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ENHANCEMENT OF CHARM QUARK PRODUCTION DUE TO NONLINEAR CORRECTIONS TO THE DGLAP EQUATIONS

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Previously:

- Parton distribution functions (PDFs) which include the first nonlinear corrections (so called GLRMQ terms) in the LO DGLAP evolution have been constructed

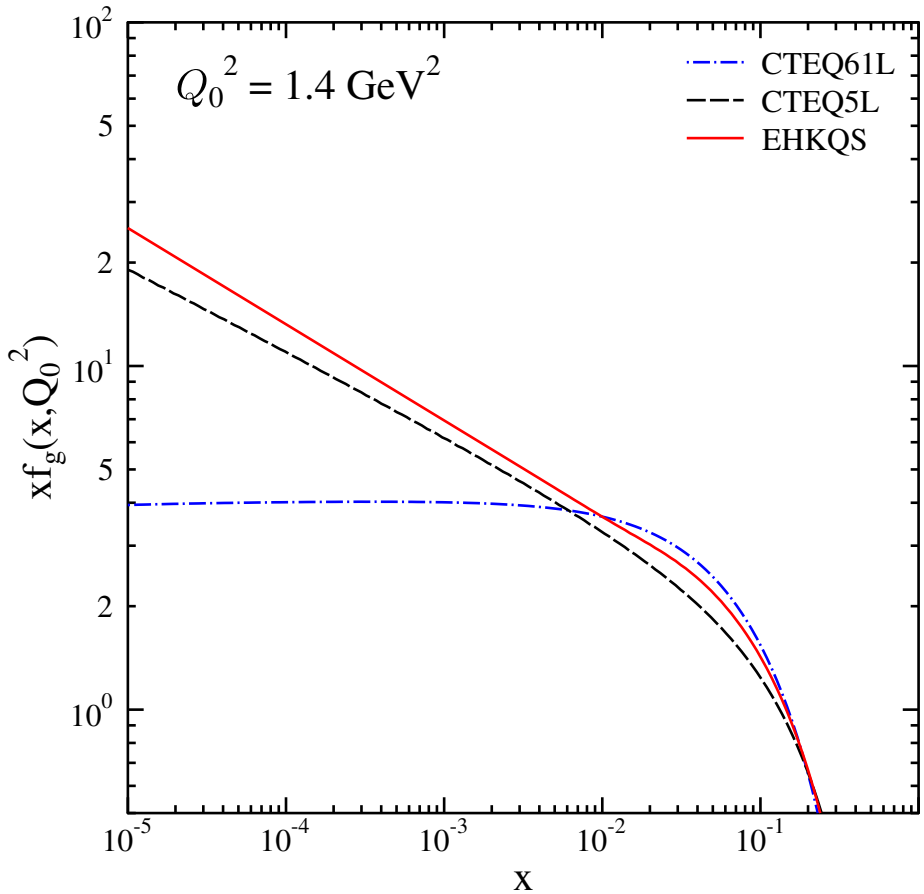
- Baselines used: CTEQ5L & 61L PDFs, HERA DIS data

- Result: EHKQS PDF set, with a good fit to the HERA data for $F_2^{\mathrm{p}}(x, Q^2)$ at $x > 3 \times 10^{-5}$, $Q^2 > 1.5$ GeV^2

