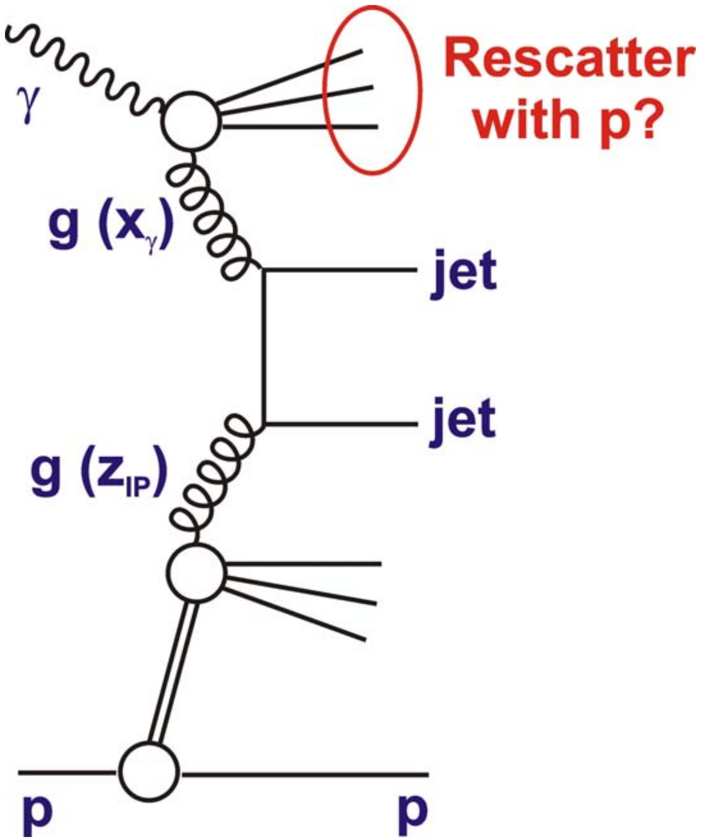
Dijets in Diffractive Photoproduction and Diffractive Factorisation



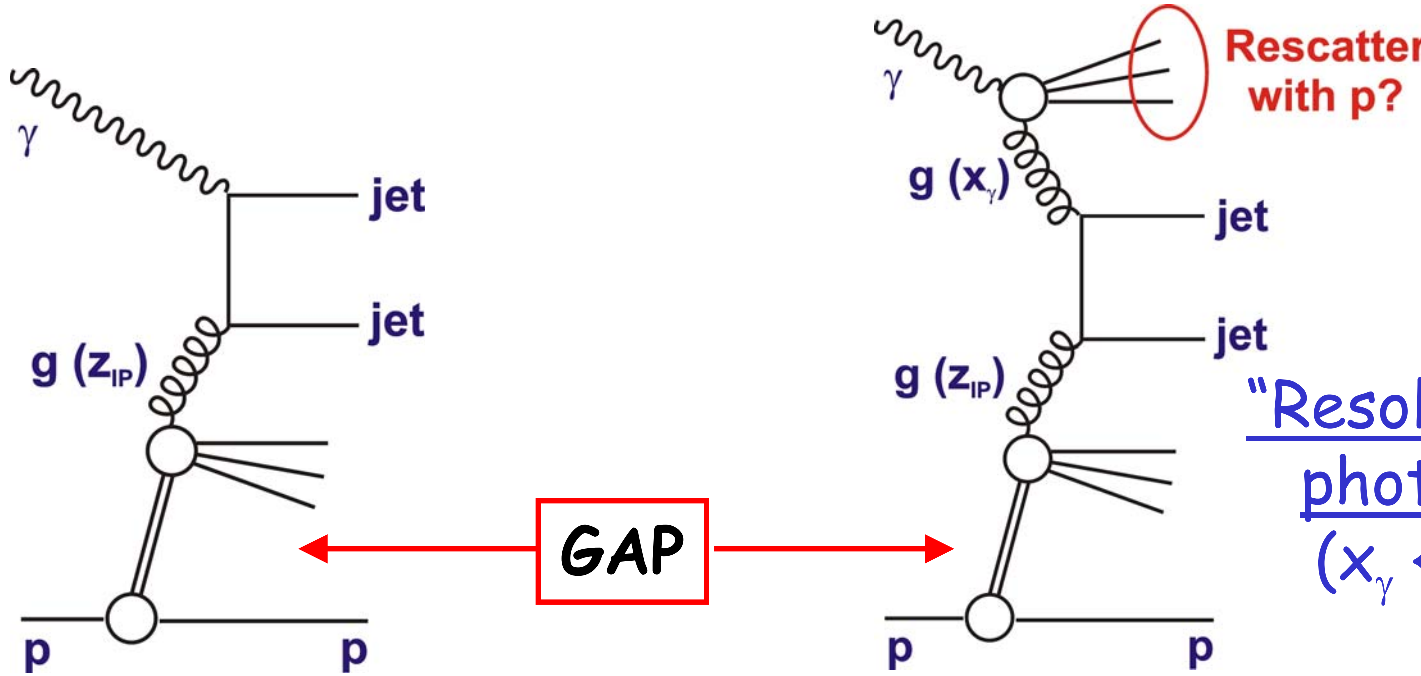
Presented by P.Newman
(University of Birmingham)
on behalf of the H1 Collaboration

DIS 2009, Madrid
27 April 2009

Why Diffractive Dijet Photoproduction?

Switch "photon remnant" on and off …
… unique control over rescattering → crude LO picture …

<u>"Direct" photon</u> ($x_\gamma \to 1$)

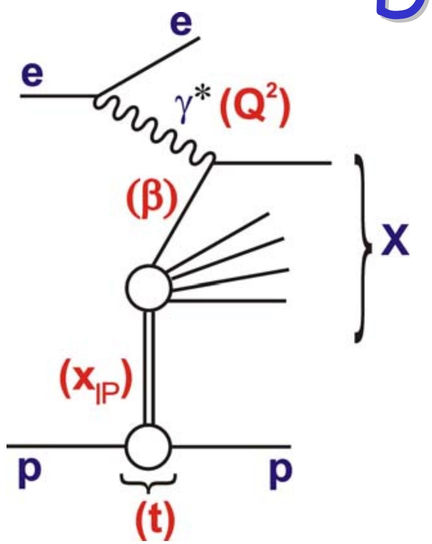


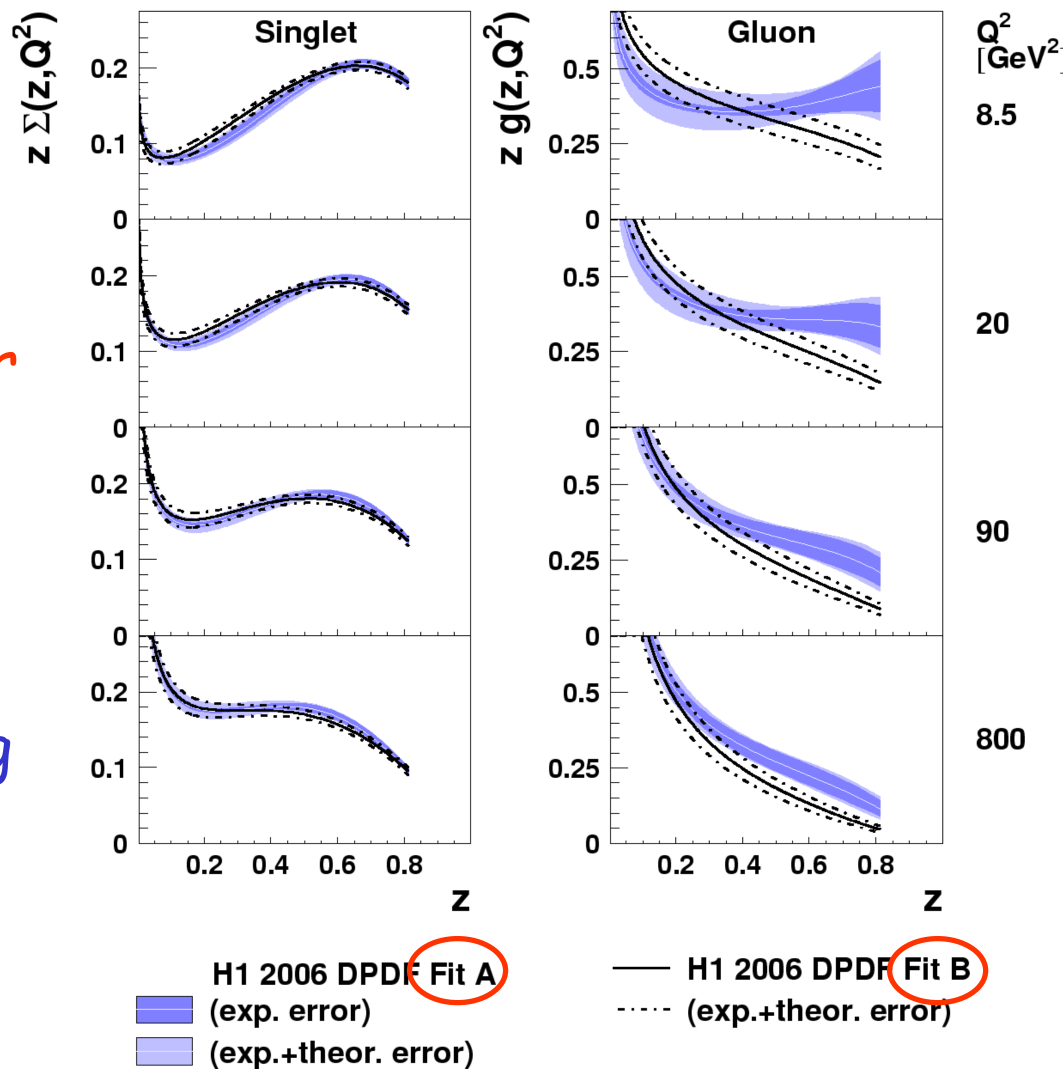
<u>"Resolved" photon</u> ($x_\gamma < 1$)

