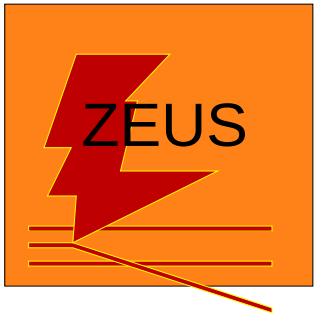
Xavier Janssen - DESY Hamburg

On behalf of H1 and ZEUS Collaborations



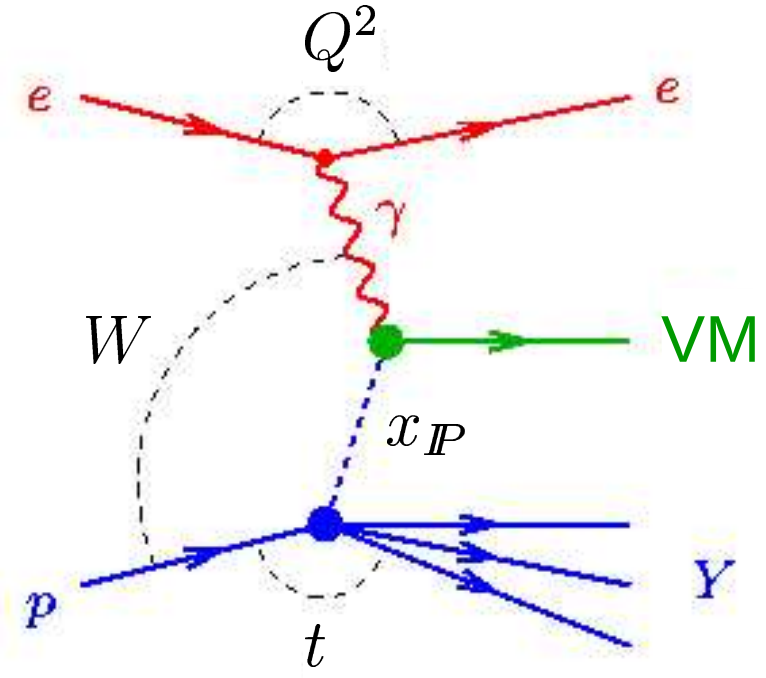
Diffractive Photoproduction of Vector Mesons and Photons at High $|t|$

32nd International Conference on High Energy Physics

Beijing, China, 16-22 August, 2004

High $|t|$ Diffractive Vector Meson Production

$$e + p \rightarrow e + VM\,(= \rho, \phi, J/\psi, ...) + Y$$



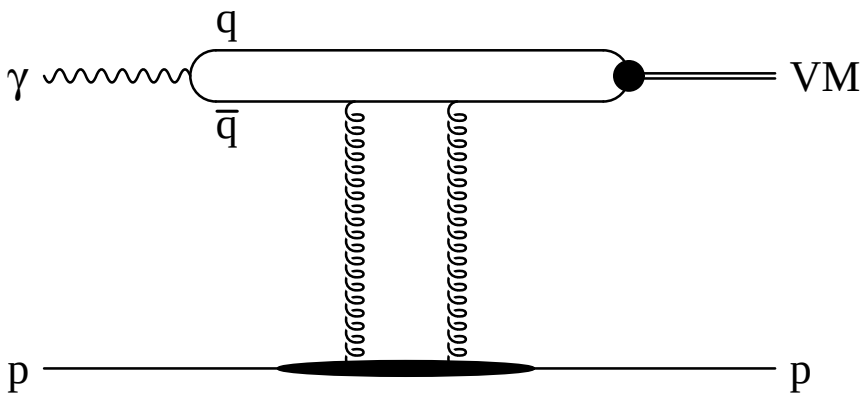
Q^2	Photon Virtuality Photoproduction: $Q^2 \sim 0$
W	γp CMS energy
t	4-momentum transfer squared
$x_{I\!P}$	Momentum fraction of the colour singlet exchange

- Hard Scales for pQCD in Photoproduction: $M_{J/\psi}$, t

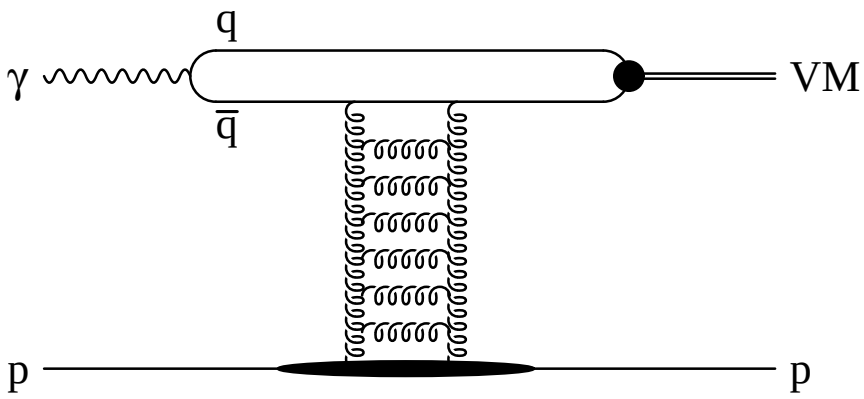
  $\longrightarrow$ Study nature of the Diffractive Exchange at high $|t|$
- High W (i.e. small x_{Bj}) $\longrightarrow$ BFKL contributions expected

Diffractive VM Production in pQCD

LO: 2 gluon exchange



LLA: Gluon ladder



DGLAP Evolution ($|t| < M_{VM}^2$):

Strong k_T ordering along ladder

$\rightarrow$ No increase of $\mathrm{d}\sigma/\mathrm{dt}$ with W

BFKL Evolution (small x_{Bj}):

No k_T ordering in ladder

$\rightarrow \mathrm{d}\sigma/\mathrm{dt} \sim |\mathrm{t}|^{-\mathrm{n}}$

$\rightarrow$ Increase of $\mathrm{d}\sigma/\mathrm{dt}$ with W

$\rightarrow$ Little shrinkage $\mathrm{d}\sigma/\mathrm{dW} \propto \mathrm{W}^{4(\alpha_{\mathrm{P}}(\mathrm{t})-1)}$

