

Exclusive Vector Meson & Diffractive Jets @ HERA

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Outline of the talk:

Short review of low x HERA data, Dipole Picture,
Diffractive Jets in the Dipole Picture
vs Diffractive Structure Function approach
DVCS & VM in the Dipole Picture
→ abundance of multiple interactions

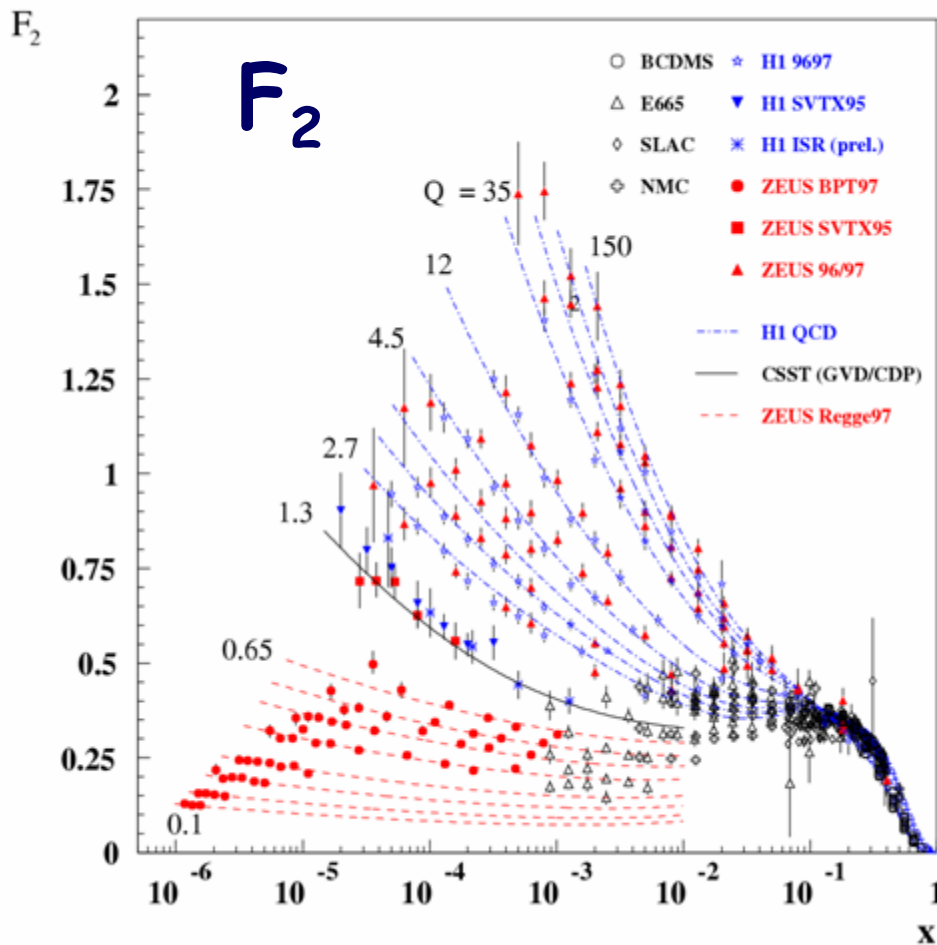
Saturation, oomph factor and all that

Why Pomeron at HERA?,
What is DAF-BFKL Pomeron
Evidence for DAF-Pomeron from HERA data

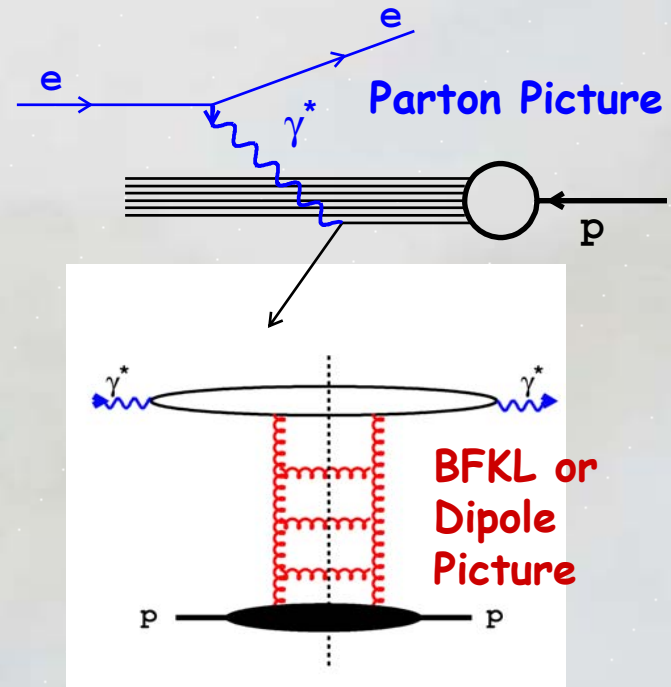
Relation with DGLAP
MRST \leftrightarrow EKR

Pomeron-Graviton Correspondence

Low-x Physics @ HERA



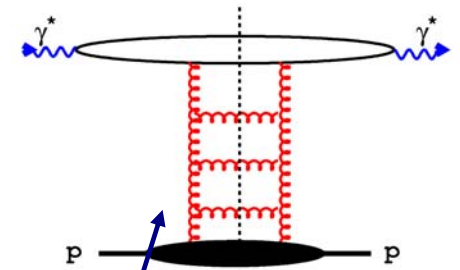
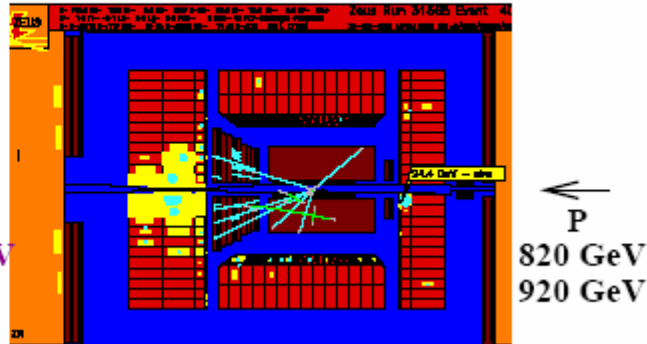
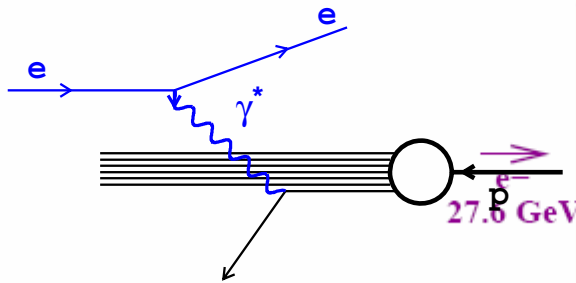
- At low x and high Q^2 , steep rise in structure function



Behavior of F_2 is dominated by gluon density at small- x

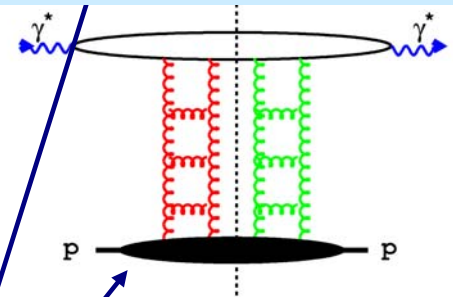
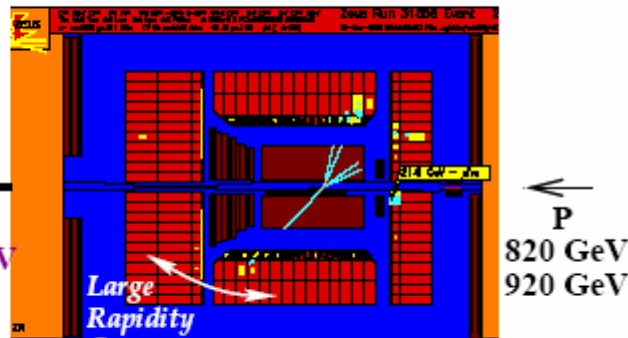
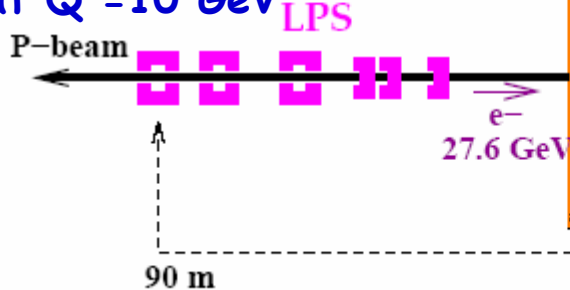
Hard Diffraction - the HERA surprise

Non-Diffractive Event



$$\tau_{qq} \approx \frac{1}{\Delta E} \approx \frac{1}{m_p x} \approx 10 - 1000 \text{ fm}$$

Diffractive Event expected before HERA <0.01%, seen over 10% at $Q^2=10 \text{ GeV}^2$

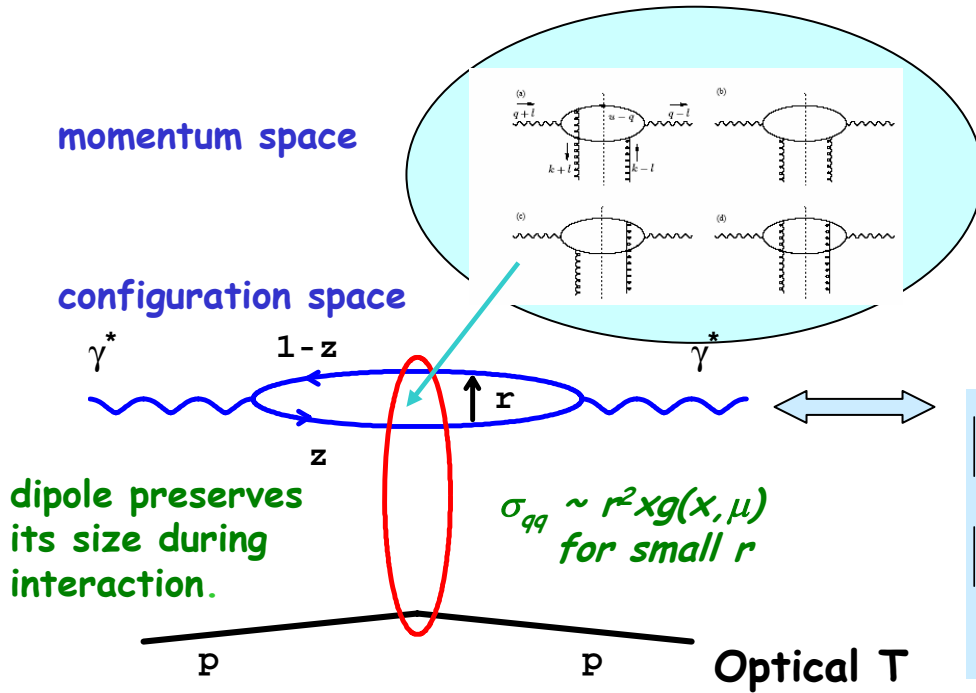


Diffraction at HERA is so large because it is a shadow of DIS (i.e. inelastic processes) → **dipole picture**

$$\sigma_{tot}^{\gamma^* p} = \frac{1}{W^2} \text{Im} A_{el}(W^2, t=0)$$

Dipole description of DIS

equivalent to Parton Picture in the perturbative region



$$|\Psi_T^f|^2 = \frac{3\alpha_{em}}{2\pi^2} e_q^2 \{ [z^2 + (1-z)^2] \varepsilon^2 K_1^2(\varepsilon r) + m_q^2 K_0^2(\varepsilon r) \}$$

$$|\Psi_L^f|^2 = \frac{3\alpha_{em}}{2\pi^2} e_q^2 \{ 4Q^2 z^2 (1-z)^2 K_0^2(\varepsilon r) \}$$

$$\varepsilon^2 = z(1-z)Q^2 + m_q^2$$

$$\varepsilon r \ll 1$$

$$Q^2 \sim 1/r^2$$

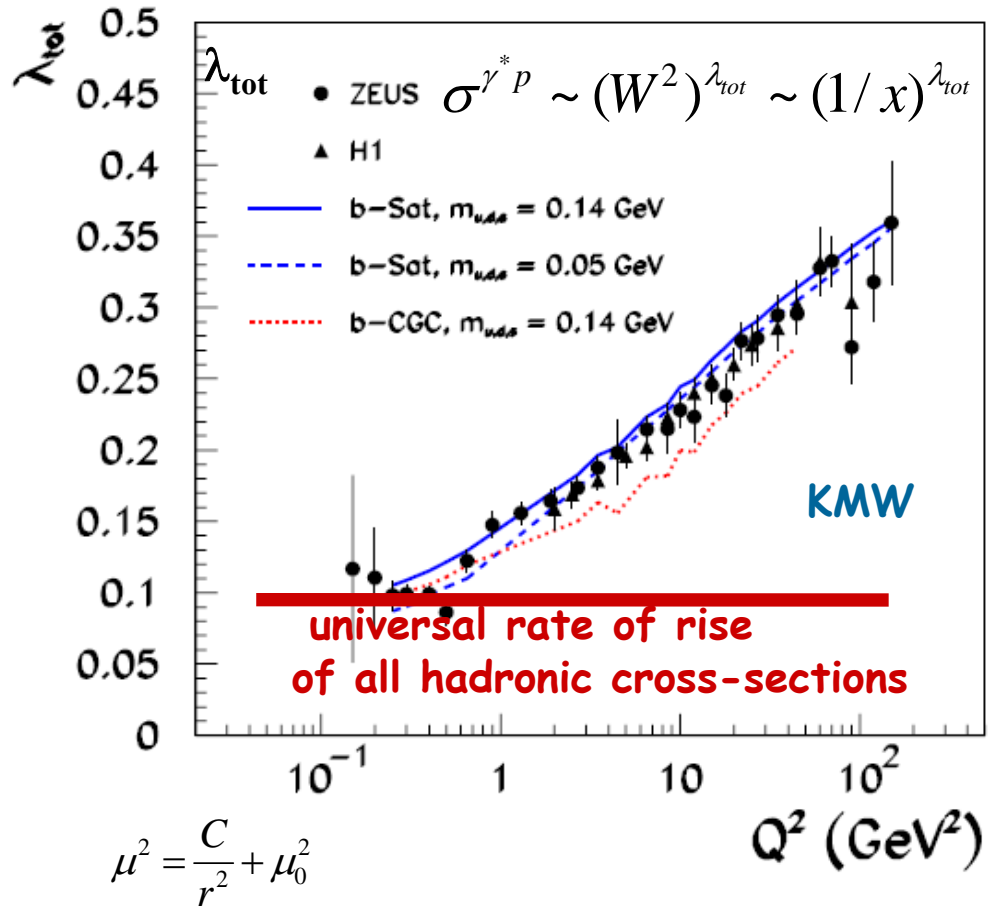
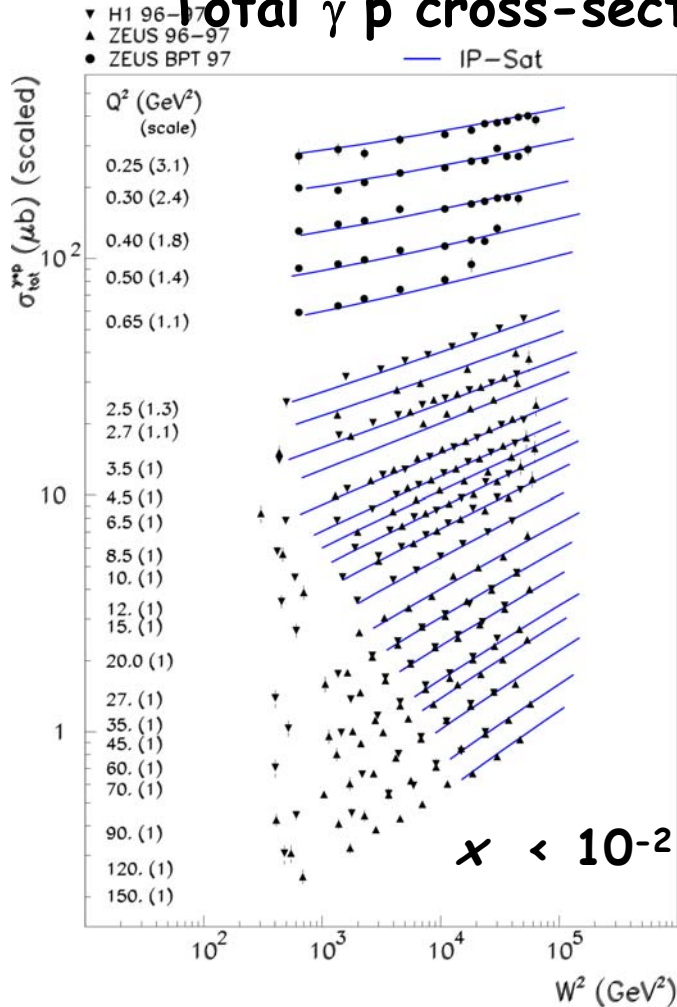
Mueller, Nikolaev, Zakharov

$$\sigma_{tot}^{\gamma^* p} = \int d^2 \vec{r} \int_0^1 dz \Psi^* \sigma_{q\bar{q}}(x, r^2) \Psi$$

$$\frac{d\sigma_{VM}^{\gamma^* p}}{dt} \Big|_{t=0} = \frac{1}{16\pi} \left| \int d^2 \vec{r} \int_0^1 dz \Psi_{VM}^*(Q^2, z, \vec{r}) \sigma_{q\bar{q}}(x, r^2) \Psi(Q^2, z, \vec{r}) \right|^2$$

$$\frac{d\sigma_{diff}^{\gamma^* p}}{dt} \Big|_{t=0} = \frac{1}{16\pi} \int d^2 \vec{r} \int_0^1 dz \Psi^* \sigma_{q\bar{q}}^2(x, r^2) \Psi$$

Total $\gamma^* p$ cross-section



$$\frac{d\sigma_{q\bar{q}}}{d^2b} = 2 \left[1 - \exp \left(-\frac{\pi^2}{2N_c} r^2 \alpha_S(\mu^2) x g(x, \mu^2) T(b) \right) \right] xg(x, \mu_0^2) = A_g \left(\frac{1}{x} \right)^{\lambda_g} (1-x)^{5.6}$$

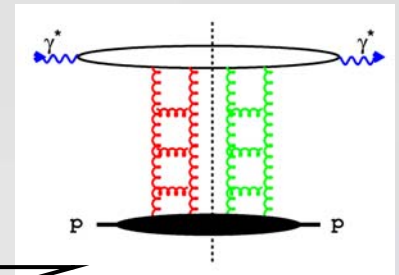
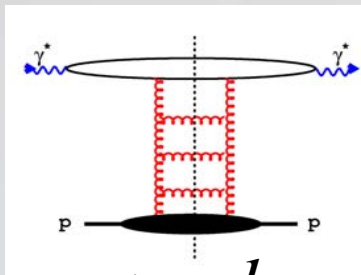
b-Sat

$$\frac{d\sigma_{q\bar{q}}}{d^2b} \equiv 2\mathcal{N}(x, r, b) = 2 \times \begin{cases} \mathcal{N}_0 \left(\frac{rQ_s}{2} \right)^{2(\gamma_s + \frac{1}{\kappa\lambda Y} \ln \frac{2}{rQ_s})} & : rQ_s \leq 2 \\ 1 - e^{-A \ln^2(BrQ_s)} & : rQ_s > 2 \end{cases}$$

