N^{3}LO effects in PDF evolution

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Evolution for N^{3}LO

- A fundamental ingredient to use N^{3}LO computations in extractions of PDFs is the **evolution** accurate to the same order.

- The main ingredients to achieve N^{3}LO accuracy in PDF evolution are:

  - the $O(\alpha_s^4)$ contribution to the anomalous dimensions, *i.e.* $\beta_3(n_f)$ and $P^{(3)}(x, n_f)$,

    - $\beta_3(n_f)$ was computed long ago [van Ritbergen, Vermaseren, Larin, hep-ph/9701390].

    - The **non-singlet** component of $P^{(3)}(x, n_f)$ exact in the planar limit has been achieved only recently [Moch *et al.*, arXiv:1707.08315]. **Singlet** still **unavailable**.

    - When a variable-flavour number scheme is used, **matching conditions** for the evolution of α_s and PDFs accurate to $O(\alpha_s^3)$ are also necessary.

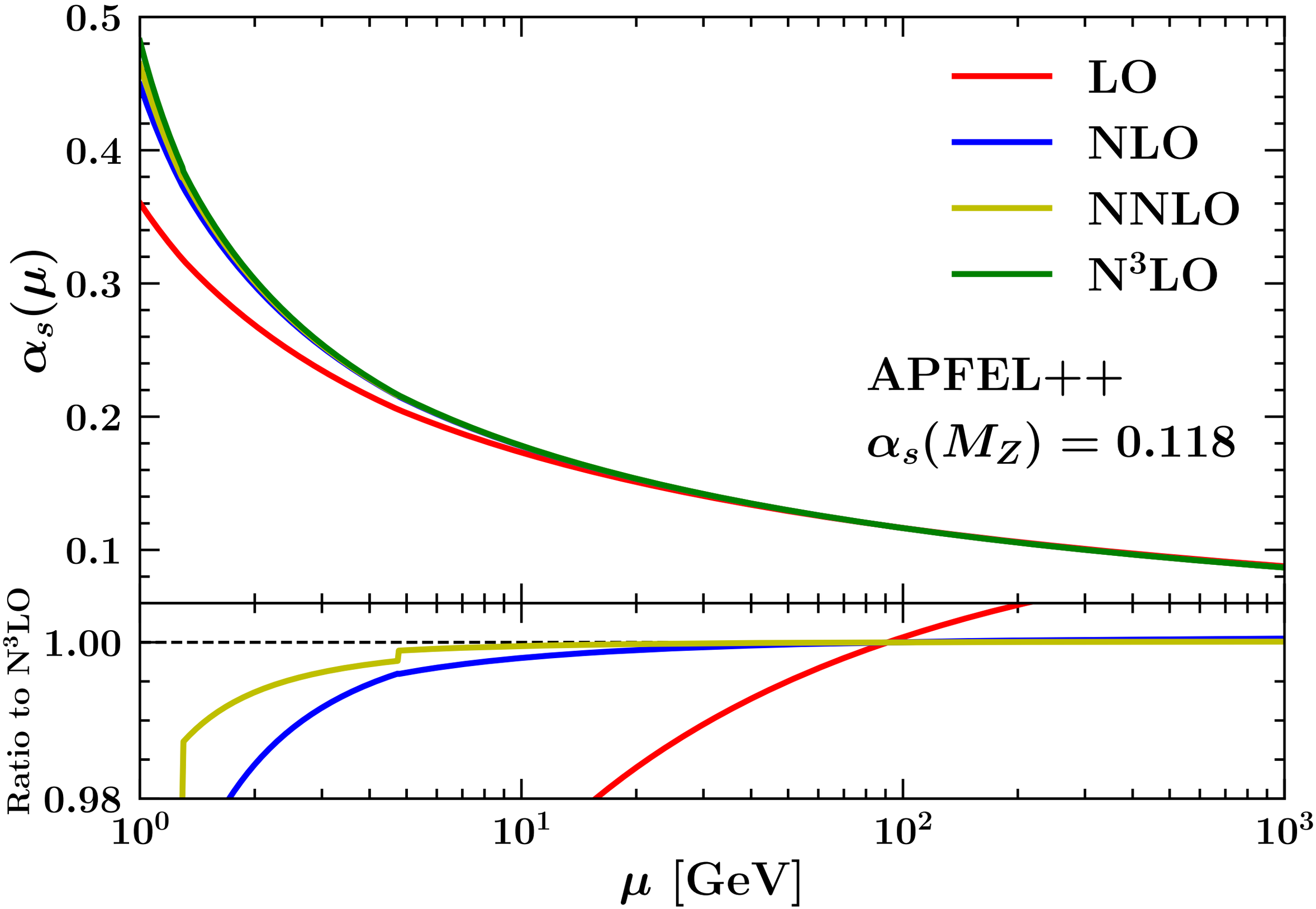
      - $O(\alpha_s^3)$ matching conditions for α_s are known (see *e.g.* [Chetyrkin *et al.*, hep-ph/0004189]).

