Precision predictions for t-channel single-top-quark production

based on arχiv:1903.11023 and 2006.XXXXX

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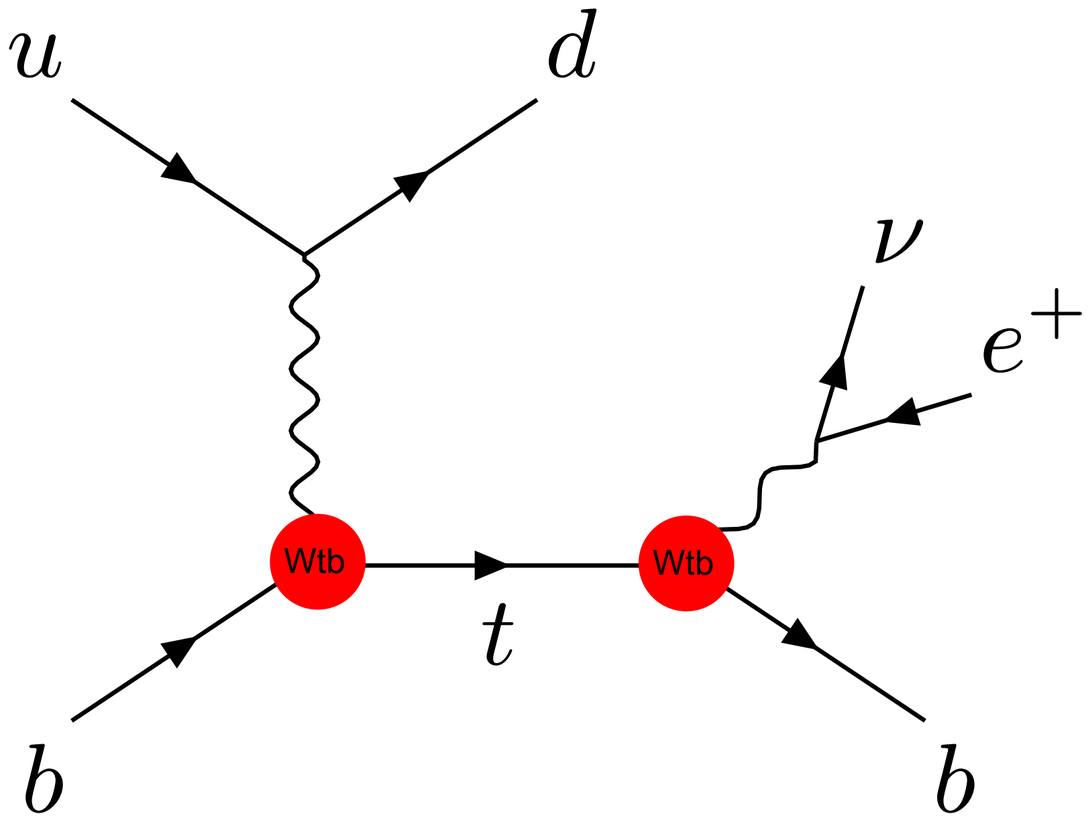
t-channel single-top: Multitalent and standard candle



- Double deep inelastic scattering
- consistency check for PDFs
  - 5σ inconsistency with NLO PDFs at Tevatron *Sullivan 1711.04018*
  - further inconsistencies at LHC *Nocera, Ubiali, Voisey 1912.09543*
- PDF transverse momentum dependence *Lipatov et al. '18*
- Access to V_{tb}: $\propto |V_{tb}|^2$
- Prime process to test V-A structure $\gamma^\mu P_L$
- Top-quark mass: m_{bl} lineshape
- As background with signature W, b + light jets

Theory predictions

- NLO: 4-flavor scheme, 5-flavor scheme, stable, on-shell, off-shell
- threshold and transverse momentum resummation
  Q.-H. Cao, P. Sun, B. Yan, C.-P. Yuan, F. Yuan

