

Low x parton behaviour

accounting for J/ψ and Υ exclusive data
and absorptive corrections

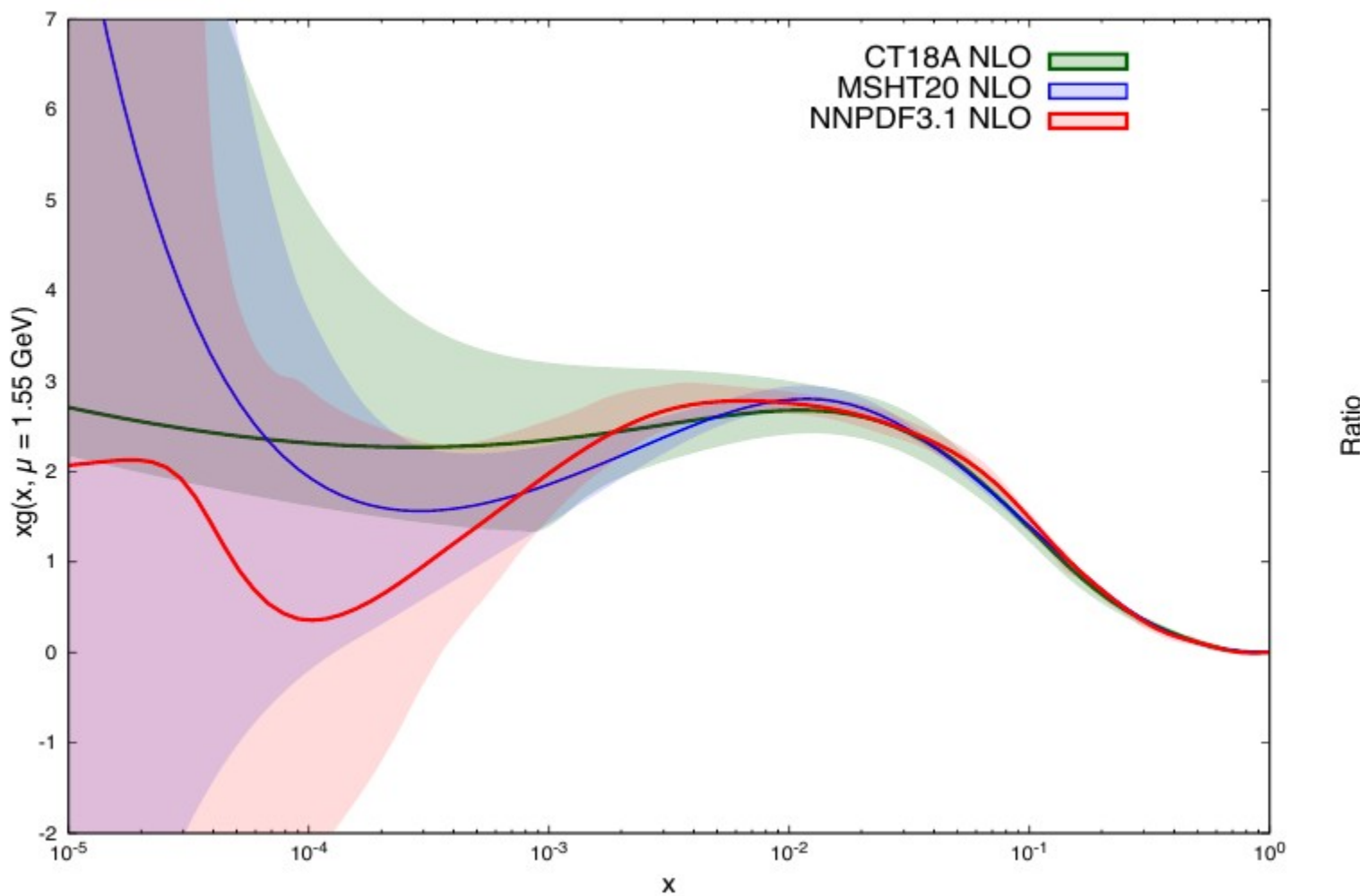
M.G.Ryskin

C. A. Flett, A. D. Martin, M. G. Ryskin, T. Teubner

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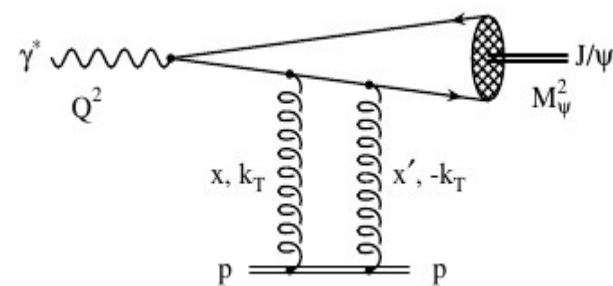
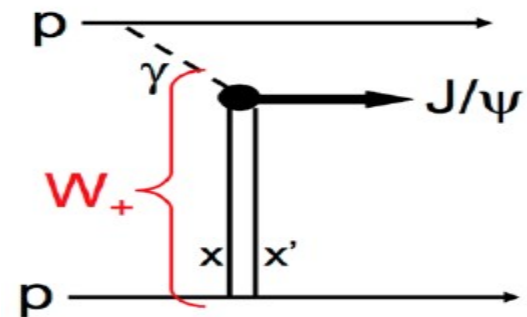
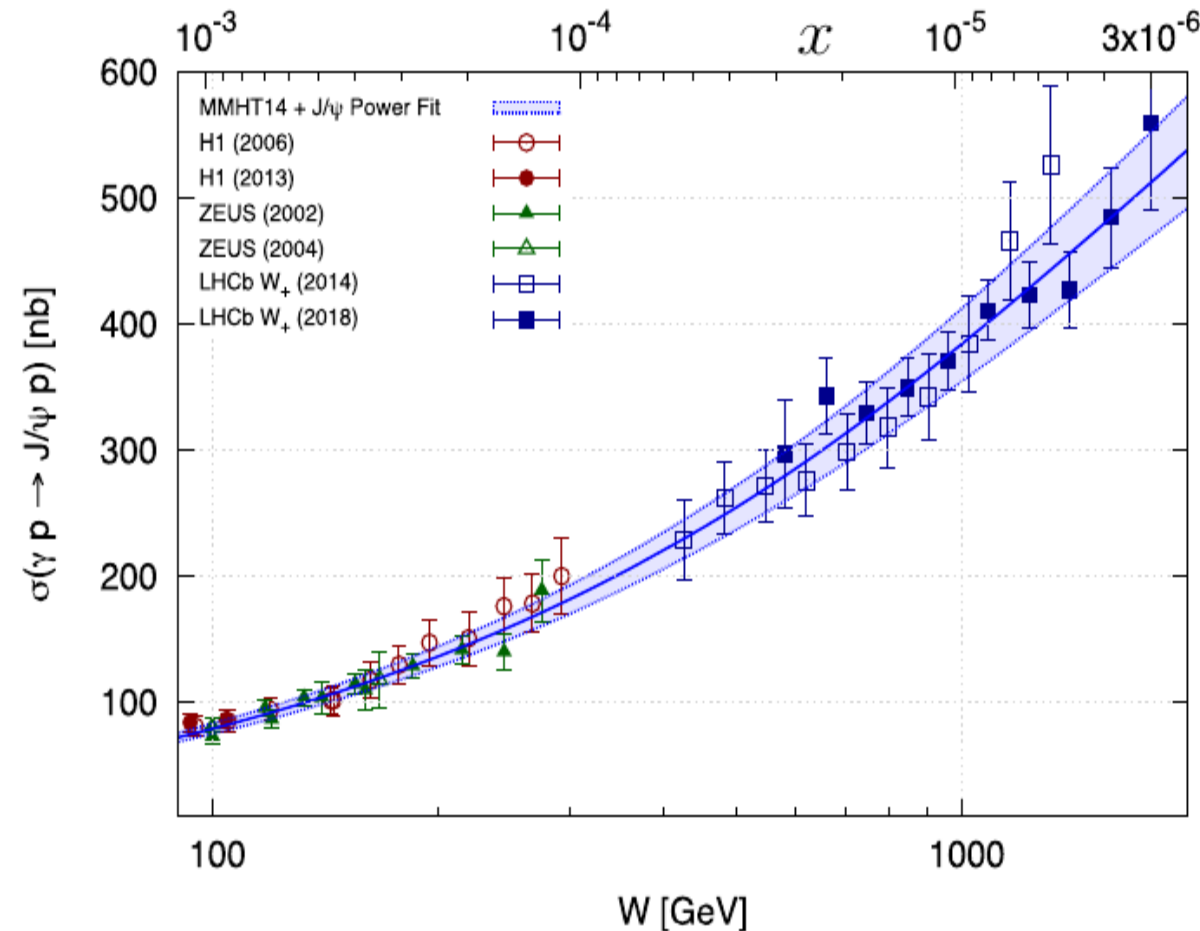
V. Bertone, C. A. Flett, A. D. Martin and M. G. Ryskin

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Gluon densities given by today global analysis

fall down at $x < 0.01$ What is the reason?



LO

$$\left. \frac{d\sigma}{dt} (\gamma^* p \rightarrow J/\psi p) \right|_{t=0} = \frac{\Gamma_{ee} M_{J/\psi}^3 \pi^3}{48\alpha} \frac{\alpha_s (\bar{Q}^2)^2}{\bar{Q}^8} \left[\underline{xg(x, \bar{Q}^2)} \right]^2 \left(1 + \frac{Q^2}{M_{J/\psi}^2} \right)$$

$$\bar{Q}^2 = (Q^2 + M_{J/\psi}^2)/4$$

Why J/ψ data from LHC are not included in global parton analysis?

1. At NLO we have to deal with the GPD (not PDF)

2. for $x \ll 1$ GPD can be calculated from PDF via the Shuvaev transform

$$F_g(X, \xi) = \sqrt{1 - \xi^2} \int_{-1}^1 dx' \left[\frac{2}{\pi} \text{Im} \int_0^1 \frac{ds (X + \xi(1 - 2s))}{y(s) \sqrt{1 - y(s)x'}} \right] \frac{d}{dx'} \left(\frac{g(x')}{|x'|} \right)$$

