# Jets in Diffraction

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# Introduction



hard scattering
QCD-matrix element
perturbatively calculated
process-dependent

universal diffractive
parton densities
identical for all
DIS processes
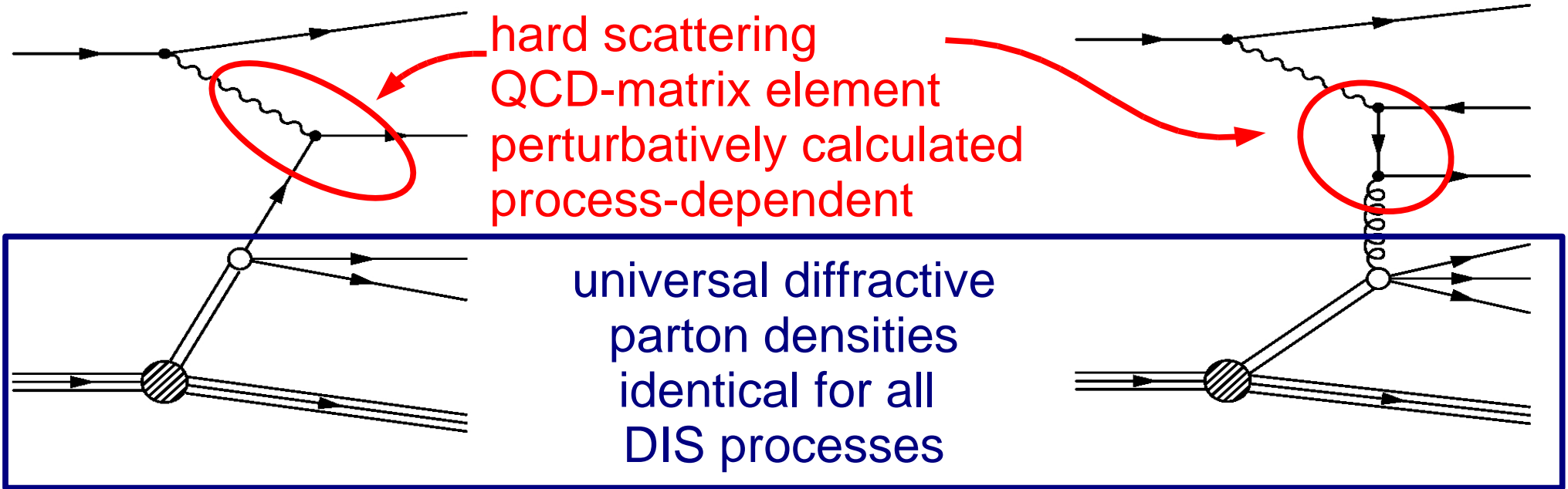
Measurement: $F_2^D$
quark measured
directly

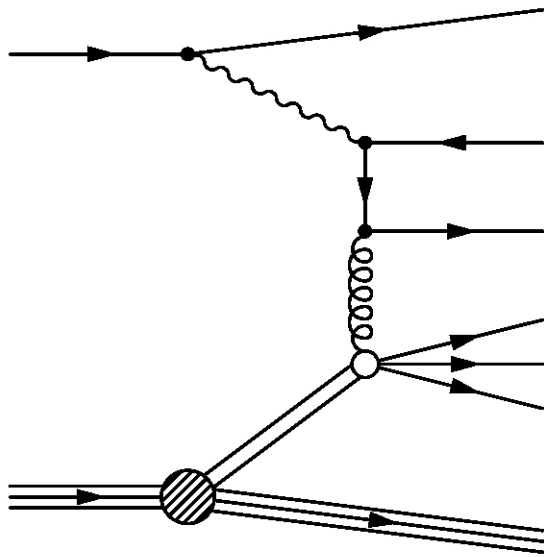Measurement: $\dfrac{d\sigma(dijet/charm)}{dz_{IP}}$

gluon measured
directly

- Factorization valid for DIS, fails in p-p (salvagable?)
- Test factorization: measure PDF's with one process, compare to others
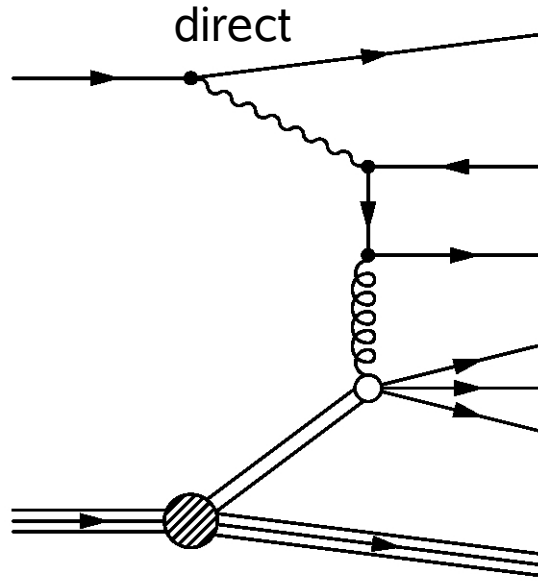- Improve precision by combining data sets

# Factorization

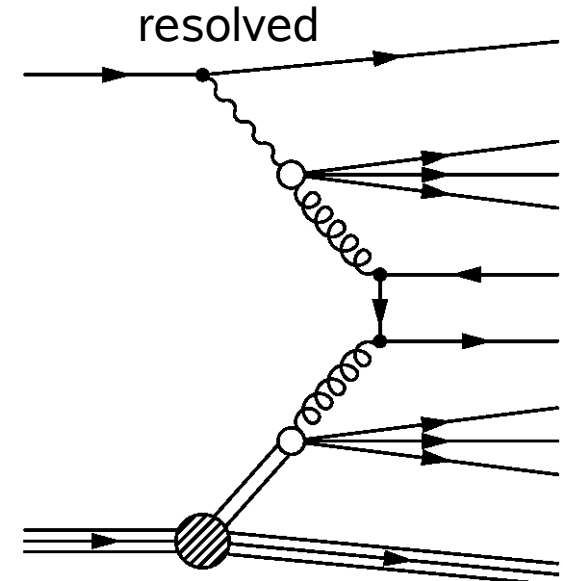$$\sigma_{diffractive} = \int \text{pdf} \cdot \sigma_{parton}$$

**DIS**

**γp**

direct

resolved

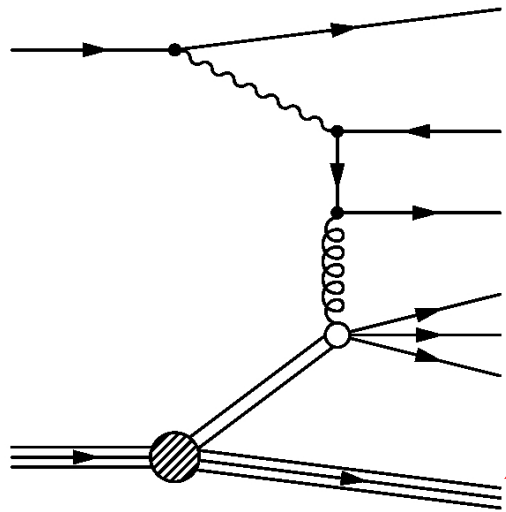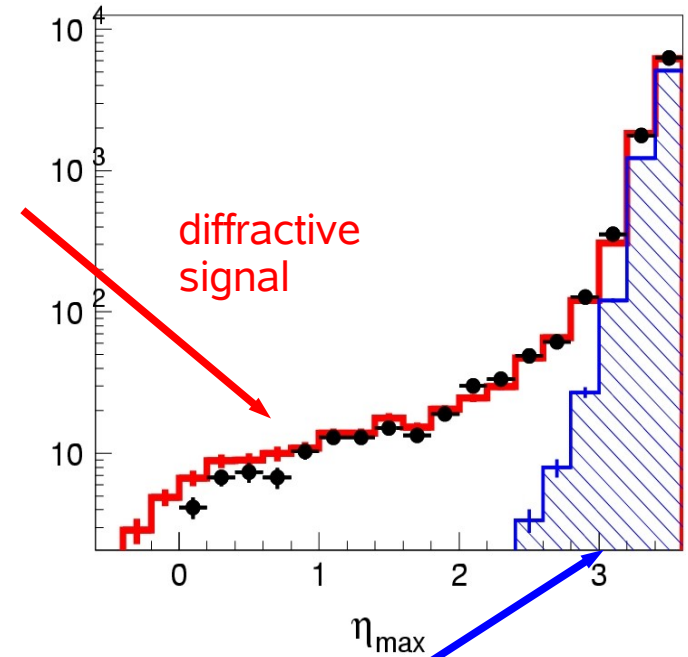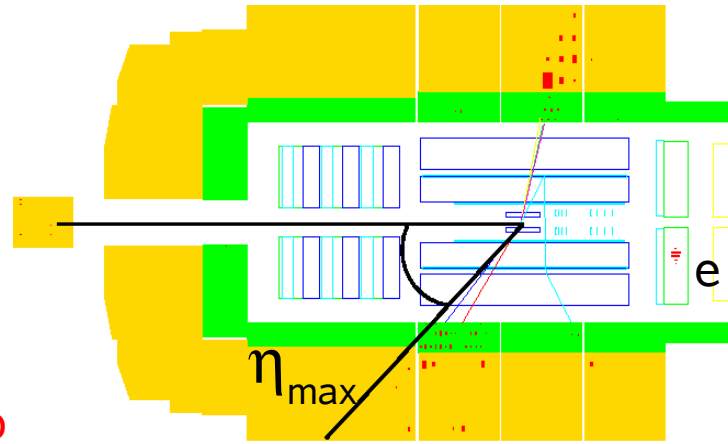expected to hold
(proof by collins)

