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Search for the SM four-top-quark production in pp collisions at $\sqrt{s}$ = 13 TeV with the ATLAS detector

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Recently the ATLAS Collaboration carried out two searches for the Standard Model four-top-quark production in the single-lepton and opposite-sign dilepton channel, and in the same-sign dilepton and multilepton channels. The searches are based on a dataset of pp collisions at $\sqrt{s} = 13$ TeV recorded in 2015 and 2016 with the ATLAS detector at the CERN Large Hadron Collider and corresponds to an integrated luminosity of 36.1 fb^{-1}. No significant excess above the Standard Model expectation is observed in either of the two searches. The results are combined and an observed (expected) upper limit of 49 fb (19 fb), or 5.3 (2.1) times the four-top-quark Standard Model cross section is obtained at 95% confidence level.

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The ATLAS Collaboration [1] at the LHC carried out a search [2] for Standard Model (SM) four-top-quark ($t\bar{t}t\bar{t}$) production based on events with at least two leptons, including a pair of the same electric charge, at least one b-tagged jet, sizeable missing transverse momentum and large scalar sum of the p_{T} of all selected jets and leptons (referred to as "SS dilep. / trilep." channel). The search is based on pp collision data with $\sqrt{s} = 13$ TeV collected by the ATLAS detector at the LHC during the year 2015 and 2016, corresponding to an integrated luminosity of 36.1 fb^{-1}. Several kinematic criteria are imposed to suppress the background sources, dominated by ttW, ttZ, ttH, and diboson production. Substantial background comes from events that appear to have the targeted final state only because one or more objects is misidentified. To test for the presence of the $t\bar{t}t\bar{t}$ signal, the observed number of events in a set of signal regions are compared with the expected background yields in those regions.

In order to improve the sensitivity to final states containing four top-quarks, the results are combined with a complementary search [3] in the single-lepton or dilepton events with two opposite-sign charged leptons, characterized by the presence of one or two isolated electrons or muons with high-transverse momentum and multiple jets (referred to as "Single lep. / OS dilep." channel). The usage of the data-driven technique to estimate the $t\bar{t}$+jets background, as opposed to a purely simulation-based approach, allows to reduce significantly the uncertainty on its prediction in the high jet and b-tagged jet multiplicity topologies exploited by this search: the total uncertainty on the $t\bar{t}$+jets background prediction across the signal regions is reduced from 43–89% to 14–42%.

After combination, an observed (expected) 95% CL upper limit on the SM $t\bar{t}t\bar{t}$ production cross section of 49 fb (19 fb) is obtained. The excess is driven by the SS dilep. / trilep. channel, where the observed (expected) SM $t\bar{t}t\bar{t}$ signal significance amounts to 3.0 (0.8) σ. Events were compared with the expectations from the BSM $t\bar{t}t\bar{t}$ benchmark models and found to agree poorly with all of them. Figure 1(a) shows the expected and observed upper limits on $\sigma^{t\bar{t}t\bar{t}}_{\mathrm{SM}}$, while Figure 1(b) shows a summary of the signal-strength measurements for each of the two searches and their combination.

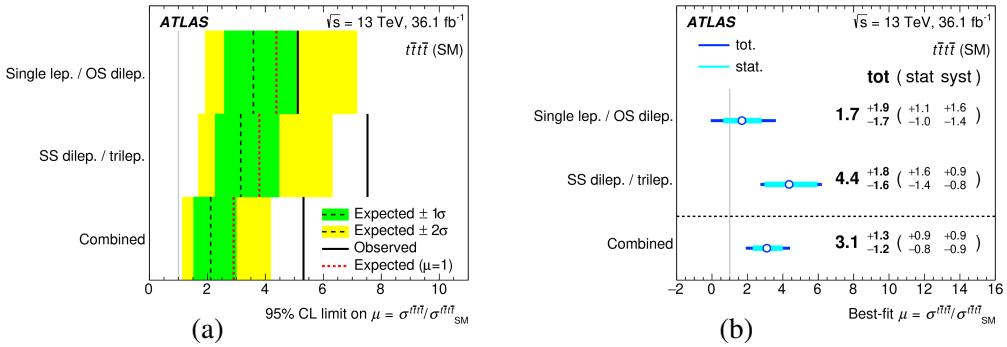

Figure 1: Summaries of (a) 95% CL upper limits on $\sigma(t\bar{t}t\bar{t})$ relative to the SM prediction, and (b) signal-strength measurements in the individual channels and for the combination [3].

References

[1] ATLAS Collaboration, JINST **3** S08003, (2008).

[2] ATLAS Collaboration, (2018), arXiv: 1807.11883 [hep-ex].

[3] ATLAS Collaboration, (2018), arXiv:1811.02305 [hep-ex].