DDIS!

Dijets: H1, JHEP 0710:042 (2007)
ZEUS, EPJ C52 (2007) 813

First measurement of dijets in DDIS with a **tagged proton** (H1 FPS) - **H1prelim-10-013**



Deviations might be related to missing pomeron remnant in NLO predictions (NLOJET++)
Deviations at high $\Delta\eta^*$ → interesting to look at forward jets

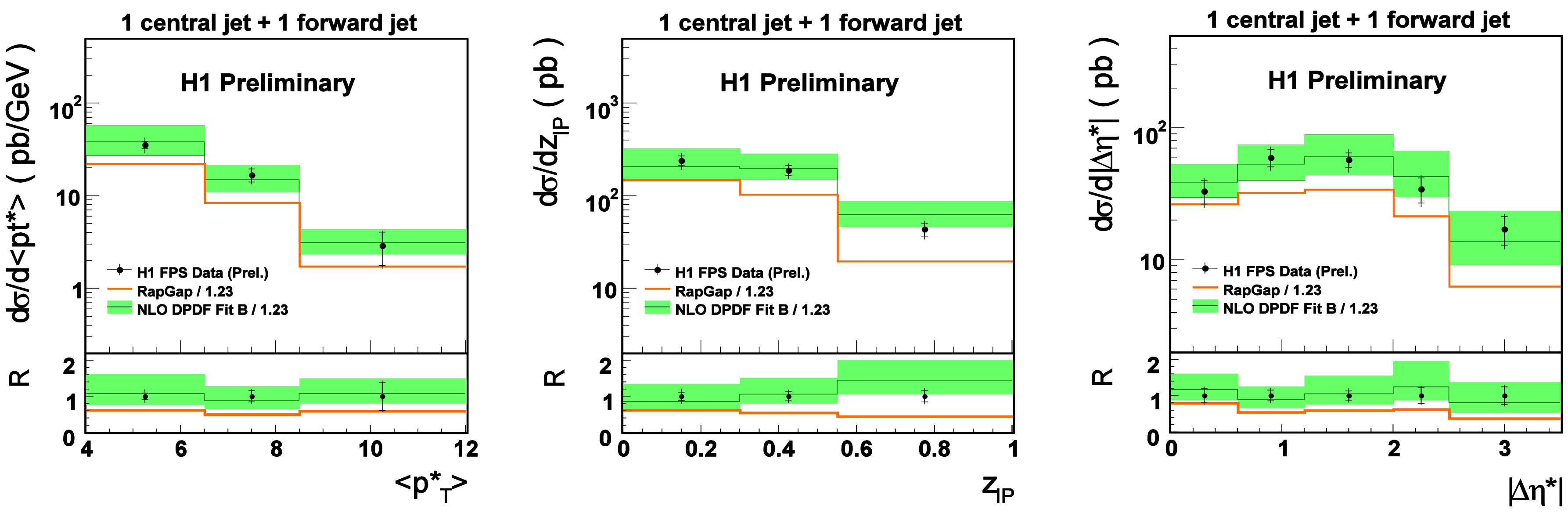
Forward jets in DDIS with proton tag

Dijet system: **Forward jet**: $p_T^* > 4.5$ GeV, $1 < \eta_{fwd} < 2.8$

Central jet: $p_T^* > 3.5$ GeV, $-1 < \eta_{cen} < \eta_{fwd}$

(previous 2 central jets: $p_{T1}^* > 5$ GeV, $p_{T2}^* > 4$ GeV, $-1 < \eta < 2.5$)