holds maybe

modification essential
to account for
additional hadronic
interactions
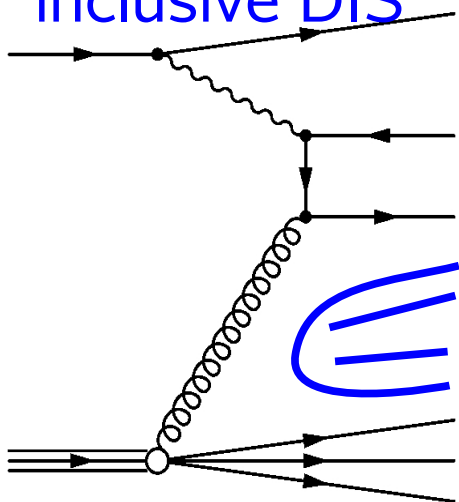(similar to p-p)

# Diffractive Event Selection
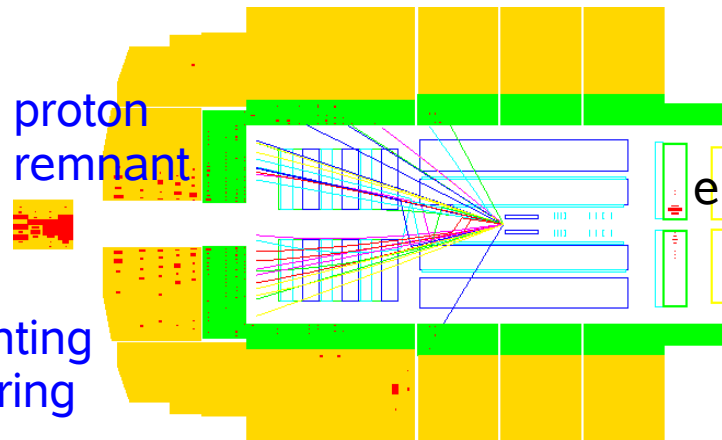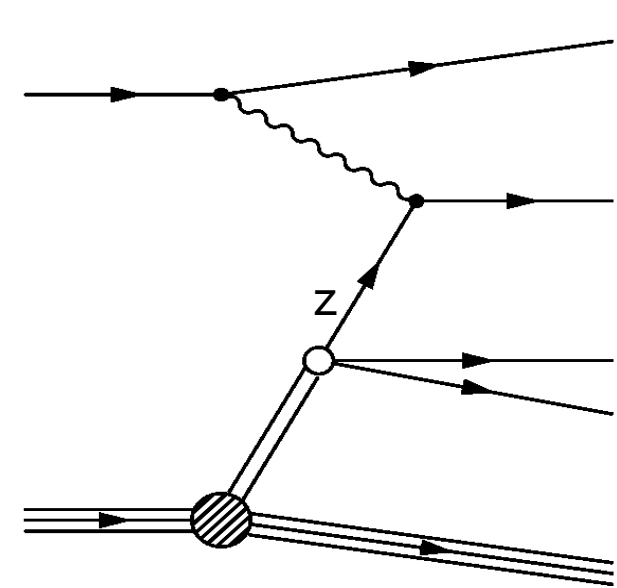## (rapidity gap)

**Diffraction**

no color-string

$\eta_{max}$

diffractive signal
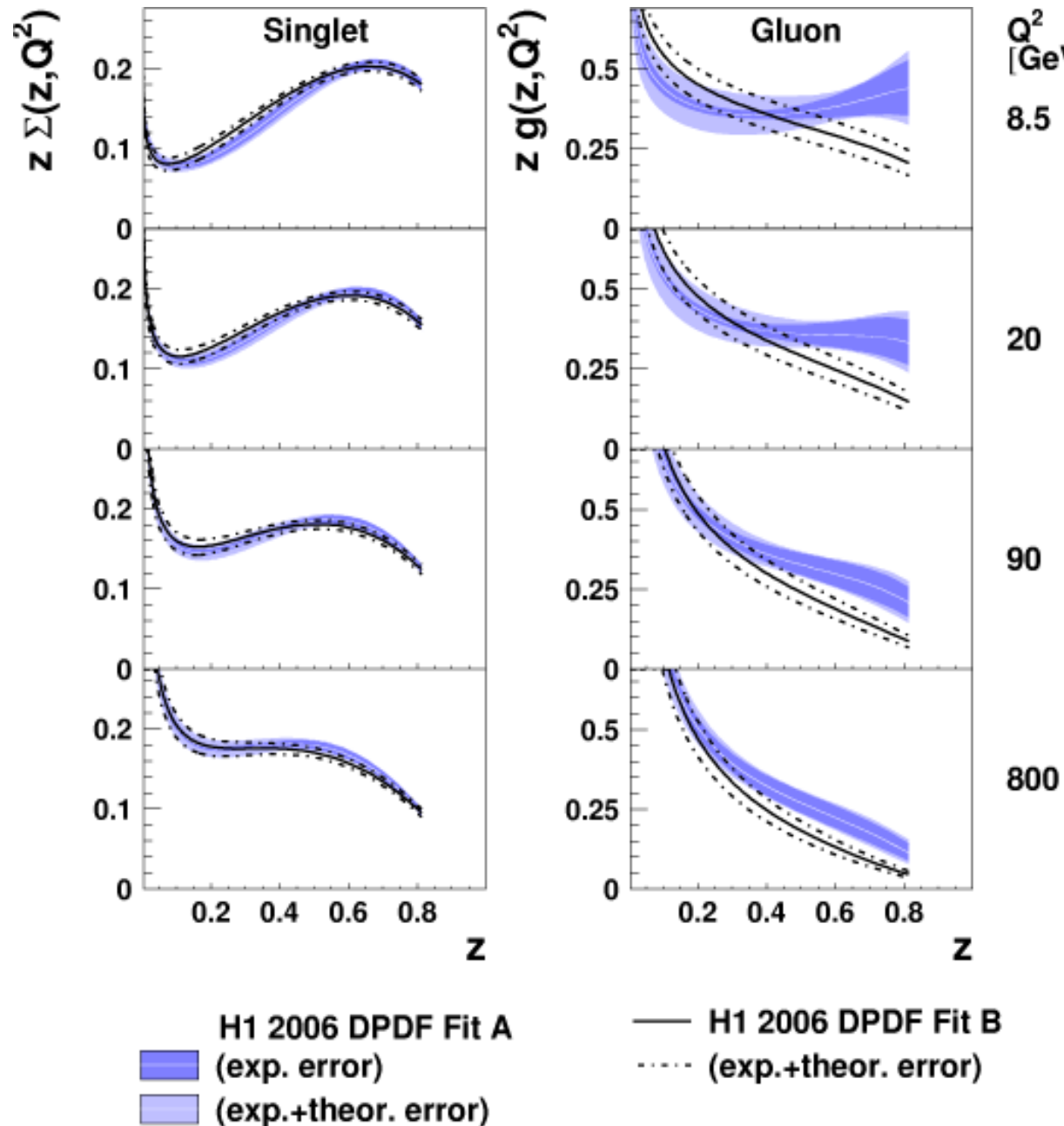
**inclusive DIS**

proton remnant

fragmenting color-string

non diffractive background

$\eta_{max}$

# Diffractive Parton Densities



- H1 DPDF fit A/B extracted from inclusive diffracitve scattering
- Quark density well constrained
- Gluon less well determined, especially at high z
- Large systematic uncertainties at high z