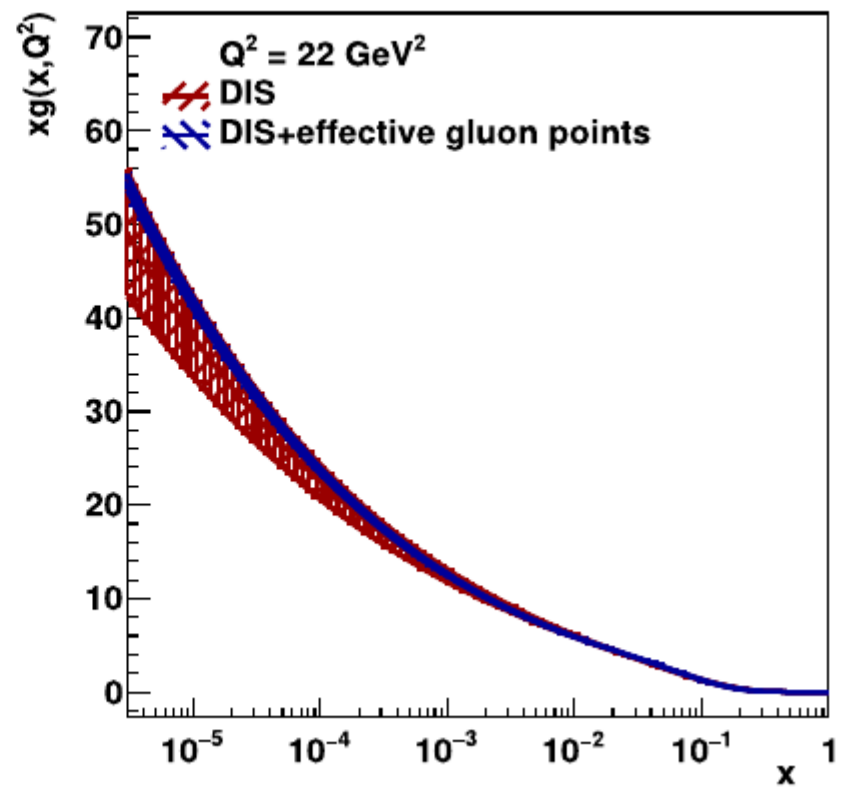
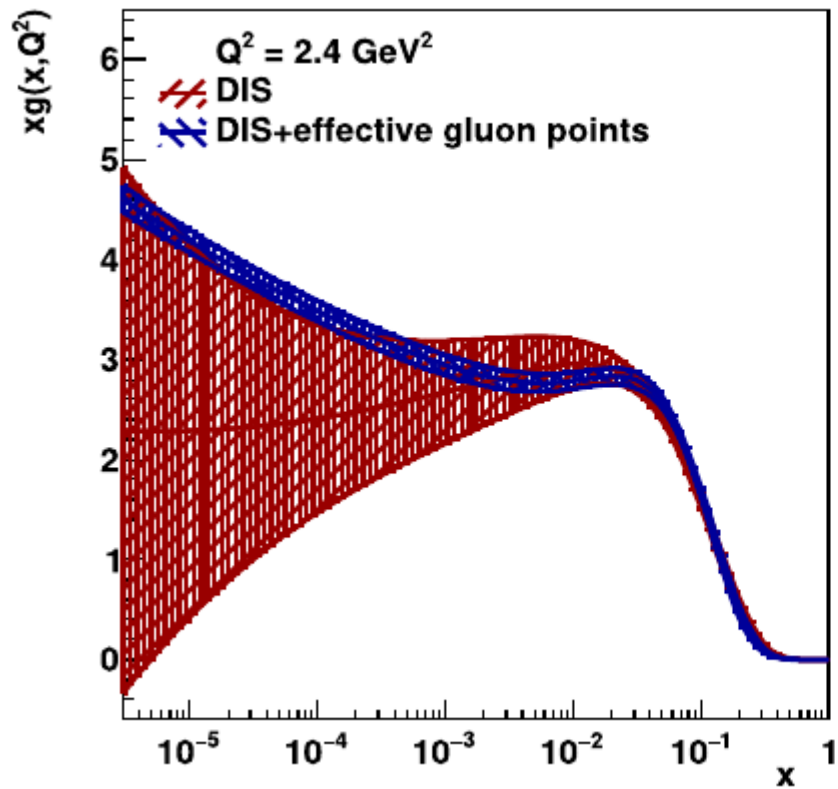
this **two dimensional** integral is **badly converges** very time consuming!

