reSolve Update – 31/01/2020

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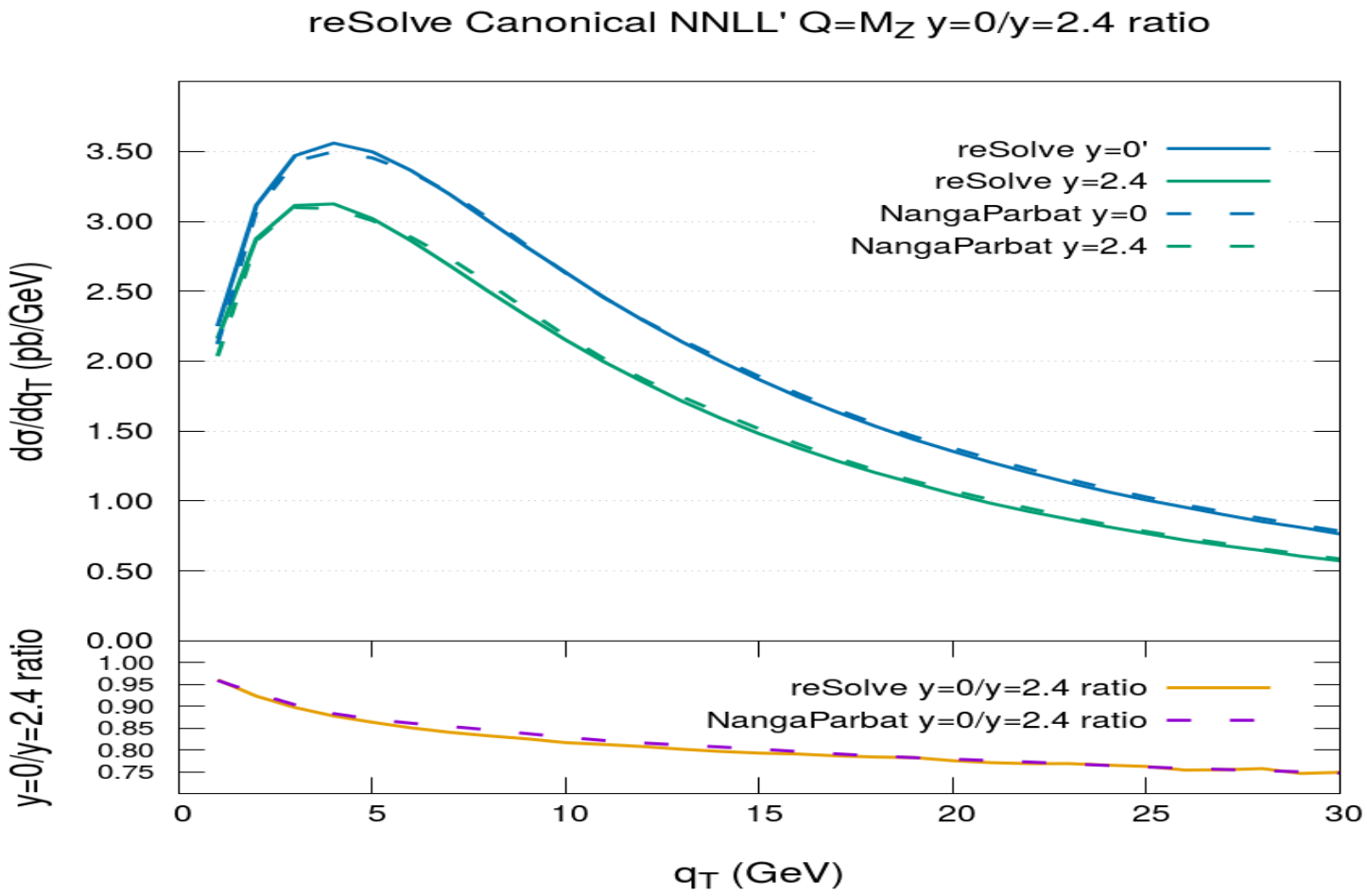
Update on reSolve results

- reSolve results available for level 1 canonical logs resummation at Q=mZ inclusive y, y=0, y=2.4 at LL, NLL', NNLL' in qT and logqT (as before).
- reSolve results available for level 2 nominal logs resummation at Q=mZ inclusive y, y=0, y=2.4 at LL, NLL', NNLL' in qT and logqT (as before).
- reSolve results for Q=1TeV y=0 at LL, NLL', NNLL' now available, canonical and nominal.
- reSolve result investigating effect of changing b_{lim} now available (canonical NNLL', Q=mZ, y=0).
- reSolve results for changing the resummation scale now available for canonical vs nominal comparison (Q=mZ and Q=1TeV, y=0 at LL, NLL', NNLL').
- Some comparison plots within reSolve and with different codes in the following slides for these results, largely **preliminary**….

