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CEPC experiment potential for observation of rare Higgs boson decay $H \rightarrow ZZ^* \rightarrow 4\nu$ at $\sqrt{s}=240$ GeV

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The CEPC working point at the center of mass energy around 240 GeV corresponds to the largest cross section of the higgsstrahlung process and allows effective usage of the recoil mass technique for measurements of Higgs boson parameters. The interesting task is the search for invisible decays of the Higgs boson: $H \rightarrow ZZ^* \rightarrow 4\nu$. The dijet final states of the process $e^+e^- \rightarrow ZH$, where Z boson decays to quarks, have large branching fractions but quite large background contributions. In this work, a two-stage machine learning algorithm for separation of the invisible Higgs decay signal in dijet final states is presented. At the first stage, separate binary classifiers are trained on signal-background pairs for several dominating background channels. At the second stage, a combined classifier is trained using the outputs of the first-stage models as inputs. The study was done with full simulation and reconstruction of the signal and background processes by the CEPC software. The performance of the two-stage approach is compared with conventional kinematic selections, and its effect is discussed on the upper limit on the branching fraction of the Higgs boson invisible decay.

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