Proton Dissociative J/Ψ Photoproduction at High $|t|$

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Overview of this Presentation

1. Reconstruction of Event Kinematics.

2. Diffractive Vector Meson Production in Perturbative QCD.

3. Kinematic Region / Event Selection with the H1 Detector.

4. Measurement of $\sigma_{\gamma p \to J/\psi Y}$ as a function $W_{\gamma p}$.

   - Comparison to Elastic J/ψ Production.

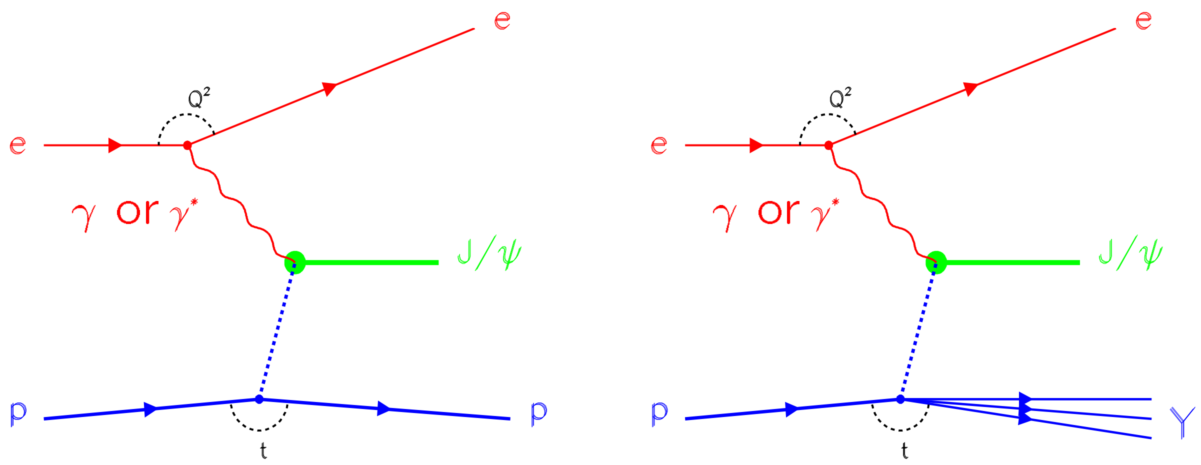
5. Comparison of pQCD Predictions with:

   - Total Cross Section $\sigma_{\gamma p \to J/\psi Y}$ as a function $W_{\gamma p}$.

   - Differential Cross Section $d\sigma/d|t|$ as a function of $|t|$.

6. Conclusions

Event Kinematics for Diffractive J/ψ Production at HERA



$\Rightarrow$ Proton predominantly dissociates at high-|t|.

Investigate $W_{\gamma p}$, |t| dependencies:

$\Rightarrow$ Work in photoproduction ($Q^2 \sim 0$):

$W_{\gamma p}^2 \sim ys$ where $y = \dfrac{\sum(E - P_z)}{2E_e}$, $s = 4E_eE_p$

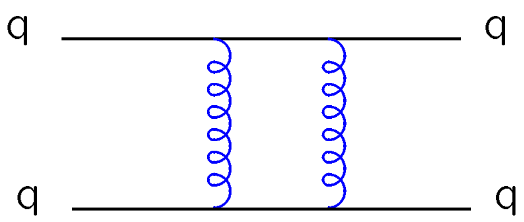
$\Rightarrow$ Can reconstruct |t| in photoproduction for $z \sim 1$:

$$t = -\frac{1}{z}p_t^2 - (1-z)Q^2 + \left(1 - \frac{1}{z}\right) m_{J/\psi}^2$$

Elasticity $z = \dfrac{P^\mu \cdot v^\mu}{P^\mu \cdot q^\mu}$ $\Rightarrow$ $t \sim -p_t^2 + t_{min}$