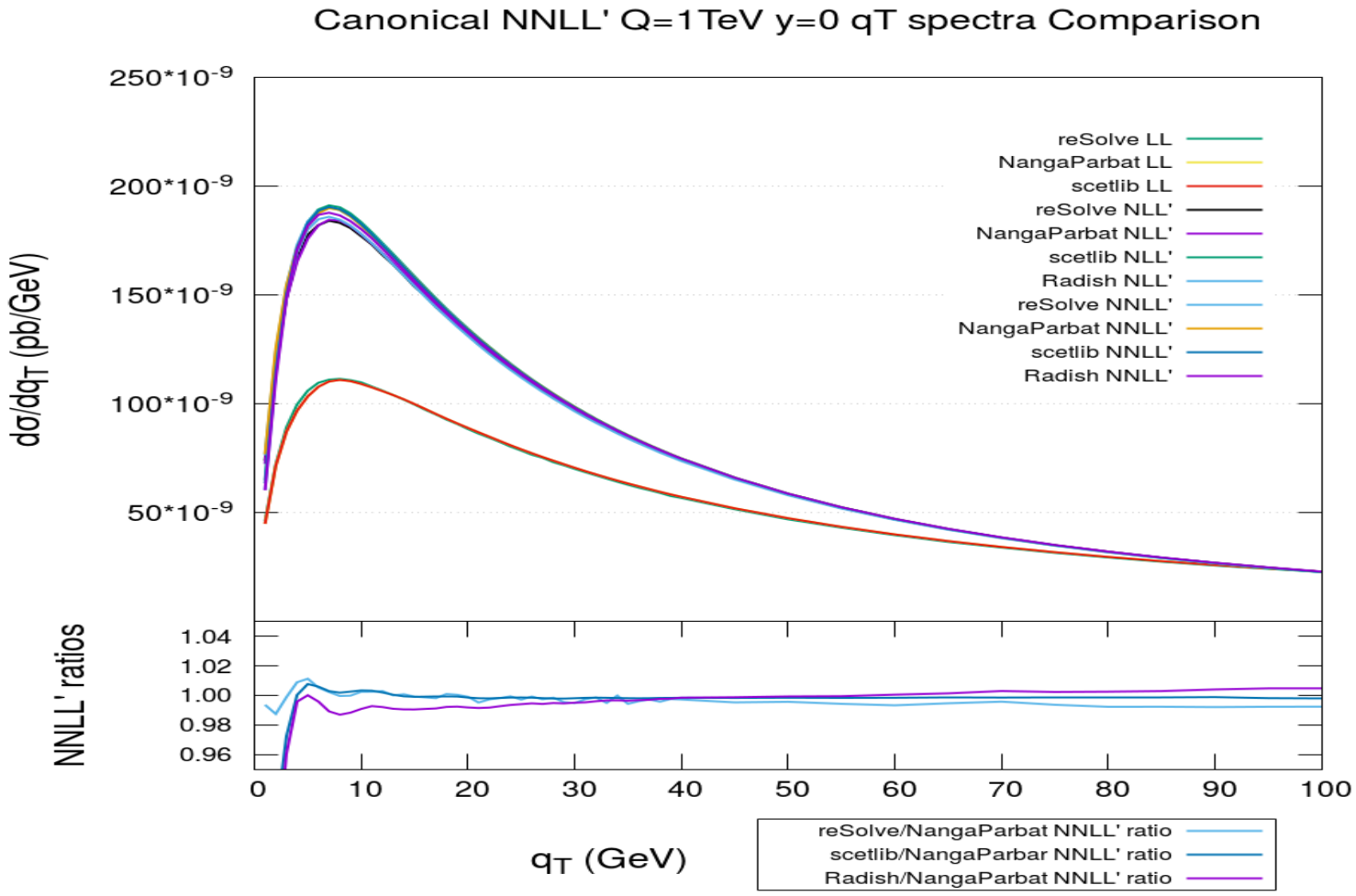
reSolve kinematic evolution: y=2.4/y=0 at Q=mZ