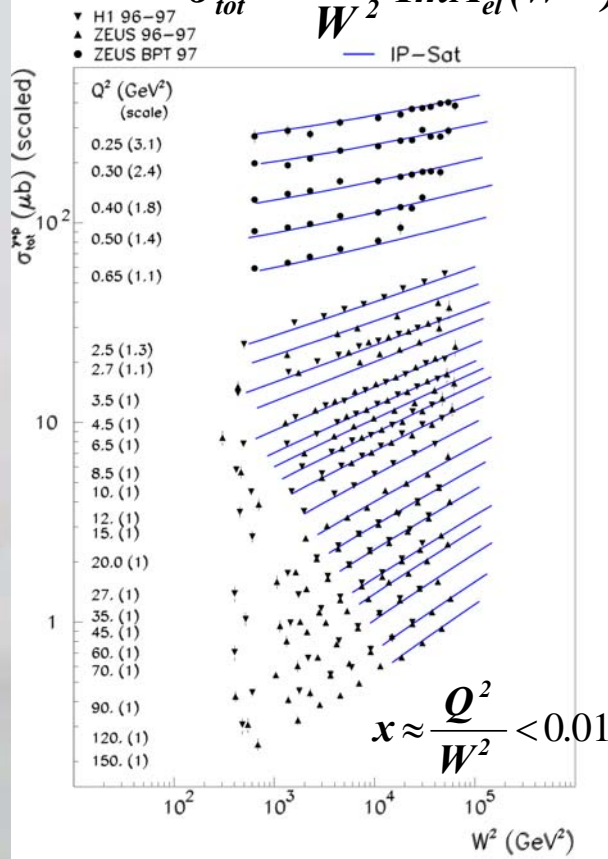
b-CGC

IIM+KMW

Low-x Physics @ HERA



$$\sigma_{tot}^{\gamma^* P} = \frac{1}{W^2} \text{Im} A_{el}(W^2)$$

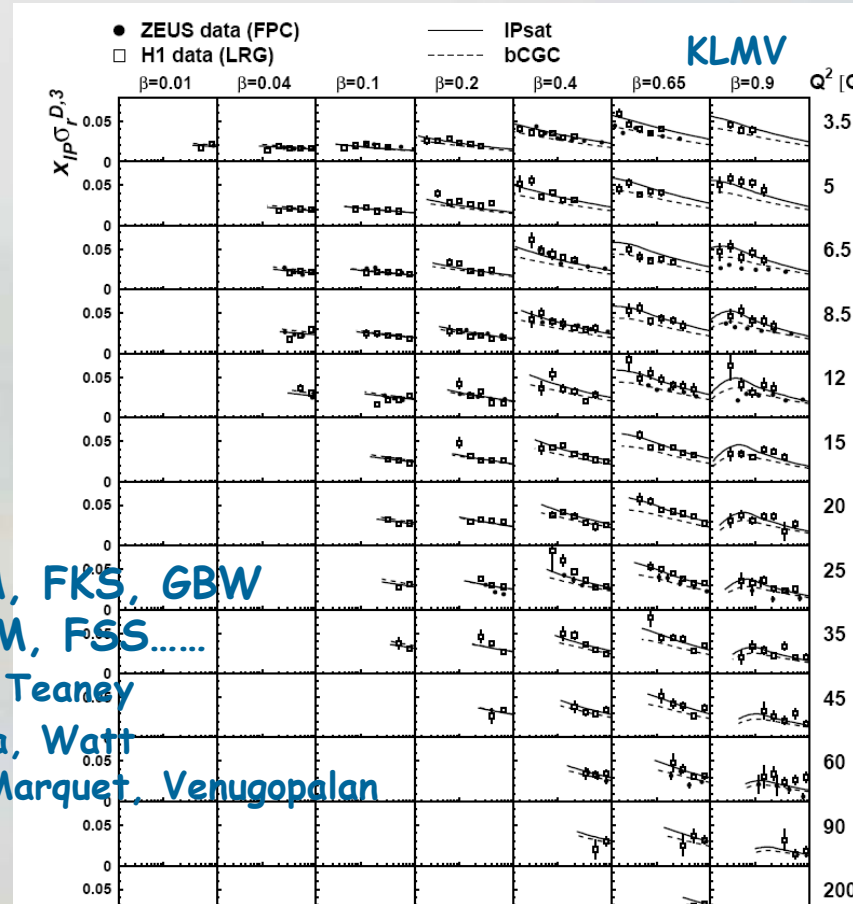


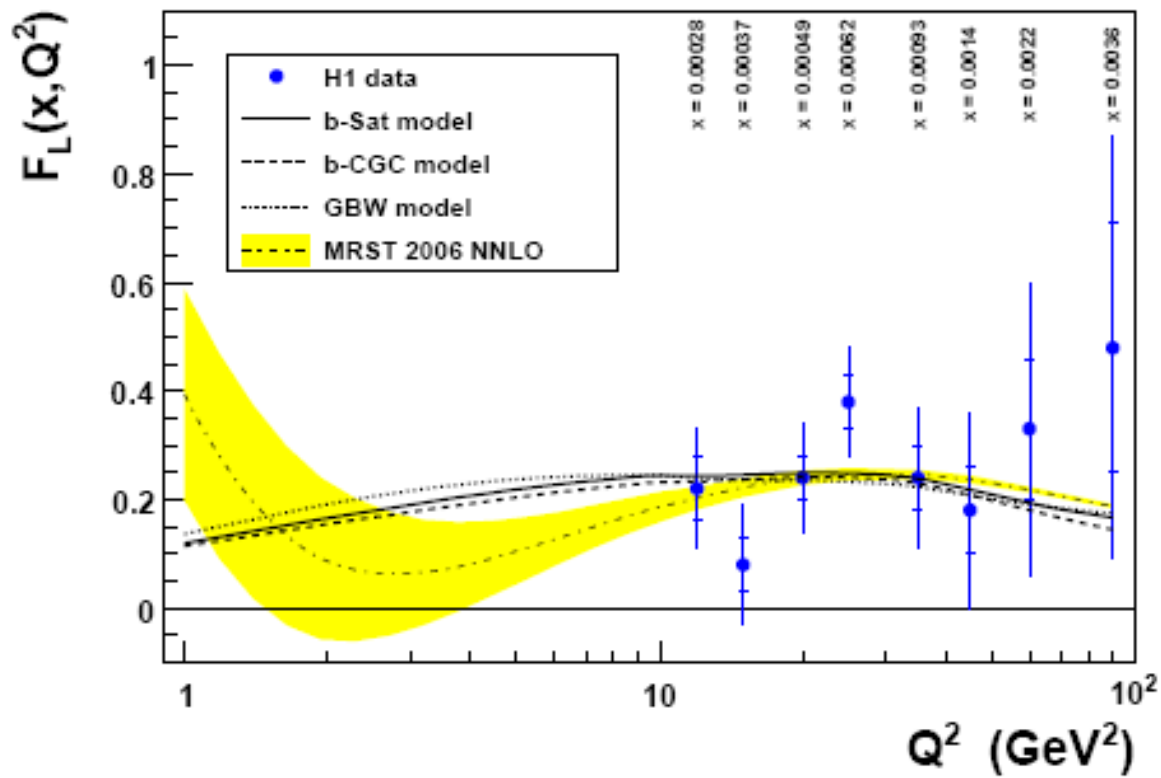
Diffraction at HERA is a shadow of DIS

→
 dipole picture,
 equivalent to
 LO p-QCD
 for small
 dipoles,
 $Q \sim 1/r$

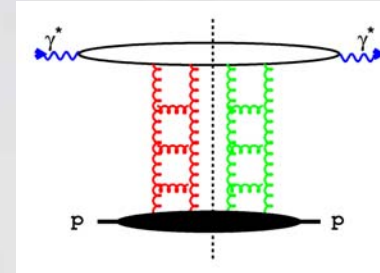
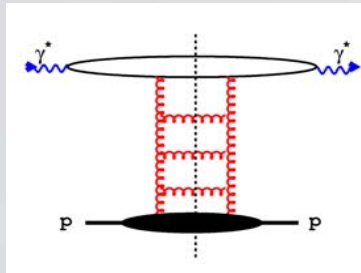
NNZ, AM, GLM, FKS, GBW
 DGKP, BGBK, IIM, FSS.....
 KT - Kowalski, Teaney
 KMW - K, Motyka, Watt
 KLMV - K, Lappi, Marquet, Venugopalan

$$\sigma_{tot}^{\gamma^* P}(W, Q^2) = \frac{4\pi^2 \alpha_{em}}{Q^2} \cdot F_2(x, Q^2)$$





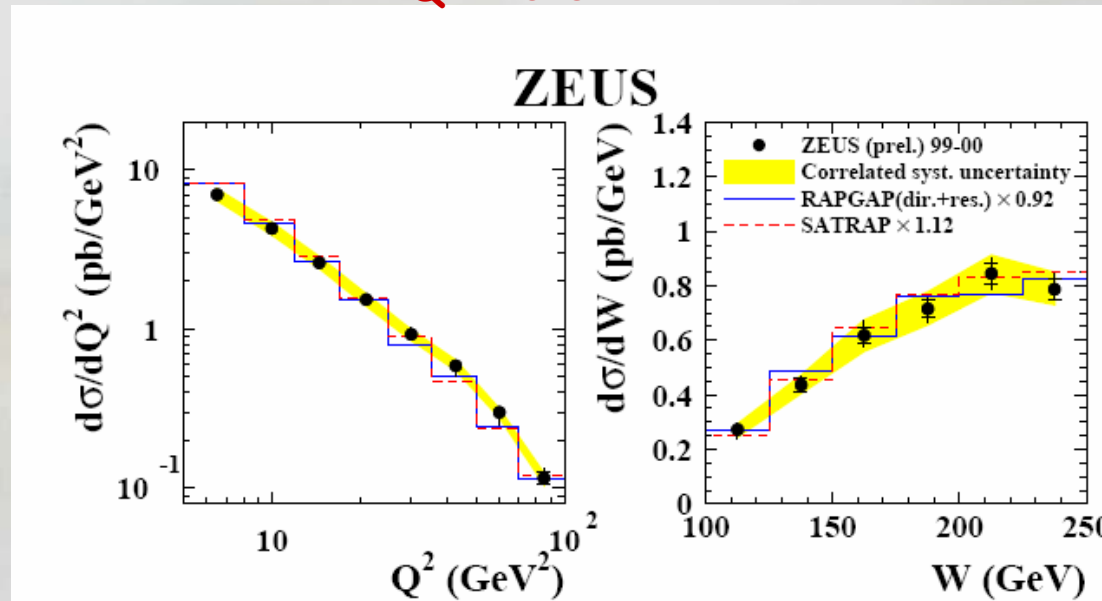
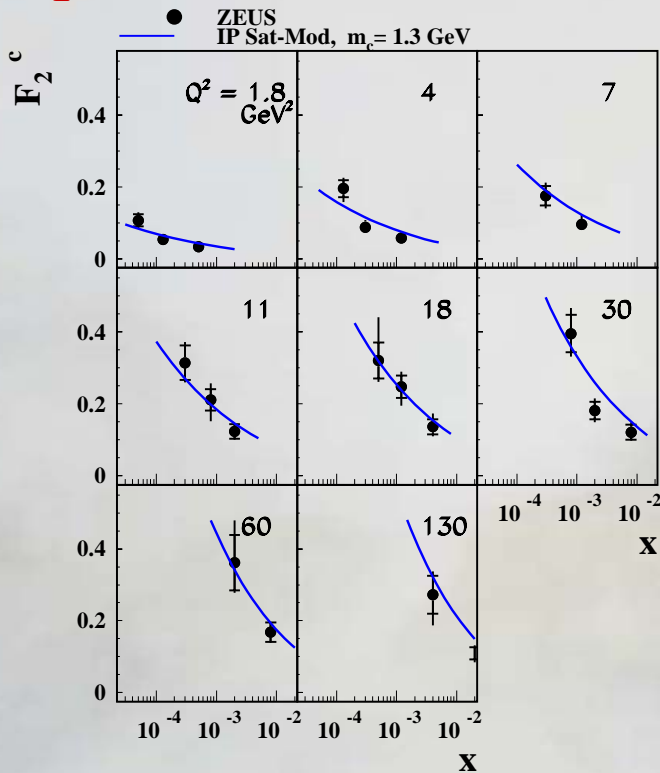
Dipole Picture-gluon density convoluted with the dipole wave functions \rightarrow simultaneous prediction/description of many reactions



Diffractive Di-jets
 $Q^2 > 5 \text{ GeV}^2$

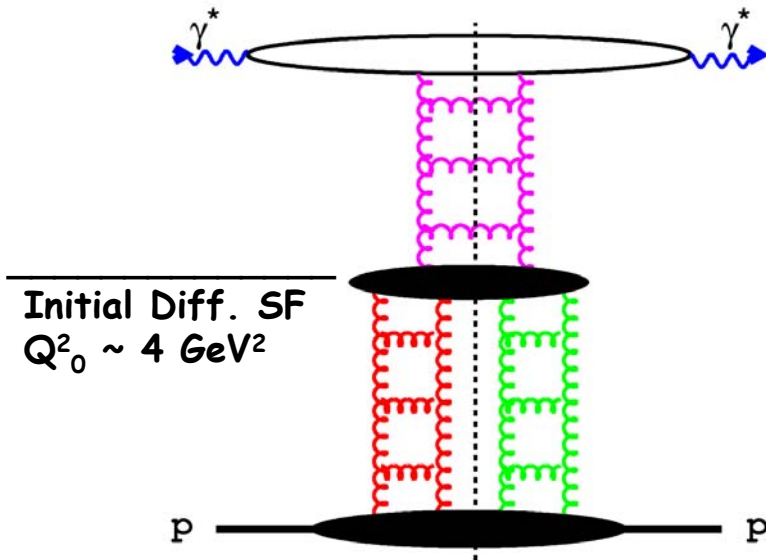
KT

F_2^c

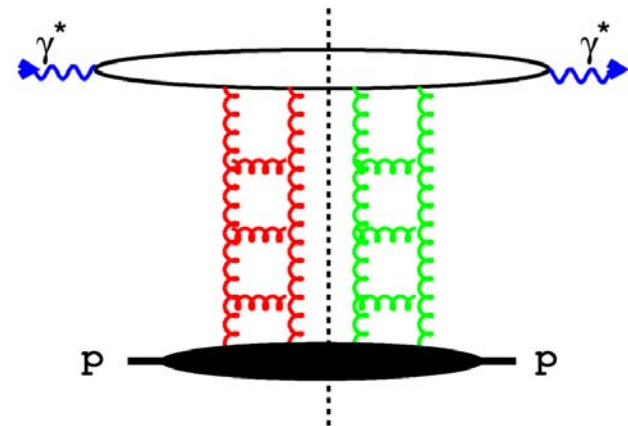


Observation of diffraction indicates that single ladder may not be sufficient (partons produced from a single chain produce exponentially suppressed rap. gaps)

Diffractive Structure Function



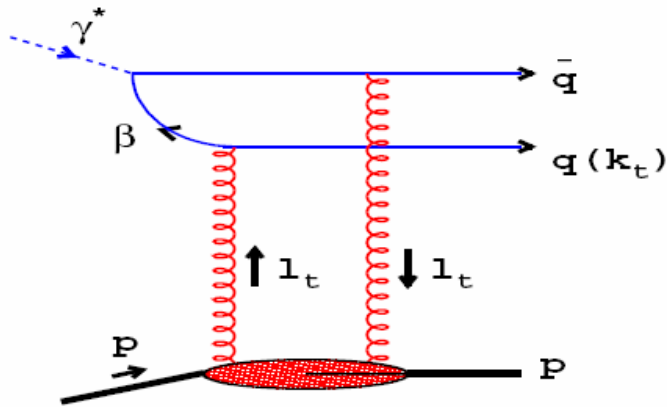
Dipole Model



Study of exclusive diffractive states may clarify which pattern is right

Only few final states present in DiMo:
 qq , qqg (aligned and as jets)
 VM

Diffractive production of a $q\bar{q}$ pair



$$\begin{aligned} \tilde{f}(x_{IP}, l_t^2) &\sim \text{probability to find a Pomeron}(2g) \text{ in } p \\ &= \text{Fourier transform of } \sigma_{qq} \\ \tilde{f}(x_{IP}, l_t^2) &= \frac{3\sigma_0}{4\pi^2} R_0^2(x_{IP}) l_t^2 \exp(-R_0^2(x_{IP}) l_t^2) \end{aligned}$$

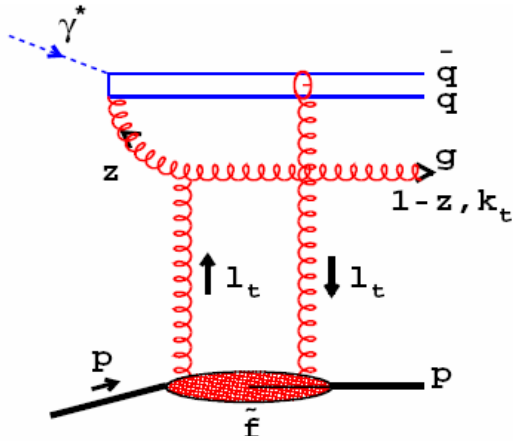
$$\begin{aligned} \left. \frac{d\sigma^T}{dt dM^2} \right|_{t=0} &= \sum_f e_f^2 \frac{\pi^2 \alpha_{em}}{12 Q^4} \frac{\beta^2}{(1-\beta)^2} \int dk_t^2 \frac{k_t^2 + m_q^2}{k_t^2 \sqrt{1 - 4\beta k^2/Q^2}} \\ &\quad \left\{ \left[1 - \frac{2\beta k^2}{Q^2} \right] P_{\mathbb{P}q}^T + 4 \frac{k_t^2 m_q^2}{k^4} P_{\mathbb{P}q}^L \right\} \quad k^2 = (k_t^2 + m_q^2)/(1-\beta) \end{aligned}$$

$$\left. \frac{d\sigma^L}{dt dM^2} \right|_{t=0} = \sum_f e_f^2 \frac{4\pi^2 \alpha_{em}}{3 Q^6} \frac{\beta^3}{(1-\beta)} \int dk_t^2 \frac{k^2}{\sqrt{1 - 4\beta k^2/Q^2}} P_{\mathbb{P}q}^L$$

$$P_{\mathbb{P}q}^T(\beta, k^2) = \left| \int \frac{dl_t^2}{l_t^2} \tilde{f}(l_t^2) \left[1 - 2\beta - 2 \frac{m_q^2}{k^2} + \frac{l_t^2 - (1-2\beta)k^2 + 2m_q^2}{\sqrt{(l_t^2 + k^2)^2 - 4l_t^2 k^2}} \right] \right|_2$$

$$P_{\mathbb{P}q}^L(\beta, k^2) = \left| \int \frac{dl_t^2}{l_t^2} \tilde{f}(l_t^2) \left[1 - \frac{k^2}{\sqrt{(l_t^2 + k^2)^2 - 4l_t^2 k^2}} \right] \right|_2 \sim \text{probability for a Pomeron}(2g) \text{ to couple to a quark}$$