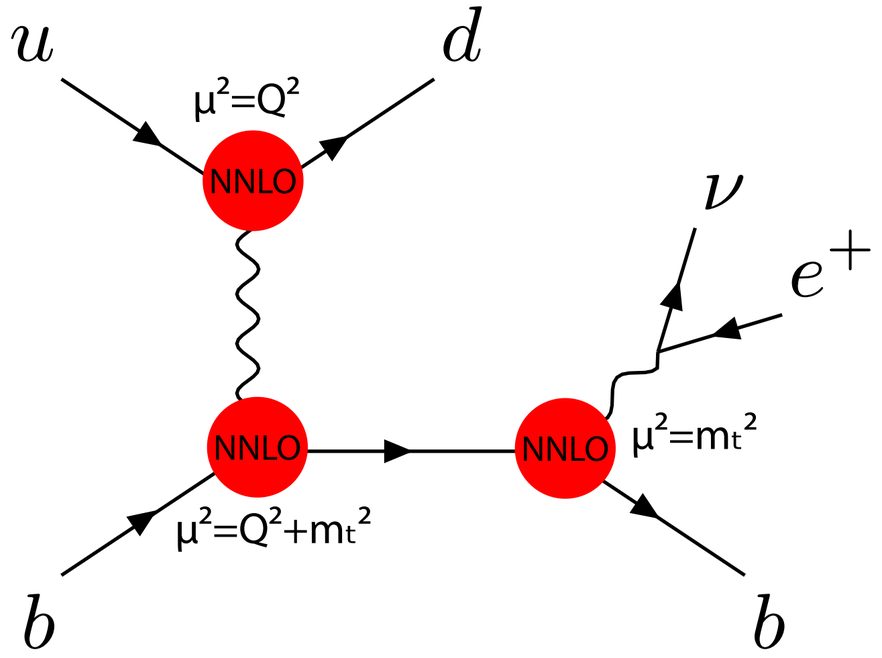
Fully inclusive top production at LO: $164.4\,\mathrm{pb} \pm 10\%$
NLO corrections: $-6.6\,\mathrm{pb}$; reduction to $\pm 3\%$

Here focused on **NNLO** corrections: $-4.5\,\mathrm{pb}$; reduction to $\pm 1\%$

- NNLO calculation with stable (non-decaying) top
  Brucherseifer, Caola, Melnikov '14
- NNLO calculation with on-shell decaying top
  Berger, Gao, Yuan, Zhu '16 '17