- Investigate resummation effects in different kinematic regions via ratios of different y at Q=mZ results:



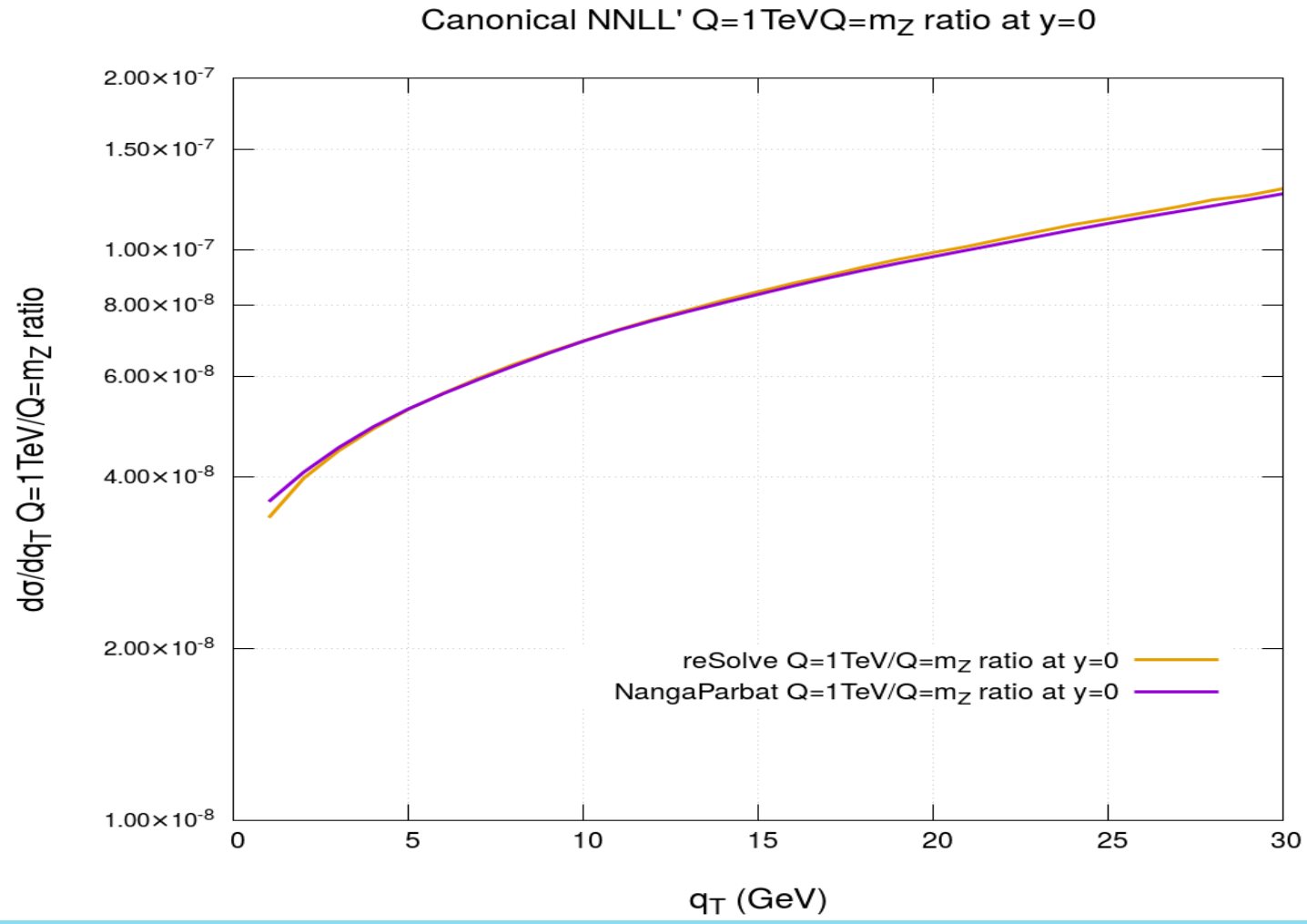
reSolve Q=1TeV, y=0 results

- First Q=1TeV results at y=0 - LL, NLL' and NNLL' as usual:



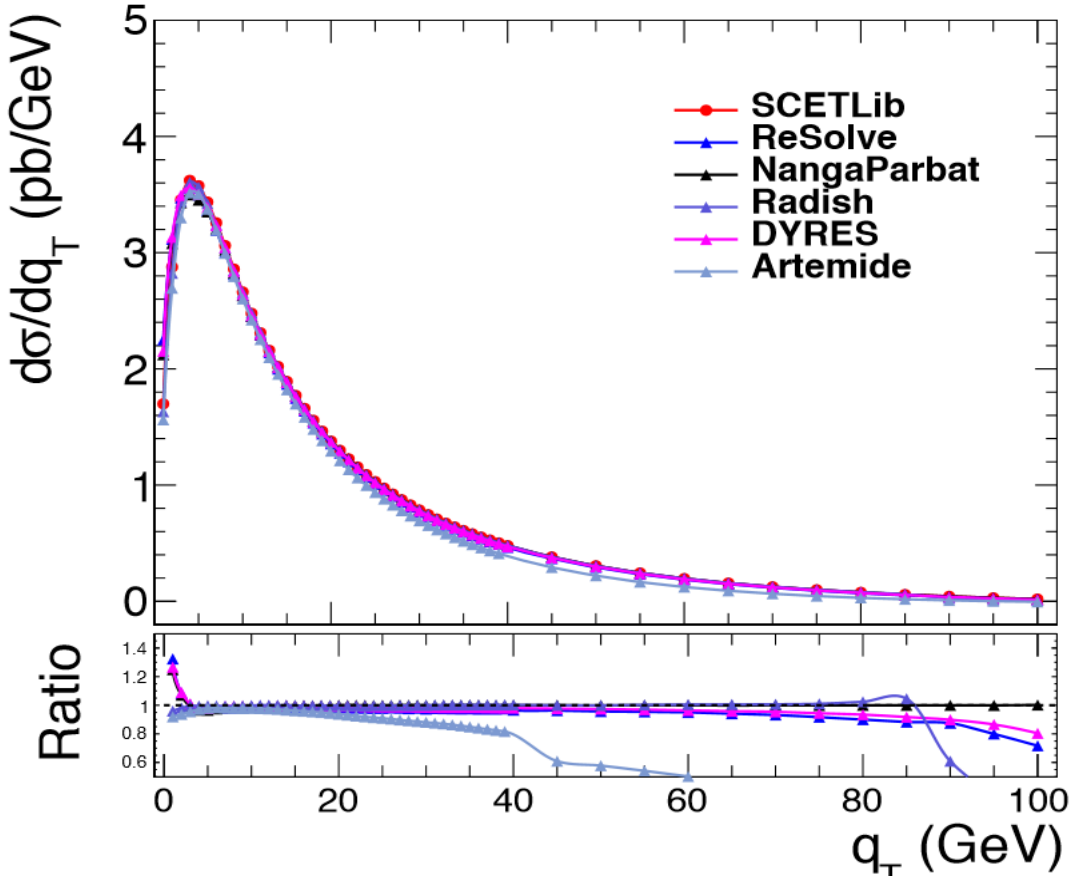
reSolve kinematic evolution: Q=1TeV/Q=mZ at y=0

