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## Ultra long-lived particles searches with MATHUSLA

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Many extensions of the Standard Model (SM) include particles that are neutral, weakly coupled, and long-lived that can decay to hadronic and leptonic final states. Long-lived particles (LLPs) can be detected at colliders as displaced decays from the interaction point (IP), or missing energy if they escape. ATLAS, CMS, and LHCb have performed searches at the LHC and significant exclusion limits have been set in recent years.

The current searches performed at colliders have limitations. An LLP does not interact with the detector and it is only visible once it decays. Unfortunately, no existing or proposed search strategy will be able to observe the decay of non-hadronic electrically neutral LLPs with masses above  $\sim$  GeV and lifetimes near the limit set by Big Bang Nucleosynthesis ( $c\tau \sim 10^7 - 10^8$  m). Such ultra-long-lived particles (ULLPs) produced at the LHC will escape the main detector with extremely high probability.

In this talk, we describe the MATHUSLA surface detector (MAssive Timing Hodoscope for Ultra Stable neutral pArticles) [1], which can be implemented with existing technology in time for the turn-on of the high luminosity LHC (HL-LHC). The MATHUSLA detector will consist of an air-filled decay volume surrounded by charged particles detectors (top, bottom, and sides) that provide timing and a robust multilayer tracking system located in the upper region. Ref. [1] proposes covering a total sensitive area of  $200 \times 200$  square meters on the surface in the region near the interaction point of ATLAS or CMS detectors for the beginning of the HL-LHC run.

We installed a small-scale test stand ( $\sim$  6.5 meters tall, covering an area of  $2.5 \times 2.5$  square meters) on the surface above ATLAS IP in autumn 2017 that consists of three layers of resistive plate chambers used for timing/tracking and two layers of scintillators (top, bottom) for timing measurements to study efficiency of downward cosmic track rejection. The goal is to estimate cosmic background that mimics upward going tracks and the proton-proton collision backgrounds from ATLAS during nominal LHC operations. The test stand will resume operation above the ATLAS IP in April 2018 and collect data with pp collisions until December 2018. This will provide useful information for the design of the main detector and important inputs for the future physics and detector simulations.

We will present preliminary results obtained with data collected in 2017 and the on-going background studies. The sensitivity of MATHUSLA to various ULLP theoretical constructs will be summarized and current design concepts reviewed.

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