



**Recent developments in Higgs
precision calculations**

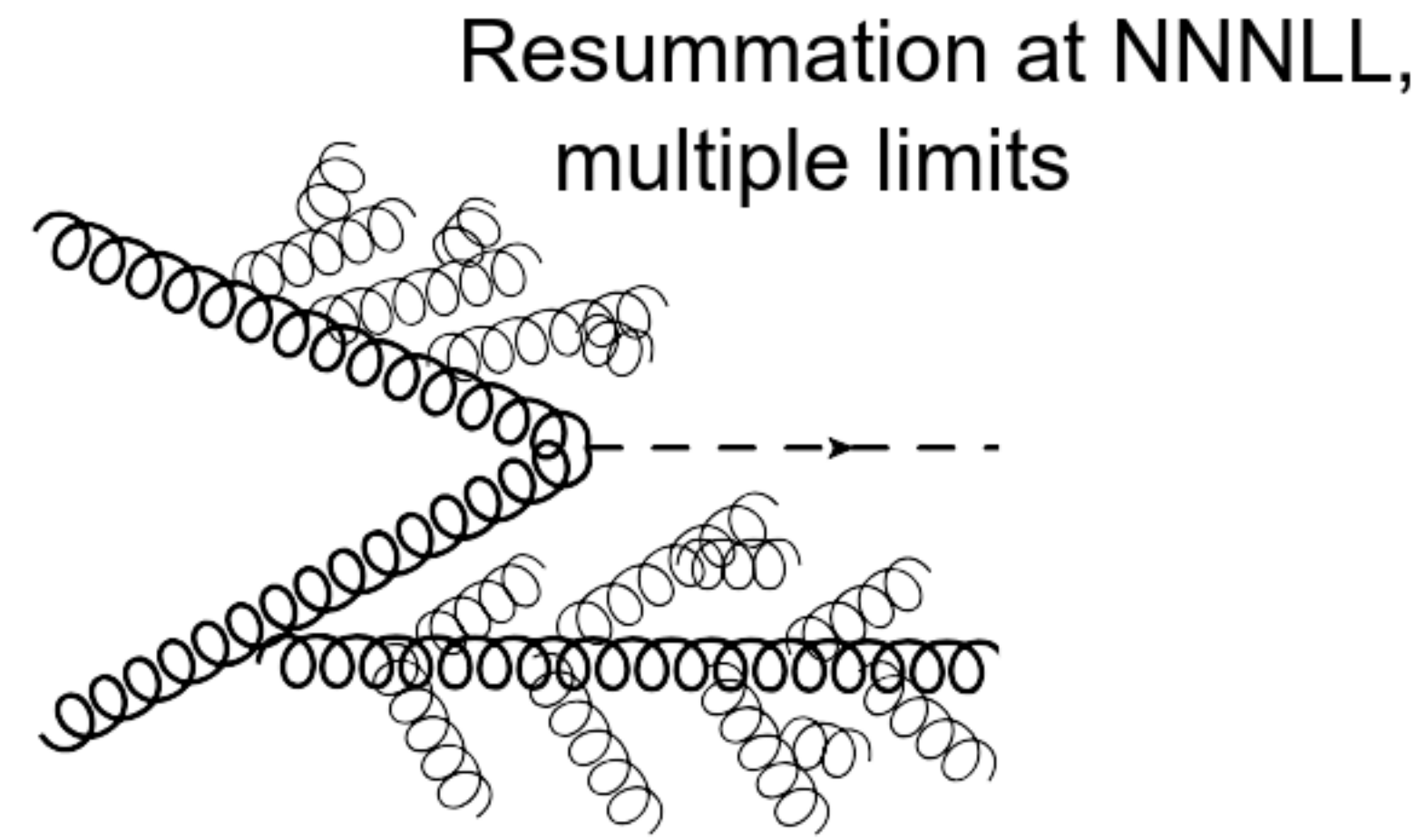
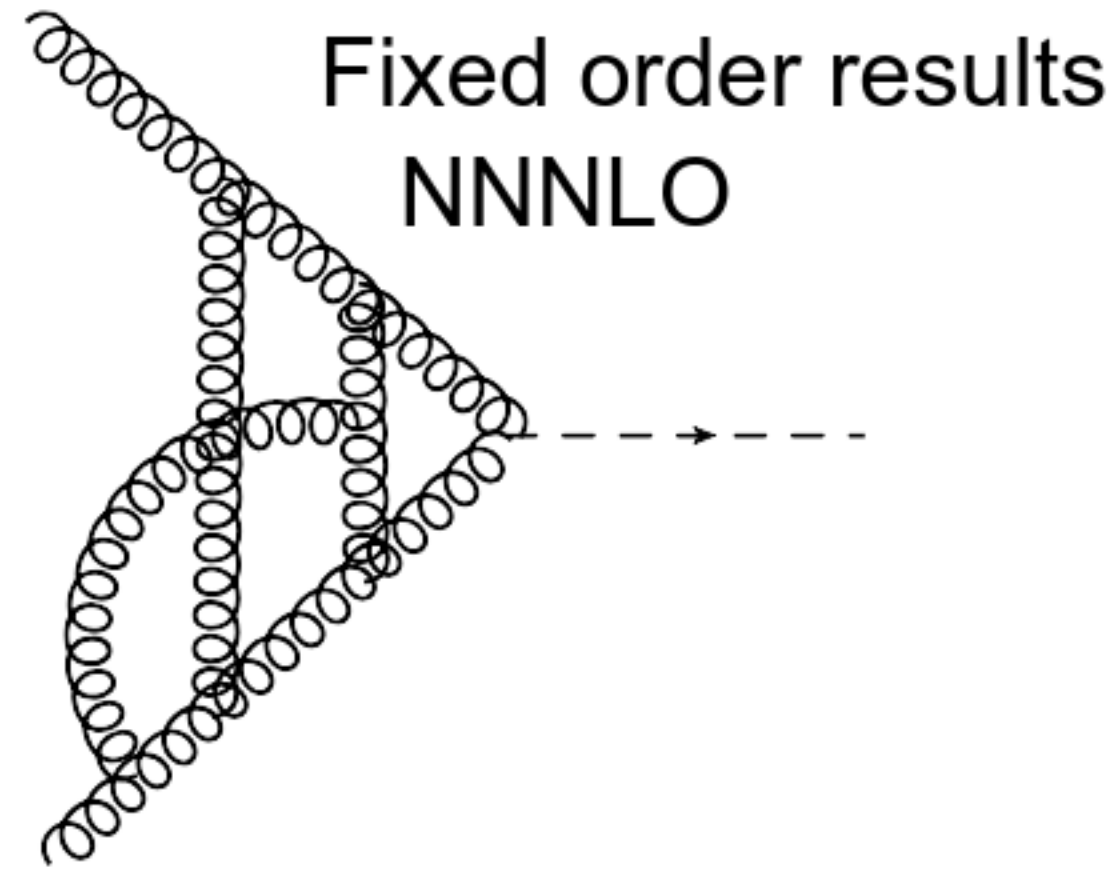
Tobias Neumann, Illinois Tech/Fermilab