Rescattering (= `absorptive' or `screening' corrections) gives radiation into rapidity gap → `gap survival probability' S < 1

→ Must be understood for LHC … e.g. CEP Higgs (S~1-3%)
→ Closely related to the underlying event, low-x saturation …

Diffractive Parton Densities from Fits to Inclusive Diffraction



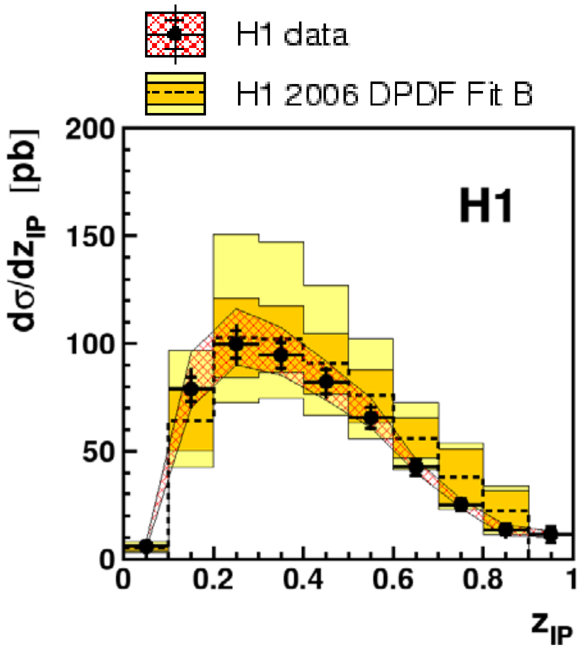


- Obtained in QCD collinear factorisation framework' …

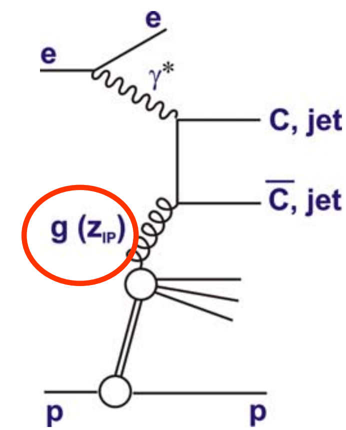
- $Q^2 > 8.5 GeV^2$ ensures negligible resolved γ^* Contribution / rescattering

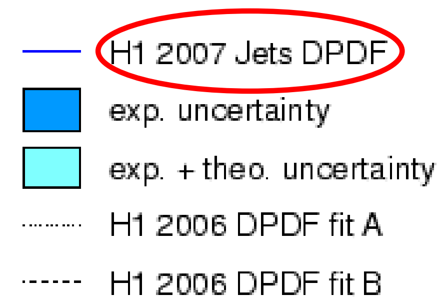
- Singlet quarks to ~5%, gluon to ~15% for z <~ 0.1, growing fast at higher z

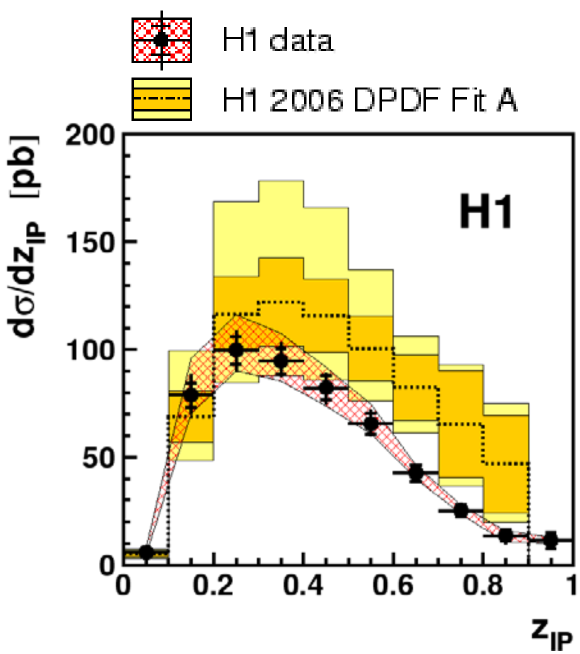
Factorisation, DIS Dijets & the high z Gluon

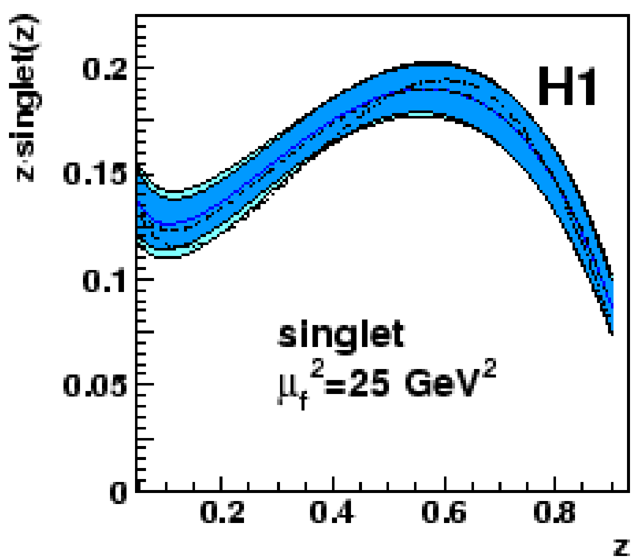


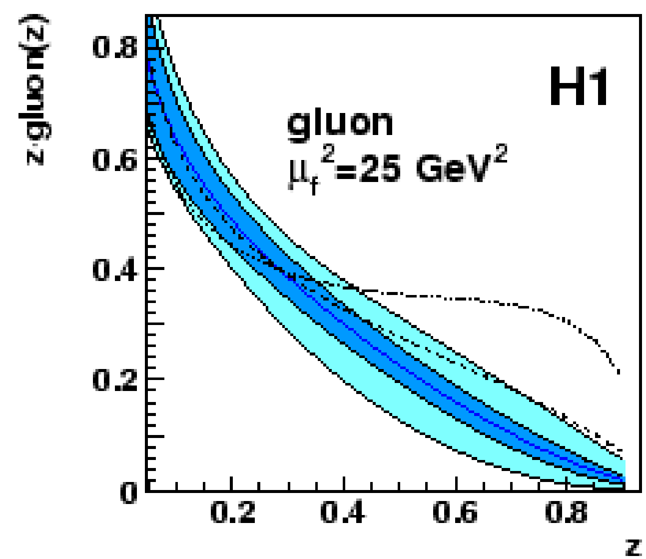
- Fit A, B describe diverse diffractive DIS data
- Dijet data dominantly at large z_{IP} … distinguish between `fit A' & `fit B'
- Include jet data in fit → `H1 2007 Jets' DPDFs





