Proton-dissociative J/ψ Photoproduction at High $|t|$ and at High W at HERA

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On behalf of the H1 and ZEUS collaborations

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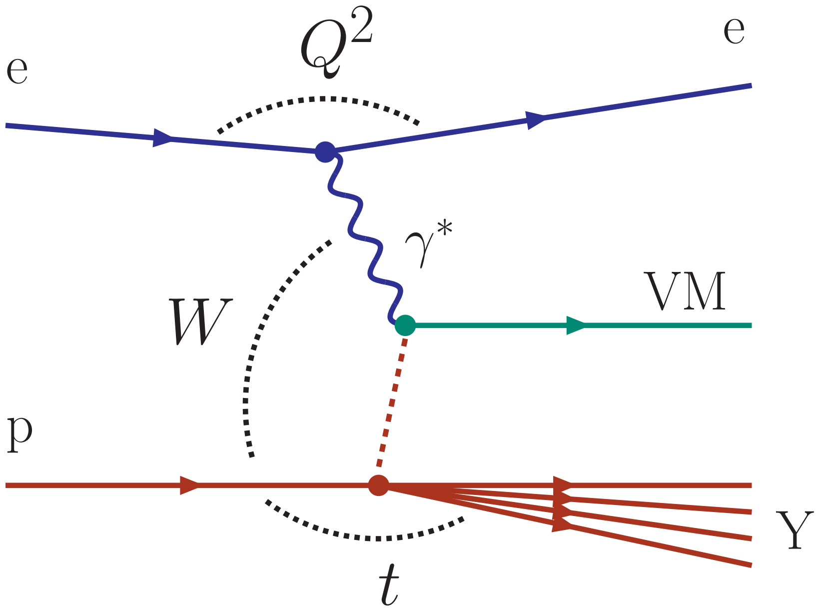
Contents of Talk

- Proton-dissociative J/ψ photoproduction at HERA at hight $|t|$ and high W

- Expectation of pQCD

- Experimental results vs theory

Kinematics



$$ep \rightarrow eJ/\psi Y$$

$50 < W < 245$ GeV

$|t| < 30$ GeV^2

$0 \sim Q^2 < 1$ GeV^2

$M_Y < 30$ GeV^2

W photon-proton CMS energy

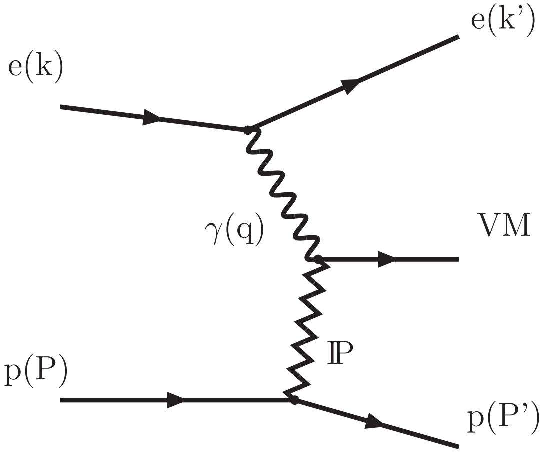
$|t|$ (4-mom. transfer)^2 at proton vertex; $t \approx -p_T^2$

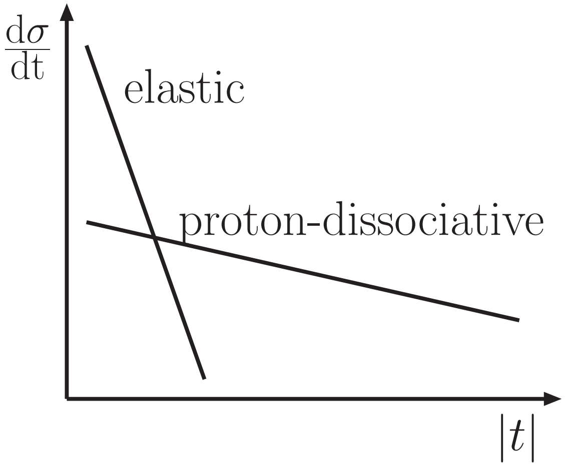
M_Y the mass of the proton dissociative system

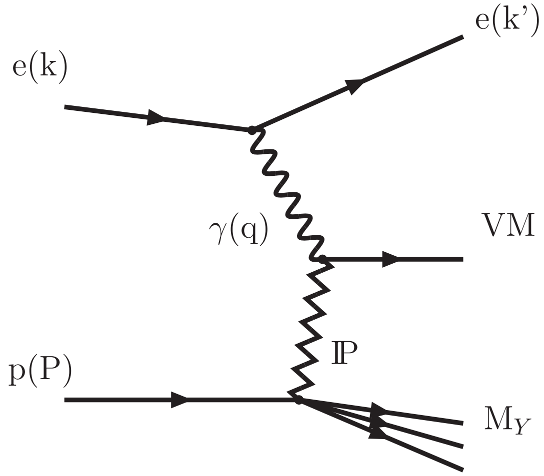
Q^2 photon virtuality
– $Q^2 < 1$ GeV^2: photoproduction, electron undetected in main detector