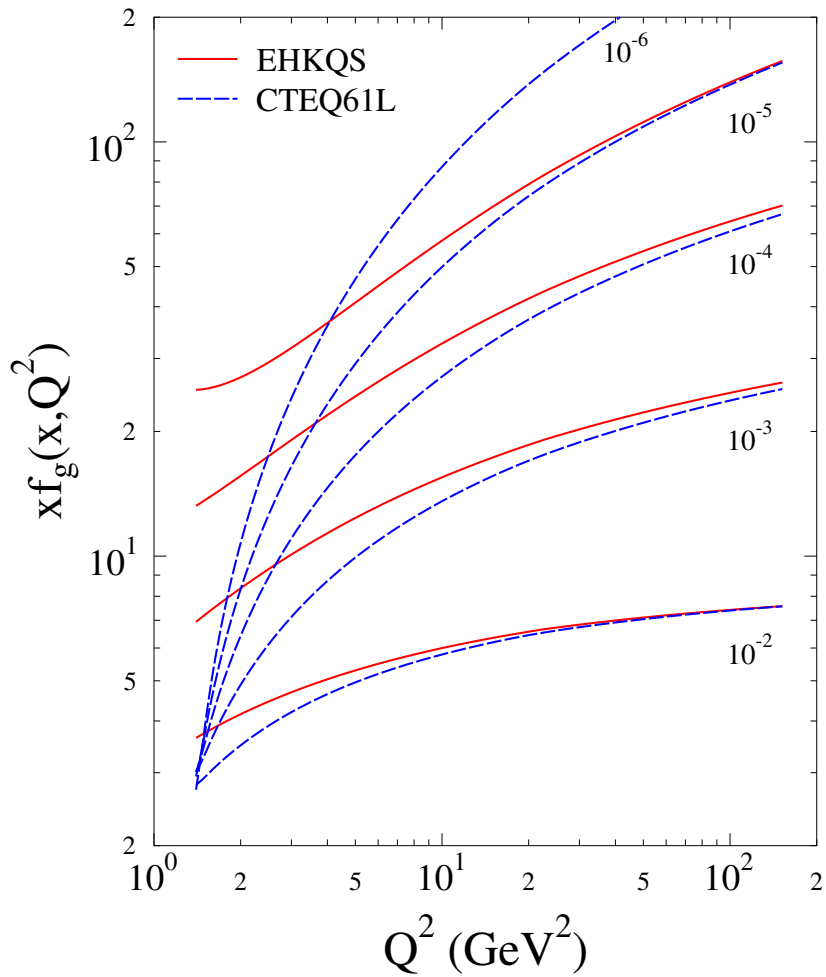
- Corrections slow down the evolution
  $\rightarrow$ enhances small-x gluons

$$\frac{\partial xg(x,Q^2)}{\partial \log Q^2} = \frac{\partial xg(x,Q^2)}{\partial \log Q^2}|_{\mathrm{DGLAP}} - \frac{9\pi}{2}\frac{\alpha_s^2}{Q^2}\int_x^1 \frac{dy}{y} y^2 G^{(2)}(y,Q^2)$$

Initial gluon distribution



Gluon evolution



How to detect possible nonlinearities?

Charm production

- Optimal process: m_c small, production dominated by gluons

- How does the enhancement of the gluon PDF manifest itself in charm procuction?

- We calculate

$$R(p_T, y, y_2) \equiv \frac{d^3\sigma(\text{EHKQS})/(dp_T dy dy_2)}{d^3\sigma(\text{CTEQ61L})/(dp_T dy dy_2)}$$

at fixed rapidities y, y_2, and $\sqrt{S}$ = 14, 8.8 and 5.5 TeV, and at various mass and scale choices, m_c=1.2, 1.3, 1.8 GeV, $Q^2 = m_T^2$, $4m_T^2$.

