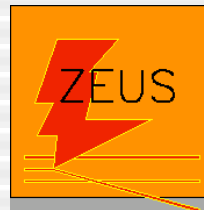# Studies of the structure of diffraction and the diffractive final state in *ep* collision

Shinji Kagawa (ZEUS)

Diffractive structure function
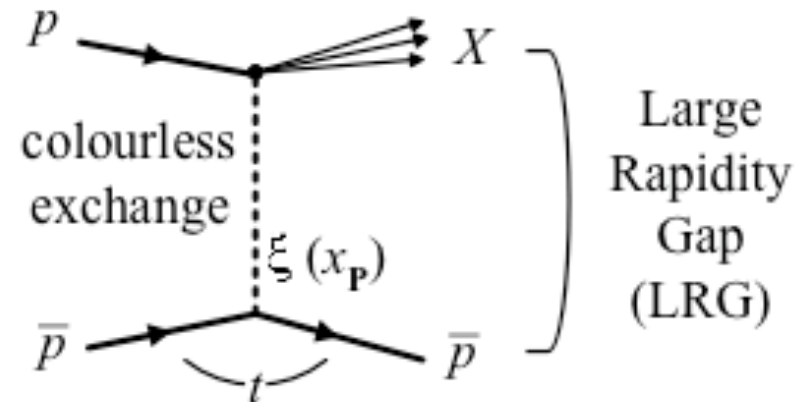
Diffractive D^* in DIS

Diffractive dijets in DIS and photoproduction
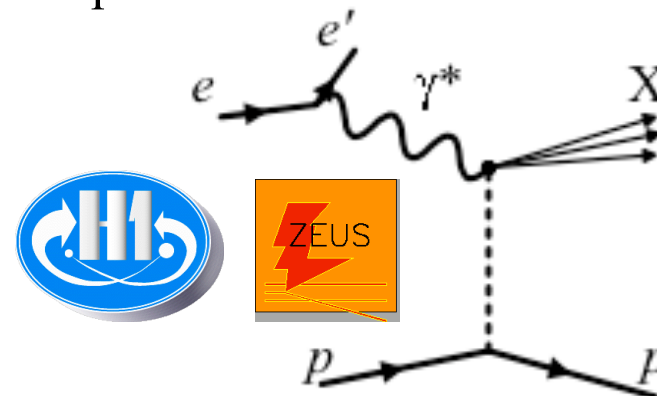
Diffractive CC in DIS

Diffraction in high energy collisions

- Colourless exchange in the t - channel
  - Momentum transfer, $t \ll s$
  - Called Pomeron *(IP)*, or diffractive exchange

