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Searching for dark radiation at the LHC

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Ultra-relativistic particles can be produced by the decay of weak-scale LLPs and act as dark radiation. The cosmologically interesting range $\Delta N_{\text{eff}} \sim 0.01\text{--}0.1$ corresponds to LLP decay lengths at the mm scale. These decay lengths lie at the boundary between prompt and displaced signatures at the LHC. We consider a scenario where the LLP decays into a lepton and a (nearly) massless invisible particle. By reinterpreting searches for promptly decaying sleptons and for displaced leptons we can then compare LHC exclusions with cosmological observables. We find that the CMB-S4 target value is already excluded by current LHC searches.

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