Perturbative QCD and the Pomeron

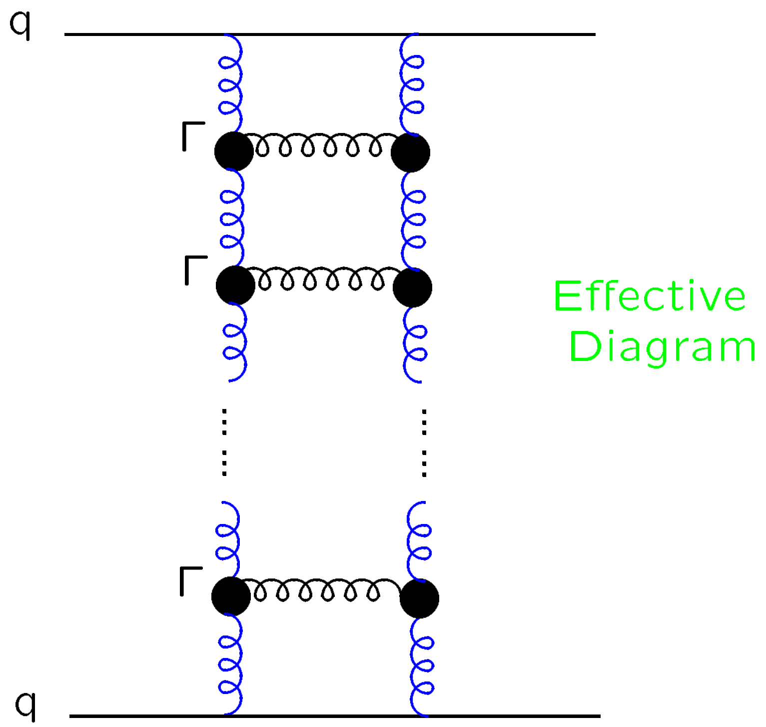
Two Gluon Exchange



⇒ Pomeron exchange can be simulated in QCD.

BFKL Equation (At large $W^2_{\gamma p} >> |t|$)

⇒ Reggeized Gluon Ladder

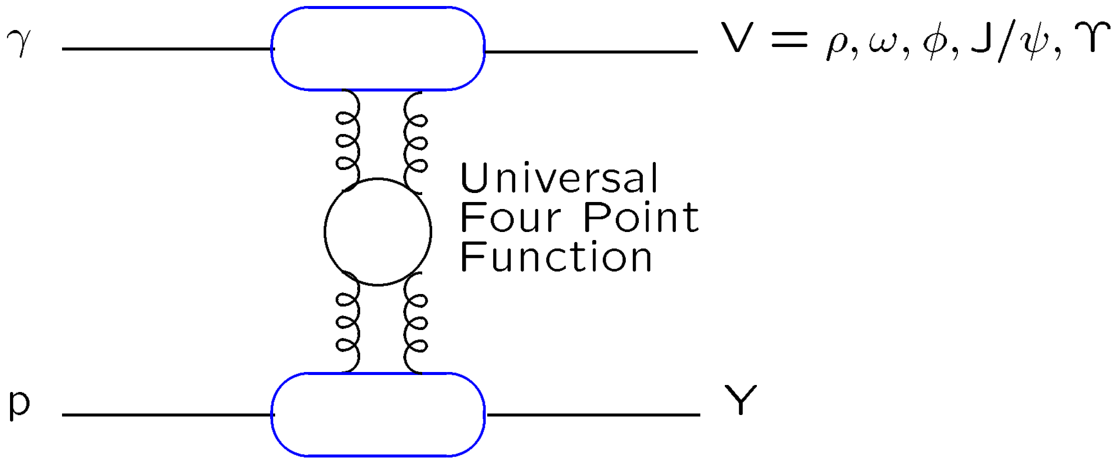


⇒ BFKL iteration adds a rung to the ladder.

Perturbative QCD and the Pomeron

Diffractive Vector Meson Production

[1] Forshaw and Ryskin,
Z. Phys.C68 (1995) 137-148
[2] Bartels, Forshaw, Lotter and Wüsthoff,
Phys.Lett.B375 (1996) 301-309



The series converges if $|t|$ is large (> 1.0 GeV^2)

