Yukawa corrections to b anti-b H production (LHC)

LE Duc Ninh

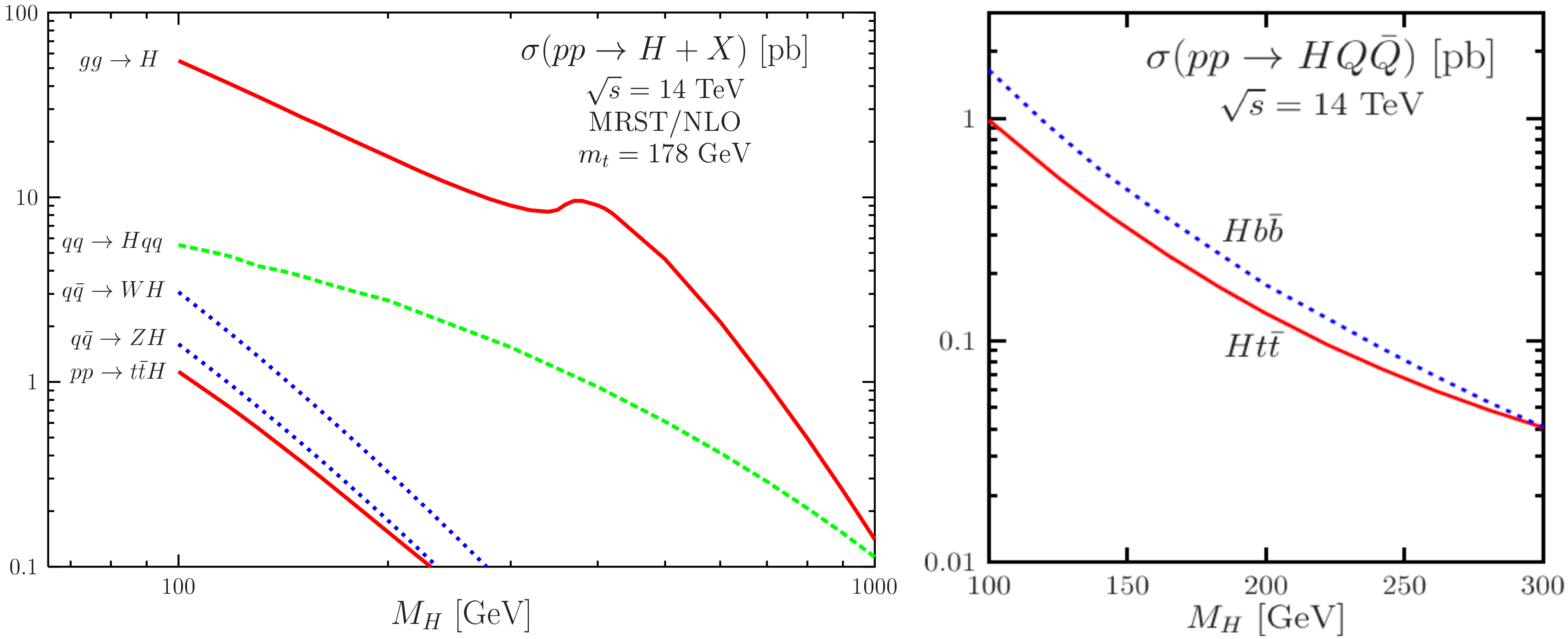
leduc@lapp.in2p3.fr

Laboratoire d'Annecy-le-Vieux de Physique THeorique (LAPTH)

partly based on ref. arXiv:hep-ph/0711.2005; Phys. Rev. D77 033003

(work in collaboration with Fawzi Boudjema)

Why $pp \to b\bar{b}H$?

