Color screening in DDIS

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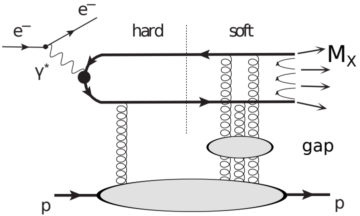
- Color screening in diffractive $e + P$
- DDIS in soft screening model
- Monte Carlo study
- Comparison with data
- Sensitivities

Color screening model

- Consider DDIS on parton level
- Color octet exchange
- Momentum dominantly exchanged via hard gluon

- Soft rescattering of $n \to \infty$ gluons
- No change in momenta
- Can change the color topology
- Obtain amplitude in impact space

- Method differs from SCI (prb. based. reconn.)



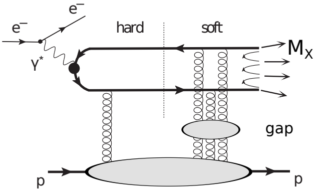
Pasechnik, Enberg, Ingelman
arxiv 1004.2912v3

$$x = \frac{Q^2}{2Pq} = \beta x_{\mathbb{P}}$$

$$\beta = \frac{Q^2}{Q^2 + M_X^2}$$

Factorization

- Low-x, large W^2
- Use factorization in $\mathbf{k}_\perp$
- uGDF via evolution from $k_\perp^{\text{cut}}$

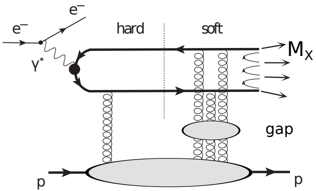


- $F(x,\mu^2) = \int \frac{d\mathbf{k}_\perp^2}{\mathbf{k}_\perp^2} F(x,\mathbf{k}_\perp^2,\mu^2)$
- Fact. scale: first hard gluon and qq virtualities

Color screening model

- Soft amplitude unknown
- Factorization:
  Separation of hard and soft part

$$M(\delta) = \int d^2 b \, \exp^{-i\delta\mathbf{b}} \, \hat{M}^{\text{hard}}(b)\hat{M}^{\text{soft}}(b)$$



- Dipole picture $r \sim \frac{1}{k_\perp}$
- Frame: $P_{M_X} + P'$

Color screening model

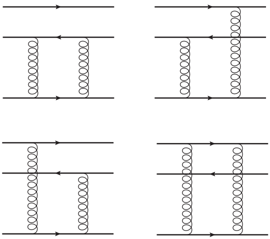
- Gluon rescattering perturbatively
- Summed up order by order in α_s
- Exponentiates

$$\hat{M}_1^{\text{soft}} + \hat{M}_2^{\text{soft}} + \cdots = e^{\mathrm{i}\mathbf{r}(\mathbf{k}\perp' - \mathbf{k}_\perp)} \left(A\ W(r,b) + \frac{1}{2!} A^2\ W(r,b)^2 + \cdots\right)$$

$$A = 2\pi \mathrm{i} C_F \alpha_s(\mu^2_{\text{soft}})$$

$$W(r,b) = \frac{1}{2\pi} \ln \frac{|\mathbf{b}-\mathbf{r}|}{|\mathbf{b}|}$$

2nd order α_s:



$$\hat{M}^{\text{soft}}(\mathbf{b},\mathbf{r}) = -e^{\mathrm{i}\mathbf{r}(\mathbf{k}'_\perp - \mathbf{k}_\perp)} \left(1 - e^{A \ln \frac{|\mathbf{b}-\mathbf{r}|}{|\mathbf{b}|}}\right)$$

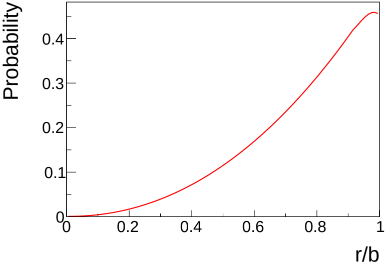
$\alpha_s(Q^2) = \frac{12\pi}{(33-2n_f)\ln Q^2/\Lambda^2} \to 0.7$ for low scale

Shirkov, Solovtsev

Monte Carlo implementation

Amplitude $\rightarrow$ Probability

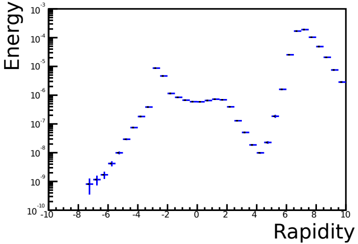
- Soft rescattering in terms of Monte Carlo language
- Need probability $\left|1 - e^{A \ln \frac{|\mathbf{b}-\mathbf{r}|}{|\mathbf{b}|}}\right|^2$
- Freedom in relative angles of impact parameters
- Average over different orientations
- $\int \, d\phi \, |A|^2$

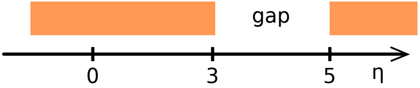


Monte Carlo implementation

- Selecting diffraction
- Gap for $3.0 < \eta < 5.0$ meaning no particles
- Require forward low mass cluster $< 1.5\,\mathrm{GeV}$
- Kinematical cuts on
  $x_{\mathbb{P}} < 0.02$
  $40 < W < 240$

Distribution for screened events:





- No large sensitivity on the selection cuts
- Require leading protons: Remnant treatment.

