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Jet Substructure Studies for HL-LHC and pileup mitigation algorithms in CMS

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Summary

The most critical new event reconstruction techniques developed by CMS for LHC Run 2 are pileup mitigation tools for jets, MET and lepton isolation. Pileup affect jets by modifying the shapes of jet observables, such as jet mass, jet pt, and jet substructure observables, and by introducing anomalous jets known as pileup jets. In addition, pileup can lead to a large degradation in the performance of missing transverse momentum and estimators for isolation of leptons. This talk will give an overview of the pileup mitigation tools in CMS and their performance in LHC Run 2 data. Decays of new heavy resonances can produce highly Lorentz boosted particles, such as top quarks, Vector Bosons and Higgs Bosons. Novel techniques based on analyzing the substructure of the jets have been developed in order to efficiently identify the highly collimated decay products of these boosted particles. Using jet substructure techniques the CMS experiment, during Run 1 and Run 2 of the LHC, is able to probe ever higher mass scales in the search for new physics. The luminosity upgrade of the Large Hadron Collider planned for 2023 and beyond, is foreseen to provide a factor-of-ten increase in the integrated luminosity to 3/ab. This increase will have a major impact on the Physics program of the CMS detector. However, this upgrade will lead to an average of about 200 simultaneous interactions (pile-up events) per crossing, creating extreme operating environment for the detectors with much higher occupancies and unprecedented levels of radiation for the innermost part of the detectors. This will degrade the performance of the current detector. Thus all of the detector systems are being upgraded. The CMS upgrade includes a new tracker, and partially new parts for the muon and the calorimeter system. With higher instantaneous luminosity, pile-up mitigation will become a serious challenge for the use of jet substructure techniques, which are expected to remain a powerful tool for the HL-LHC. The CMS experiment is studying methods to improve jet reconstruction and substructure tools to increase the resilience against high pile-up.

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