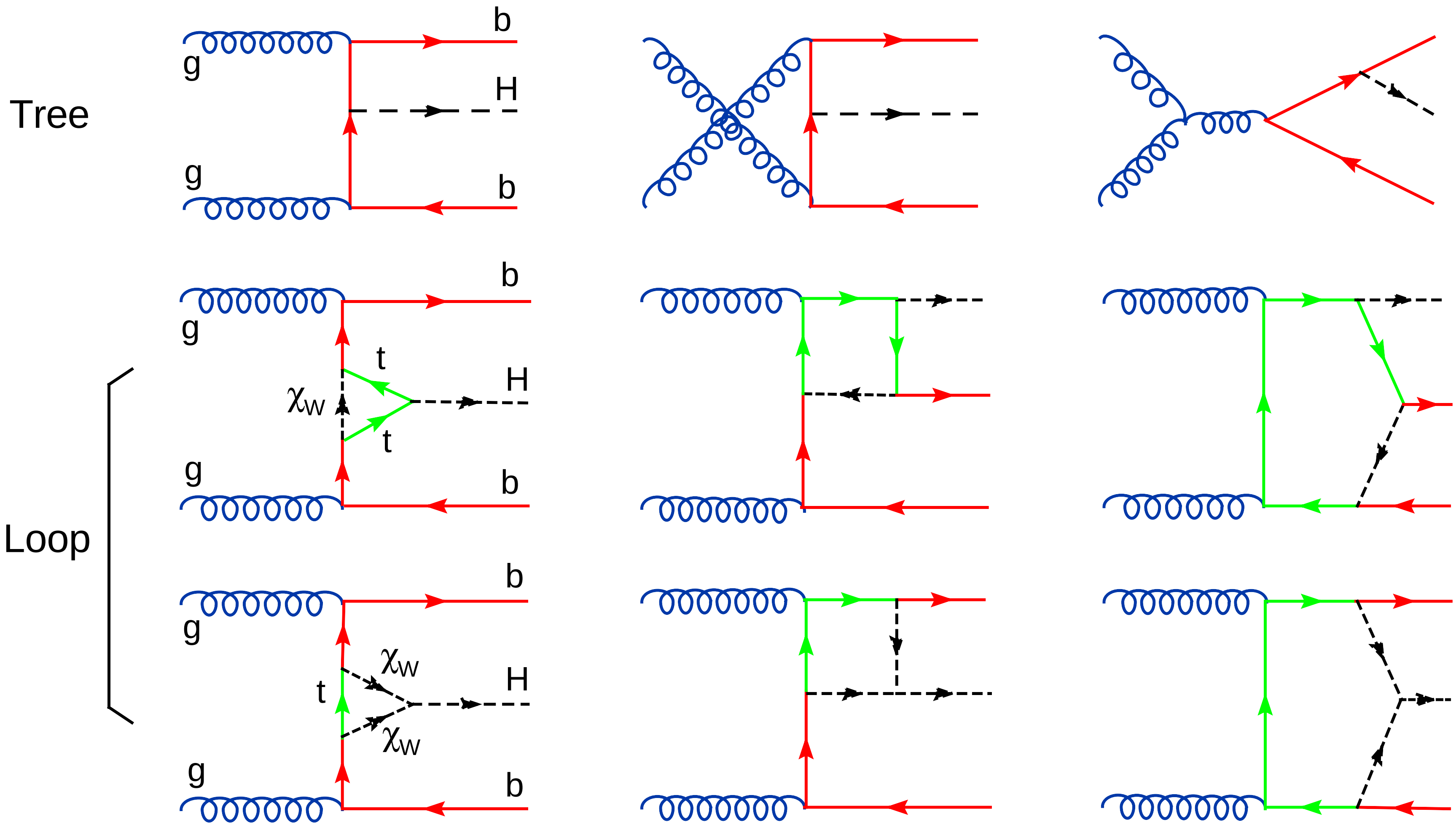


M. Spira, A. Djouadi

- Direct measurement of the λ_{bbH} which can be strongly enhanced in the MSSM.
- Tagging b-jets with high p_T to identify the process, QCD background is reduced.
- $\delta^{NLO}_{QCD} \approx -22\%$ ($M_H = 120$GeV, $\mu = M_Z$)

S. Dittmaier et al., *Phys. Rev. D70 (2004); S. Dawson* et al., *Phys. Rev. D69 (2004).*

Diagrams: $gg \rightarrow b\bar{b}H$



- $\lambda_{ttH} \equiv -\frac{m_t}{v}, \lambda_t = -\sqrt{2}\lambda_{ttH} \approx g_s$
- $\lambda_{\chi^+\chi^- H} \equiv \frac{M_H^2}{v}, \lambda_{tb\chi} = i\lambda_t(P_L - \frac{\lambda_b}{\lambda_t} P_R)$
- $\lambda_{bbH} = 0 \rightarrow \begin{cases} Tree & = 0 \\ Loop & \neq 0 \end{cases}$