Diffractive production of a qqq state



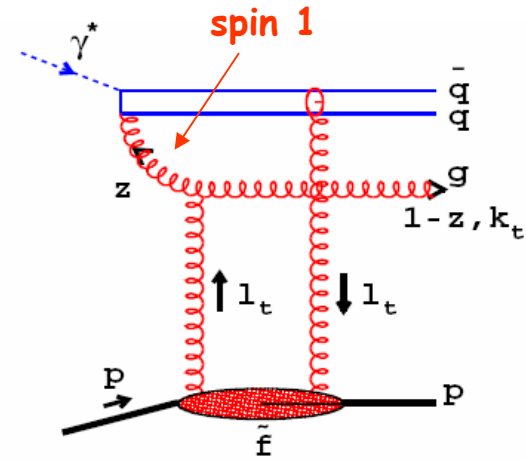
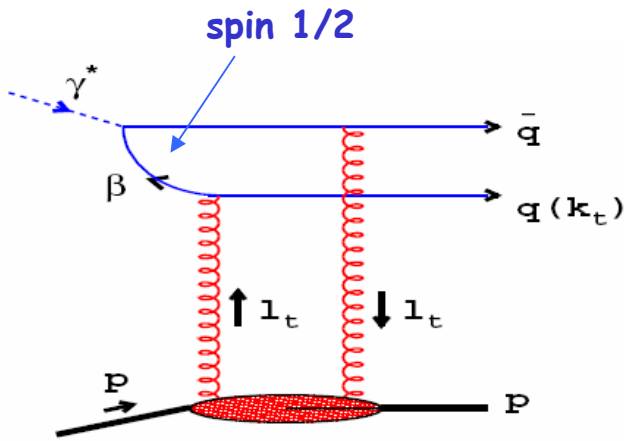
$$\left. \frac{d\sigma}{dt dM^2} \right|_{t=0} = 2 \sum_f e_f^2 \frac{4\pi^2 \alpha_{em}}{Q^2} \frac{\beta^2}{Q^2} \int dk_t^2 \int d\phi \int dq_t^2 \frac{\alpha_s}{2\pi} \int \frac{dz}{z} P_{qg} \left(\frac{\beta}{z} \right) P_{\mathbb{P}g} \left(z, \frac{k_t^2}{1-z} \right)$$

D.C. : $Q^2 \gg q_t^2 \gg k_t^2$

$$P_{\mathbb{P}g}(z, k^2) = \frac{9}{64} \frac{1}{z} \frac{1}{(1-z)^3} \left\{ \int \frac{dl_t^2}{l_t^2} \tilde{f}(x_{\mathbb{P}}, l_t^2) \left[z^2 + (1-z)^2 + \frac{l_t^2}{k^2} - \frac{[(1-2z)k^2 - l_t^2]^2 + 2z(1-z)k^4}{k^2 \sqrt{(l_t^2 + k^2)^2 - 4(1-z)l_t^2 k^2}} \right] \right\}^2$$

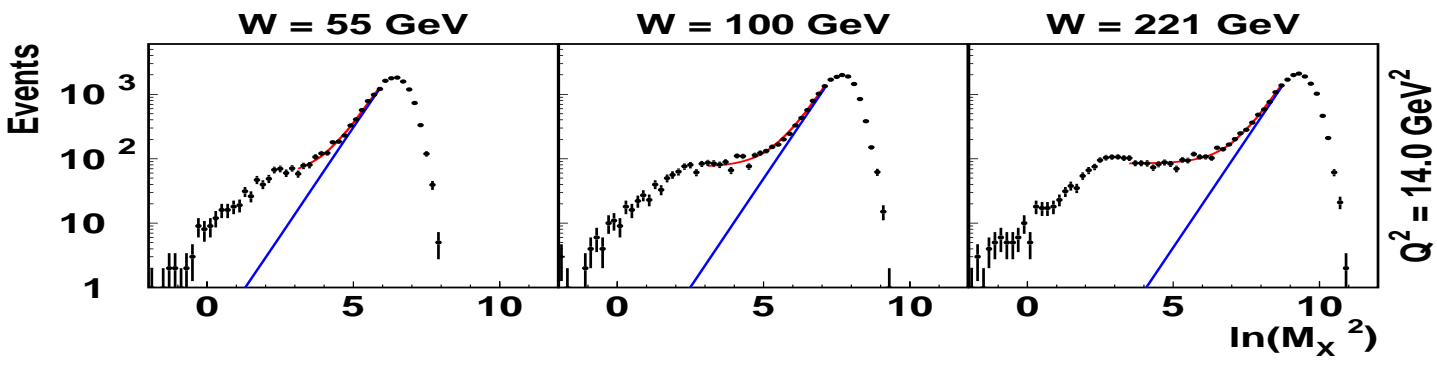
$$\begin{aligned} z &= (Q^2 + m^2)/(Q^2 + M^2) \\ m^2 &= (q + \bar{q})^2 + k_t^2 \end{aligned}$$

$$\begin{aligned} P_{qg} \left(\frac{\beta}{z} \right) &= \frac{1}{2} \frac{1 - 2 \frac{q_t^2 + m_q^2}{m^2}}{q_t^2 + m_q^2} \left[\left(\frac{\beta}{z} \right)^2 + \left(1 - \frac{\beta}{z} \right)^2 \right] \\ &+ \frac{4}{q_t^2 + m_q^2} \frac{\beta}{z} \left(1 - 2 \frac{\beta}{z} \right) \frac{m_q^2}{Q^2} \\ &+ \frac{2m^2}{(q_t^2 + m_q^2)^2} \left(\frac{\beta}{z} \right)^2 \left(1 - 2 \frac{\beta}{z} \right) \frac{m_q^2}{Q^2} \end{aligned}$$

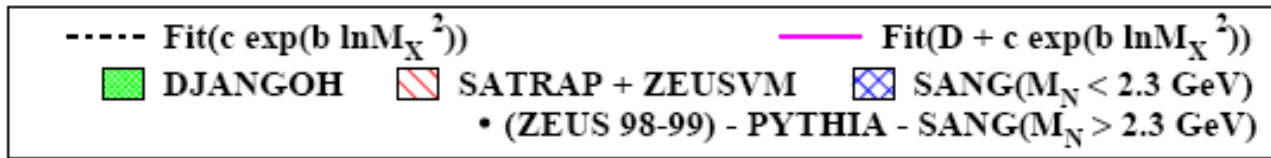


$\sigma \sim s^{\alpha-1} \rightarrow dN/d\log M_x^2 \sim \text{const}$

*

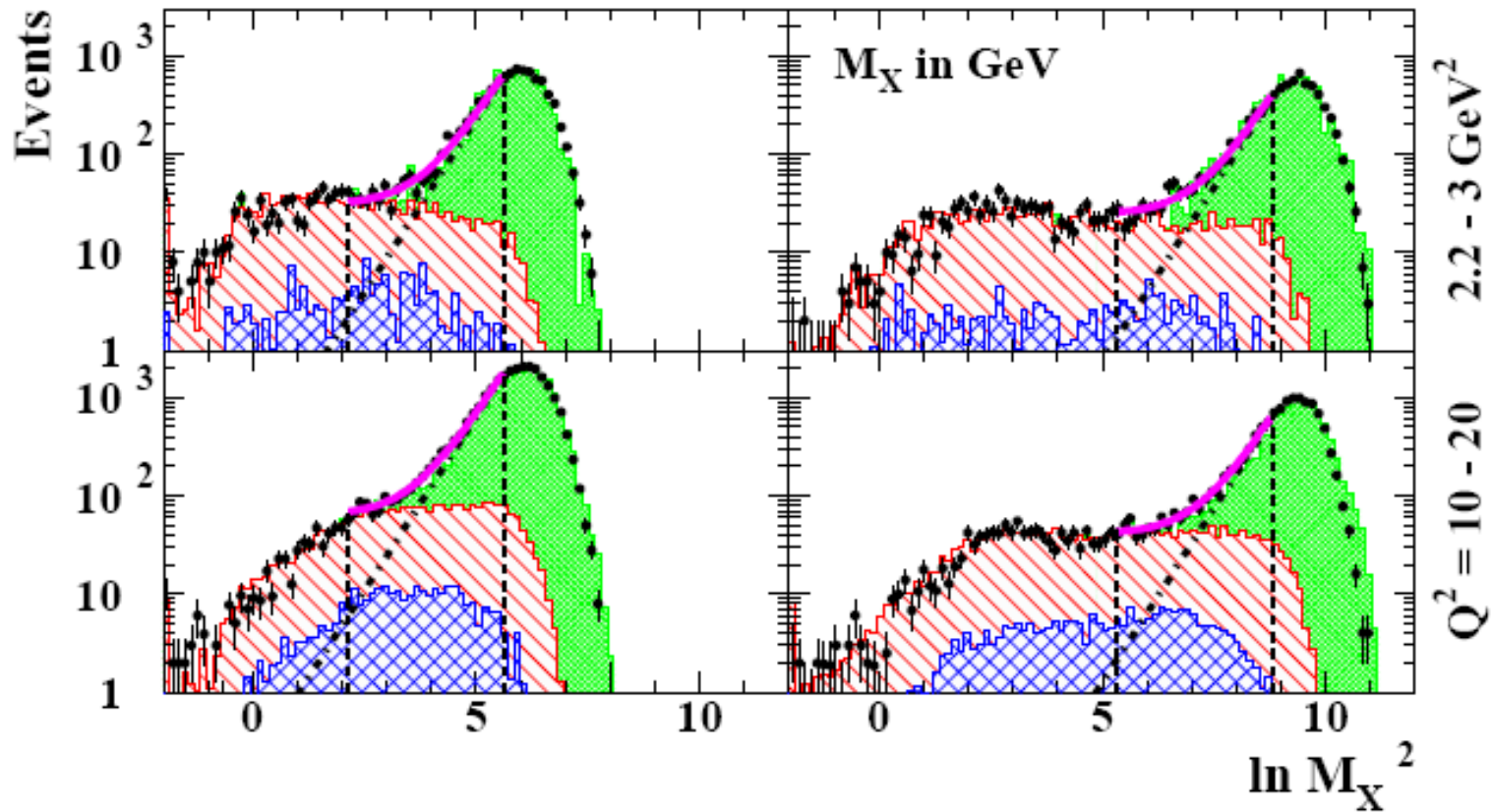


ZEUS



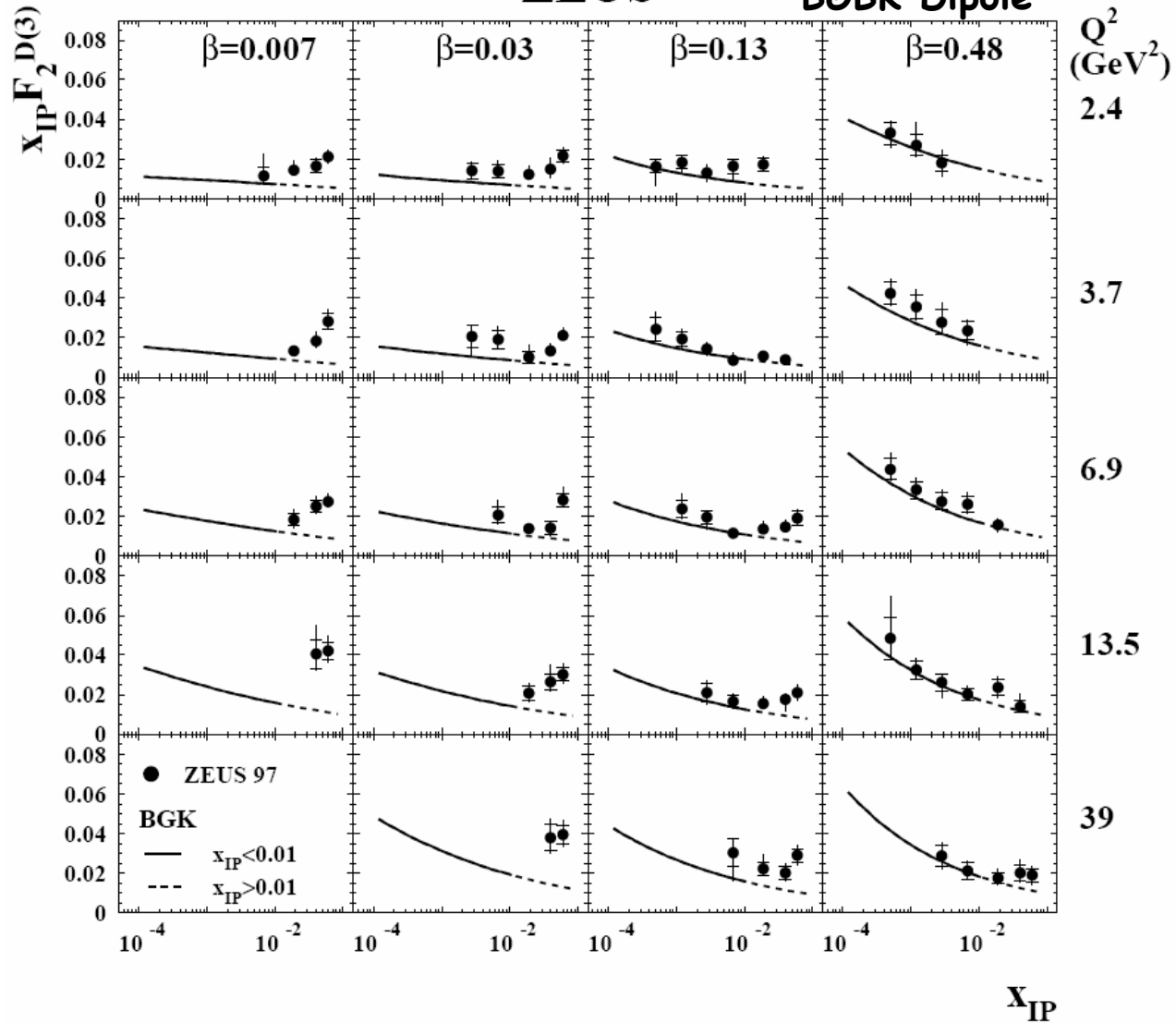
W = 37 - 55 GeV

W = 200 - 245 GeV



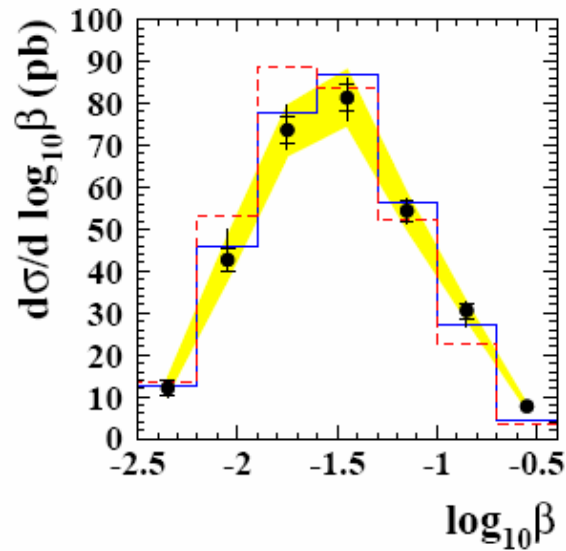
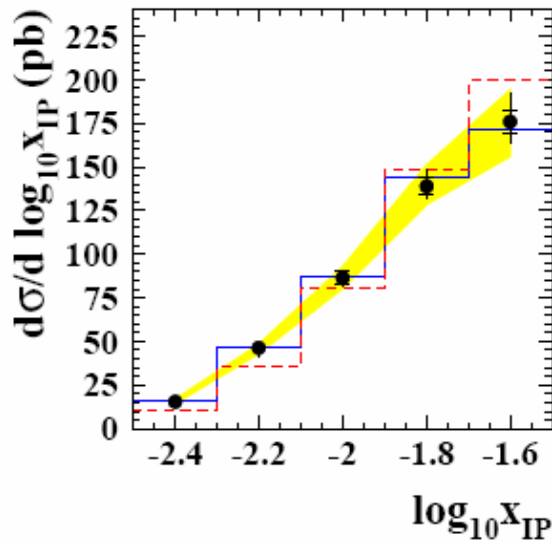
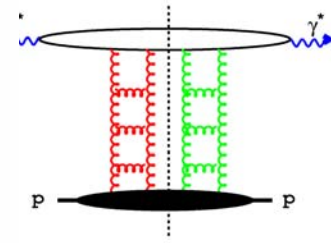
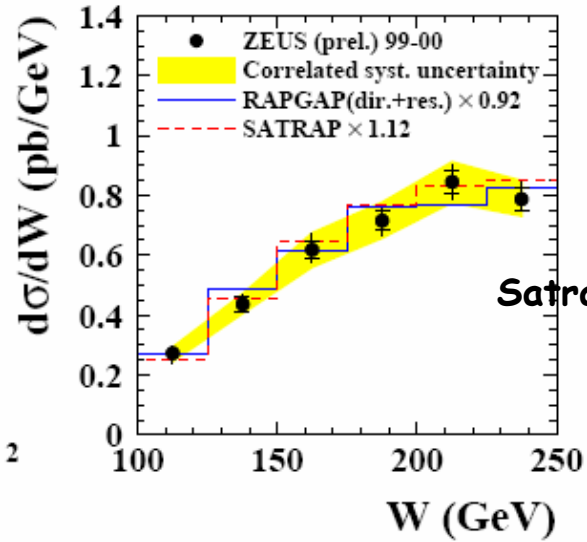
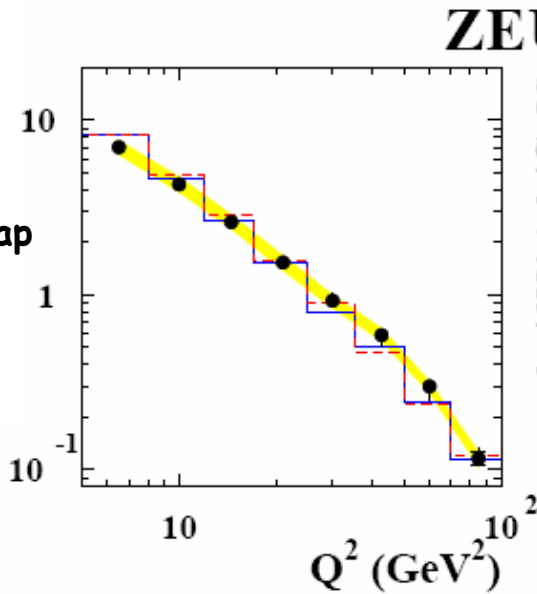
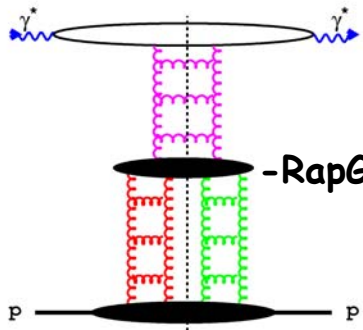
Inclusive Diffraction LPS