H1 2006 DPDF Fit A
(exp. error)
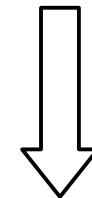(exp.+theor. error)

H1 2006 DPDF Fit B
(exp.+theor. error)

# Scaling Violations
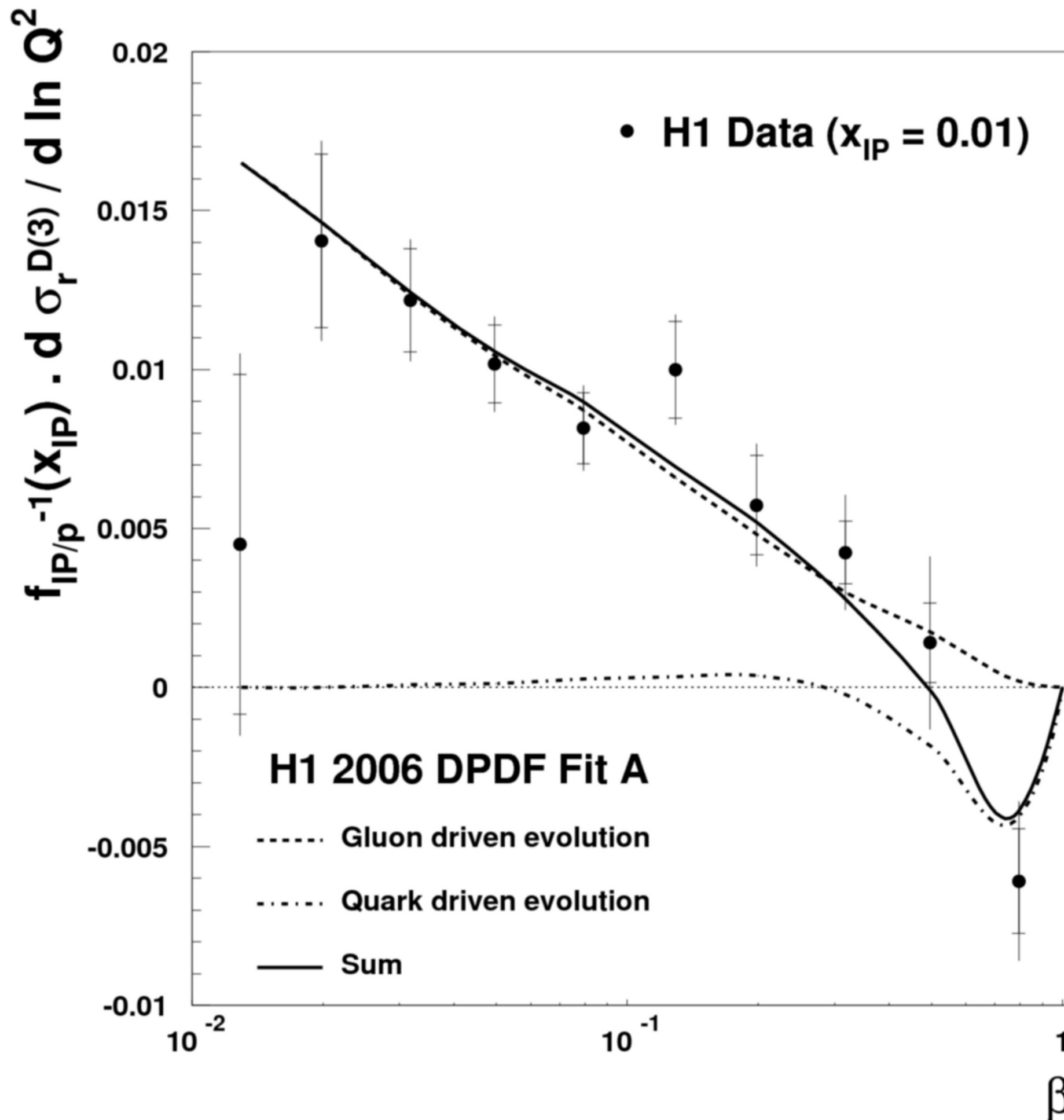


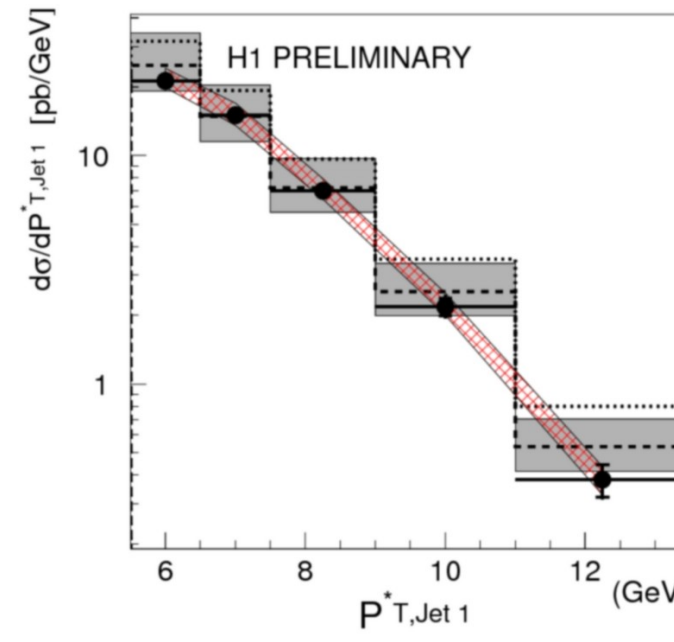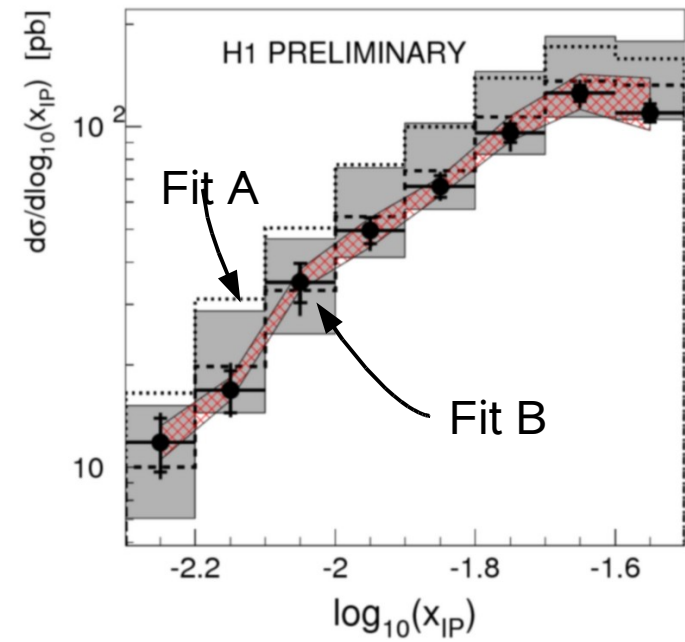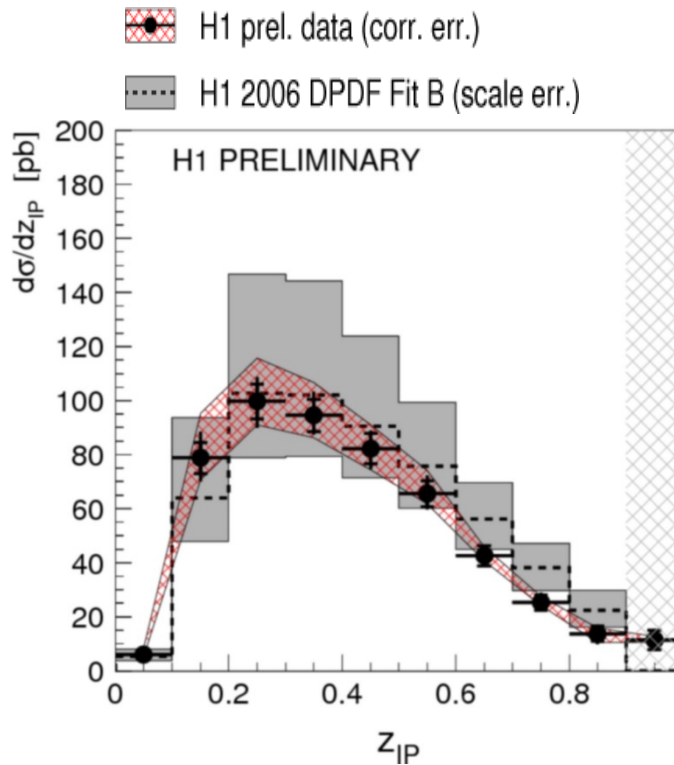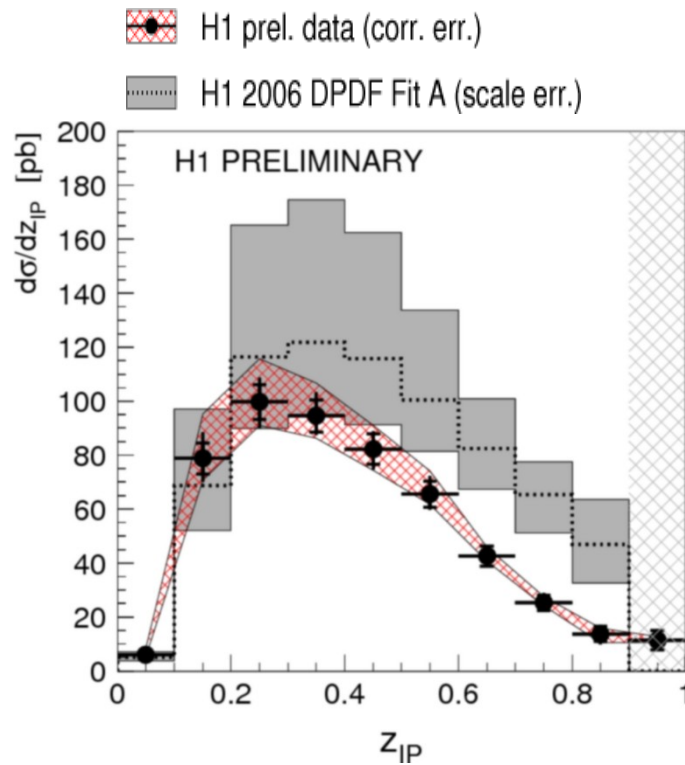gluon density derived from scaling violations