Proton-dissociative J/ψ production at high $|t|$

- High $|t|$ domain little explored so far
- Proton-dissociative production (double diffraction) dominates at large values of $|t|$
- Looking for hard scale parameters: M^2_{VM}, $|t|$



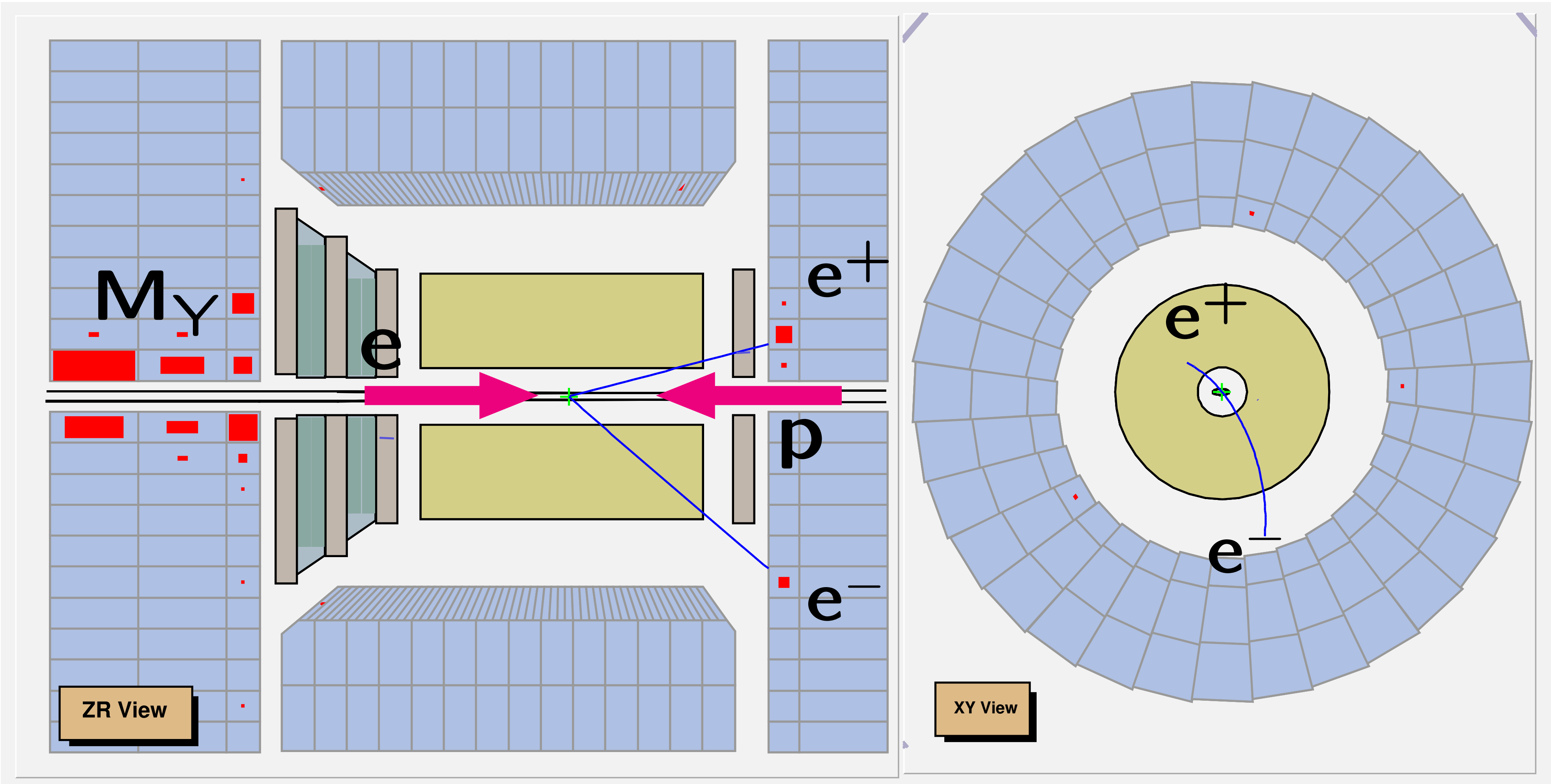




study proton dissociation to investigate high $|t|$ dynamics

$$ep \to eJ/\psi Y \\ \to l^+l^-$$

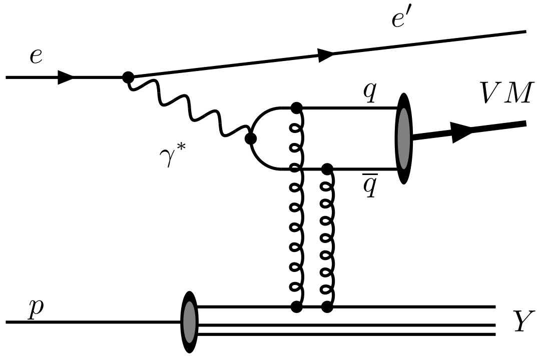
scattered electron tagged at 35m from IP



