M2 subject proposal 2024

Laboratoire Leprince-Ringuet École Polytechnique

Search for new physics through the Higgs boson pair production

Project overview

The 2012 Nobel Prize-winning Higgs boson discovery, made by the ATLAS and CMS experiments at the Large Hadron Collider (LHC), is considered one of the most significant breakthroughs in high-energy particle physics. This observation opened the gateway to a deeper understanding of the electroweak sector of the Standard Model (SM) and the electroweak symmetry-breaking mechanism.

The landscape of Higgs boson physics has expanded significantly since then. In this context, the associated production of two Higgs bosons has become highly relevant, particularly for providing direct access to the trilinear Higgs boson self-coupling, λ_{HHH}, and consequently, to the shape of the Higgs potential. Furthermore, many models beyond the SM (BSM) predict the possibility of deviations in λ_{HHH} from the SM prediction, which could be observable in the LHC data.

The goal of the M2 project is to offer the best constraints or hints regarding new physics by studying Higgs boson pair production in the HH → bbττ final state. The student will join the ongoing efforts of the local team and contribute to the development of the analysis framework and strategy for characterizing and extracting potential BSM signals. The student will conduct the proposed analysis using the proton-proton collision data set recorded by the CMS detector during the ongoing LHC Run 3 at a center-of-mass energy of $\sqrt{s}$ = 13.6 TeV.

If the project is followed by a PhD thesis, the student will have the opportunity to continue working on a similar topic within the CMS group at LLR. This will involve the analysis of proton-proton collision data collected during the current run of the LHC.

Local team

The CMS group at LLR is a founding member of the CMS Collaboration. It has designed, built, and is responsible for the operation of the L1 trigger for the electromagnetic calorimeter (ECAL). It has also designed the calorimeter

mechanics and contributed to the front-end readout electronics. It has major involvement in particle reconstruction and identification with the e/gamma and tau Physics Object Groups, and contributed to the development of the Particle Flow event reconstruction. It is among the leading protagonists within the CMS collaboration in diboson, multiboson and Higgs physics, as well as in heavy ions physics.

Contact

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