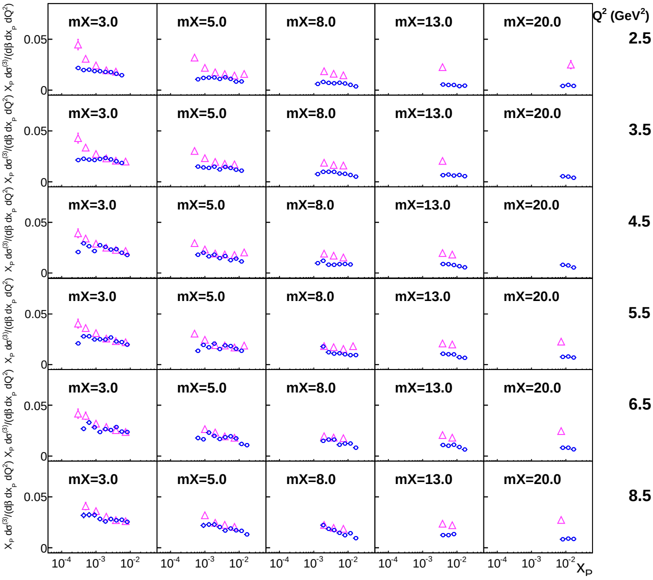
Comparison with data

- Data presented in terms of reduced diffractive cross section

$$\frac{d\sigma^{eP\to eXP}}{d\beta dQ^2 dx_{\mathbb{P}}} = \frac{4\pi\alpha^2}{Q^4\beta}\left(1 - y + \frac{y^2}{2}\right)\ \sigma_r^{(3)}(\beta, Q^2, x_{\mathbb{P}})$$

- Or, depending on M_X instead of β

$$\frac{d\sigma^{eP\to eXP}}{dM_X dQ^2 dx_{\mathbb{P}}} = \frac{4\pi\alpha^2}{Q^4(Q^2+M_X^2)} 2M_X \left(1 - y + \frac{y^2}{2}\right)\ \sigma_r^{(3)}(M_X, Q^2, x_{\mathbb{P}})$$



