Erratum: Technipion limits from LHC Higgs searches [Phys. Rev. D 84, 115025 (2011)]

R. Sekhar Chivukula, Pawin Ittisamai, and Elizabeth H. Simmons

Jing Ren

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In [1] the authors used the results of LHC searches for the standard model Higgs boson in the $\tau\tau$ decay mode to place strong constraints on the light technipion state predicted in technicolor models that include colored technifermions. The results from the analyses [2–4] quoted there (and used in Fig, 3 of [1]), however, arose in large part from the production of a standard model Higgs boson through vector-boson fusion or in association with a W boson—production mechanisms that are absent for technipions [1]. In this paper, updated results on searches for the Higgs in the $\tau\tau$ decay mode from the ATLAS experiment [5] are used instead. Using Higgs results from the gluon fusion production mode only, which is common to both the standard model Higgs and technipions, we show that constraints on light technipions in models with colored technifermions are very similar to that quoted in the original paper [1].

The search for the standard model Higgs boson in the $\tau\tau$ decay mode reported in [5] is based on the combination of searches for three different decay channels of the final state τ particles: $\tau_{\rm had}\tau_{\rm had}\nu\nu$, $\ell\tau_{\rm had}3\nu$, and $\ell\ell 4\nu$. The results of the individual analysis in each channel I is expressed as a 95% C.L. upper limit on

$$\mu_I(m_H) = \frac{\sigma(pp \to H){\rm BR}(H \to \tau\tau \to I)}{\sigma_{\rm SM}(pp \to H){\rm BR}_{\rm SM}(H \to \tau\tau \to I)}, \tag{1}$$

as a function of the Higgs boson mass m_H. The individual channels are then combined using[1]

$$\mu(m_H) = \left(\sum_I^N \frac{1}{\mu_I^2(m_H)}\right)^{-(1/2)}, \tag{2}$$

to find an overall bound on the standard model Higgs boson in the $\tau\tau$ decay channel.

In the Higgs search, each $\tau\tau$ decay channel receives contributions from three different production modes for the Higgs boson: gluon fusion (gg), vector-boson fusion (VBF), and associated production (VH). In order to correctly scale these results to find limits on technipions, we need the limits on μ_I that would arise solely from gluon fusion [1]. This can be done by scaling $\mu_I(m_H)$ by using the fraction of expected signal events (including both production cross section and detection efficiency) arising from gluon fusion, through

$$\tilde{\mu}_I(m_H) = \left(\frac{n_{\rm gg}^I(m_H)}{n_{\rm gg}^I(m_H) + n_{\rm VBF}^I(m_H) + n_{\rm VH}^I(m_H)}\right)^{-1} \mu_I, \tag{3}$$

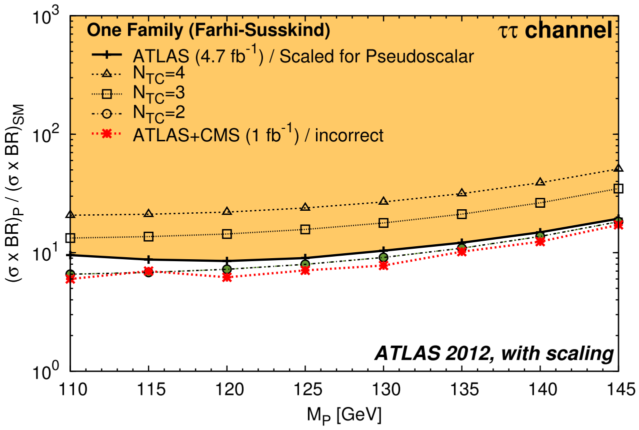
where $n_P^I(m_H)$ is the number of signal events expected for a standard model Higgs boson produced via mechanism P and detected in $\tau\tau$ decay channel I. In [5] the expected number of signal events for each production mode and decay channel, including both cross section and detection efficiency, is listed for a 120 GeV standard model Higgs boson. Assuming that the detection efficiency is roughly constant over the mass range of interest (100 GeV $< m_H <$ 145 GeV), we estimate the number of expected signal events by

$$n_P^I(m_H) = \frac{\sigma_P(m_H)}{\sigma_P(120~{\rm GeV})} n_P^I(120~{\rm GeV}) \equiv R_P(m_H) \cdot n_P^I(120~{\rm GeV}). \tag{4}$$

