

Boosted Higgs bosons from non-ggF channels

Jonas M. Lindert

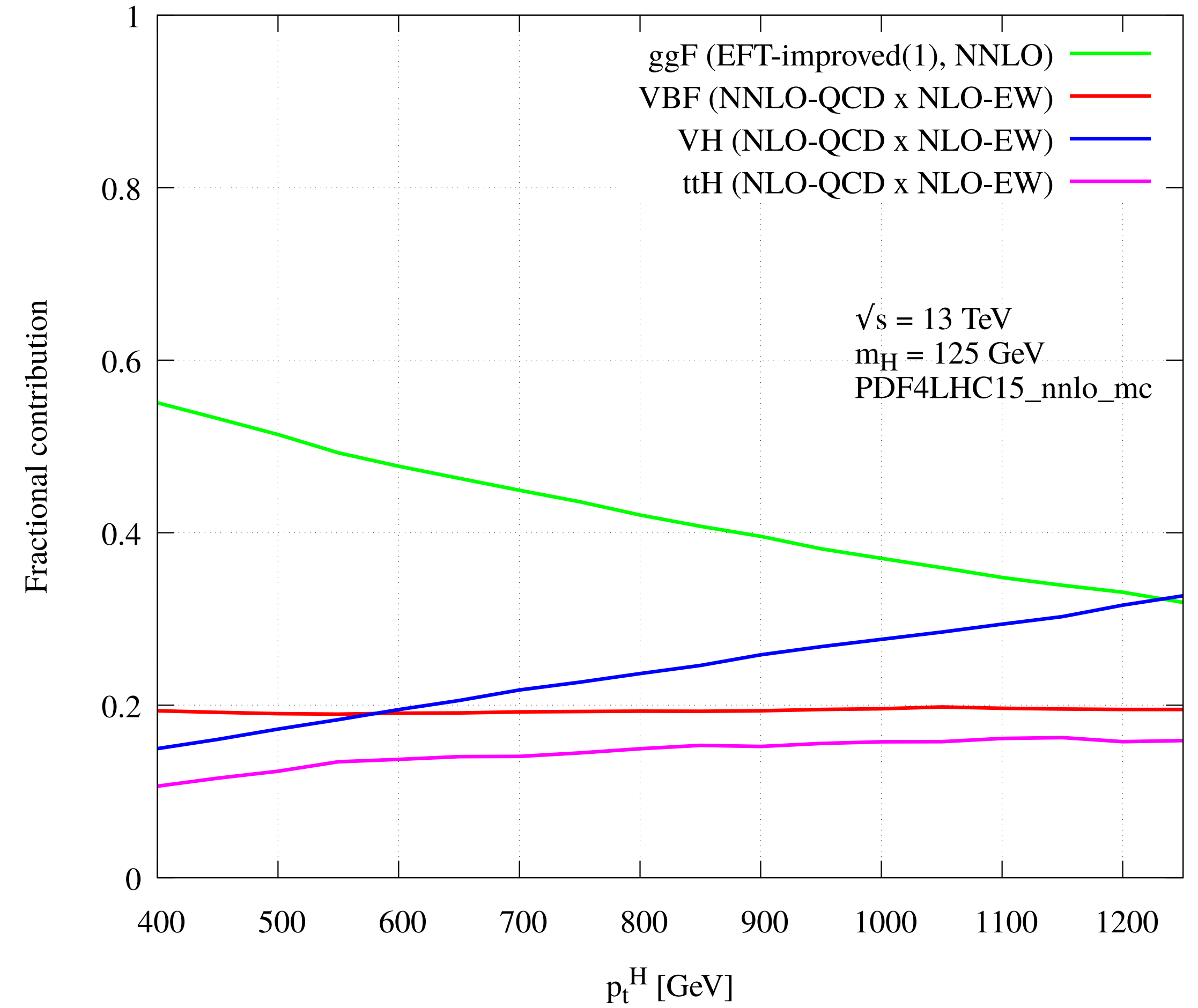
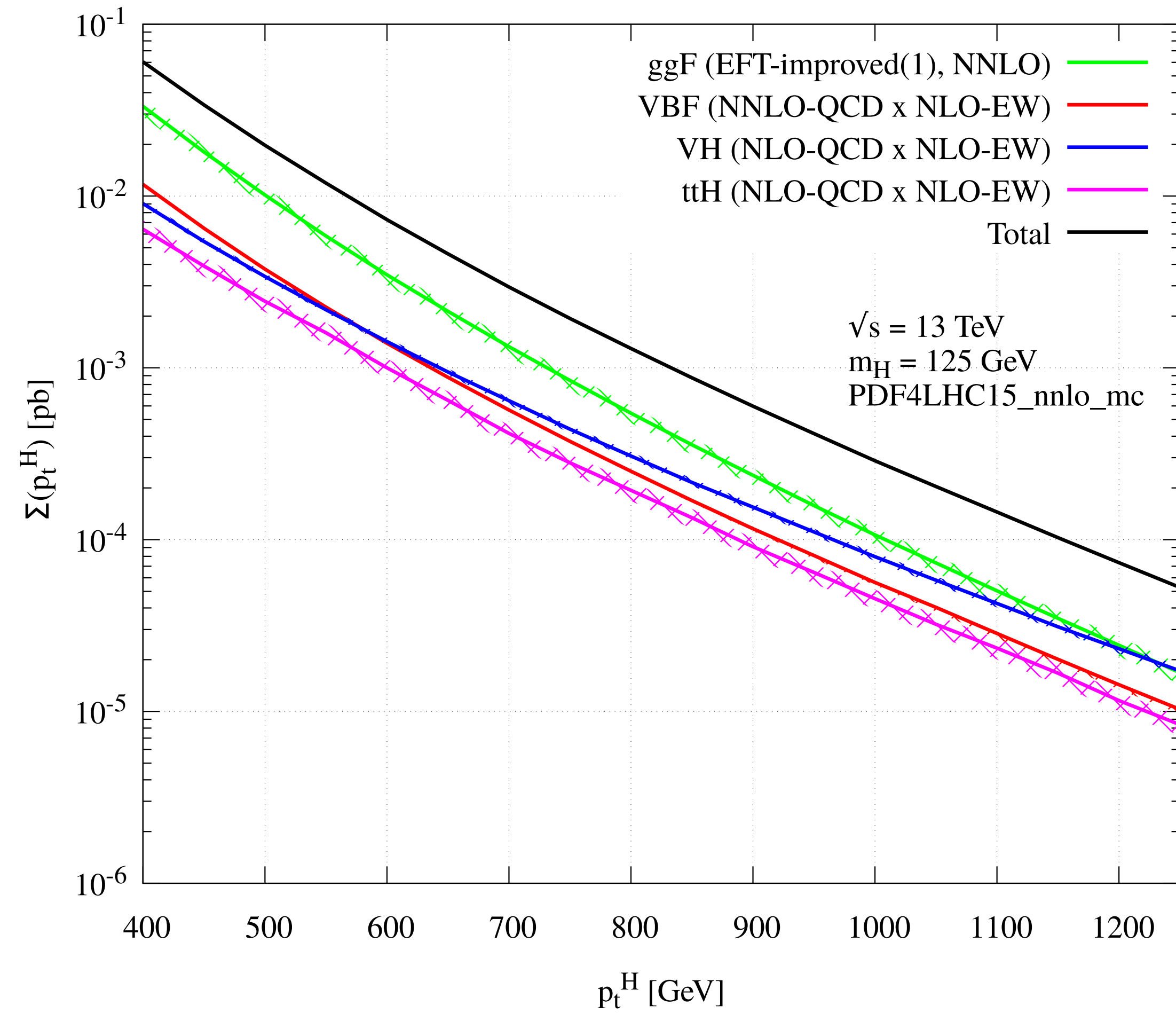