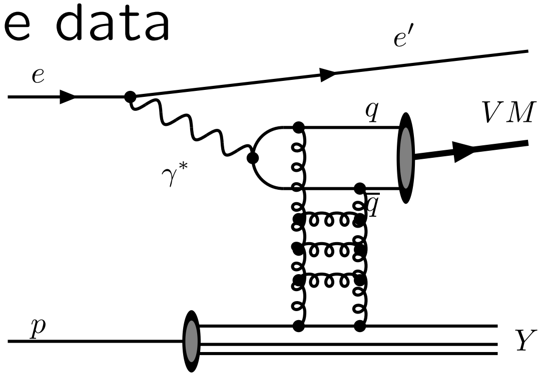
Expectation of perturbative QCD

- factorization:

   1. photon fluctuates into $q\bar{q}$
   2. lowest order exchange of 2 gluons
   3. $q\bar{q}$ forms a bound state J/ψ



- two gluon exchange does not follow the data
- need reggeized gluon ladder
- Leading Log Approximation
- pQCD based models:



BFKL and DGLAP calculation tuned to ZEUS and H1 data for $<$W$>$=100 GeV

predictions: $\boxed{\text{d}\sigma/\text{dt} \sim |t|^{-n} \quad \textbf{steep rise of the cross section with W (BFKL)}}$

pQCD models

Predictions using the BFKL evolution

- Unordered momenta along the gluon ladder

  Bartels, Forshaw, Lotter, Wüsthoff; Phys. Lett. B375 (1996) 301

  Forshaw, Ryskin; Z.Phys. C68 (1995) 137

- The recent extensions

  BFKL LL (inc.higher conformal spin)

  BFKL LL + NL (estimate of Non-Leading corrections)

  BFKL LL + NL + running α_s

  Enberg, Motyka, Poludniowski; Eur. Phys. J. C26 (2002) 219

Predictions using the DGLAP Evolution

- Ordered momenta along the gluon ladder

  DGLAP LL applicable for $|t| < M^2_{J/\psi}$

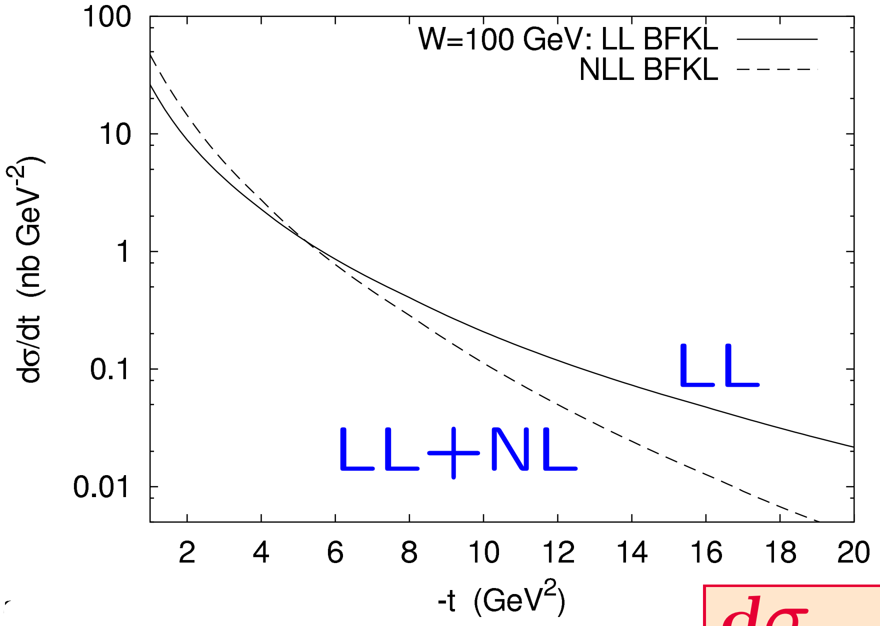
  Gotsman, Levin, Maor, Naftali; Phys. Lett. B352 (2002) 37

pQCD predictions for large $|t|$ and W

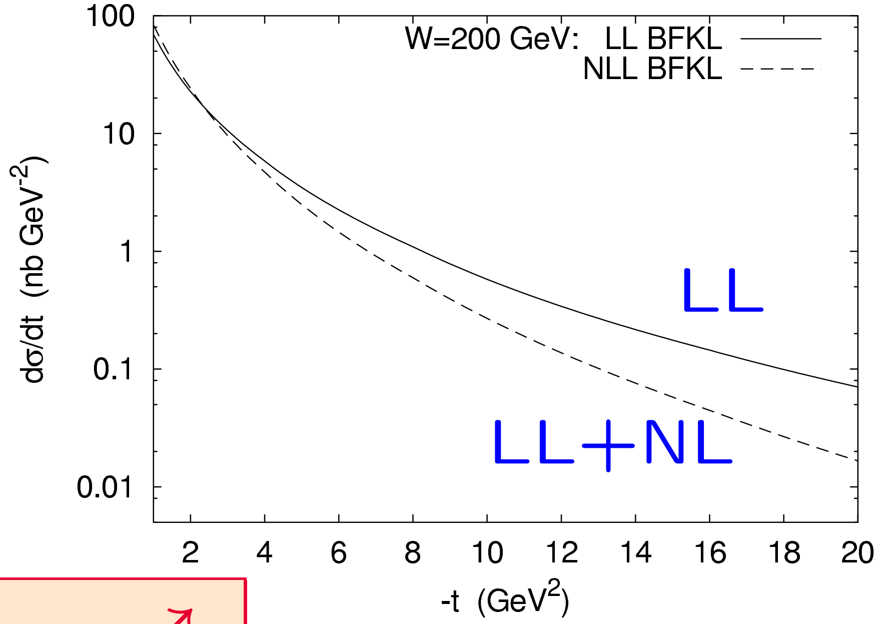
Starting with $W = 100\,\text{GeV}$ BFKL and DGLAP calculations give predictions for W=200 GeV