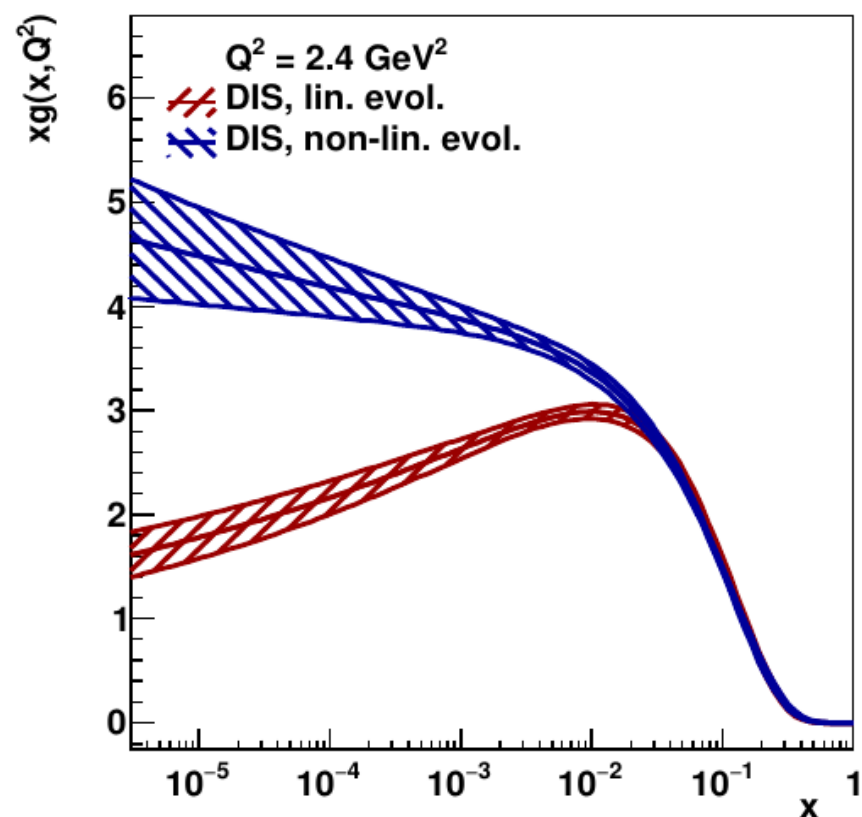
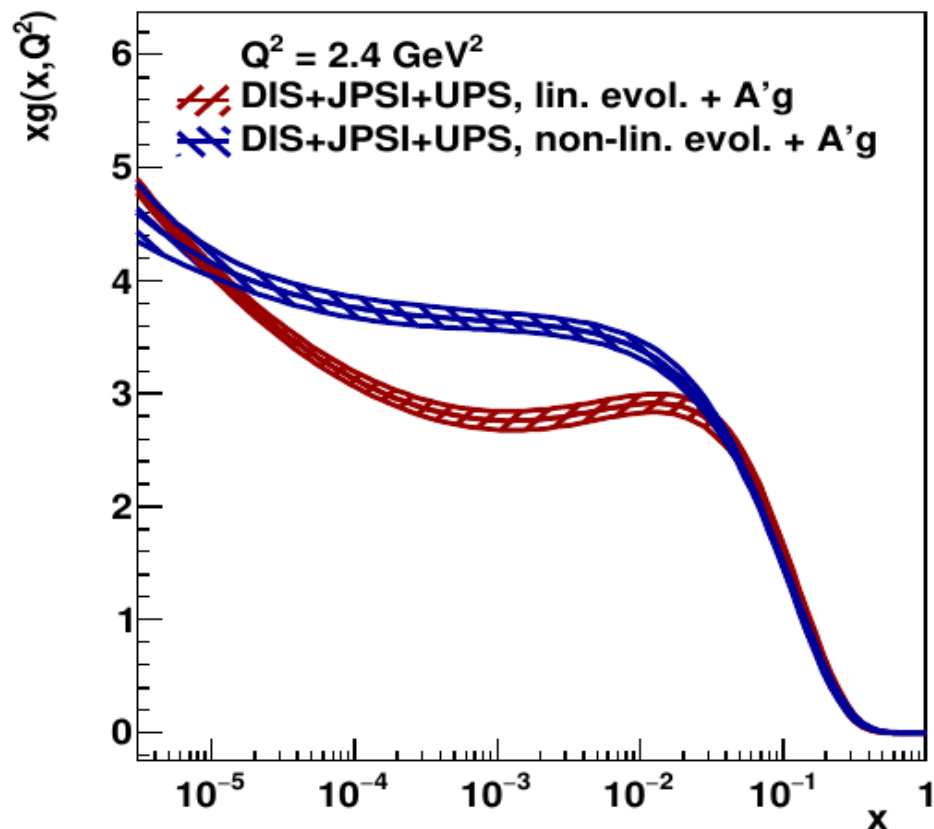
Solution: to replace the J/ψ cross sections

by ”**effective**” gluon densities $xg_{eff}(x, q^2)$

$$g_{\text{eff}}(x_i, \mu_{\text{opt}}) = g_{\text{fit}}(x_i, \mu_{\text{opt}}) \sqrt{\frac{\sigma_+(\text{data})_i}{\sigma_+(\text{fit})_i}}.$$

'times' few iterations



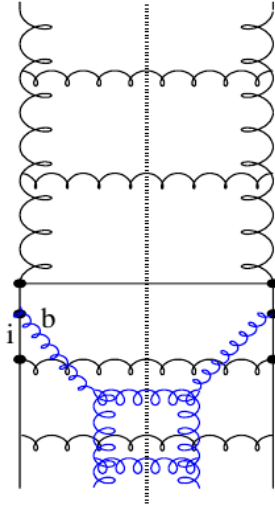
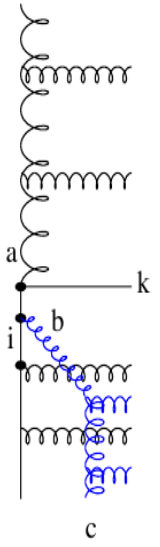
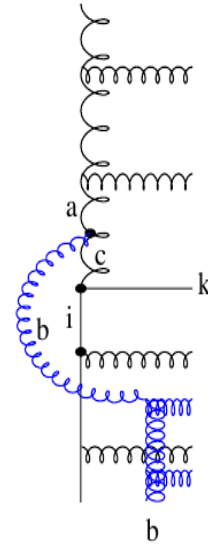
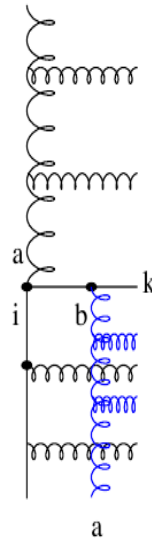
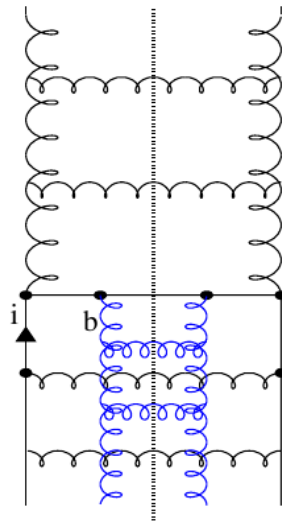
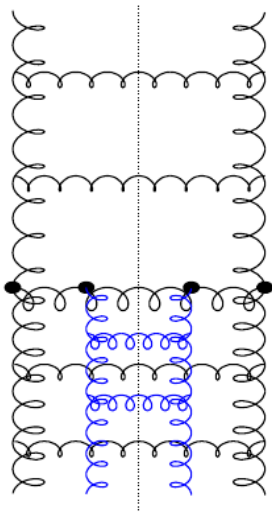