- pQCD interpretation in terms of the diffractive PDFs
  - Subject of this talk
  - Results from H1, ZEUS at HERA
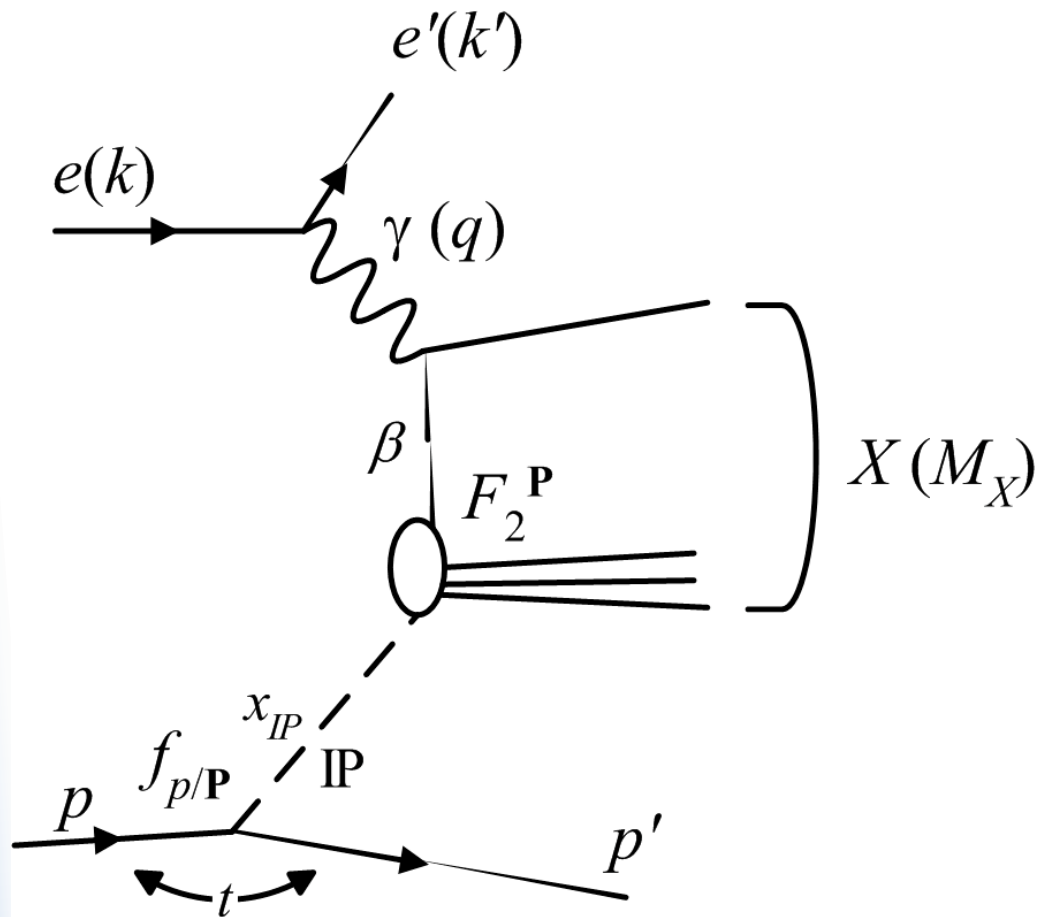
Hadron-Hadron diffraction at Tevatron
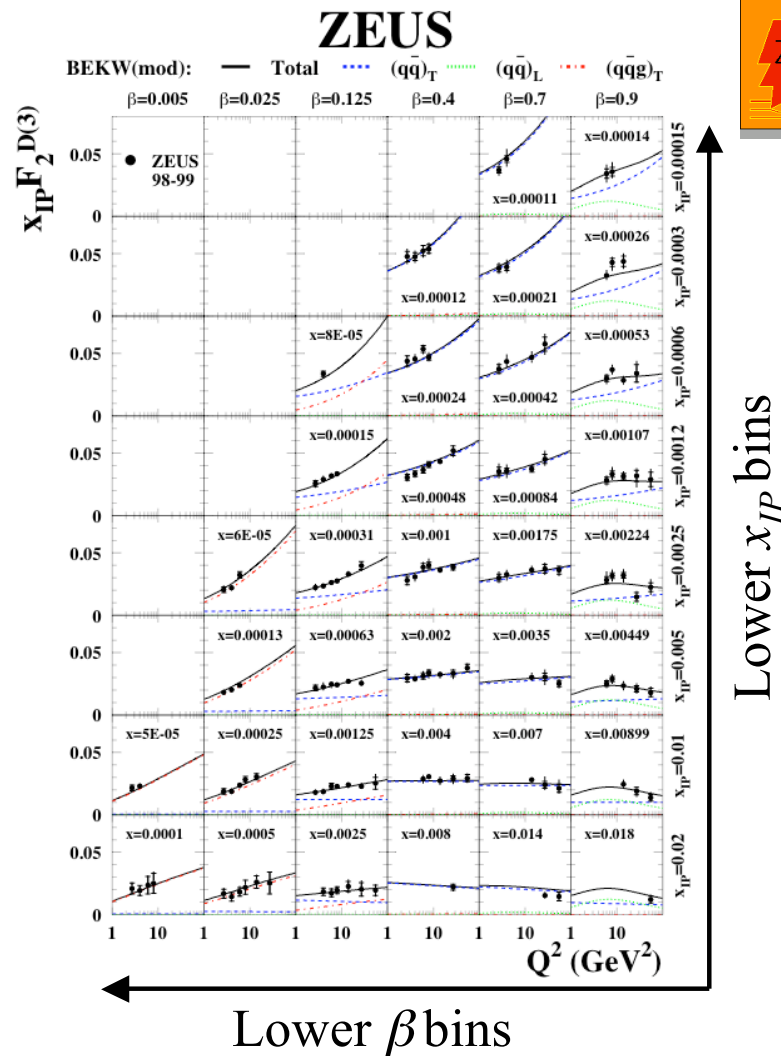

Lepton-Hadron diffraction at HERA

Kinematics of diffraction at HERA

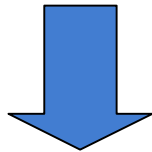| Q^2	virtuality of γ
y	frac. energy of e taken by γ
t	4-mom. transfer squared from p
x_{IP}	mom. frac. of p taken by IP
β	mom. frac. of IP taken by struck quark $(x=x_{IP}\cdot\beta)$

