Resummation benchmark: NangaParbat updates

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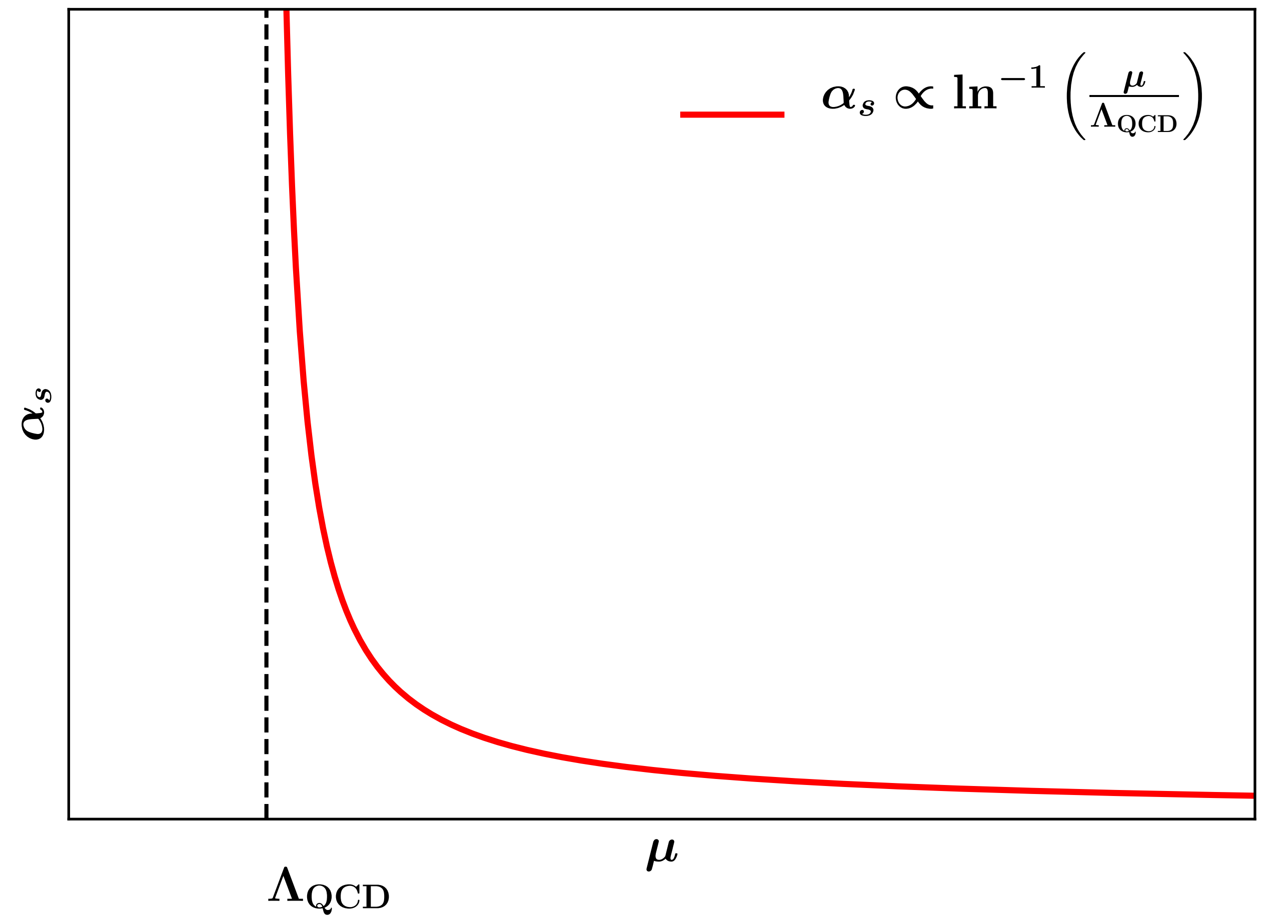
3DSPIN
MAPPING THE PROTON IN 3D

Landau pole regularisation

$$\sigma \propto \int_0^\infty db_T\, \alpha_s^p\left(\frac{1}{b_T}\right)\cdots \sim \int_0^Q dk_T\, \alpha_s^p\,(k_T)\ldots$$



- Integrating over the full phase space would give a **divergent** result.
- **Prescriptions** to avoid integrating over the **Landau pole**:
  - b^* (global or local) or k_T^* prescription, sharp cutoff, minimal prescription, etc.,
  - introduction of (non-perturbative) **power corrections** of order $(\Lambda_{QCD}/q_T)^n$,
  - difference between different prescriptions (should be) significant only at **low q_T**.