Absorptive corrections

suppress the growth of $xg(x)$ with $x \rightarrow 0$

That is we need a LARGER xg in input

xFitter with APFEL++ are used



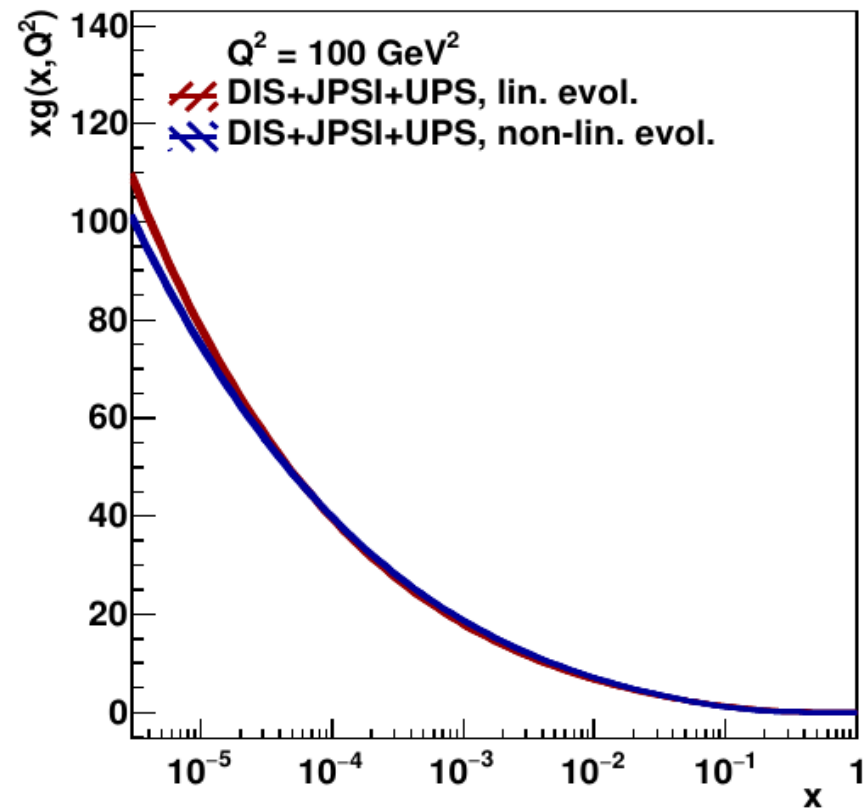
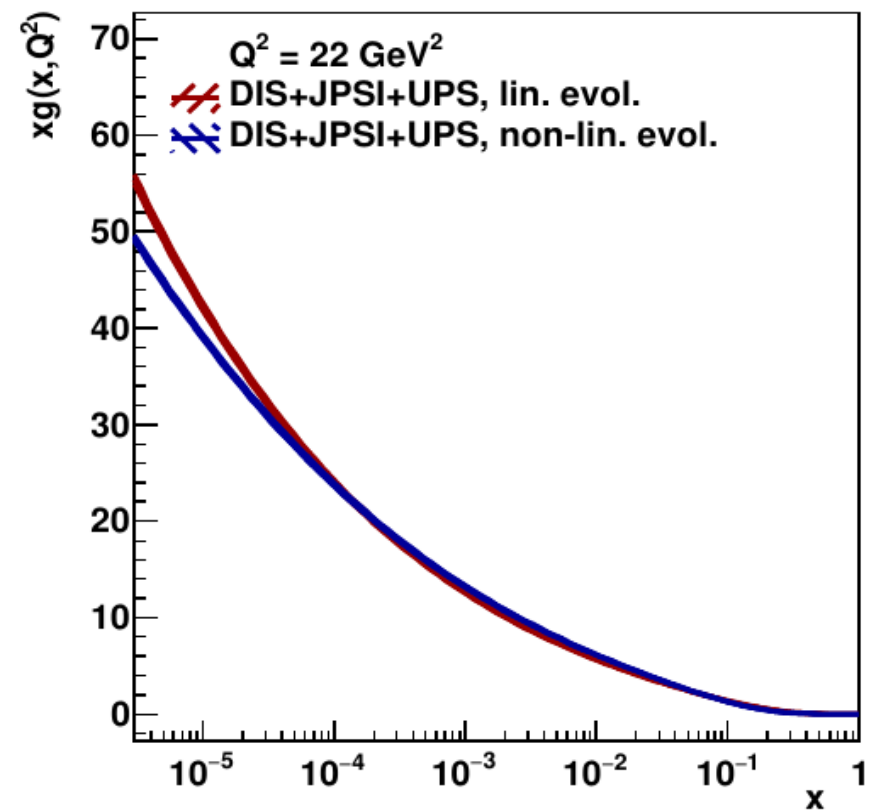
$$\frac{d(xg(x, Q^2))}{d \ln Q^2} = \frac{\alpha_s}{2\pi} \int_x^1 \frac{dx'}{x'} P_{gg}(x/x') x' g(x', Q^2) - \frac{81\alpha_s^2}{16R^2Q^2} \int \frac{dx'}{x'} (x' g(x', Q^2))^2$$

$$\frac{d(xg(x, Q^2))}{d \ln Q^2} = \frac{\alpha_s}{2\pi} \int_x^1 \frac{dx'}{x'} (P_{gg}(x/x') x' g(x', Q^2) \cdot F_g + P_{gq}(x/x') x' q(x', Q^2) \cdot F_q)$$

$$\frac{d(xq(x, Q^2))}{d \ln Q^2} = \frac{\alpha_s}{2\pi} \int_x^1 \frac{dx'}{x'} (P_{qg}(x/x') x' g(x', Q^2) \cdot F_g + P_{qq}(x/x') x' q(x', Q^2) \cdot F_q) .$$