Example: BFKL LL and BFKL LL+NL calculations with fixed α_s for

W=100 GeV



W=200 GeV



$$\boxed{\frac{d\sigma}{dt} \nearrow \quad W \nearrow}$$

Event sample at $W = 100\,\mathbf{GeV}$ (H1)

$J/\psi \to \mu^+\mu^-$

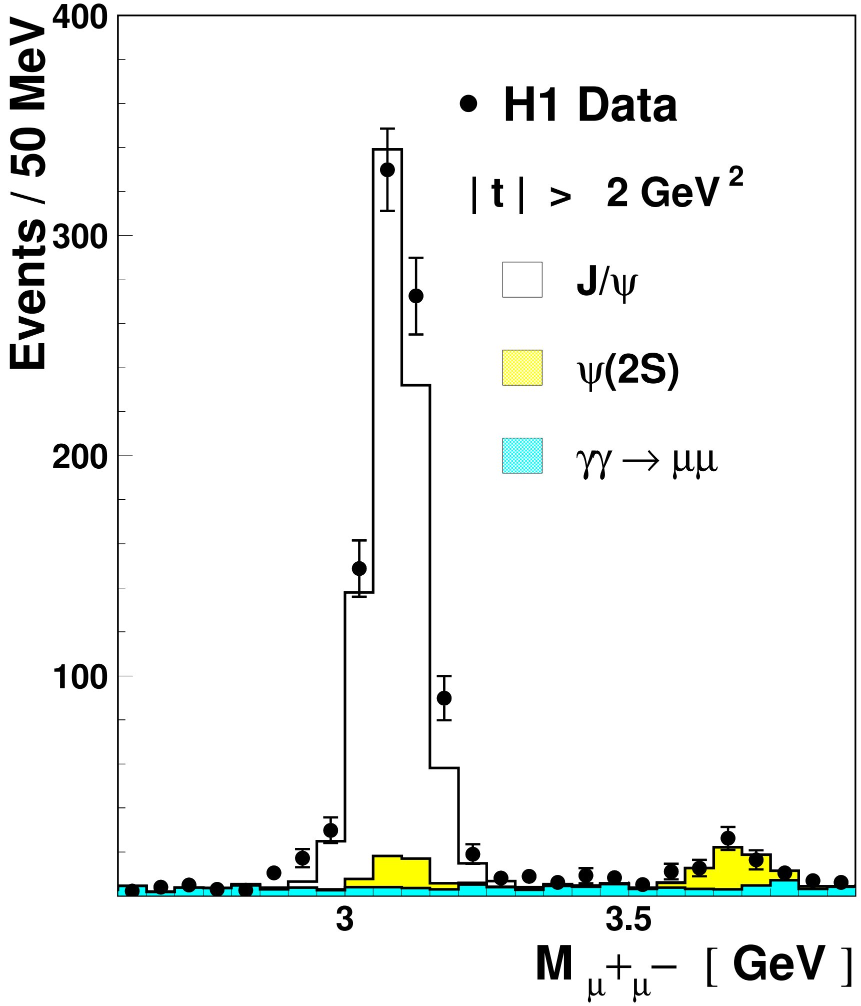
$50 < W_{\gamma p} < 150$ GeV

$2 < |t| < 30$ GeV^2

$\sim 0 < Q^2 < 1$ GeV^2

$\mathcal{L} = 78$ pb^{-1}

$z = \frac{p \cdot p_{J/\psi}}{p \cdot q} > 0.95$



Differential cross section in $|t|$ (H1)