May 29th, 2018

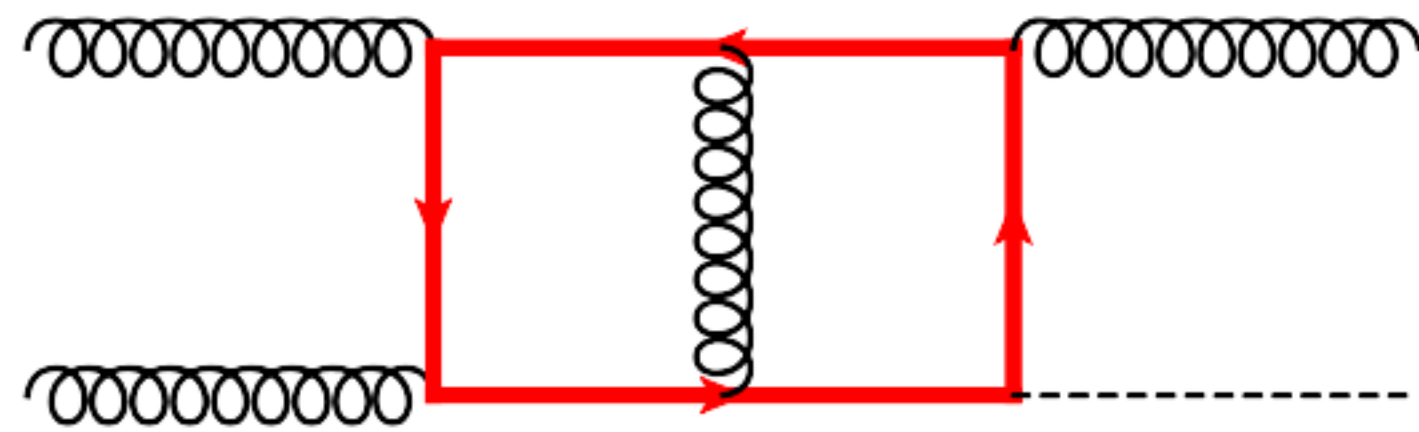


What's new in Higgs predictions?

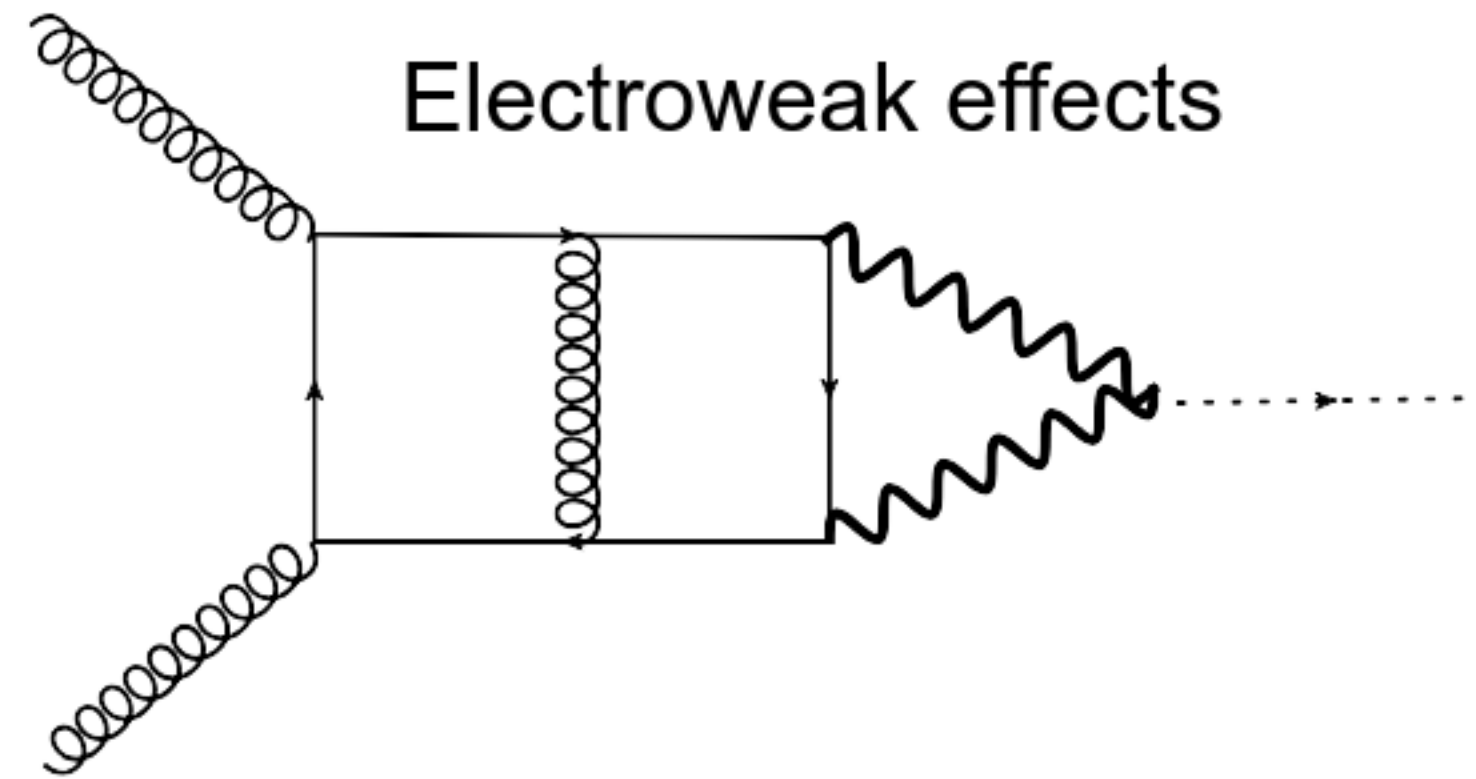
... give me more time and it's not just gluon fusion!