Landau pole regularisation

- In b_T space the ***unregularised*** (diverging) cross section looks like this:

$$\frac{d\sigma}{dq_T} = \int_0^\infty db_T\, b_T J_0(b_T q_T) \left[\sum_{n=0}^{\infty} \alpha_s^n \left(\frac{1}{b_T}\right) \sum_{k=0}^{2n} \ln^k(Q^2 b_T^2) \frac{d\bar{\sigma}^{[n,k]}}{dq_T}\right] \otimes \mathcal{L}\left(\frac{1}{b_T}\right)$$

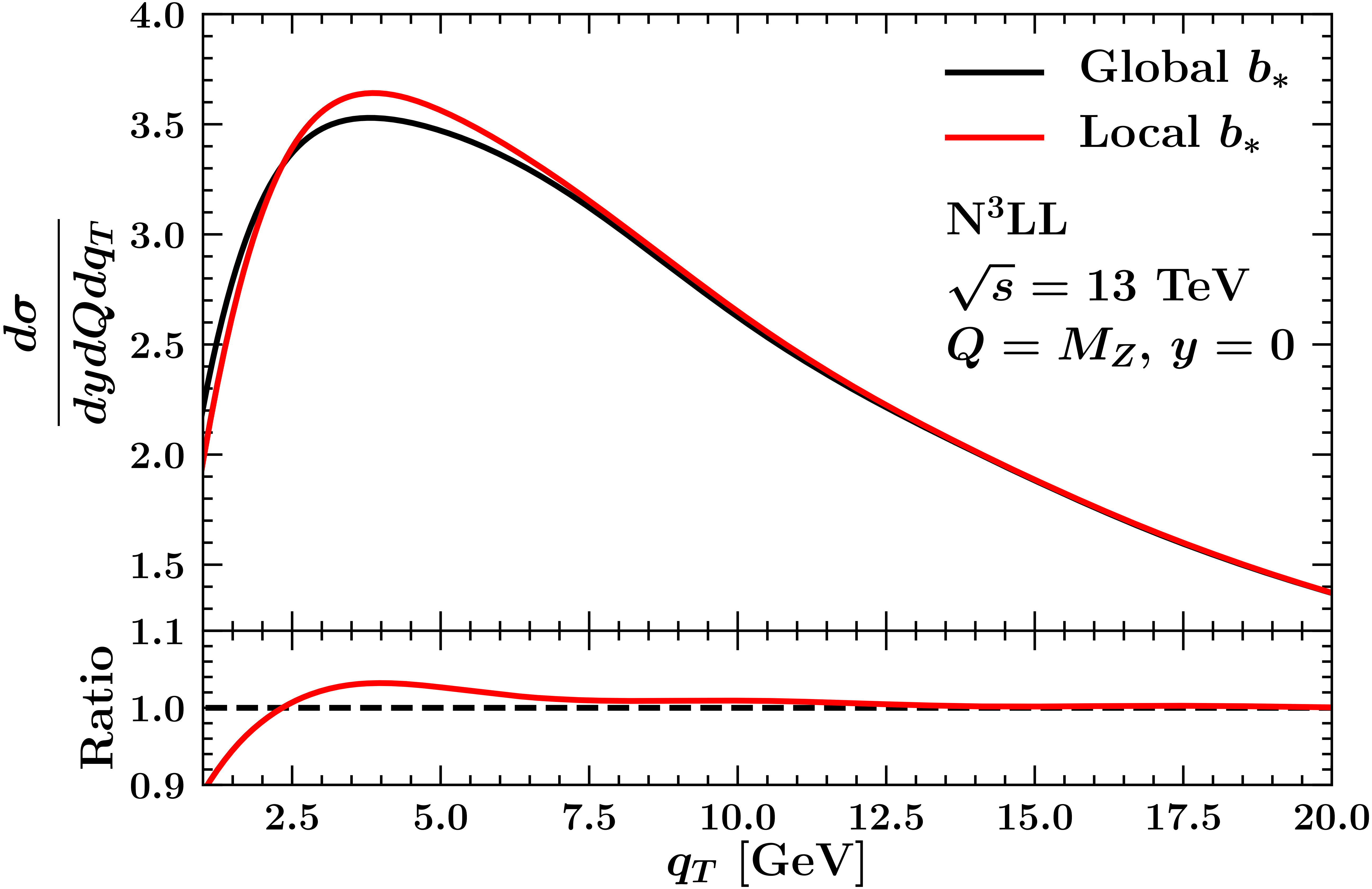
- The **global** b* prescription is:

$$\frac{d\sigma}{dq_T} = \int_0^\infty db_T\, b_T J_0(b_T q_T) \left[\sum_{n=0}^{\infty} \alpha_s^n \left(\frac{1}{b_*(b_T)}\right) \sum_{k=0}^{2n} \underline{\ln^k(Q^2 b_*^2(b_T))} \frac{d\bar{\sigma}^{[n,k]}}{dq_T}\right] \otimes \mathcal{L}\left(\frac{1}{b_*(b_T)}\right)$$

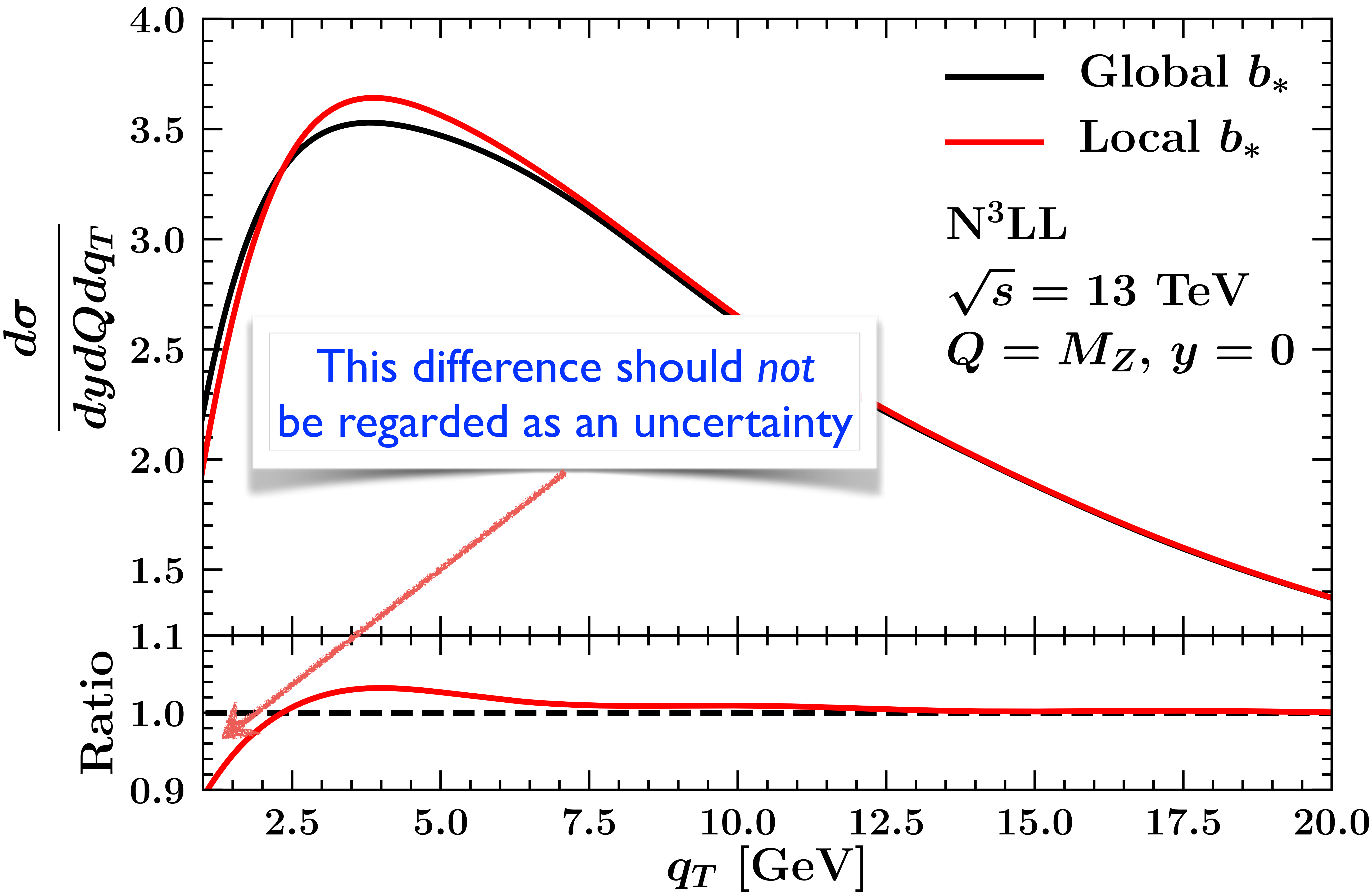
- The **local** b* prescription is:

$$\frac{d\sigma}{dq_T} = \int_0^\infty db_T\, b_T J_0(b_T q_T) \left[\sum_{n=0}^{\infty} \alpha_s^n \left(\frac{1}{b_*(b_T)}\right) \sum_{k=0}^{2n} \underline{\ln^k(Q^2 b_T^2)} \frac{d\bar{\sigma}^{[n,k]}}{dq_T}\right] \otimes \mathcal{L}\left(\frac{1}{b_*(b_T)}\right)$$

Landau pole regularisation



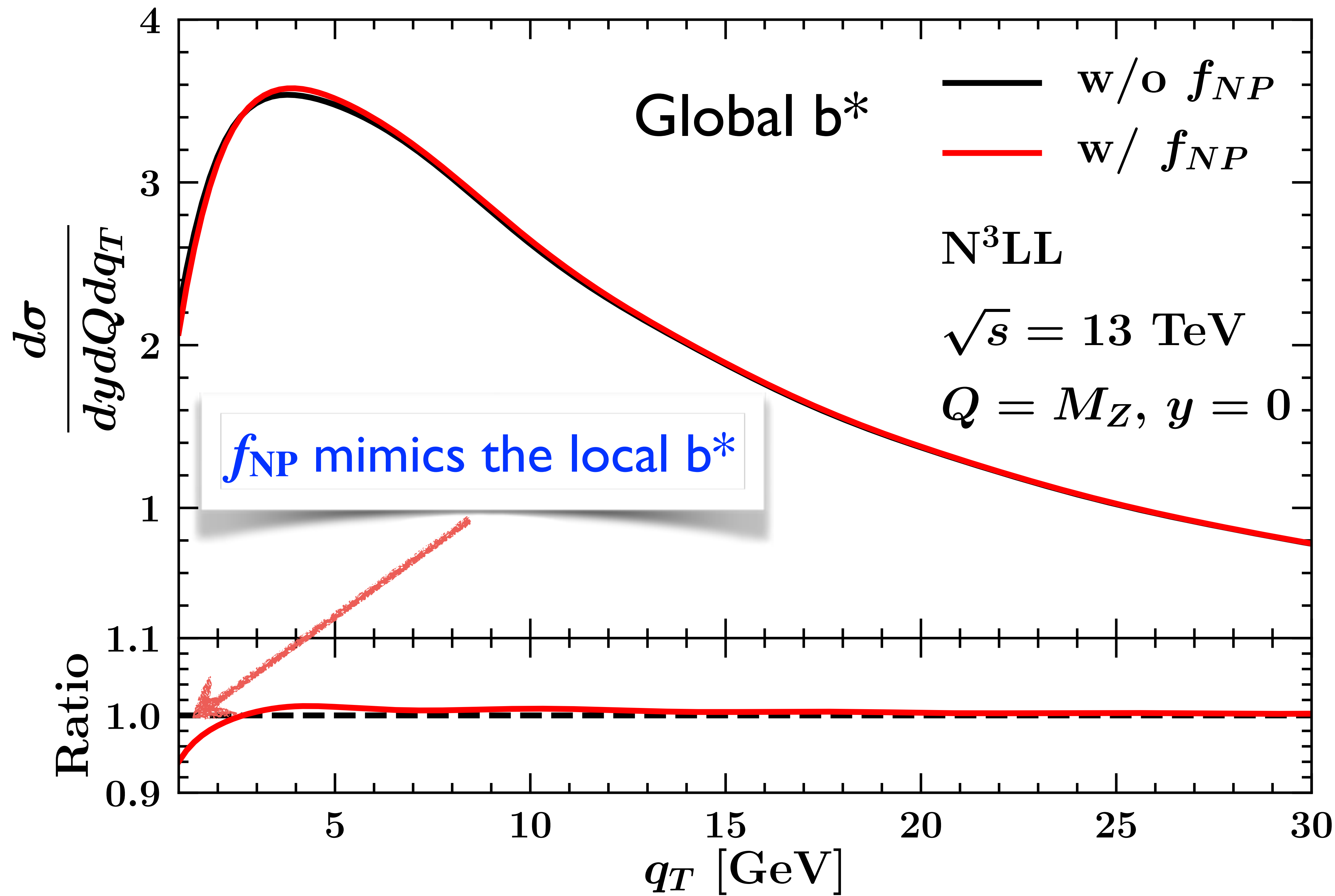
Landau pole regularisation



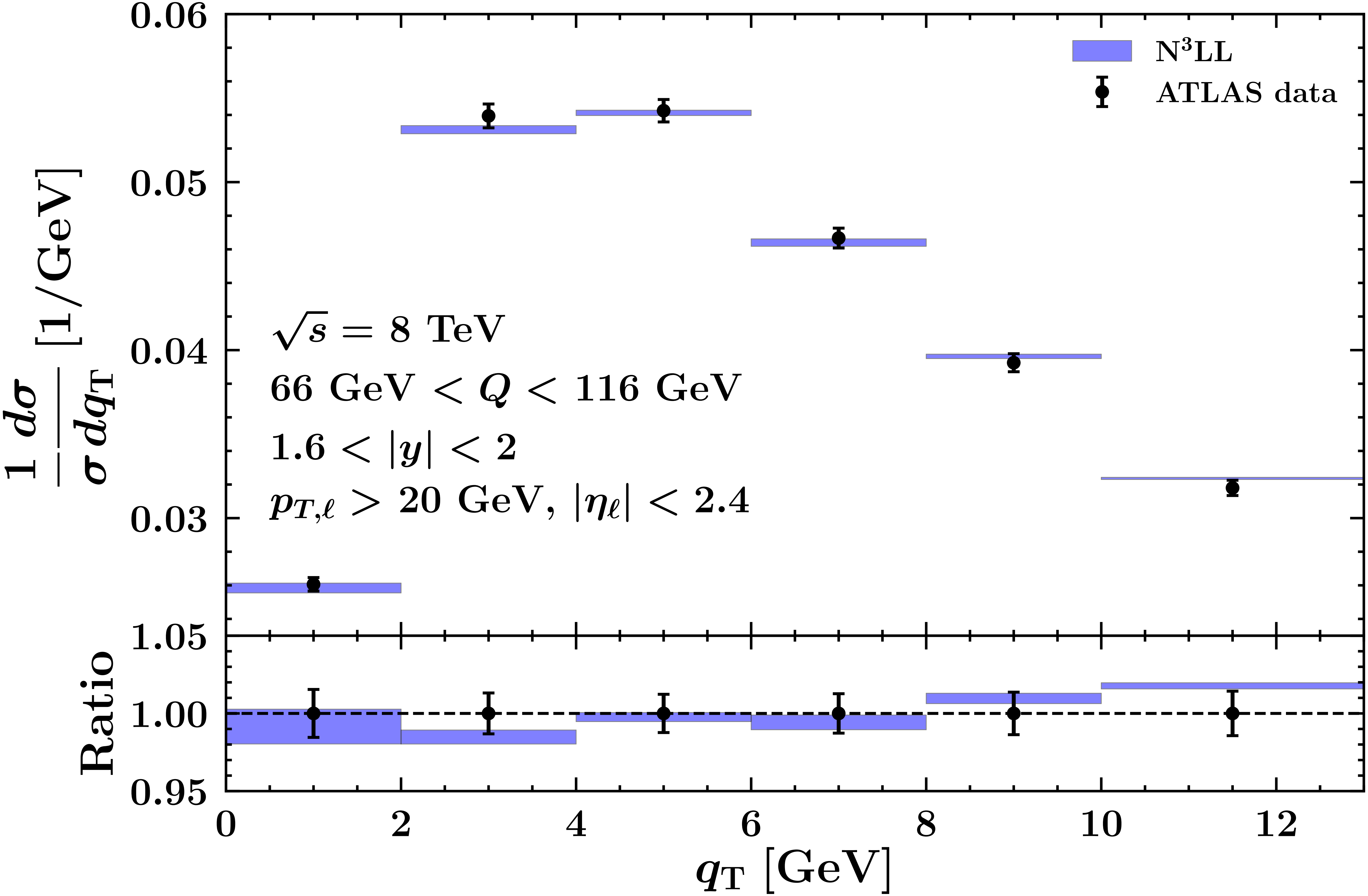
Intrinsic k_T

- Any particular regularisation the Landau pole **naturally** entails the presence of ***its own*** **intrinsic non-perturbative component**:

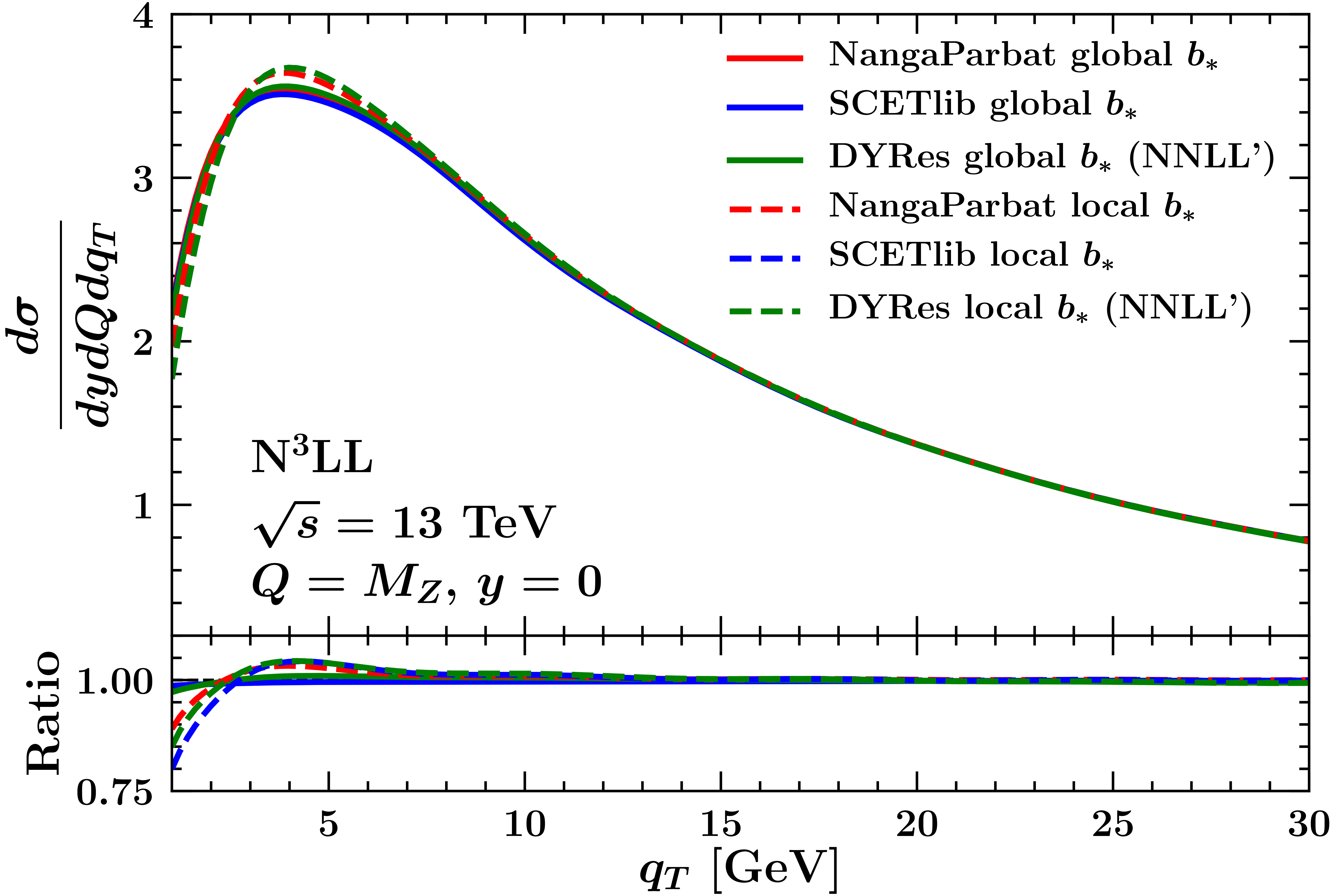
$$\sigma = f_{\rm NP} \otimes \hat{\sigma}_{\rm reg.}$$