Measurement of $F_2^{D(3)}$ (ZEUS)
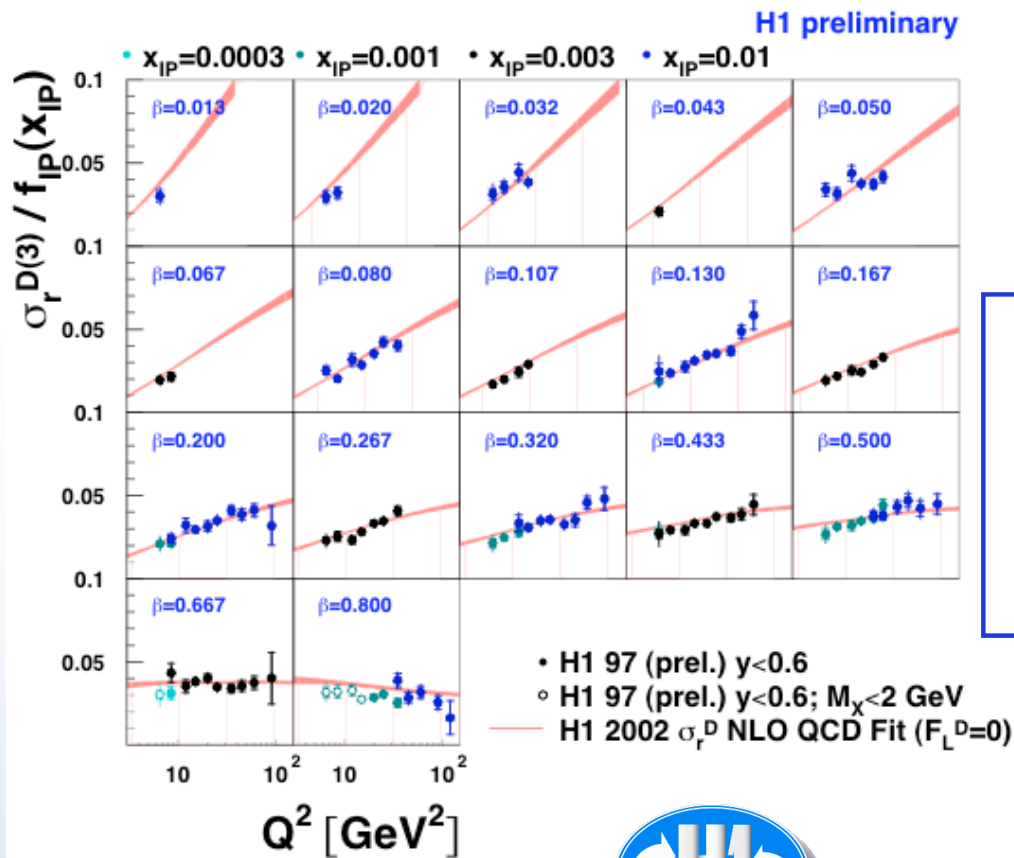

DGLAP QCD fit to the inclusive diffractive DIS σ:
$d^3\sigma/dxdQ^2dx_{IP}$
$= (2\pi\alpha^2/Q^4)[1+(1-y)^2] \cdot F_2^{D(3)}$

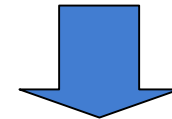Analogous to the measurement of the proton structure function, F_2

Scaling violation at smaller x ($=x_{IP}\cdot\beta$)
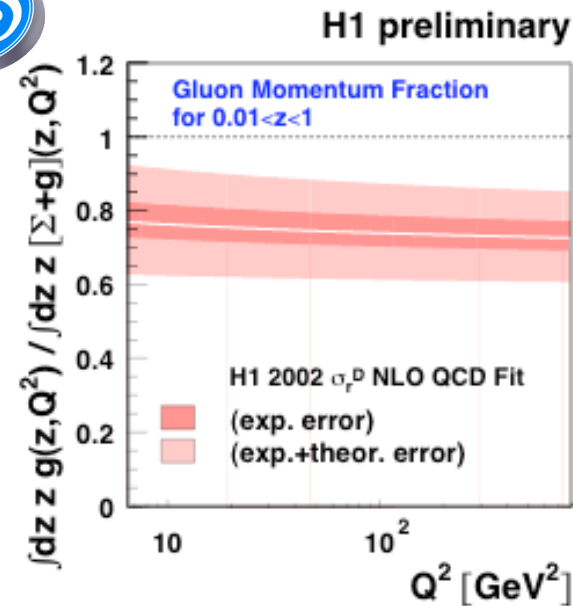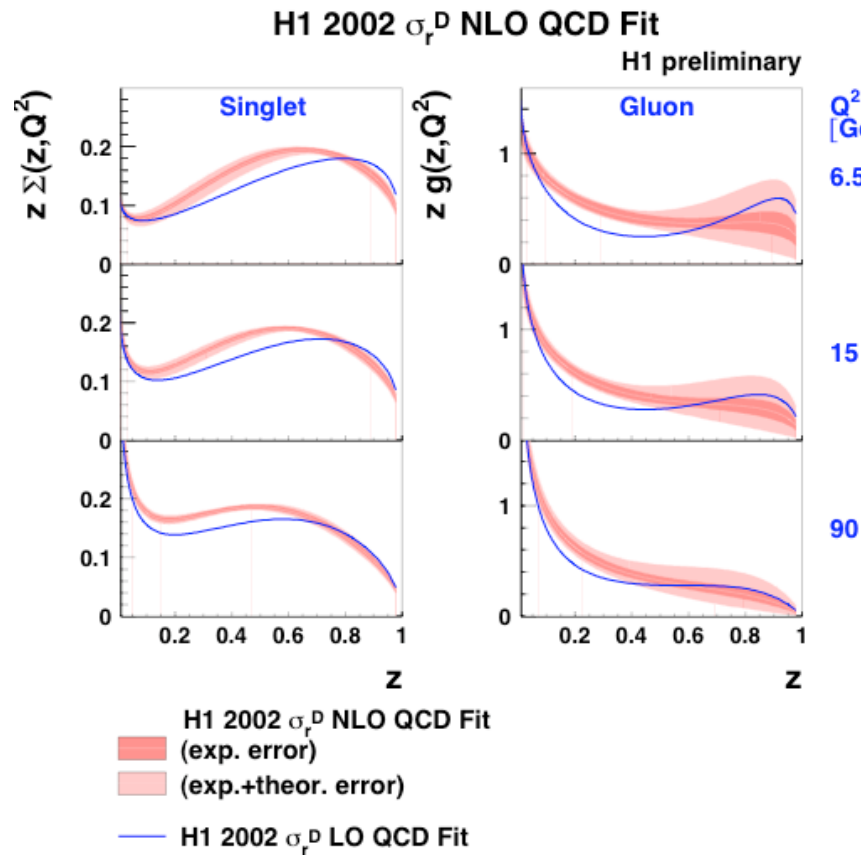
Measurement of $F_2^{D(3)}$ (H1)