$$F_g = \exp \left(-\frac{C_A 9\alpha_s \pi}{16R^2Q^2} x' g(x', Q^2) \right)$$

$$F_q = \exp \left(-\frac{C_F 9\alpha_s \pi}{16R^2Q^2} x' g(x', Q^2) \right)$$



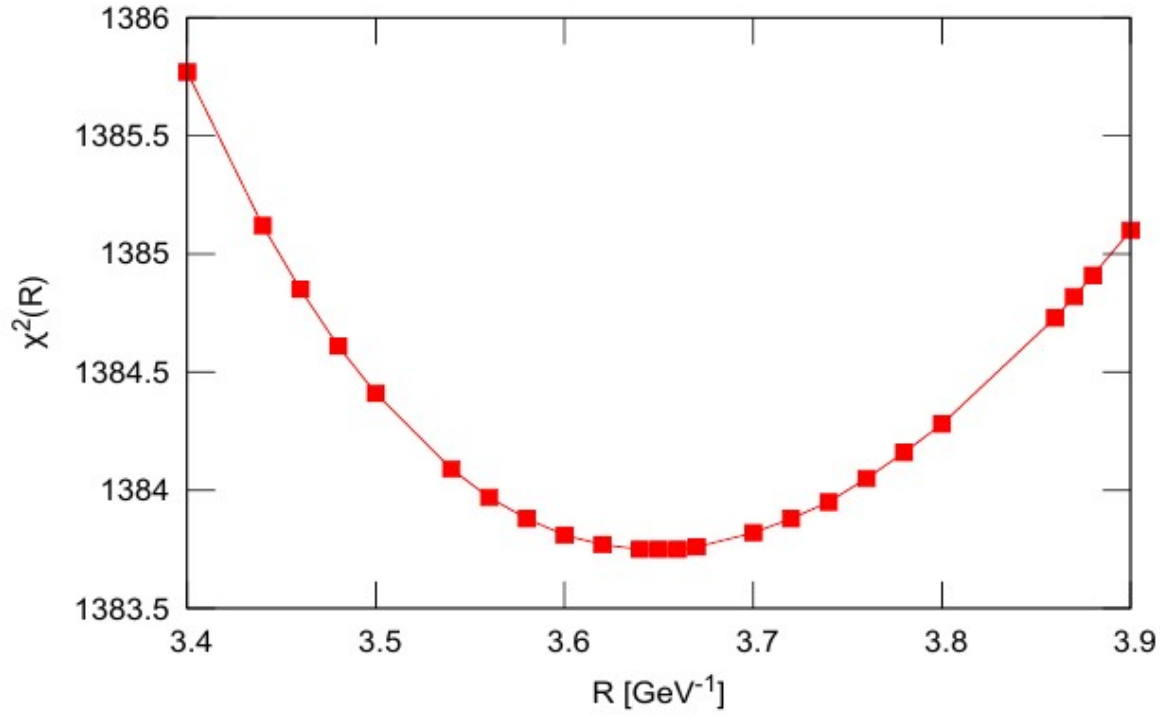


Figure 7: Dependence of $\chi^2(R)$ on the strength of the non-linear correction, as determined by the parameter R . Here, the ‘negative gluon component’ term proportional to A'_g is fixed to zero.

$$\frac{1}{R^2} = \frac{n-1}{nR_N^2} + \frac{1}{nR_{h.s.}^2}$$

with $n = 3$, the value $R_{h.s.} = 2.57 \text{ GeV}^{-1}$.