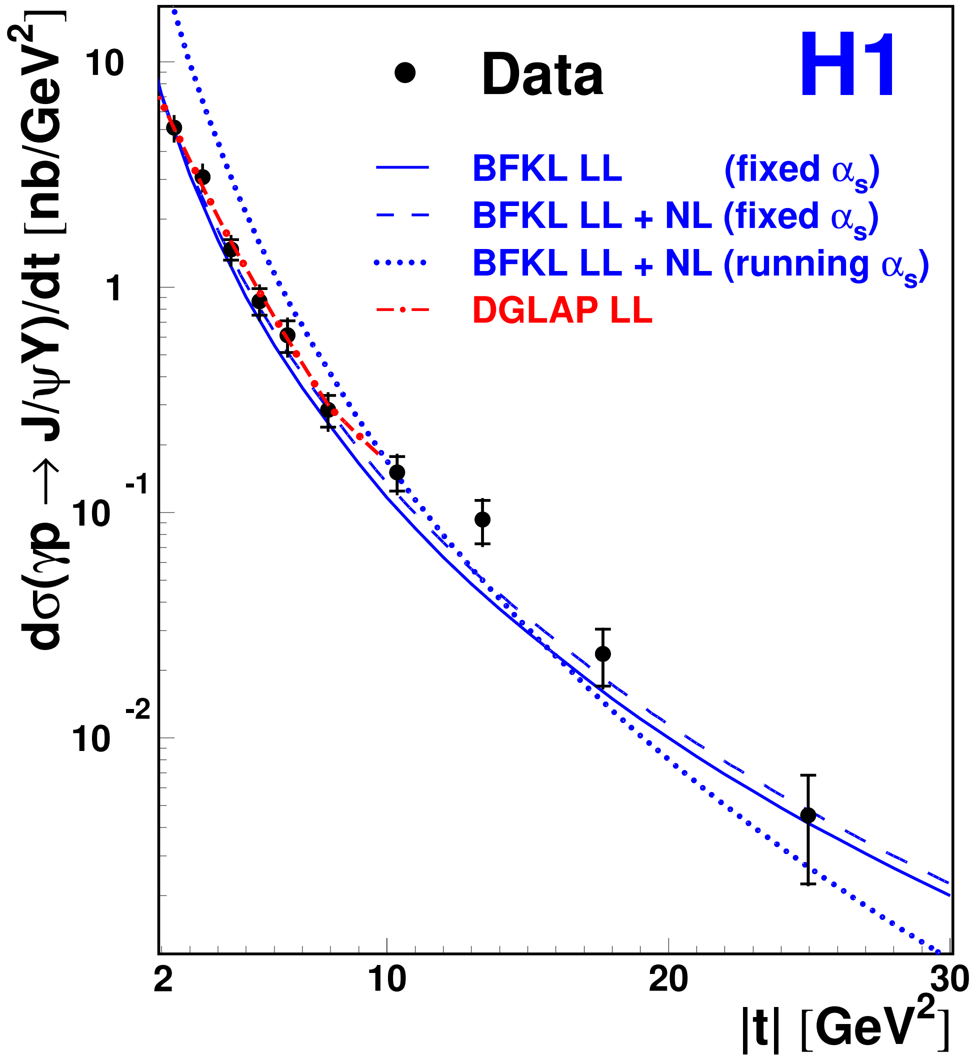
H1 Collab: DESY 03-061
hep-ex/0306013

- $d\sigma/dt \sim |t|^{-n}$,
n=3.00 $\pm$0.08(stat.) $\pm$0.05(syst.)
for $|t| > 3.45\,\text{GeV}^2$

- DGLAP consistent with the data
in range of the model ($|t| < 10\,\text{GeV}^2$)

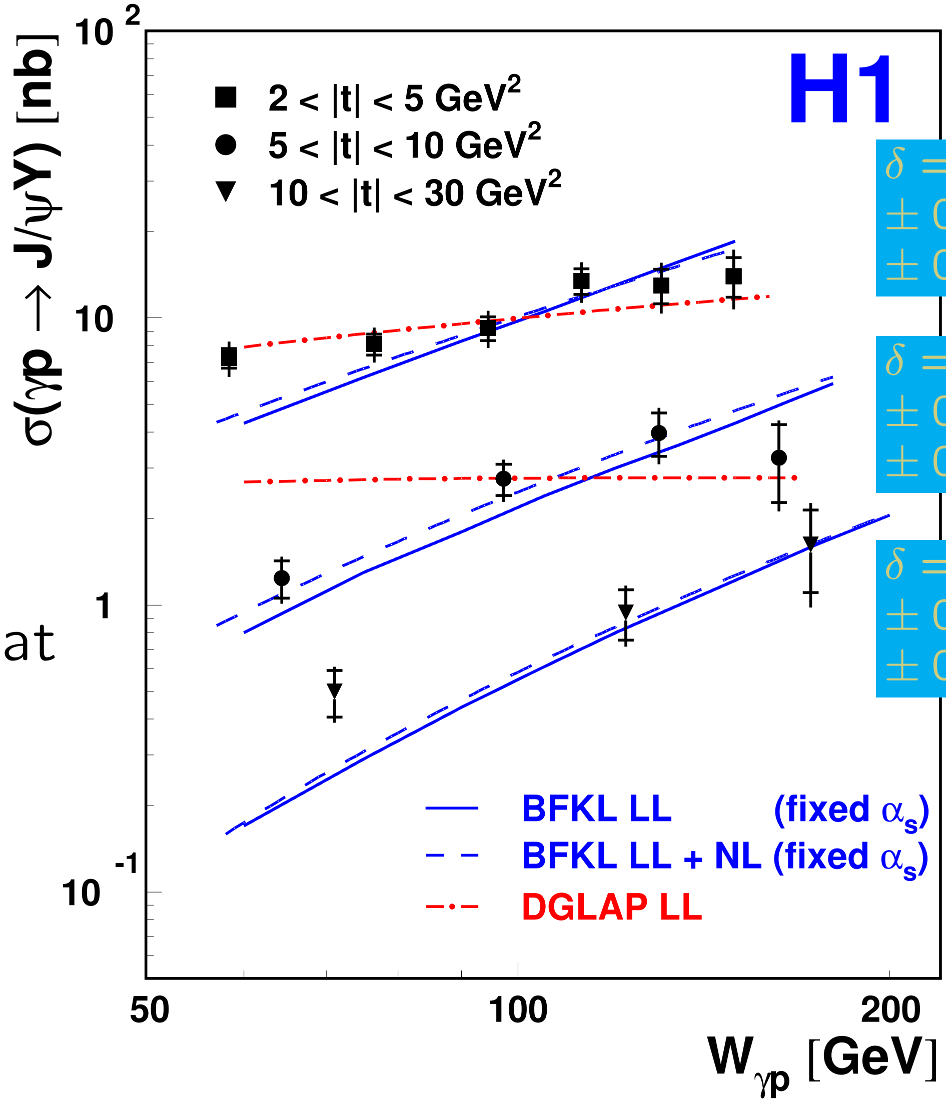
- BFKL (fixed α_s)
describes data very well

