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Bounds on Invisible Higgs Boson Decays Extracted from LHC t(t)over-barH Production Data (vol 113, 151801, 2014)

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Erratum: Bounds on Invisible Higgs boson Decays from $t\bar{t}H$ Production

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Bounds on invisible decays of the Higgs boson from $t\bar{t}H$ production were inferred from a CMS search for stop quarks decaying to $t\bar{t}+E_{\mathrm{T}}^{\mathrm{miss}}$. Limits on the production of $t\bar{t}H$ relied on the efficiency of the CMS selection for $t\bar{t}H$, as measured in a simulated sample. An error in the generation of the simulated sample lead to a significant overestimate of the selection efficiency. Corrected results are presented.

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In a recent Letter [1], we recast a CMS search for supersummetric stop quarks ($\tilde{t} \to bW + E_{\mathrm{T}}^{\mathrm{miss}}$) [2] to set bounds on $t\bar{t}H$ production where the Higgs boson decays invisibly.

The result relies on the measurement of the efficiency of the CMS selection for $t\bar{t}H$ events, as measured in simulated samples generated with Madgraph5 [3], showering and hadronization with Pythia [4] and detector response simulated by Delphes [5]. The event generation used a model which included a $H\chi\bar{\chi}$ vertex to describe the invisible decay $H \to \chi\bar{\chi}$. Inadvertantly, the contribution from diagrams containing a ggH effective vertex was overestimated. These diagrams tend to give larger transverse momentum to the Higgs boson, leading to larger measured $E_{\mathrm{T}}^{\mathrm{miss}}$ and a significant overestimate of the selection efficiency. Figure 1 shows a comparison of the original flawed sample and a new, correct sample. Figure 2 shows a comparison of the kinematics of the corrected $t\bar{t}H$ sample to the primary sources of background, top quark pair production.

For the corrected sample, we again apply the results of the CMS $\tilde{t}$ search to invisible Higgs boson decays by calculating the expected yield of $t\bar{t}H$ in each

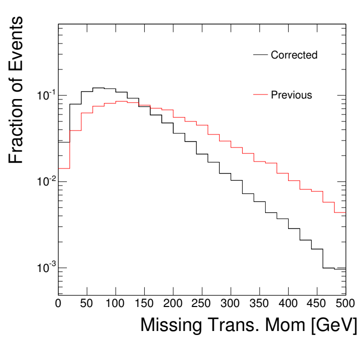

FIG. 1: Distribution of missing transverse momentum $t\bar{t}H$ with $H \to$invisible for the simulated sample in the original paper as well as the corrected simulated sample. Distributions are shown after requiring exactly one lepton, at least four jets and one b-tag.

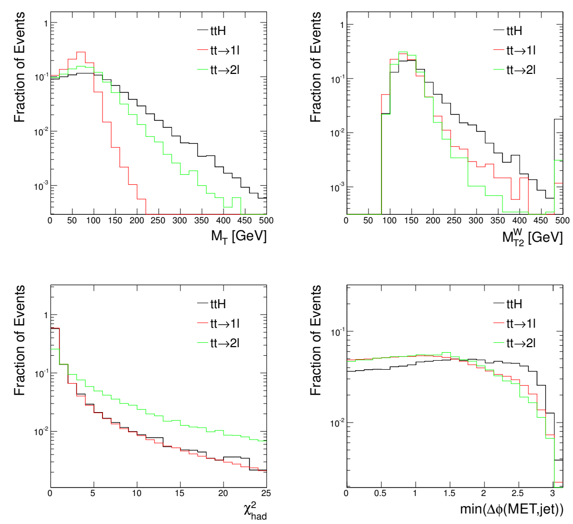

FIG. 2: Kinematics of $t\bar{t}H$ with $H \to$invisible and all $t\bar{t}$ decay modes, compared to the two dominant backgrounds, SM top quark production with either single lepton ($\ell\nu bqq'b$) or di-lepton ($\ell\nu b\ell'\nu b$) decay modes. Distributions are shown of M_T, the transverse mass; M_{T2}^W, as defined in Ref. [10]; χ^2_{had}, the consistency of the jjb system with a top quark hadronic decay; and min($\Delta\phi$[MET, jet]), the minimum angle between the $E_{\mathrm{T}}^{\mathrm{miss}}$ and any jet . Distributions are shown after requiring exactly one lepton, at least four jets and one b-tag.