Particularly valid for $J/\psi, \Upsilon, \ldots$

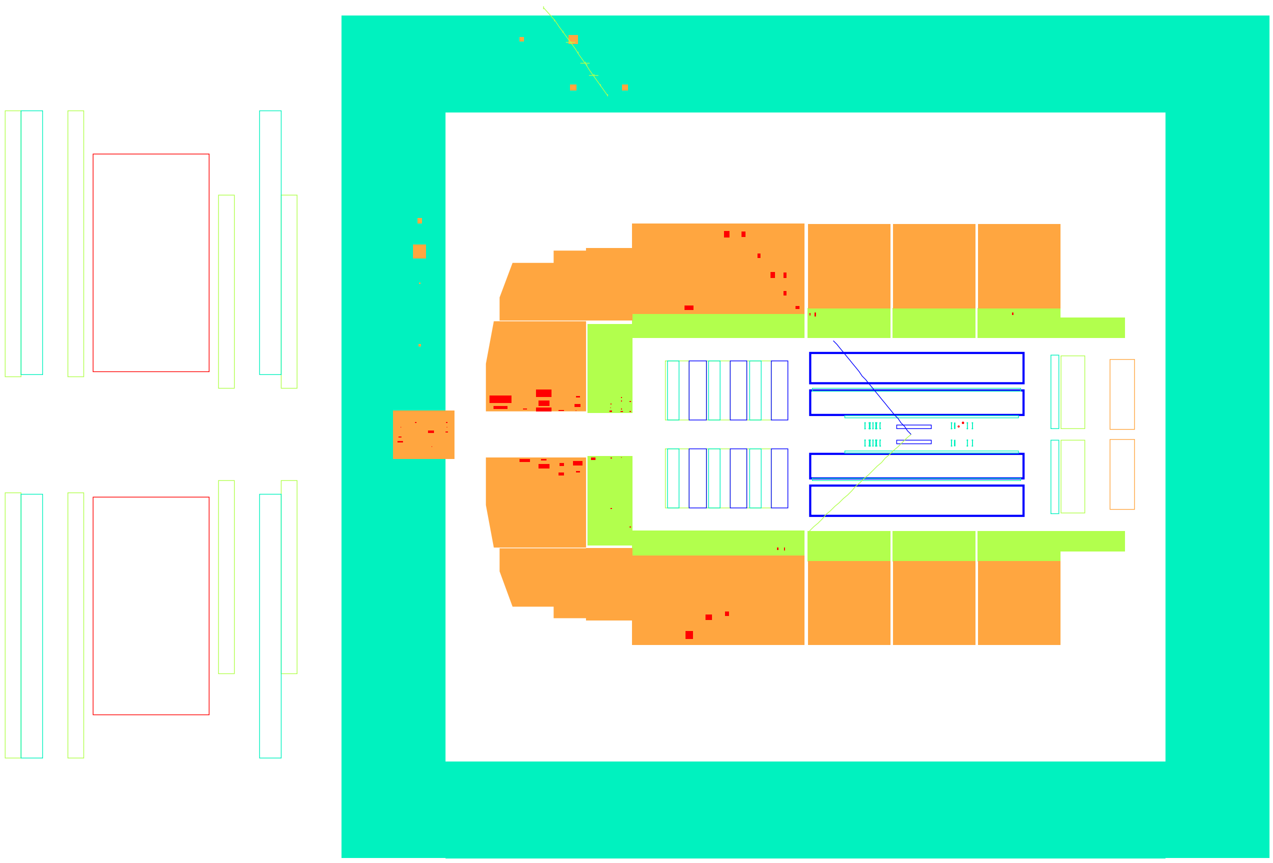
Predictions depend on $\bar{\alpha}_s$

The pomeron scattering amplitude Reggeizes:

$A(s,t) \sim s^{\alpha(t)}$ with $\alpha(t) = 1 + 4\bar{\alpha}_s \ln 2.$

Proton Dissociative J/Ψ Production at High |t| with H1 Detector.

Two identified tracks with proton dissociation:



Event Selection

1999 Data : H1 Detector : Integrated Luminosity 19.1 pb^{-1}.

Kinematic Region which has been investigated:

- Photoproduction $Q^2 < 1.0$ GeV^2.
- Medium $W_{\gamma p}$: $50 < W_{\gamma p} < 160$ GeV

  ⇒ Select the J/Ψ via its decay to $\mu^+\mu^-$.

  ⇒ Two identified tracks

  – in LAr calorimeter and/or instr. Iron

  – in the polar angular range $30^\circ < \theta < 160^\circ$ ($\theta = 0^\circ$ incoming proton, or forward, direction)

- Proton remnant mass $1.6 < M_Y < 30.0$ GeV.

