Laboratoire LEPRINCE-RINGUET

Ecole Polytechnique – IN2P3 / CNRS

Study of events featuring τ pairs and b jets in the CMS experiment

The discovery of the Higgs boson and the first studies of its properties have been major achievements of the Run 1 of the LHC. In the Run 2, it will be crucial to determine whether the Higgs boson is a standalone object in the scalar sector or if it is the lightest of a collection of Higgs bosons, as they arise in Two-Higgs Doublet Models (2HDM) such as SuperSymmetry (SUSY). In this context, the channels with τ pairs will be particularly important. Indeed, thanks to its mass, the τ lepton has a non-negligible coupling to the Higgs boson that can be significantly enhanced in extensions of the Standard Model (SM).

In this thesis work, it is proposed to search for events containing two Higgs bosons, one decaying into ττ, one decaying into two b jets. In 2HDM, a pair of Higgs boson can result from a resonant production (H->hh), but final states with two Higgs bosons also naturally arise in the SM through top loops and Higgs boson tri-linear self-coupling. Sensitivity to the SM-predicted value of the λ_{HHH} coupling is not within the reach of Run 2, but important constraints on scenarii beyond the SM that enhance λ_{HHH} will be set.

It should also be mentioned that the production of a Higgs boson in association with two b jets is enhanced at large tan β. If relevant, the expertise acquired with the bbττ final state could therefore be redeployed in case of SUSY discovery or to set direct constraints on the Minimal SUSY Standard Model parameter space.

Advanced analysis techniques, such as the Matrix Element Method that have been successfully developed and applied to channels with τ leptons in the LLR team, will be investigated for the analysis.

Optimal performance of the τ triggers and reconstruction are crucial in the context of this analysis and it is expected that the student will dedicate about 30% of the thesis work on studying and improving those aspects.

The thesis will be conducted at the LLR with frequent stays at CERN.

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