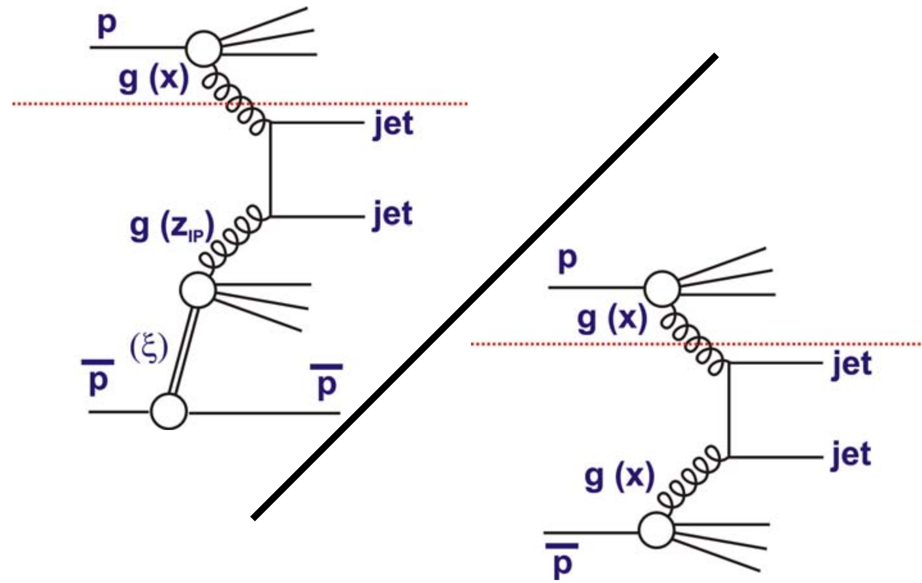






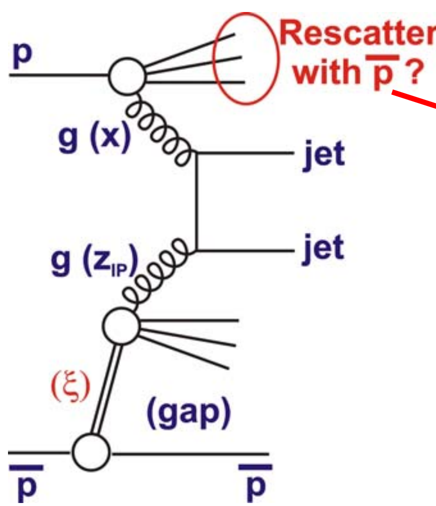
Moving to pp(bar) …

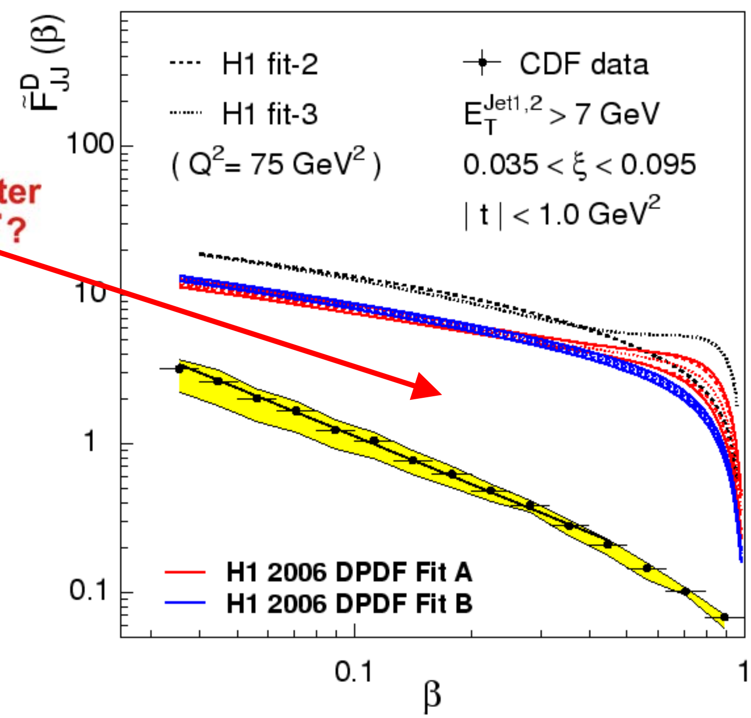
Effective DPDFs derived from **ratio of diffractive to total dijet cross sections** and (known) proton PDFs



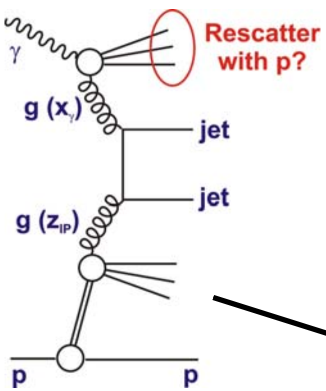
- Compared with predictions from HERA DPDFs, fact^n strongly broken …(z_{IP} dependent?) S ~ 0.1

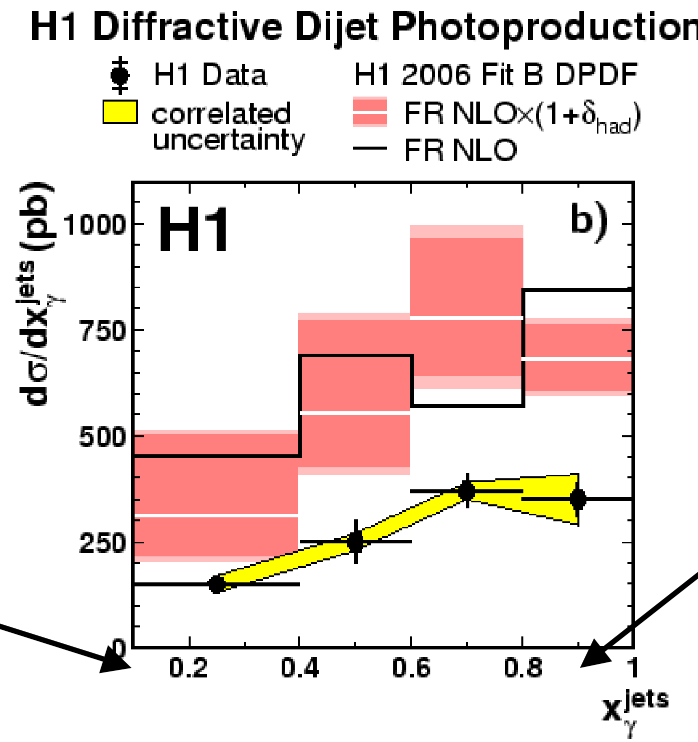
- Successfully explained in terms of rescattering / absorption e.g. by Kaidalov, Khoze, Martin & Ryskin

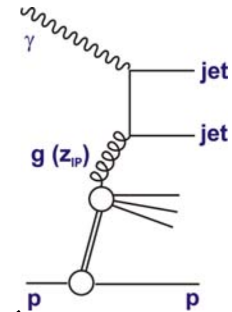


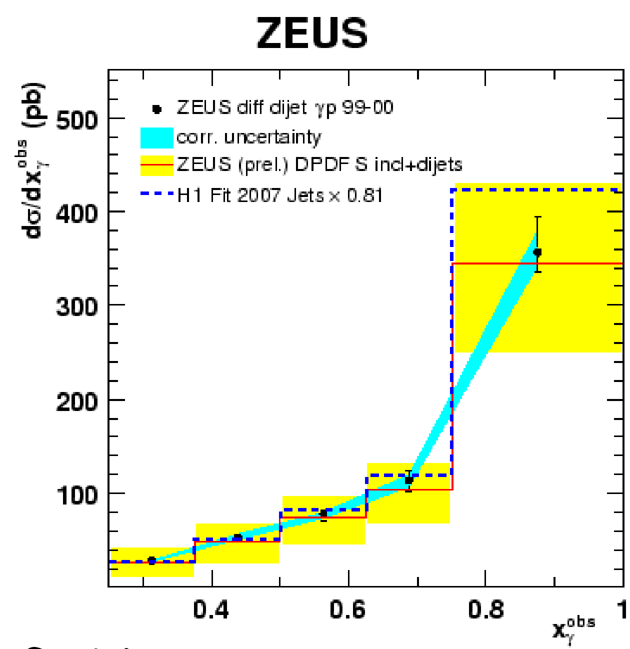


Previous γp Data









- No significant differences between descriptions of high and low x_γ regions!