$y = y_2 = 0$

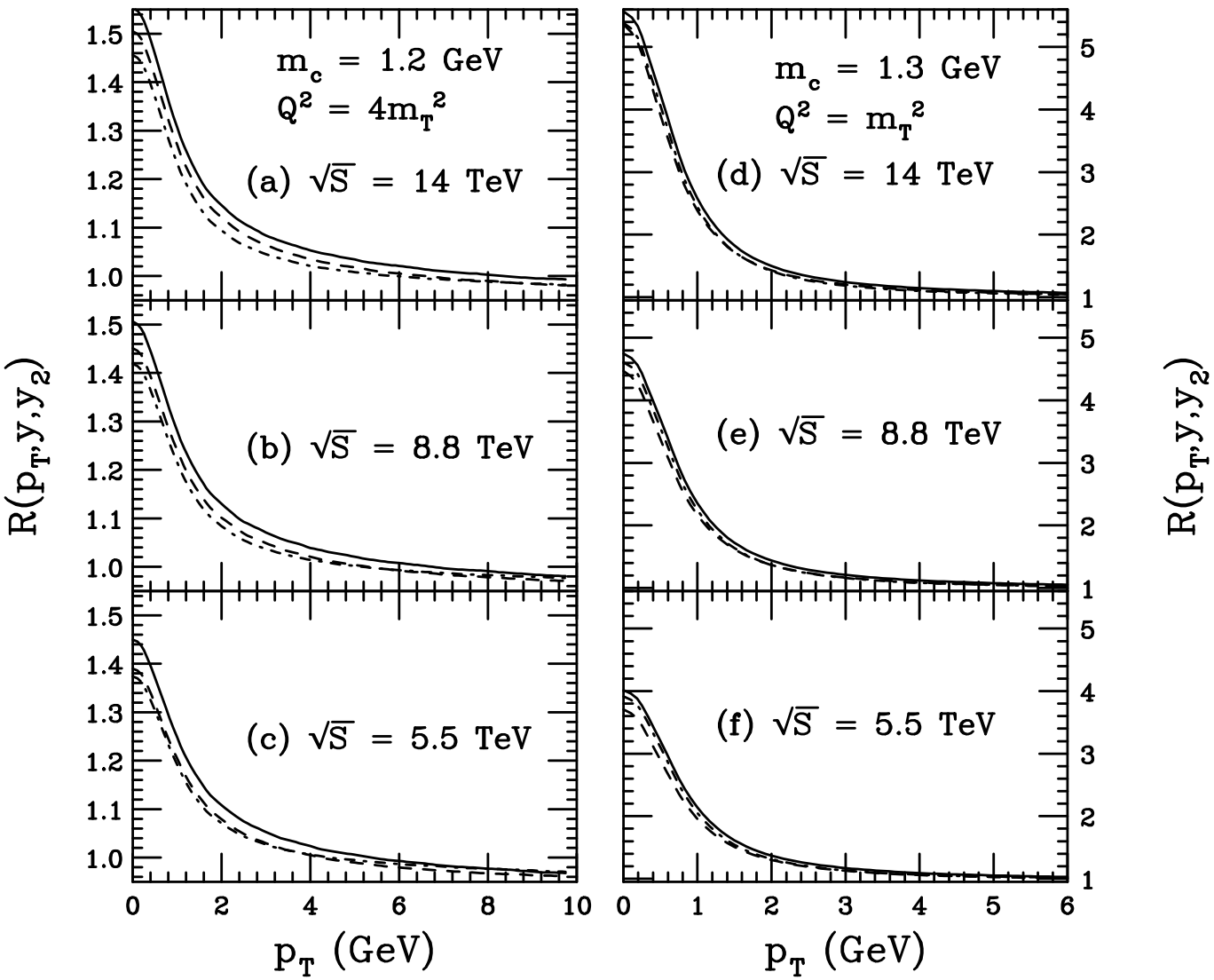
(solid)

$y = 2, y_2 = 0$

(dashed)

$y = y_2 = 2$

(dot-dashed)