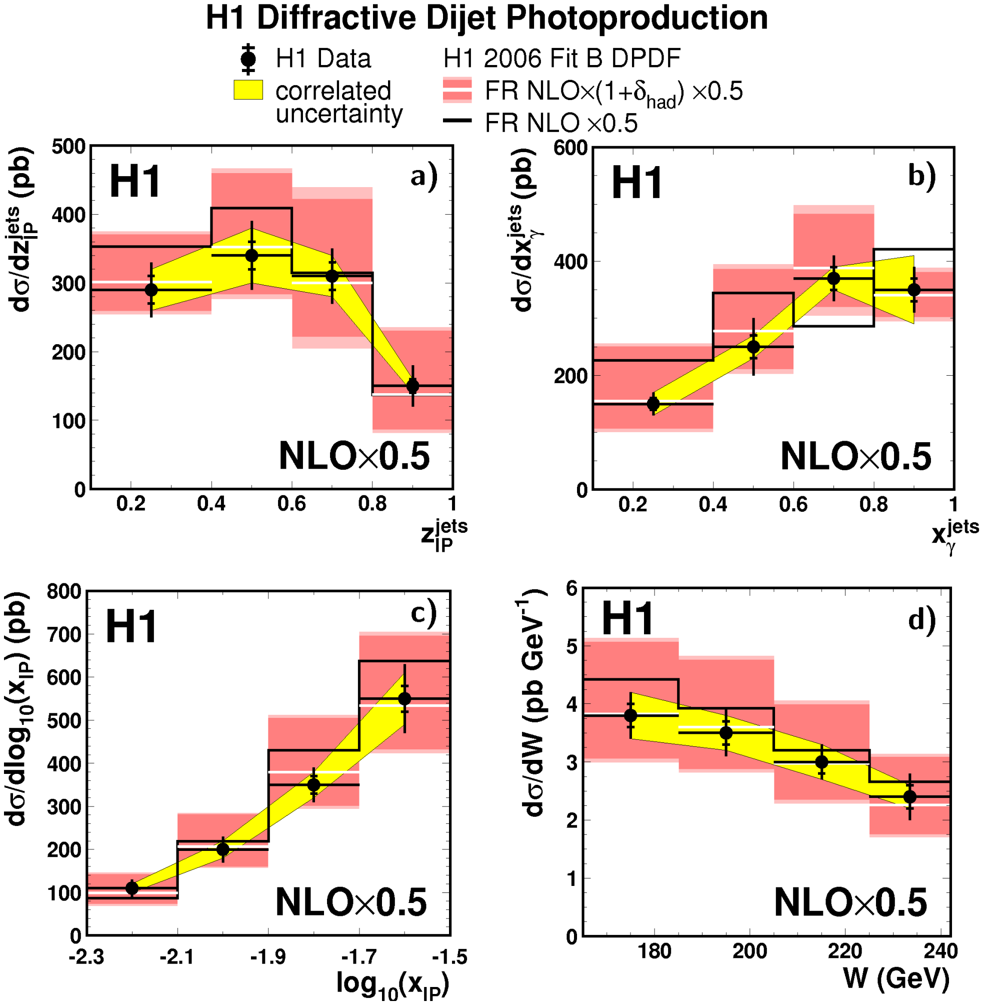
Predictions scaled by 1.23 due to proton dissociation not present in FPS data



NLO DGLAP with H1 fit B DPDFs gives a good description of the data

Dijets in diffractive photoproduction

H1, EPJ C51 (2007) 549



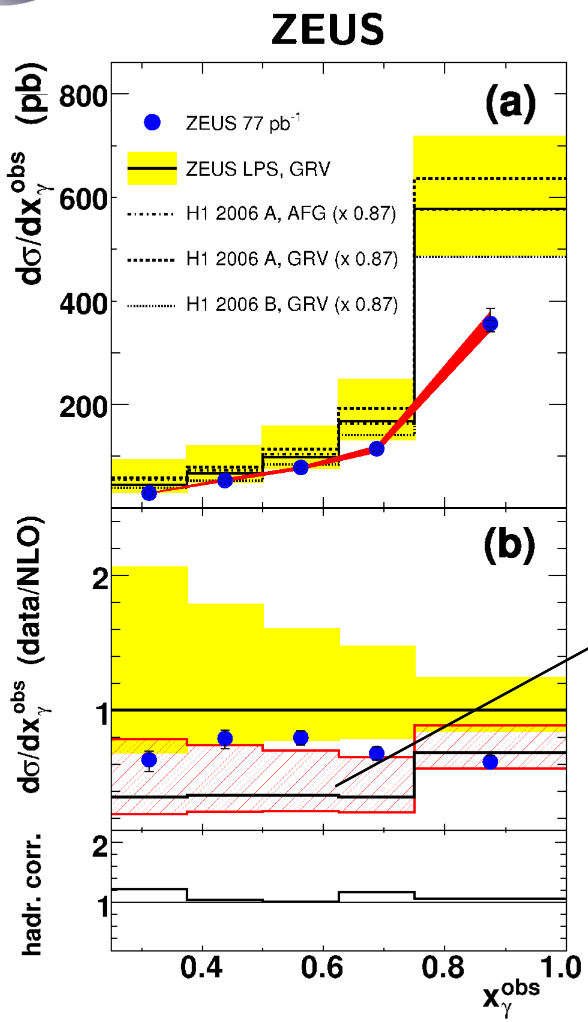
- $E_T^{jet1} > 5$ GeV, $E_T^{jet2} > 4$ GeV
- Cross section include p dissoc. with $M_Y < 1.6$ GeV
- Cross section corrected at hadron level