- H1 97 (DESY07-018): $E_t^{jet1} > 5$ GeV

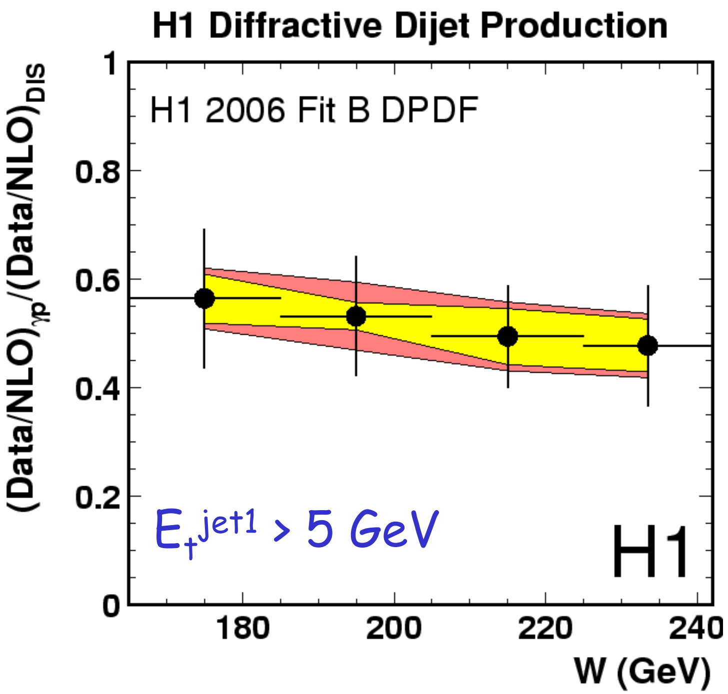
… suppression by factor ~2

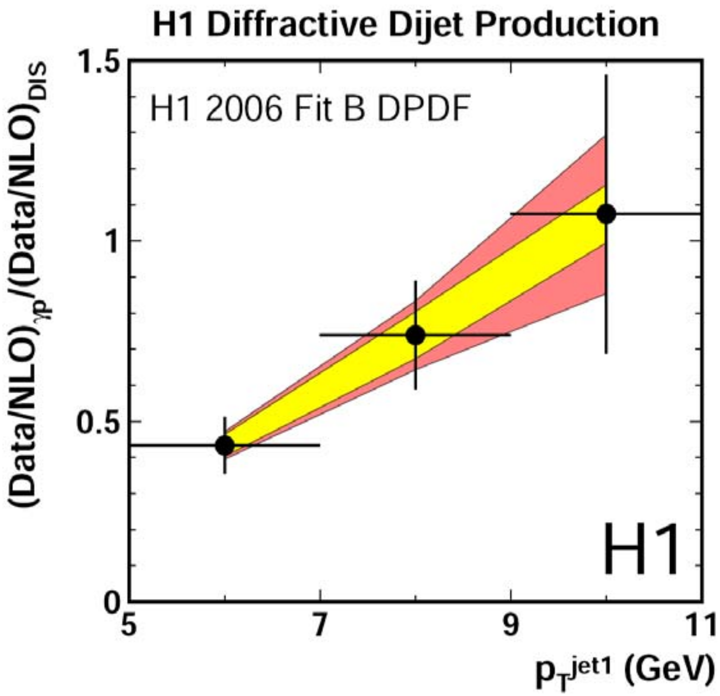
- ZEUS 99-00 (DESY 07-161): $E_t^{jet1} > 7.5$ GeV

… little or no suppression … E_T dependent effect

Double Ratios of (DIS : γp) (Data / NLO)

Working with double ratio leads to full or partial cancellation of many uncertainties (e.g. energy scales for data, sensitivity to DPDF choices for theory)

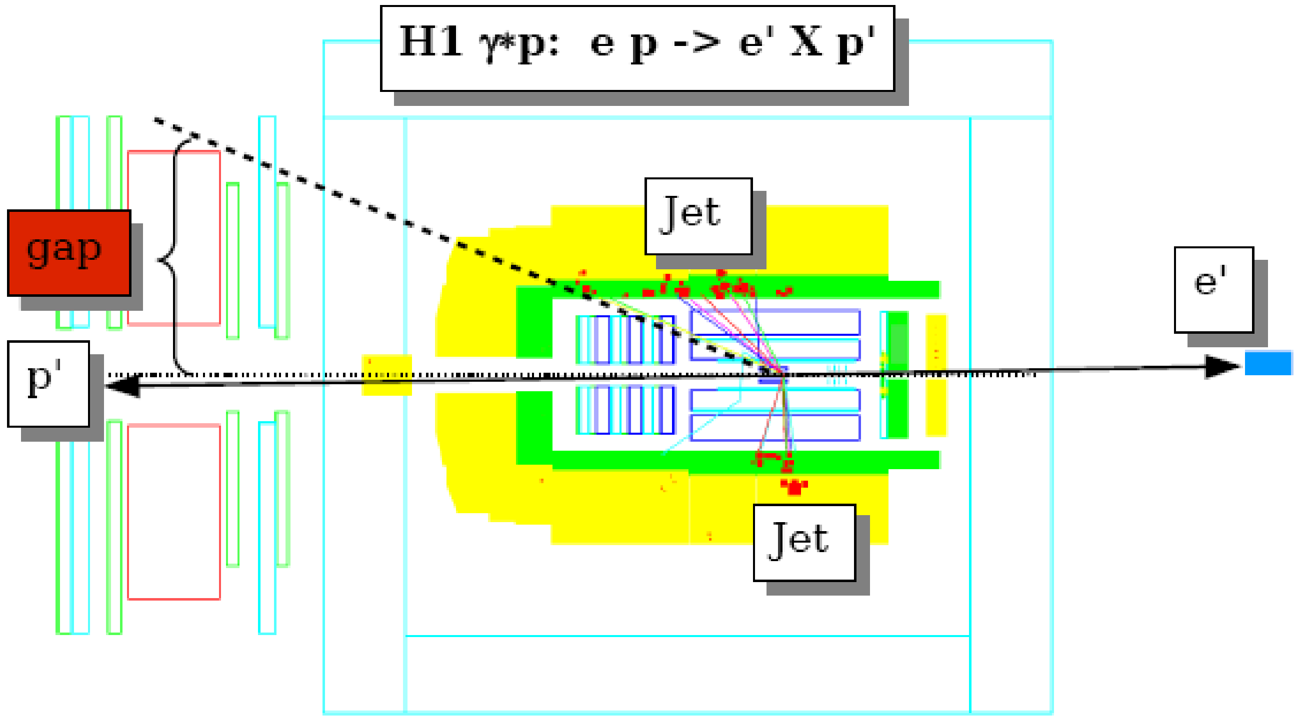




Another hint at jet E_t dependence …

… precision limited by statistics in DIS

Latest H1 Photoproduction Measurement



54 pb^{-1} of 1999-2000 data (3x previous H1 analysis)

Photoproduction selected by tagging outgoing electron @ 33m

Diffraction selected by requiring large forward rapidity gap

Dijet selection based on k_T longitudinally invariant algorithm

Phase Space and Theoretical Models

$0.3 < y < 0.65$
$|t| < 1\ \mathrm{GeV}^2$

$Q^2 < 0.01\ \mathrm{GeV}^2$
$M_Y < 1.6\ \mathrm{GeV}$

Region I
(matching previous H1)

$E_t^{jet1\,(jet2)} > 5\ (4)\ \mathrm{GeV}$
$-1 < \eta^{jet1,2} < 2$
$x_{IP} < 0.03$

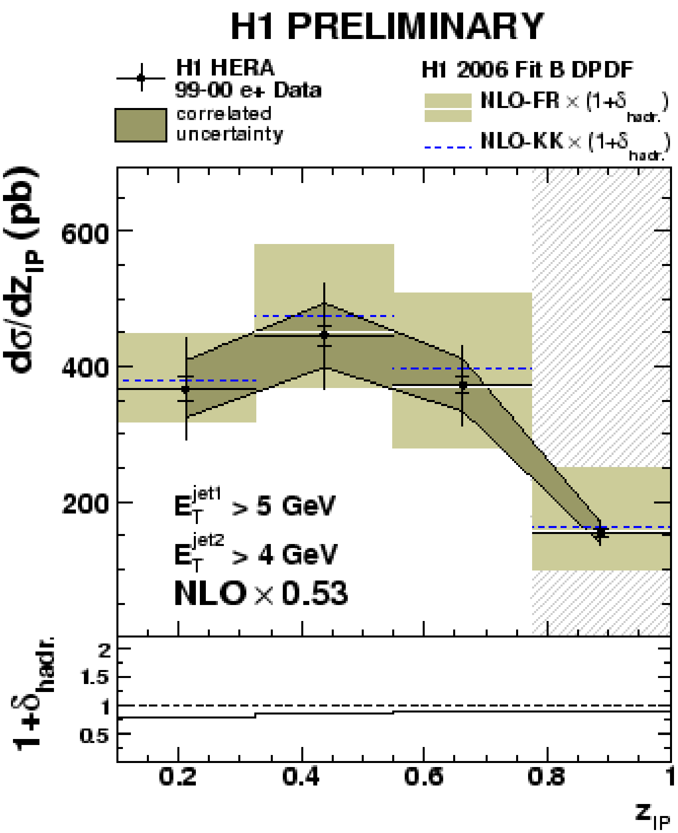
Region II
(matching ZEUS)

$E_t^{jet1\,(jet2)} > 7.5\ (6.5)\ \mathrm{GeV}$
$-1.5 < \eta^{jet1,2} < 1.5$
$x_{IP} < 0.025$

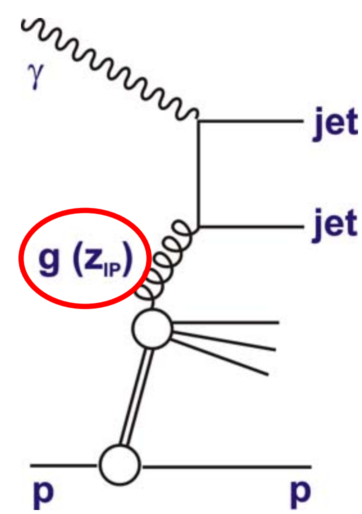
- Data are compared with NLO calculations using code from Frixione & Ridolfi (cross check with Klasen & Kramer):
3 Sets of DPDFs: H1 2006 fit B, H1 2006 fit A, H1 2007 Jets
GRV γ PDFs, $N_f=4$, $\Lambda_4=330$ MeV, $\mu_r=\mu_f=E_t^{jet1}$, DIS-γ scheme