- BFKL + running α_s too steep



Total cross section in $W_{\gamma p}$ (H1)

- fit form $\sigma \sim W_{\gamma p}^{\delta}$,
$\delta = 4\alpha(t) - 4$
- BFKL reasonable
- DGLAP good for lower $|t|$,
for $|t| > 5\,\text{GeV}^2$ perhaps too flat



$\delta = 0.770$
$\pm 0.139(stat.)$
$\pm 0.101(sys.)$

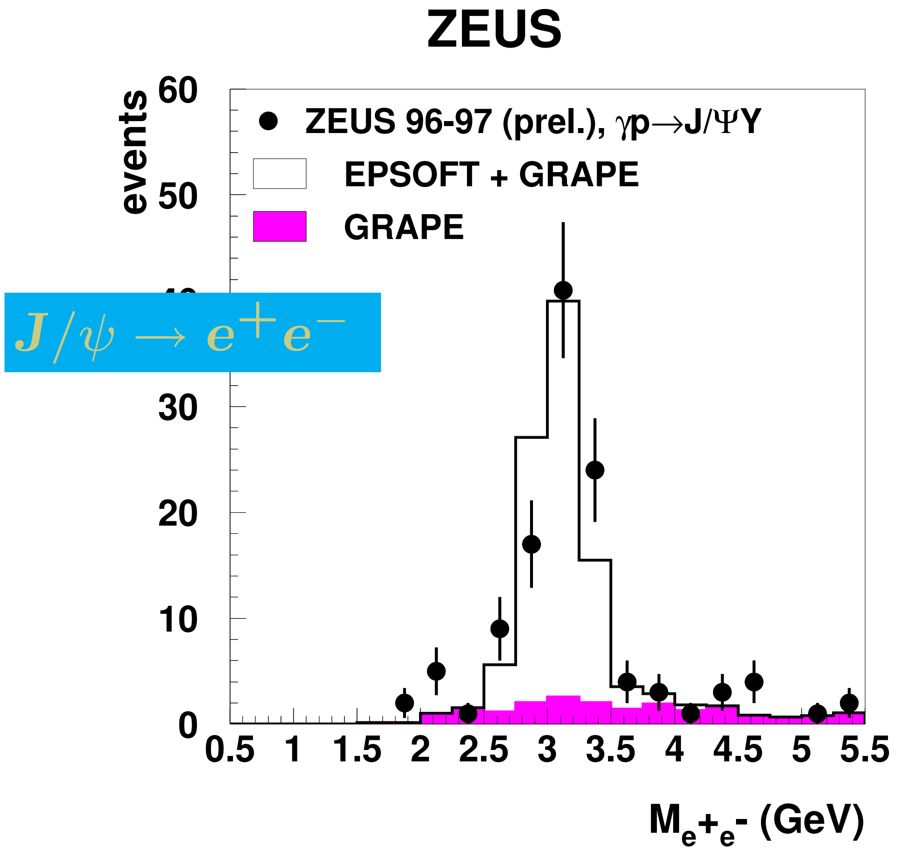
$\delta = 1.29$
$\pm 0.23(stat.)$
$\pm 0.16(sys.)$