➕

scaling violations at high z dominated by quark contribution

⬇

little sensitivity for z<0.4
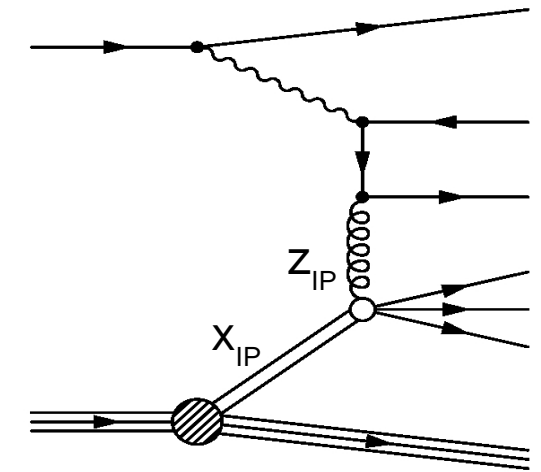
# Dijets in Diffractive DIS



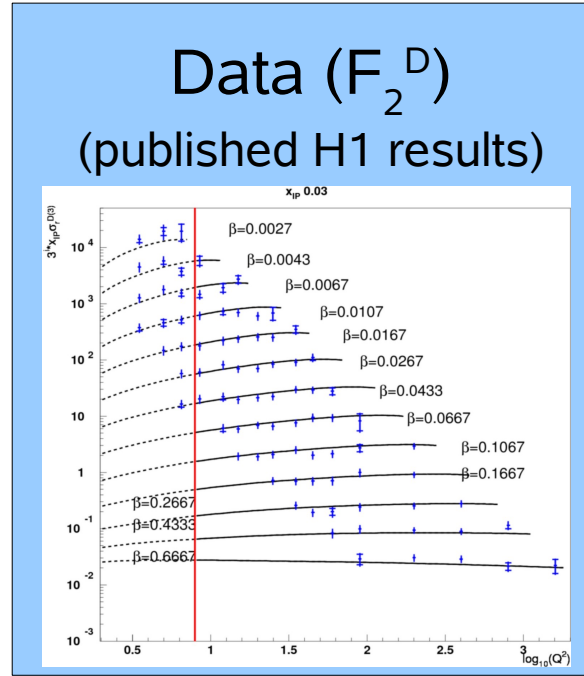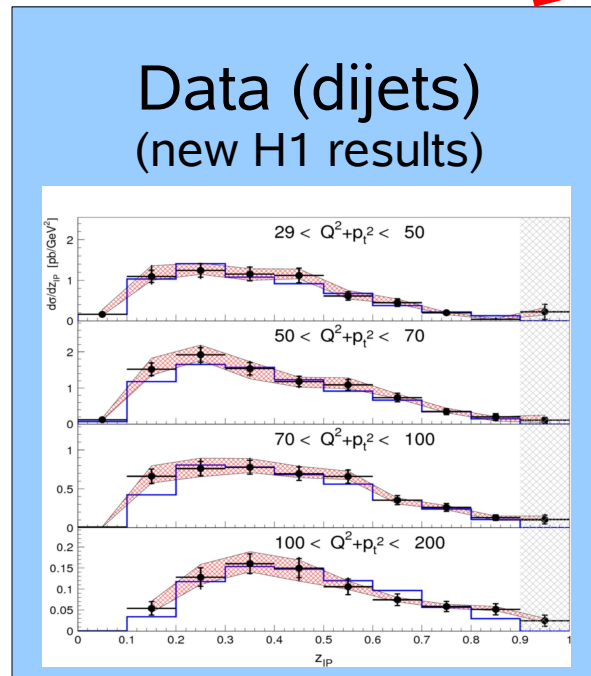**Selection:**
- incl $k_t$ in $\gamma p$ cms
- $4 < Q^2 < 80$ GeV$^2$
- $0.1 < y < 0.7$
- $p_{t1} > 5.5$, $p_{t2} > 4.5$ GeV

- nlojet++ (Z. Nagy)
- DPDFs H1 2006 Fit A&B
- $\mu^2 = Q^2 + p_t^2$

- Problematic at high $z_{IP}$
- Fit B better than Fit A

# Extraction of Parton-Densities



Data (dijets)
(new H1 results)

Data ($F_2^D$)
(published H1 results)

$\chi^2$

fixed parameters

• $\alpha_s(M_Z)=0.118$
• reggeon-structure

free parameters

• parton-densities (6)
  $Ax^B(1-x)^C$
• pomeron-Flux (1)
• reggeon-norm. (1)

