

# Analysis of Higgs boson decays to four leptons

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April 26, 2022

## Abstract

This project contains an analysis of the decay  $H \rightarrow ZZ \rightarrow 4l$  using reduced NanoAOD files created from CMS Open Data (found [here](#)). The analysis follows loosely the official CMS analysis published in 2012 [Phys. Lett. B 716 (2012) 30] and consists in two main parts: the reconstruction of the Higgs boson mass and the development of a machine learning algorithm which allows for a better discrimination between signal and background. The first is obtained by skimming the dataset, i.e. by removing all events which are not of interest for the reconstruction of Higgs bosons, and by computing the various observables necessary for the analysis using RDataFrame. The remaining variables are finally plotted distinguishing the data from the simulated signal and background. The second part consists in training a machine learning algorithm with Keras using as input the simulated signal and background samples and as discriminant variables five angles formed by the leptons in the final state as described in detail in the article [Phys.Rev.D86:095031,2012]. Then, the algorithm is applied to the whole dataset in order to obtain a graph, similar to Fig. 5 of the CMS article mentioned above, in which the distribution of the kinematic discriminant  $K_D$  versus the invariant mass of the four leptons is plotted. This shows a clear separation between signal and background, hence a further cut on the data can be applied in order to obtain a "cleaner" sample.