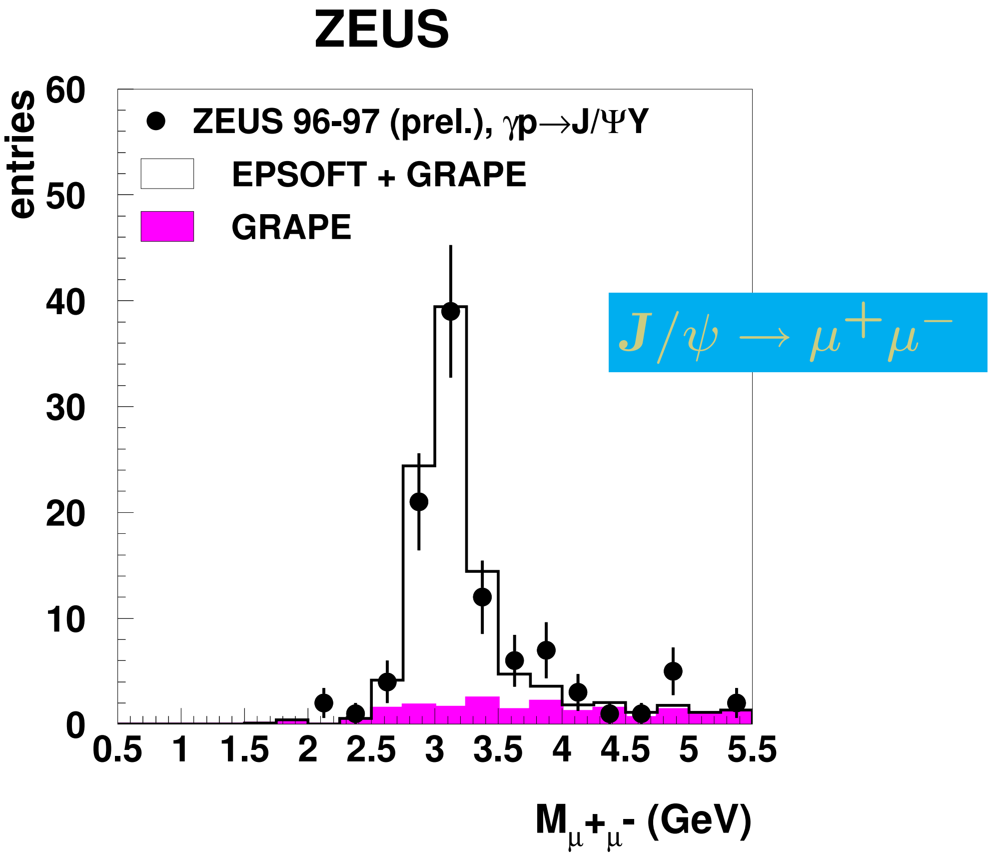
$\delta = 1.30$
$\pm 0.39(stat.)$
$\pm 0.36(sys.)$

Event sample at $W = 200\,\text{GeV}$ (ZEUS)

$185 < W_{\gamma p} < 245\,\text{GeV}$ $\qquad Q^2 < 0.02\,\text{GeV}^2$

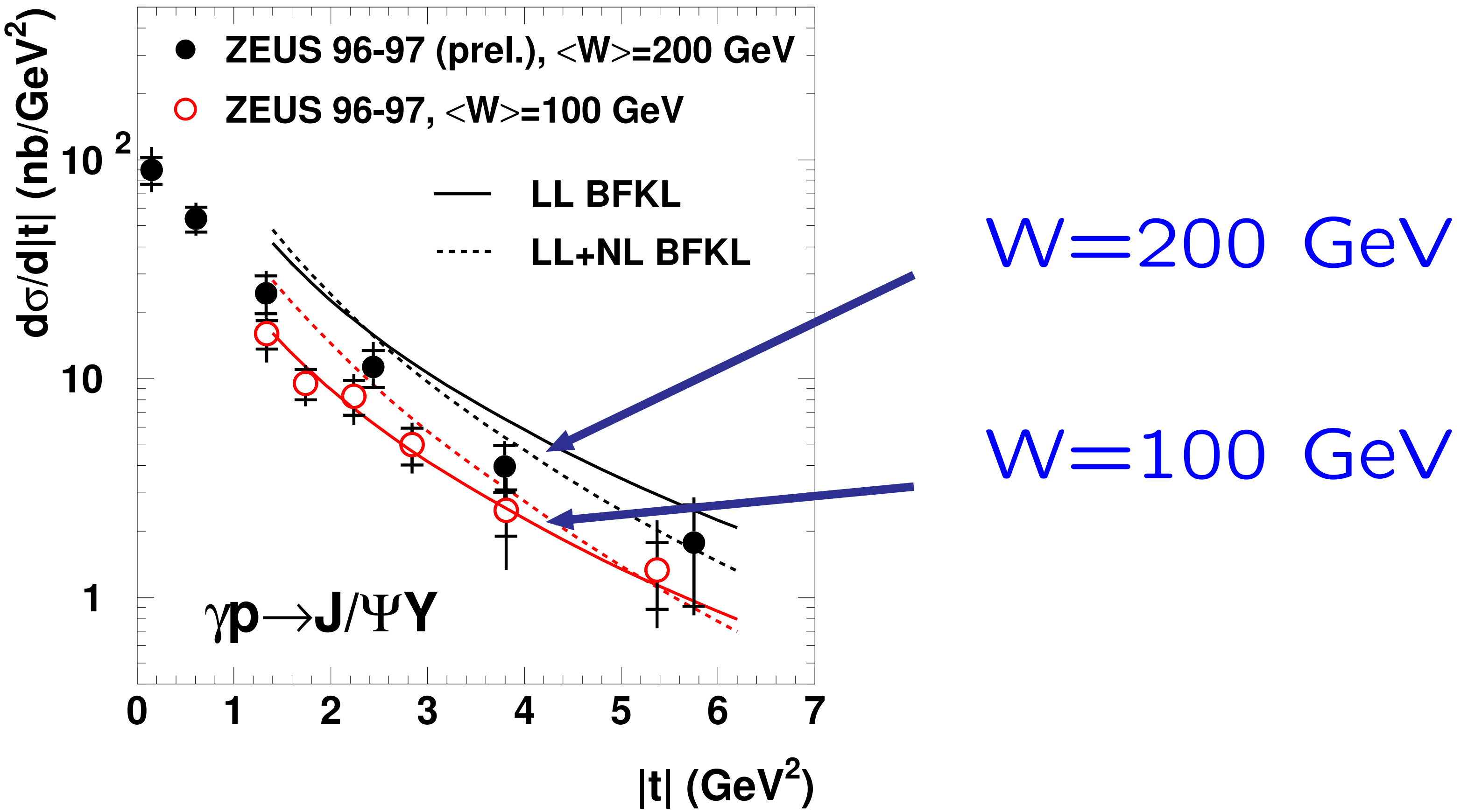
$|t| < 7\,\text{GeV}^2$ $\qquad \mathcal{L} = 38\ \text{pb}^{-1}$