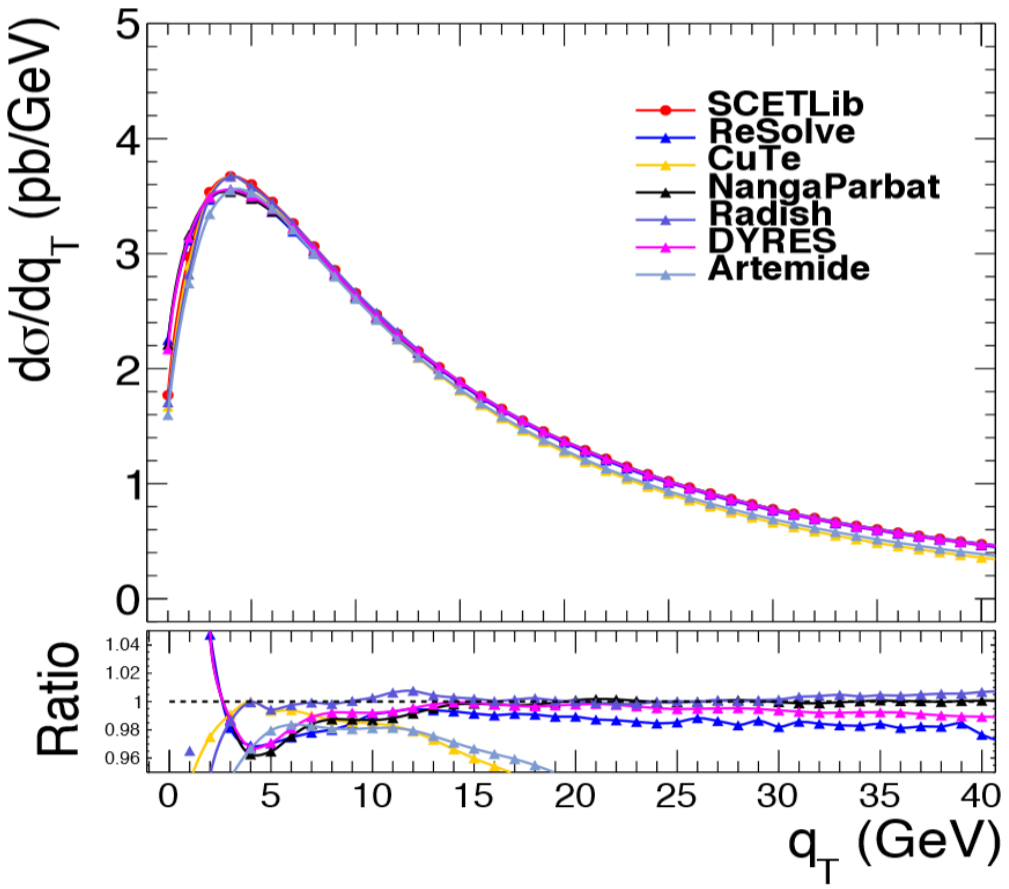
- Investigate resummation effects in different kinematic regions via ratios of different Q at y=0 results:



Small q_T differences reminder

- Difference seen at low q_T between codes shown to be due to different approaches to this.
- reSolve, DYRes, NangaParbat higher in very low q_T bins than Scetlib, Radish.





b_* prescription and b_{lim} setting

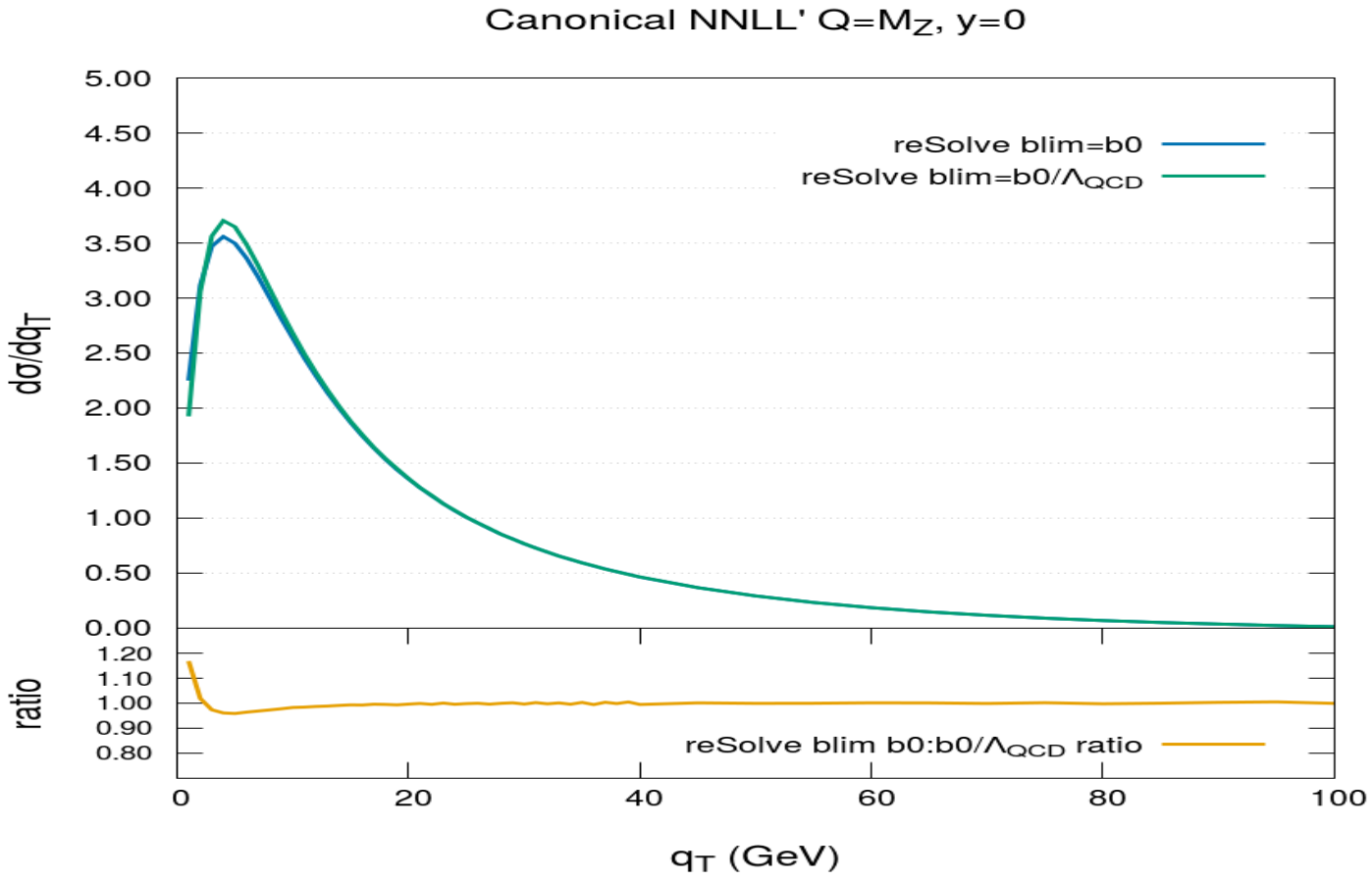
- b_* prescription used to freeze b above b_{lim}: b replaced by