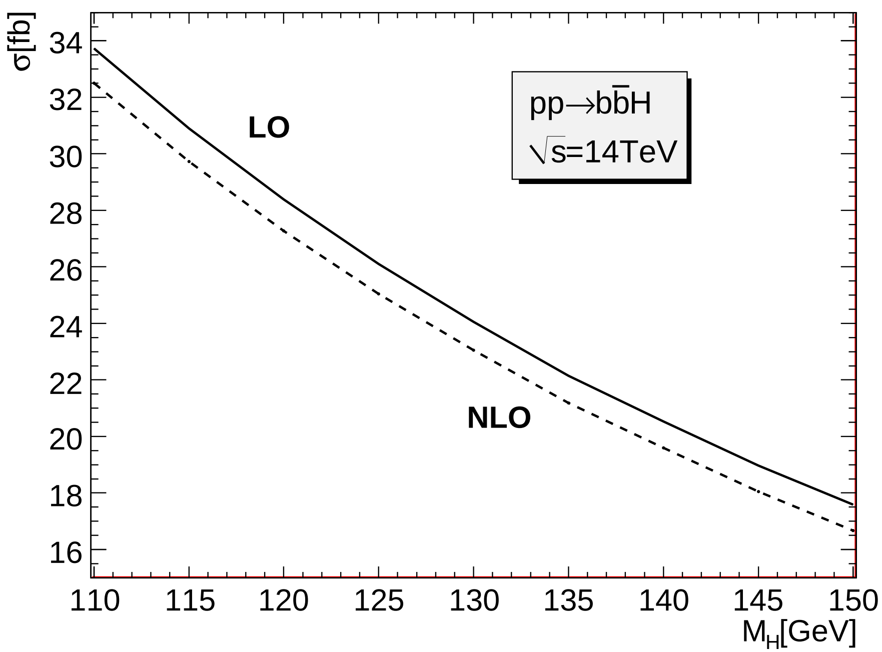
One-loop calculation

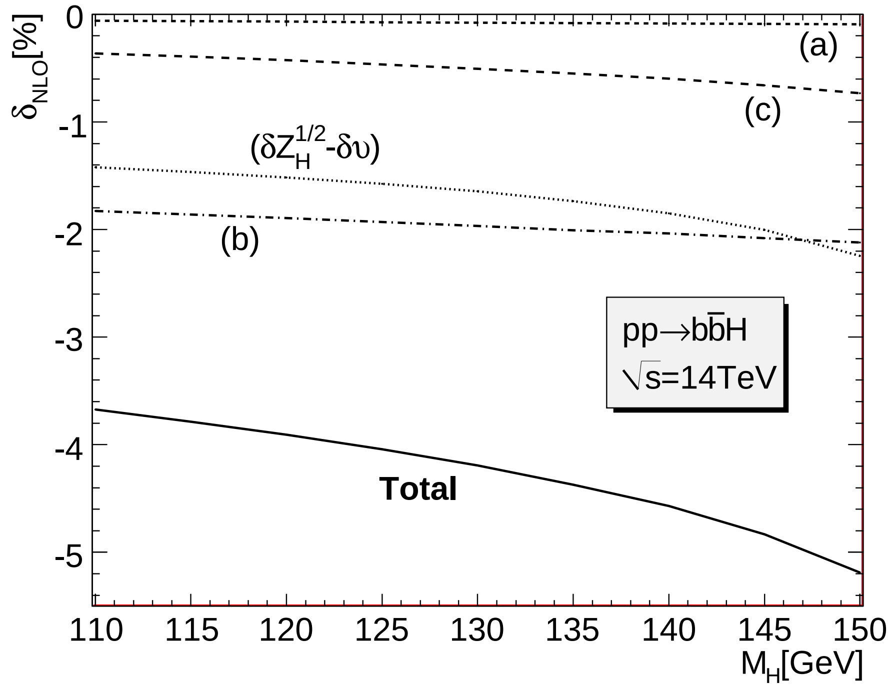
- The total cross section as a function of λ_{bbH} can always be written in the form

$$\begin{aligned}\sigma(\lambda_{bbH}) &= \lambda_{bbH}^2\sigma'(\lambda_{bbH}=0) + \sigma(\lambda_{bbH}=0) + \cdots \\ \lambda_{bbH}^2\sigma'(\lambda_{bbH}=0) &= \sigma_0[1+\delta_{EW}(m_t, M_H)], \\ \sigma(\lambda_{bbH}=0) &= \sigma_{EW}(\lambda_{bbH}=0).\end{aligned}$$

- Approximation: Yukawa corrections (m_t, M_H) $\rightarrow$ leading EW corrections.
- Renormalisation: on-shell scheme.
- Checks on the results: UV finite and QCD gauge invariant.