      - Matching conditions for PDFs fully known only up to $O(\alpha_s^2)$ (in fact, matching conditions involving a heavy quark in the initial state are known to $O(\alpha_s)$).

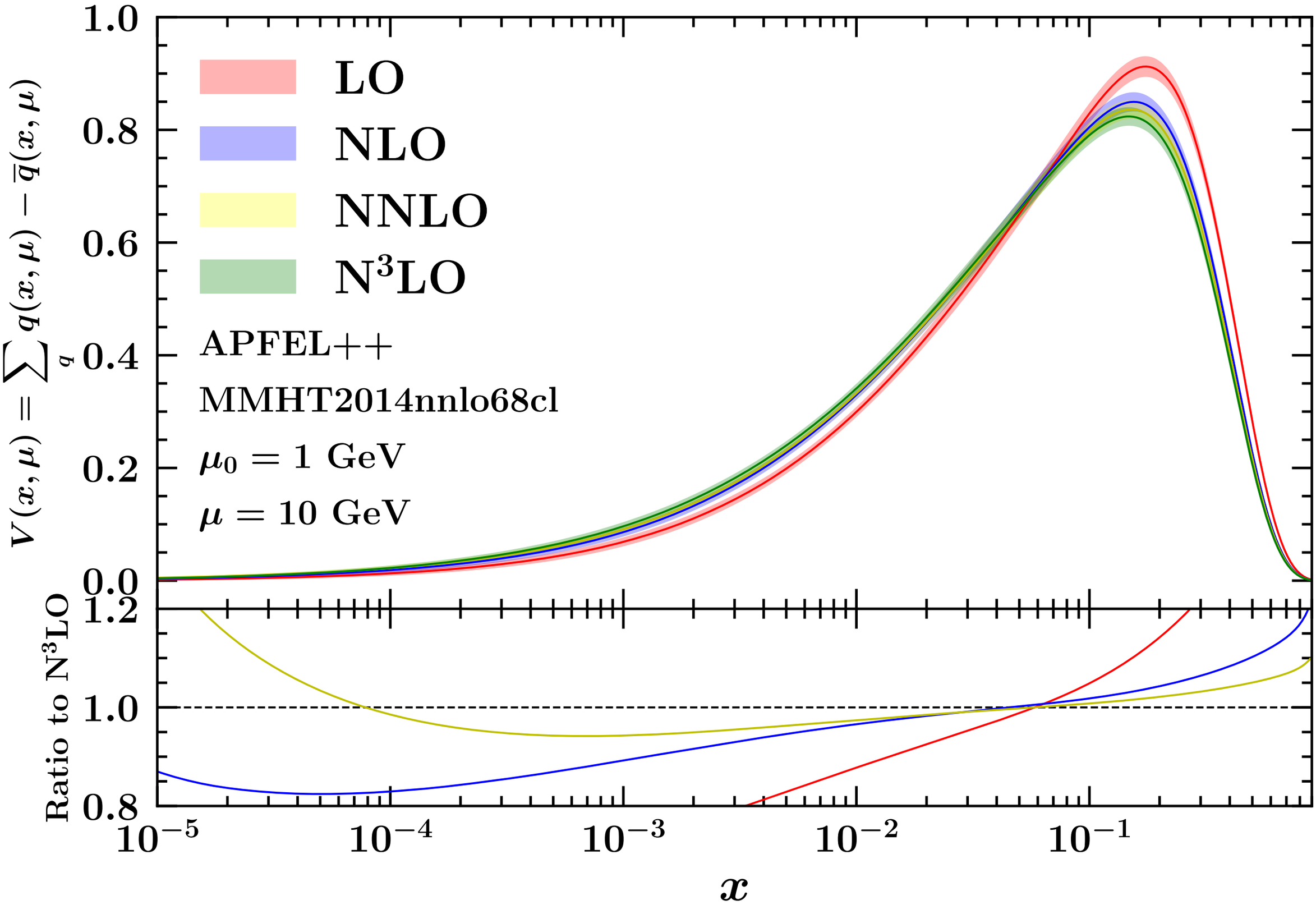
- All the *currently known* ingredients necessary for PDF evolution at N^{3}LO are implemented in **APFEL++.** [https://github.com/vbertone/apfelxx]