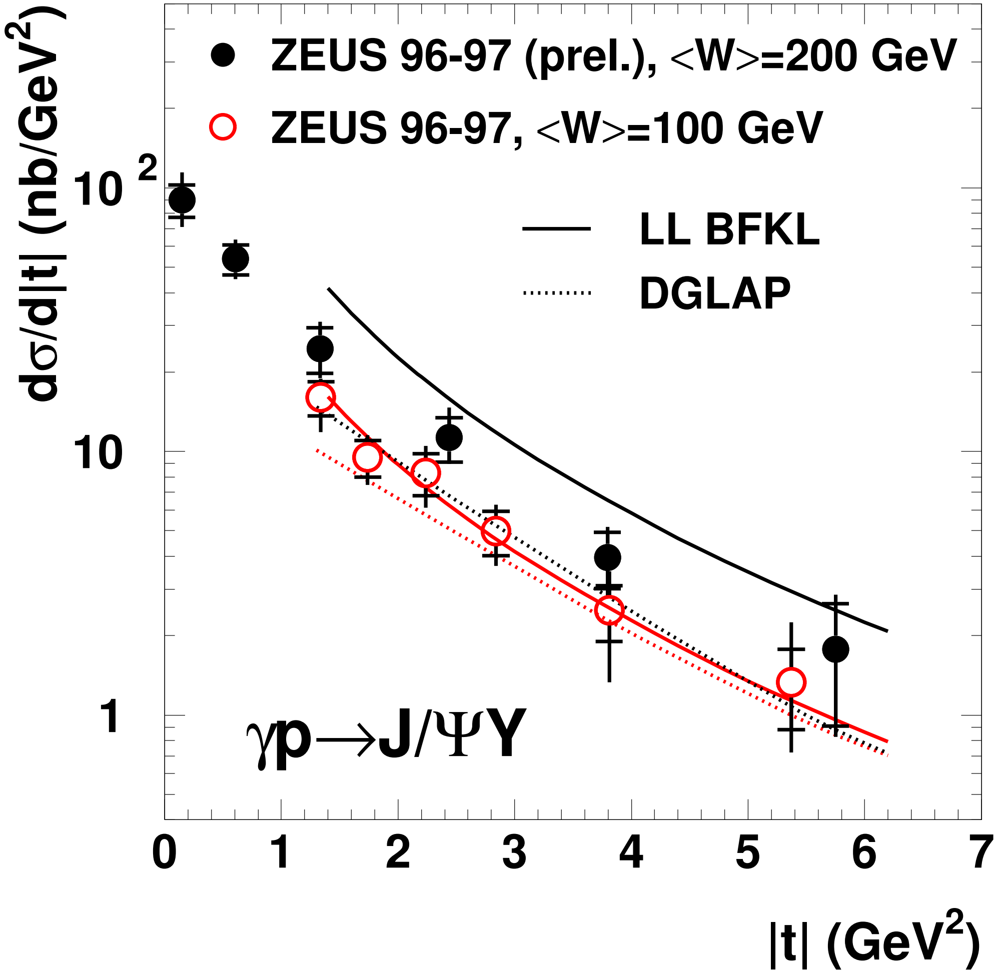
Differential cross section in $|t|$ (ZEUS)

- the rise of $d\sigma/dt$ with W is observed
- BFKL reproduces the general behaviour of the data



Differential cross section in $|t|$ (ZEUS)

- DGLAP too slow with W



Conclusions

- HERA experiments ZEUS and H1 provide a unique way for study of the pQCD based models and evolutions

  H1 – J/ψ photoproduction sample for wide $|t|$ range (2-30 GeV^2)
  with reasonable statistics

  ZEUS – J/ψ photoproduction sample to investigate cross section
  W dependence for <W>=100 GeV and <W>=200 GeV

  – good agreement between ZEUS and H1 data in the range of $1.2 < |t| < 6.5$ GeV^2 and $80 < W < 120$ GeV

- the experimental results compared to predictions based on BFKL and DGLAP evolution equations (gluon ladder exchange)

  – pQCD models describe the data at <W>=100 GeV

  – experimentally $\frac{d\sigma}{dt}$ rises with W

  BFKL overestimates this rise

  DGLAP underestimates it