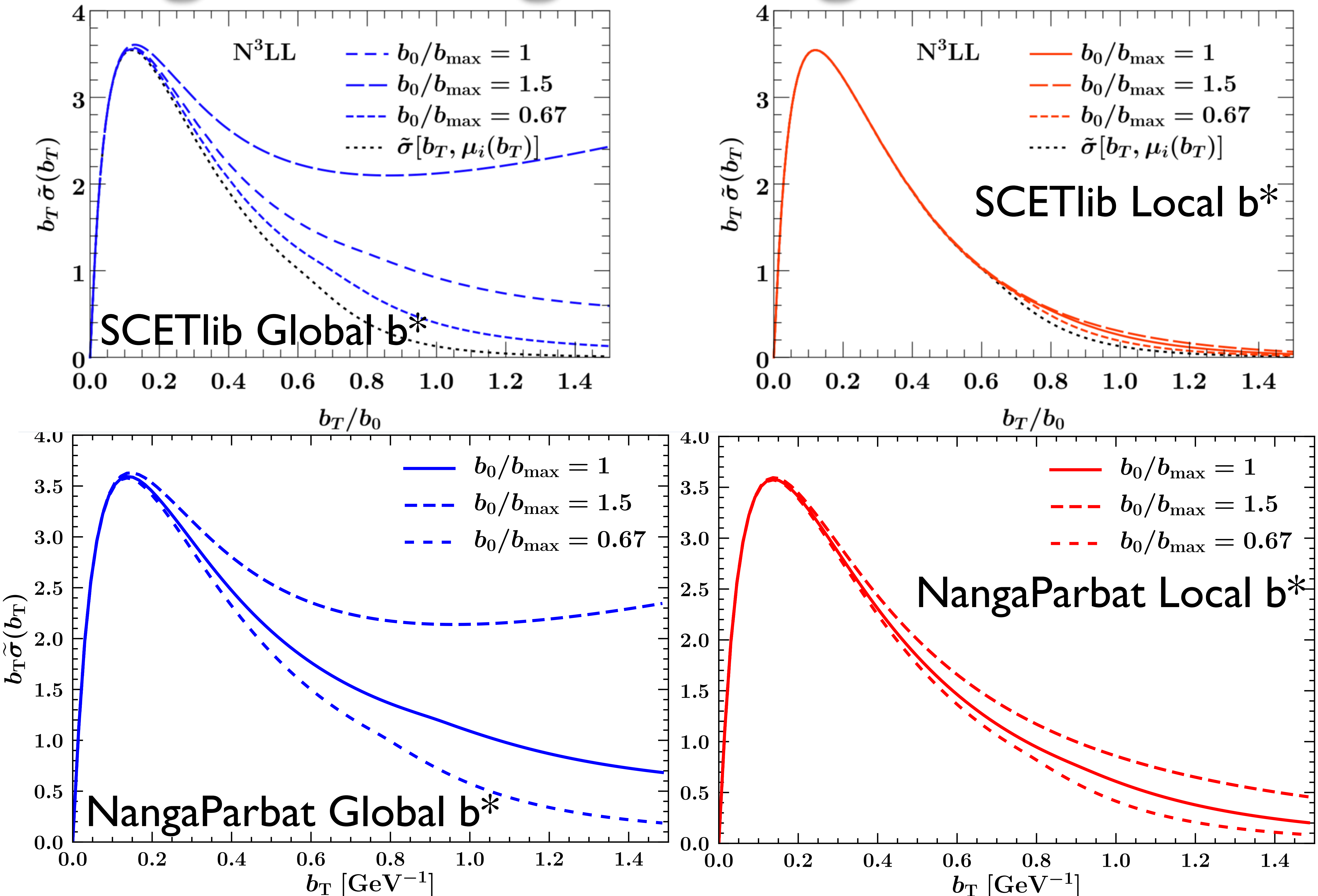
Intrinsic k_T



Regularising strategies



Regularising strategies



Benchmark settings: next steps

- **Step-2** benchmarking:
  - inclusion of **modified logs**,
  - different codes use their **"nominal" settings**:
    - for example: favorite Landau pole regularisation
- **Systematic uncertainties** become relevant for this step:
  - perturbative uncertainties (μ_R/μ_F and resummation scales),
  - profile/matching scales, modified logarithms, etc.
  - …
- Aiming at completing Step-2 within the next 2-3 months.
  - optimistic but involved groups are all working actively.
- **Step-3** benchmarking:
  - full **quantitative** understanding of the resummation formalisms,
  - **matching** to fixed-order.
- **Documenting** the three steps:
  - material for the next **yellow report**.