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A Novel "Beam-Dump" Measurement with CMS for Searching for MeV-Scale Dark-Sector Physics

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We propose a novel scheme for performing a beam-dump-like experiment with the ATLAS/CMS detector. At the LHC, high-energy proton collisions result in jets containing a number of energetic hadrons/electromagnetic objects that are essentially "dumped" to HCAL/ECAL, inducing the production of secondary hadrons, electrons, and photons in calorimetric showers. We envision a situation where MeV-scale dark-sector particles are produced by the interactions of these secondary particles inside HCAL/ECAL. For illustration purposes, we consider the axion-like particles (ALPs) produced via the Primakoff process in the presence of their interaction with photons at CMS. We argue that the DT chambers and the ME0 module of the CMS muon system can serve as detectors to record the photons from the ALP decay, demonstrating that the associated sensitivity reach is competitive due to their close proximity to the signal source points. We further show that the LHC does not suffer from a barrier, dubbed beam-dump "ceiling", that typical beam-dump experiments hardly surpass, carrying the great potential for exploring a wide range of parameter space in increasing statistics.

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