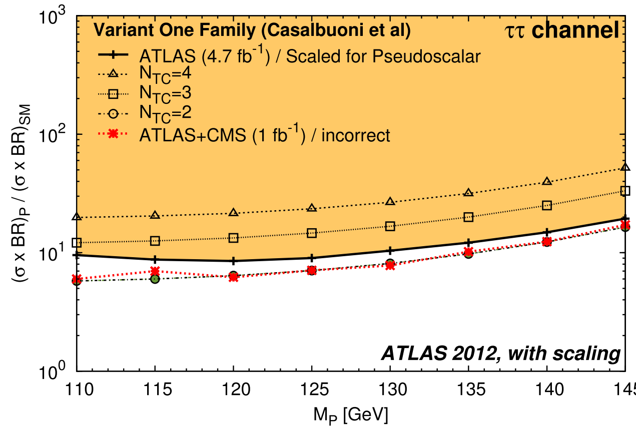
We take the ratio of production cross sections, $R_P(m_H)$, from [7].

Using (4) and (3), we scale the data from [5] to obtain the upper bound $\tilde{\mu}(m_H)$ on $\sigma(pp \to H \to \tau\tau \to I)/\sigma_{\rm SM}(pp \to H \to \tau\tau \to I)$ arising solely from gluon fusion. We then combine these different $\tau\tau$ decay channels using (2). This result is then used as described in [1] to bound the production cross section for technipions in the three models in

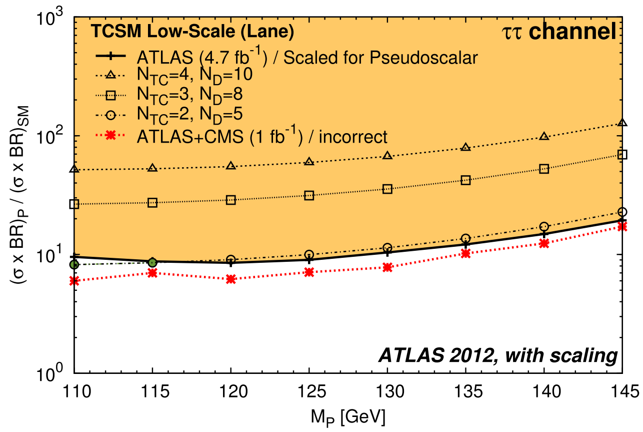
[1]This equation is only approximately correct since the limit on each μ_I arises from a finite number of events in the data sample in channel I, and this formula does not account for fluctuations in the number of events observed. For a recent analysis of the validity of this approximation, see [6]—on the basis of which we expect this approximation to be good to 20%.



(a)Traditional one-family model [8].



(b)Variant one-family model [9].



(c)Technicolor Straw Man (TCSM) low-scale model [10].

FIG. 1 (color online). Comparison of experimental limits and technicolor model predictions for production of a new scalar decaying to tau lepton pairs. In each pane, the shaded region (above the solid line) is excluded by the combined 95% C.L. upper limits on $\sigma_h B_{\tau^+\tau^-}$ normalized to the SM expectation as observed by ATLAS [5], with the bound modified as discussed in the text of this note. Each pane also displays (as open symbols) the theoretical prediction from one of our representative technicolor models with colored technifermions, as a function of technipion mass and for several values of N_{TC}. The red line shows the combined ATLAS + CMS limit (incorrectly) presented in the original paper [1].

Refs. [8–10]. Our results are shown in Fig. 1 and replace the bounds shown in Figure 3 of [1]: coincidentally, the resulting corrected bounds are very similar to the erroneous bounds originally reported in [1].

Finally, for clarity, we note that the bounds shown in Figs. 2 (for the $\gamma\gamma$ decay mode) and 4 (for the $\tau\tau$ decay mode at higher technipion mass) of Ref. [1] are correct as originally reported.

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