- One may attempt, at least at small-x, to use a fixed-order expansion as obtained from **HELL** [Bonvini, Marzani, arXiv/1805.06460] for the missing parts but… see Marco's talk.

The strong coupling



The (valence) PDFs



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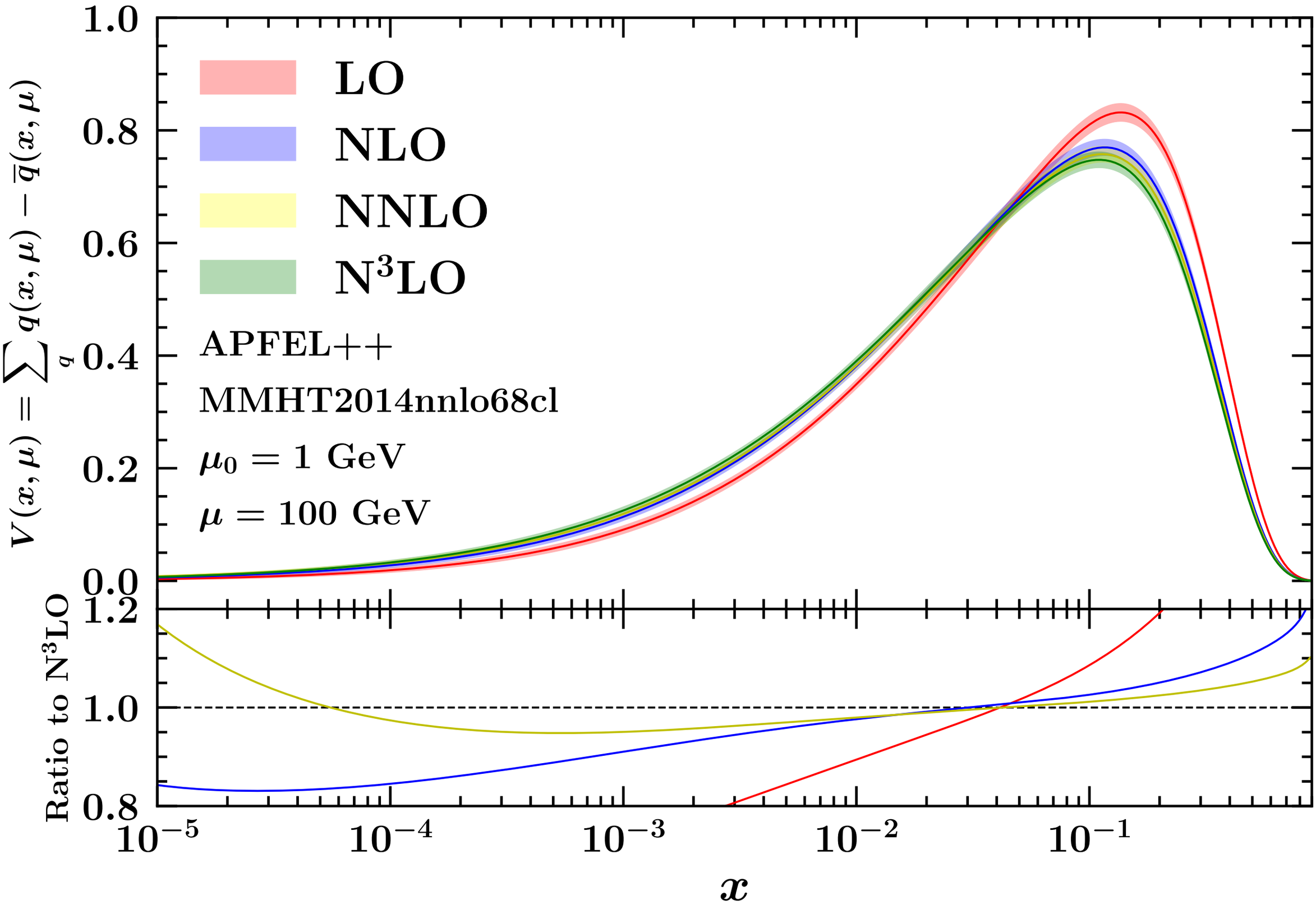