NLO prediction

compute $F_2^D$ in NLO

NLO dijet prediction
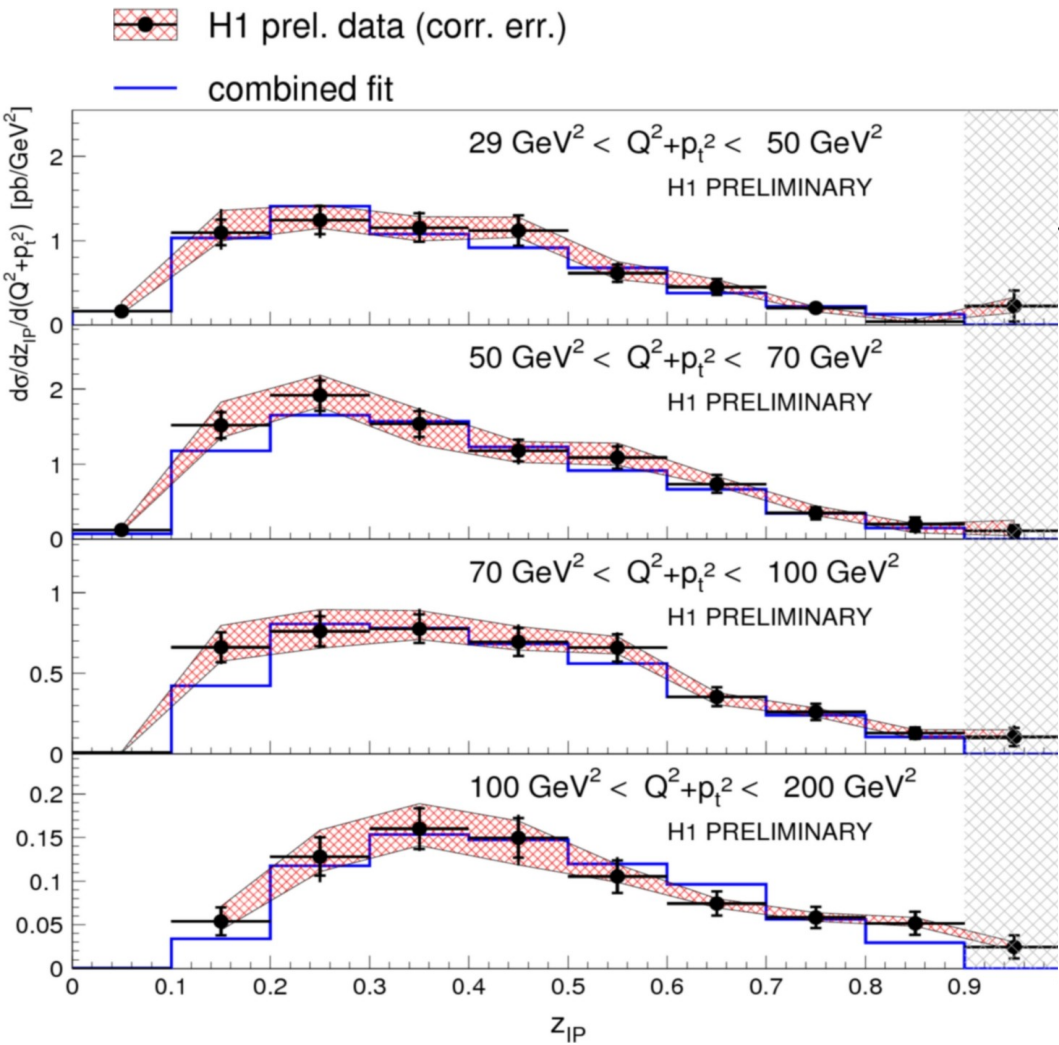(parameterized like ZEUS)

DGLAP evolved
parton-densities

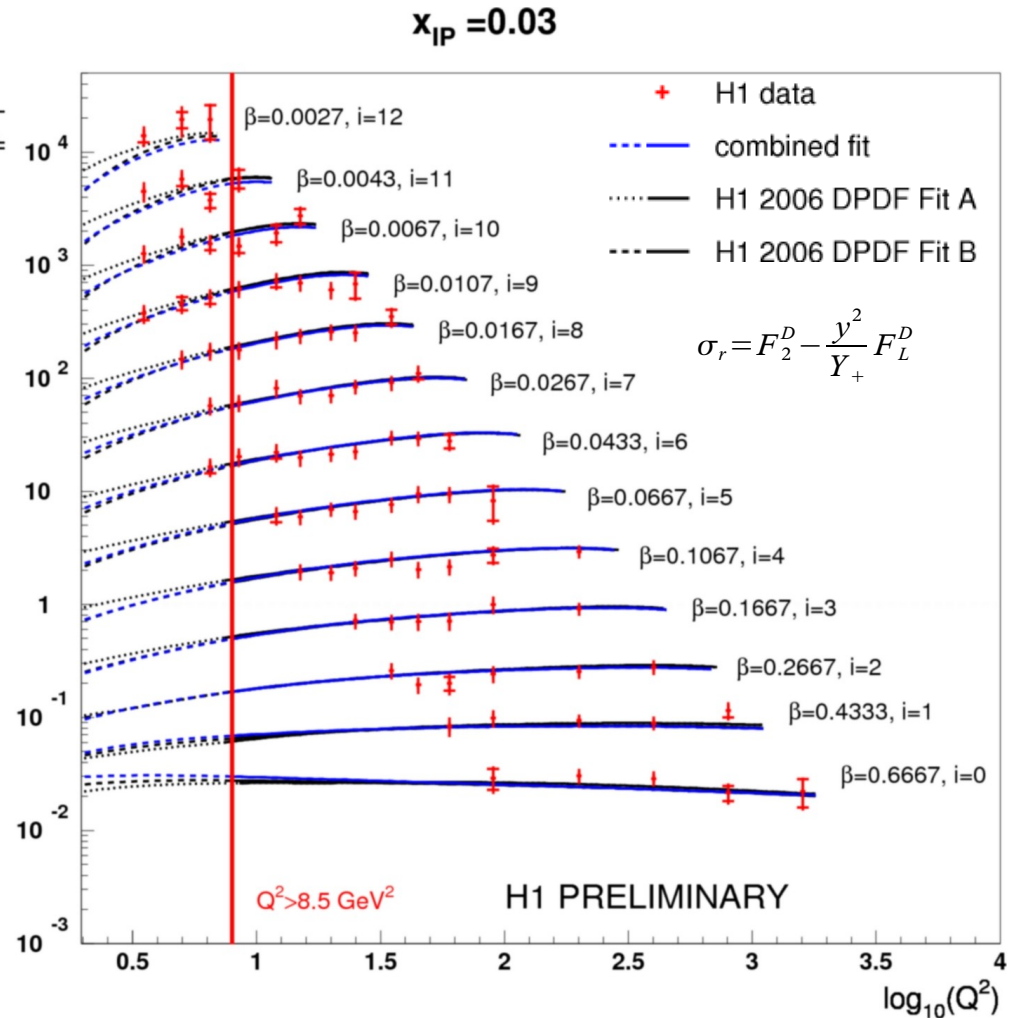DGLAP-evolution
$\chi^2$-Minimization

New
Parton-Densities

# Combined Fit (Incl. + Dijets)



Fit describes dijets well
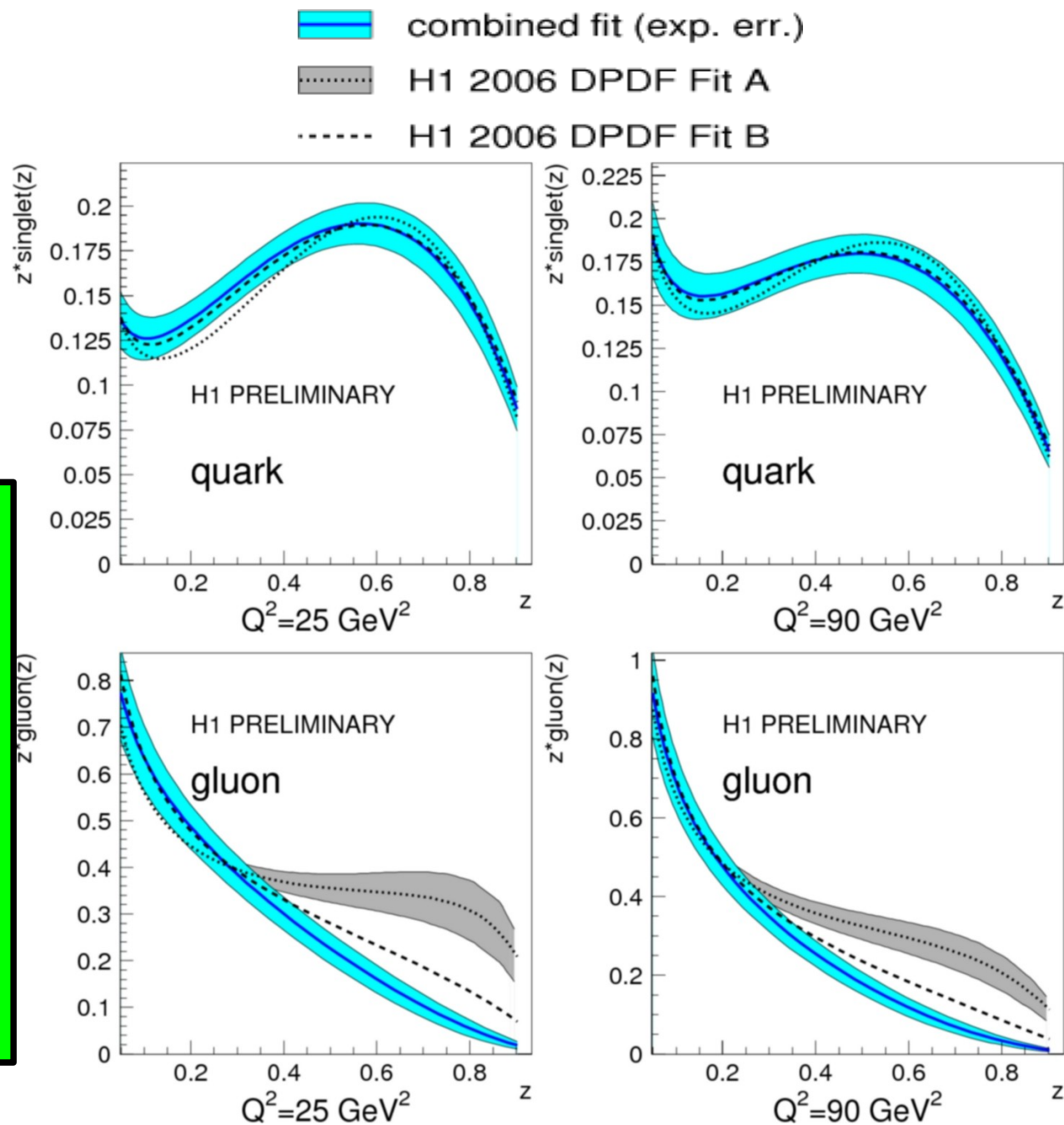
Little difference in description of inclusive data

