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MATHUSLA: An External Long-Lived Particle Detector to Maximize the Discovery Potential of the HL-LHC

We present the current status of the MATHUSLA (MASSive Timing Hodoscope for Ultra-Stable neutral pArticles) long-lived particle (LLP) detector at the HL-LHC, covering the design, fabrication and installation at CERN Point 5. MATHUSLA40 is a 40 m-scale detector with an air-filled decay volume that is instrumented with scintillator tracking detectors, to be located near CMS. Its large size, close proximity to the CMS interaction point and about 100 m of rock shielding from LHC backgrounds allows it to detect LLP production rates and lifetimes that are one to two orders of magnitude beyond the ultimate reach of the LHC main detectors. This provides unique sensitivity to many LLP signals that are highly theoretically motivated, due to their connection to the hierarchy problem, the nature of dark matter, and baryogenesis. Data taking is projected to commence with the start of HL-LHC operations. We summarize the new 40m design for the detector that was recently presented in the MATHUSLA Conceptual Design Report, alongside new realistic background and signal simulations that demonstrate high efficiency for the main target LLP signals in a background-free HL-LHC search. We argue that MATHUSLA's uniquely robust expansion of the HL-LHC physics reach is a crucial ingredient in CERN's mission to search for new physics and characterize the Higgs boson with precision.

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