UK Research
and Innovation

Predictions for Boosted Higgs Production
2. March 2022

Higgs at very high- p_T

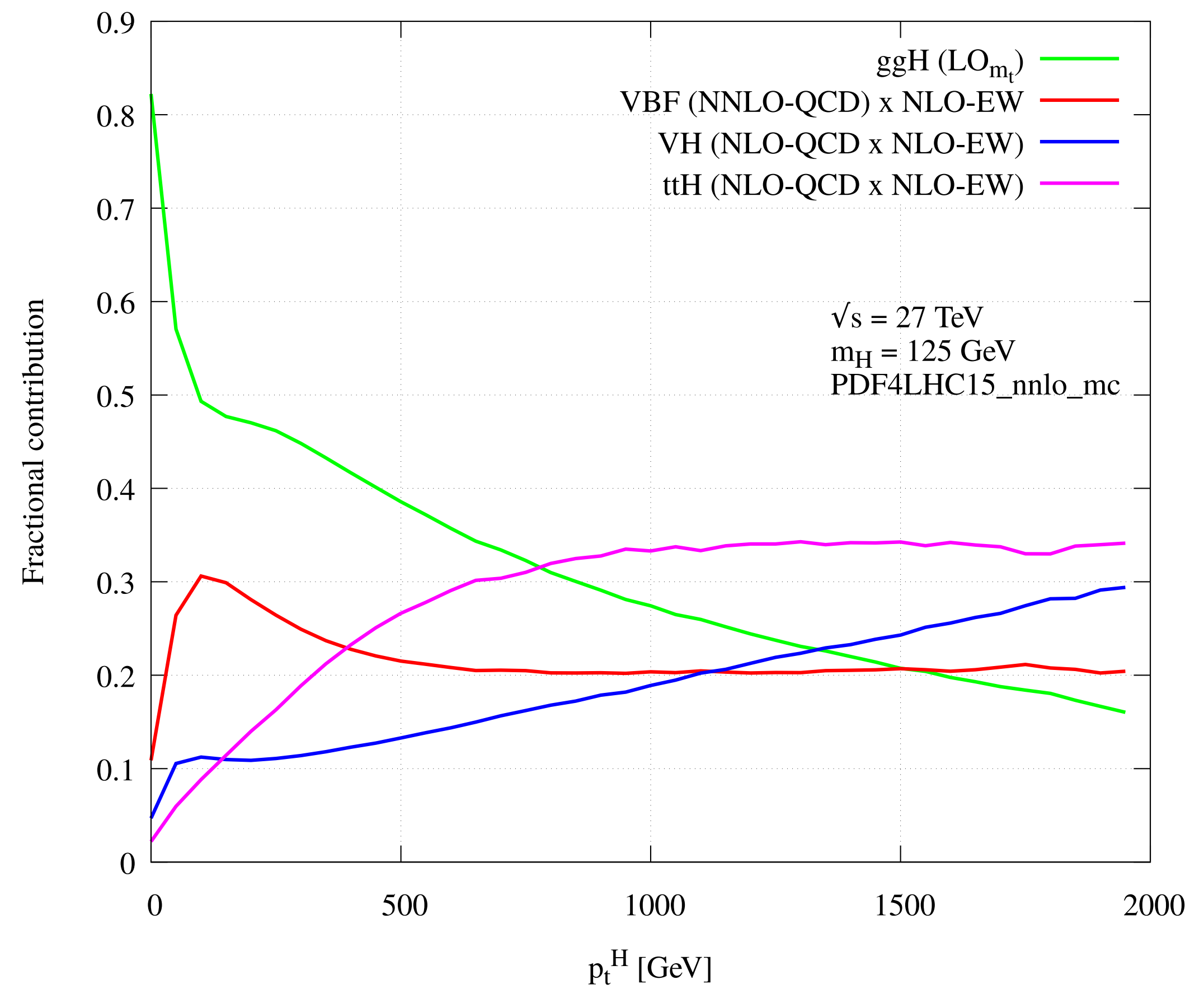
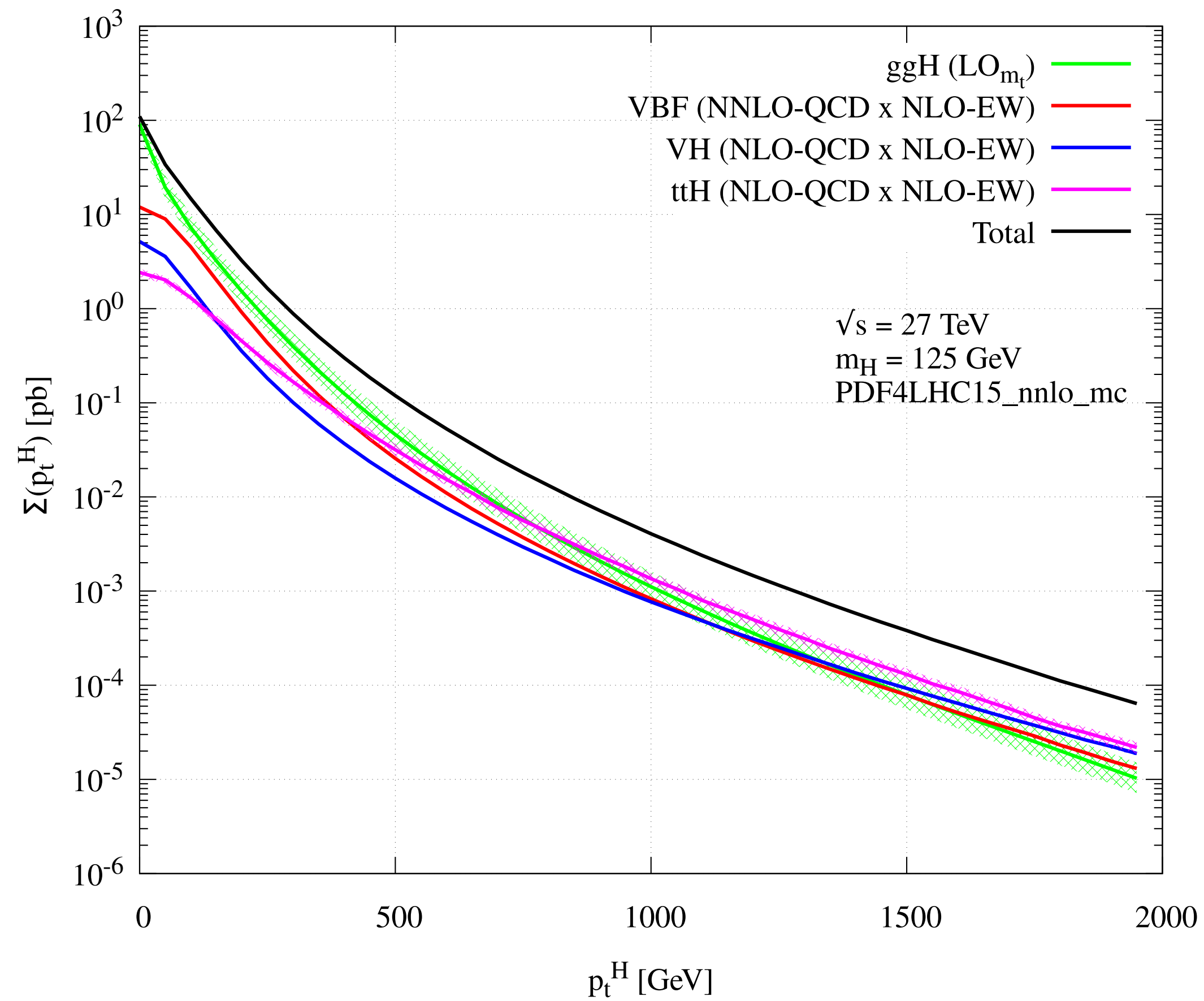
[Becker et. al.]