ZEUS — BGBK Dipole



Diffractive Di-jets

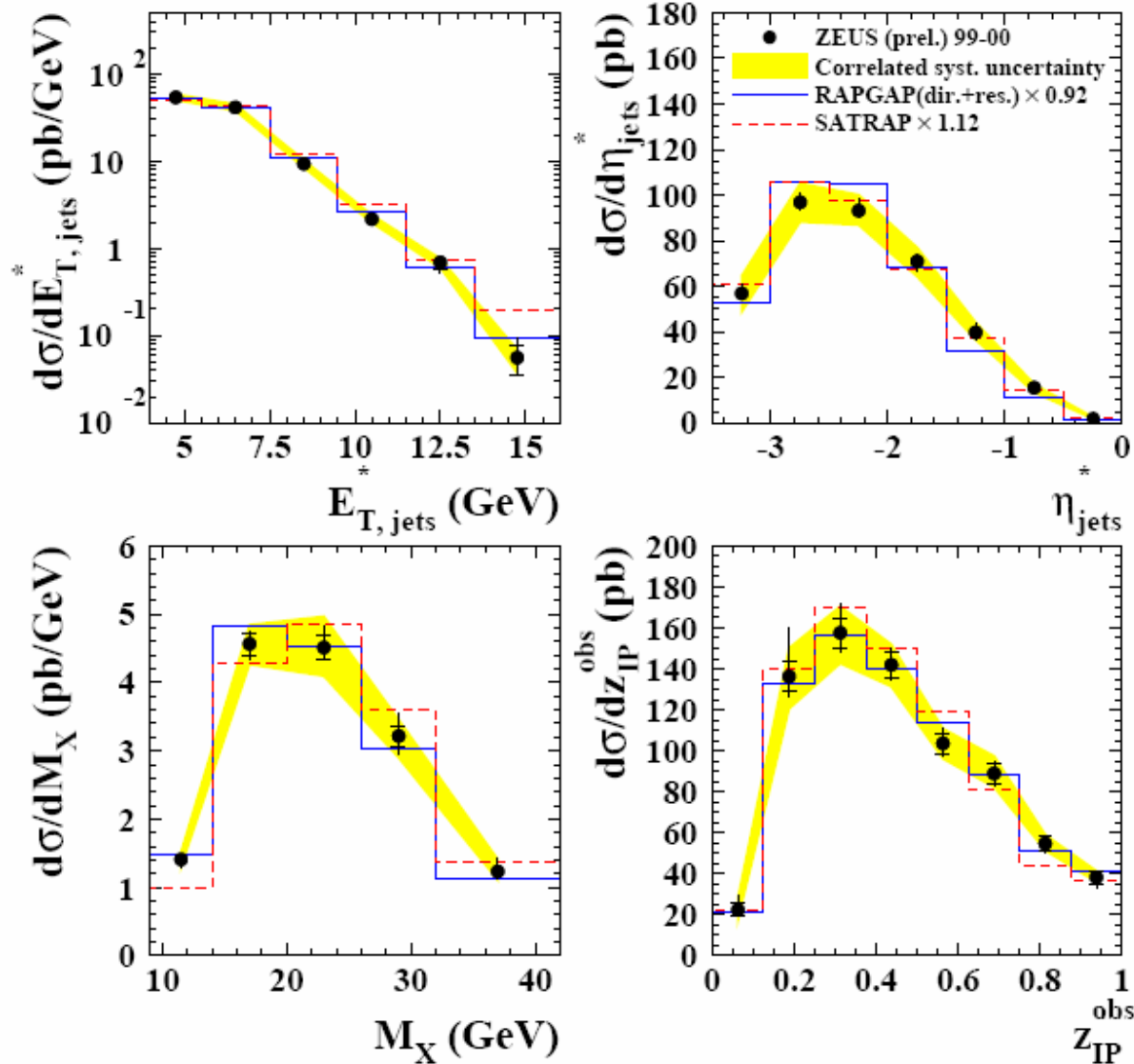
$$Q^2 > 5 \text{ GeV}^2$$



Diffractive Di-jets

$$Q^2 > 5 \text{ GeV}^2$$

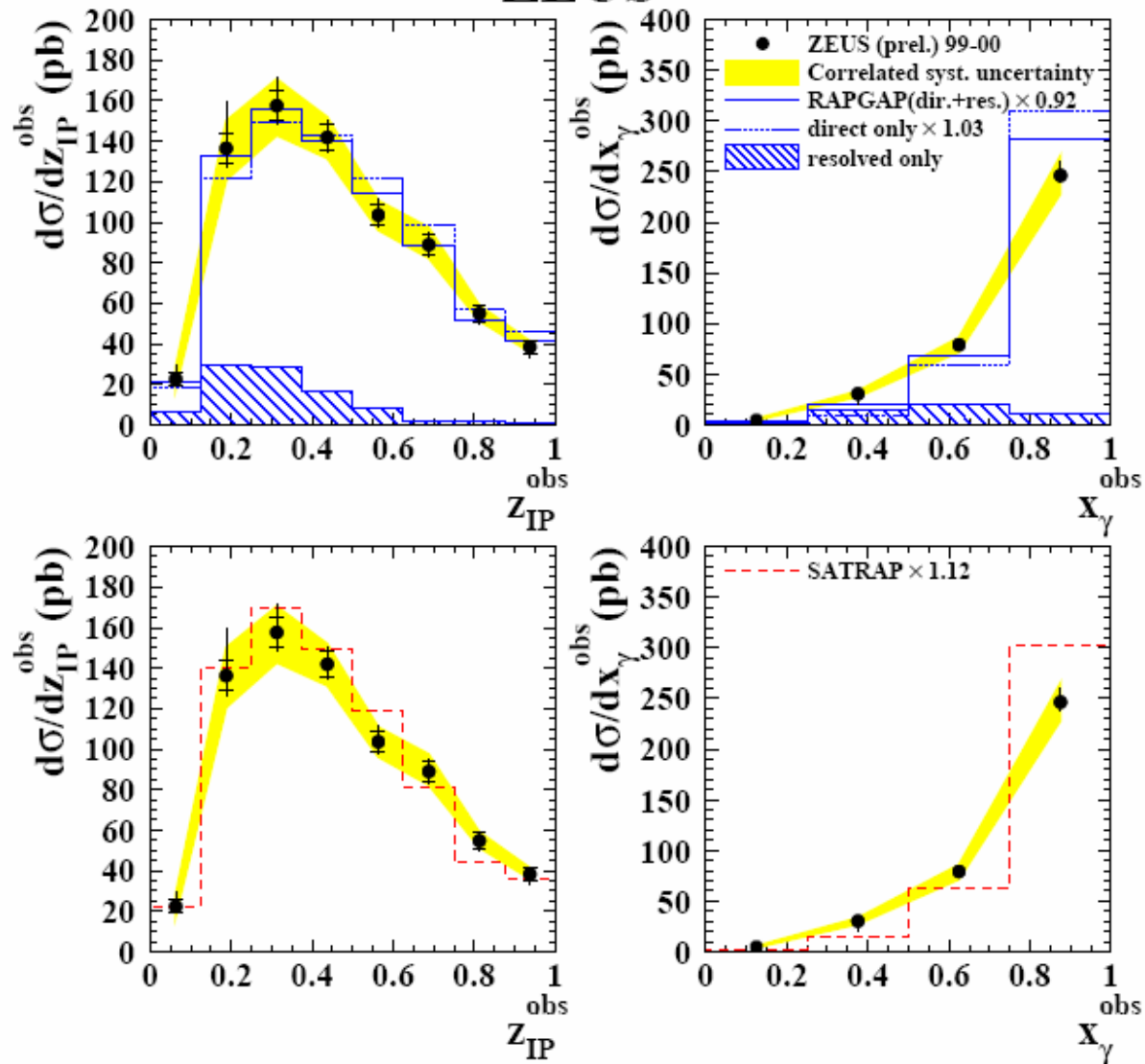
ZEUS



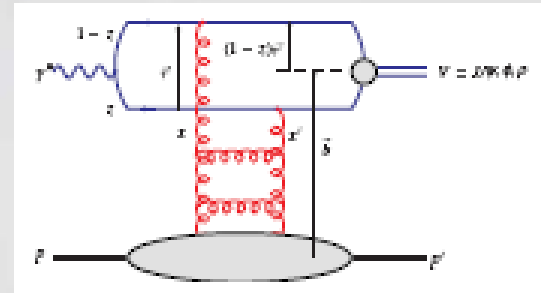
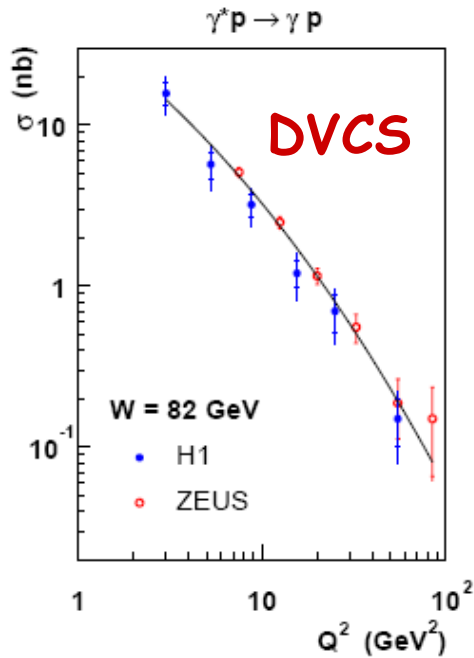
Diffractive Di-jets

$$Q^2 > 5 \text{ GeV}^2$$

ZEUS

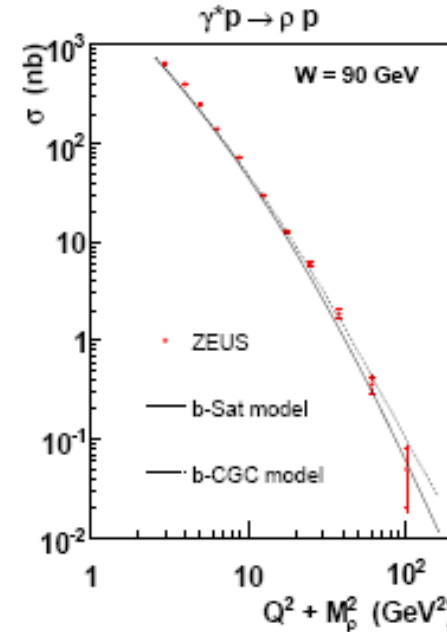
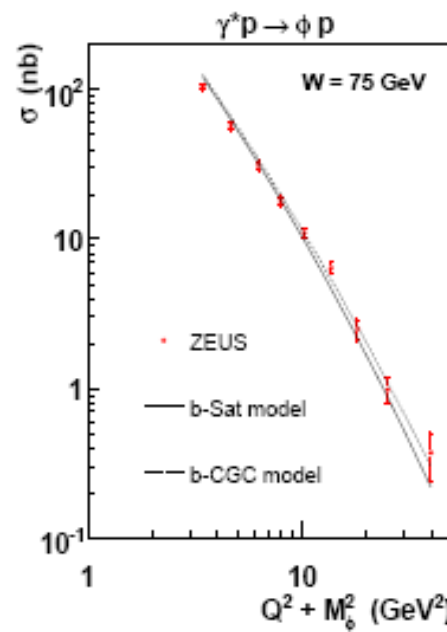
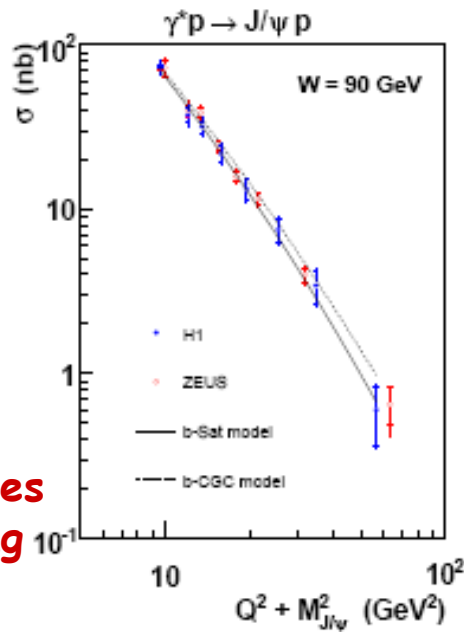


Dipole Picture-gluon density convoluted with the dipole wave functions \rightarrow simultaneous prediction/description of many reactions



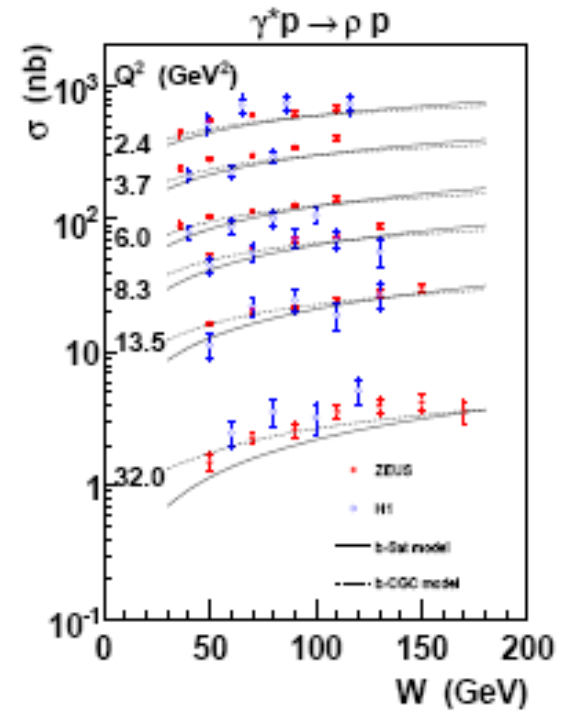
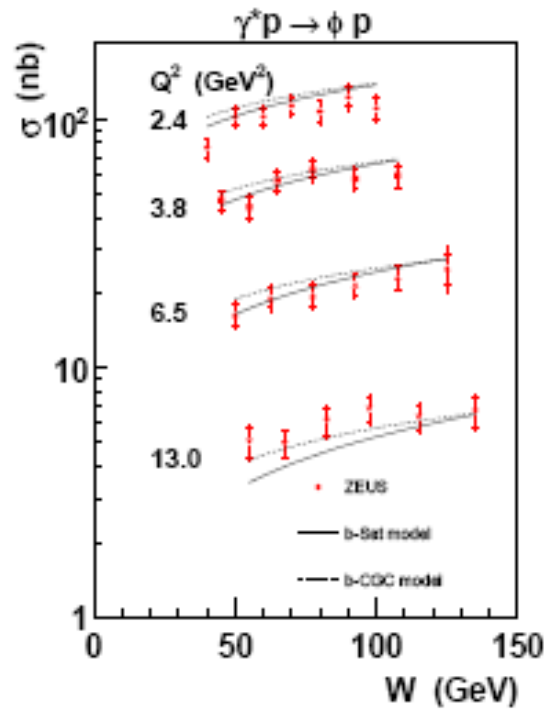
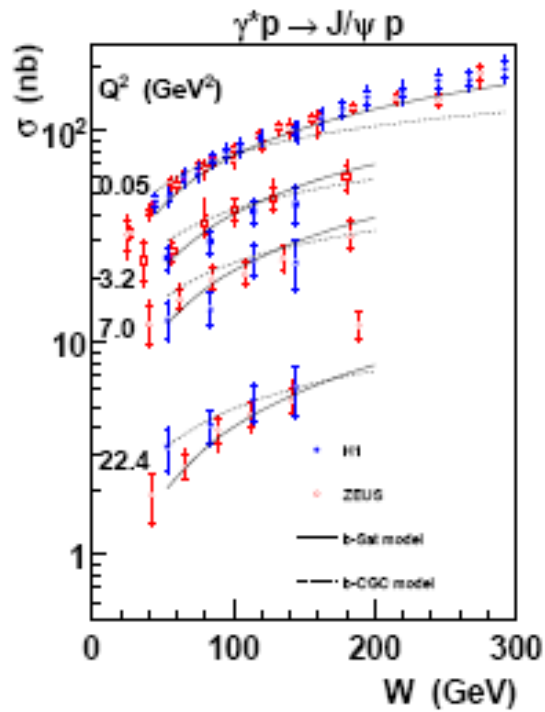
Vector Mesons