$\rightarrow$ S-channel helicity conservation

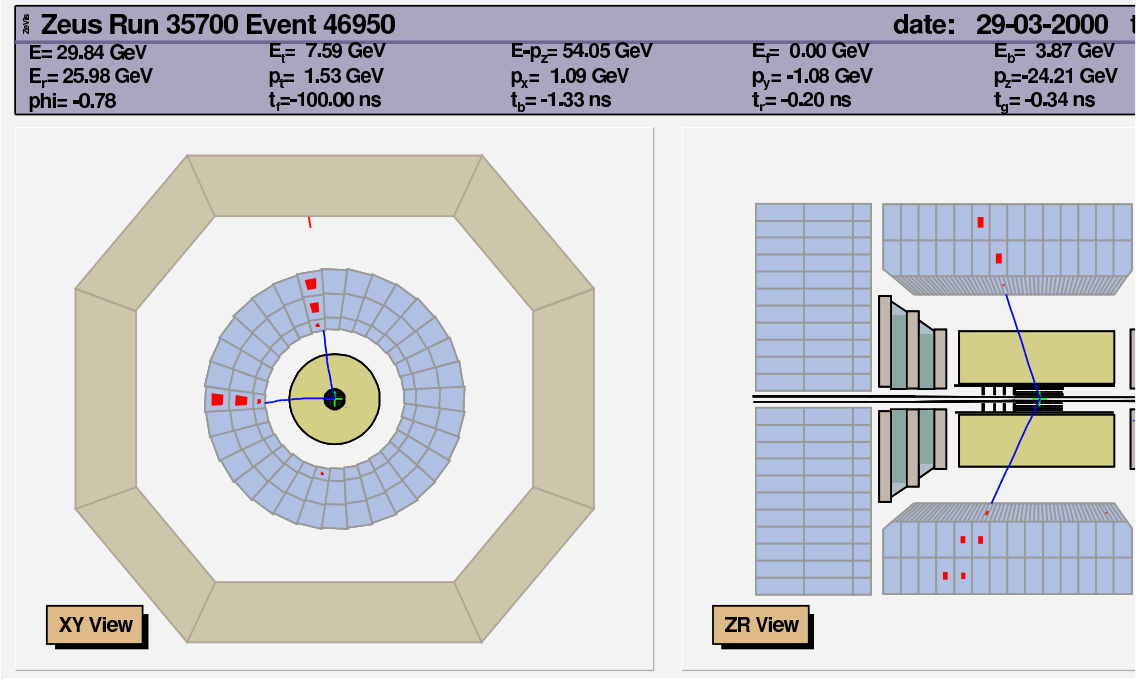
$\leftrightarrow$ Meson Wave Fct

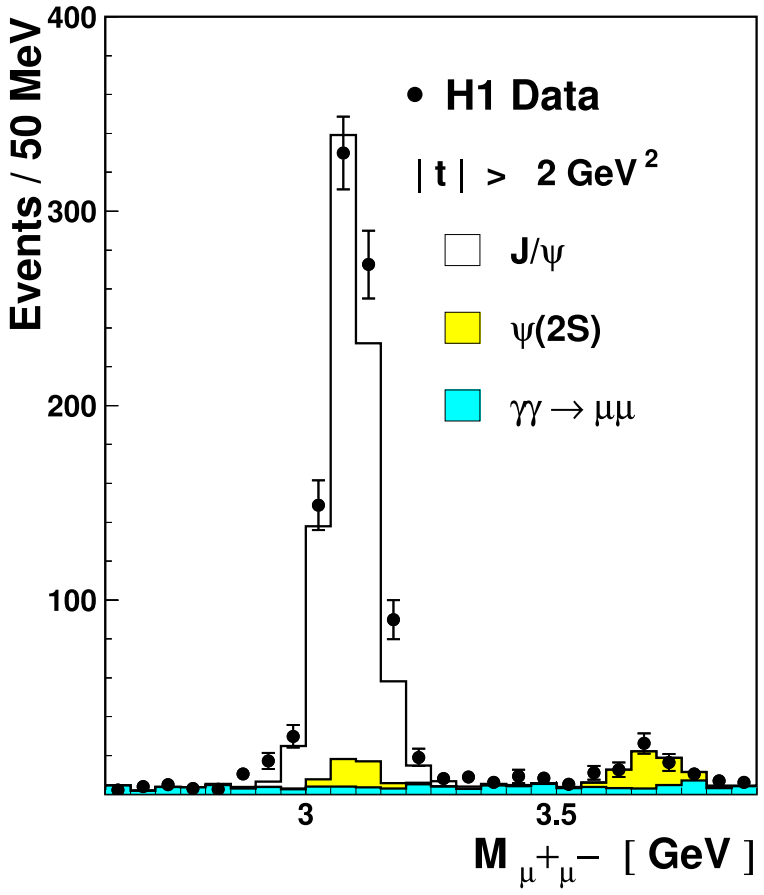
($\leftrightarrow$ Equal long. momentum sharing)

Diffractive Photoproduction of J/ψ at high $|t|$

$$J/\psi \longrightarrow e^+ + e^-$$
$$J/\psi \longrightarrow \mu^+ + \mu^-$$

Decay channels selected





Backgrounds: $\gamma\gamma \to e^+ + e^-, \mu^+ + \mu^-$ and $\Psi(2S)$

J/ψ at High $|t|$: t Dependence

H1 data 1999-2000 $\int \mathcal{L} = 78\,\mathrm{pb}^{-1}$

$50 < W < 150$ GeV $\qquad Q^2 < 1\ \mathrm{GeV}^2 \qquad 2 < |t| < 30\ \mathrm{GeV}^2$

- Data follow $|t|^{-n}$ (not e^{-bt})

  Fit: $n = 3.00 \pm 0.08 \pm 0.05$ for $|t| > 3.5\ \mathrm{GeV}^2$

- DGLAP:

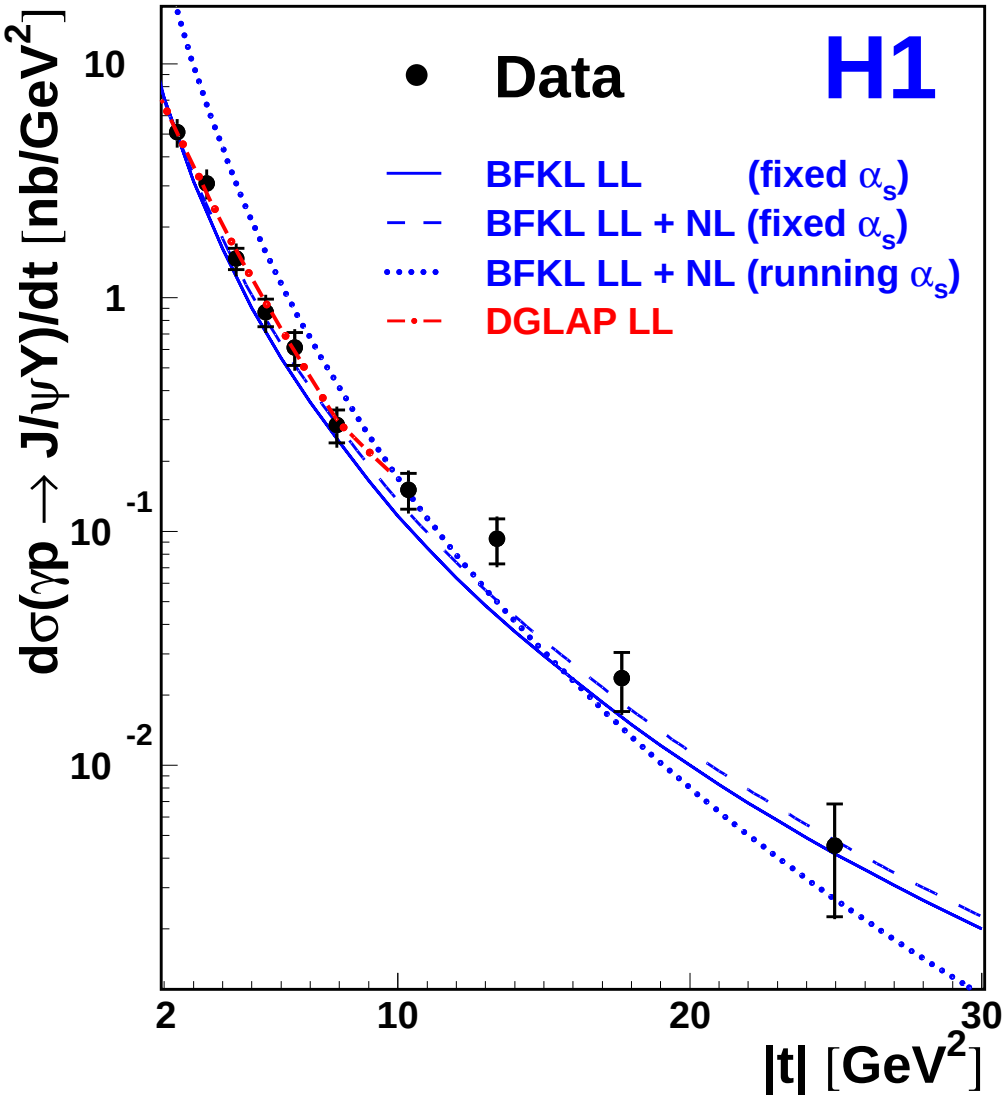
  OK for $|t| < 10\ \mathrm{GeV}^2$

- BFKL:

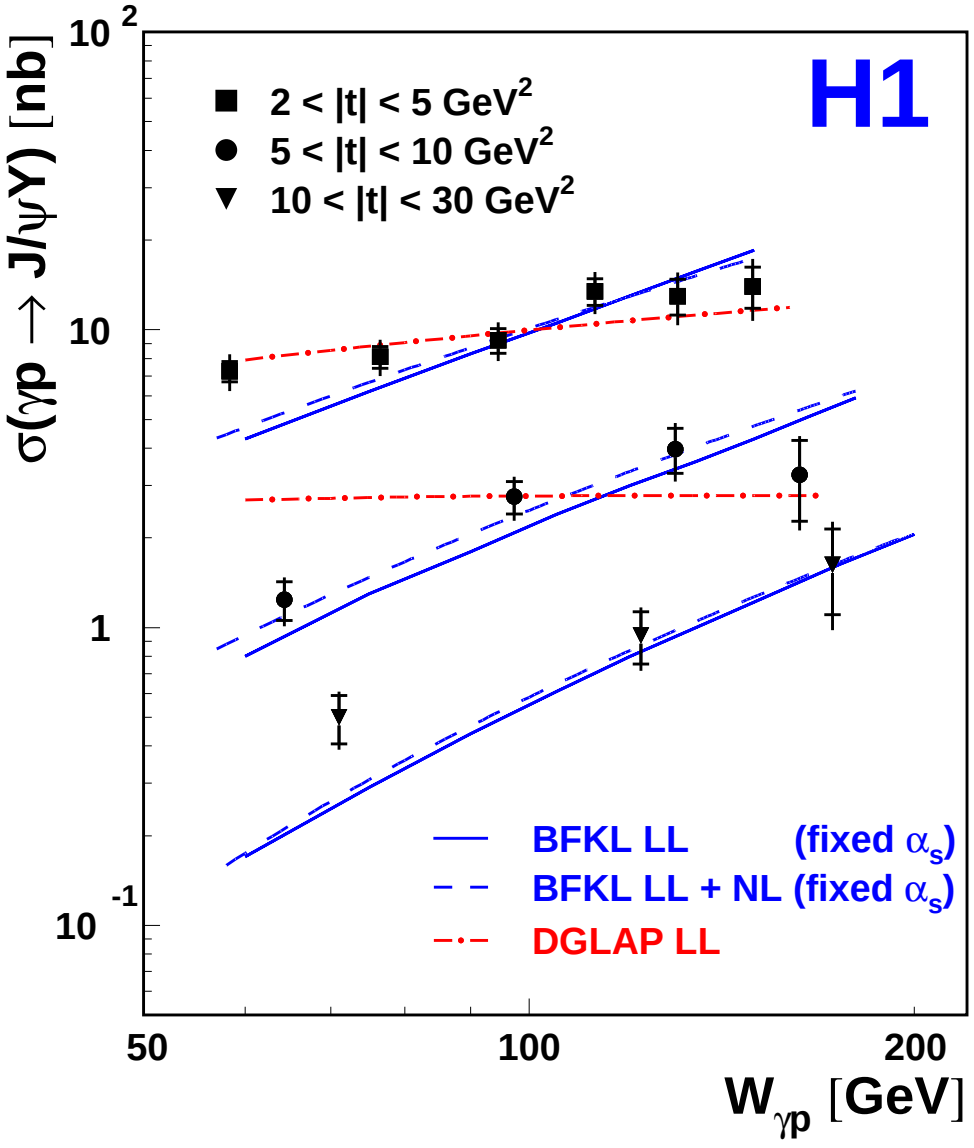
  $\rightarrow$ (fixed) α_s = 0.18 describes the t dependence

