

Chapter 1

Summary and Conclusion

In the literature, there are numerous studies done on Higgs production through several channels. Though Higgs decays into b jets carry the highest branching ratio, this channel was not of interest due to high QCD backgrounds, and $b\bar{b}\tau^-\tau^+$ was the next promising channel to consider for future targets, like measuring Higgs self couplings. In this study, we evaluated some important cross sections for measuring the trilinear Higgs couplings at the LHC. The processes we considered here were $pp \rightarrow hh \rightarrow b\bar{b}b\bar{b} + X$ and $pp \rightarrow hh \rightarrow b\bar{b}\tau^+\tau^- \rightarrow b\bar{b}lj_\tau + \cancel{E}_T$ for both the SM and the MSSM via gluon fusion and b quark fusion. Using a new method of mass cuts on the $b\bar{b}b\bar{b}$ final state, we could reduce 90% of background while saving 80% of the signal. For the SM, this improved the ratio of signal vs background significantly which could lead to measurements of the trilinear Higgs couplings at the LHC in future, probably at $\sqrt{s} = 14$ TeV.

In the MSSM, b quark fusion is especially interesting because the couplings and, hence the signal, can be greatly enhanced with large values of $\tan \beta$. Neutral Higgs production via b quark fusion was studied, and with the updated mass cut for the $4b$ final state, we could get $N_{ss} = 2.87(9.0)$ with signal events of 2562(25620) for the integrated luminosity $= 300(3000) fb^{-1}$, at $\sqrt{s} = 14$ TeV for a pseudo scalar mass of 200 GeV and for $\tan \beta = 50$. We also evaluated the $b\bar{b}\tau^+\tau^-$ final state followed by $\tau^+\tau^- \rightarrow lj_\tau + \cancel{E}_T$ both via gluon fusion and b quark fusion. With the selection cuts applied to the reconstructed mass of Higgs from $\tau^+\tau^-$, the cross section rates were

improved and hence the significance.

The results presented in this study conclude that gluon fusion with a $(b\bar{b})(b\bar{b})$ final state places a high constraint on measuring the trilinear Higgs couplings in the SM at the LHC running at 14 TeV. SM Higgs pair production via gluon fusion was studied here with the ratio of Higgs self couplings (κ). For $\kappa = 1$, a statistical significance of 6.9 (with 137 events for the signal) and 7.7 (with 180 events for the signal) was obtained for $b\bar{b}b\bar{b}$ final state and the $b\bar{b}\tau^+\tau^- \rightarrow b\bar{b}lj_\tau$ final state respectively with integrated luminosity of 3000 fb^{-1} at the LHC 14 TeV. With these results, we can claim that there is a high possibility of measuring the trilinear Higgs self coupling at the LHC through these two channels. However, for a precise measurement of trilinear Higgs couplings, we also investigated the possible processes for measuring it at the proposed electron positron linear collider, the ILC, in the future.

References