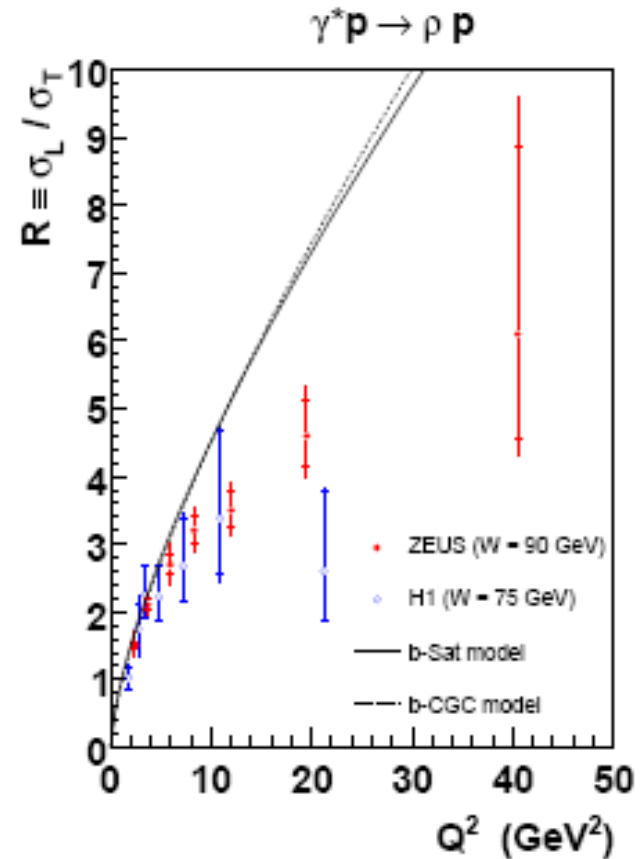
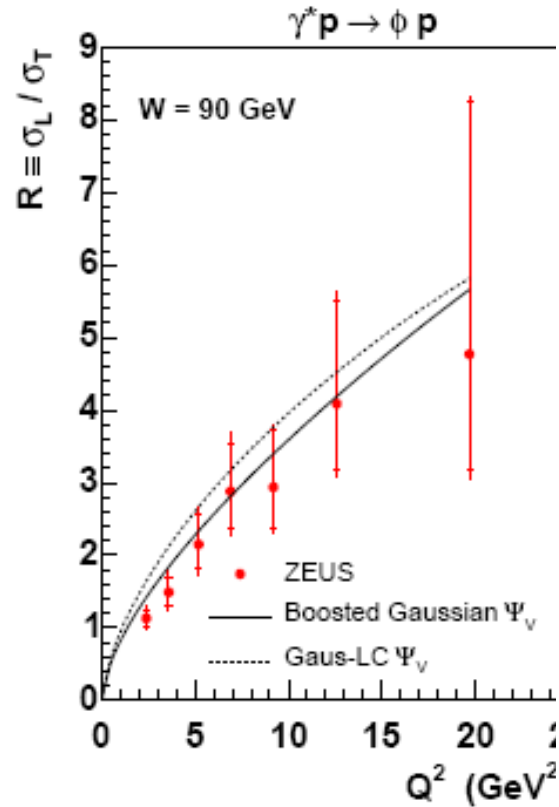
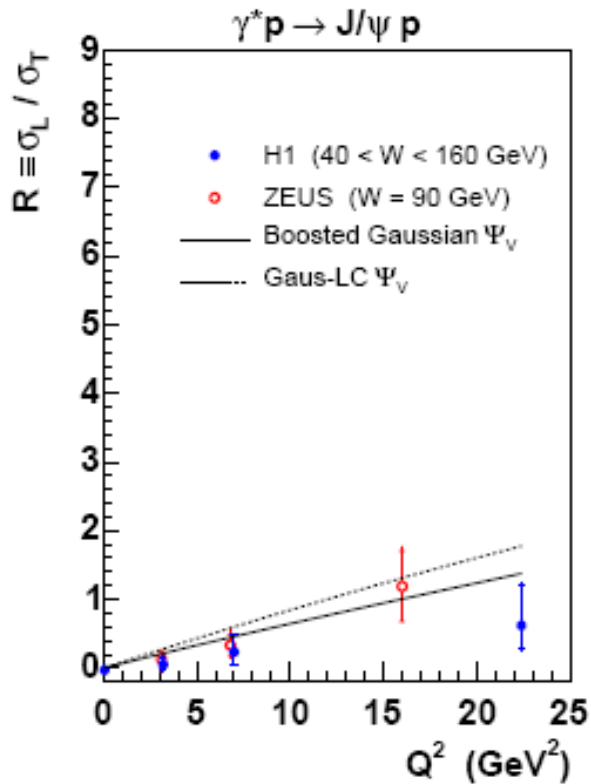
KMW



Note: educated guesses for VM wf are working very well

KMW

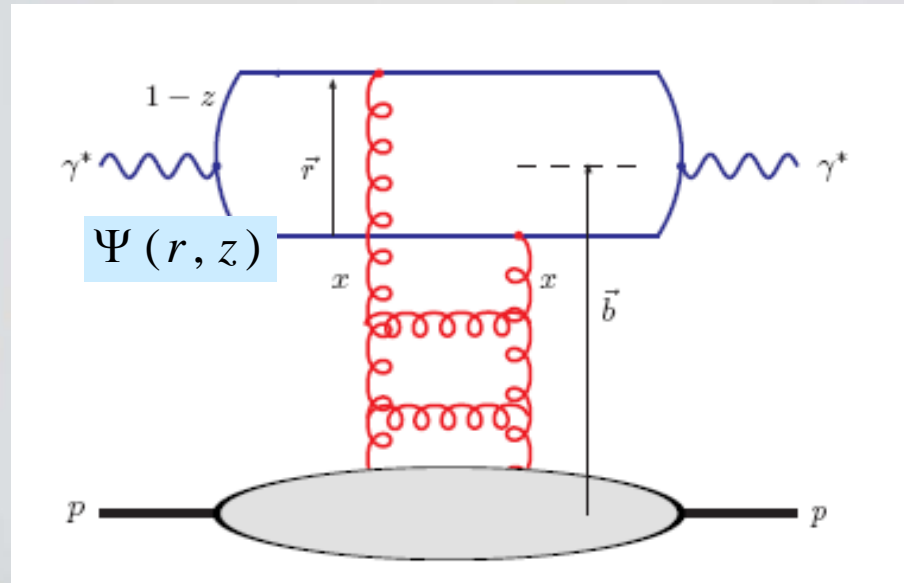




Note: educated guesses for J/ψ and φ wave functions are working very well

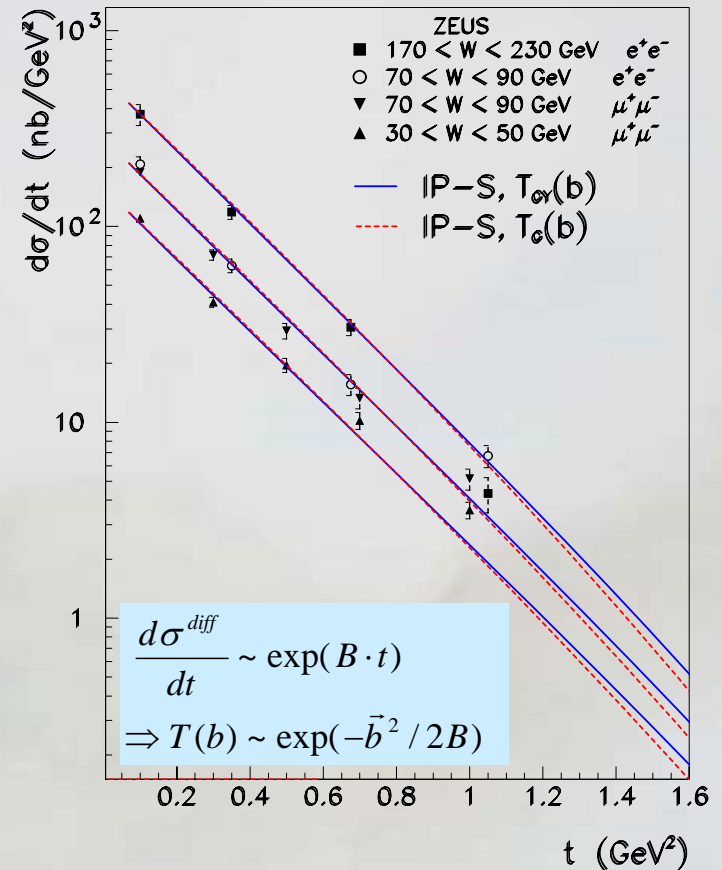
More work to do for ρ meson wave function

Extracting Proton Vertex using Dipole Models



$$\gamma^* p \rightarrow J/\psi p$$

$Q^2 = 0$



Can use vector meson production to extract proton profile:

$$\frac{d\sigma_{VM}^{\gamma^* p}}{dt} = \frac{1}{16\pi} \left| \int d^2\vec{r} \int d^2\vec{b} e^{-i\vec{b} \cdot \vec{\Delta}} \int_0^1 dz \Psi_{VM}^* 2 \left\{ 1 - \exp\left(-\frac{\Omega}{2}\right) \right\} \Psi \right|^2$$

KT, KMW

$$\Omega = \frac{\pi^2}{N_C} r^2 \alpha_s(\mu^2) x g(x, \mu^2) T(b)$$

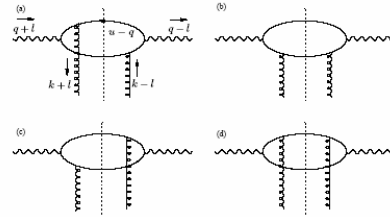
$T(b)$ -proton shape

Description of the size of interaction region B_D

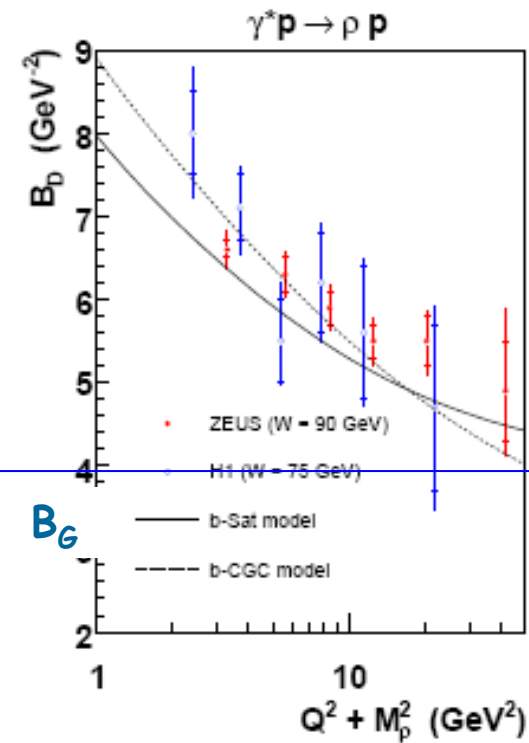
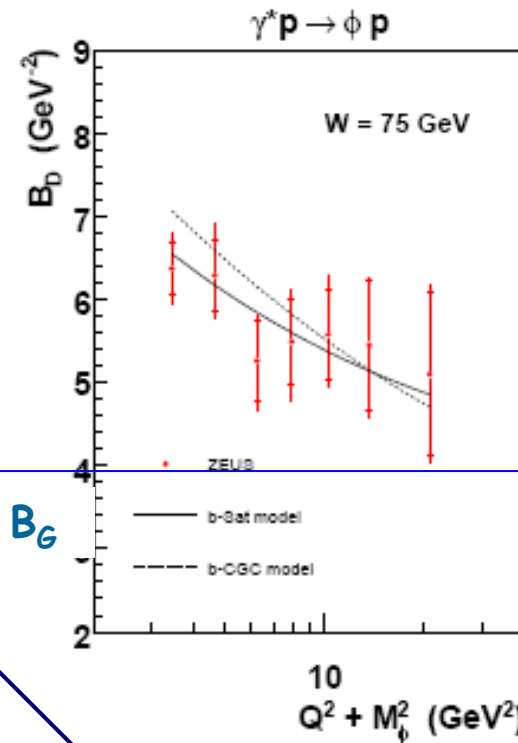
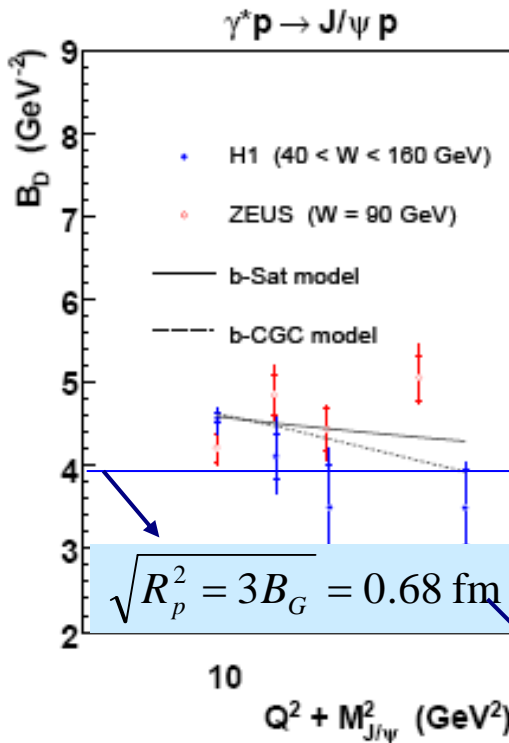
$$\frac{d\sigma^{diff}}{dt} \sim \exp(B_D \cdot t) \quad \Rightarrow \quad T(b) \sim \exp(-\vec{b}^2 / 2B_G)$$

Modification by Bartels, Golec-Biernat, Peters

$$e^{i\vec{b} \cdot \vec{\Delta}} \rightarrow e^{i(\vec{b} + (1-z)\vec{r}) \cdot \vec{\Delta}}$$



KMW

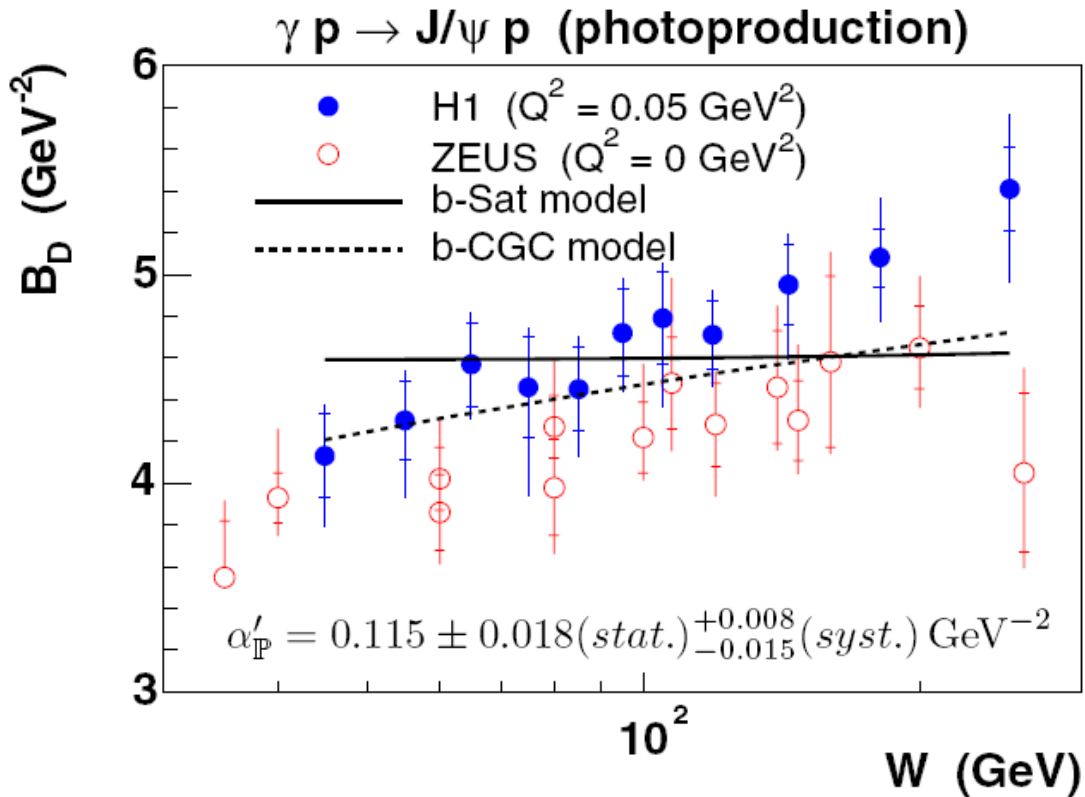


$$R_p = 0.870 \pm 0.008 \text{ fm}$$

$$\Rightarrow B_G = 6.48 \text{ GeV}^2$$

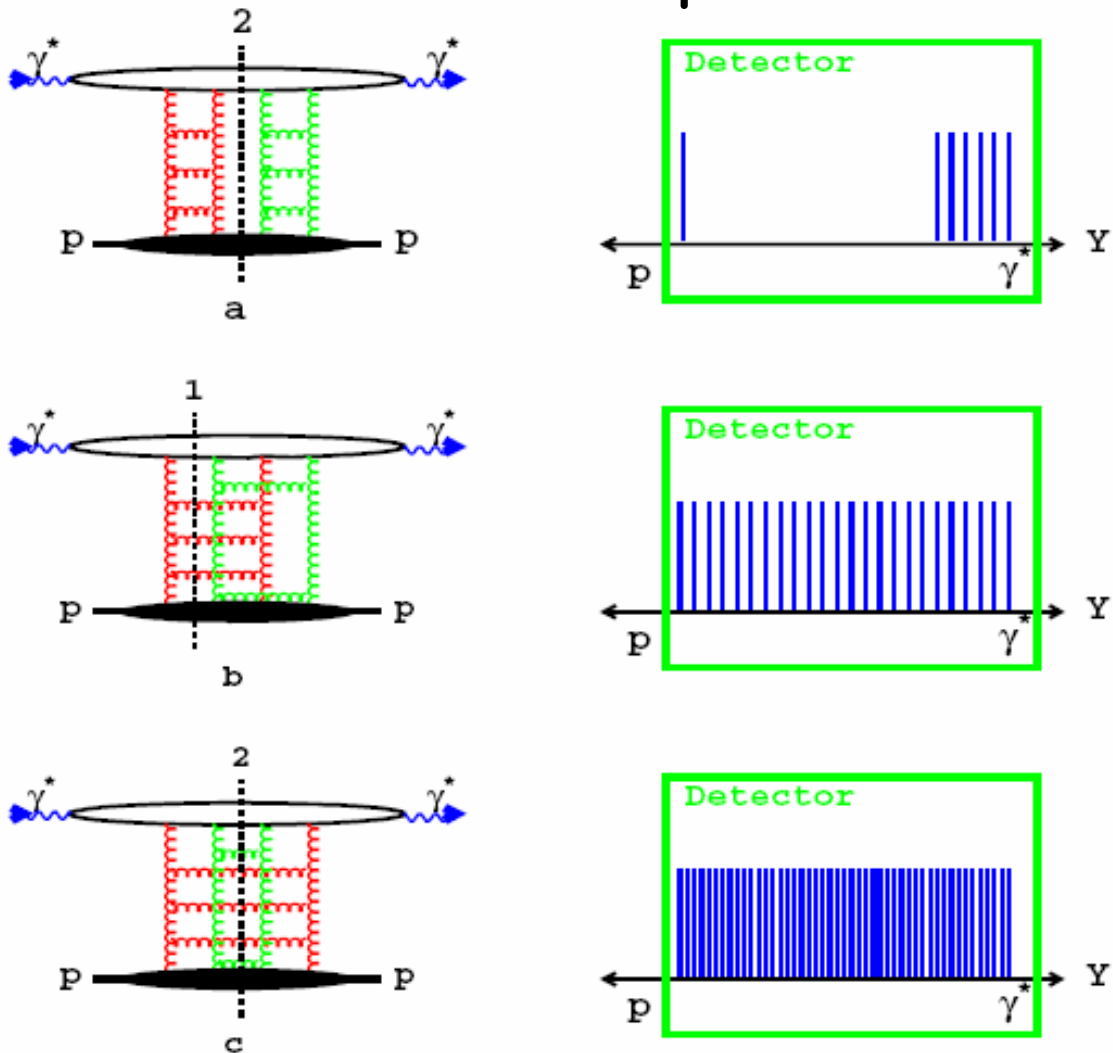
the gluonic proton radius smaller than the quark radius

measurement of α'