  $\rightarrow$ NL corrections are small

  $\rightarrow$ Running α_s: too steep t dependence



J/ψ at High $|t|$: W Dependence



- Fit $\sigma \propto W^{\delta}$; $\delta = 4(\alpha_{I\!P}(t) - 1)$

$$\alpha_{I\!P}(t) = \alpha_{I\!P}(0) + \alpha' t$$

$$\alpha_{I\!P}(0) = 1.167 \pm 0.048 \pm 0.024$$

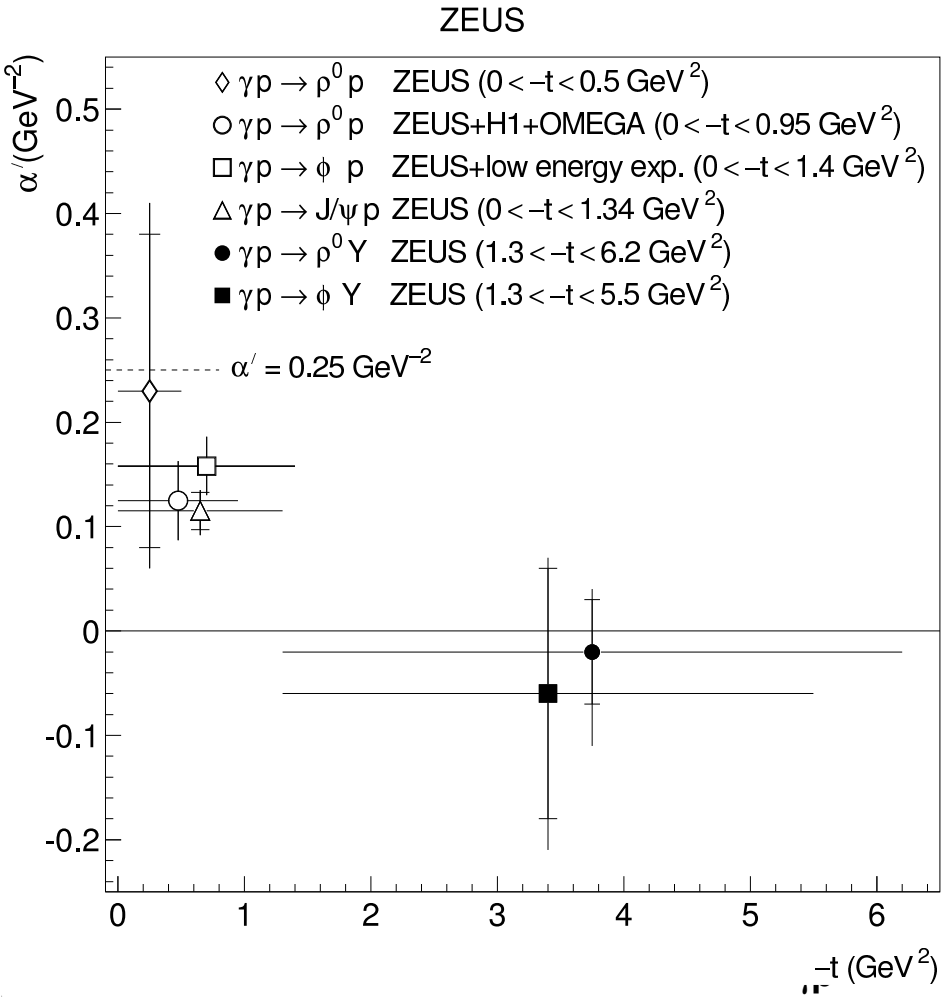
$$\alpha' = -0.0135 \pm 0.0074 \pm 0.0051 \ \mathrm{GeV}^{-2}$$

$\longrightarrow$ No Shrinkage at Hight $|t|$

J/ψ at High $|t|$: W Dependence

Same as for ZEUS

ρ and ϕ results:



