Search for new physics through the resonant Higgs boson pair production in the $bb\tau\tau$ final state

Project overview

The 2012 Nobel-prize-winning Higgs-boson discovery, by the ATLAS and CMS experiments [1, 2] at the Large Hadron Collider (LHC) is considered as one of the most important breakthrough in high-energy particle physics. This observation opened the gate to a finer understanding of the electroweak sector of the Standard Model (SM), and of the electroweak symmetry breaking mechanism.

During the LHC Run 2, from 2015 to 2018, the accelerator operated at a center-of-mass energy of $\sqrt{s} = 13$ TeV, and provided about 150 fb^{-1} of data that were collected by the CMS experiment. Its operation is expected to resume in 2021 for Run 3, during which the amount of data is expected to double. In that context, the associated production of two Higgs bosons is becoming extremely relevant, notably for allowing a direct access to the trilinear Higgs boson self-coupling λ_{HHH} and consequently to the shape of the Higgs potential. Moreover, many models predict the existence of heavy beyond-Standard-Model (BSM) particles, such as radions [3], gravitons [4], or additional Higgs bosons [5, 6]. Such high-mass particles are expected to couple significantly to the SM Higgs boson (H) , making the Higgs boson pair production a naturally good candidate for their observation.

The student will join the ongoing effort to constrain these new-physics models in the $HH \to bb\tau\tau$ final state. (S)he will contribute to the developement of the analysis framework and strategy to characterise and extract the possible BSM signals from the Run 2 data at 13 TeV collected by CMS, and to the preparation of the subsequent Run 3 analysis.

The student may pursue his or her work in the context of a doctoral thesis, subject to funding from the doctoral school of the Institut Polytechnique de Paris.

Team

The student will join the CMS group at Laboratoire Leprince-Ringuet (LLR, École Polytechnique). The group is a founding member of the CMS Collaboration. It has designed and built the ECAL L1 trigger and is responsible for its daily operation and monitoring. The group has major involvement in particle reconstruction and identification (electrons,

taus, particle flow), and is involved in Electroweak (di-boson, tri-boson, gauge couplings, ...), Heavy Ions and Higgs physics.

The group is one of the main contributors for the Higgs boson discovery, and for the first measurements of its properties. It has been playing a leading role in some of the high priority Higgs boson analyses of CMS ($H \to \tau\tau$, $H \to ZZ^* \to 4\ell$, $HH \to bb\tau\tau$ and $ttH \to \tau\tau$). It has developed strong ties with physicists from many other groups in the CMS Collaboration from Europe and the USA.

The group is also strongly involved in the development of the Phase II CMS Upgrades for the High-Luminosity LHC, with major responsibilities in the mechanics, trigger and software algorithms of the future endcap calorimeters (HGCAL).

Master and doctoral school

Master 2 High-Energy Physics
Doctoral school – Institut Polytechnique de Paris

Contact

Roberto Salerno
roberto.salerno@cern.ch
+33 1 69 33 55 94

Louis Portalès
louis.portales@llr.in2p3.fr

References

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