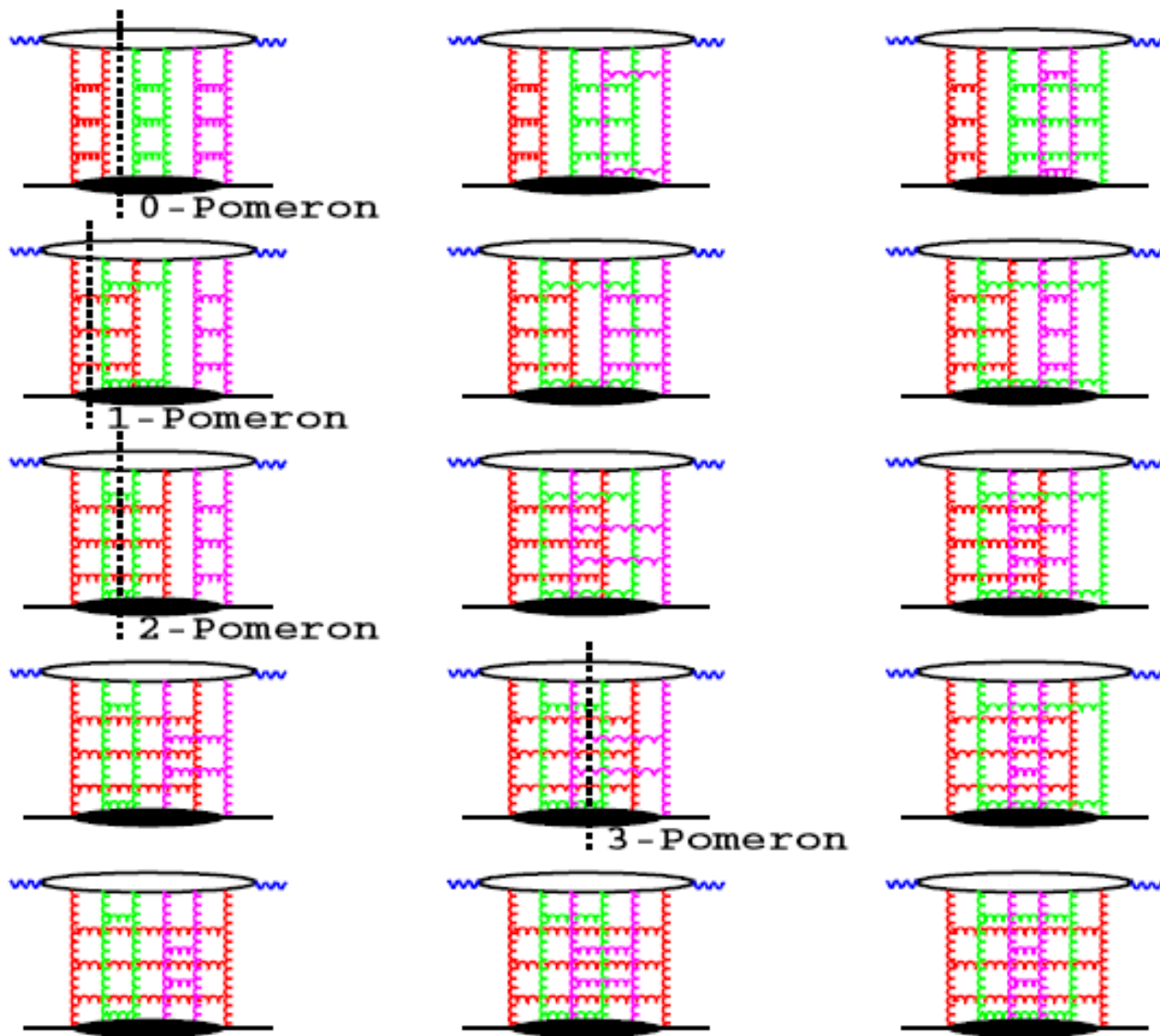


α' measurement
suggests that $B_G \sim 3 \text{ GeV}^{-2}$
 $\rightarrow R_p \sim 0.6 \text{ fm}$

AGK rules in the Dipole Model



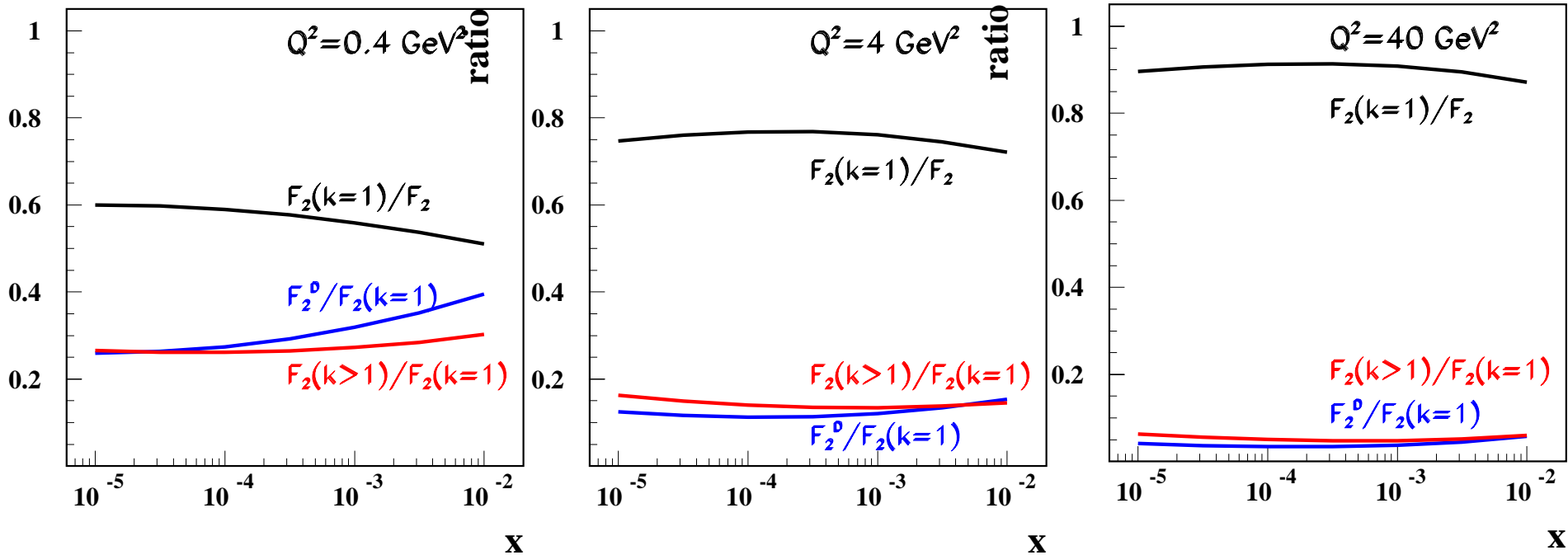
The cross-section for k -cut pomerons:
$$\sigma_k = \sum_{m=k}^{\infty} (-1)^{m-k} 2^m \frac{m!}{k!(m-k)!} F^{(m)}$$



AGK rules in the Dipole Model \rightarrow

$$\frac{d\sigma_k}{d^2b} = \frac{\Omega^k}{k!} \exp(-\Omega)$$

$$\Omega = \frac{\pi^2}{N_C} r^2 \alpha_s(\mu^2) xg(x, \mu^2) T(b)$$

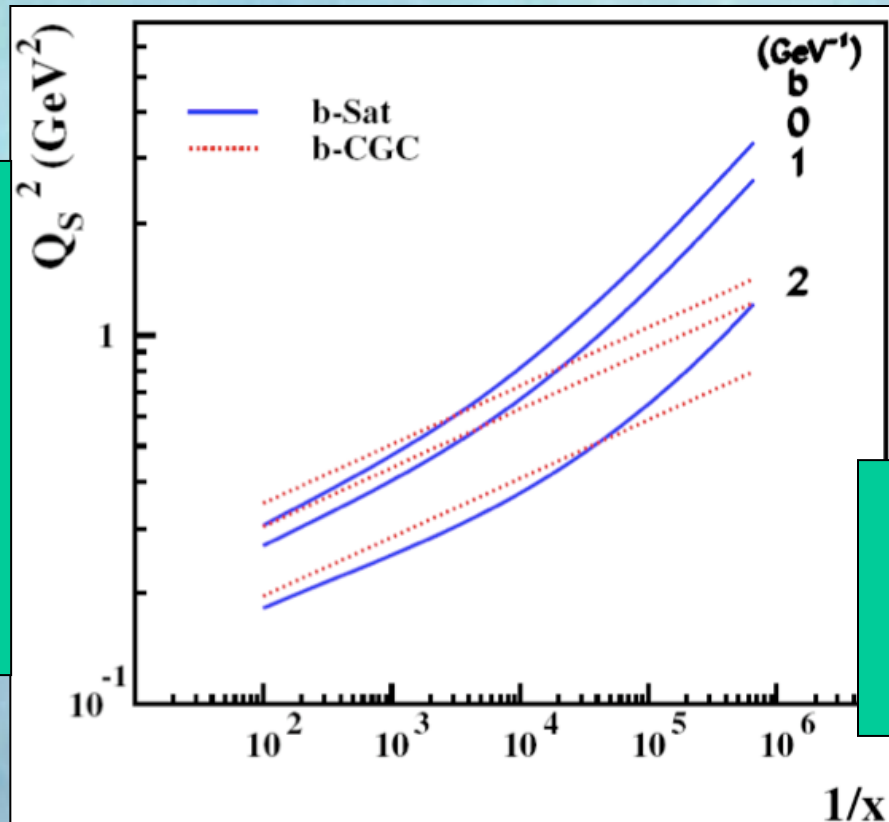


Note: AGK rules underestimate the amount of diffraction in DIS

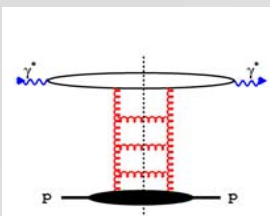
Saturation

Q_S : Measure of gluon density for which a dipole, r_S , is absorbed by a proton with 1-1/e probability: $Q_S = 2/r_S$

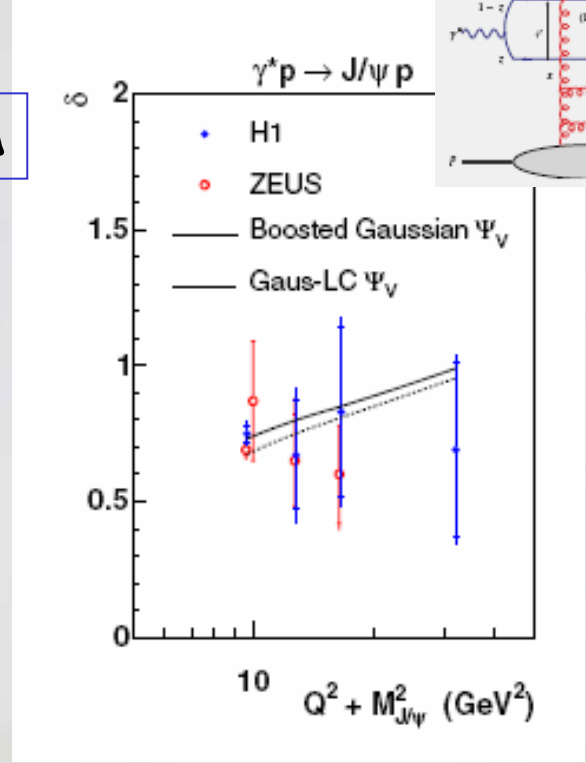
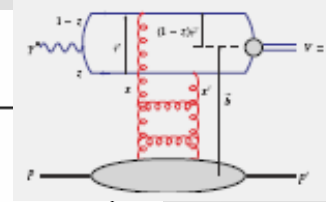
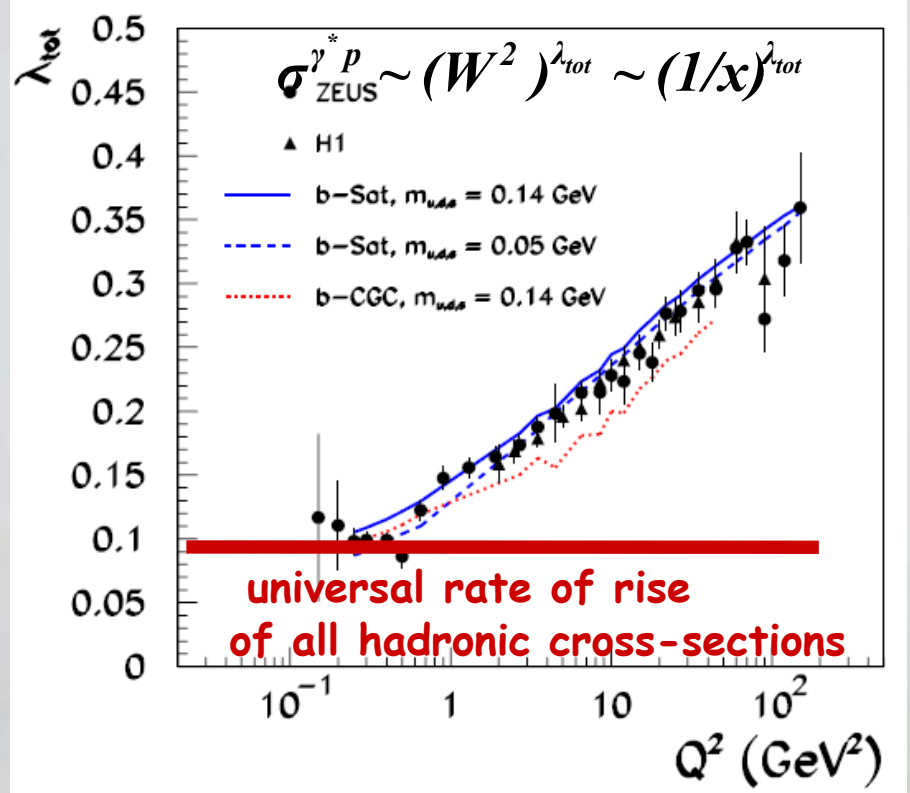
BGBK → Saturation shapes data in a similar way as DGLAP
→ Difficult to distinguish at HERA



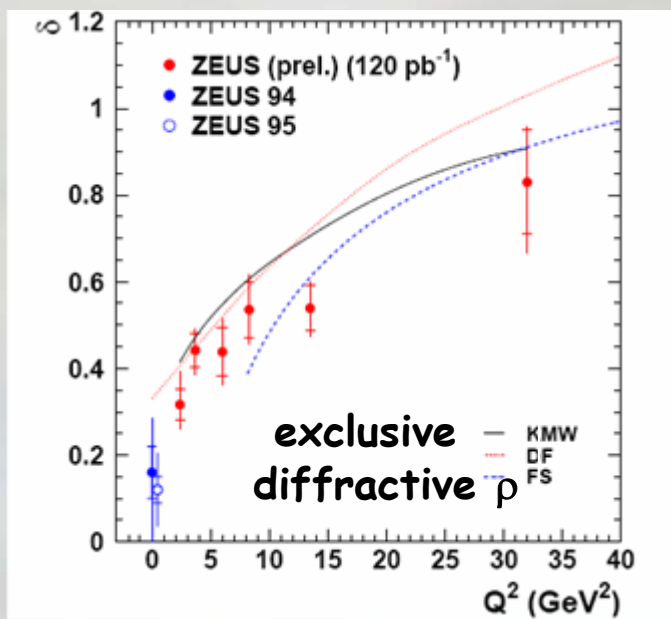
→ Oomph factor
Increase saturation by going to nuclei



Discovery of HERA

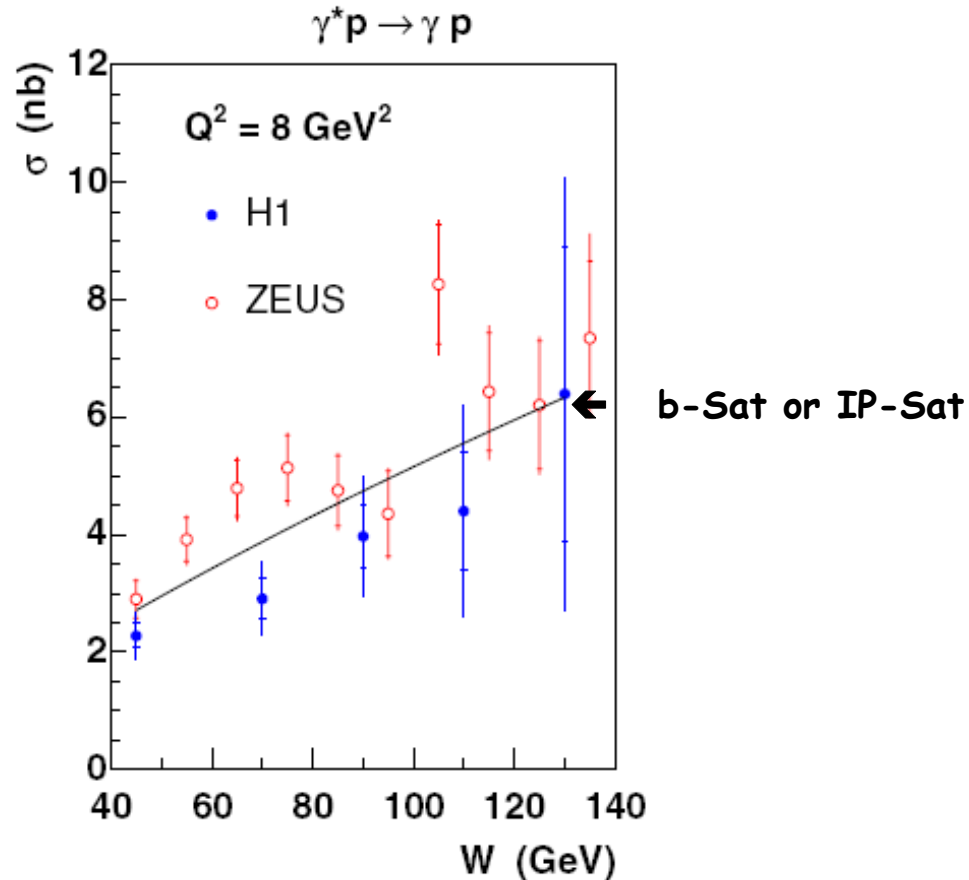


Universality of the observed intercepts
 → Universal, "Pomeron like" QCD object
 soft and hard Pomeron join together



Pomeron at work

Rise of the DVCS cross-sections



At EIC (LHeC) it should be possible to reduce the errors by a large factor, $O(100)$
→ detailed study of the Pomeron possible

Ongoing Investigation
First talks at Columbia & Hampton Universities, May 2008

THE PHYSICS DEPARTMENT INVITES YOU TO A:
SPECIAL EXPERIMENTAL/ THEORY SEMINAR

Dr. Henri Kowalski, DESY

"The DAF Pomeron and the LHC"