- Fit $\sigma \propto W^{\delta}$; $\delta = 4(\alpha_{I\!P}(t) - 1)$

$$\alpha_{I\!P}(t) = \alpha_{I\!P}(0) + \alpha' t$$

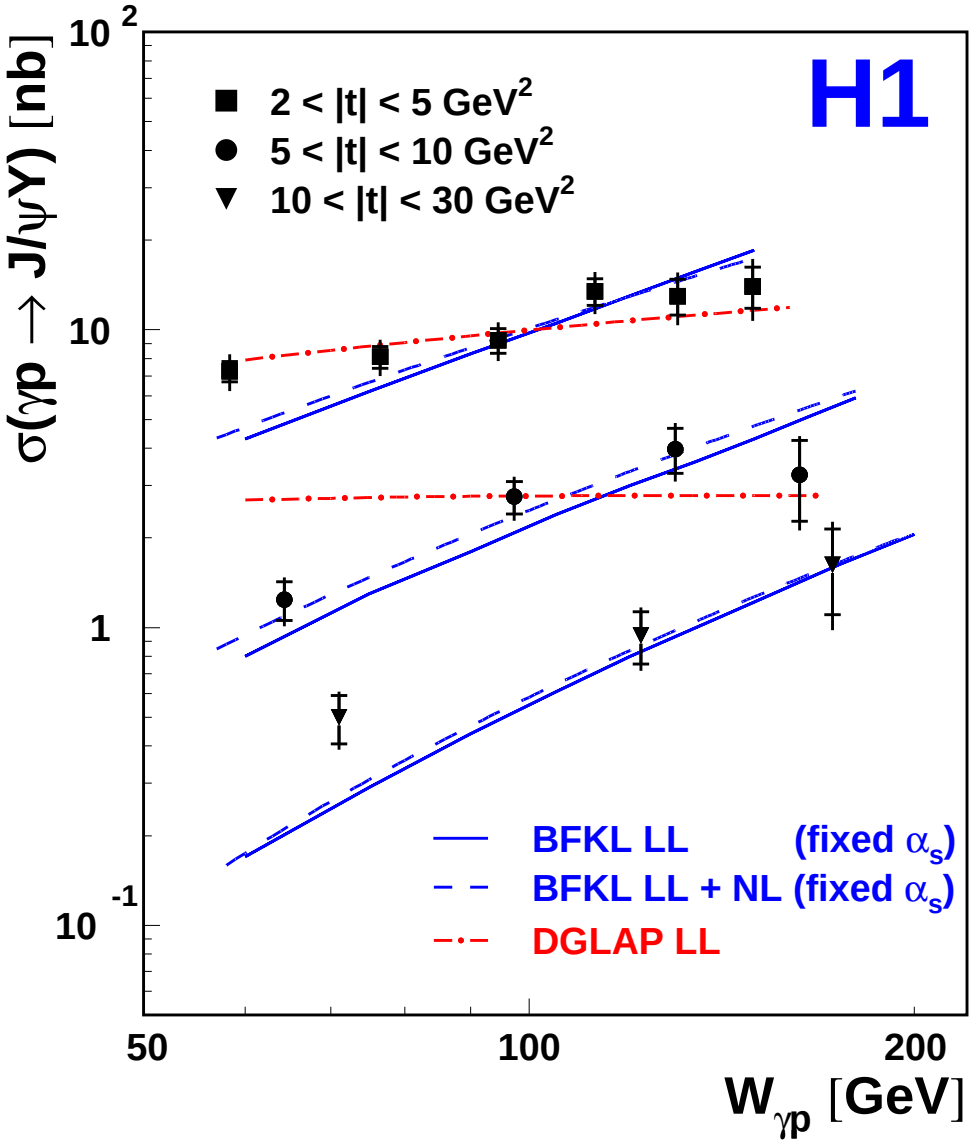
$$\alpha_{I\!P}(0) = 1.167 \pm 0.048 \pm 0.024$$

