

# A Search for Vector-Like Quark Pair Production using a New Multiclassification Machine Learning Algorithm for Boosted Final State at CMS

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We present a unique search for vector-like T quark pair production, targeting all possible decay modes  $tH$ ,  $tZ$ , and  $bW$ , of the T quark at once. We use data collected from the CMS experiment at center of mass energy of 13 TeV. We use a multivariate algorithm, the 'boosted event shape tagger' (BEST), to classify candidate jets as originating from top quarks, W, Z, or Higgs bosons. BEST uses kinematic distributions evaluated in several hypothesized reference frames of the candidate jet as inputs to a neural network-based machine-learning algorithm, to better determine consistency with the decay products of a heavy standard model particle. With this multiclassification algorithm, we categorize candidate events according to multiplicities of heavy objects observed in the final state, and use the sum of all observed jet momenta to better discriminate signal events from the expected QCD multijet backgrounds. With this strategy, we increase signal acceptance relative to standard search techniques, and obtain sensitivities competitive with existing VLQ searches, optimized for specific final states.

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