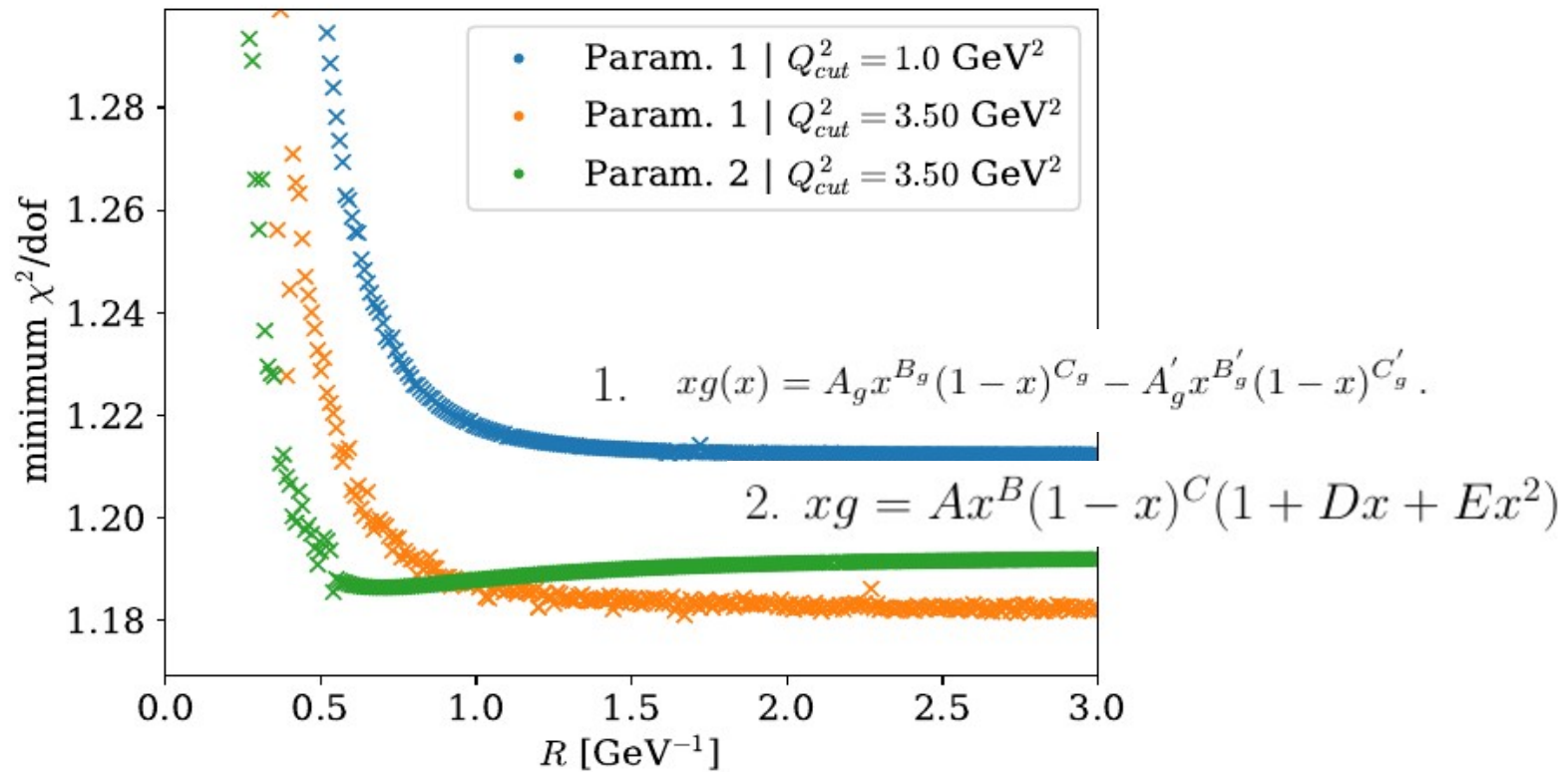


FIG. 3: Minimum χ^2/N_{dof} as a function of R for parameterization 1 with $Q^2 > 3.5 \text{ GeV}^2$ (orange) and $Q^2 > 1 \text{ GeV}^2$ (blue), and parameterization 2 with $Q^2 > 3.5 \text{ GeV}^2$ (green).

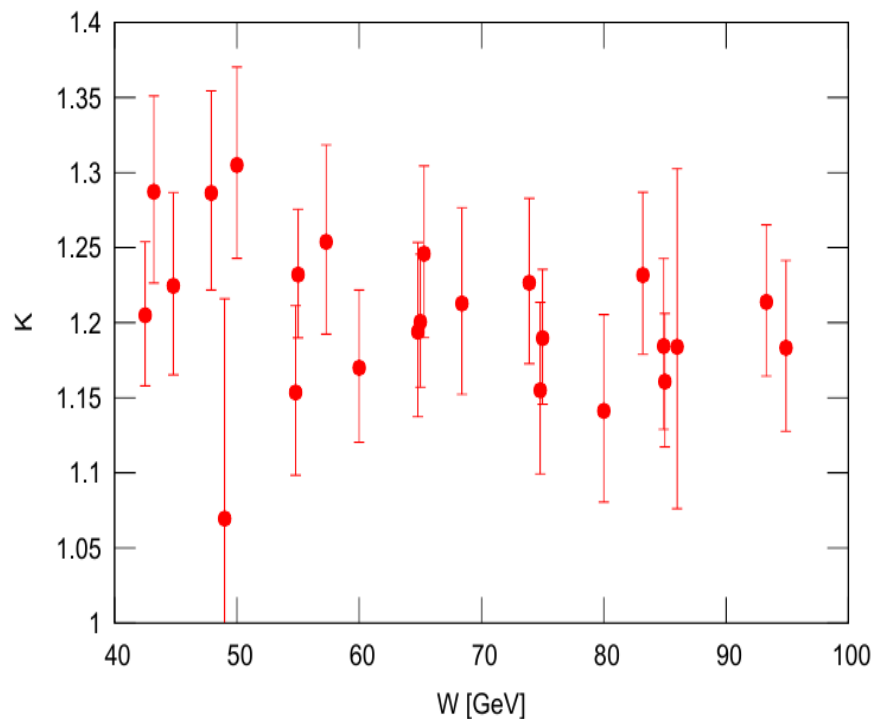
Proton PDFs with non-linear corrections from gluon recombination