Top, bottom mass effects at NLO



Electroweak effects

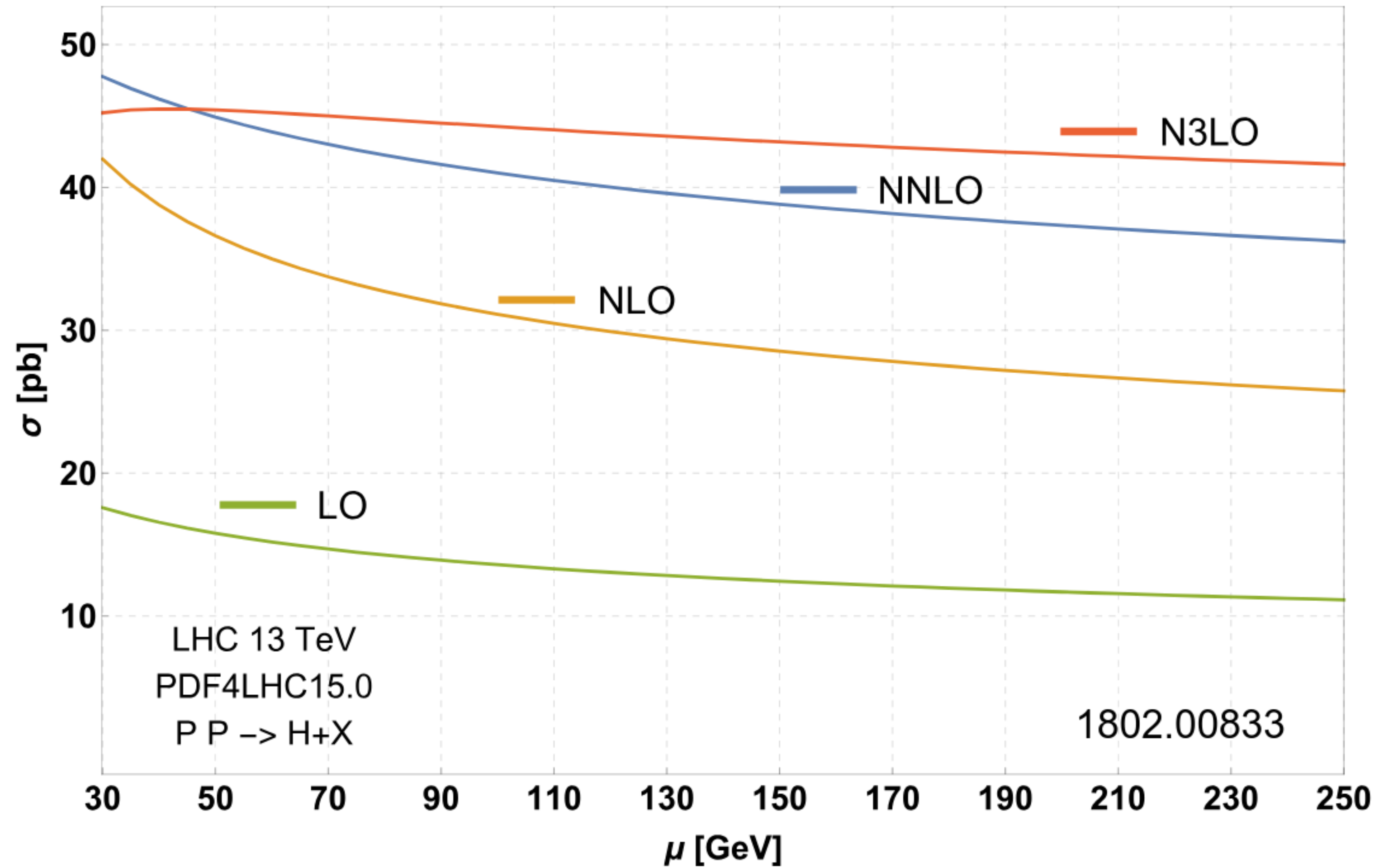


The low hanging fruits are gone..

