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Event characterization of dark bosons via exotic Higgs decays with final states of displaced dimuons in high luminosity era of the LHC

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We investigate the potential reach at the large hadron collider (LHC) of a search for a long-lived dark vector boson, also called a dark Z or Z_D, through exotic decays of the standard-model Higgs boson h into either $Z_D Z_D$ or $Z Z_D$. Besides, we investigate a decay of h into two dark Higgs bosons $h_D h_D$ with each h_D decaying into a pair of Z_D's. We consider the production of h via gluon-gluon fusion (ggF) and use production cross sections from the literature for Runs 2 and 3 of the LHC, calculated to a combination of next-to-next-to-next-to-leading order with QCD corrections (N^{3}LO QCD) and next-to-leading order with electroweak corrections (NLO EW). The Z_D production through the Higgs portal is completed via one of two mechanisms, kinetic mixing of Z_D with the hypercharge boson and the mixing of h_D with h. The branching fractions are calculated to NLO and scanned over the relevant mixing parameters and particle masses in Monte Carlo (MC) simulation using the MadGraph5_aMC@NLO v2.7.2 framework. Emphasis is given to a final state of dimuons, displaced up to 7500 mm, where the muons can be reconstructed without vertex constraint using data from the ATLAS and CMS detectors to be collected in Run 3 of the LHC. Integrated luminosities of 137, 300, and 3000 fb^{-1} for Run 2, Run 3, and High Luminosity (HL) era, respectively, of the LHC are used for estimating the expected search sensitivity of the LHC to each decay mode. Finally, we investigate the kinematics of the displaced dimuons and the Z_D decay lengths in the detectors.

In-person participation

No

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