of the signal regions. We calculate upper bounds on $\sigma(t\bar{t}H) \times BF(H \to \mathrm{inv.})$ using a one-sided profile likelihood and the CLs technique [6, 7], evaluated using the asymptotic approximation [8]. For each of the sixteen signal regions, we calculate the median expected limit on $\sigma(t\bar{t}H) \times BF(H \to \mathrm{inv.})$. As with the original sample, the region with the strongest expected limit is that targeting $\tilde{t} \to t\tilde{\chi}$ in the high-ΔM regime, with $E_{\mathrm{T}}^{\mathrm{miss}} > 250$ GeV. This region has the additional requirements of min($\Delta\phi[E_{\mathrm{T}}^{\mathrm{miss}}, j]) > 0.8$, $M_{T2}^W > 200$ GeV and $\chi^2_{\mathrm{had}} < 5.0$. The expected background is reported to be 9.5 ± 2.8. With our simulated sample, we calculate an expected $t\bar{t}H$ yield of 2.1 events if BF$(H \to$ inv.$) = 1.0$ (compare to 11.4 events for the incorrect sample). The

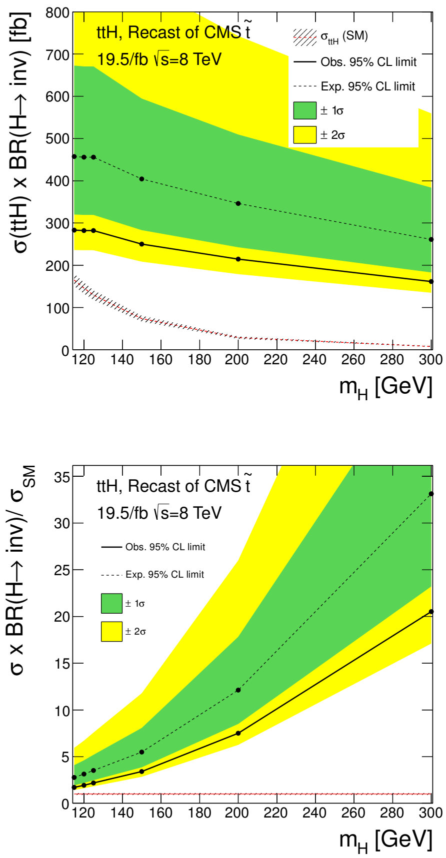

FIG. 3: Top pane gives 95% CL upper limits on $\sigma(t\bar{t}H) \times BF(H \to \text{inv.})$, including both expected and observed limits. Also shown is the SM rate of $\sigma(t\bar{t}H)$ [9]. The bottom pane shows the ratio of the constraint to the SM $\sigma(t\bar{t}H)$ cross section.

efficiency of this selection for $t\bar{t}H \to t\bar{t}\chi\bar{\chi}$ events with $m_H = 125$ GeV is 0.085% (compare to 0.45% for the incorrect sample).

In this particular signal region, the data have fluctuated quite low, $N_{\text{obs}} = 3$ events, giving an observed upper bound considerably stronger than the median expected results; see Fig. 3. Dividing by the predicted rate of $t\bar{t}H$ production in the SM [9] gives a limit on BF($H \to$ inv); the observed (expected) result is < 1.9 (3.0) at 95% CL for $m_H = 125$ GeV.

This result is significantly weaker than the previous. For this reason, we do not perform a combination with other channels nor provide an interpretation in terms of the Higgs portal model.

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