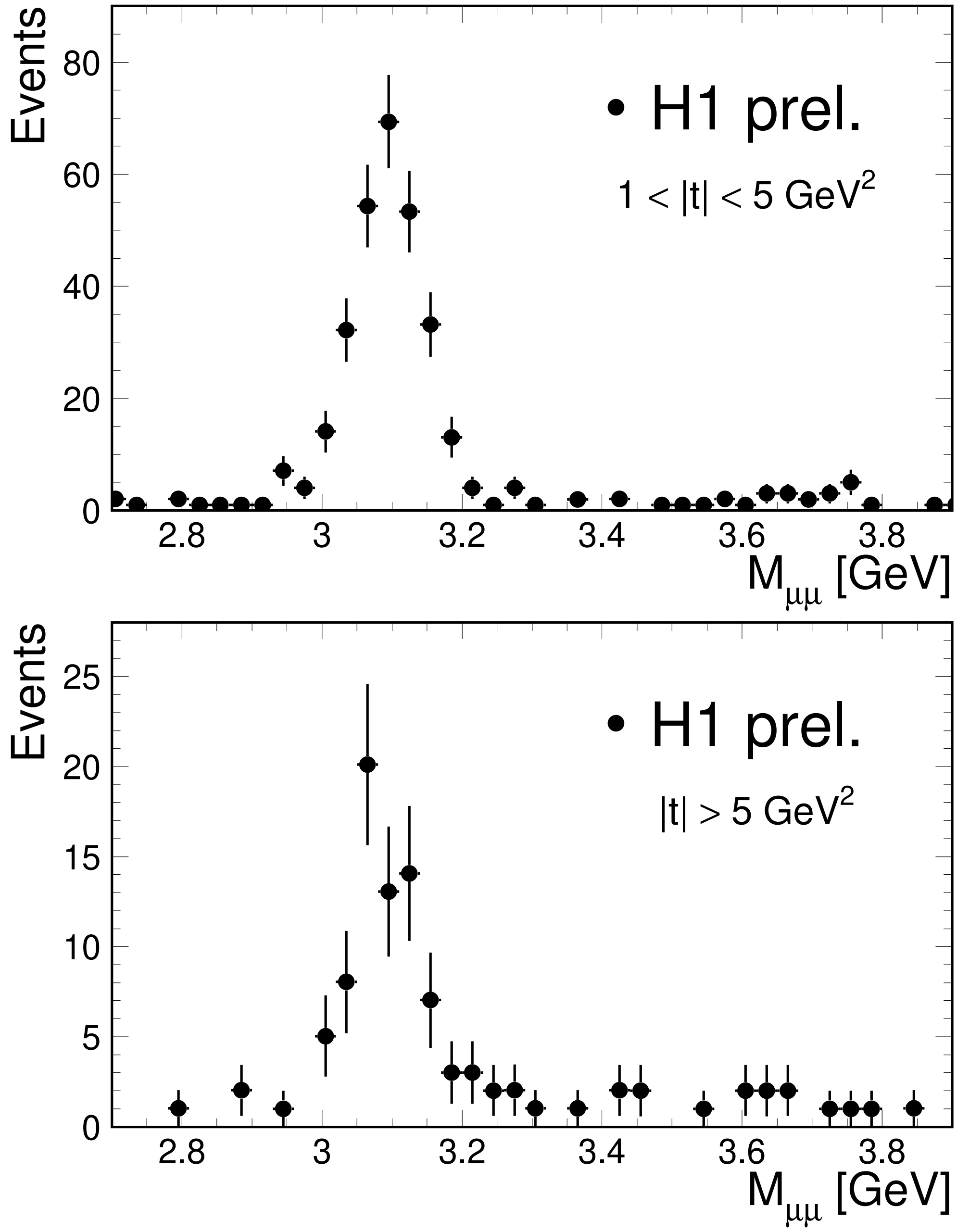
  ⇒ Remove elastic events by demanding

  – secondary scattering in forward detectors,
  – or an energy deposit in Forward LAr.

  ⇒ Proton remnant restricted to ($\theta < 20^\circ$).

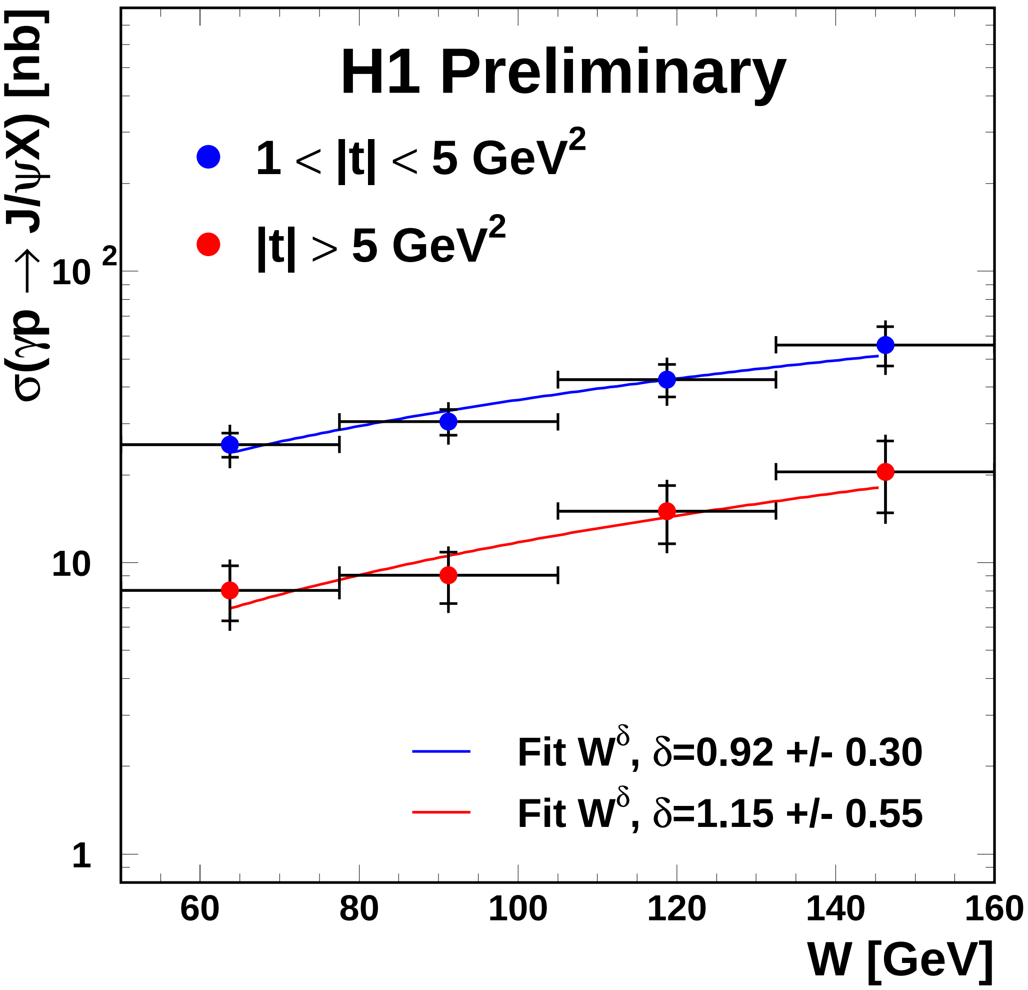
  ⇒ high elasticities z for |t|-reconstruction