$$b_* = b/\sqrt{1 + b^2/{b_{lim}}^2} \text{ so as } b \to \infty,\ b_* \to b_{lim}.$$

- Avoids issues of Landau pole at small q_T (large b), non-perturbative effects then captured by a non-perturbative function (not applied in this benchmarking).
- reSolve uses global b_*, where b is replaced everywhere by b_* (in α_s, PDFs and Sudakov logs).
- In CSS global b_* means that b is frozen everywhere, setting $b_0/b_{lim} = 1\text{GeV}$ freezes out at too large q_T.
- Default setting in reSolve/global b_* is $b_{lim} = b_L = b_0'/Q^2 \exp[1/(2\alpha_s\beta_0)] \sim 1/\Lambda_{QCD}$ which is lower and closer to Landau pole, causing less issues of early freeze out.
- Stefano showed in DYTurbo that using this default b_{lim} is closer to minimal prescription.
- Investigate using default b_{lim} and effect on low q_T .

reSolve small q_T effect of b_{lim} setting

- $b_{lim} = b_0$ vs $b_{lim} = b_L = b_0'/Q^2 \exp[1/(2\alpha_s\beta_0)] \sim 1/\Lambda_{QCD}$
- Same effect as seen in results comparison, reSolve effect same as seen elsewhere.

