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Fully-hadronic search for standard model production of four top quarks in Run II proton-proton collision events

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Standard model four top quark production is a rare process with great potential to reveal new physics. Measurement of the cross section is not only a direct probe of the top quark Yukawa coupling with the Higgs, but an enhancement of this cross section is predicted by several beyond the standard model (BSM) theories. This process is studied in fully-hadronic proton-proton collision events collected during CERN LHC Run II by the CMS detector, which corresponded to an integrated luminosity of 137fb−1 and a center of mass energy of 13TeV. In order to optimize signal sensitivity with respect to QCD and hadronic ttbar backgrounds, machine-learning based tools are applied in a multi-step approach. BDT and DNN based hadronic top taggers are used to identify boosted and resolved hadronic top quark candidates 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. Data-driven methods are used to estimate the background. In combination with other four top channels the expected significance of this analysis is estimated to reach at least 3 standard deviations, corresponding to the "observation" of standard model four top production. These results can further be used to constrain the top quark Yukawa coupling as well as BSM (Beyond the Standard Model) parameters. A result is anticipated by the end of this year.

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