→ At very high p_T all channels contribute significantly!

Higgs at very high- p_T

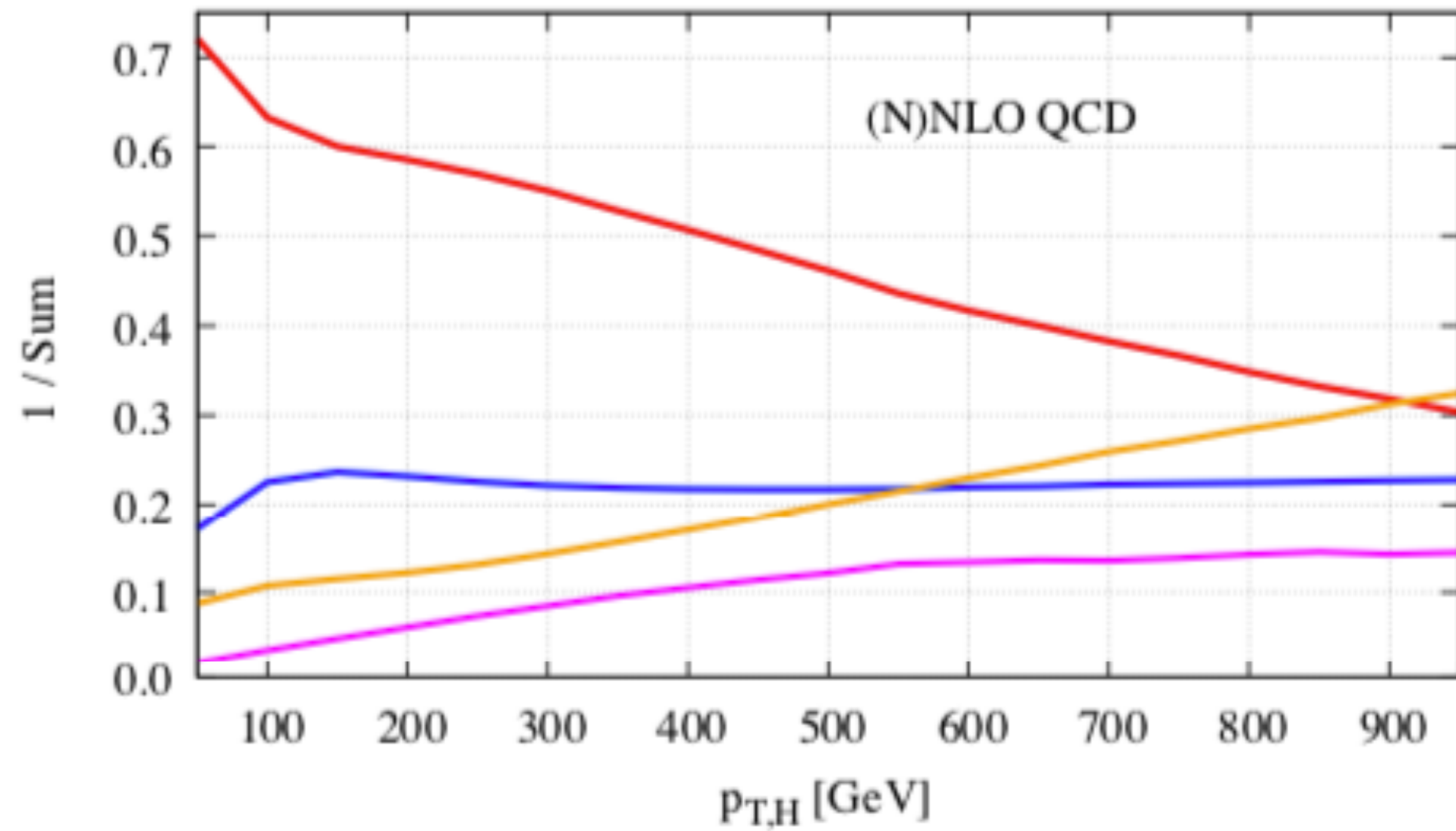
[HL/HE report '19, 1902.00134]



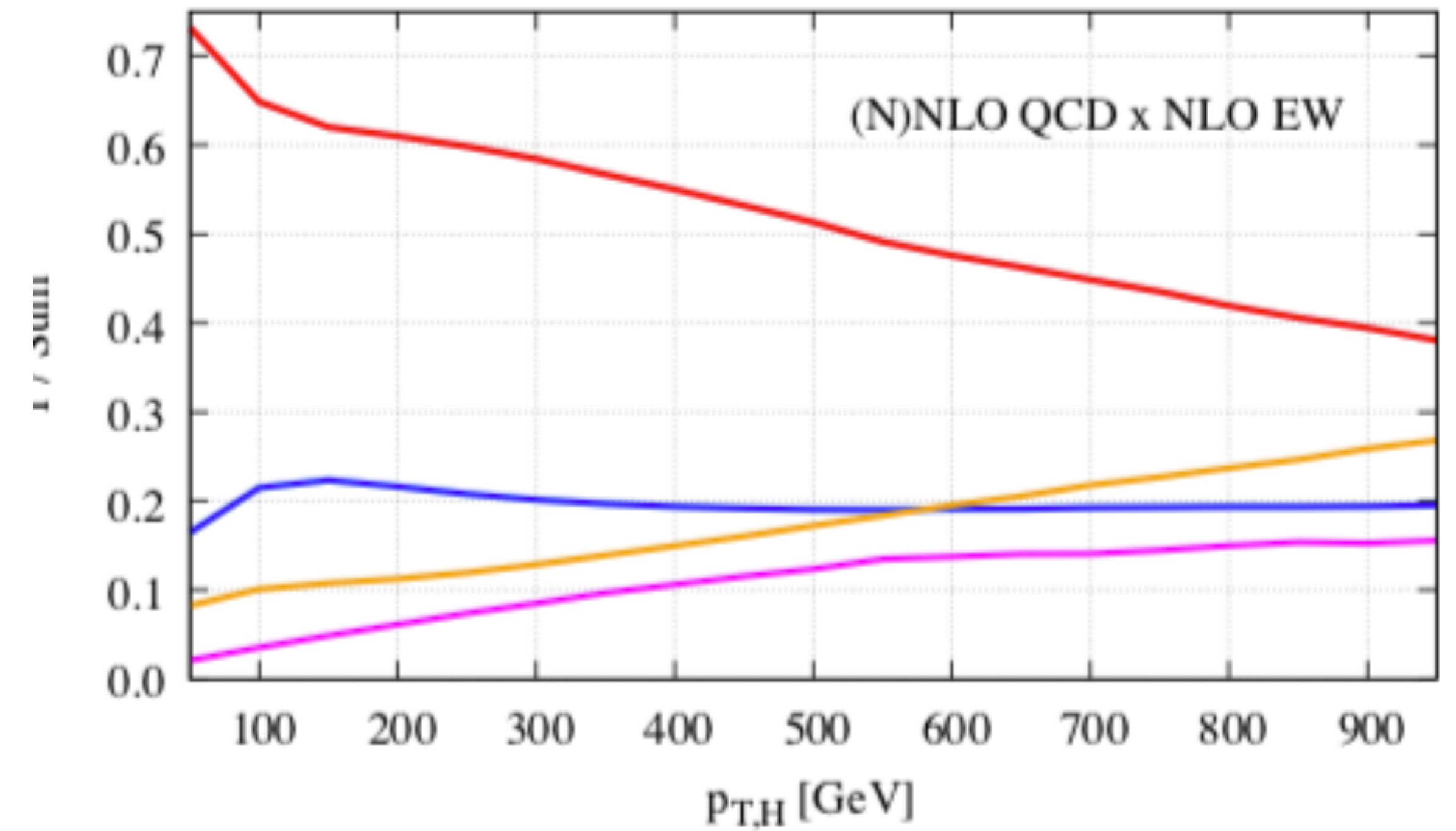
→ At 27 TeV ttH starts dominating at very large Higgs- p_T