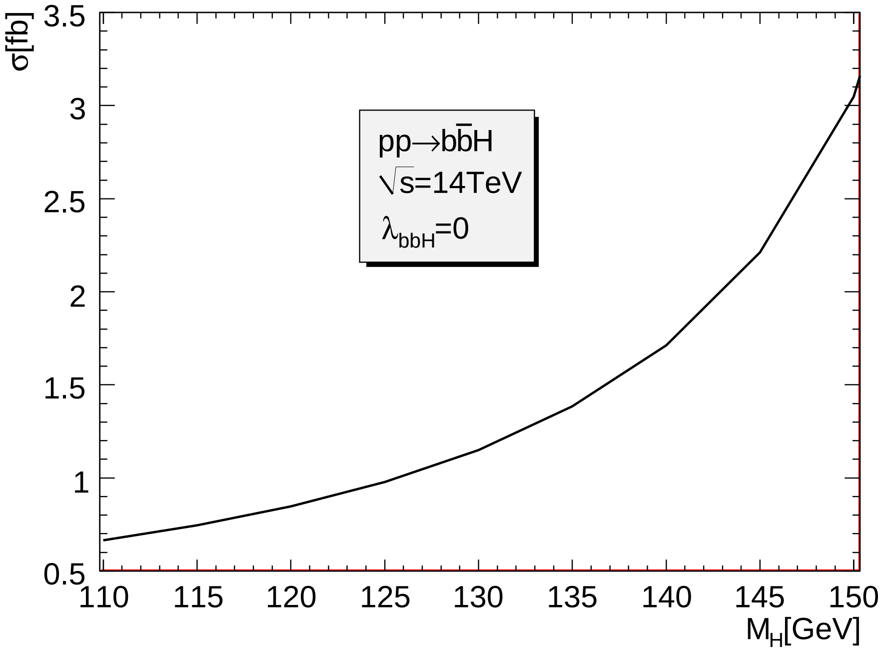
Cross section@NLO

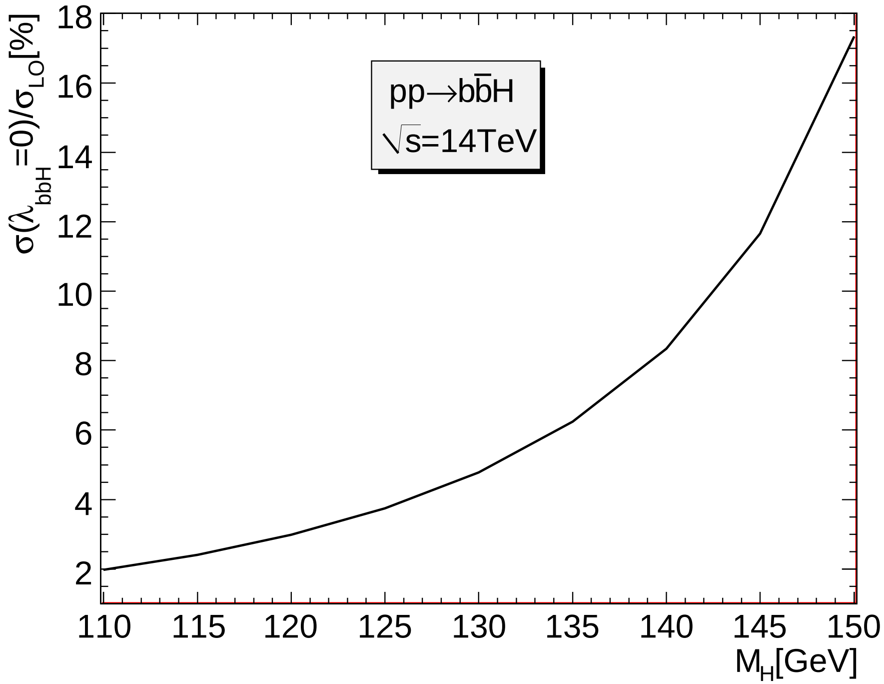




- Input parameters: $\sqrt{s} = 14$TeV, $m_b = 4.62$GeV, $m_t = 174$GeV, $Q = M_Z$.
- Cuts: $\mathbf{p}_T^{b,\bar{b}} > 20$GeV, $|\eta_{b,\bar{b}}| < 2.5$.
- $\delta_{EW}/\delta_{QCD} \approx 1/5$ ($M_H = 120$GeV).