Proton Dissociative J/Ψ Production at High |t| : Event Sample



⇒ Sample divided into two |t|-regions

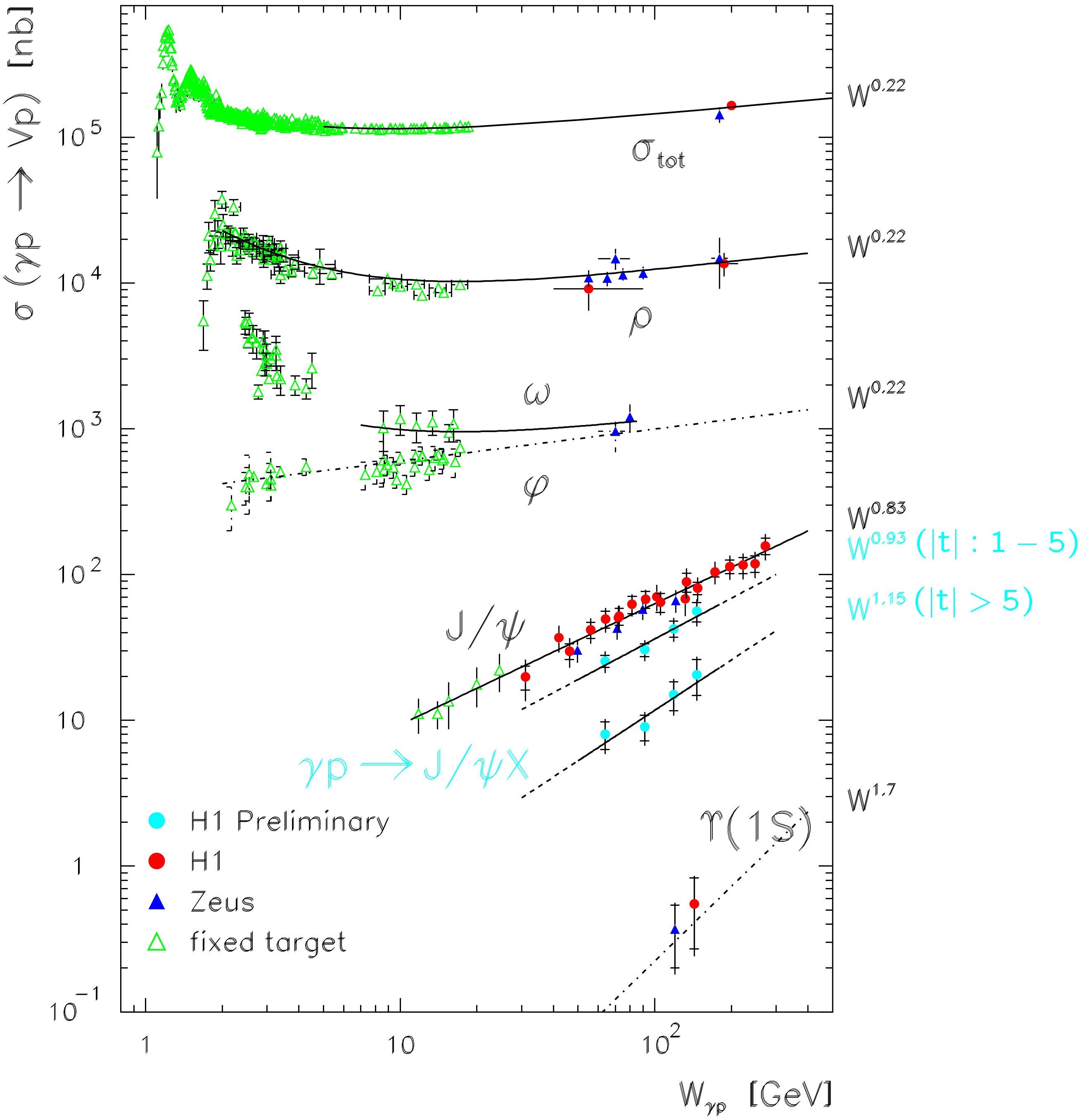
Total cross section at high-$|t|$



$50 < W_{\gamma p} < 160$ GeV