Scaling violation also at H1

Diffractive PDFs can be extracted from $F_2^{D(3)}$
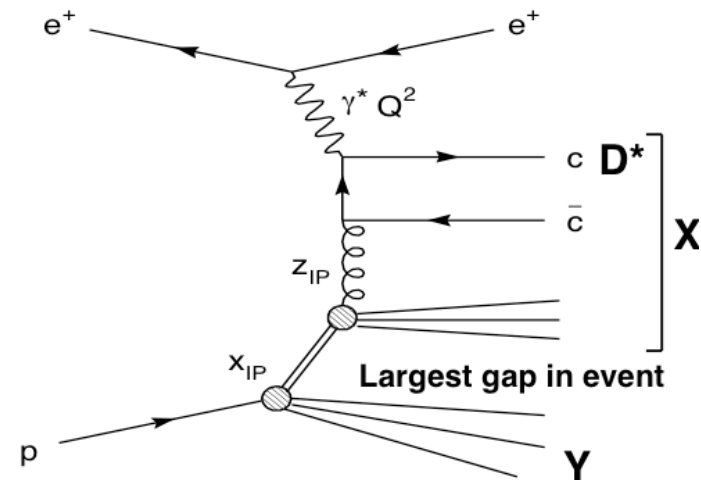
Diffractive PDFs and QCD factorization

H1 2002 σ_r^D NLO QCD Fit

H1 preliminary

Singlet

Gluon

Q^2 [GeV^2]

6.5

15

90

$z \Sigma(z,Q^2)$

$z\, g(z,Q^2)$

z

z

H1 2002 σ_r^D NLO QCD Fit

(exp. error)

(exp.+theor. error)

— H1 2002 σ_r^D LO QCD Fit

H1 preliminary

Gluon Momentum Fraction
for 0.01<z<1

$\int dz\, z\, g(z,Q^2) / \int dz\, z\, [\Sigma+g](z,Q^2)$

Q^2 [GeV^2]