> *"We found a difference of ~1% on the NNLO cross sections"*

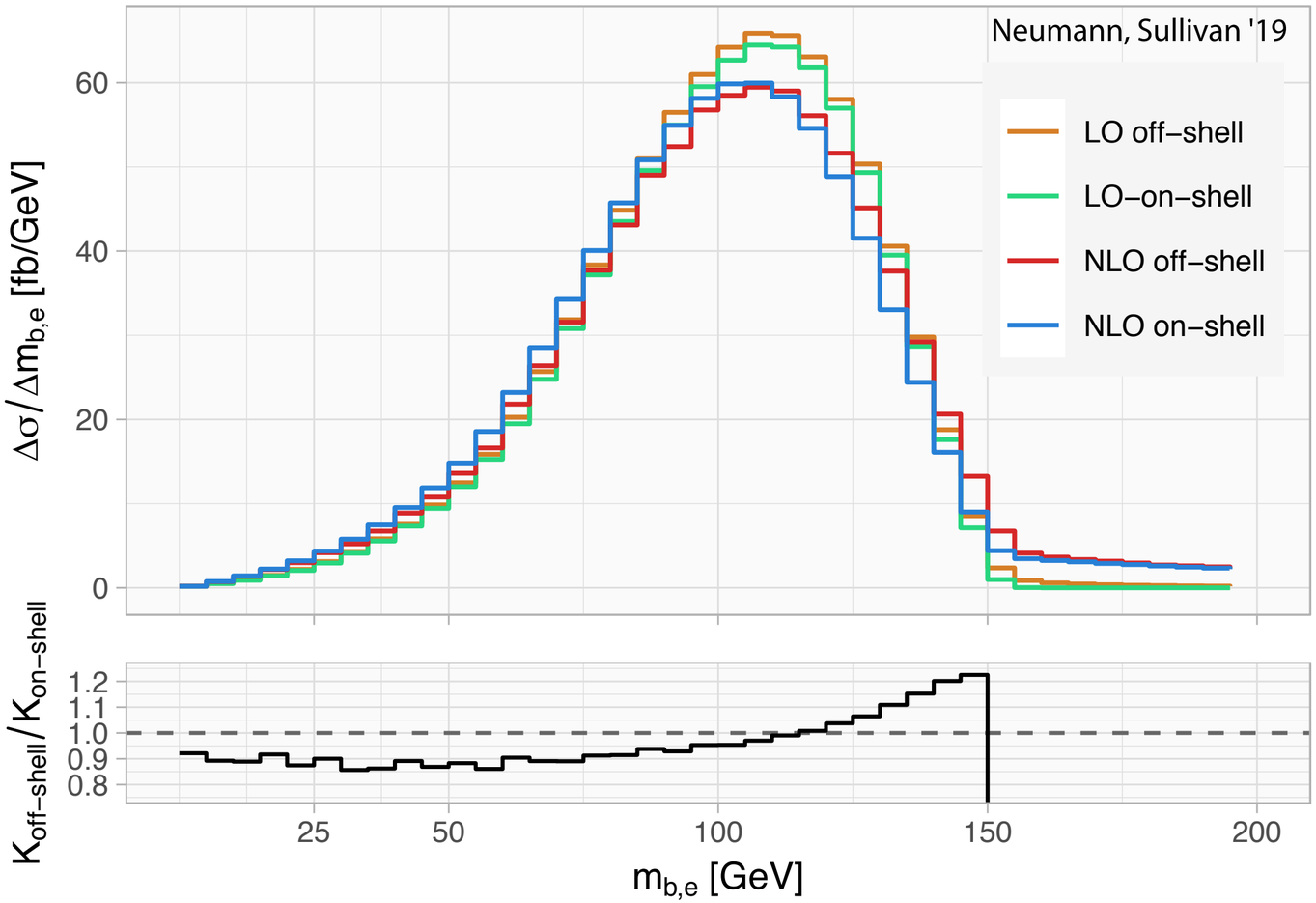
The (three, six?) NNLO calculations



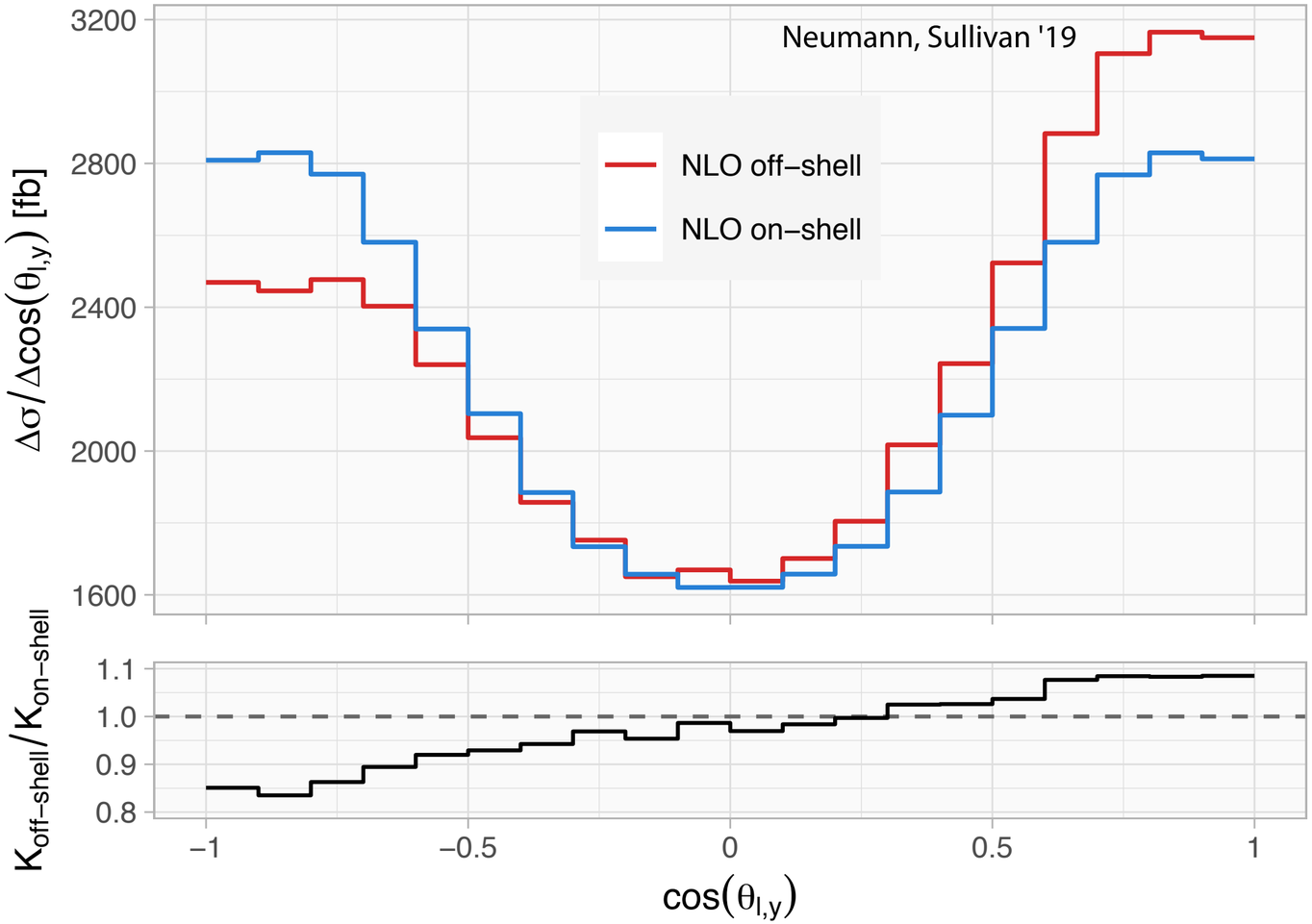
Ingredients: st+jet @ NLO; NNLO subtraction scheme (jettiness-like slicing); two-loop hard functions

We confirm inclusive top-production results of Berger, Gao, Yuan, Zhu '16 '17 !