EW corrections

[Buckley et. al., 2105.11399] (N)NLO QCD

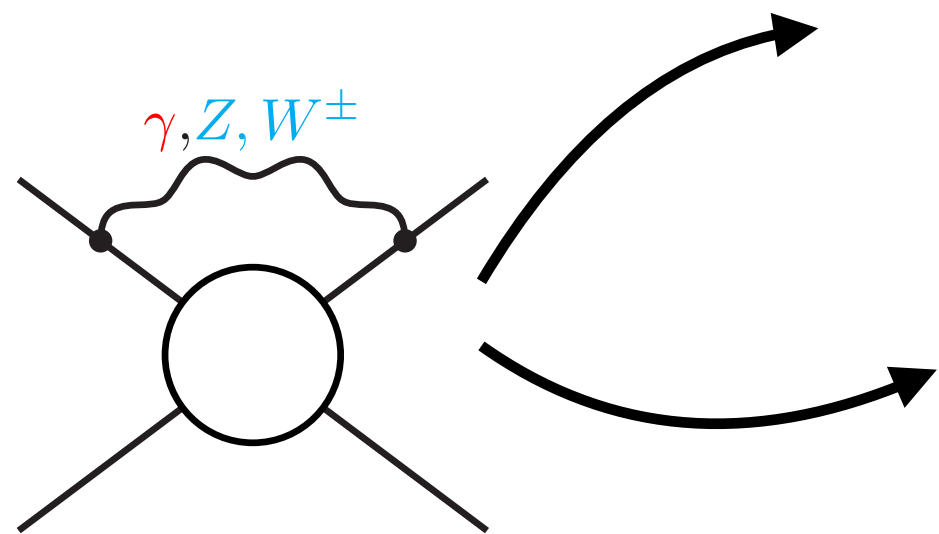