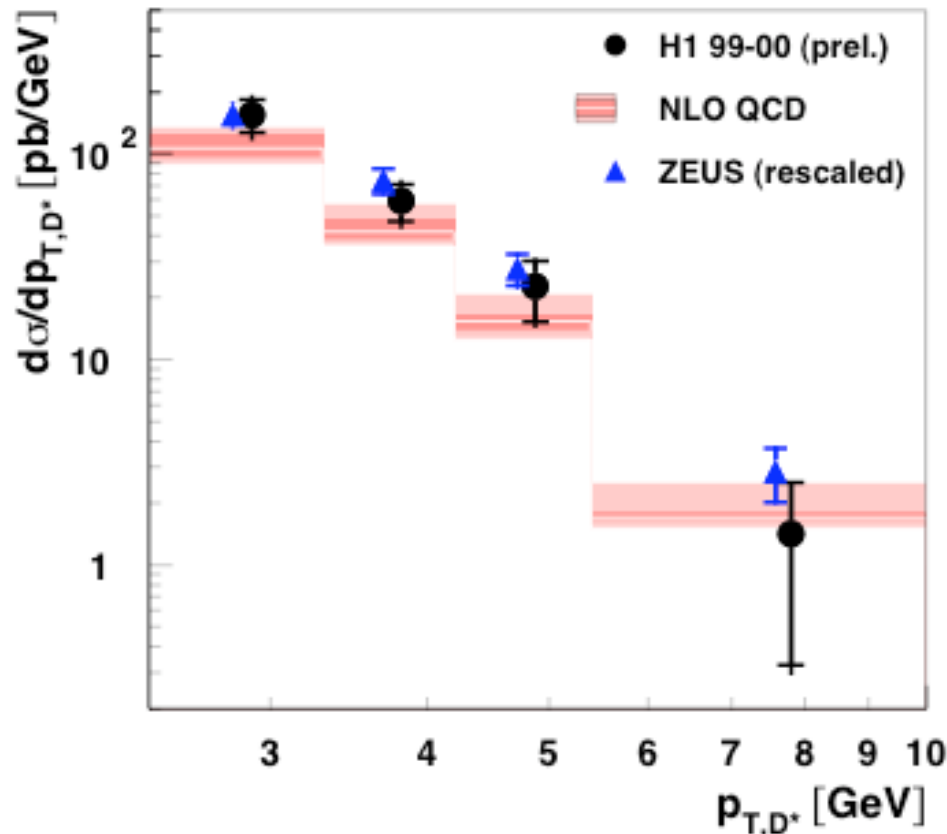H1 2002 σ_r^D NLO QCD Fit

(exp. error)

(exp.+theor. error)

- 75% gluon, independent of Q^2
- Large uncertainties at high z
  (z: fractional momentum of parton)

QCD factorization: $\sigma \propto$ (partonic σ) $\otimes$ PDFs
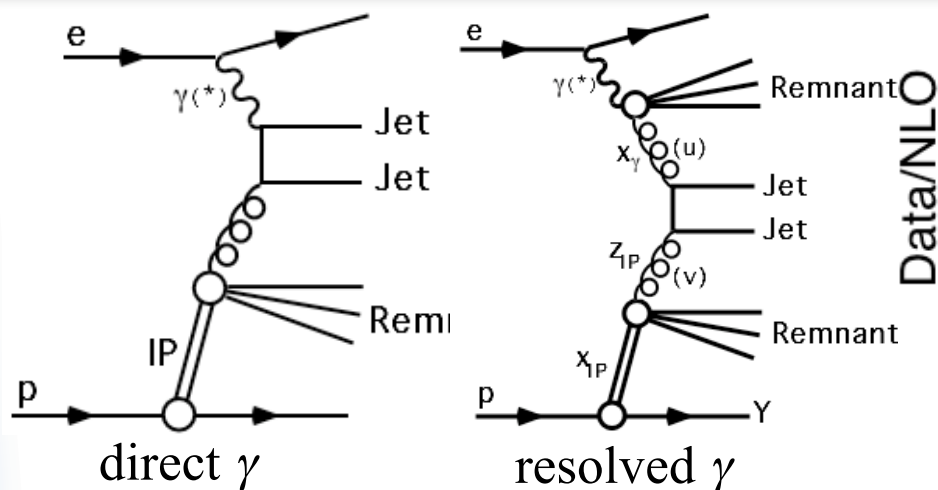$\Rightarrow$ Applicable also to hard diffraction ?

