Laboratoire de Physique de Clermont, Université Clermont-Auvergne - CNRS/IN2P3

Internship Proposal

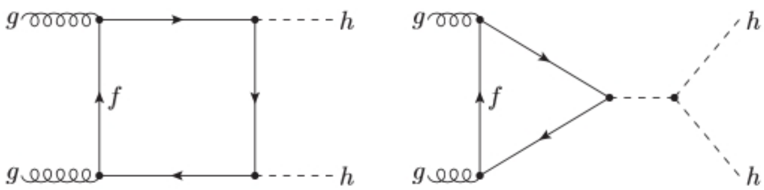
Study of the Higgs self-coupling with the ATLAS detector at LHC

Supervisor: D. Boumediene (CNRS)
Djamel.Boumediene@cern.ch (00334 73 40 72 97)

Many of the Standard Model limitations are related to the couplings of the Higgs boson to different fields. For example, the coupling of the Higgs field to itself, labelled λ_{HHH}, arises from the Higgs potential, and CP violation appears in the coupling of the Higgs field to fermions. Another illustration of how the Higgs sector can be used as a probe is the impact of Top quark Yukawa coupling on the running of the Higgs self-coupling and then on the stability of the Electro-Weak vacuum.
The ability to experimentally study these couplings of the Higgs gives us a powerful tool to make progress on today's pressing questions in particle physics.

The ATLAS experiment is one of the large experiments of the LHC at CERN. The beam delivered by the LHC allowed performing direct measurements of several Higgs couplings. A substantial test of the Higgs sector is the direct measurement of the still not observed Higgs self-coupling (λ_{HHH}). It gives direct access to the Higgs potential and is considered a vital measurement of the HL-LHC (High Luminosity Large Hadron Collider) program.

The Higgs self-coupling is accessible through the double Higgs production (HH). The Higgs boson pair decay modes lead to multiple final states, mainly combining W bosons, Z bosons, *b* quarks, photons and τ leptons. From an experimental point of view, several signatures can be used to identify an HH production and distinguish it from background processes.



The first part of the work will be performed using even generators to understand the interplay between the Higgs self-coupling and final state observables.

The internship will get familiar with ATLAS data analysis techniques by developing different signal selections and event reconstructions.
The objective will be to use event by event regressions to build observables highly correlated to λ_{HHH}. This approach will require using refined Machine Learning models. Finally, significant work on the operation and understanding statistical methods is foreseen to exploit and estimate the expected precisions on λ_{HHH}.

In addition to a good knowledge of high energy physics, students applying to this internship are expected to have reasonable knowledge in computing.