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Boosted Top Tagging through Flavour-violating interactions at the LHC

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We focus on a rare, exotic decay channel of the top quark, $t \rightarrow cH$, with H decaying to a pair of b-quarks produced at the High Luminosity runs of the Large Hadron Collider. For our study, we propose and implement a new jet tagging algorithm, which is efficient in identifying the said decay mode of the boosted top using a large-R jet with b- and c-tagged jets inside it. Identifying observables that can effectively discriminate the signal from the Standard Model (SM) backgrounds we perform a Multi Variate Analysis (MVA) and compared the results of two different boosting algorithms, viz., XGBoost and AdaBoost. The comparative analysis of the performance of the proposed top tagger to the conventional cut-based top taggers establishes the proposed tagger to be more efficient than others. Furthermore, we use the game theoretic approach SHAP, to understand the contribution of each observable towards the result of the tagger. Using the tagger for a vector-like quark Y , having a b-quark and a c-quark in the final state, we observe clear resonance peak of the large-R jet at the mass of the Y , signifying the tagger to be also efficient to probe a BSM particle giving the same final state topology, as the above-mentioned top quarks with flavour-violating decay mode.

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Institution

SRM University-AP

Author: CHOWDHURY, Shreecheta (SRM University-AP)

Co-authors: Dr CHAKRABORTY, Amit (SRM University-AP); Dr DUTTA, Saunak (ATLAS SkillTech University)

Presenter: CHOWDHURY, Shreecheta (SRM University-AP)

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