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Diffractive D^* in DIS

Sensitive to gluon density

Fairly well described using the extracted PDFs
$\Rightarrow$ QCD factorization OK
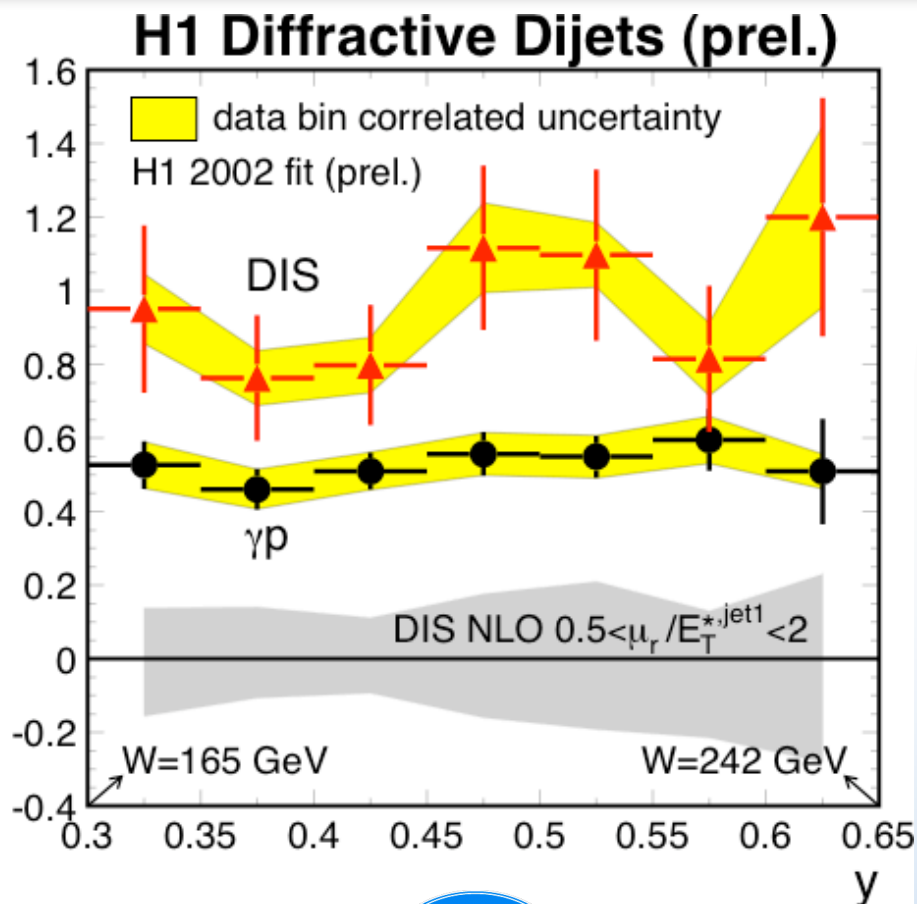
Diffractive dijets in DIS and photoproduction

direct γ   resolved γ

Dijets are also sensitive to gluon

 DIS
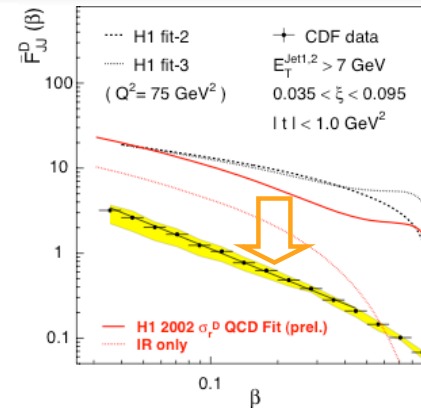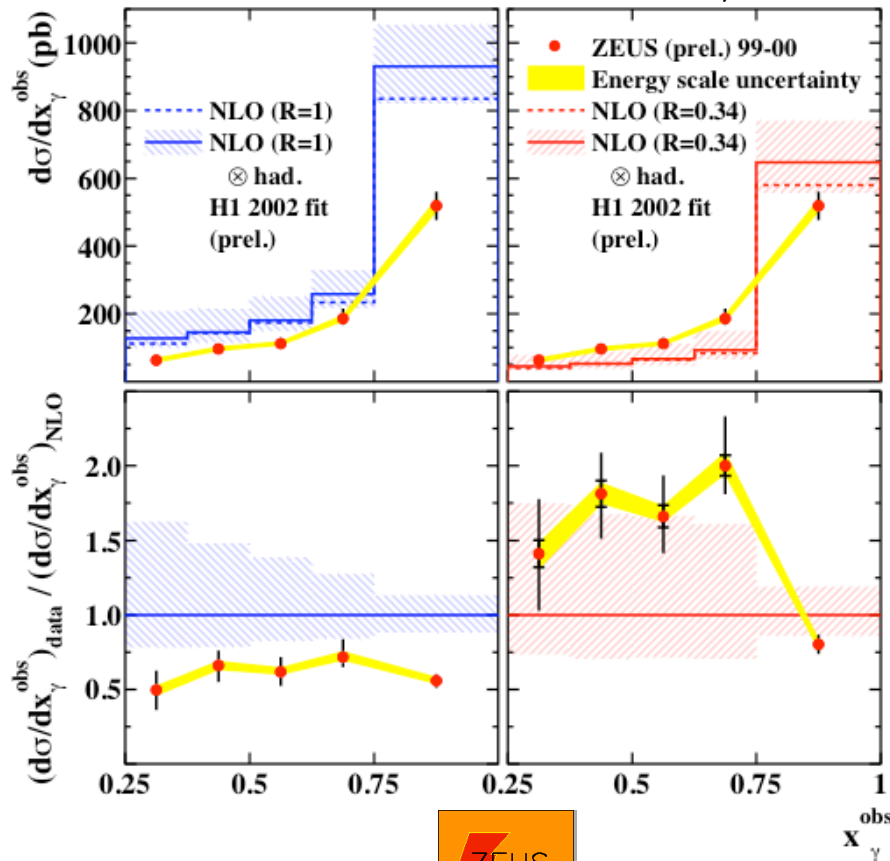- $Q^2 >> 0$, mostly direct
- Well described by PDFs