(c) Martin Gordon, Flickr



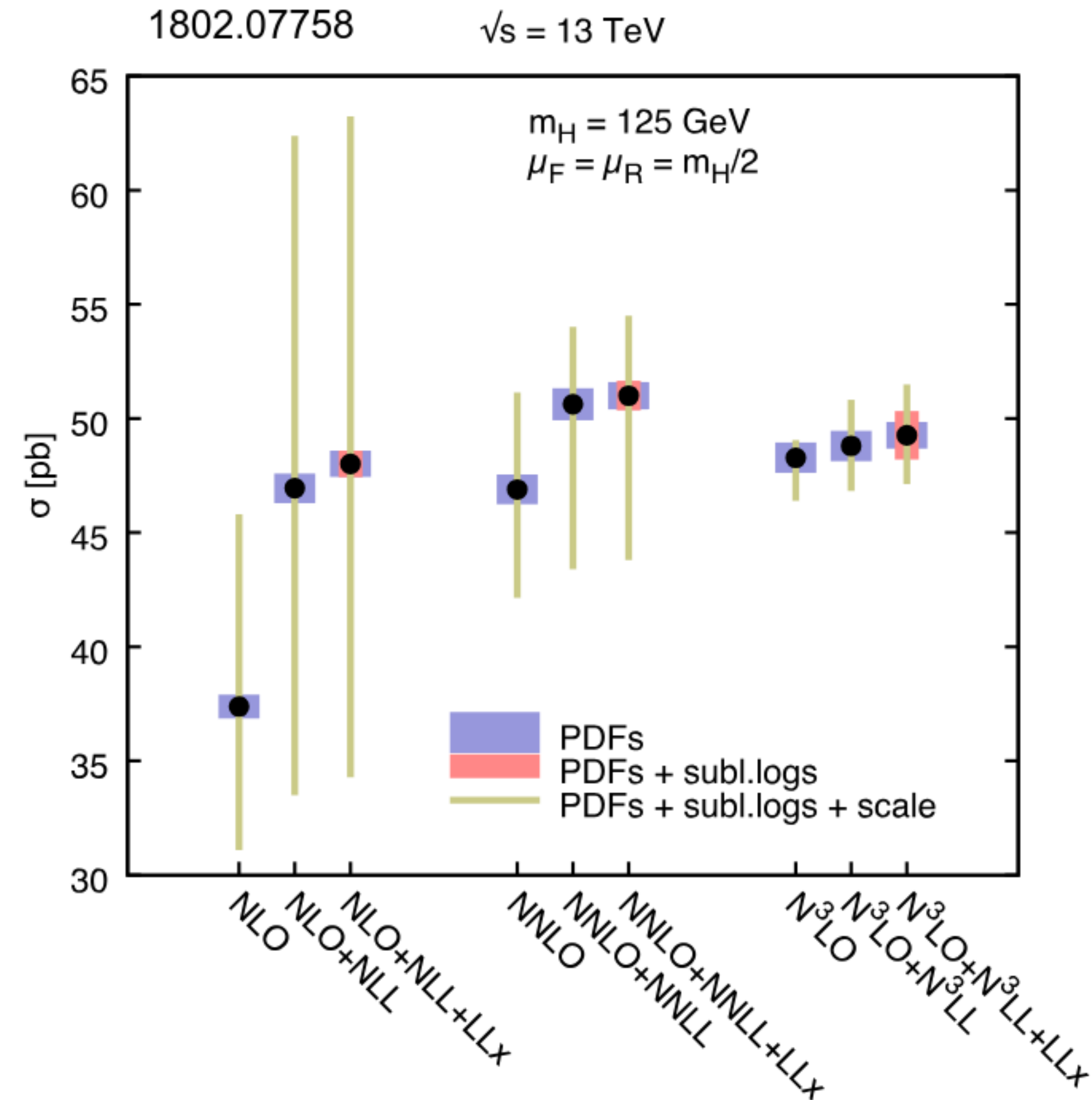
High fruits #1: N³LO Higgs inclusive in EFT



Mistlberger '18; Anastasiou, Duhr, Dulat, Herzog, Mistlberger '15

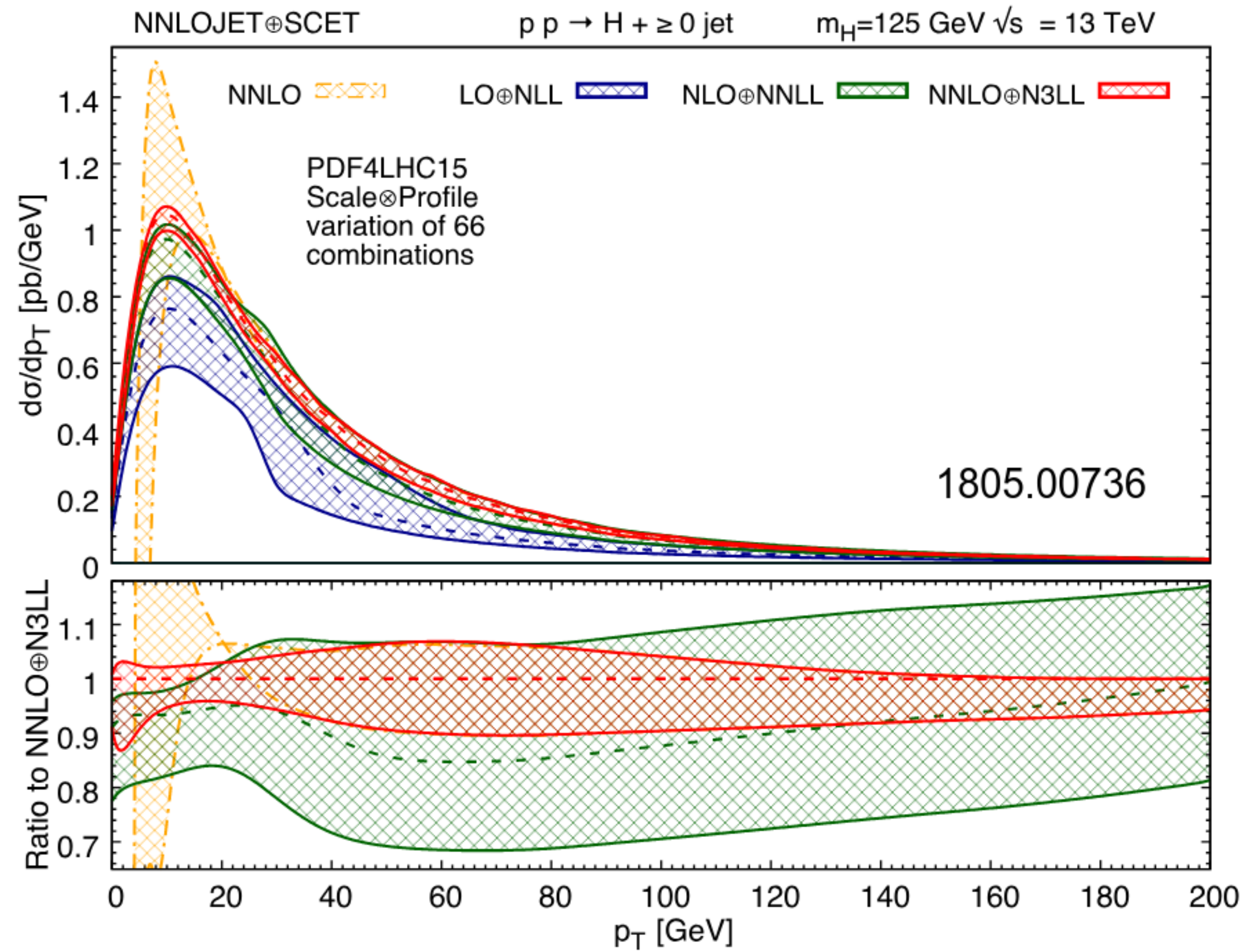
High fruits #2: Inclusive joint resummation