- Experimental precision limited by HFS energy scale & Proton dissociation. Theory has large scale uncertainties …

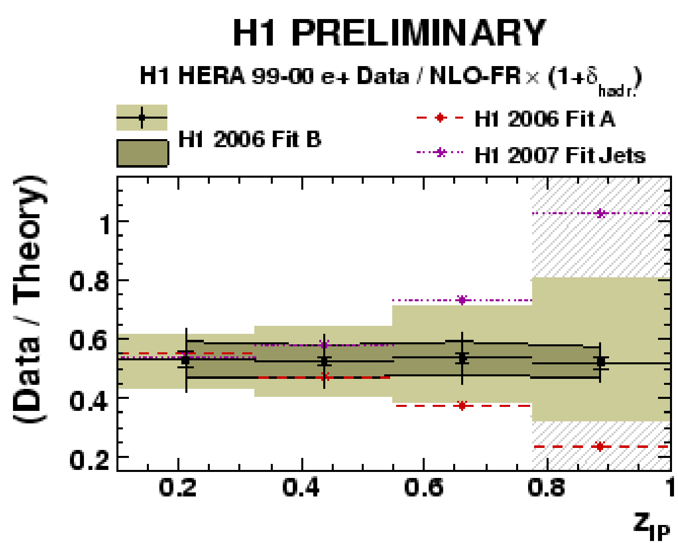
X-Section Differential in z_{IP}



$$z_{IP} = \frac{\sum_{jets} (E + p_z)}{2E_p \; x_{IP}}$$



Global suppression ~0.5 needed for NLO calculations … confirms previous result

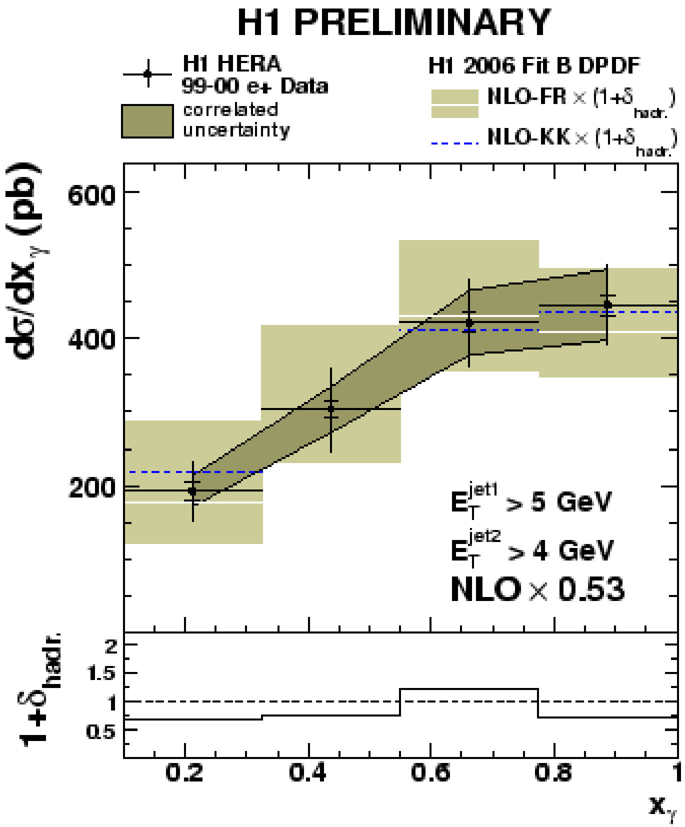


Best shape description from Fit B

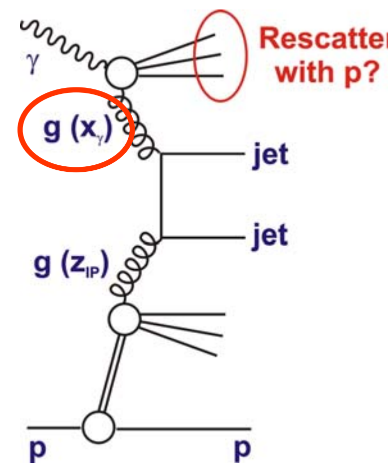
DPDF uncertainties small at low z_{IP}, but explode at high z_{IP} !

Highest z_{IP} bin is even beyond the range of DPDF fits, so predictions should be taken very cautiously

X-Section Differential in x_γ

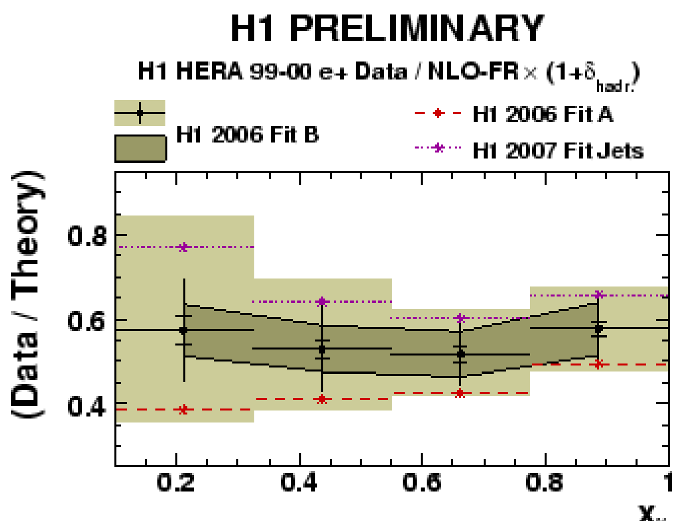


$$x_\gamma = \frac{\sum_{jets}(E - p_z)}{\sum_{HFS}(E - p_z)}$$



Again fit B describes shape

There remains no evidence for any difference between gap survival probabilities for direct and resolved photons ...



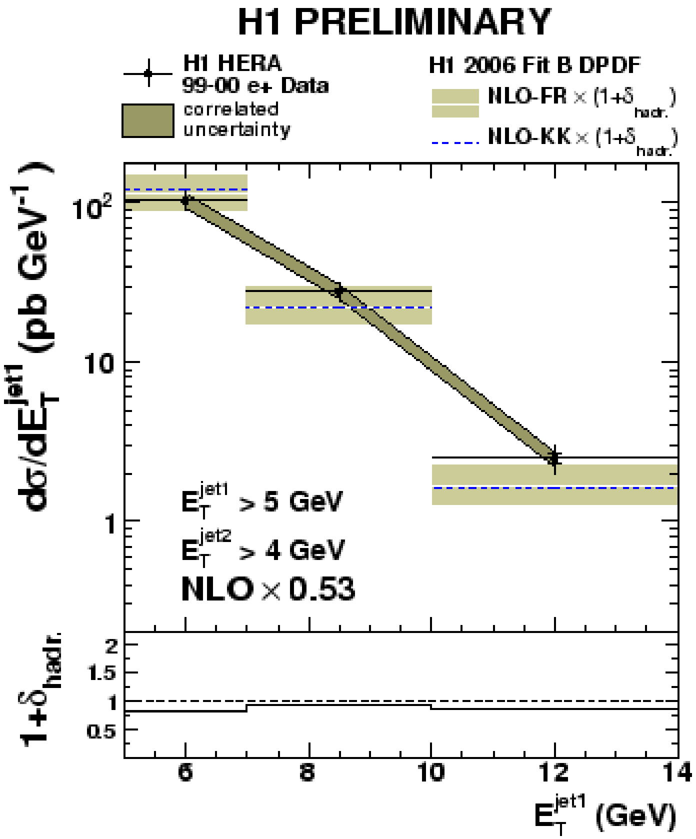
Integrated survival probabilities:

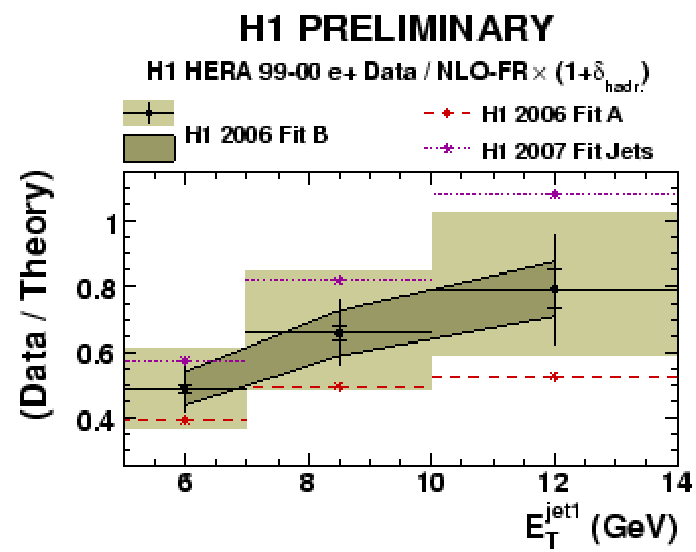
$$S(\text{fit B}) = 0.54 \pm 0.01(\text{stat.}) \pm 0.10(\text{syst.}) \pm 0.13(\text{scale})$$

$$S(\text{fit jets}) = 0.65 \pm 0.01(\text{stat.}) \pm 0.11(\text{syst.})$$

$$S(\text{fit A}) = 0.43 \pm 0.01(\text{stat.}) \pm 0.10(\text{syst.})$$

Cross Section Differential in E_T



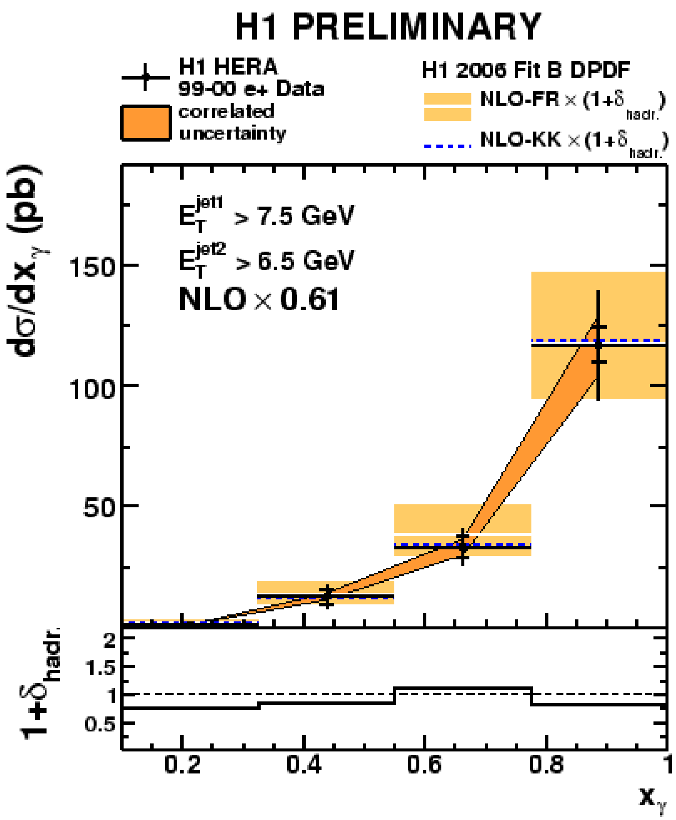


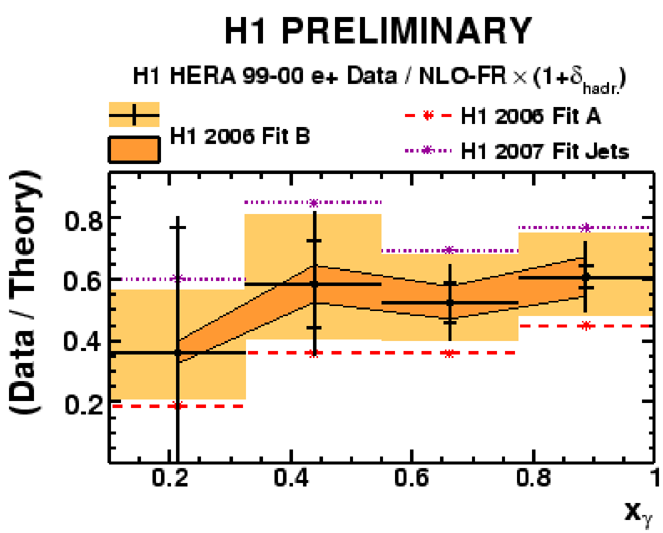
Another suggestion of harder Et dependence in data than NLO theory … thus of E_t dependent gap survival probability

Allowing all studied DPDF variations, survival probability for $5 < E_t^{jet1} < 7$ GeV is in range 0.3 … 0.7 (confirming previous H1 result)

For highest E_t^{jet1}, survival probability compatible with unity (c.f. previous ZEUS results)

x_γ Dependence at large E_T





Analysis repeated in kinematic range as close to ZEUS as possible … cross sections for …

$E_T^{jet1} > 7.5$ GeV $\quad$ $E_T^{jet2} > 6.5$ GeV

- Here, and for various other observables, fit B continues to describe shape well

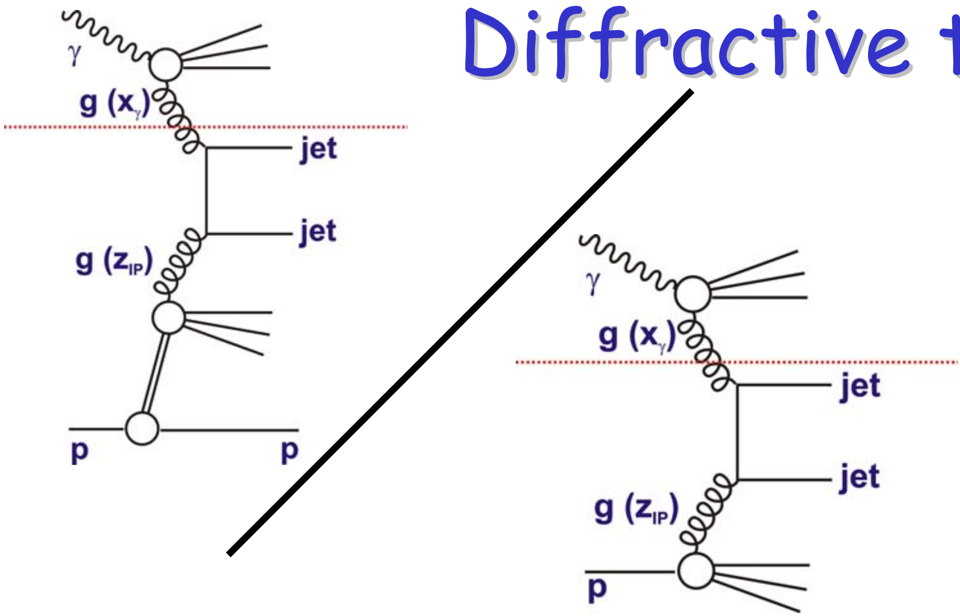
$$S(\text{fit B}) = 0.61 \pm 0.03(\text{stat.}) \pm 0.13(\text{syst.}) \pm 0.15(\text{scale})$$

$$S(\text{fit jets}) = 0.79 \pm 0.04(\text{stat.}) \pm 0.16(\text{syst.})$$

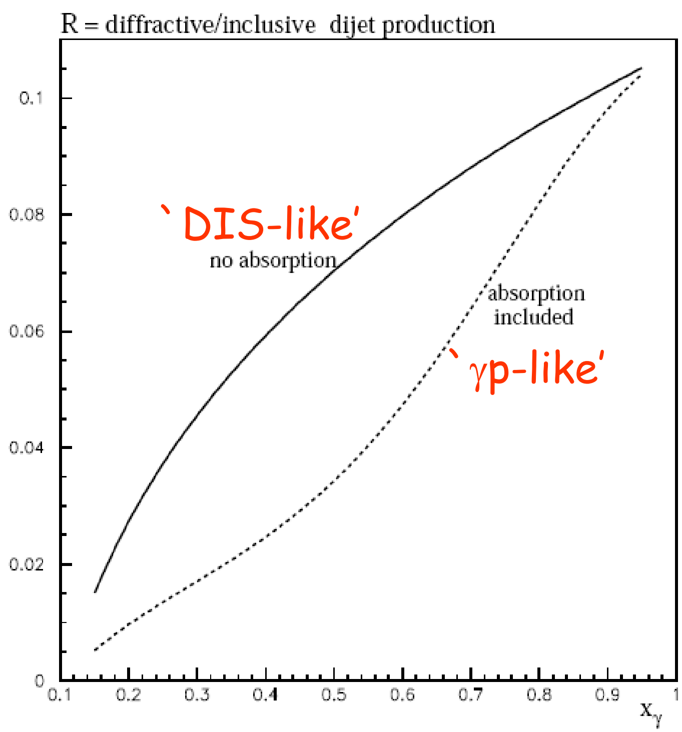
$$S(\text{fit A}) = 0.44 \pm 0.02(\text{stat.}) \pm 0.09(\text{syst.})$$

Small suppression …
… compatible with ZEUS results
… still no evidence for x_g dependence

Diffractive to Inclusive Ratios



… a la CDF, measures ratio of diffractive gluon (convaluted with flux) to inclusive gluon
… full or partial cancellation of photon PDFs, scale uncertainites, jet energy scales …