Evidence for the discrete asymptotically-free BFKL Pomeron from HERA data

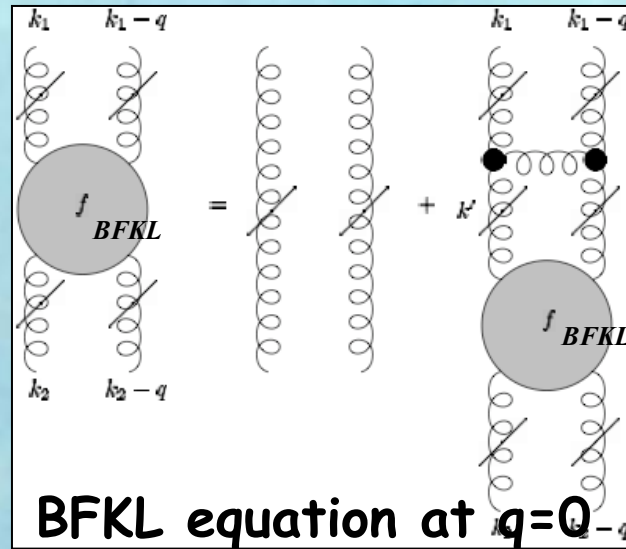
J. Ellis^a, H. Kowalski^b, D.A. Ross^{a,c,*}

Physics Letters B

in print

Basics

of BFKL



Conformal invariance

solved by finding a

$$\omega \tilde{f}(\omega, \mathbf{k}_1, \mathbf{k}_2) = \delta^2(\mathbf{k}_1 - \mathbf{k}_2) + \frac{\alpha C_A}{\pi^2} \int \frac{d^2 \mathbf{k}'}{(\mathbf{k}_1 - \mathbf{k}')^2} \left[\tilde{f}(\omega, \mathbf{k}', \mathbf{k}_2) - \frac{\mathbf{k}_1^2}{\mathbf{k}'^2 + (\mathbf{k}' - \mathbf{k}_1)^2} \tilde{f}(\omega, \mathbf{k}_1, \mathbf{k}_2) \right]$$

complete set of eigenfunctions

Eigen-
functions

$$f_\omega(k^2) = \frac{(k^2)^{i\nu}}{\sqrt{k^2}}$$

$$\omega = \bar{\alpha}_s \chi(\nu)$$

Characteristic
function

$$\chi(\nu) = -2\gamma_E - \psi(1/2 + i\nu) - \psi(1/2 - i\nu)$$

ψ is the Digamma function

Green
function

$$f_{BFKL}(\omega, k_1, k_2) = \int_{-\infty}^{\infty} d\nu \left(\frac{k_1^2}{k_2^2} \right)^{i\nu} \frac{1}{2\pi^2 k_1 k_2} \frac{1}{(\omega - \bar{\alpha}_s \chi(\nu))}$$

NLO BFKL with running α_s

NLO

$$\omega \equiv \chi(\alpha_s, \nu) = \bar{\alpha}_s (1 - A\bar{\alpha}_s) \chi_0 \left(\frac{1}{2} + \bar{\alpha}_s B + i\nu + \frac{\omega}{2} \right) + \bar{\alpha}_s^2 \chi_1(\nu).$$

running coupling

$$\omega = \chi(\alpha_s(k), \nu_\omega(k)).$$

$$\omega = \chi(\alpha_s(k_{\text{crit}}), 0).$$

Fadin, Lipatov
G. Salam
resummation

property of χ :
largest ω at $\nu=0$

Airy functions are solving BFKL eq. around $k \sim k_{\text{crit}}$

$$\left[\frac{d^2}{d \ln(k^2/k_0^2)} + \frac{\beta_0}{2\pi} \frac{\dot{\chi}(\alpha_s(k_{\text{crit}}), 0)}{\chi''(\alpha_s(k_{\text{crit}}), 0)} \ln \left(\frac{k^2}{k_0^2} \right) \right] \overline{f}_\omega(k) = 0,$$

$$f_\omega(k^2) = \frac{\overline{f}_\omega(k)}{\sqrt{k^2}},$$

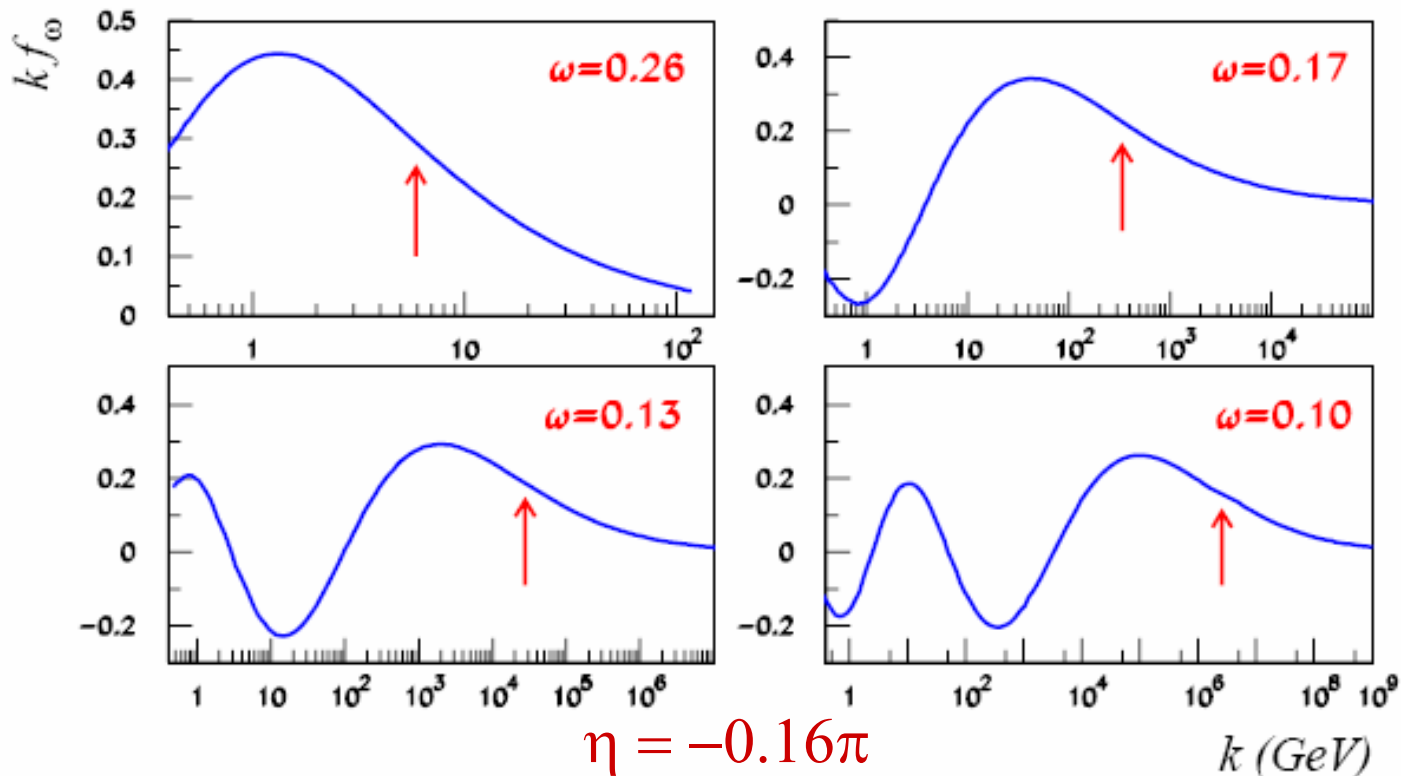
away of k_{crit}

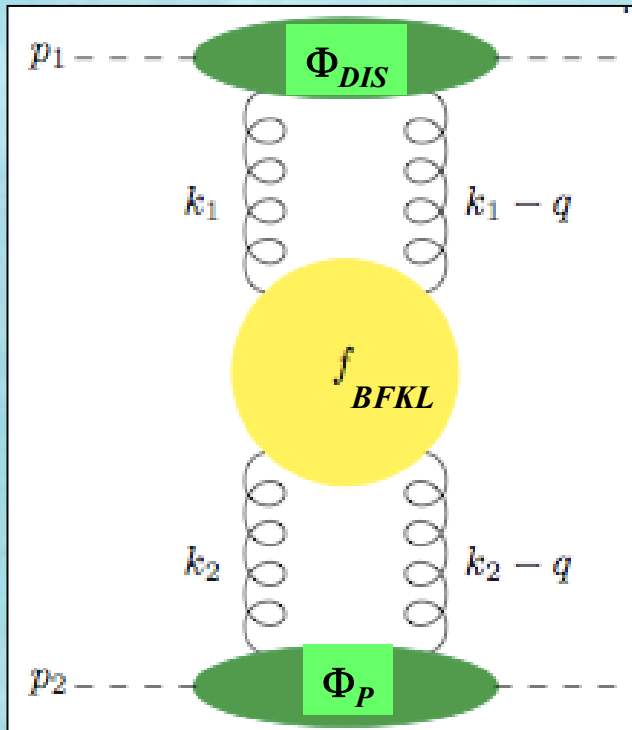
$$\overline{f_\omega(k)} = e^{\pm i\varphi_\omega(k)},$$

$$\varphi_\omega(k) = 2 \int_k^{k_{crit}} \frac{dk'}{k'} |\nu_\omega(k')|.$$

Matching the solutions at $k=k_{crit}$ determines the **phase of oscil.** = $\pi/4$
 Lipatov 86 \rightarrow encode the infrared behaviour of QCD by
 assuming a **fixed phase η at k_0**

$$\varphi_\omega(k_0) \equiv 2 \int_{k_0}^{k_{crit}} \frac{dk'}{k'} |\nu_\omega(k')| = \left(n - \frac{1}{4}\right) \pi + \eta,$$





Structure functions in DIS

$$F_2(x, Q^2) = \int_x^1 dz \int \frac{dk}{k} \Phi_{\text{DIS}}(z, Q, k) xg\left(\frac{x}{z}, k\right),$$

unintegrated gluon density

$$xg(x, k) = \sum_n \int \frac{dk'}{k'} \Phi_p(k') \left(\frac{k'x}{k}\right)^{-\omega_n} k^2 f_{\omega_n}^*(k') f_{\omega_n}(k),$$

enhancement of leading eigenfun. by $(1/x)^\omega$

Φ_{DIS} known in QCD

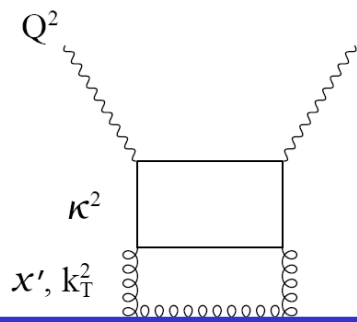
Φ_p barely known

$$xg(x, k) = \sum_n a_n x^{-\omega_n} k^{(2+\omega_n)} f_{\omega_n}(k).$$

HERA
LHeC

no enhancement of leading eigenfun.

$$\Phi_p(k) = \sum_n a_n k^{(2-\omega_n)} f_{\omega_n}(k),$$



Φ_{DIS}

*Kwiecinski, Martin
Stasto*

$$S_q(x, Q^2) = \frac{Q^2}{4\pi^2} \int \frac{dk^2}{k^4} \int_0^1 d\beta \int d^2\kappa' \alpha_S \left\{ [\beta^2 + (1-\beta)^2] \left(\frac{\kappa}{D_{1q}} - \frac{\kappa - k}{D_{2q}} \right)^2 + [m_q^2 + 4Q^2\beta^2(1-\beta)^2] \left(\frac{1}{D_{1q}} - \frac{1}{D_{2q}} \right)^2 \right\} f\left(\frac{x}{z}, k^2\right) \Theta\left(1 - \frac{x}{z}\right)$$

$\kappa' = \kappa - (1-\beta)k$ and

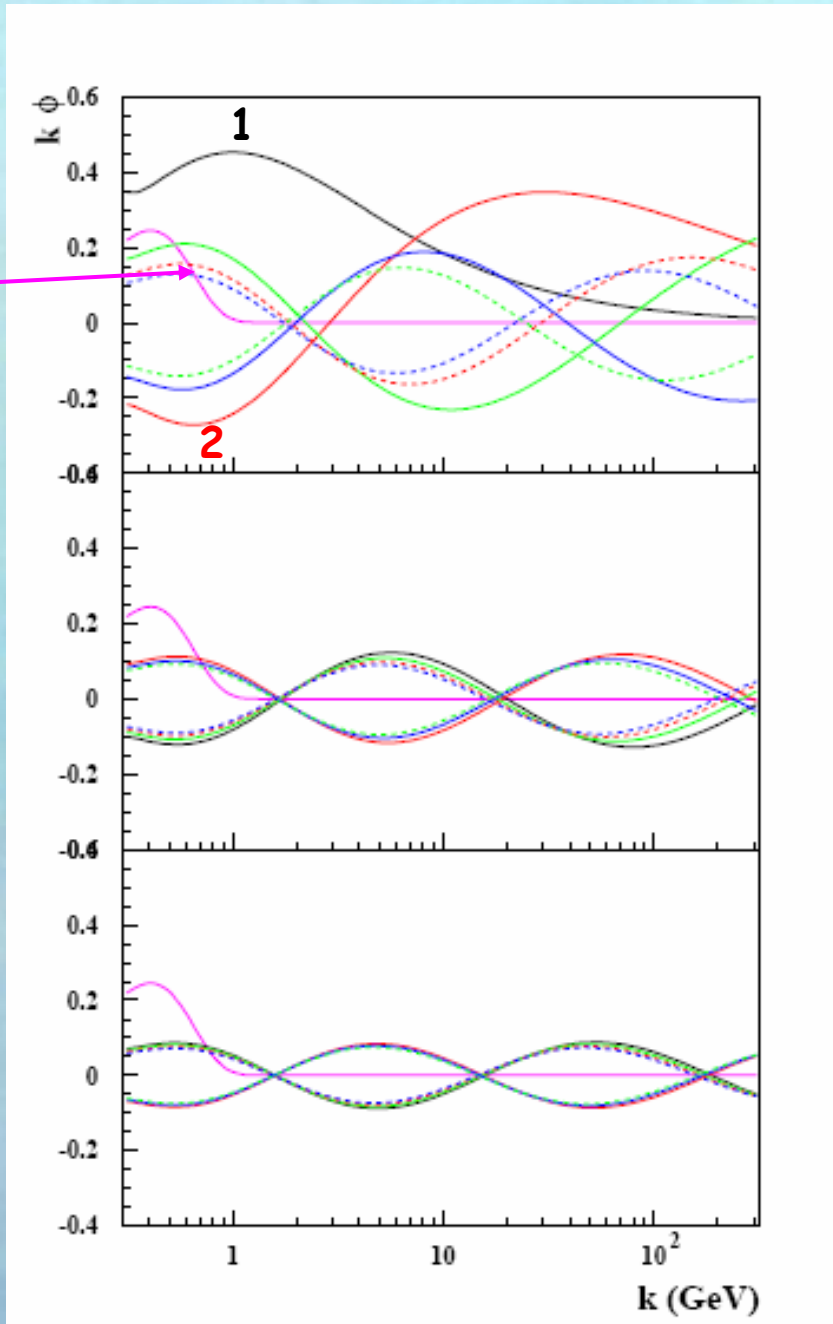
$$D_{1q} = \kappa^2 + \beta(1-\beta)Q^2 + m_q^2$$

$$D_{2q} = (\kappa - k)^2 + \beta(1-\beta)Q^2 + m_q^2$$

$$z = \left[1 + \frac{\kappa'^2 + m_q^2}{\beta(1-\beta)Q^2} + \frac{k^2}{Q^2} \right]^{-1}.$$