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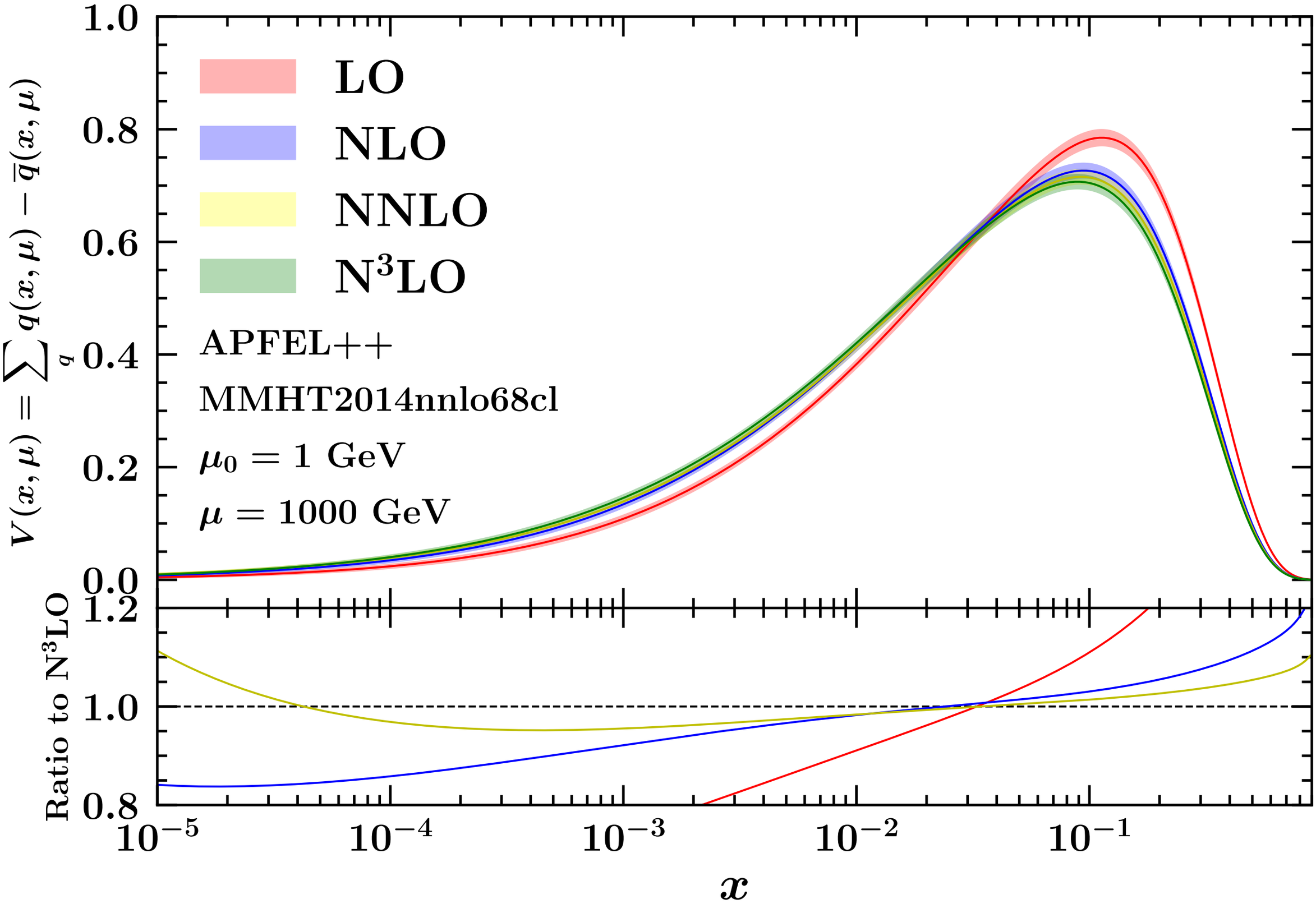
