

## Direct constraints on the top-Higgs coupling from the 8 TeV LHC data

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The LHC experiments have analyzed the 7 and 8 TeV LHC data in the main Higgs production and decay modes. Current analyses show a near degeneracy in the relative sign of the  $Ht\bar{t}$  and  $HWW$  couplings. In order to remove this degeneracy and strongly constrain these couplings we have consider single top production in association with a Higgs in the  $t$ -channel. This process can be very sensitive to both the magnitude and the sign of a non-standard top-Higgs coupling. We show that at 8 TeV center of mass energy and  $50 \text{ fb}^{-1}$  integrated luminosity the combination of diphoton and multi-lepton signatures, originating from different combinations of the top and Higgs decay modes, can be a potential probe to constrain a large portion of the negative top-Higgs coupling space presently allowed by the ATLAS and CMS global fits.

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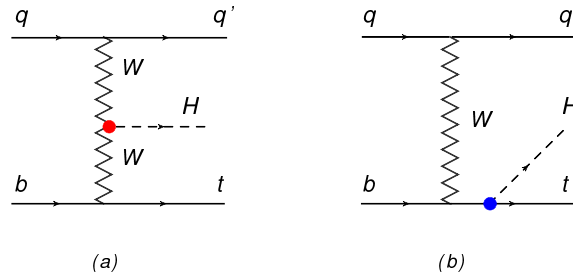
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\*Speaker.

## 1. Introduction

The discovery of a Higgs-like resonance at the LHC [1] has started up a new phase in the experimental exploration of the electroweak symmetry-breaking (EWSB) mechanism of the standard model (SM). The observed resonance is, within present experimental errors, well compatible with the minimal structure of a Higgs sector. However, it is important to pin down its properties and couplings with other SM particles. With the present moderate statistics collected at 7 and 8 TeV ( $\sim 25 \text{ fb}^{-1}$  per experiment), where the main analyses are based on the  $H \rightarrow \gamma\gamma, ZZ^*, WW^*$  signatures, global fits for the Higgs-like particle couplings are made under simplified assumptions [2, 3] and show a near degeneracy in the relative sign of the  $Ht\bar{t}$  and  $HWW$  couplings.

To remove this degeneracy, we have analyzed  $t$ -channel single top production in association with a Higgs assuming a *universal* scale factor  $C_f$  (either positive or negative) for the Higgs Yukawa couplings to all fermion species  $f$ ,  $Y_f = C_f Y_f^{SM}$  (where  $Y_f^{SM}$  is the SM Yukawa coupling) and a *universal* (according to custodial symmetry) coupling scale factor  $C_V$  to  $W$  and  $Z$  bosons,  $C_V = g_{HVV}/g_{HVV}^{SM}$ . This channel is highly sensitive to the relative sign of the  $Ht\bar{t}$  and  $HWW$  couplings. In fact, in the SM there is a strong destructive interference between the two diagrams shown in figure 1. The content of this presentation is based on the references [4, 5].



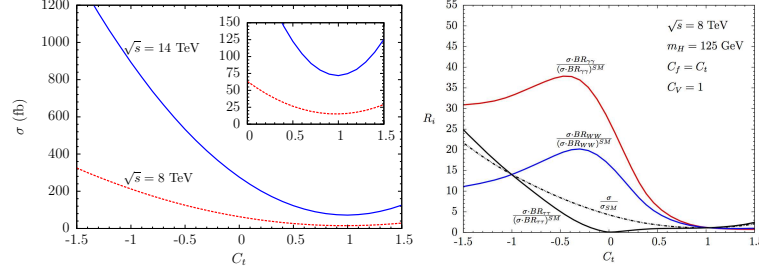
**Figure 1:** Feynman diagrams for the t-channel single top production in association with a Higgs.

## 2. Results

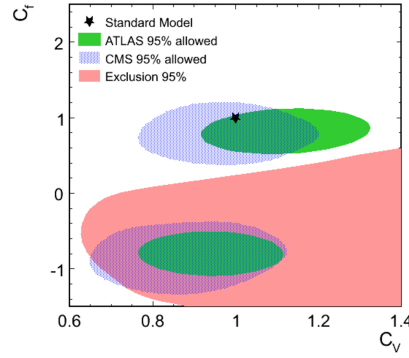
The potential of the  $pp \rightarrow tq'H$  in the context of the LHC has been exploited in various search channels, depending on the possible combinations of various decay modes of the Higgs and the top. Figure 2 shows the enhancement in the production cross-section and in the signal strength (defined as the product of the cross-section times the branching function of respective channels) for a wide range of values of  $C_f$  (assuming  $C_V = 1$ ). The final state considered are  $2\gamma + b + 3j$ ,  $2\gamma + b + \ell + j$ ,  $\ell^\pm \ell^\pm + b + 3j$ ,  $\ell_i^\pm \ell_j^\pm \ell_j^\mp + b + j$  and  $\ell_i^\pm \ell_j^\pm \ell_j^\mp + b + j$ , where the last but one represents the two same sign same flavor leptons with the third one having different flavor and the last one represents 3 $\ell$  signal complementary to the former one. We have also studied the potential SM backgrounds and prescribed some cuts based on the kinematics of the signal (see [4, 5]). The LHC reach of the combined search channels have been shown in figure 3.

## 3. Conclusion

We have shown that a combined search channels can potentially exclude the  $C_f \leq 0$  region (as-



**Figure 2:** Cross-section and signal strength for difference Higgs decay modes at the LHC.



**Figure 3:** The 95% exclusion plot in the  $(C_V, C_f)$  plane with the currently allowed parameter regions by the ATLAS and CMS experiments, in the universal  $C_f$  scaling assumption with  $50 \text{ fb}^{-1}$  of LHC data at 8 TeV.

suming universal  $C_f$  scaling) at 8 TeV center of mass energy and  $50 \text{ fb}^{-1}$  of integrated luminosity. The corresponding significance can be more than  $2.5\sigma$  in this region.

## References

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