$$F_2 = \sum_q e_q^2 (S_q + V_q),$$

DAF Pomeron fit
with
 $\Phi_p = k^2 \exp(-bk^2)$



Eigenfunctions

1-7

8-14

15-21

DAF Pomeron fit with

$$\Phi_p = k^2 \exp(-bk^2) * (x_0)^\omega$$

$$\eta = -0.20 * \pi$$

$$b = 6 \text{ GeV}^{-2}$$

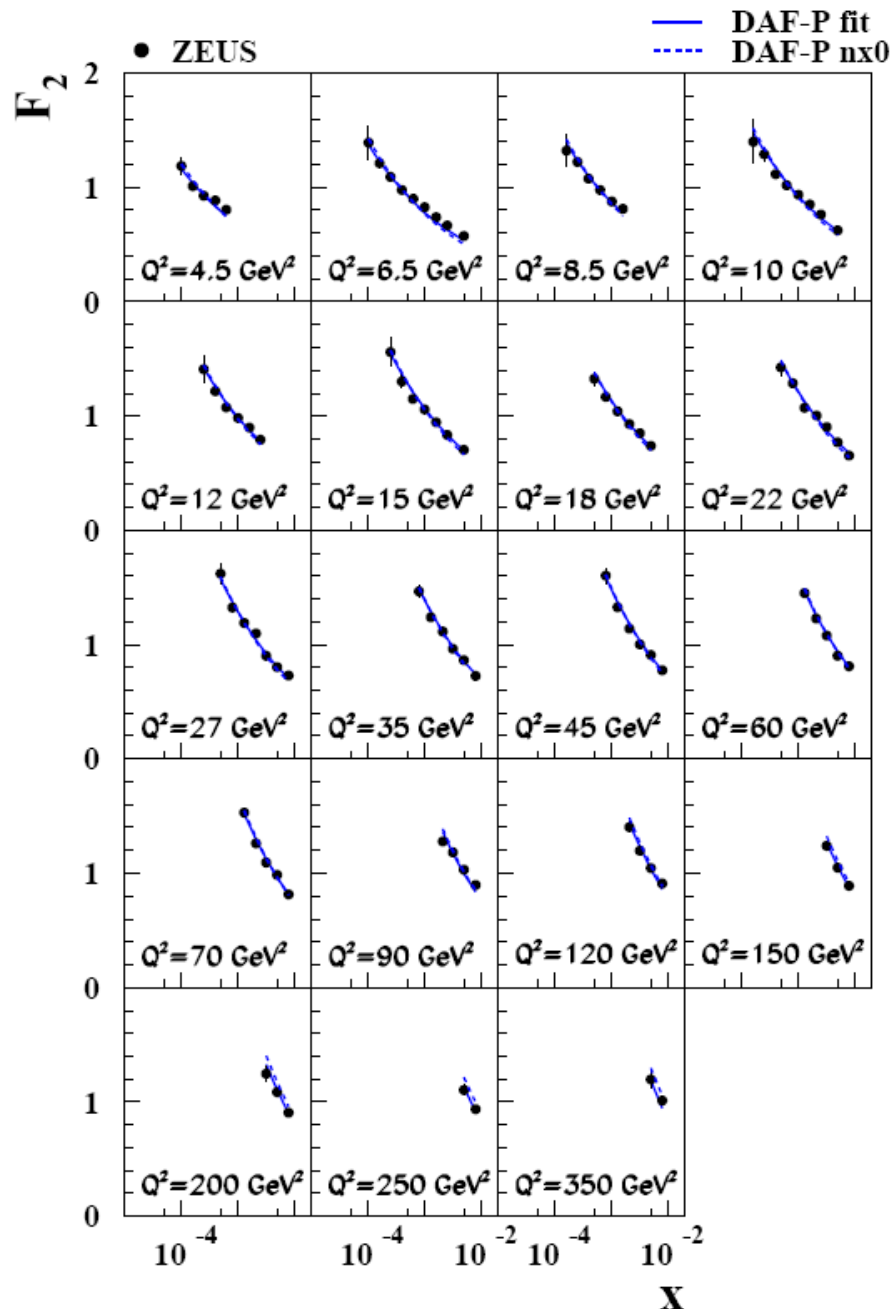
$$x_0 \sim 0.4$$

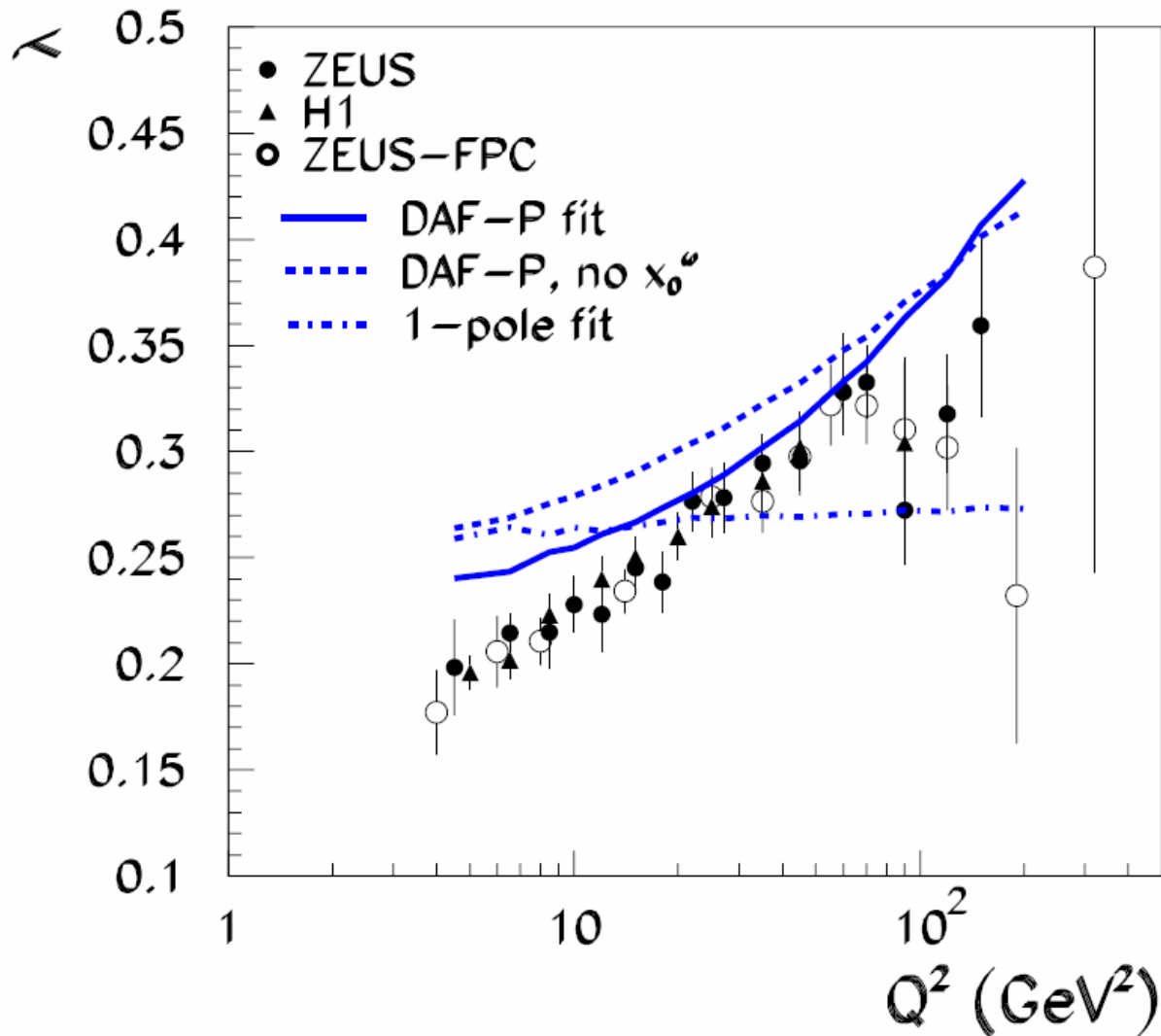
for $x < 0.001$

$$\chi^2/\text{ndf} = 18/30$$

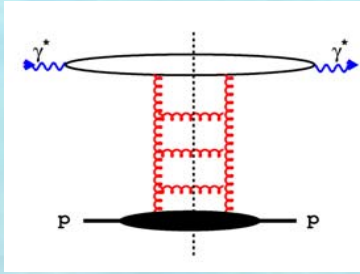
for $x < 0.01$

$$\chi^2/\text{ndf} = 115/100$$

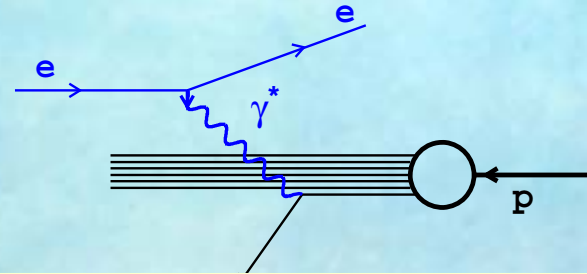




Sum of contributions
 with small eigenvalues
 can give a larger
 rate of rise than the
 leading eigenvalue !!!

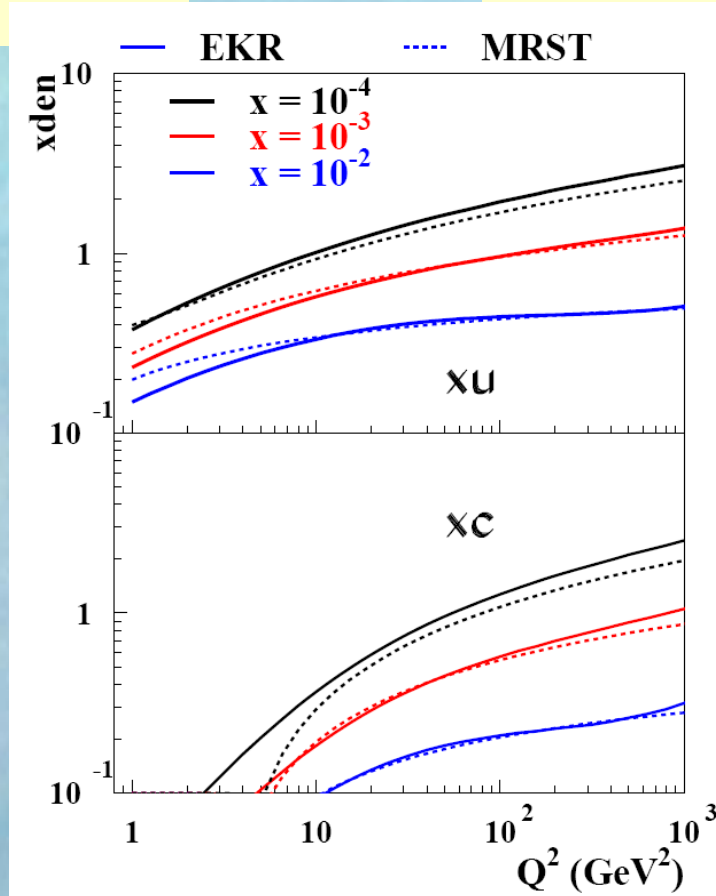


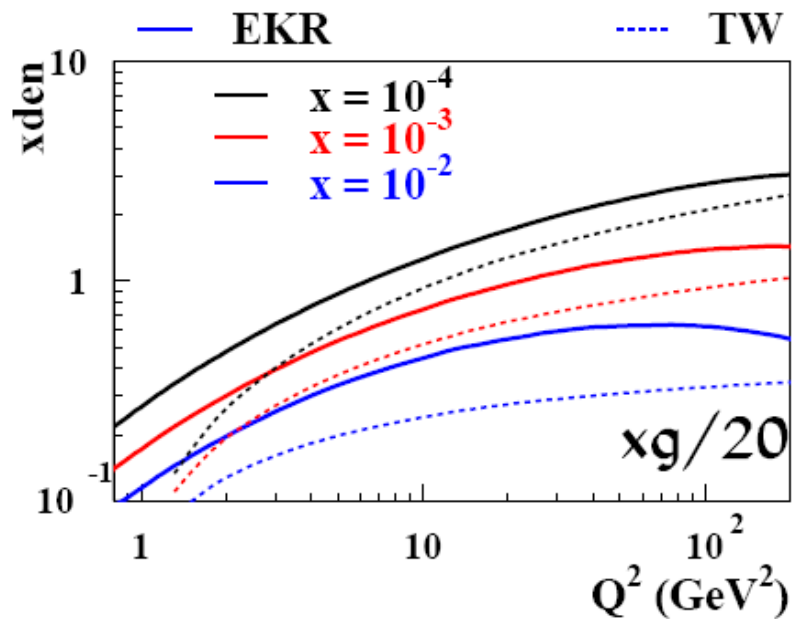
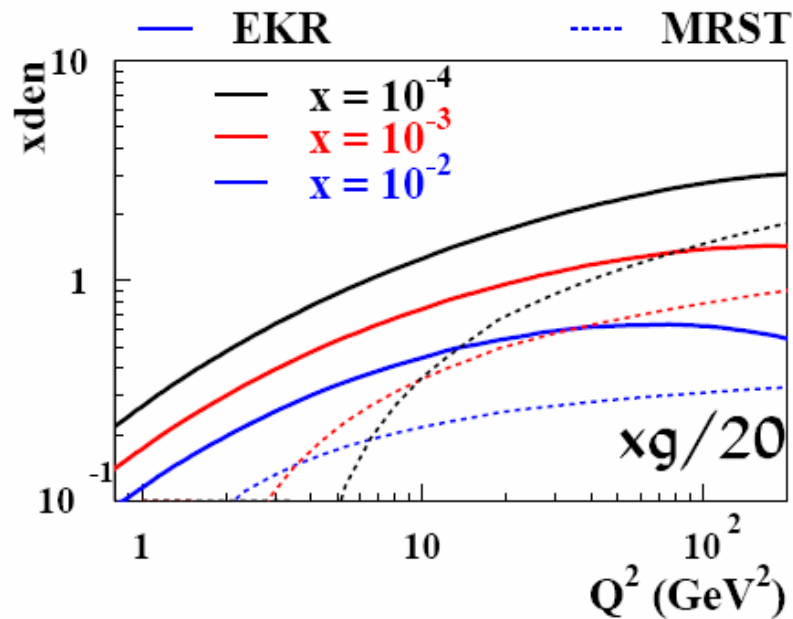
$$F_2(x, Q^2) = x \sum_q e_q^2 q(x, Q^2)$$



$$q(x, Q) = \int_0^Q \frac{dk}{k} \Phi_{DIS}(Q, k) x g(x, k)$$

$$q(x, \mu^2) = q_0(x) + \frac{\alpha_s}{\pi} \int_x^1 \frac{d\xi}{\xi} q_0(\xi) \left\{ P_{qq} \left(\frac{x}{\xi} \right) \ln \mu / \kappa + \dots \right.$$





Where Do BFKL and DGLAP Meet

Lipatov, private communication

Unintegrated BFKL gluon density (LO, no running α_s)

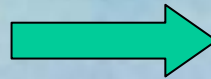
$$xg(x, k^2) = \int d\gamma \Phi_p(\gamma) \left(\frac{k^2}{\mu^2}\right)^\gamma x^{-\bar{\alpha}_s \chi(\gamma)} = \int d\gamma \Phi_p(\gamma) \exp(F(\gamma))$$

$$\gamma = 1/2 + i\nu$$

Saddle point

$$(F(\gamma))' = (\gamma \ln(k^2/\mu^2) + \bar{\alpha}_s \ln(1/x) \chi(\gamma))' = 0$$

$$\chi(\gamma) = \frac{1}{\gamma} - 2\zeta(3)\gamma^2 + \dots$$



$$\gamma^2 = \frac{\bar{\alpha} \ln(1/x)}{\ln(k^2/\mu^2)}$$

$$\omega \approx \bar{\alpha}_s / \gamma = \sqrt{\frac{\bar{\alpha}_s \ln(k^2/\mu^2)}{\ln(1/x)}}$$

valid if $\bar{\alpha}(k^2) \ln(1/x) \ll 1$,

! not fulfilled for HERA
or even Higgs at LHC !

equal to DLL limit of DGLAP (LO, no running α_s)

Pomeron and Gauge/String Duality

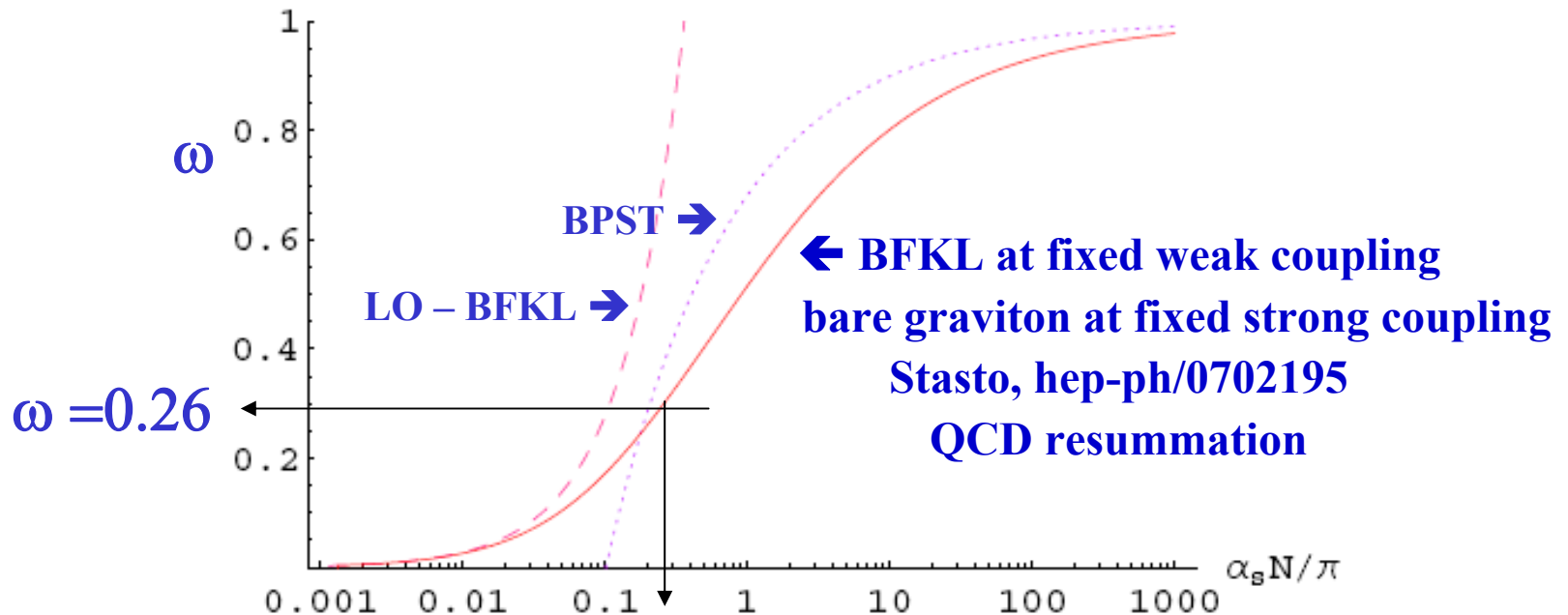
Brower, Polchinski, Strassler, and Tan, hep-th/0603115

Pomeron is a coherent color-singlet object, build from gluons, with universal properties; it is a closed string propagating in ADS space, when the conformal symmetry is broken at some infrared point in the fifth dimension

$$1 + \omega = 2 - \frac{2}{\sqrt{4\pi\alpha_s N}} \quad \text{in ADS/CFT}$$

in N=4 YM SuSy QCD

Kotikov, Lipatov, Onishchenko, Velizhanin, Physt. Lett. B 632, 754 (2006)

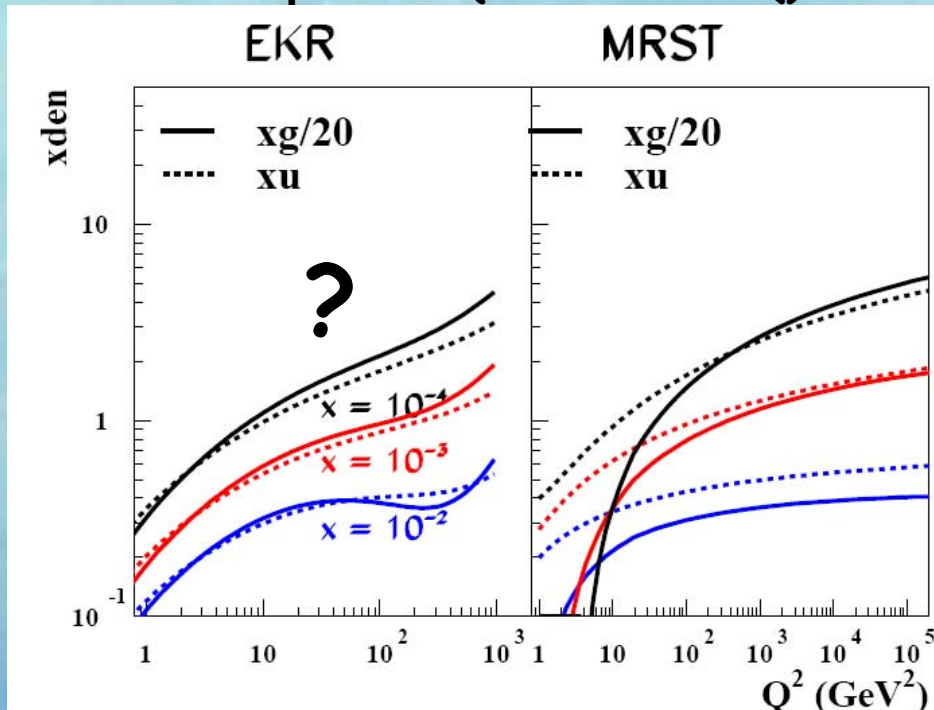


Consequences for LHC

Good knowledge of gluon density around $x \sim 10^{-2}$ and $Q^2 \sim 10000 \text{ GeV}^2$ is essential for LHC physics (Higgs region)

Large effort is going into precise measurement of W and Z inclusive X-sections → precise determination of sea-quark distributions
→ precise gluon density

Is the sea-quark ↔ gluon density relation the same in the DGLAP-like picture (MRST/CTEQ) and DAF-Pomeron?



sea-quark ↔ gluon relation can be checked by the jets with p_T around 50 GeV

Instead of Conclusions

Study of Gluon Density are very important because it is the analog of Black Body Radiation in QED

It seemed hopeless to study pure Gluon Radiation since it is never free. However, it is becoming free for a short moment in HEP reactions

HERA has shown that physics processes at low- x are completely dominated by pure Gluon Density,

Investigation of Gluon Density has a chance to become as fundamental as Black Body radiation

