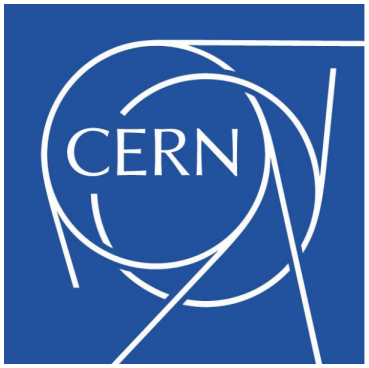


Resummation benchmarking

LHC EW precision group workshop

December 16, 2019

Resummation codes

- The benchmarking exercise and W mass measurement
  - We benchmark Z/W analytic resummed predictions
  - Has never been done before and there is already much to be learned

	b-space	k_t-space	add.	mult.	m. logs	profile	trans. fun	NP corr
PB-TMD		✓						✓
CuTe		✓	✓				✓	✓
DYres/DYTURBO	✓		✓		✓			(✓)
NangaParbat	✓		✓		✓			✓
RadISH		✓	(✓)	✓	✓			
ResBos2	✓		✓		✓			✓
Resolve	✓		✓		✓			✓
SCETLib	✓		✓			✓		

+Artemide

Benchmarking levels

- Benchmarking of resummed $p_T Z$, $p_T W/p_T Z$:
  - Inputs: https://gitlab.cern.ch/arapyan/pt-comparison

1) Canonical logarithms (as much as possible)
   - Strictly $\ln(Qb_T/b_0)$, $\ln(q_T/Q)$, i.e. $\mu_H = Q_{\rm res} = Q$, $\mu_r = \mu_f = Q$
   - Including b^* or equivalent prescription, but no nonpert. form factor etc.
   - Result in b_T space (if possible)
   - Result in q_T space

Great progress in 2018!

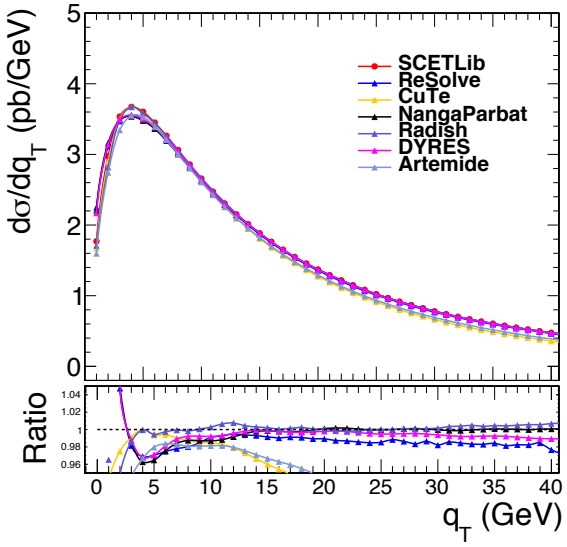
2) Nominal, favourite logarithms
   - Including turning off resummation at large q_T, e.g. $Q_{\rm res} = Q/2$, profile scales, $\ln(b_T) \to \ln(1 + b_T)$, etc. ...

3) Resummation as in 2) plus matching nonsingular FO correction

Order	Boundary cond. (FO singular)	Anomalous dimensions γ_i (noncusp)	$\Gamma_{\rm cusp}$, β	FO matching (nonsingular)
LL	1	-	1-loop	-
NLL	1	1-loop	2-loop	-
NLL′ (+NLO$_0$)	α_s	1-loop	2-loop	α_s
NNLL (+NLO$_0$)	α_s	2-loop	3-loop	α_s
NNLL′ (+NNLO$_0$)	α_s^2	2-loop	3-loop	α_s^2
N^{3}LL (+NNLO$_0$)	α_s^2	3-loop	4-loop	α_s^2
N^{3}LL′ (+N^{3}LO$_0$)	α_s^3	3-loop	4-loop	α_s^3
N^{4}LL (+N^{3}LO$_0$)	α_s^3	4-loop	5-loop	α_s^3

Level-1 benchmarking

- As seen in Valerio's slides the first step of benchmarking has been quite successful
  - ReSolve, NangaParbat, DYRES, Radish, SCETlib are within ~1% in qT>10 GeV and qT<80 GeV regions
    - Cute, Artemide, and PB-TMD show larger differences
    - No inputs from Resbos
  - Demonstrated that low qT (<10GeV) differences are due to Landau-pole regularization procedure



Next steps…

- Level-2 benchmarking
  - Inclusion of modified logs
  - Different codes use their ‘nominal’ settings
    - For example: favorite Landau pole regularization
- Systematic uncertainties become relevant for this step
  - Perturbative uncertainties (μR/μF and resummation scales)
  - Profile scales, modified logarithms, etc.
  - We should list all relevant uncertainty sources at this step and add it to the benchmarking document.
- Timelines for level-2
  - Would it be reasonable to aim for the level-2 inputs from the groups by the end of January?
- Level-3 (matching to fixed-order) can follow after

Timelines and documentation

- From the Precision EW group the 3 steps will converge for the Yellow Report. it was also tentatively agreed:
  - There will be real added value in publishing the results of these comparisons (one can include a suitable version of such a publication in a Yellow Report). This would be jointly signed by all participating resummation groups.

- As discussed during the last meeting the modeling of the correlations of the uncertainties in the pT W/Z ratio is outside of the scope of this first benchmarking result and documentation
  - This will be studied beyond Summer of 2020 within the LHC EW group

ADDITIONAL MATERIAL