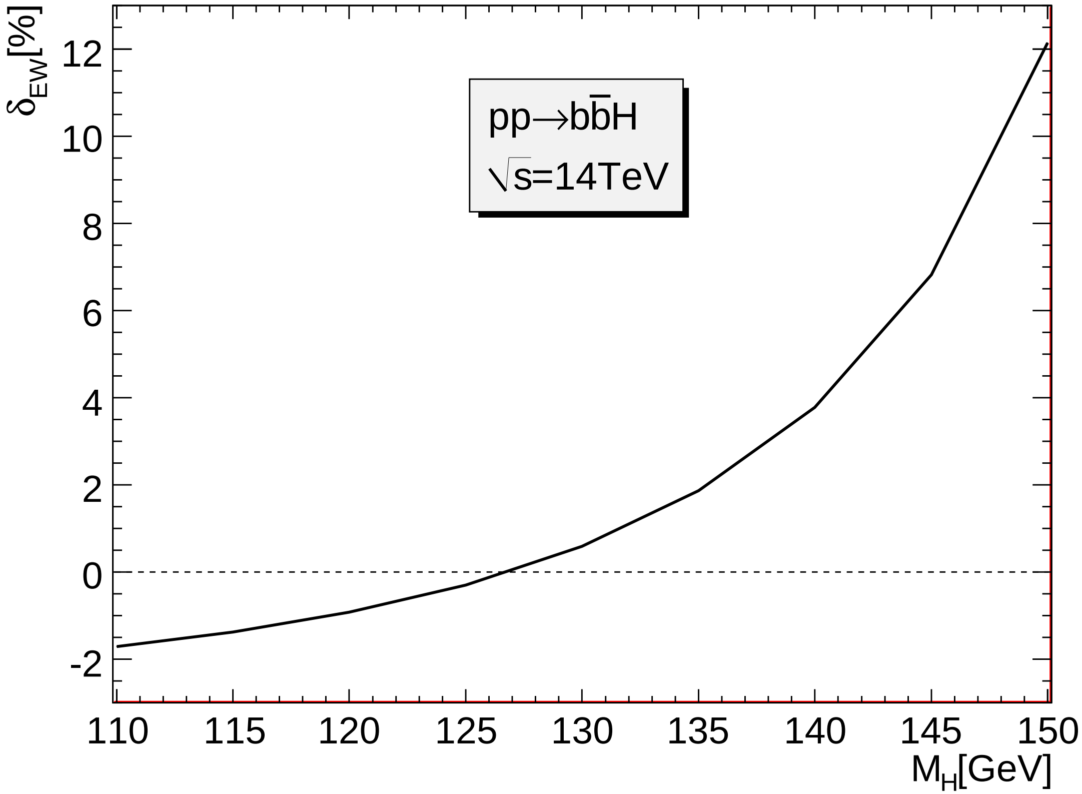
$\sigma_{EW}(\lambda_{bbH} = 0)$: $M_H < 2M_W$





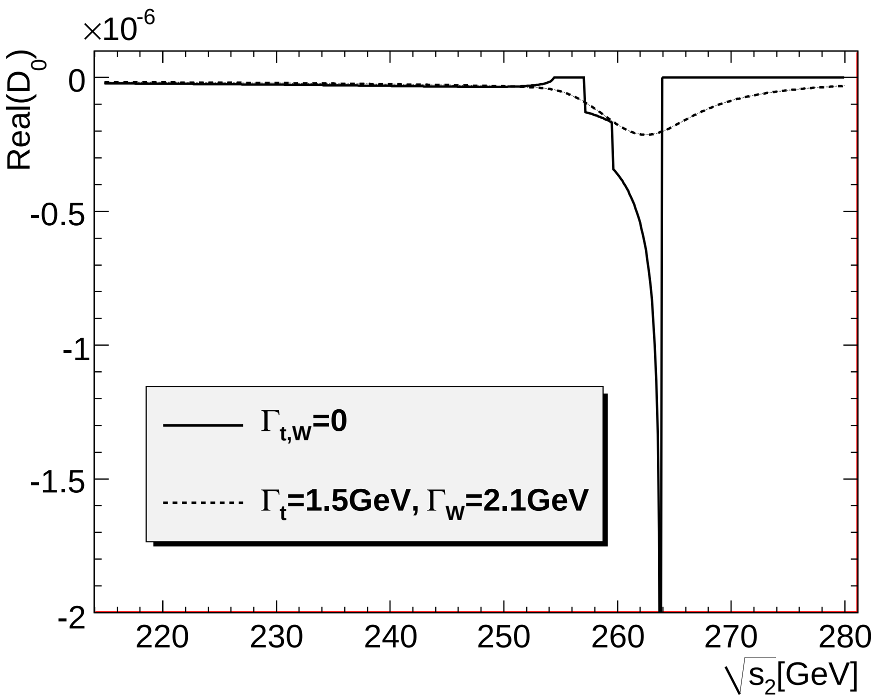
- it rapidly increases when $M_H \to 2M_W$.

