Search for top-quark partners with charge 5/3 in the same-sign dilepton final state

—Supplemental Material—

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Additional figures are provided to illustrate the agreement of data with background predictions and to show the reconstruction of the $T_{5/3}$ mass. Figure 1 gives the H_{T} distribution after the requirement of same-sign dileptons, the Z-boson veto, and a requirement of at least two jets. Figure 2 shows the distribution of the reconstructed $T_{5/3}$ mass. The mass of the $T_{5/3}$ quark can be reconstructed when the decay of one of the top-quark partners leads to same-sign leptons and the decay of the second partner is fully hadronic. The selection for this distribution requires same-sign leptons, the Z-boson veto, and the presence of enough jets to reconstruct a top quark and a W boson using any combination of top-quark jets, W-boson jets, and AK5 jets. Top-quark and W-boson jets are assumed to correspond to the respective particles, while combinations of AK5 jets are required to have an invariant mass consistent with the particles from which they originate.

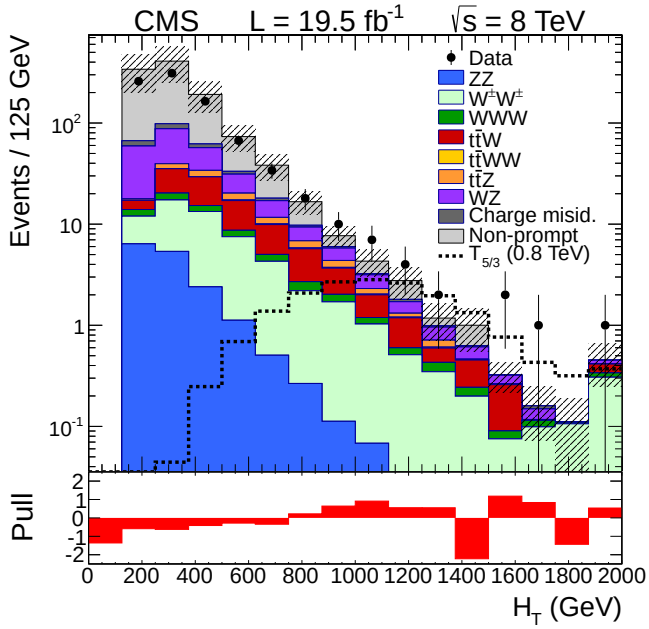

FIG. 1. The distribution of H_{T} for all channels combined, after after the requirement of same-sign dileptons, the Z-boson veto, and a requirement of at least two jets. The shaded band represents the total uncertainty in the predicted backgrounds. The final bin includes all overflow events. The pull is defined as the difference between the observed and expected values divided by the total uncertainty.

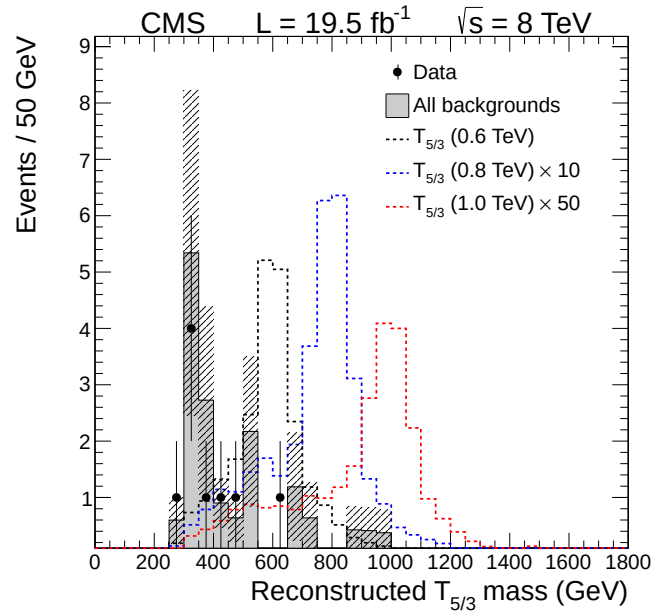

FIG. 2. The distribution of the reconstructed $T_{5/3}$ mass for the data, the background, and three signal mass points. The background is dominated by the contribution due to non-prompt leptons and also contains much smaller contributions due to $t\bar{t}W$, $t\bar{t}WW$, $t\bar{t}Z$, WWW, same-sign WW, and charge misidentification. The shaded band represents the total uncertainty in the predicted background.

This selection differs from the one used for computing the 95% CL limit: not every event used for the limit setting has jet combinations that result in a top quark and a W boson and there is no H_{T} requirement in the selection used for the $T_{5/3}$ mass reconstruction. The $T_{5/3}$ mass distribution is consistent with the exclusion of the $T_{5/3}$ in this mass range: no excess is observed and the jet content of the data is different from that of the signal. The nine data events contain only AK5 jets whereas even at the relatively low mass of 600 GeV, 75% of $T_{5/3}$ events for which the mass can be reconstructed are expected to have at least one W-boson jet and 17% are expected to have at least one top-quark jet.