NLO overestimates the measured cross section by a factor ~ 2, both in the direct and resolved region

Suppression in γp is much smaller than in ppbar

NLO predictions assuming factorization with Frixione et al. program [NP B467 (1996) 399; B507 (1997) 295]

Dijets in diffractive photoproduction



ZEUS, EPJ C55 (2008) 177

- $E_T^{jet1} > 7.5$ GeV, $E_T^{jet2} > 6.5$ GeV
- Cross section scaled down for p-dissoc. contribution: (16 4)%
- Cross section corrected at hadron level

Suppression factor 0.34 applied to resolved component only

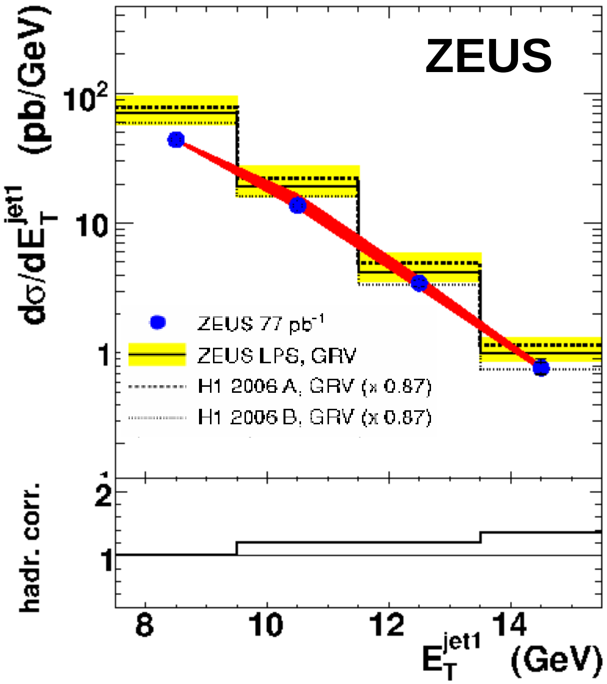
Within uncertainties data show a weak (if any) suppression: 0.6-0.9

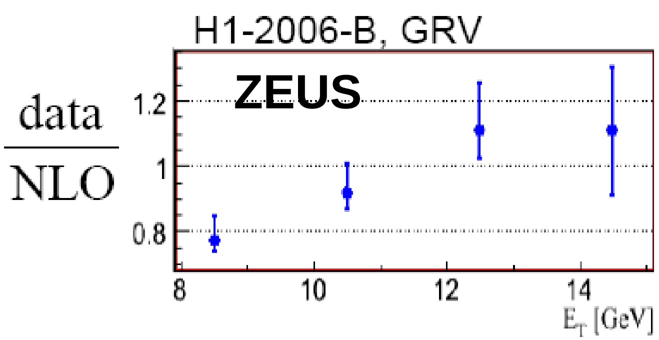
ZEUS as H1 do not see any difference between the resolved and direct regions, in contrast to theory!

NLO predictions assuming factorization with Klasen & Kramer program [**EPJ C38 (2004) 9**]

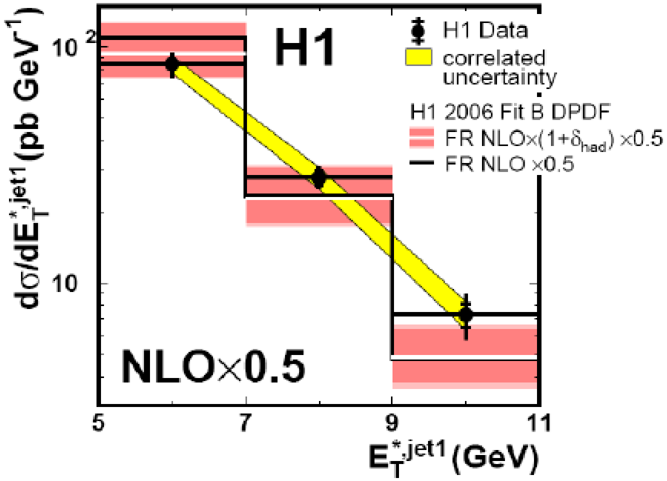
E_T dependence of suppression?

Difference between H1 and ZEUS possibly due to different E_T regions?