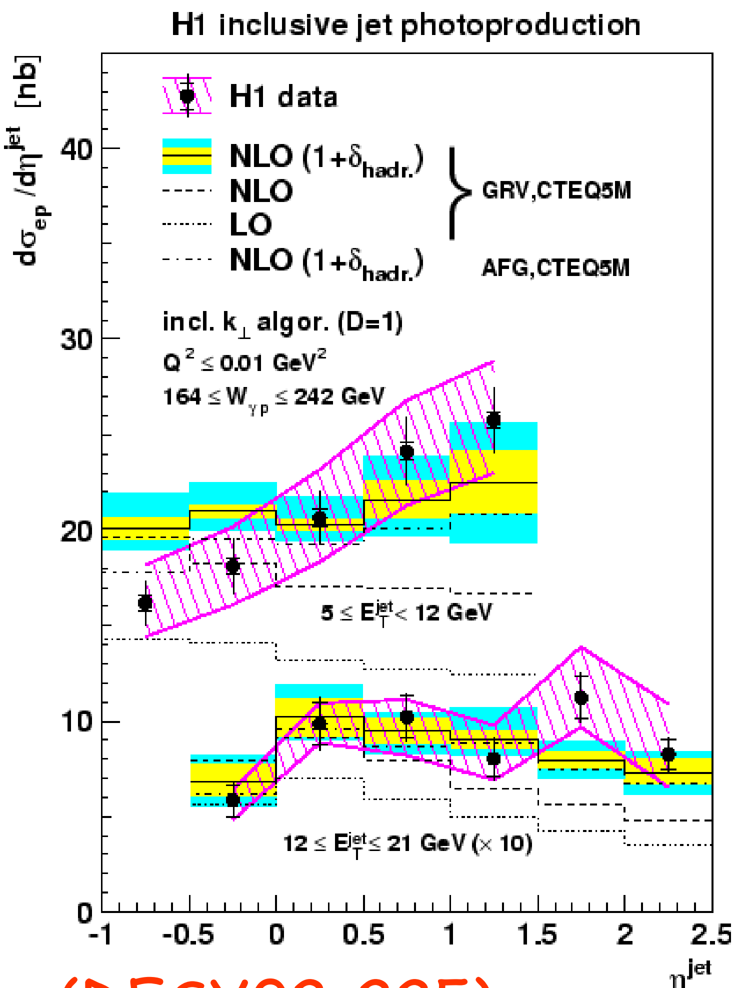
- x_γ dependence sensitive to absorption / gap survival, as well as differences between diffractive and inclusive phase space …

- e.g. Kaidalov et al.

Phys. Lett. **B567** (2003) 61.

Inclusive Cross Sections

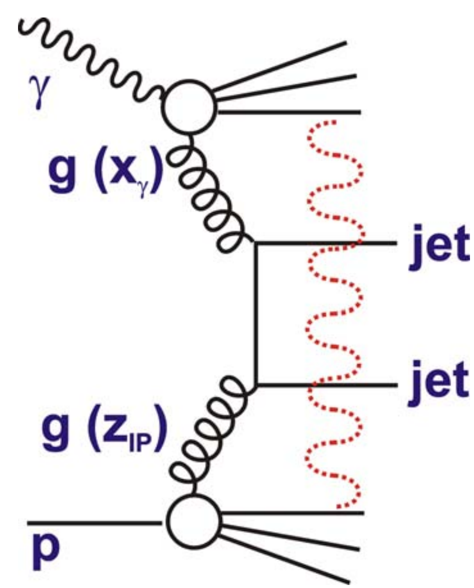
- Measured in same kinematic range with same method as diffractive cross sections
- Acceptance corrections using PYTHIA (CTeQ5L, GRV-G LO)



(DESY02-225)

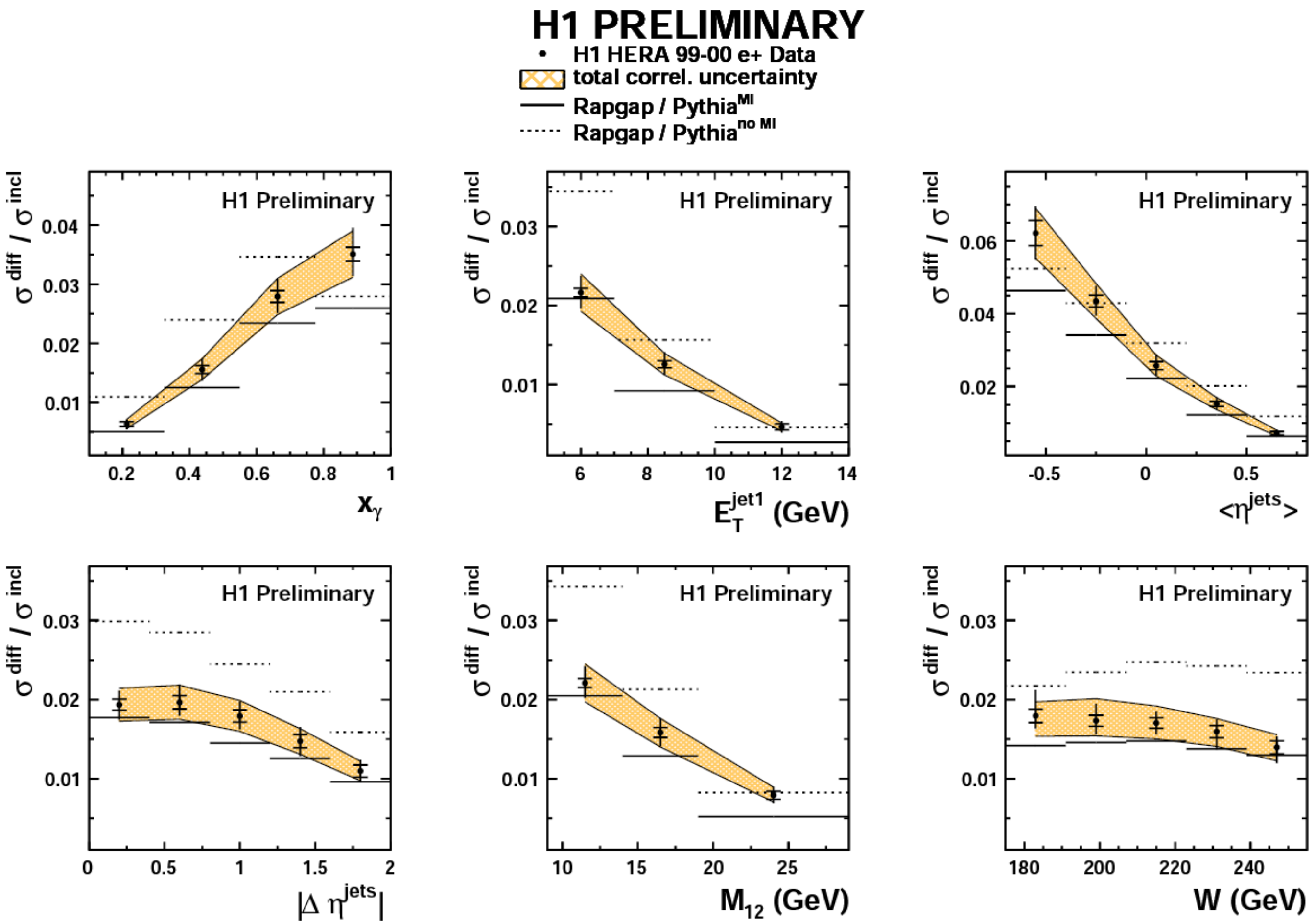
→ describes low E_T data only with inclusion of underlying event model (multiple interactions) & large hadronisation corrections

... introduces a large uncertainty ...