$y = y_2 = 0$

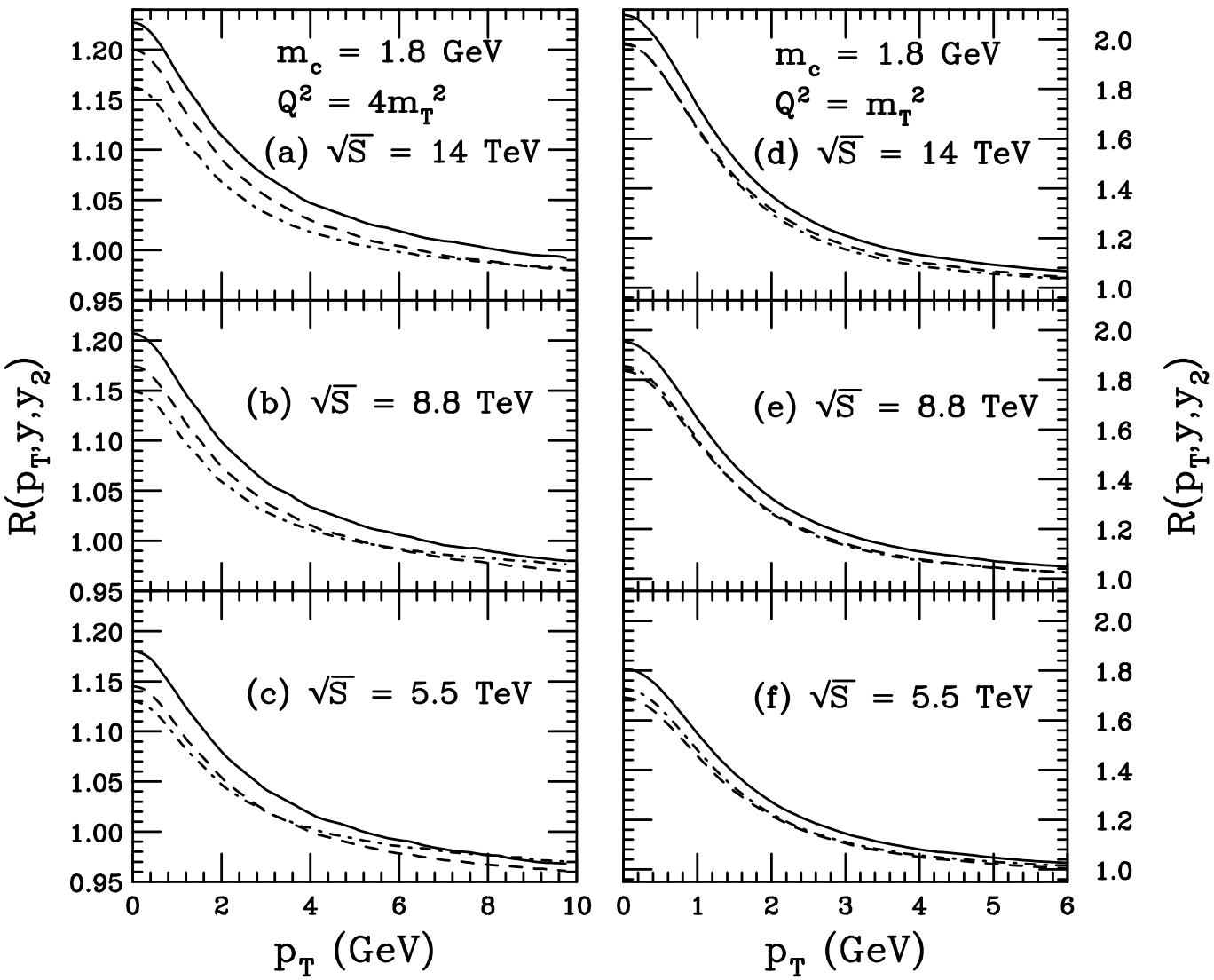
(solid)

$y = 2, y_2 = 0$

(dashed)

$y = y_2 = 2$

(dot-dashed)



