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Multi-vertex jet trigger at ATLAS' upgrade for HL-LHC using Boosted Decision Trees on FPGAs

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The Large Hadron Collider (LHC) will undergo a major improvement from 2026-2028 called High Luminosity LHC (HL-LHC). The number of collisions per proton bunch crossing will increase from ~60 to ~200. This will stress the current event selection (trigger) system, and the efficiency of specialized jet triggers in particular. An important challenge lies in classifying jets coming from a single vertex or from multiple ones, and the difficulty in distinguishing this is exacerbated by the increased pile-up interactions and high energy background jets under high luminosity. Therefore, as part of the ongoing ATLAS detector upgrade, we are developing a multi-vertex jet trigger for Level 0 (hardware-based level) at HL-LHC, using machine learning techniques, such as Boosted Decision Trees (BDTs) to do the classification. Building on recent advancements, such as the development of the fwXmachina package in the University of Pittsburgh (useful for BDTs implementation in Level 1), the project spans describing HL-LHC multi-jet background, creating BDTs to classify single and multi-vertex events, and implementing them on Field Programmable Gate Arrays (FPGAs). This trigger will benefit the identification of specific di-Higgs decays like HH $\rightarrow$ 4b, but also any interesting physics with 4 jets in the final state.

Mini Symposia (Invited Talks Only)

Authors: CANE, Santiago (University of Pittsburgh (US));   HONG, Tae Min (University of Pittsburgh (US))

Presenter: CANE, Santiago (University of Pittsburgh (US))

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