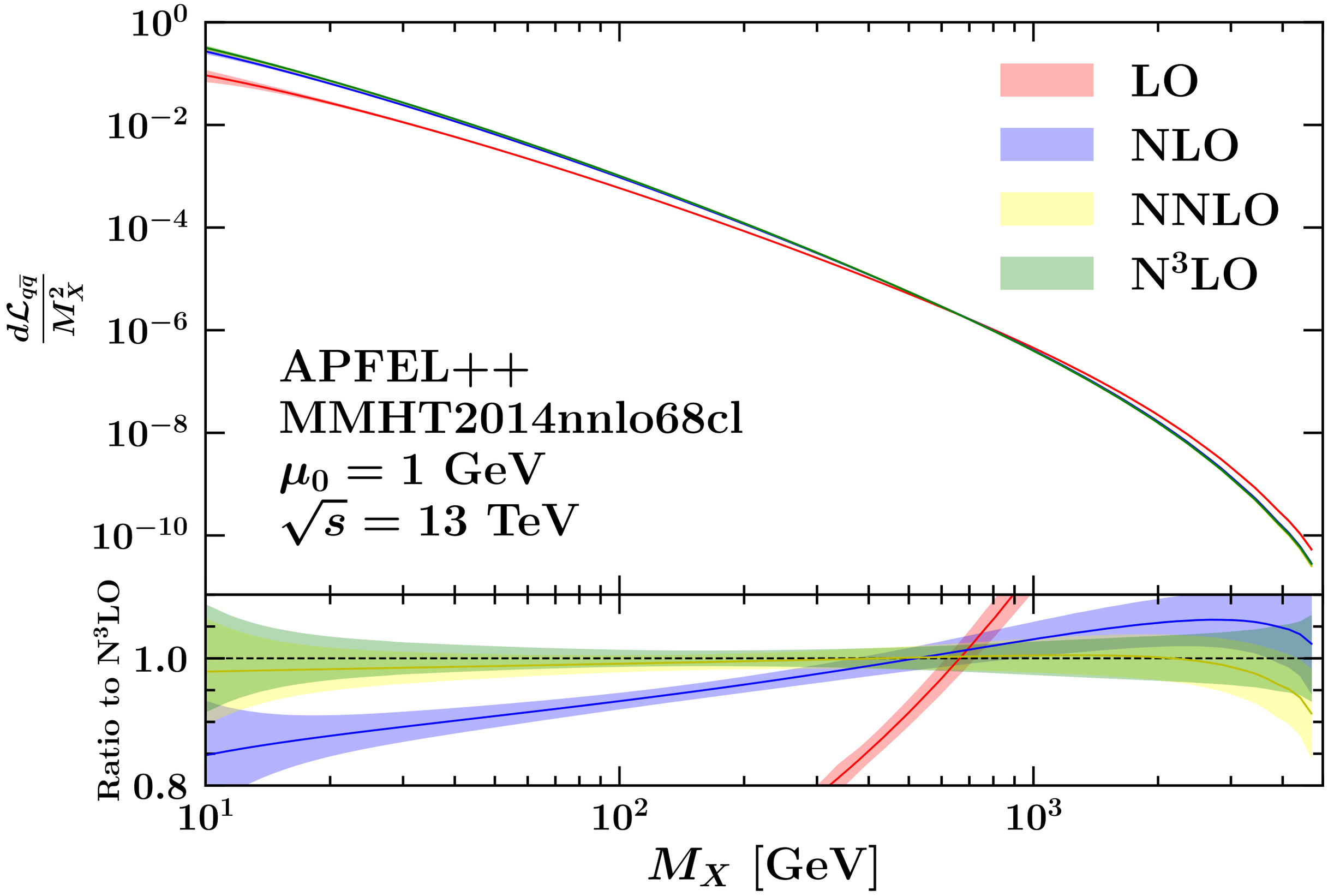
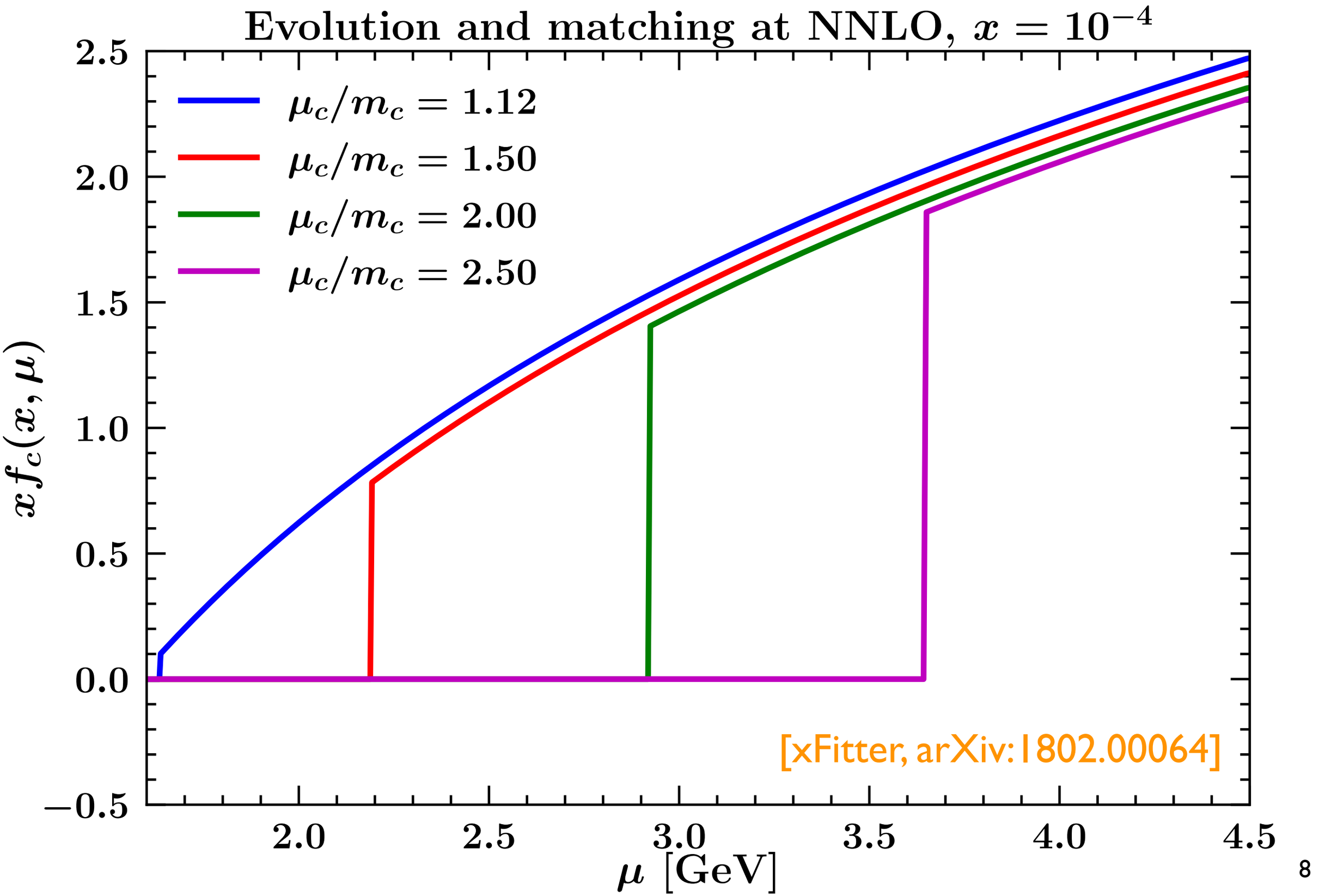
