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LEADING ELECTROWEAK CORRECTIONS TO THE PROCESS $pp \to b\bar{b}H$ IN THE STANDARD MODEL AT THE LHC*

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We investigate the leading one-loop electroweak corrections to the process $pp \to b\bar{b}H$ in the SM. We find that the NLO electroweak correction to the total cross-section at the tree level is about -4% if the Higgs mass is 120 GeV. In the limit of vanishing bottom Yukawa coupling the cross section is generated solely at the loop level. This contribution is very small at $M_H \sim 120$ GeV and increases with growing Higgs mass, reaching about $+17\%$ of the cross-section when the Higgs mass is about 150 GeV.

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1. Introduction

In the Standard Model (SM) the dominant mechanisms for Higgs production at the Large Hadron Collider (LHC) are the gluon and electroweak (EW) gauge boson fusion processes [1]. Higgs production associated with heavy quarks like the top or bottom quark is not considered as a discovery channel because of its small total cross-section. However, if one wants to determine the bottom-Higgs Yukawa coupling (λ_{bbH}) then Higgs production associated with a bottom–antibottom pair could provide a direct measurement of this coupling. In the minimal supersymmetric standard model (MSSM), the bottom Yukawa coupling is enhanced by a factor $\tan\beta$, the ratio of the vacuum expectation values of the two Higgs doublets. For high $\tan\beta$ this provides an important discovery channel for the supersymmetric Higgses. In order to exploit this production mechanism to study the Higgs couplings to b's, one must identify the process and therefore one needs to

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tag both b's, requiring somewhat large p_{T} b's. This reduces the cross-section but gives a much better signal over background ratio. The next-to-leading order (NLO) QCD correction to the exclusive process $pp \to b\bar{b}H$ has been calculated by two groups [2]. The aim of this work is to calculate the leading electroweak corrections (LEWC) to the exclusive bbH final state at the LHC. These LEWCs are triggered by top-charged Goldstone loops whereby, in effect, an external b quark turns into a top quark. Such type of transitions can even trigger $gg \to b\bar{b}H$ even with vanishing λ_{bbH}, in which case the process is generated solely at one-loop level.

2. Numerical results

At the LHC, the dominant contribution comes from the sub-process $gg \to b\bar{b}H$. The contribution from the light quarks in the initial state is therefore neglected in our calculation. The total cross-section as a function of λ_{bbH} can be written in the form

$$\begin{aligned} \sigma(\lambda_{bbH}) &= \sigma(\lambda_{bbH}=0) + \lambda_{bbH}^2 \sigma'(\lambda_{bbH}=0) + \cdots , \\ \lambda_b^2 \sigma'(\lambda_{bbH}=0) &\approx \sigma_{\mathrm{NLO}} = \sigma_{\mathrm{LO}}[1+\delta_{\mathrm{NLO}}(m_t, M_H)] , \end{aligned}$$

where $\sigma(\lambda_{bbH}=0)$ is shown in Fig. 1 (right), σ_{LO} and σ_{NLO} are shown in the same figure (left). $\sigma(\lambda_{bbH}=0)$ is generated solely at one-loop level and gets large when M_H is close to $2M_W$. This is due to the threshold effect occurring when the Higgs is produced by an on-shell-W fusion process.

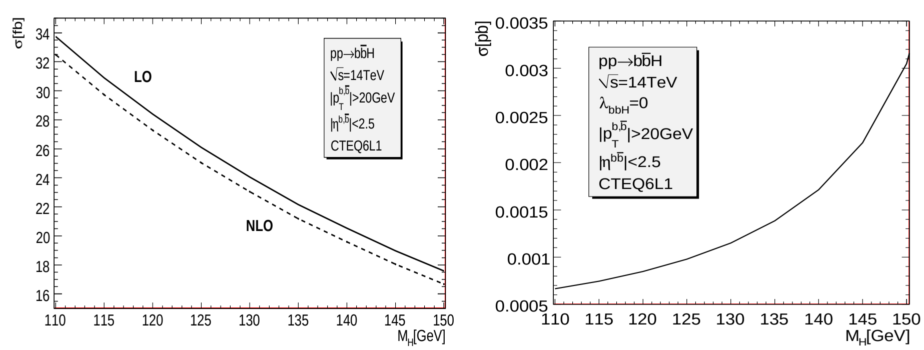

Fig. 1. Left: the leading order (LO) and NLO cross-sections as functions of M_H. Right: the cross-section in the limit of vanishing λ_{bbH}. The phase space integral is done by using BASES [3], the loop integrals are done by using LoopTools [4].

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