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Enhancing long-lived particles searches at the LHC with precision timing information

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We explore the physics potential of using precision timing information at the LHC in searches for long-lived particles (LLPs). In comparison with the light Standard Model particles, the decay products of massive LLPs arrive at detectors with time delays around nanosecond scale. We propose new strategies to take advantage of this time delay feature by using initial state radiation to timestamp
the collision event and require at least one LLP to decay within the detector. This search strategy is effective for a broad range of models. In addition to outlining this general approach, we demonstrate its effectiveness with the projected reach for two benchmark scenarios: Higgs decaying into a pair of LLPs, and pair production of long-lived neutralinos in the gauge mediated supersymmetry breaking models. Our strategy increases the sensitivity to the lifetime of the LLP by two orders of magnitude or more and particularly exhibits a better behavior with a linear dependence on lifetime in the large lifetime region compared to traditional LLP searches. The timing information significantly reduces the Standard Model background and provides a powerful new dimension for LLP searches.

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