P. Duwentäster ^{1,2,*} V. Guzey ^{1,2,†} I. Helenius ^{1,2,‡} and H. Paukkunen ^{1,2,§}

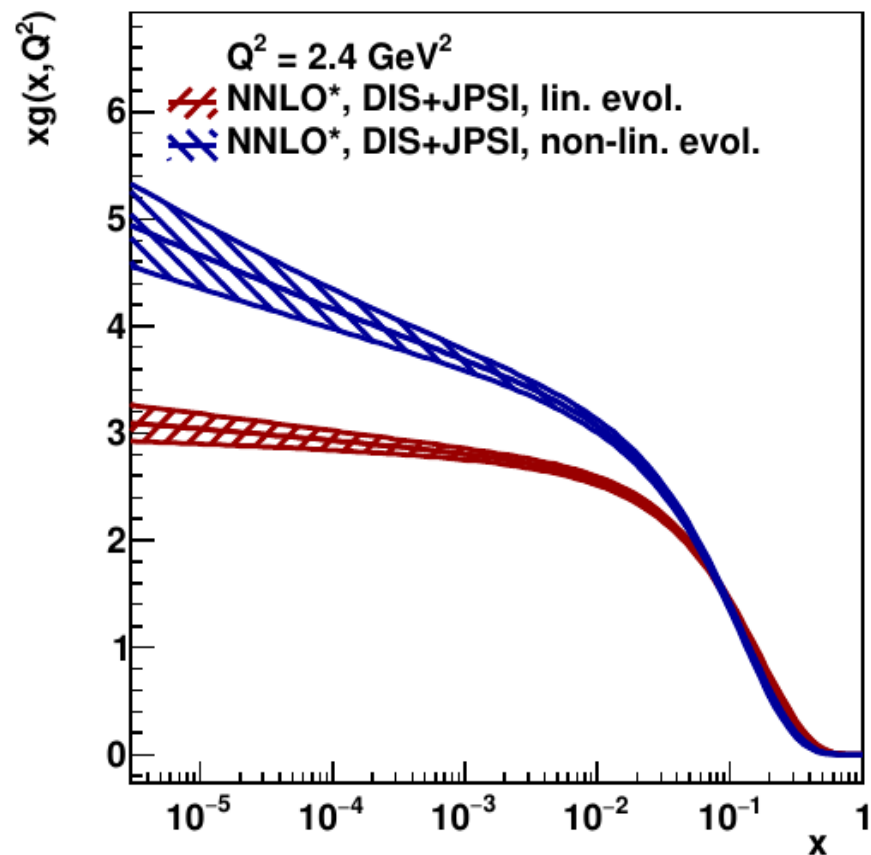
arXiv: 2312.12993

NNLO* $C^{NNLO} = K * C^{NLO}$

$$K = \sqrt{\frac{\sigma(\text{data})}{\sigma^{\text{NLO/NNLO}}}}$$

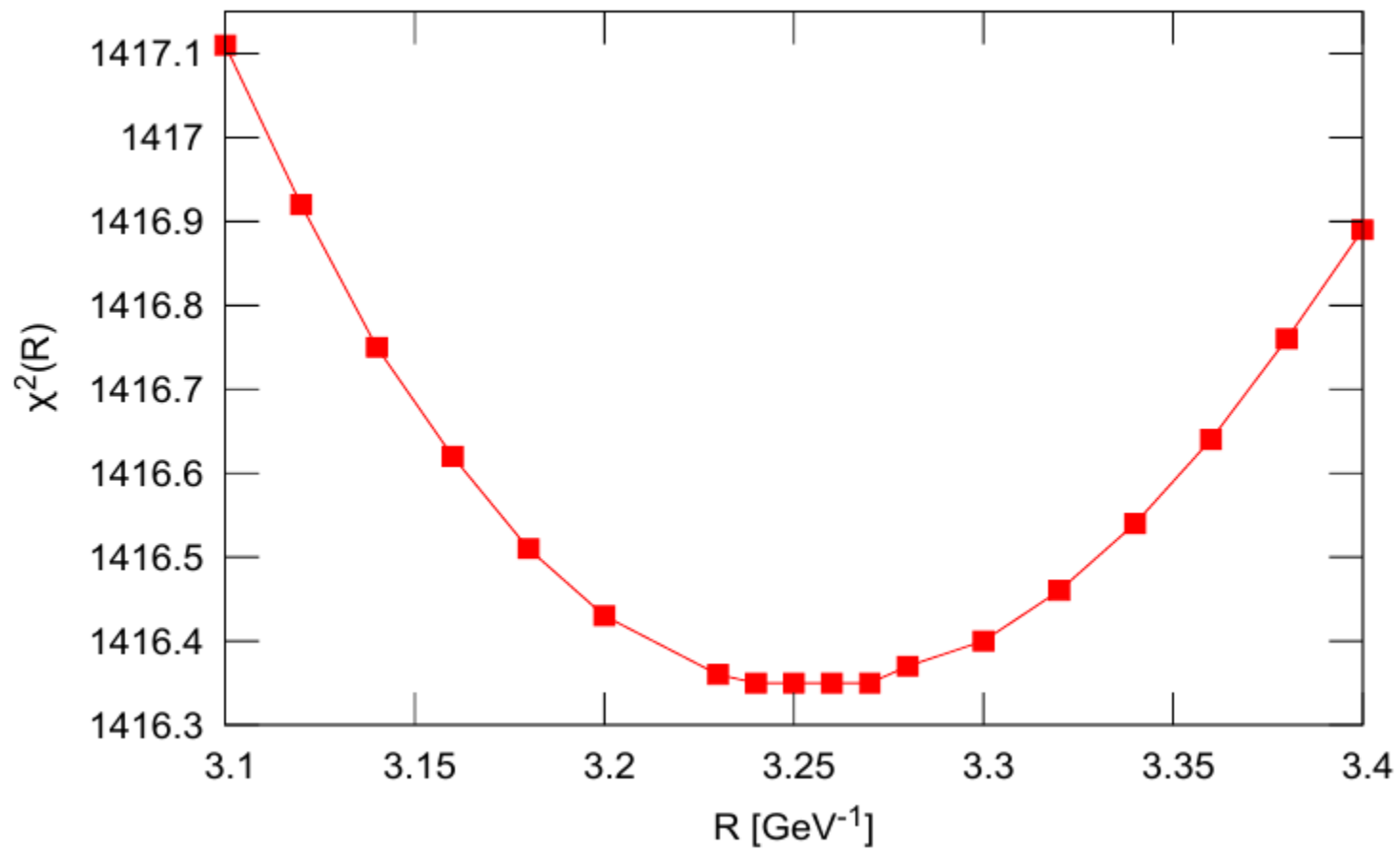


$$K = 1.2 \pm 0.1.$$



Conclusion:

- Including the LHC data on exclusive J/ψ and Υ production in the global parton analysis allows to strongly reduce the uncertainties in the obtained low- x parton distribution.
- Accounting for the absorptive corrections during the parton evolution results in the monotonically increasing (with x decreasing) input gluons, without the maximum at $x \sim 0.01$.
- $R_{hot\ spot} \sim \frac{1}{2}R_{proton}$



THANK YOU