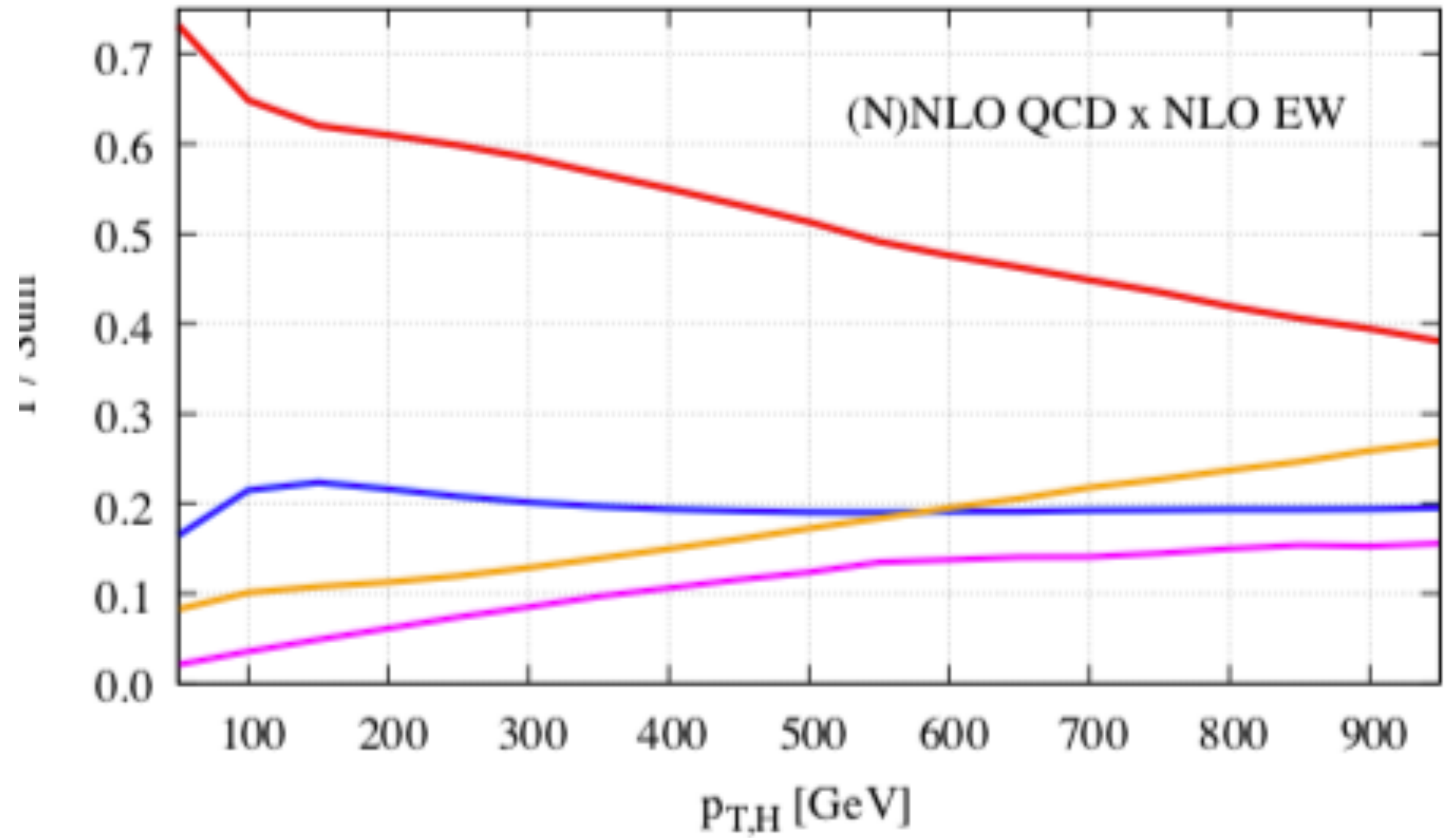
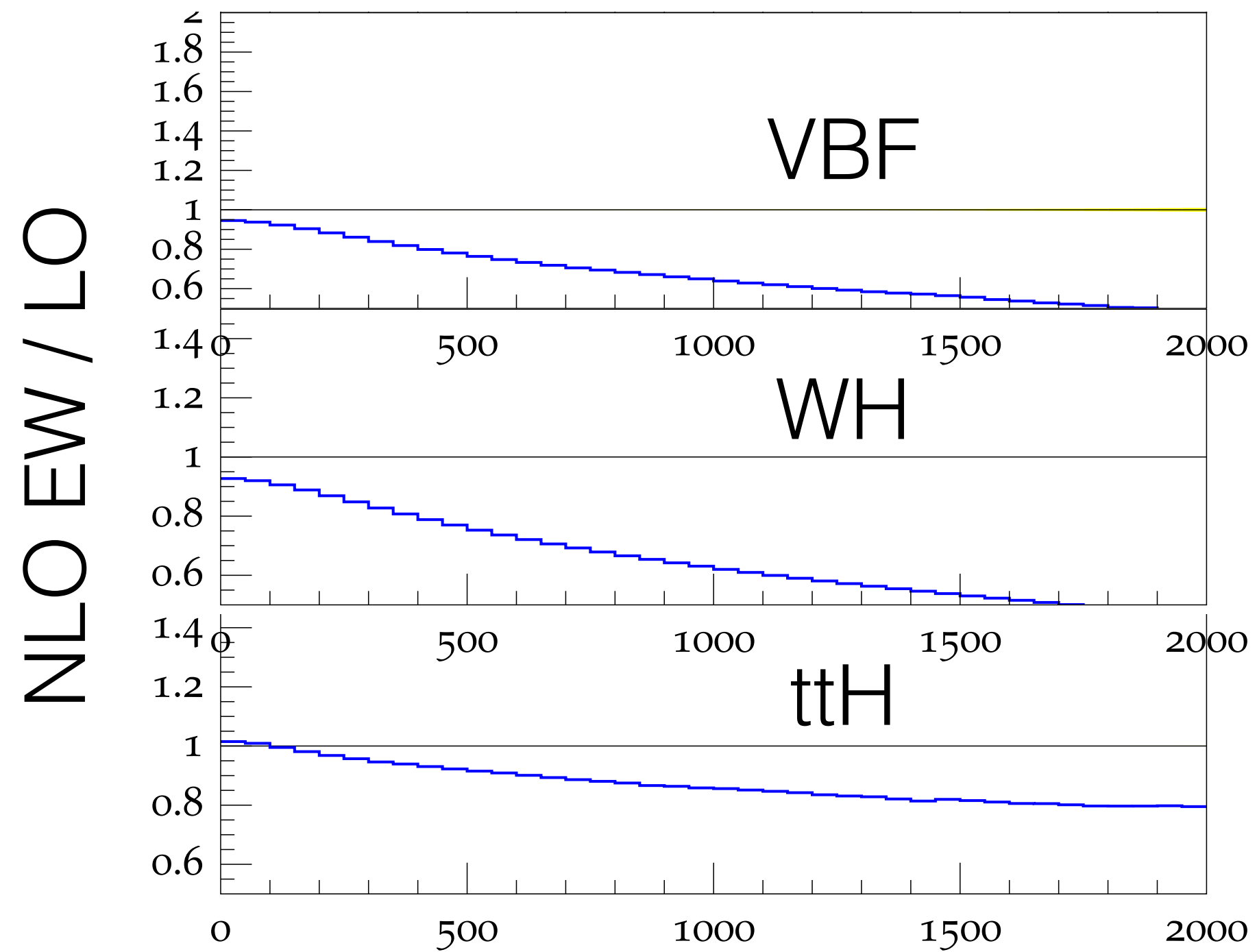


