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Long-Lived Particle Triggering with the CMS Hadron Calorimeter

Long-lived particles are a compelling direction to search for physics beyond the Standard Model, and implementing dedicated long-lived particle (LLP) triggers provides an excellent avenue to expand experimental coverage into this challenging parameter space. We present a novel Compact Muon Solenoid (CMS) Level-1 LLP trigger that exploits the Run 3 upgrade of the Hadron Calorimeter (HCAL), which introduced a precision timing ASIC, programmable front-end electronics, and depth segmentation to the CMS HCAL barrel. The hardware- and firmware-based trigger algorithm identifies delayed jets, resulting from the decay of massive LLPs, and displaced jets, resulting from LLPs that decay inside the HCAL. This approach significantly increases sensitivity to LLP signatures with soft hadronic final states, including exotic decays of the Higgs boson. We review the trigger implementation, calibration, and performance, as well as analysis prospects for Run 3. Recent HCAL timing scans provide a valuable look at artificial delayed jets in collisions data, and are crucial to understanding the detector and trigger performance. The data collected with the new triggers implemented for Run 3 provides a first look at the capabilities to capture softer events and expand the phase space accessible in LLP searches.

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