threshold and high energy



Bonvini, Marzani '18

High fruits #3: p_T resummation



Chen, Gehrmann, Glover, Huss, Li, Neill, Schulze, Stewart, Zhu '18
see also Bizon, Chen, Gehrmann-De Ridder, Gehrmann, Glover, Huss, Monni, Re, Rottoli, Torrielli '18

Further fruits..

QCD corrections to $\text{QCD} \times \text{EW}$: $\simeq 5\%$

Bonetti, Melnikov, Tancredi '18

Towards single differential Higgs at $\text{N}^3 \text{LO}$:

- analytic differential NNLO

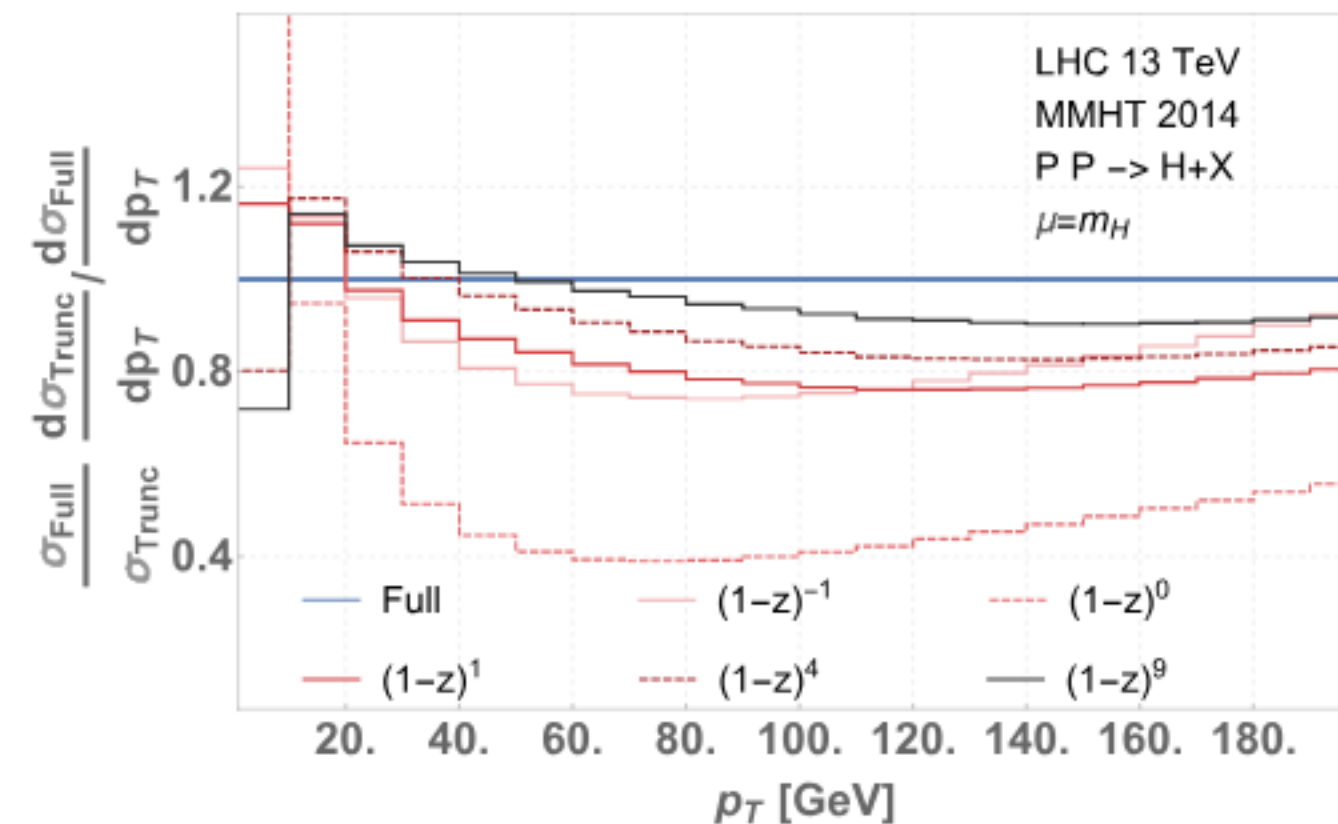
Dulat, Lionetti, Mistlberger, Pelloni, Specchia '17