**Simultaneous description of Dijets and Inclusive results: Factorization**

# Improved parton densities

- $\chi^2/ndf = 196/217$
- $\chi^2/ndf$ (dijets) $= 27/36$
- $\chi^2/ndf$ ($F_2^D$) $= 169/190$
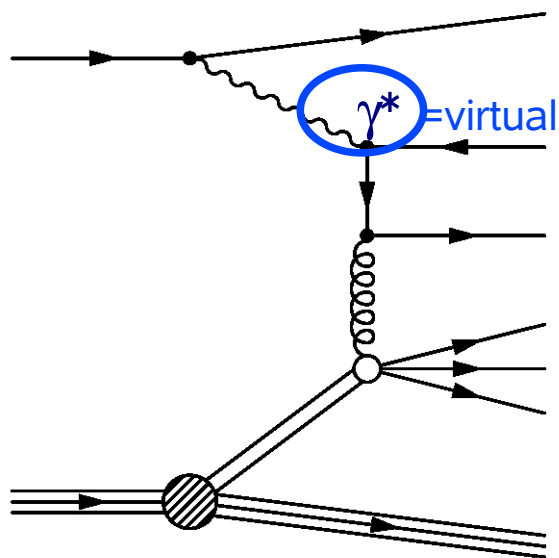
- $\chi^2$(Fit A) $= 158$
- $\chi^2$(Fit B) $= 164$

- good agreement for singlet and low $z_{IP}$ gluon
- improved measurement of high $z_{IP}$ gluon
- soon to be published



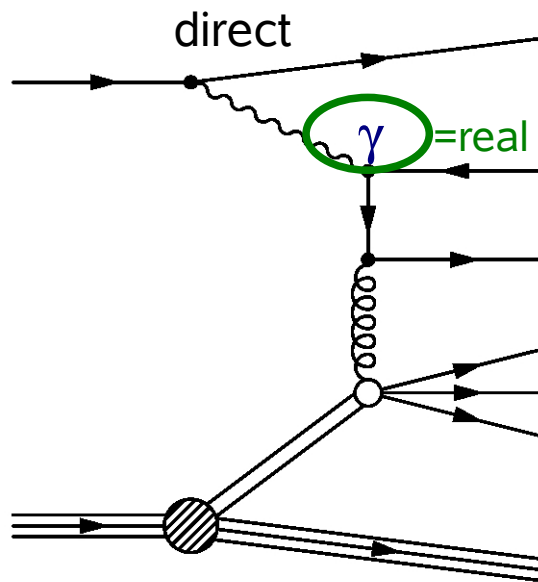combined fit (exp. err.)
H1 2006 DPDF Fit A
H1 2006 DPDF Fit B

H1 PRELIMINARY
quark
$Q^2 = 25$ GeV$^2$

H1 PRELIMINARY
quark
$Q^2 = 90$ GeV$^2$

H1 PRELIMINARY
gluon
$Q^2 = 25$ GeV$^2$

H1 PRELIMINARY
gluon
$Q^2 = 90$ GeV$^2$

# γp: the Transition to Hadron-Hadron



**DIS**

**Photoproduction (γp)**

direct

resolved

γ* =virtual

γ =real

γ

spectator Interactions

Lepton-Hadron

Photon-Hadron

Hadron-Hadron

# Dijets in γp



Frixione NLO code
+ hadronizarion correction

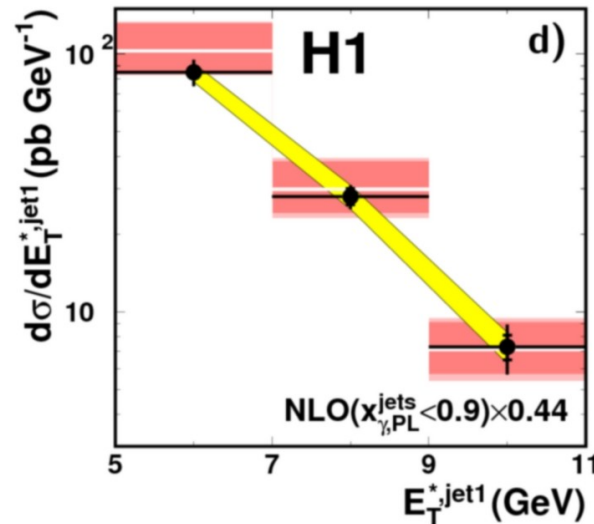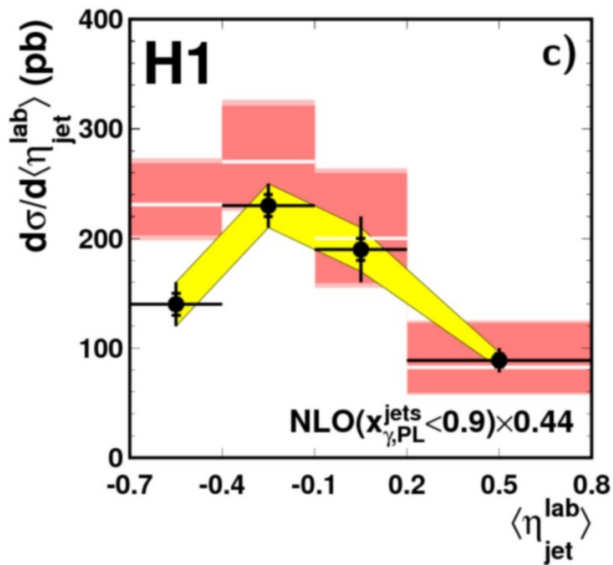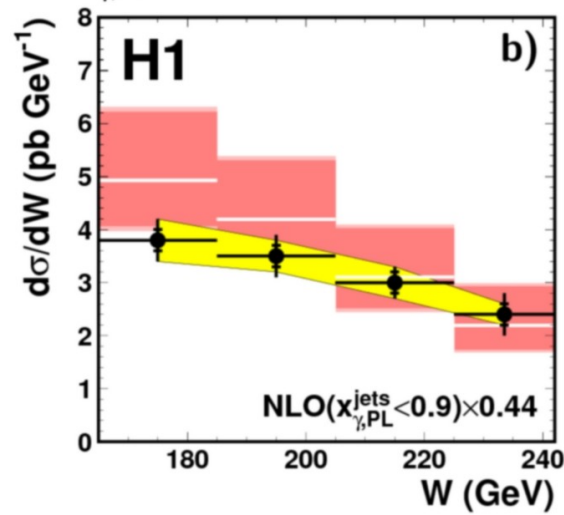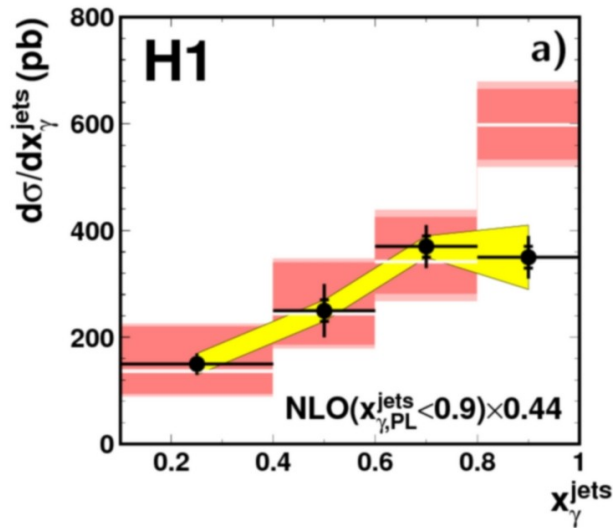**H1 Diffractive Dijet Photoproduction**
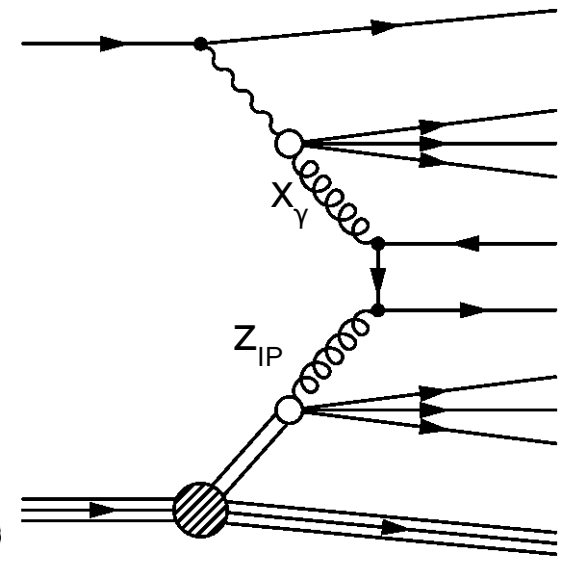
- large violation of naive factorization observed
- factorization breaking occurs in direct and resolved processes