 PHP (γp)
- $Q^2 \sim 0$, direct + resolved
- Suppressed by approx. 0.5

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Suppression of photoproduction

x_γ^{obs} : momentum fraction of γ taken by dijet
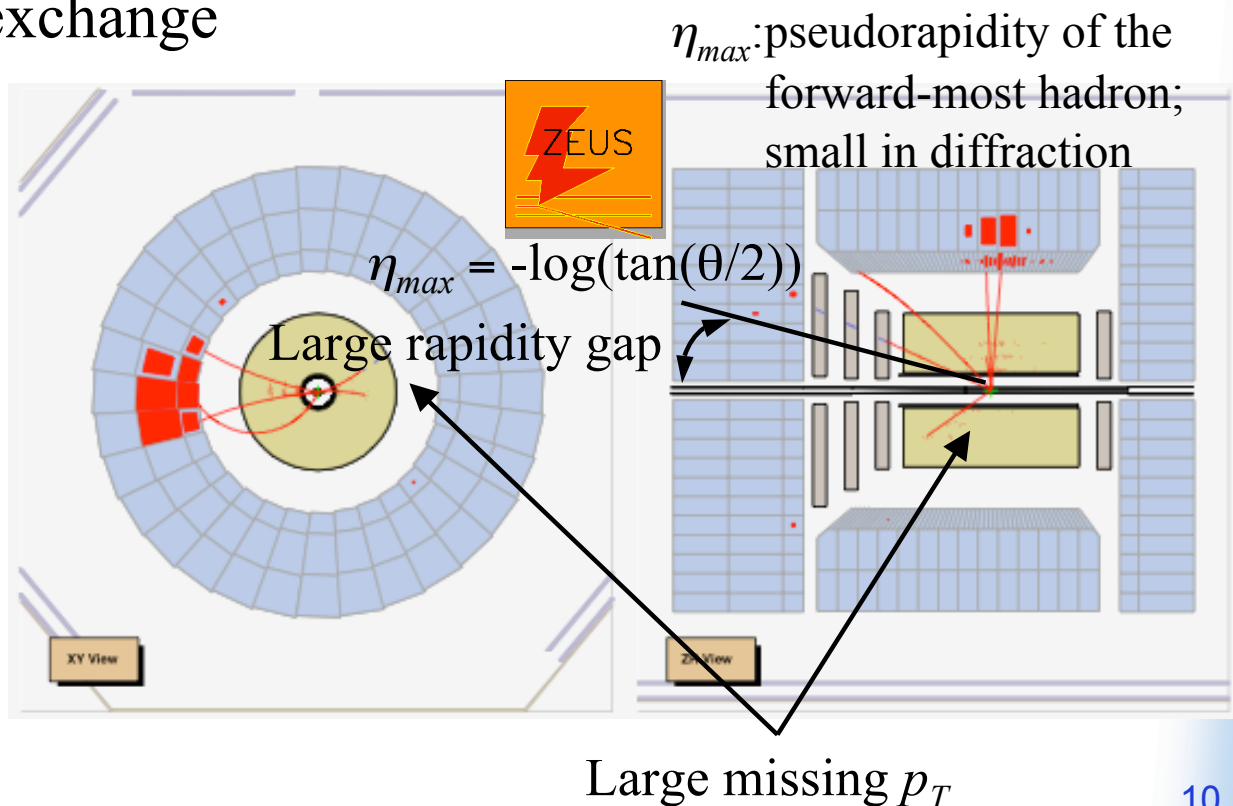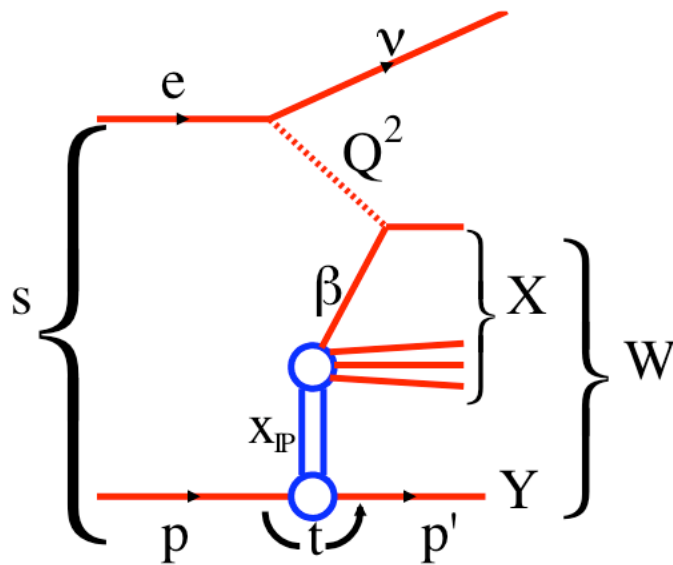direct (resolved) enriched at $x_\gamma^{obs} \geq (<)$ 0.75