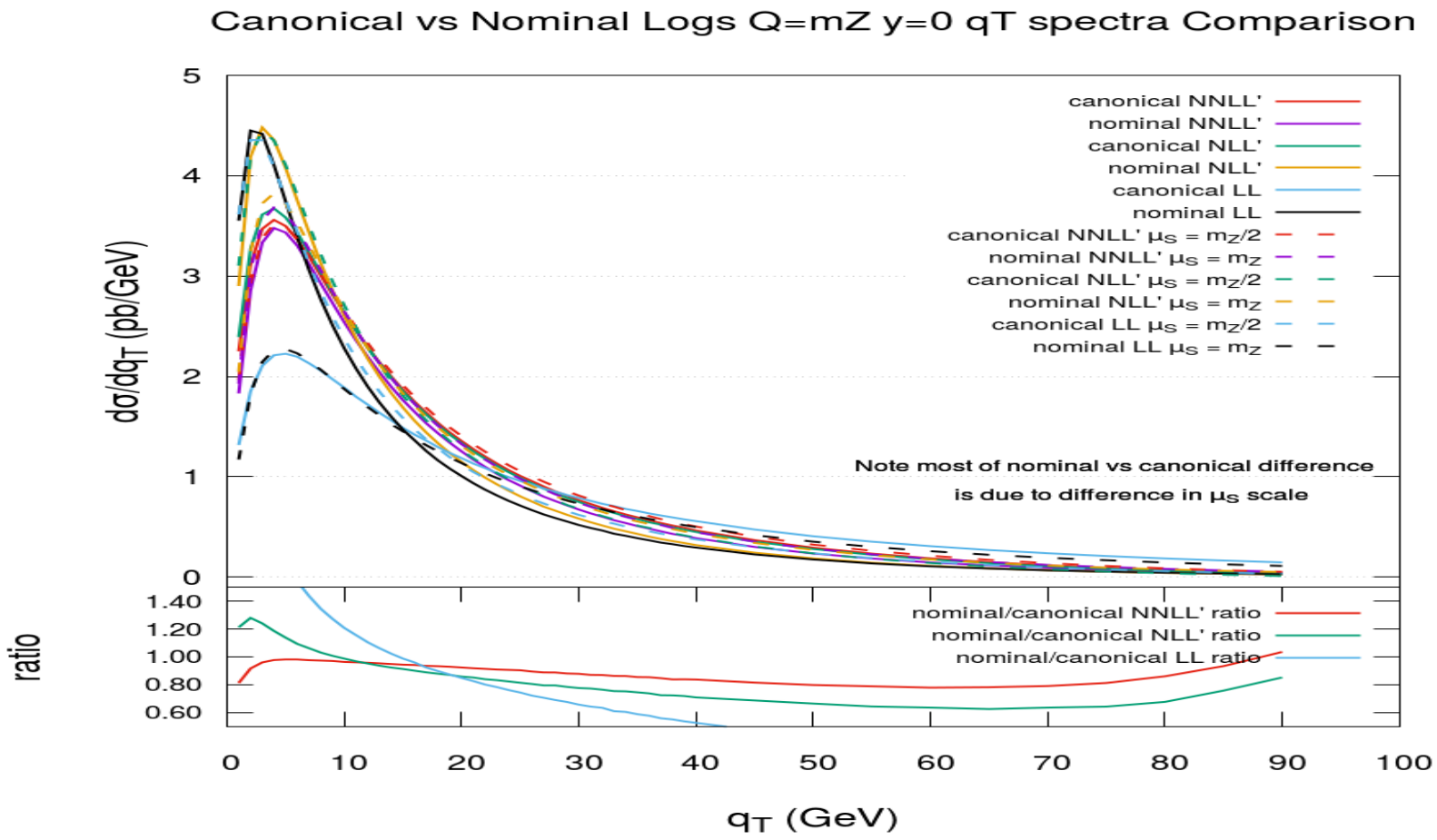


Level 2 – Nominal Logarithms

- reSolve results for nominal logs at Q=mZ, and inclusive y, y=0, y=2.4 at LL, NLL', NNLL' have been available for some time.
- Now also some reSolve results available for Q=1TeV, y=0.
- Differences of nominal logs (level 2) relative to canonical logs (level 1):
  - High q_T (low b), nominal uses modified logs to enforce unitarity as logs reduce to zero.
  - Resummation scale choice, $\mu_s = Q$ (canonical) vs $\mu_s = Q/2$ (nominal).
  - b_{lim} set to default b_L (nominal) vs b_0 (canonical), effecting low q_T.
  - Could apply additional suppression/cut-off to resummed contribution at large q_T but reSolve does not do this.