Doubly integrated ratios

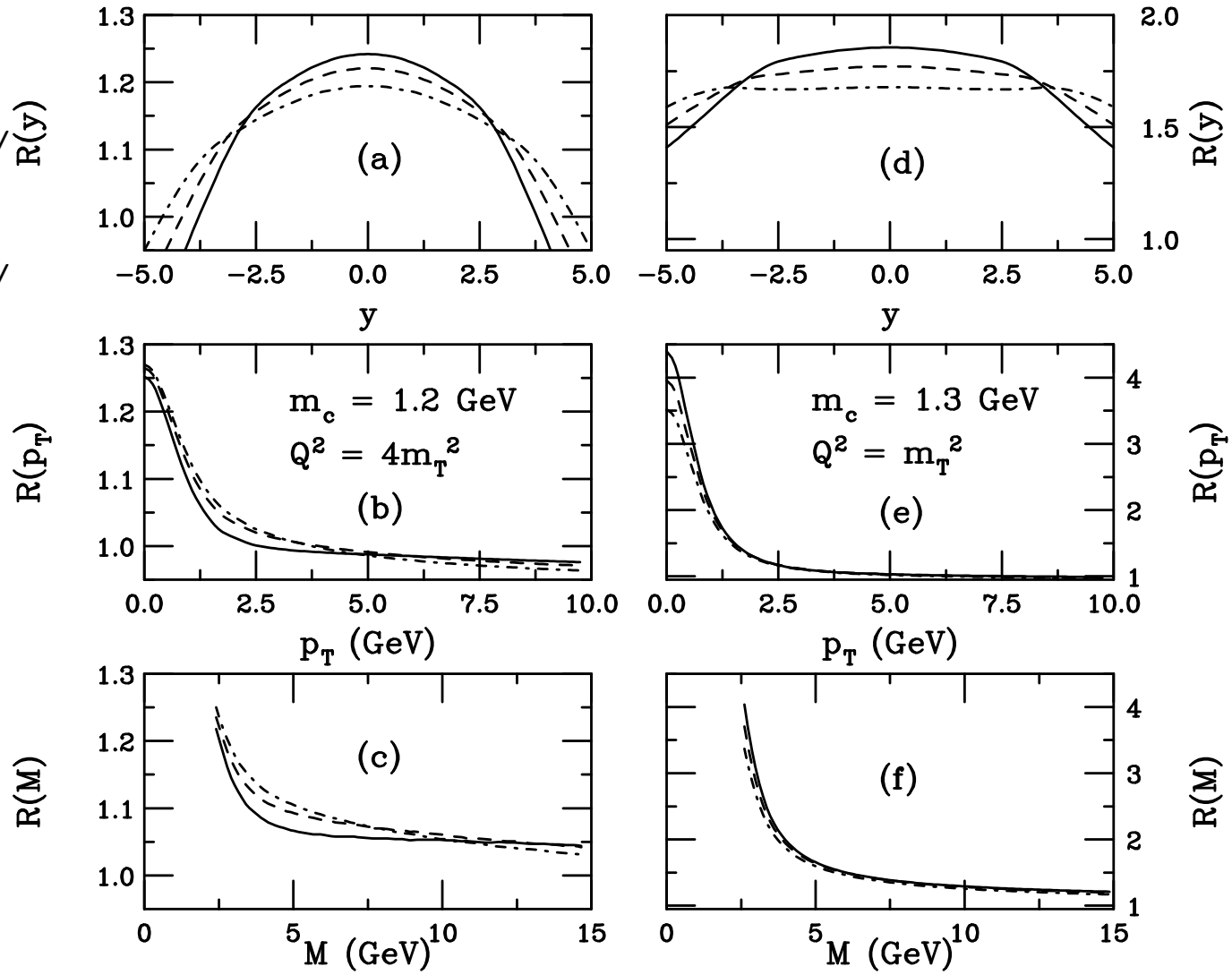
$\sqrt{S} = 14$ GeV (solid)

$\sqrt{S} = 8.8$ GeV (dashed)

$\sqrt{S} = 5.5$ GeV (dot-dashed)

PDFs unconstrained at $x < 10^{-5}$.