(NN)LOxNLO EW



→ considerable impact of higher-order EW corrections

EW corrections

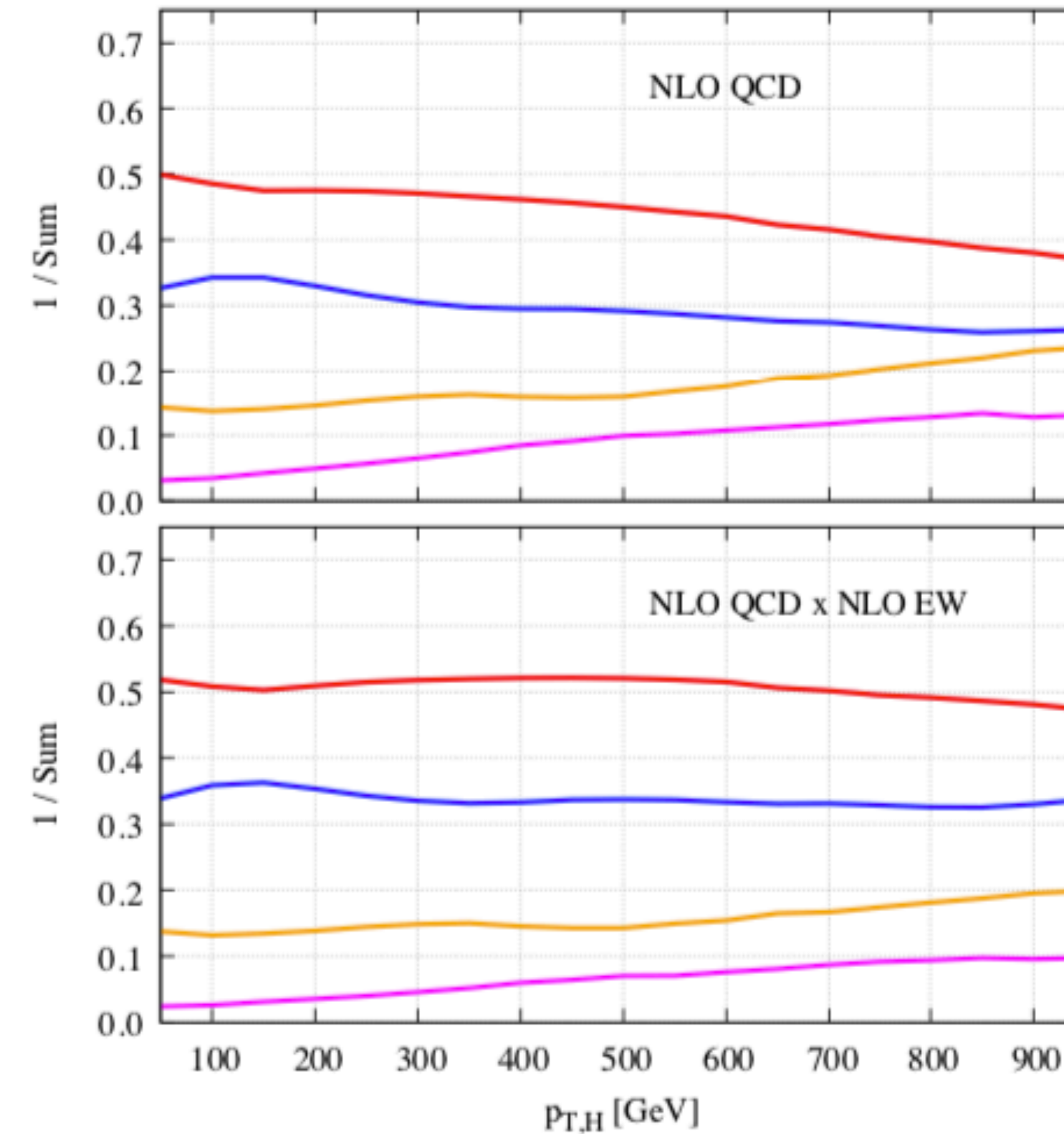
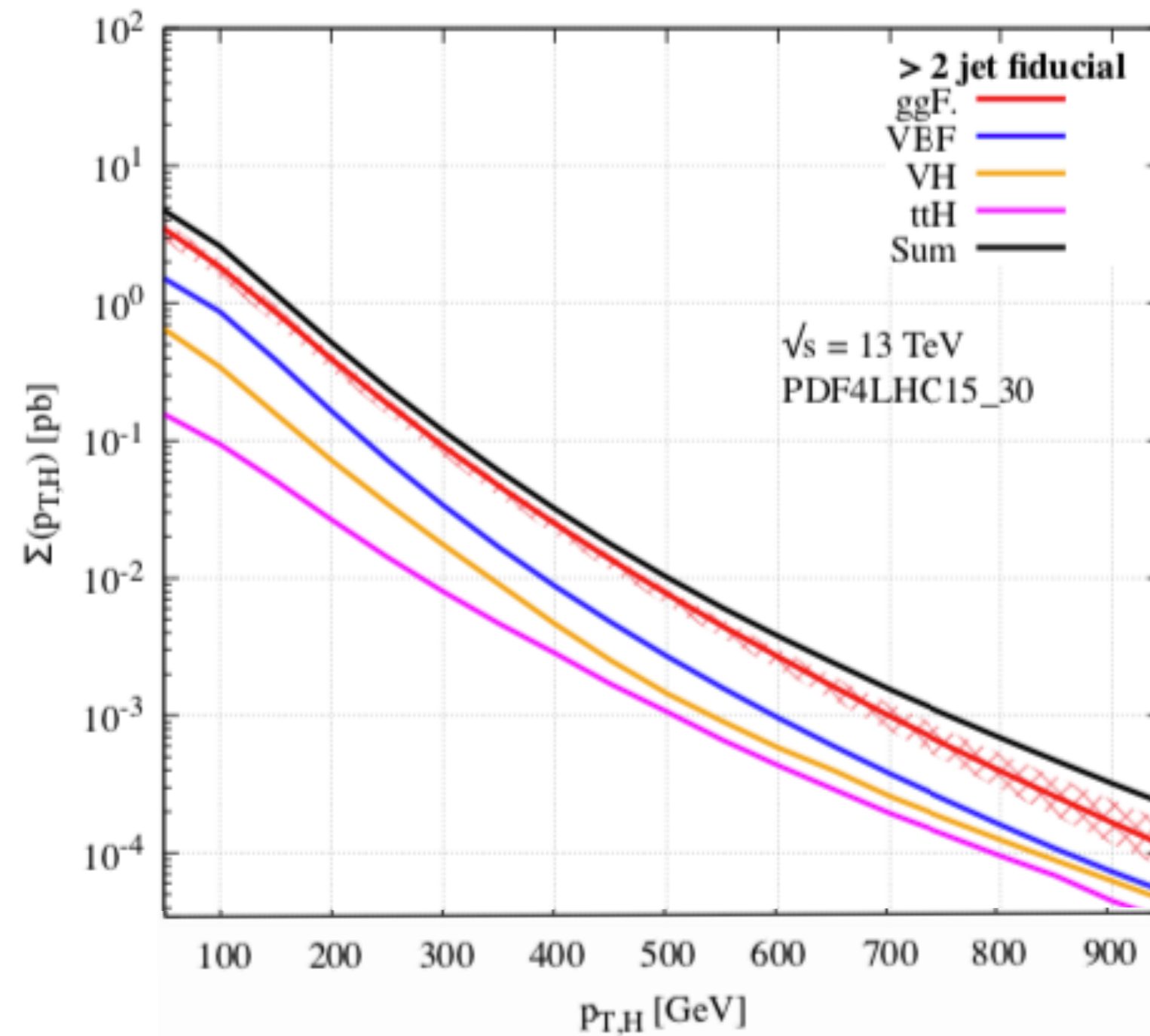


- large negative virtual EW Sudakov corrections (process dependent)
- at high- p_T : crucial to consider NLO EW corrections!

Higgs + 2 jets

[Buckley et al., 2105.11399]

> 2jet fiducial: at least two anti-kT jets with $p_T^{\text{jet}} > 30$ GeV, $|y^{\text{jet}}| < 4.4$



