

Search for a Higgs boson decaying to a four
lepton plus missing transverse energy final state
via four vector bosons

X.G Mapekula

May 12, 2023

Abstract

This analysis presents the search for the Standard Model Higgs that decays to a pair of dark Higgs to an eight-lepton final state via four dark vector bosons. In this scenario, the SM Z boson can kinetically mix with the $U(1)_D$ gauge boson Z_D while the dark Higgs S and the SM Higgs can exhibit mass mixing. Either of the Higgses can be formed from gluon-gluon fusion and decay to the other type of Higgs which in turn can decay to a Z_D pair. The overall topology envisioned is $H \rightarrow SS \rightarrow Z_D Z_D Z_D Z_D \rightarrow 8\ell$, which gives an eight lepton final state where ℓ could be ν, e or μ . The probability of observing different configurations of the final states was calculated. We compared these results to the observed final states from generated samples and found that they agreed. In the case where we observe four detectable leptons (e or μ) and four undetectable leptons (ν), an investigation was then done to see whether the visible leptons pairs from the same S particle (denoted as the 4-4 case) or different S particles (2-2-2-2 case). We then developed a discriminator based on the angular kinematics of each event in order to separate the 4-4 case from the 2-2-2-2 case. The discriminator was found to work for specific values of the parameter phase space, while in the other phase space the data was found to be irreducible.