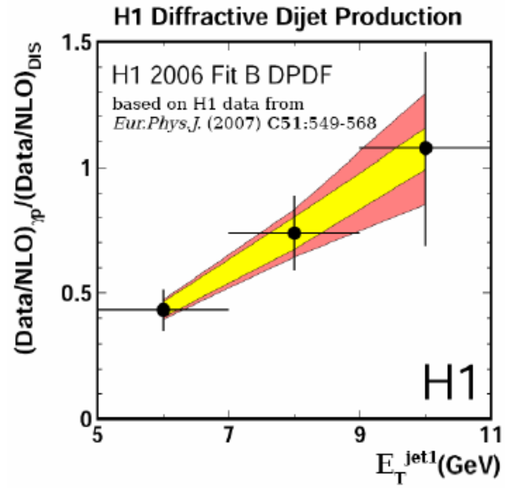
Data have a harder E_T slope than NLO



Better seen with

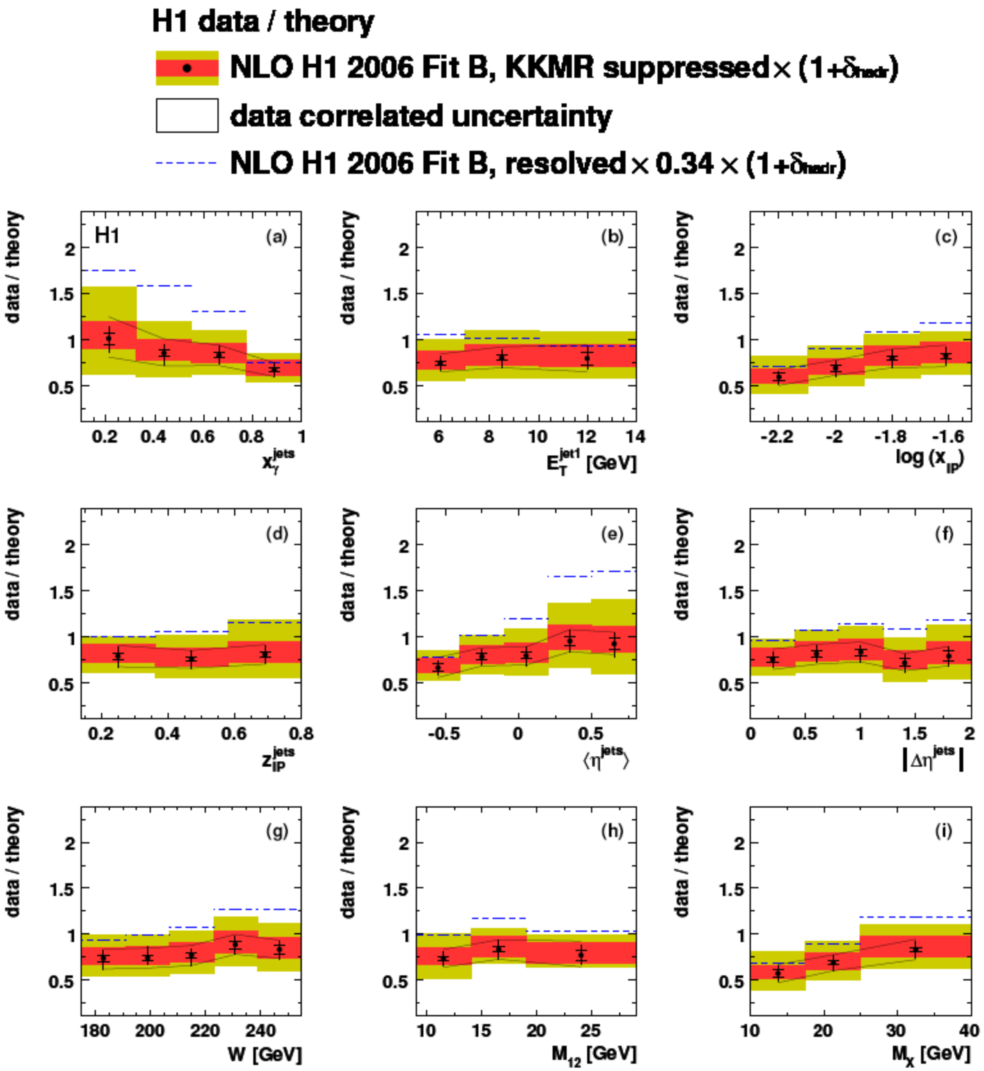
$$Double\ ratio = \frac{(Data/NLO)_{\gamma p}}{(Data/NLO)_{DIS}}$$

to cancel DPDFs uncertainty



A signal that gap survival probability might increase with E_T

Dijets in diffractive photoproduction



Refined gap survival model (KKMR, **hep-ph/0911.3716**) predicts a significantly **weaker suppression:**