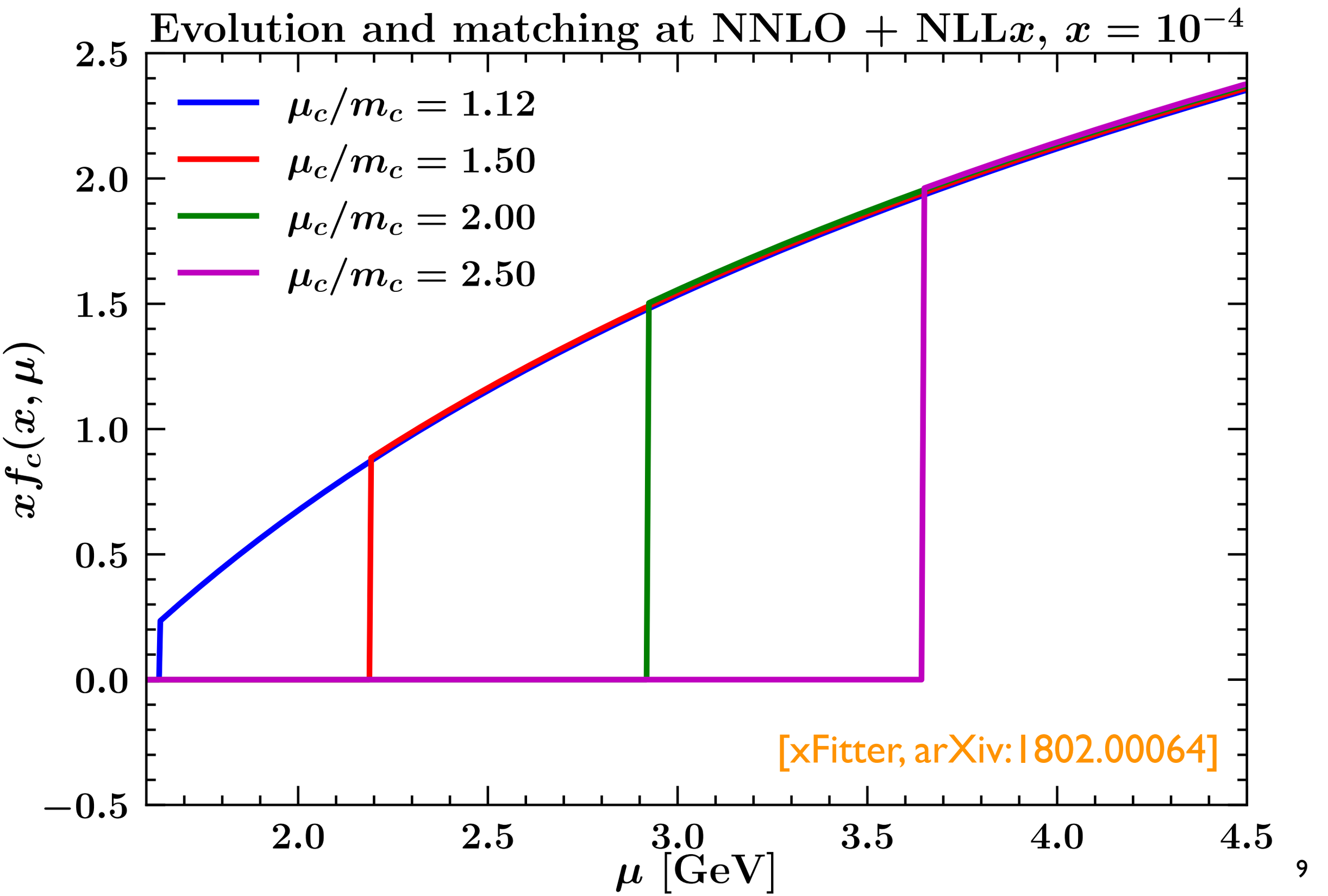


The parton luminosities



The matching conditions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