$Q^2 < 1.0$ GeV^2
$1.0 < |t| < 21.0$ GeV^2

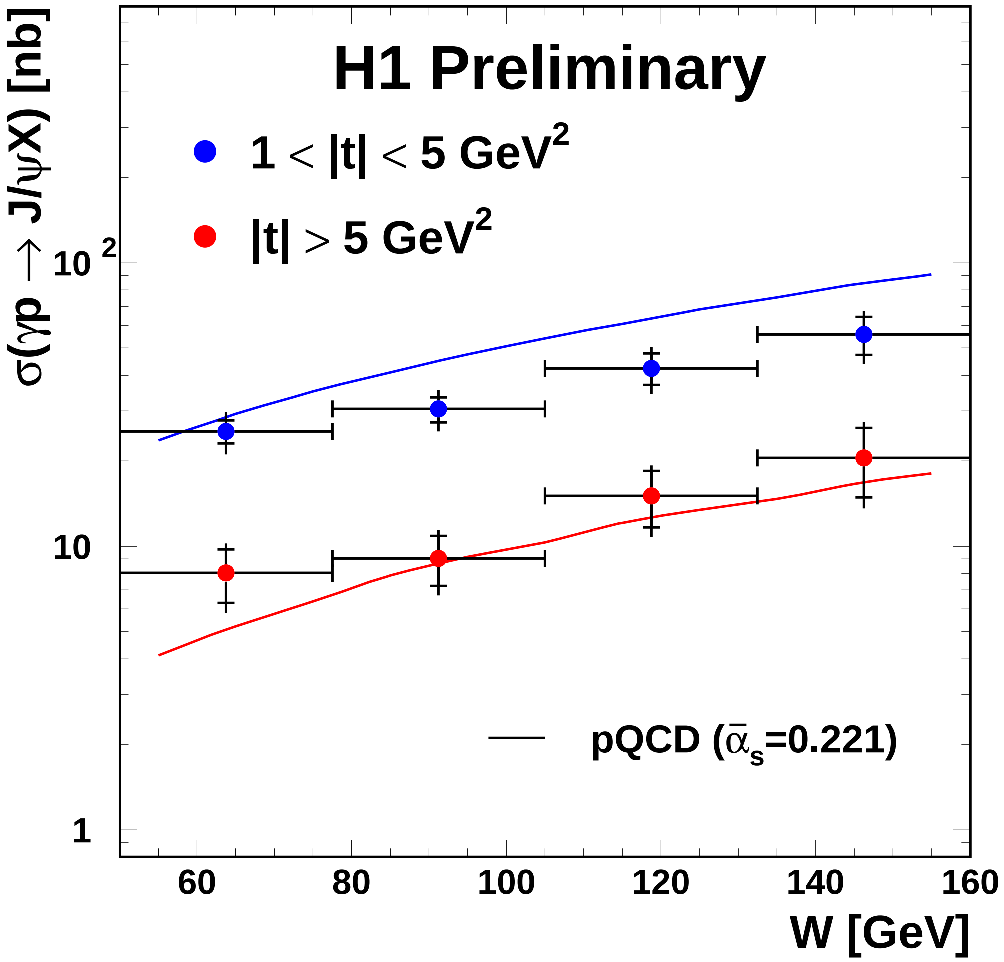
$\Rightarrow$ Rises in the cross section, in each $|t|$-range, suggest similar hard scale behaviour as for elastic J/ψ.