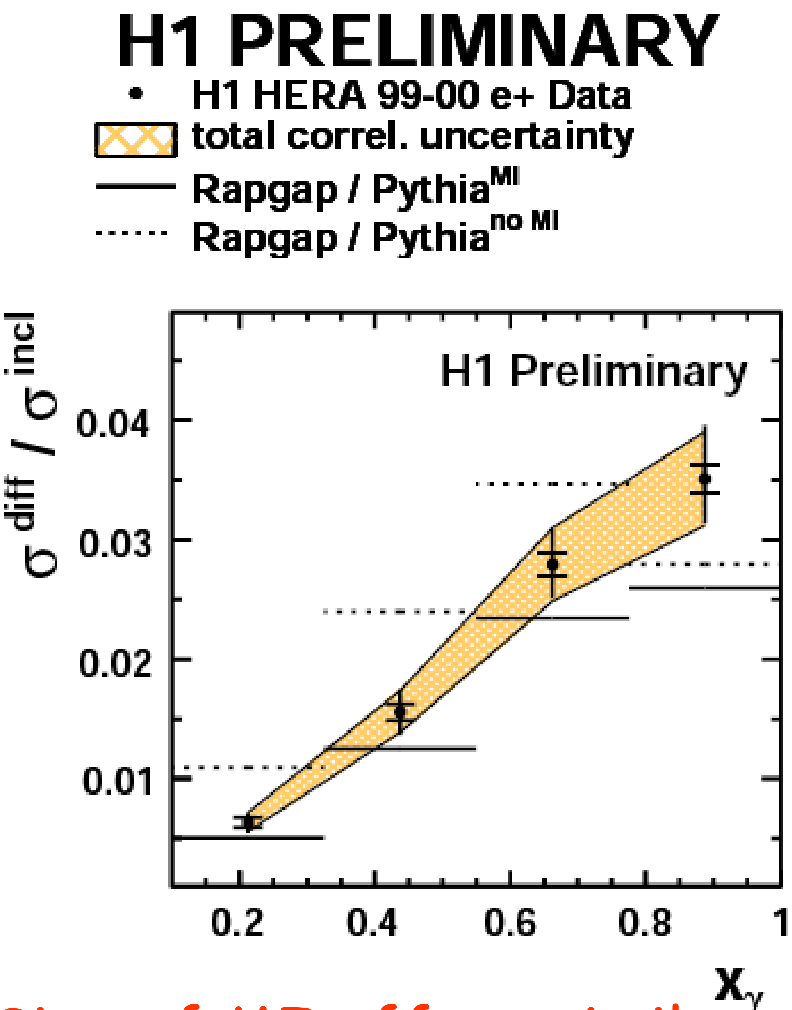
Diffractive to Inclusive Ratios

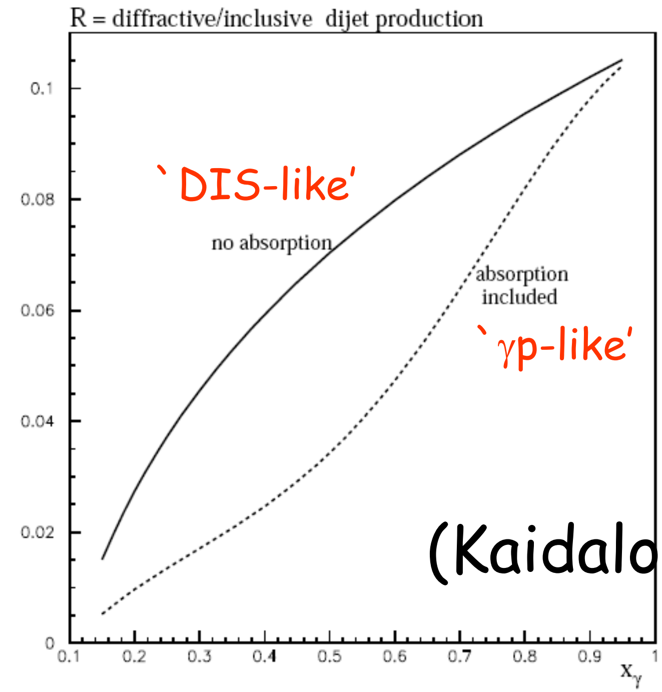
z_{IP} < 0.8 cut to reduce sensitivity to DPDF uncertainties



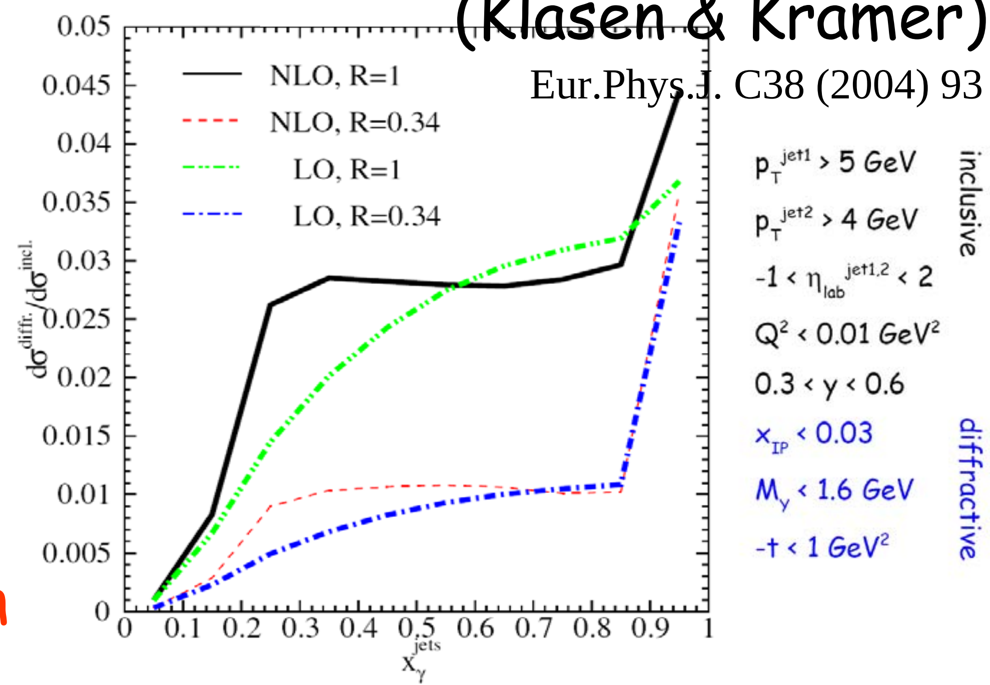
- Comparisons only with RAPGAP/PYTHIA ratios so far
- Dominant feature of distributions is phase space
- Large influence of adding multiple interactions

Diffractive / Inclusive





(Kaidalov et al.)



(Klasen & Kramer)

Eur.Phys.J. C38 (2004) 93

- Size of MI effect similar to that of absorption.
- MI Model → fair description

Summary

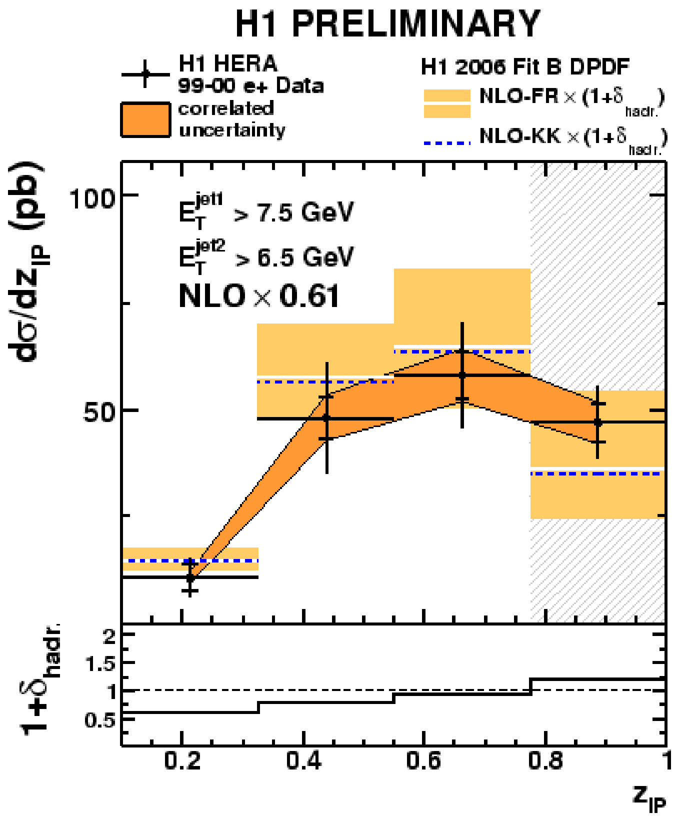
- New H1 data yield gap survival probability …
  …significantly less than unity at low E_t, low z_{IP}
  … but consistent with unity at high E_t

- (Weak) evidence that gap destruction becomes less likely as E_T increases …

- There remains no evidence for any dependence of this factor on x_γ

- Ratio of diffractive to inclusive photoproduction dijet cross sections measured for the first time …
  … general trends as expected
  … interpretation complicated by multiple scattering

z_{IP} Dependence at Larger E_t



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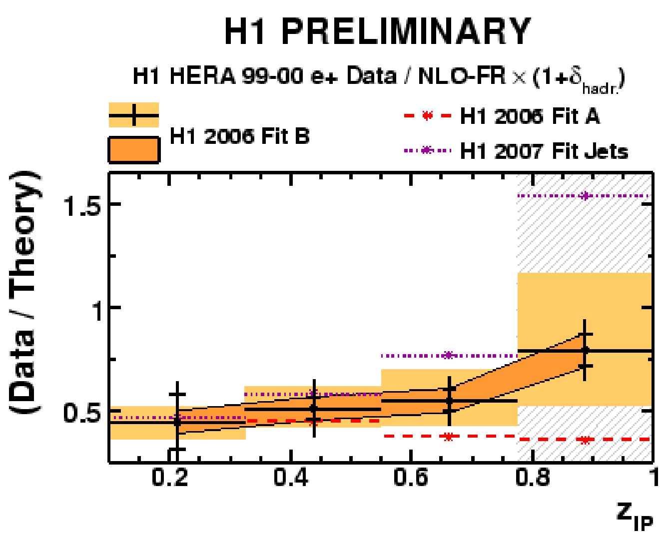

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