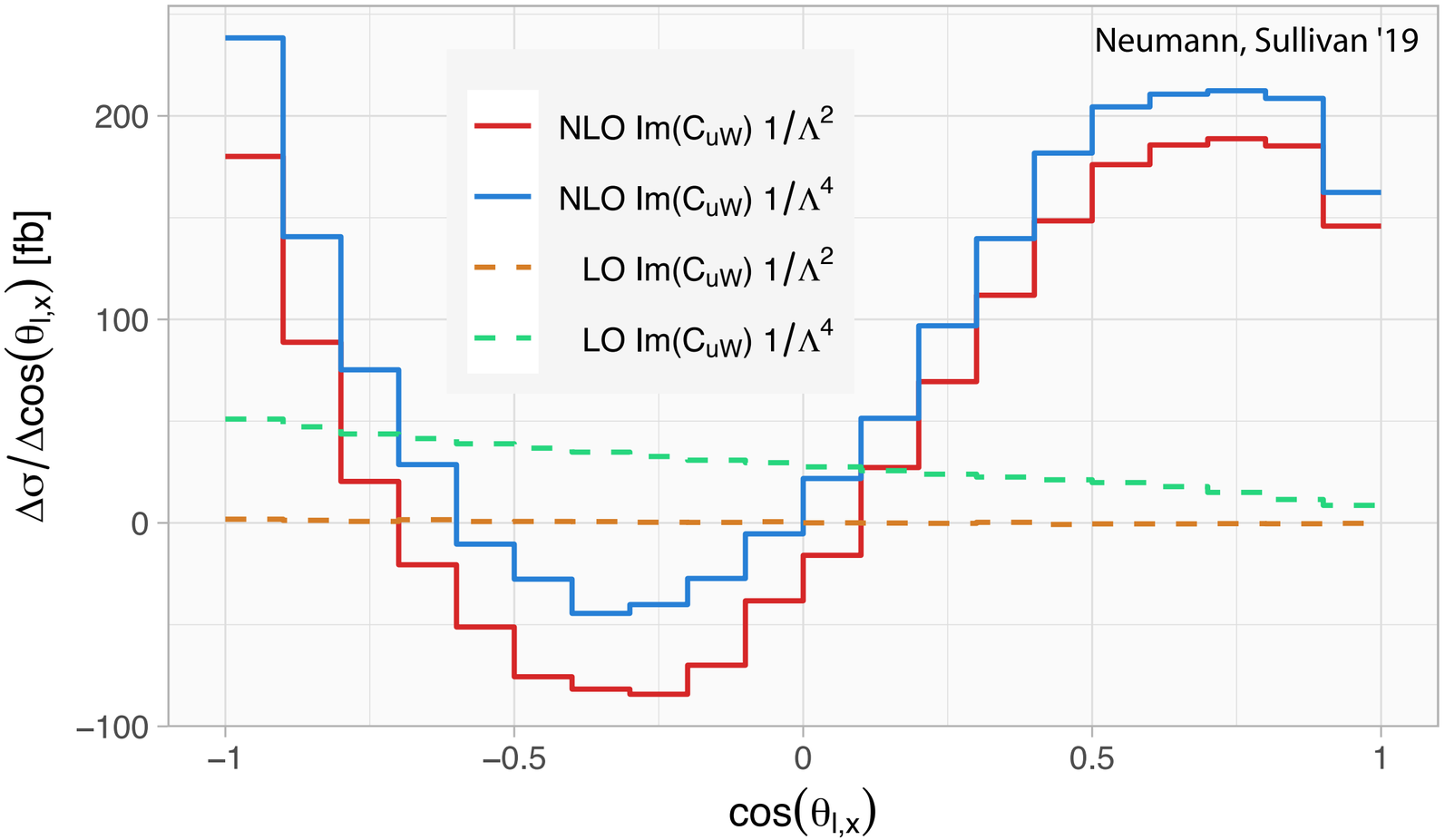
Off-shell effects! m_{bl} lineshape for top-mass measurement



Angles sensitive to new physics: NLO off-shell effects



NLO SMEFT: One of the most interesting structures: $\mathfrak{Im}C_{uW}$



Summary

Our NNLO corrections confirm the Berger, Gao, Yuan, Zhu '16 '17 results (so far only inclusively checked)

- Top-production done, still need to do CP-crossing to anti-top
- furthermore: detailed differential pheno, so arXiv:summer.XXXXX

- Public implementation im MCFM ⇒ directy benefits pheno & experimental community
- NNLO corrections ~3% (but fiducial impact twice)
- Separate scale choices on heavy and light line (and decay)

- Together with NLO off-shell SMEFT ⇒ unified precision studies
- Shipping with pre-packaged analysis framework, b-tagging (mcfm.fnal.gov)