Vector Meson Total Cross Sections



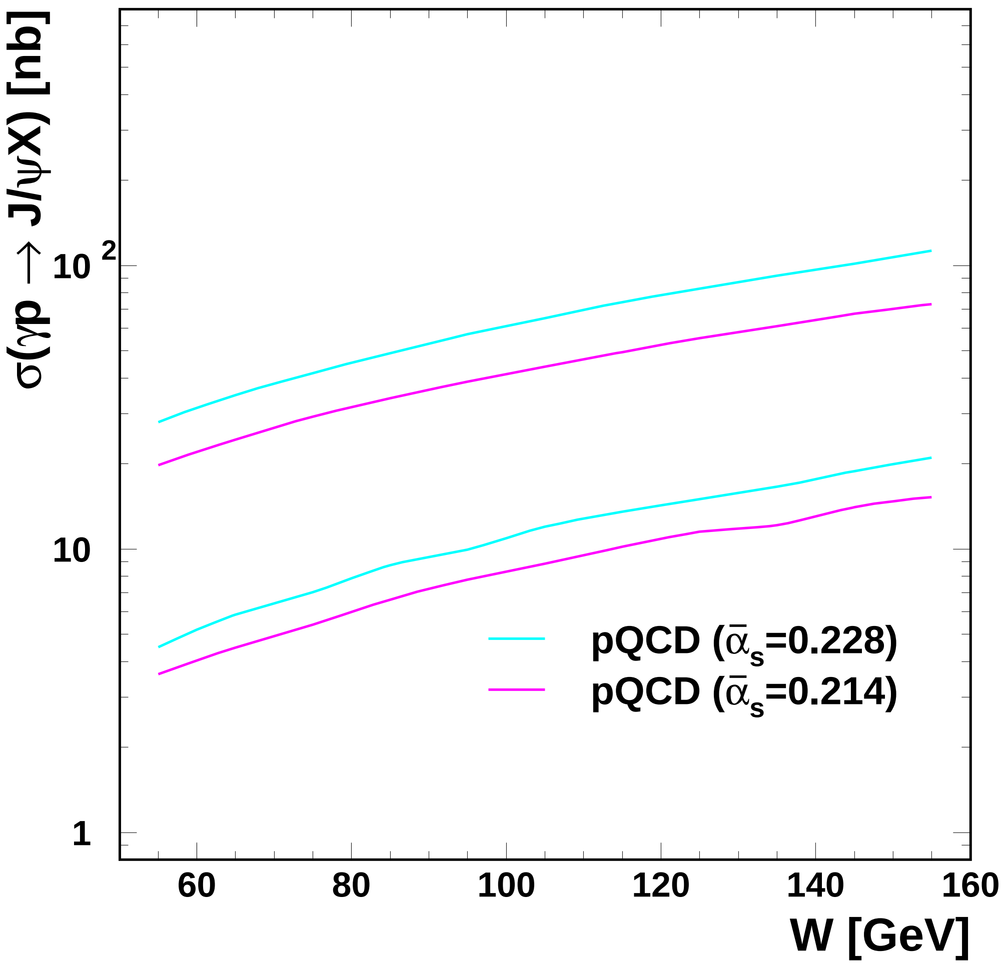
$\Rightarrow$ Consistent with the rise of elastic J/ψ production with $\delta \sim 1$

Comparison to Total Cross Section



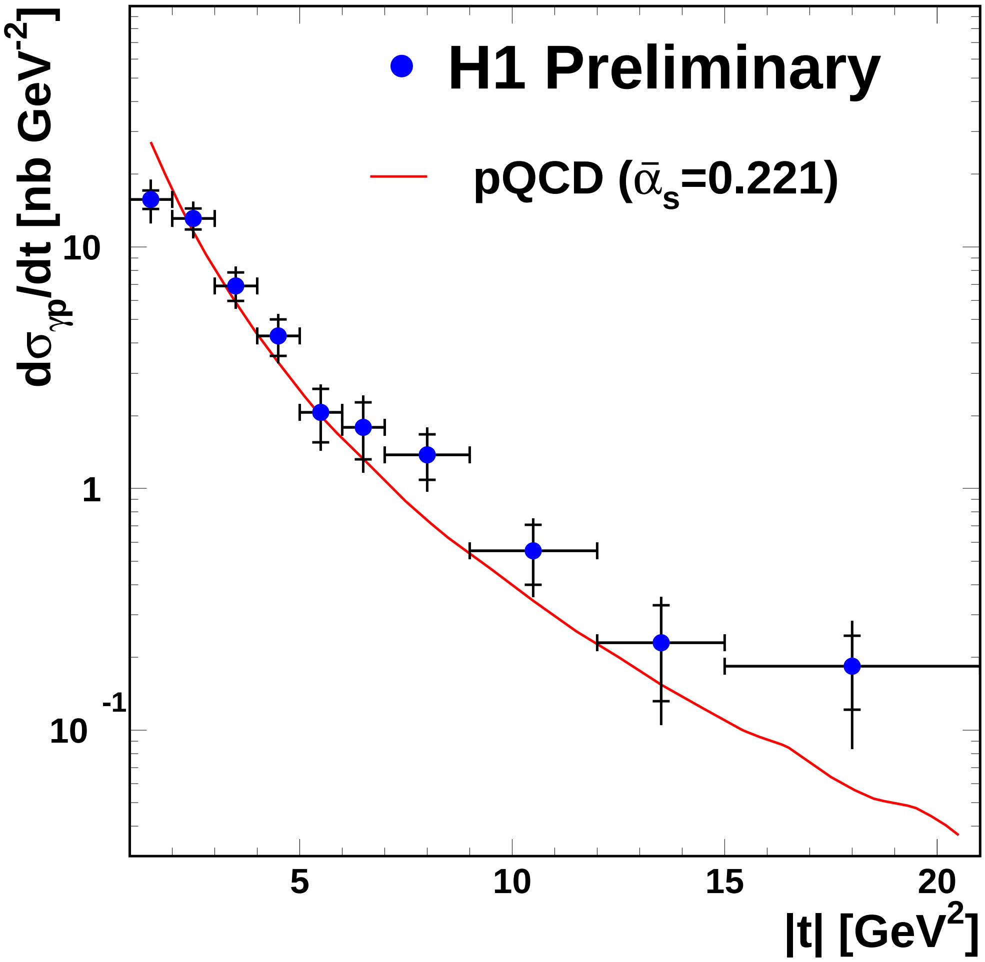
$50 < W_{\gamma p} < 160$ GeV
$Q^2 < 1.0$ GeV^2
$1.0 < |t| < 21.0$ GeV^2

$\Rightarrow$ The behaviour of the total cross section is well described by the model.