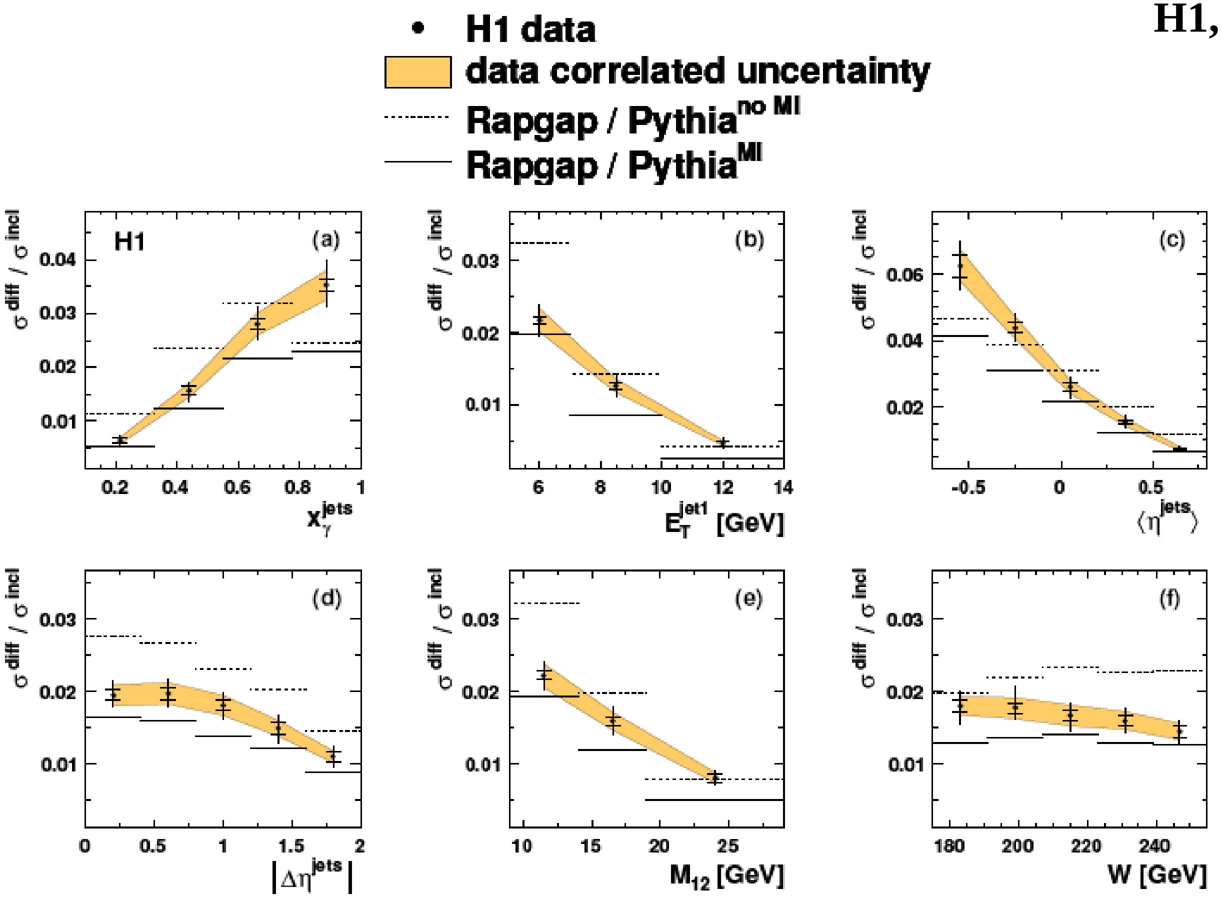
- **direct** γ unsuppressed
- **hadron-like part of resolved** γ suppressed by ~0.34 (only x_γ<0.1)
- **point-like part of resolved** γ less suppressed, ~0.7-0.8

E_T dependence: lower E_T cuts on the jets increase hadronisation corrections and absorptive effects, producing a higher suppression

Both H1 and ZEUS data prefer a global suppression factor

Diffractive/inclusive dijet γp cross sections

H1, DESY 10-043



Influence of **multiple interactions** in inclusive data is large in the kinematic range of the analysis, which preclude strong conclusions about rapidity gap survival