$$\alpha' = -0.0135 \pm 0.0074 \pm 0.0051 \text{ GeV}^{-2}$$

$\longrightarrow$ No Shrinkage at Hight $|t|$

Predicted by BFKL models

J/ψ at High $|t|$: W Dependence



- Fit $\sigma \propto W^{\delta}$; $\delta = 4(\alpha_{I\!P}(t) - 1)$

$$\alpha_{I\!P}(t) = \alpha_{I\!P}(0) + \alpha' t$$

$$\alpha_{I\!P}(0) = 1.167 \pm 0.048 \pm 0.024$$

$$\alpha' = -0.0135 \pm 0.0074 \pm 0.0051 \text{ GeV}^{-2}$$

$\longrightarrow$ No Shrinkage at Hight $|t|$

Predicted by BFKL models

- BFKL (fixed α_s) describes data reasonably
- DGLAP works only at low $|t|$

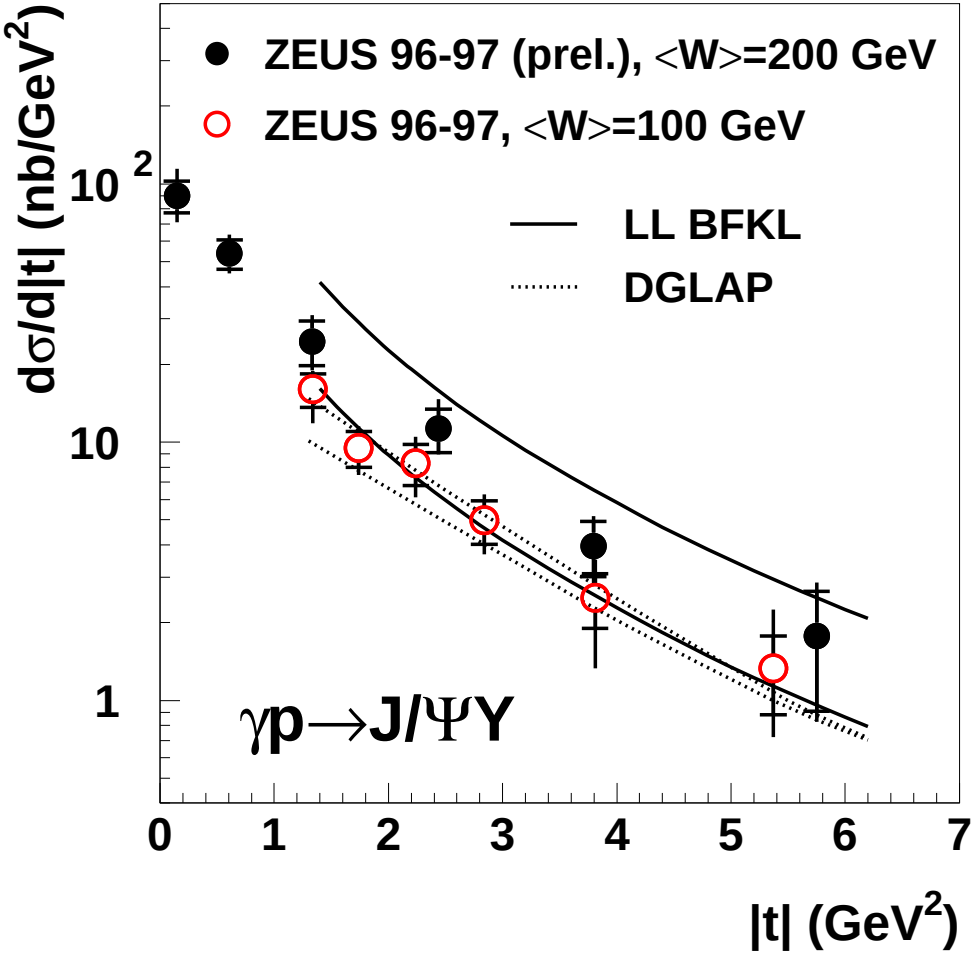
J/ψ at High $|t|$: W Dependence

ZEUS data 1996-97 $\int \mathcal{L} = 36\,\mathrm{pb}^{-1}$

$80 < W < 180$ GeV
$185 < W < 245$ GeV

$Q^2 < 0.02\ \mathrm{GeV}^2$

$|t| < 7\ \mathrm{GeV}^2$



- Cross-Section Increase with W
- Steep t-dependence $\propto |t|^{-n}$

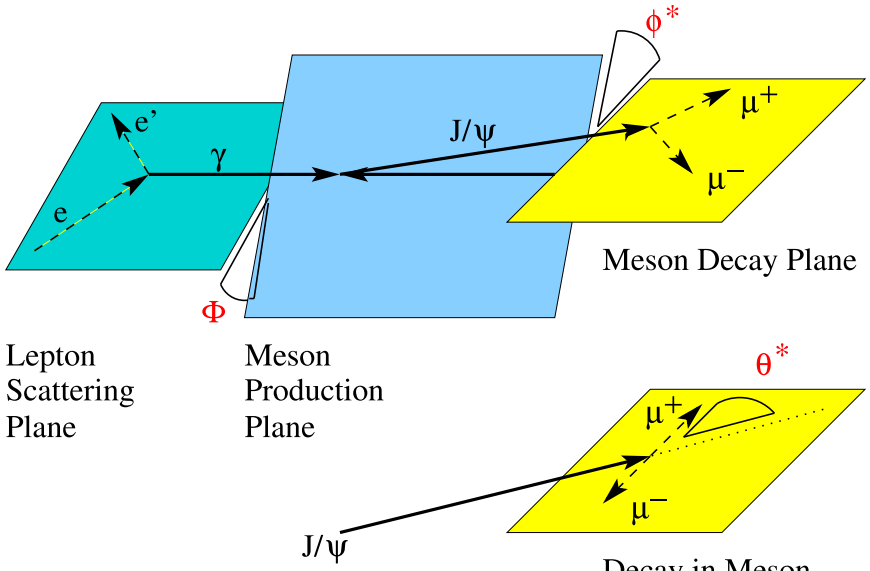
  $n = 1.7 \pm 0.2 \pm 0.3$

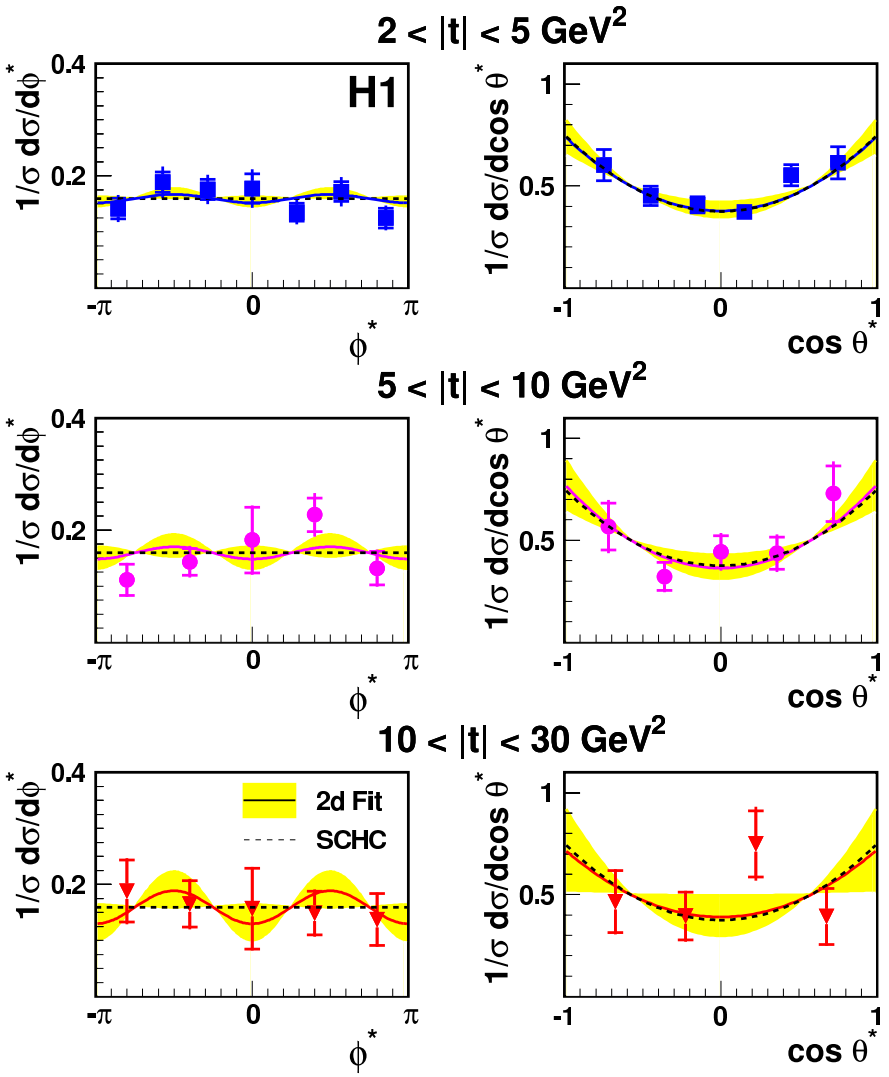
- BFKL model (tuned for $W = 100$ GeV) reproduces qualitatively the increase with W
- DGLAP model:

  $\longrightarrow$ no W dependence

Spin Density Matrix Elements

Helicity System



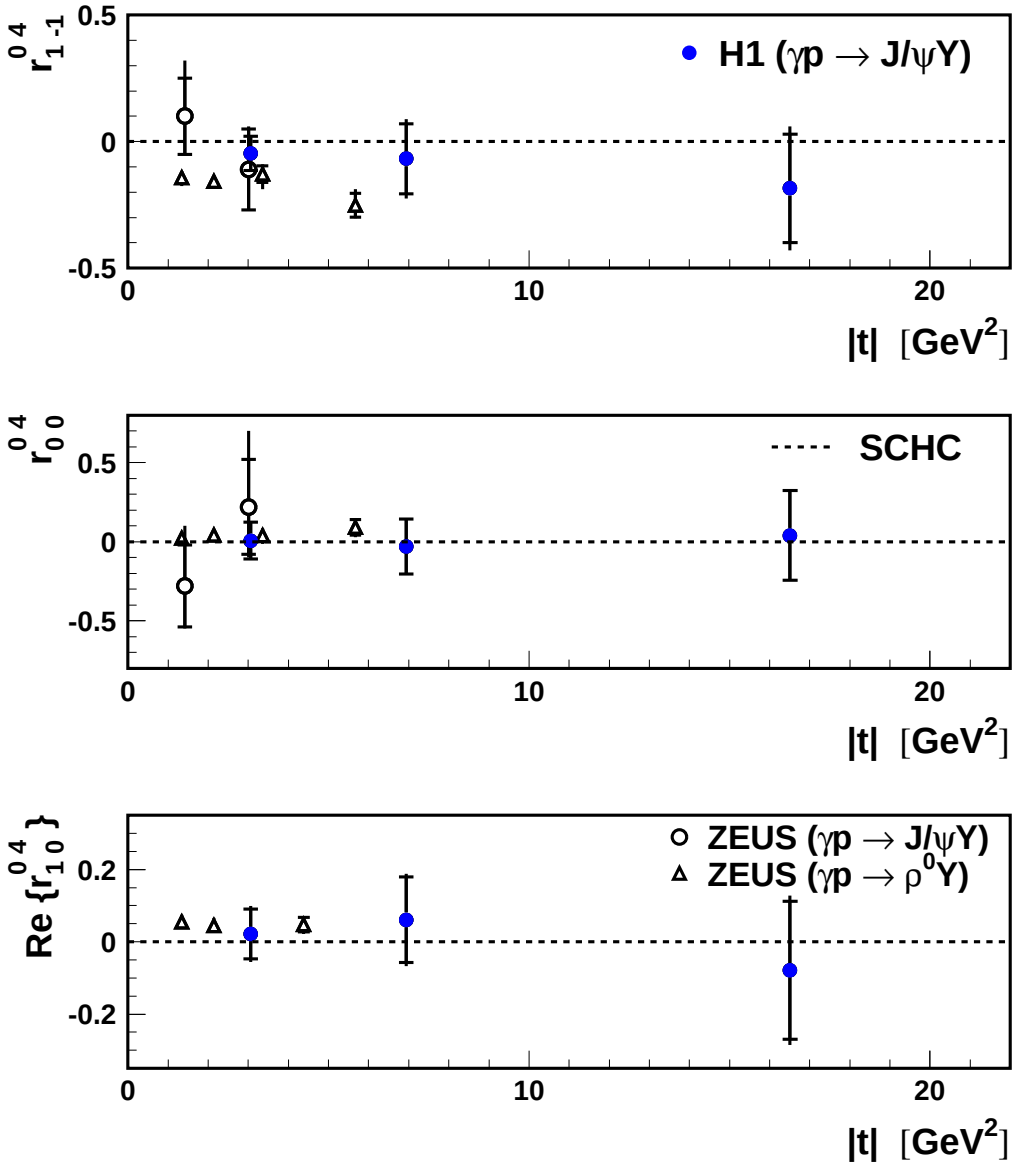


$$\frac{4\pi}{3\sigma}\frac{\mathrm{d}^2\sigma}{\mathrm{d}\cos\theta^*\mathrm{d}\phi^*} = \frac{1}{2}(1+r_{00}^{04}) - \frac{1}{2}(3\,r_{00}^{04}-1)\cos^2\theta^* + \sqrt{2}\,\mathrm{Re}\{r_{10}^{04}\}\sin 2\theta^*\cos\phi^* + r_{1-1}^{04}\sin^2\theta^*\cos 2\phi^*$$

SCHC:

Expect $r_{00}^{04},\ \mathrm{Re}\{r_{10}^{04}\},\ r_{1-1}^{04} = 0$

Spin Density Matrix Elements



J/ψ data compatible with SCHC

$\longleftrightarrow$ Choice of J/ψ Wave Fct is appropriate

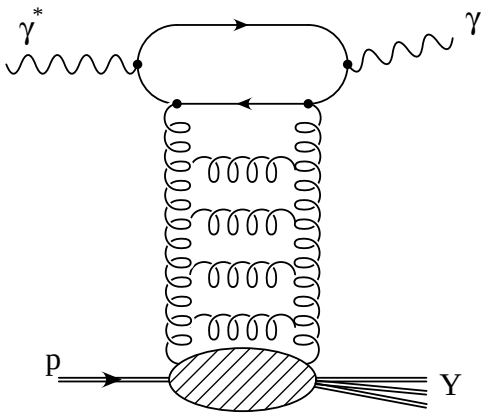
$\longrightarrow$ Equal long. momentum sharing between q and $\bar{q}$

ρ (and ϕ):

SCHC violation

Diffractive High P_T Photons

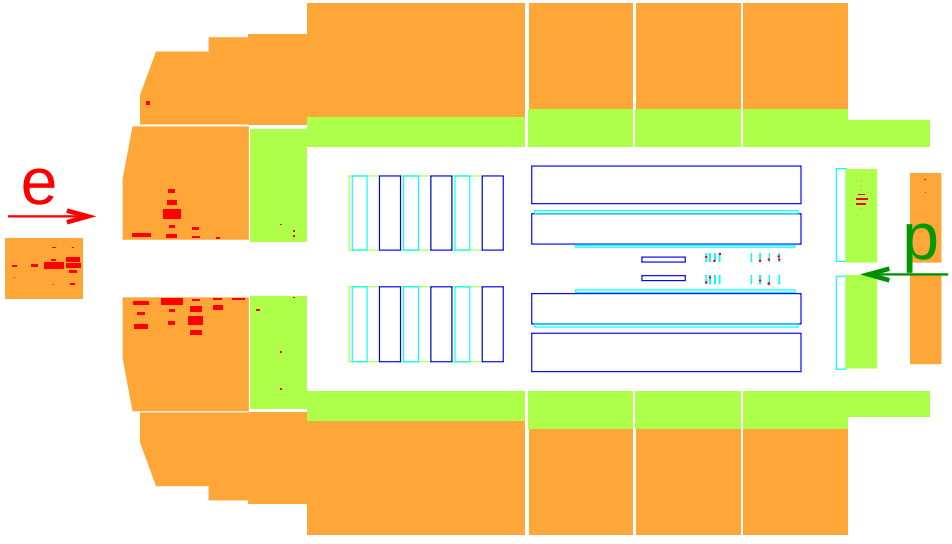
$e + p \rightarrow e + \gamma + p$



- Photoproduction $Q^2 < 0.01\ \mathrm{GeV}^2$
- No Vector Meson wavefunction
- Large rapidity gap: $\Delta\eta \simeq \log(\hat{s}/p_{t(\gamma)}^2)$