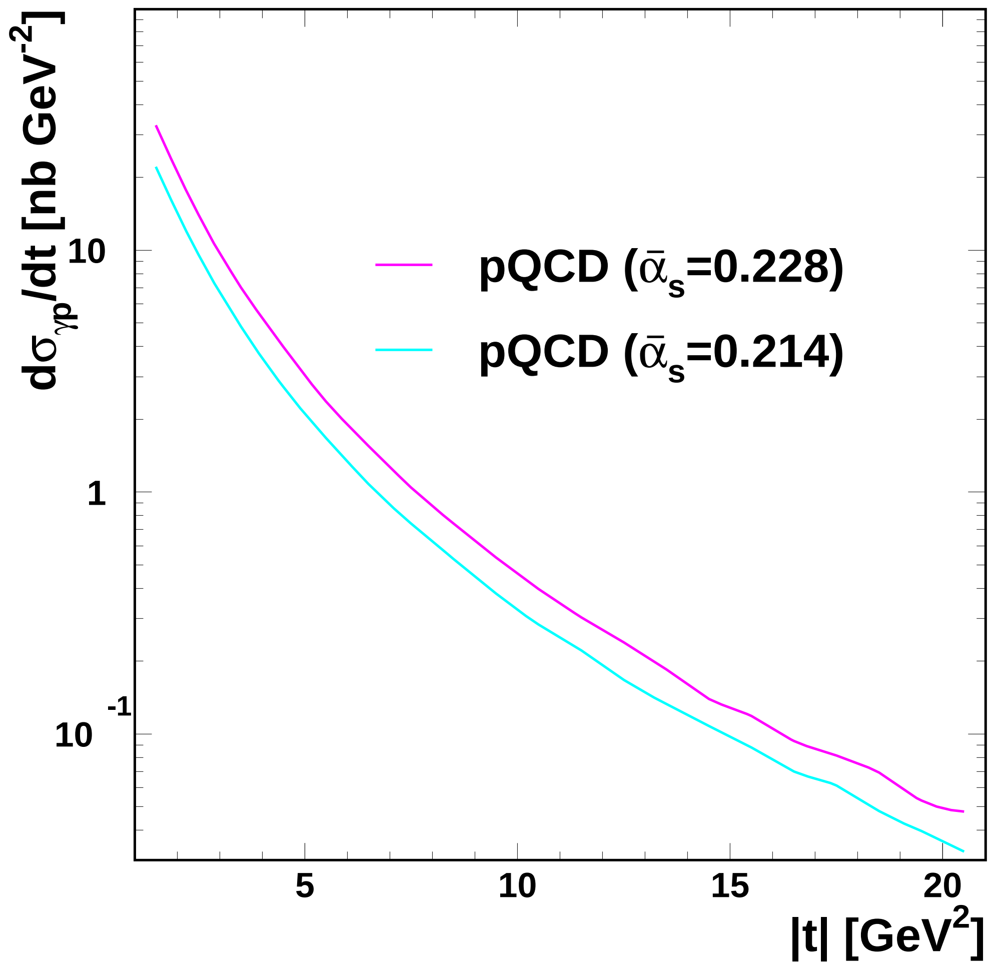
σ(γp → J/ψX) [nb]
10 2
10
1
60
80
100
120
140
160
W [GeV]
pQCD ($\bar{\alpha}_s$=0.228)
pQCD ($\bar{\alpha}_s$=0.214)

pQCD Comparison to Differential Cross Section



$50 < W_{\gamma p} < 160$ GeV
$Q^2 < 1.0$ GeV^2
$1.0 < |t| < 21.0$ GeV^2

$\Rightarrow$ BFKL Model describes the |t|-behaviour.


pQCD ($\bar{\alpha}_s$=0.228)
pQCD ($\bar{\alpha}_s$=0.214)
$d\sigma_{\gamma p}/dt$ [nb GeV^{-2}]
$|t|$ [GeV^2]
10
1
10^{-1}
5
10
15
20

Conclusions

- Measurement of the total cross section σ as a funtion of $W_{\gamma p}$ in four bins of $W_{\gamma p}$ in two $|t|$-regions

- Measurement of $d\sigma/d|t|$ spans the $|t|$ region up to $|t| = 21.0$ GeV^2.

- Fits to the total cross section ($\delta \sim 1$). Similar hard scale behaviour as for elastic J/ψ.

- Data comparison to pQCD model (Forshaw, Bartels etc.,) describes the behaviour in $|t|$ and $W_{\gamma p}$.