# Suppressed Resolved Contribution



**H1 Diffractive Dijet Photoproduction**

- H1 Data
- correlated uncertainty
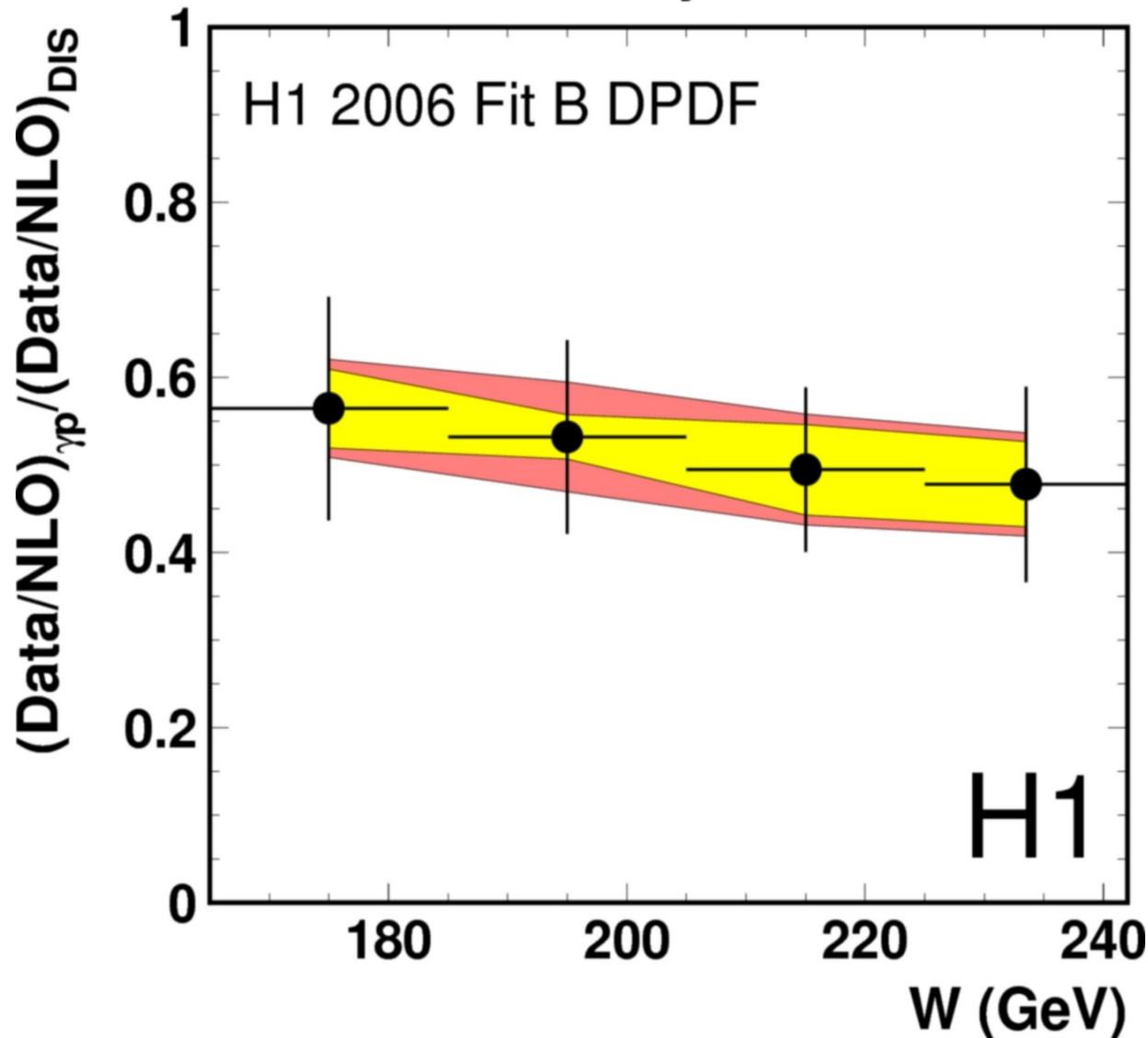- H1 2006 Fit B DPDF
- FR NLO$\times(1+\delta_{had})$, $(x^{jets}_{\gamma,PL}<0.9)\times0.44$