  $\longrightarrow$ large $\hat{s}$ accessible

  $\longrightarrow$ BFKL LL approximation:



- Steep rise at small $x_{I\!P}$:

  $$\mathrm{d}\sigma/\mathrm{d}x_{I\!P} \sim 1/W^2\,(1/x_{I\!P})^{2(1+\omega_0)}$$

  $$\omega_0 = (3\alpha_s/\pi)4\ln 2$$

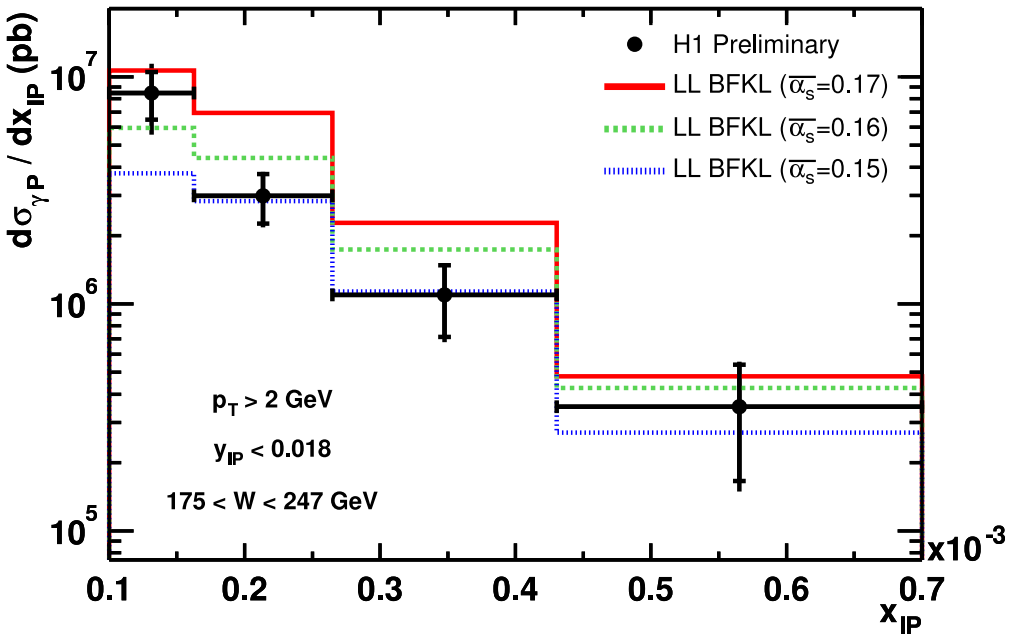
- α_s = 0.15 - 0.17

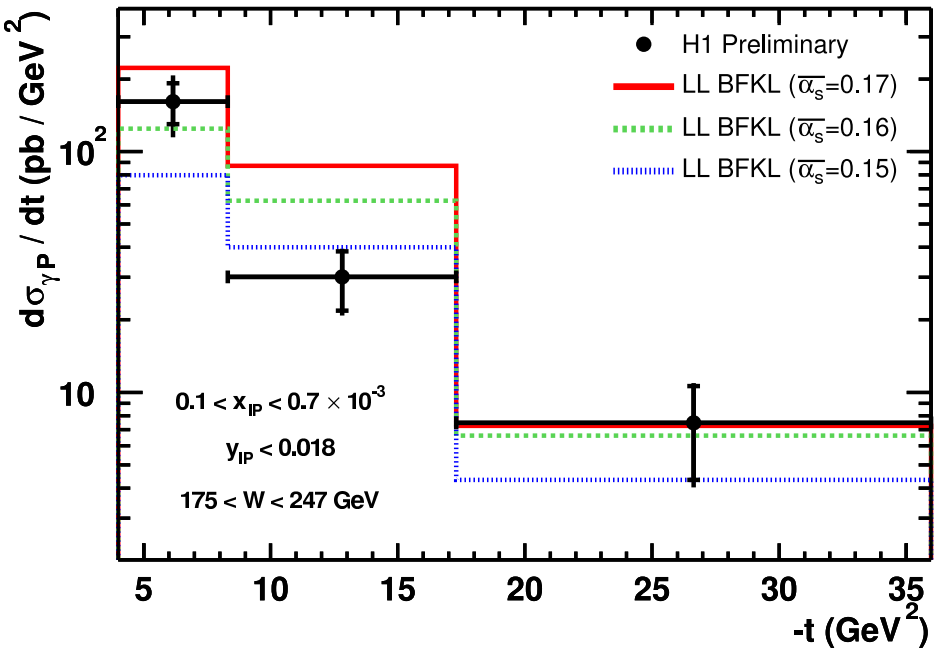
  ($\alpha_s = 0.18$ found for J/ψ)

First Measurement of High P_T Photons

H1 data 1999-2000 $\int \mathcal{L} = 40\,\mathrm{pb}^{-1}$

$175 < W < 247$ GeV $\qquad Q^2 < 0.01\ \mathrm{GeV}^2$ $\qquad p_{t(\gamma)} > 2$ GeV





Cross section basically described by BFKL LL (α_s = 0.15 - 0.17)

(J/ψ : α_s = 0.18 $\qquad$ Rapidity gaps between Jets : α_s = 0.18)

CONCLUSION

Diffractive Vector Meson Production at High $|t|$:

- Data extend to large values of $|t|$
- t-dependence: $\propto |t|^{-n}$
- Steep rise of Cross-Sections with W
- Low or no shrinkage at high $|t|$: $\alpha' \sim 0\ \mathrm{GeV}^{-2}$
- BFKL model with fixed α_s describes the data quite well in contrast to DGLAP predictions

Diffractive High P_T Photons Production:

- First measurment of this proces
- BFKL model describe basic feature of the data