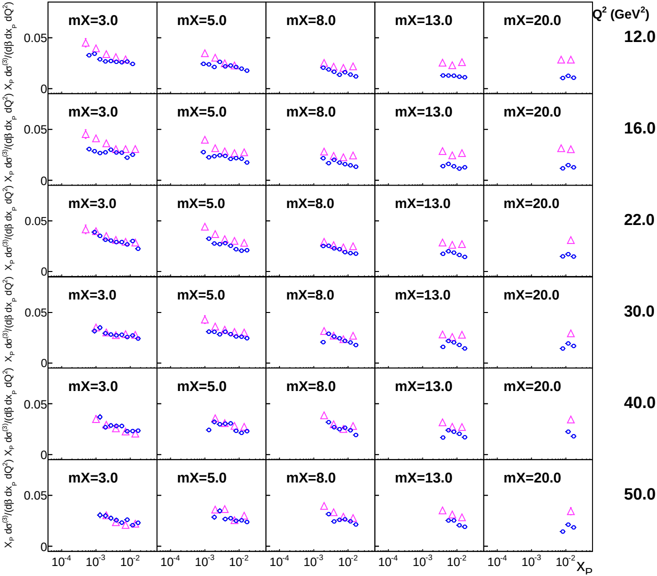
Shown here: $x_{\mathbb{P}}\sigma_r$

Screening Model

ZEUS data

Nucl.Ph.B 816(2009),1

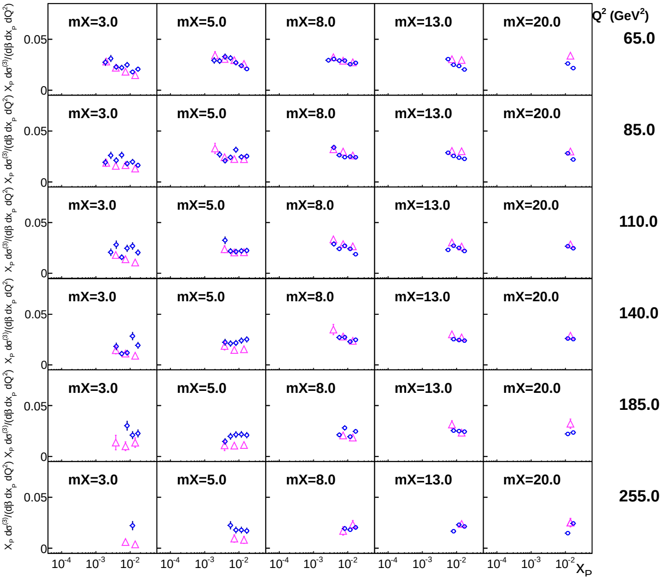
- Overall good
- Off at large mX and small scale



Screening Model
ZEUS data

Nucl.Ph.B 816(2009),1

- Larger scales: Improved fit for smaller M_X^2/Q^2



Screening Model

ZEUS data

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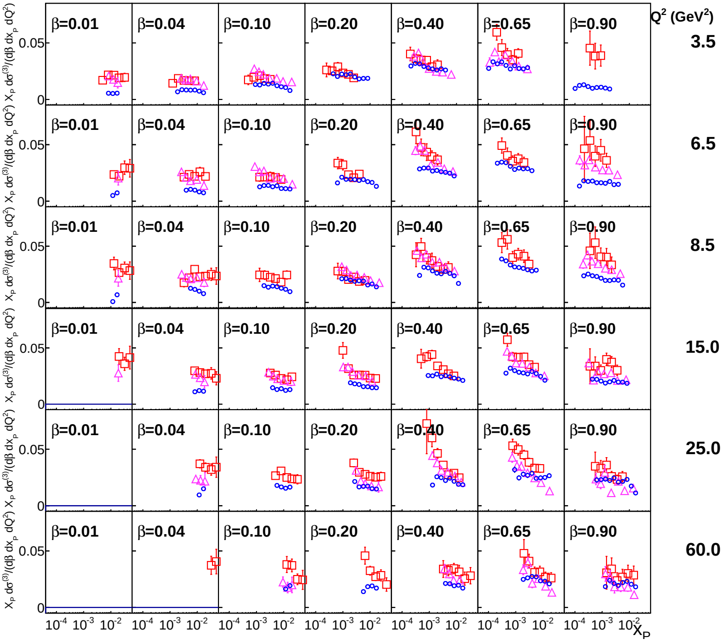


Screening Model

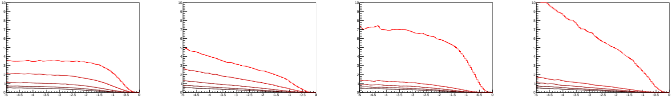
H1

ZEUS

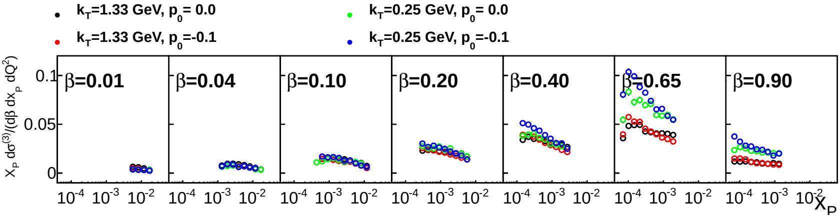
$$\beta = \frac{Q^2}{Q^2 + M_X^2}$$

uGDF dependence

A0 A1 B0 B1



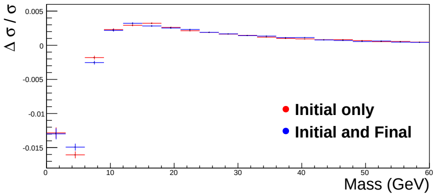
- Dependence on uGDF
- uGDFs fitted to HERA F2 data
- Differ in starting distribution
- $p_0, \; k_\perp^{\text{cut}}$



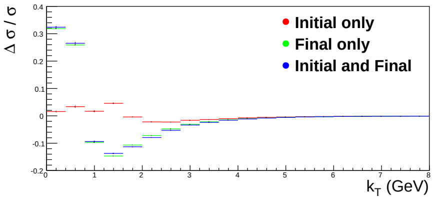
2.5

Influence of Radiation

- Radiation affects M_X distribution
- ISR typically forward



- FSR increases probability of having small transverse momentum



Conclusions

- Color screening for DIS on amplitude, impact space
- Probability in terms of $r = 1/k_\perp$
- Soft color rescattering based on simple physical arguments
- Describes H1 and ZEUS DDIS data fairly well
- Few parameters, soft scale $\Lambda_{QCD} \simeq m_{\text{eff}}$
- Pysically motivated values
- Sensitive to radiation and uGDF