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Exotic h → Z a Higgs decays into tau leptons

Exotic Higgs decays are among the most promising areas to be explored at the High-Luminosity LHC, given the unprecedentedly large amount ($\sim 3 \times 10^8$) of 125 GeV Higgs bosons that will be produced. In this context, we propose a new search channel for which the Higgs boson decays to a (leptonically decaying) Z boson and a light BSM pseudoscalar a, which subsequently decays to a pair of τ-leptons ($h \to Za \to \ell\ell\tau\tau$). After performing a validation of existing ATLAS and CMS exotic Higgs decay searches in related channels, we analyze the HL-LHC projected sensitivity of our $a \to \tau\tau$ search, targeting the kinematic region where the exotic Higgs decay is two-body. We are able to probe pseudoscalar masses $m_a \in [5, 33]$ GeV by leveraging both leptonic and hadronic τ decays, and establish model-independent 95\% C.L. sensitivity projections on the branching fraction $\mathrm{BR}(h \to Za) \times \mathrm{BR}(a \to \tau\tau)$. These $a \to \tau\tau$ projections yield a competitive probe of light pseudoscalars, which depending on the model can become significantly more sensitive than projections from existing experimental searches in $a \to \mu\mu$ and $a \to \gamma\gamma$ final states. Finally, we explore the potential of our search to probe an Axion-Like-Particle (ALP) solution to the muon $(g-2)$ anomaly (when taken face-value), finding that our proposed $h \to Za$, $a \to \tau\tau$ search can provide valuable constraints on such ALP scenario, in complementarity with existing $h \to Za$, $a \to \gamma\gamma$ experimental searches.

Secondary track

T08 - Higgs Physics

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