Suppression of Tevatron diff. dijet data wrt predictions from PDFs

- From rescattering models which explain suppression at Tevatron:
  resolved-only suppression
  (resolved ~ hadron-hadron collision)
  - Kaidalov et al.: R=0.34
- Measurements at HERA:
  - Global suppression
  - Need consistent understanding with Tevatron results

Similar results obtained by H1
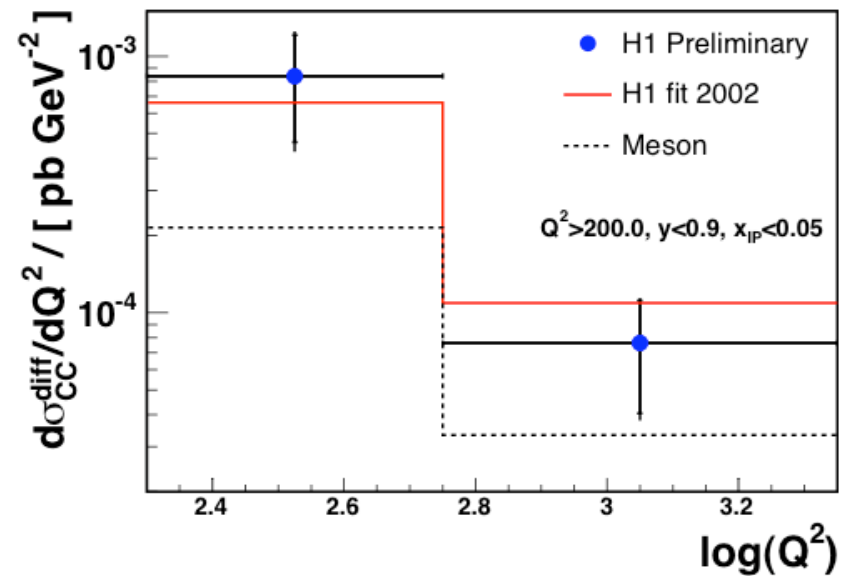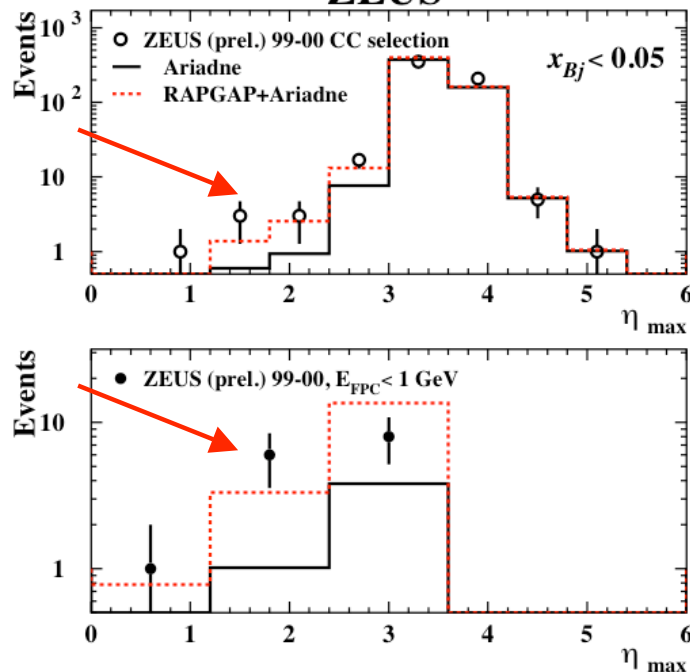
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Diffractive charged current in DIS (1)

- Test of the diffractive PDFs (extracted in NC events)
- Sensitive to particular quark flavors of the PDFs through W exchange

η_{max}: pseudorapidity of the forward-most hadron; small in diffraction

$\eta_{max} = -\log(\tan(\theta/2))$

Large rapidity gap

Large missing p_T

Diffractive charged current in DIS (2)

Excess of data over non-diffractive CC MC, Ariadne: diffractive CC

Diffractive CC data consistent with predictions from the diffractive PDFs, under limited statistics

Summary

 Diffraction at HERA studied in terms of the diffractive PDFs obtained from QCD DGLAP fits to inclusive diffractive DIS data

 Exclusive DIS processes
- Diffractive D^*
- Diffractive dijets
- Diffractive CC

consistent with predictions using the PDFs

 Diffractive dijets in PHP data: suppressed by a factor of 0.5
$\Rightarrow$ However, not consistent with resolved-only suppression, motivated from the suppression of Tevatron data