- ggF: H+2jets QCD
- VBF: H+2jets EW
- VH: V(->jj)H
- ttH: tt(all hadronic)H

Outlook

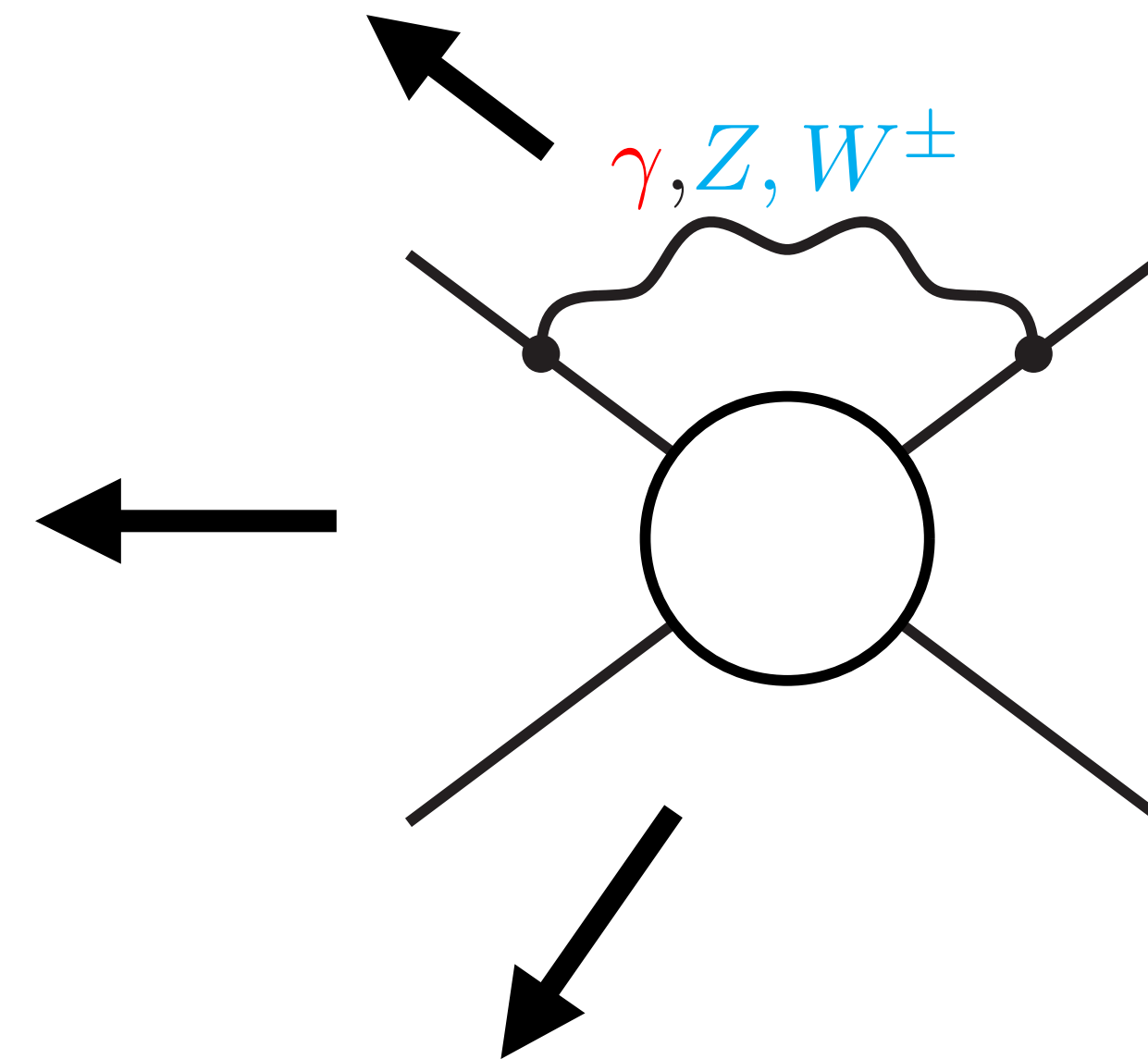
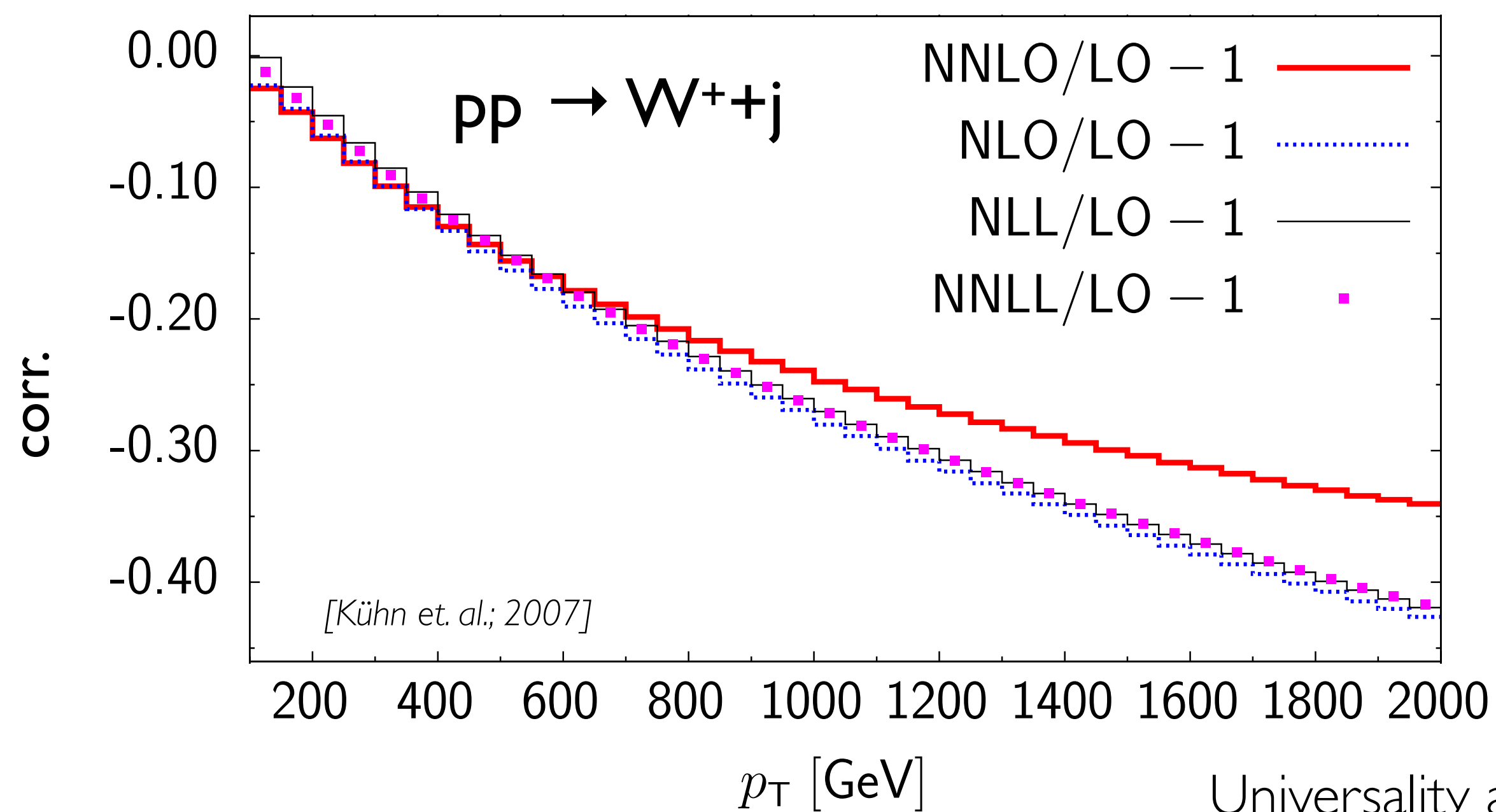
- extend range / update PDFs etc.
- EW corrections/contributions for ggF
- real weak boson radiation
- refine EW corrections? (fiducial cuts)
- define additional EW / QCD-EW uncertainties?

BACKUP

Relevance of EW higher-order corrections

Numerically $\mathcal{O}(\alpha) \sim \mathcal{O}(\alpha_s^2) \Rightarrow$ **NLO EW ~ NNLO QCD**

I. Possible large (negative) enhancement due to soft/collinear **logs** from virtual EW gauge bosons:



[Ciafaloni, Comelli, '98;
Lipatov, Fadin, Martin, Melles, '99;
Kuehen, Penin, Smirnov, '99;
Denner, Pozzorini, '00]

Universality and factorisation: [Denner, Pozzorini; '01]

