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Extending the LHC Reach for New Physics with Sub-Millimeter Displaced Vertices

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Motivated by new metastable massive particles in a variety of extensions of the Standard Model (SM), I propose a new analysis based on Displaced Vertices (DVs) at the LHC. I show that, if metastable particles are pair-produced, two decay vertices can be distinguished with the performance of the LHC detectors if they are separated by ≥ 100 μm. I discuss that the detailed study of the sub-millimeter DVs may greatly improve the discovery reach for metastable particles with 100 $\mu\mathrm{m} \leq c\tau \leq 10$ mm, which have been regarded as promptly-decaying in previous analysis. It is also possible to measure the decay length of such particles, which provides important information to understand the nature of the new physics. As an illustration, I apply our method to the metastable gluino searches at the future LHC experiments. I find that the expected reach for the gluino mass can be extended by about 300 GeV for $c\tau_{\tilde{g}} \sim 1$ mm. I also find a gluino with $c\tau_{\tilde{g}} \geq 200$ μm can be distinguished from a promptly-decaying one at a 5-σ confidence level in the case a gluino with the mass of 2 TeV exists.

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