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Heavy QCD axions via dimuon final states

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Heavy QCD axions are well-motivated extensions of the QCD axion that address the quality problem while still solving the strong CP problem. Owing to the gluon coupling, critical for solving the strong CP problem, these axions can be produced in significant numbers in beam dump and collider environments for axion decay constants as large as PeV, relevant for addressing the axion quality problem. In addition, if these axions have leptonic couplings, they can give rise to long-lived decay into lepton pairs, in particular, dominantly into muons above the dimuon threshold and below the GeV scale in a broad class of axion models. Considering existing constraints, primarily from rare meson decays, we demonstrate that current and future neutrino facilities and long-lived particle searches have the potential to probe significant parts of the heavy QCD axion parameter space via dimuon final states.

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