- analytic differential $\text{N}^3 \text{LO}$, threshold expansion

Dulat, Mistlberger, Pelloni '17

- classification of elliptic integrals

Broedel, Duhr, Dulat, Penante, Tancredi '18

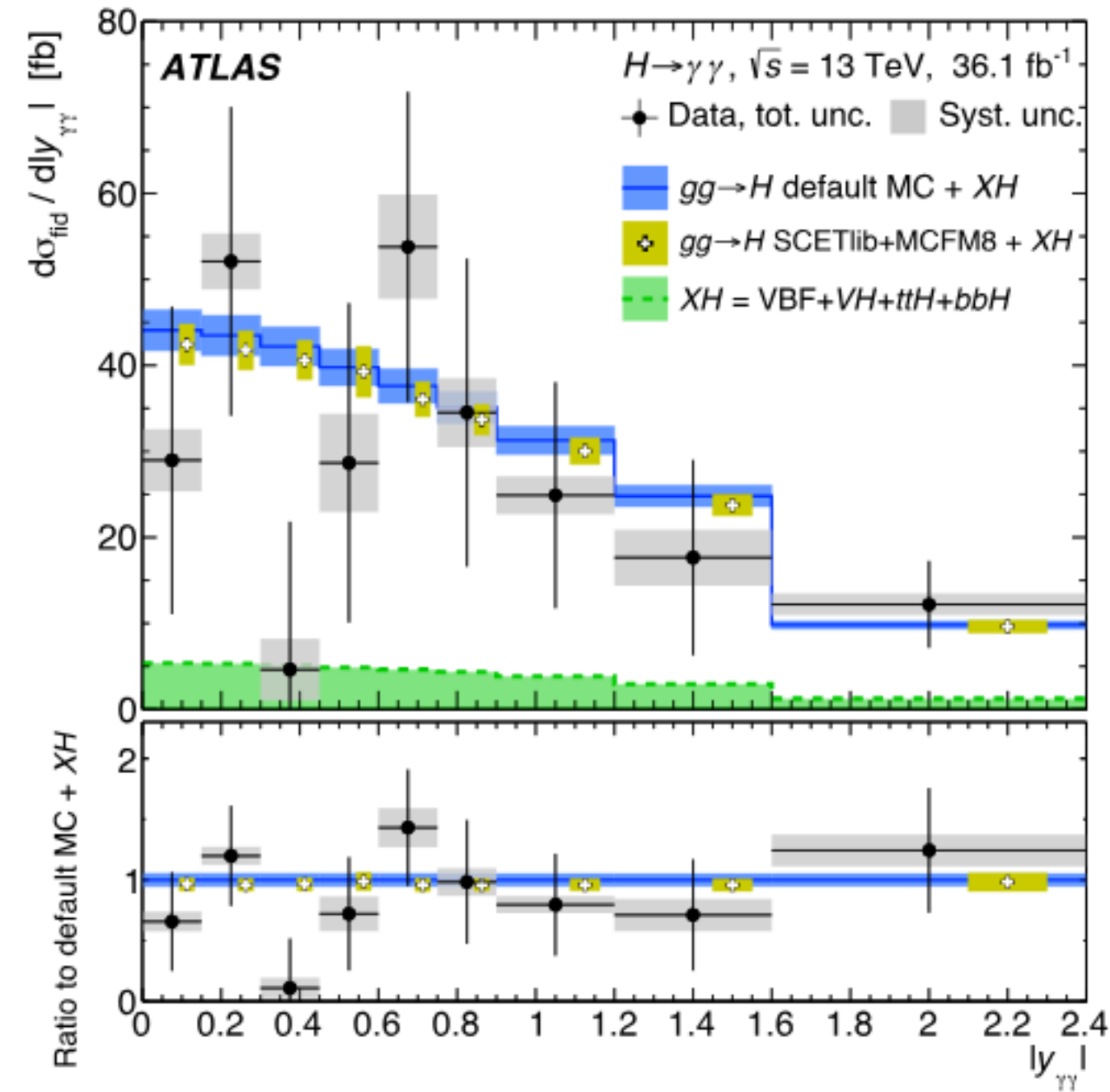
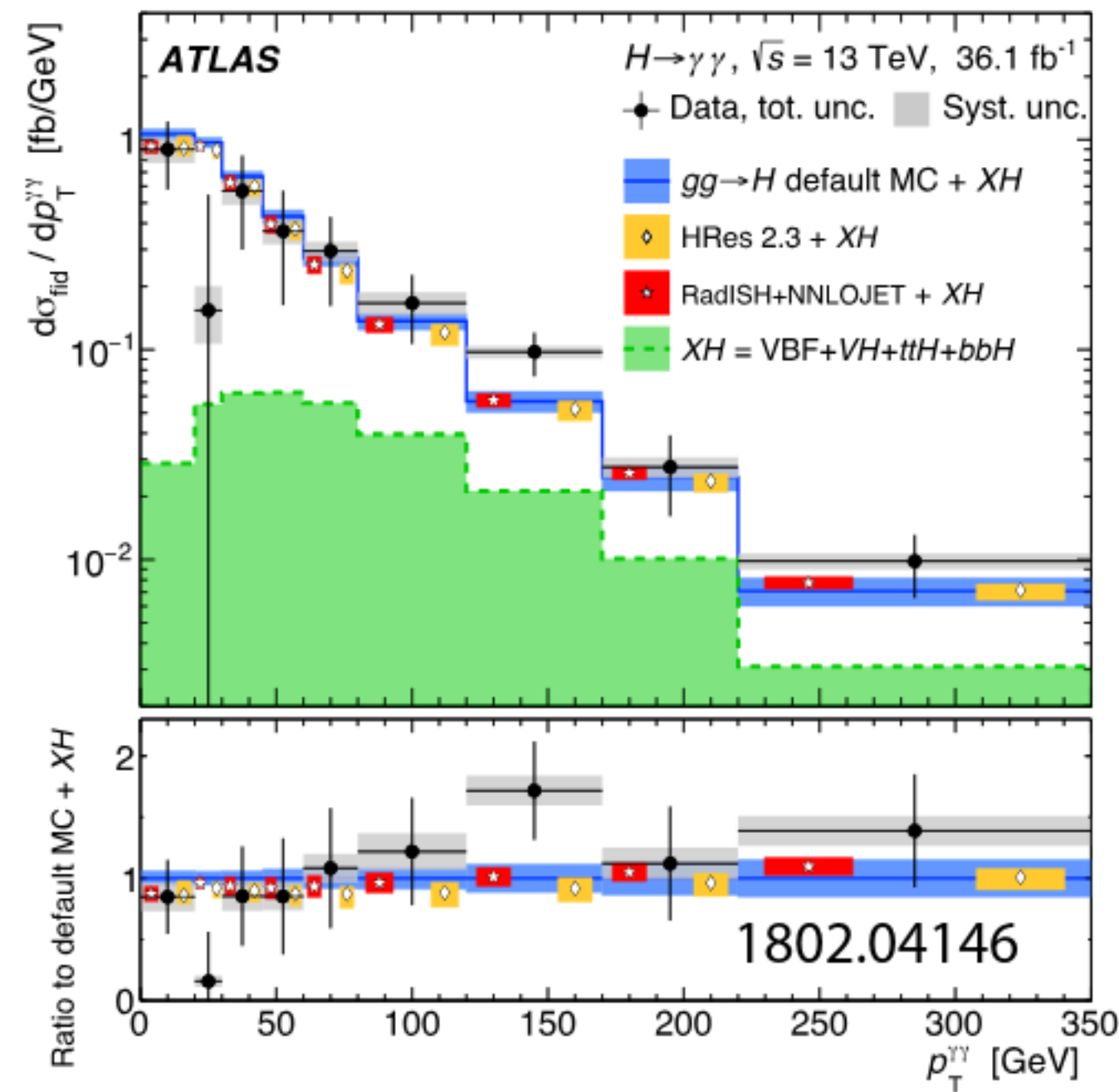