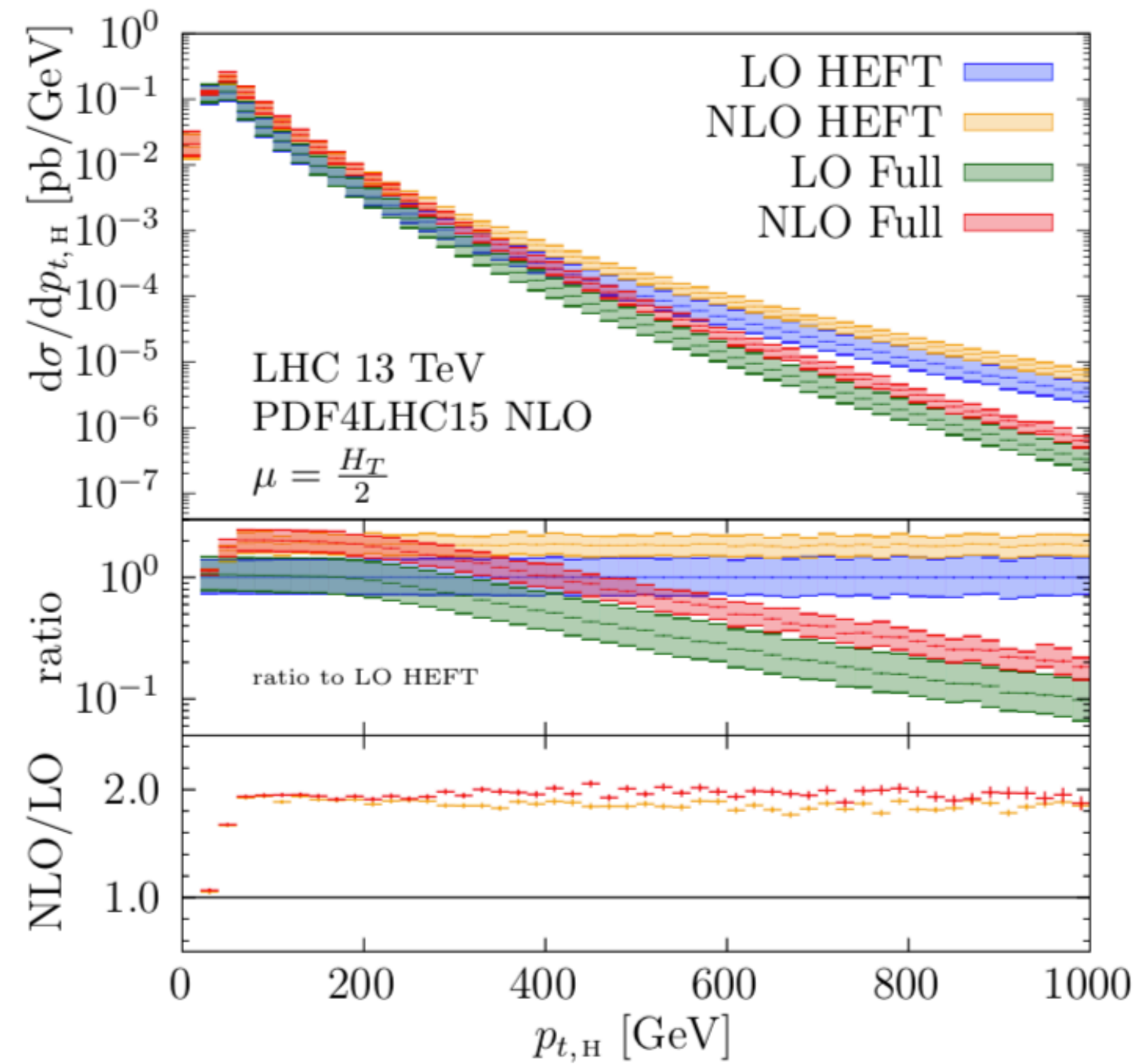
$$\delta\mathcal{M}_{\text{LL+NLL}}^{1\text{-loop}} = \frac{\alpha}{4\pi} \sum_{k=1}^n \left\{ \frac{1}{2} \sum_{l \neq k} \sum_{a=\gamma, Z, W^\pm} I^a(k) I^{\bar{a}}(l) \ln^2 \frac{\hat{s}_{kl}}{M^2} + \gamma^{\text{ew}}(k) \ln \frac{\hat{s}}{M^2} \right\} \mathcal{M}_0$$

\rightarrow overall large effect in the tails of distributions: $p_T, m_{\text{inv}}, H_T, \dots$ (relevant for BSM searches!)

$p_{\perp} > m_t$: top mass effects at NLO

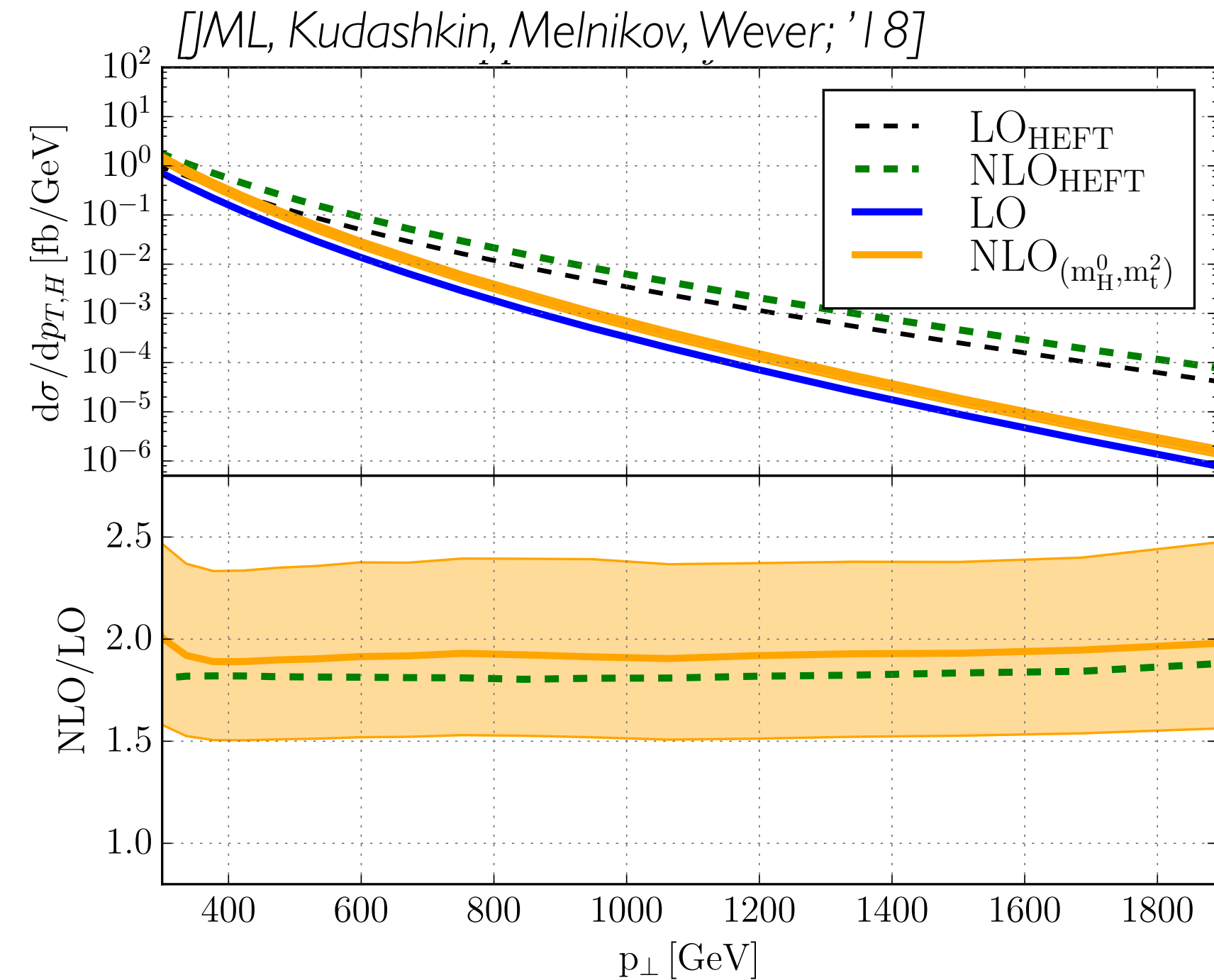
- numerical integration of two-loop integrals based on **SecDec** [Borowka et.al.]
- valid in all of the phase-space

[Iones, Kerner, Luisoni; '18]



- NLO corrections very similar as in HEFT: $K \sim 2$ with remaining scale uncertainties $\sim 20-25\%$
- hardly any shape dependence

- expansion of the two-loop integrals up to $(m_t^2/p_T^2)^1$, $(m_H^2/p_T^2)^0$ at the level of the DE [Kudashkin, Melnikov, Wever; '17]
- valid at %-level for large p_T



→ convincing agreement of results based on numerical and expanded two-loop amplitudes