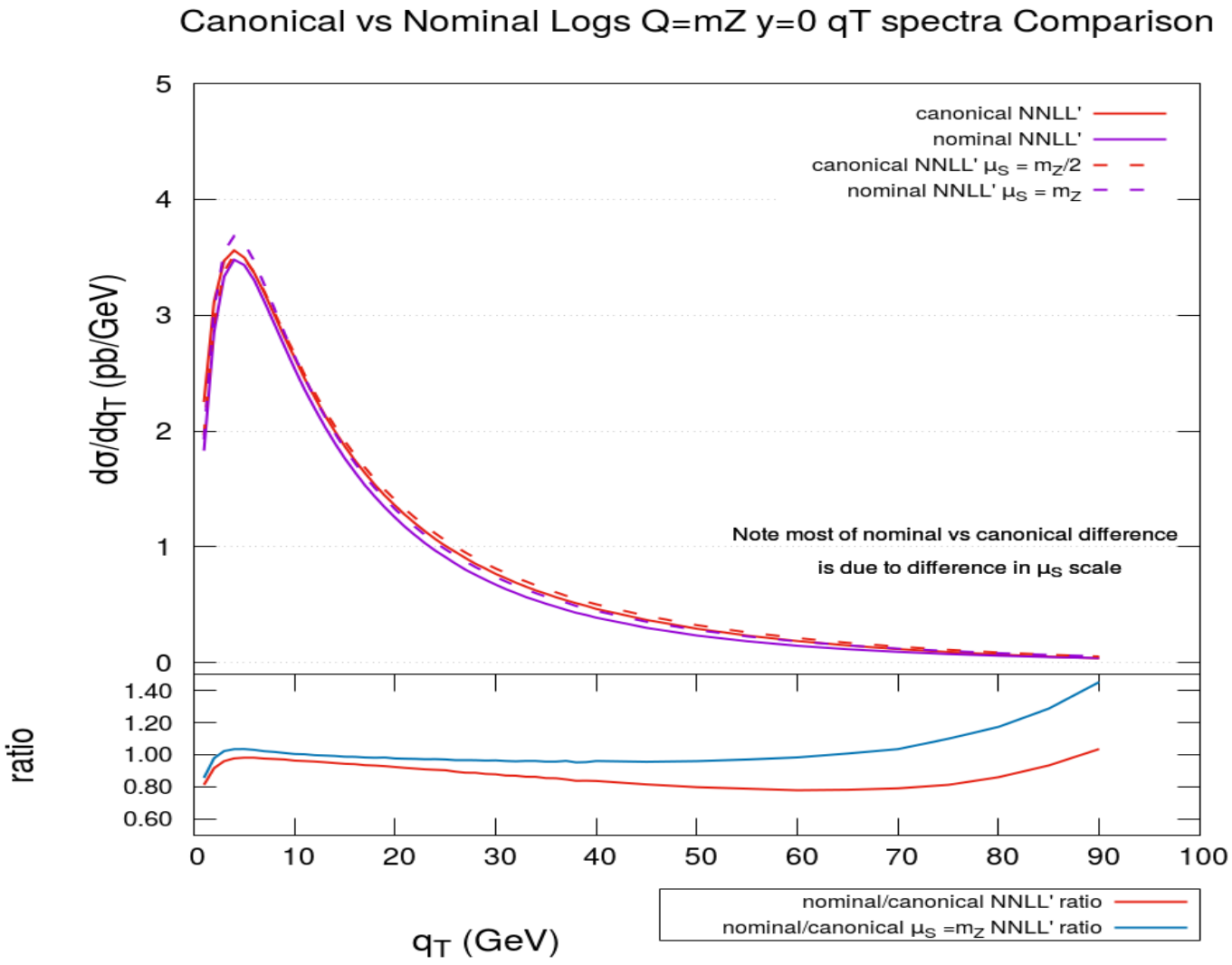
Level 2 – Nominal Logarithms – Q=mZ, y=0

- Resummation scale choice, $\mu_s = Q$ (canonical) vs $\mu_s = Q/2$ (nominal) is main difference, particularly for lower orders – measure of scale variation.



Level 2 – Nominal Logarithms at NNLL’

- Resummation scale choice, $\mu_s = Q$ (canonical) vs $\mu_s = Q/2$ (nominal) is main difference at lower orders.
- Also see effects of different b_{lim} (nominal has reSolve default rather than b_0).
- At high q_T see nominal higher than canonical, due to modified logs.
- Such ratios for lower orders show same pattern but more variation and enhanced amplitude as more scale variation.



Level 2 – Nominal Logarithms – Q=1TeV, y=0

- Similar effects at Q=1TeV, resummation scale is largest difference particularly for lower orders.
- Although here the effect of scale variation is smaller as q_T is smaller fraction of Q, so difference of canonical and nominal smaller.
- Still see effect of different b_{lim} at very low q_T -> means canonical/nominal at same scale at low q_T is >1.
- Don't see difference between canonical and nominal at high q_T as still too small relative to Q.