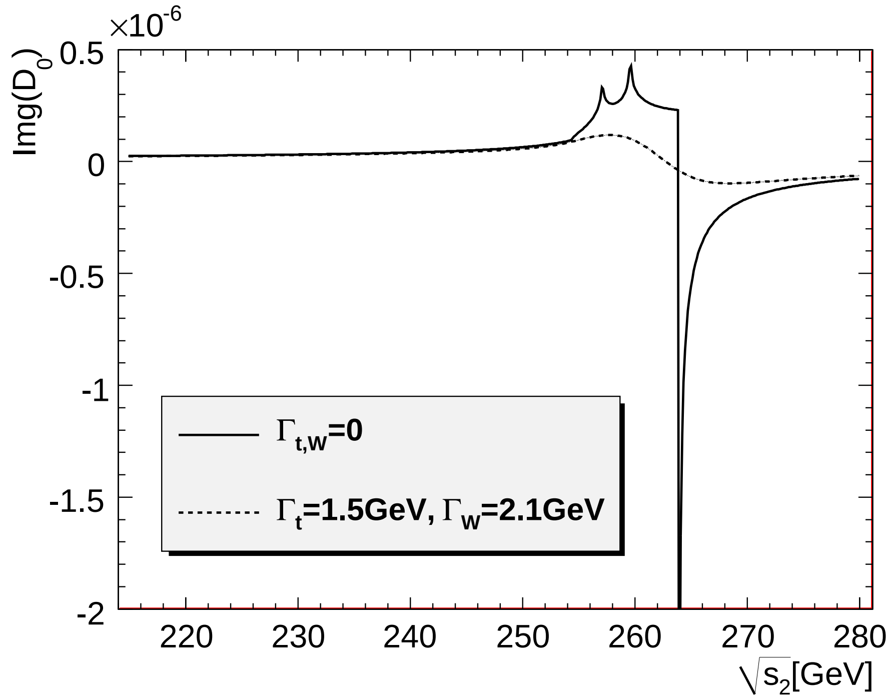
Sum of two contributions: $M_H < 2M_W$

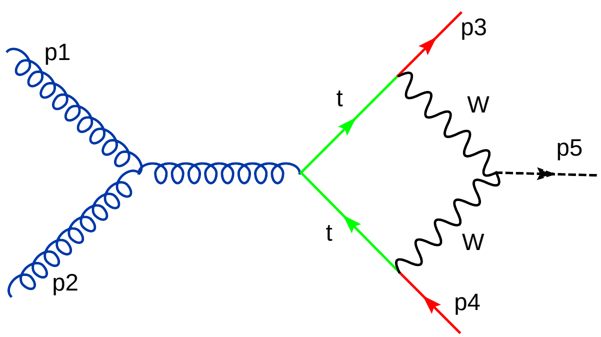


$$\delta_{EW} \equiv \delta_{NLO} + \frac{\sigma(\lambda_{bbH} = 0)}{\sigma_0}.$$

$M_H \geq 2M_W$: leading Landau singularity







$s_2 = (p_4 + p_5)^2$

- The leading Landau singularity occurs when $M_H \geq 2M_W$ and $\sqrt{\hat{s}} \geq 2m_t$ (Ws and ts on-shell).
- Not integrable at the amplitude square level.
- Solved by introducing $\Gamma_{t,W}$.
- Conclusion: the LLS can lead to a large correction, *e.g.* 49% *for* $M_H = 163$*GeV*. To be published in F. Boudjema and LDN, hep-ph/0804xxx.