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

Le Duc Ninh

LAPTH, Université de Savoie, CNRS
BP 110, 74941 Annecy-le-Vieux Cedex, France
and
CERN, Theory Division, 1211 Geneva 23, Switzerland

(Received November 11, 2007)

We investigate the leading one-loop electroweak corrections to the process $pp \rightarrow b\bar{b}H$ 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.

PACS numbers: 14.80.Bn, 12.15.Lk

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 ($\lambda_{bbH}$) 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

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 \( pp \to bbH \) 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 \( gg \to bbH \) even with vanishing \( \lambda_{bbH} \), 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 \( gg \to bbH \). The contribution from the light quarks in the initial state is therefore neglected in our calculation. The total cross-section as a function of \( \lambda_{bbH} \) can be written in the form

\[
\sigma(\lambda_{bbH}) = \sigma(\lambda_{bbH} = 0) + \lambda_{bbH}^2 \sigma'(\lambda_{bbH} = 0) + \cdots,
\]

\[
\lambda_{bbH}^2 \sigma'(\lambda_{bbH} = 0) \approx \sigma_{NLO} = \sigma_{LO}[1 + \delta_{NLO}(m_t, M_H)],
\]

where \( \sigma(\lambda_{bbH} = 0) \) is shown in Fig. 1 (right), \( \sigma_{LO} \) and \( \sigma_{NLO} \) 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 \( \lambda_{bbH} \). The phase space integral is done by using BASES [3], the loop integrals are done by using LoopTools [4].

I would like to acknowledge the Marie Curie Early Stage Training grant and the Rencontres du Vietnam scholarship.
REFERENCES