- resolved contribution scaled by 0.44

- description somewhat better than naive factorisation approach

- shapes not well described

# Double Ratio

## H1 Diffractive Dijet Production



H1 2006 Fit B DPDF
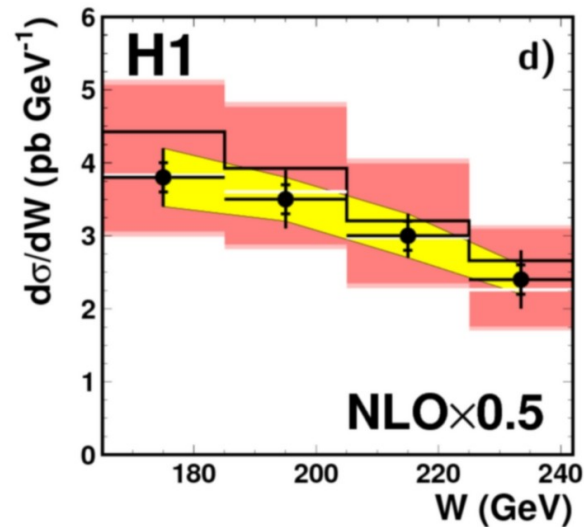
H1

$$\frac{(Data/NLO)_{\gamma p}}{(Data/NLO)_{DIS}}$$
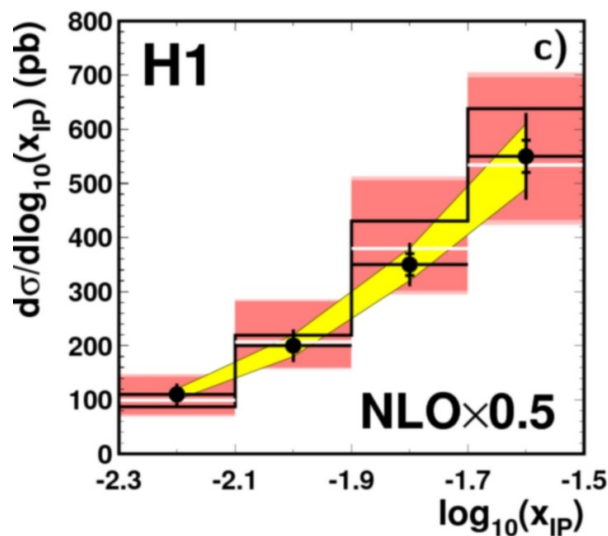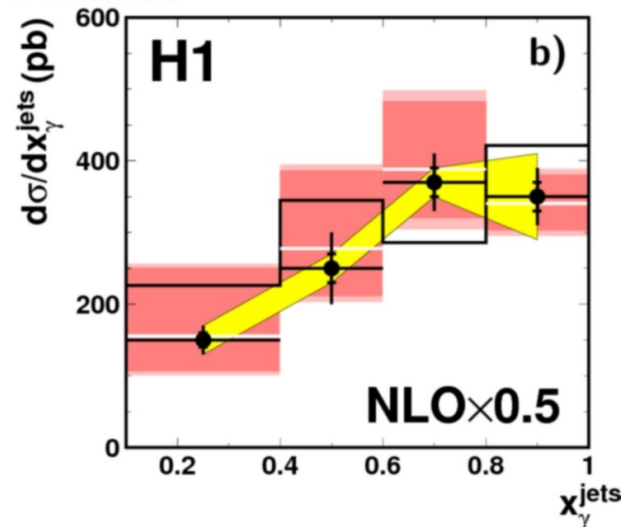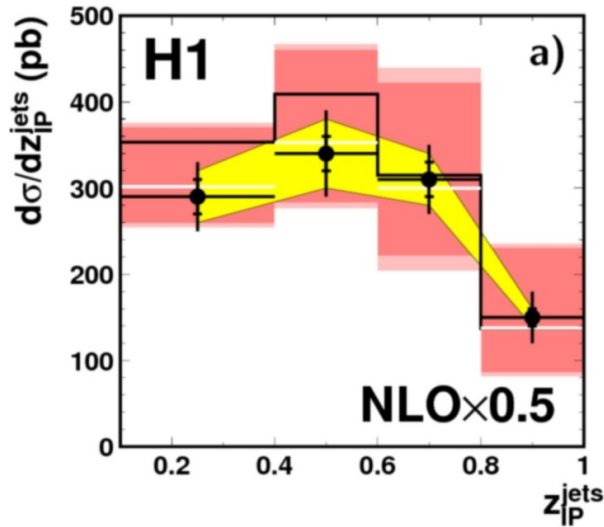
- shows differences in description of DIS and γp data

- reduced systematic uncertainties

- Gap-Survival in γp ≈0.5, independent of kinematics

# Global Suppression



H1 Diffractive Dijet Photoproduction
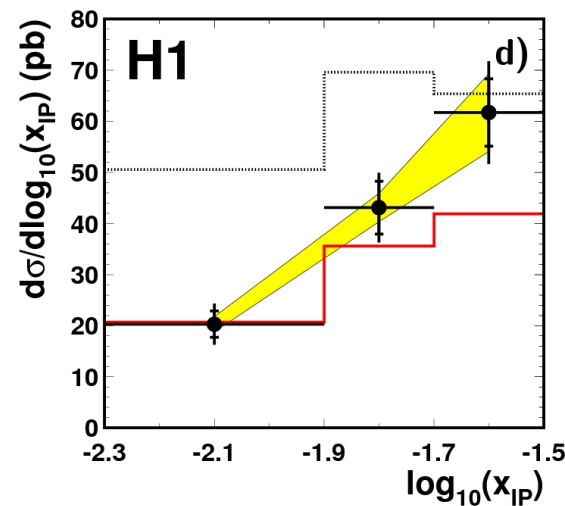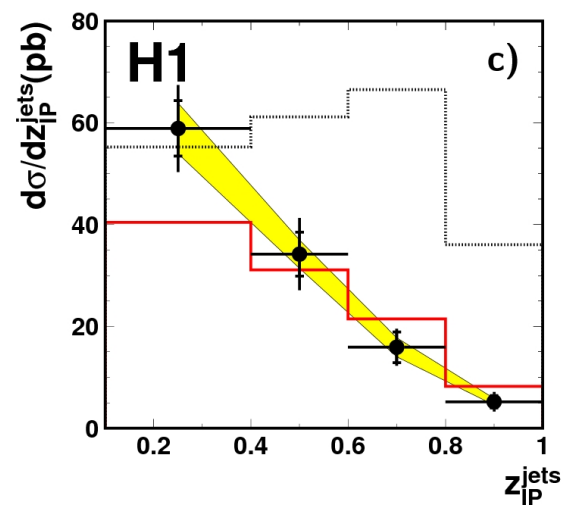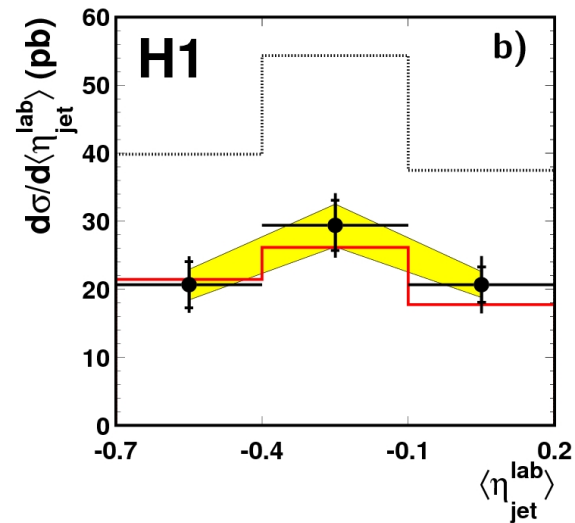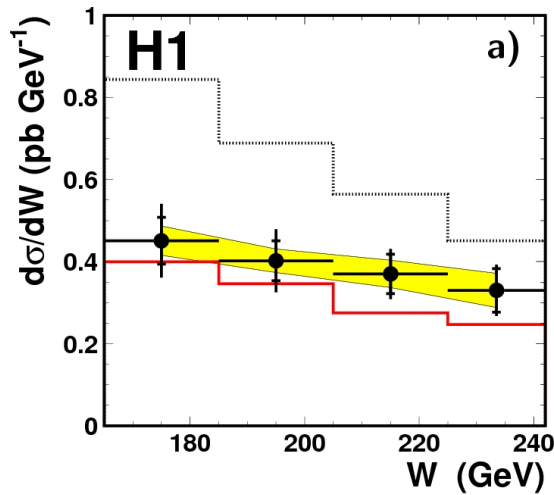
- **direct** and resolved contribution scaled by 0.5

- excellent description of all relevant variables

# Soft Colour Interactions



H1 Diffractive Dijet Production in DIS
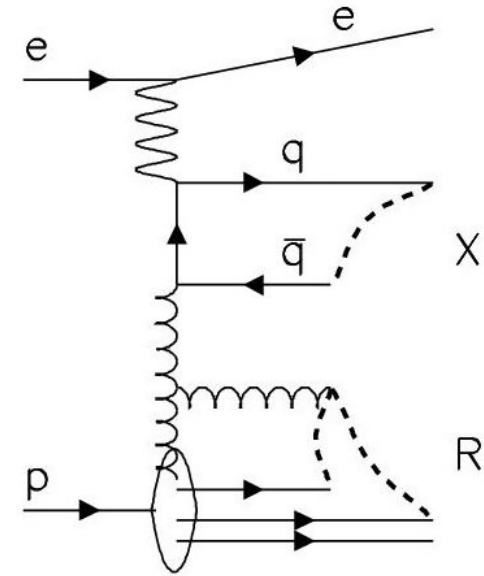
- Soft Colour Interaction model (with generalized are law, GAL)
- Good description of DIS variables
- Shape not well described for diffractive variables

# Summary:
# Status of Factorization

- DIS:
  - factorisation holds
  - jet data improves sensitivity to diffractive gluon density

- Photoproduction
  - naive factorisation not applicable
  - resolved and direct, **both** contributions show suppression