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All-Hadronic four-top production at 13 TeV with the CMS experiment

Standard model (SM) four-top quark production, pp ⟶ tt$\bar{t}$ $\bar{t}$, is a rare process with great potential to reveal new physics. This process is studied in fully-hadronic proton-proton collision events collected during Run II of the CERN LHC by the CMS detector, which corresponded to an integrated luminosity of 137 f b1 and a center of mass energy of 13 TeV. In order to optimize signal sensitivity with respect to significant and challenging backgrounds, several novel machine-learning based tools are applied in a multi-step and data-driven approach. Boosted decision tree (BDT) and deep neural net (DNN) based hadronic top taggers are used to identify hadronically decaying top quark candidates with moderate and high transverse momenta, respectively, in order to suppress backgrounds and categorize events by the multiplicity of reconstructed top tags, and an event-level kinematic BDT distribution is subsequently used to extract the signal. Control regions inspired by the "ABCD"method are used to obtain a data-driven estimate of the background, and data distributions in these control regions are given as inputs to a DNN in order to estimate the event-level BDT discriminant distributions of the major backgrounds. The observed (expected) significance for the all-hadronic channel alone is 2.5 (0.4). This analysis is part of a larger analysis that combines multiple four-top final states (TOP-21-005) and a paper focusing on the background-estimation techniques in detail is currently ongoing.

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