Progress in Higgs+jet

NNLO EFT result known, scale uncertainty $\sim 5\%$

Chen, Gehrman, Glover, Jaquier '14;

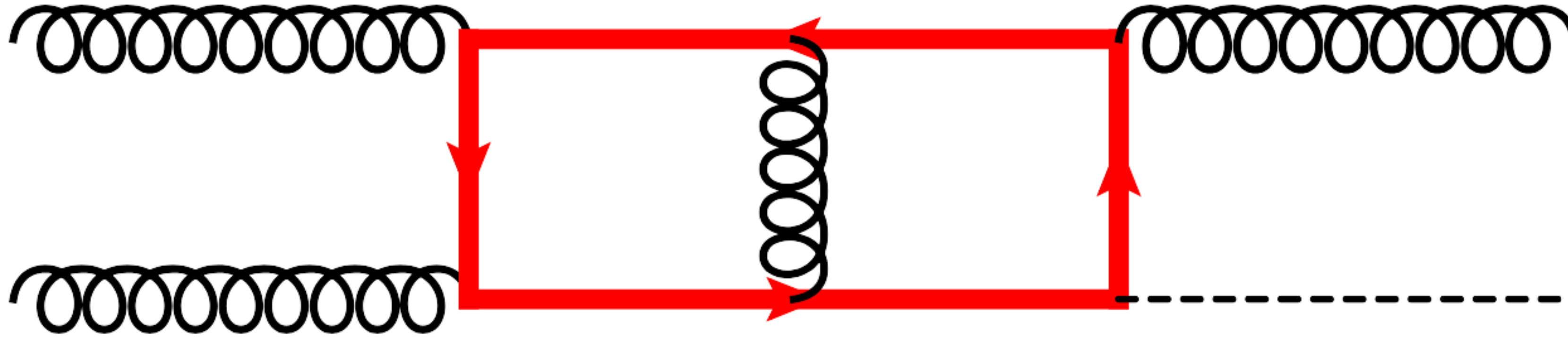
Boughezal, Caola, Melnikov, Petriello, Schulze '13, '15; Boughezal, Focke, Giele, Liu, Petriello '15



recent study discussing low p_T : tb-interference, p_T resum.

Caola, Lindert, Melnikov, Monni, Tancredi, Wever '18

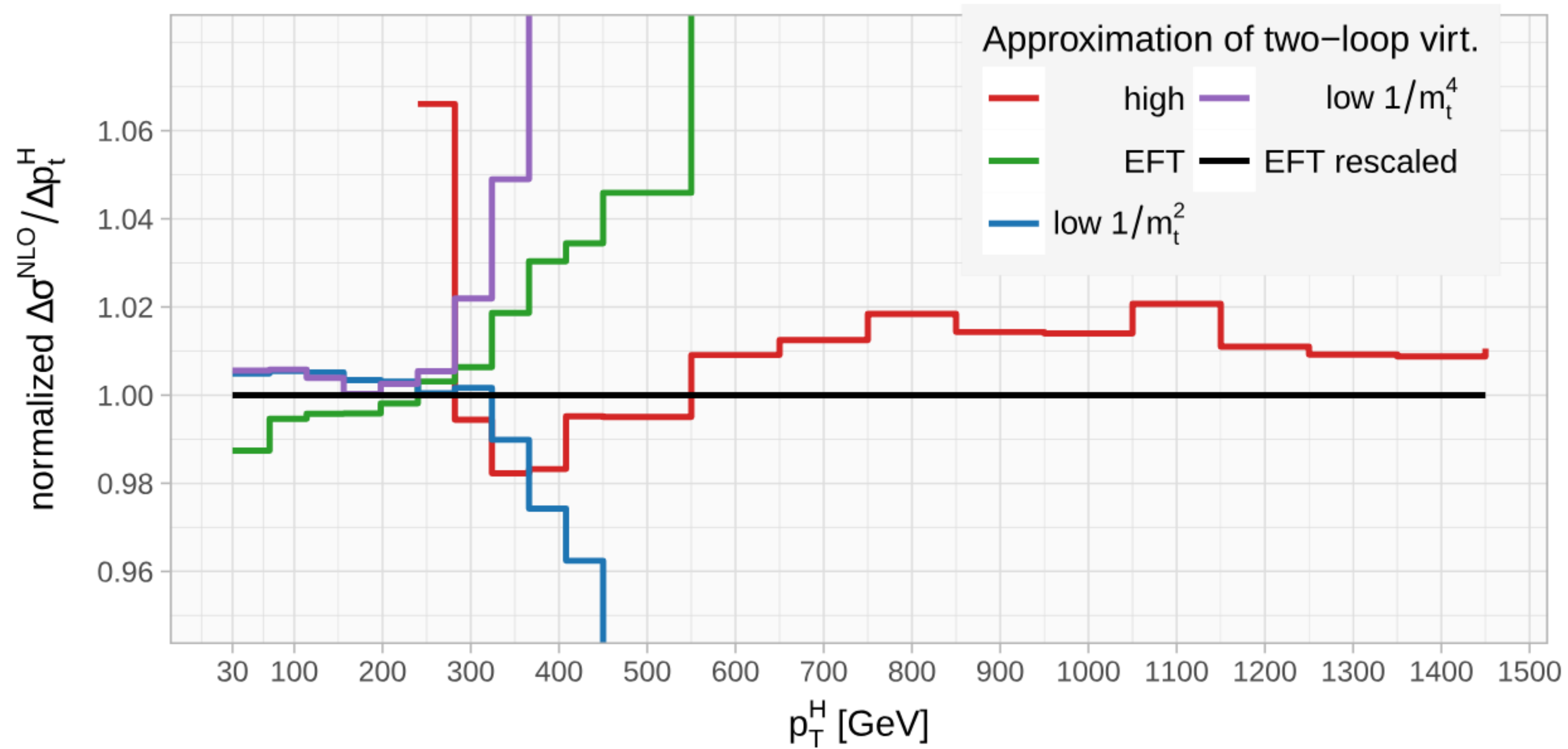
High energy: Uncertainty due to EFT approx.