$|y| < 2.5$ safe



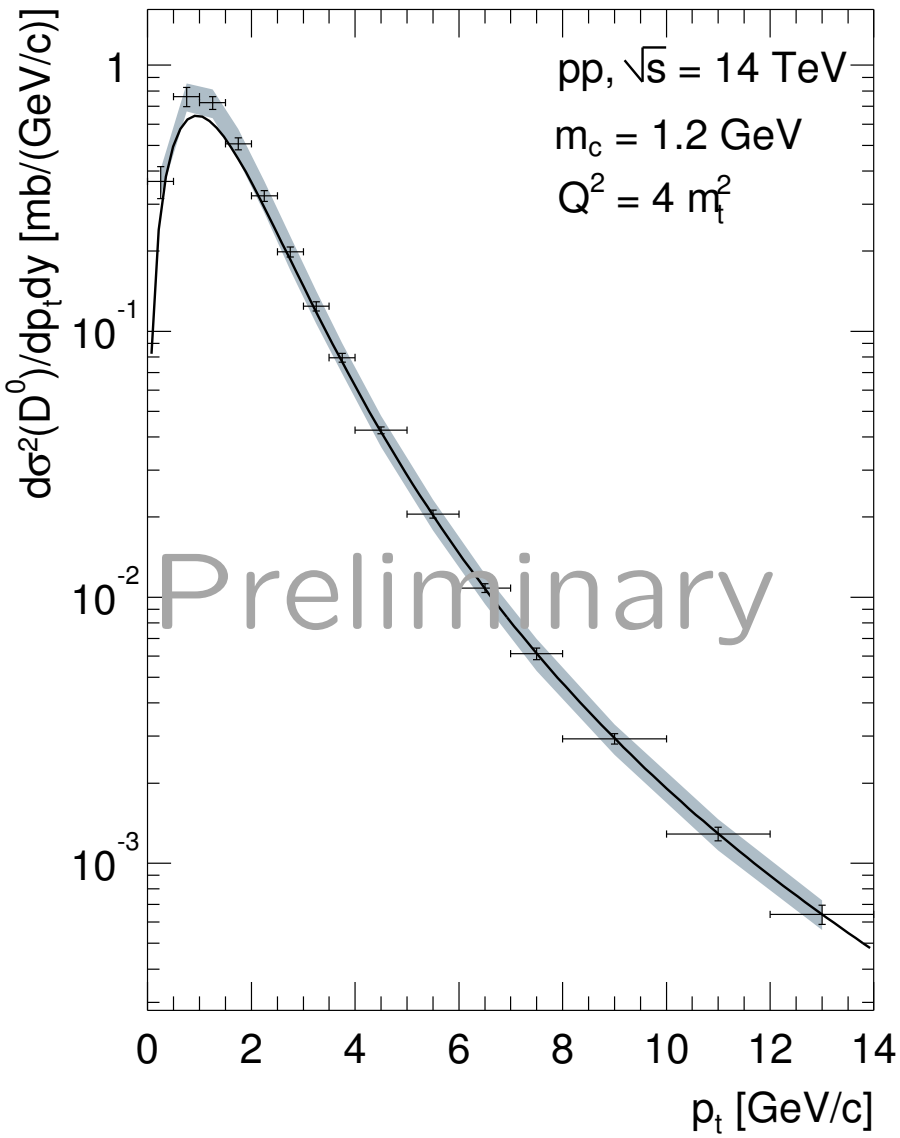
Conclusion: If a significant enhancement of charm production is observed at the LHC, it cannot be absorbed into DGLAP gluons, which are already well constrained by the HERA data
$\rightarrow$ signal of nonlinear effects in PDF evolution

To do: Full NLO analysis required

In progress: Observing the enhancement of charm production in ALICE through $D^0 \rightarrow \pi^+ K^-$

- Create "data" using nonlinear PDFs with experimental errors
- Fit DGLAP PDFs to see the effect of the enhancement

with

A. Dainese

M. Bondila