- Inclusion of exact real emission, jet merging
Frederix, Frixione, Vryonidou, Wiesemann '16
- Inclusion of exact real emission, 1/mt-expansion
Williams, TN '17

Region of high p_T is highly relevant now for analyses: CMS
 $H \rightarrow b\bar{b}$ in highly boosted regime $p_T \geq 450$ GeV (1709.05543)

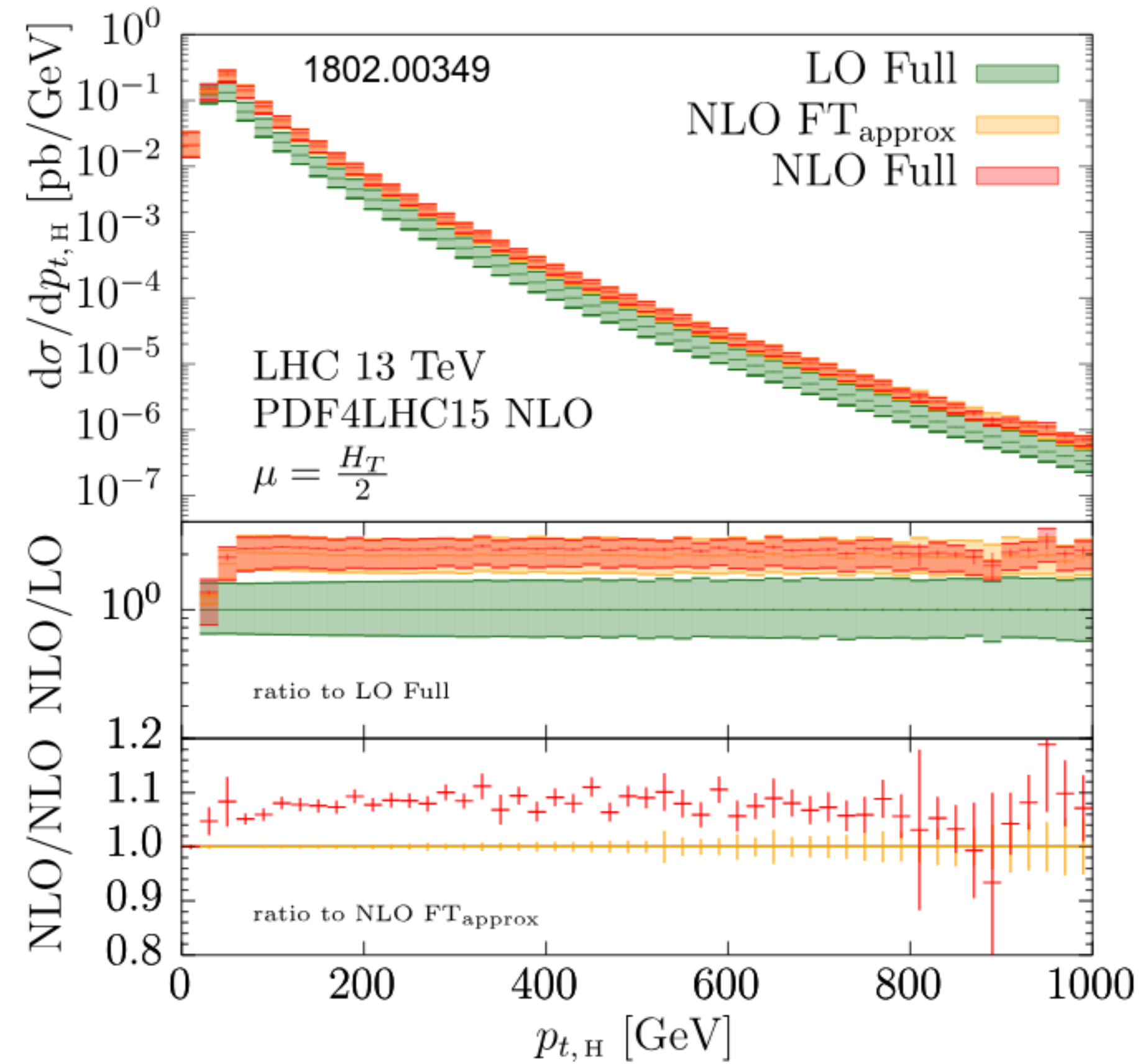
High energy expansion



TN '18; see also Lindert, Kudashkin, Melnikov, Wever '18

Full top quark mass dependence

Evaluating $\mathcal{O}(100)$ master integrals using sector decomposition



Jones, Kerner, Luisoni '18

Summary

Amazing progress in gluon fusion Higgs and Higgs+jet!

- For H+2jet, VBF, VH, HH, ttH, etc. see e.g. 1803.07977

3000 fb^{-1} LHC will reduce uncertainties
~3% (incl.) and ~10% (excl.)

- Inclusive: N³ LO in EFT, EW effects, mass effects, thres. resummation (iHixs, SusHi, ..)
- Higgs+jet: NNLO in EFT (no public code?), NLO t/b effects, NLO full top! (MCFM, ..?)

Highest hanging fruits: Combine as many things as possible and reliably assess uncertainties!