Observation et mesures du boson de Higgs produit en association avec une paire top-antitop dans l’expérience ATLAS

Spécialité Physique corpusculaire des accélérateurs

Niveau d'étude Bac+5

Formation Master 2

Unité d'accueil

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Durée 6 mois

Poursuite possible en thèse oui

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Résumé

With the discovery of a new boson compatible with the Standard Model (SM) Higgs boson, a new era of particle physics has begun. One of the most important topics in particle physics for the incoming years is to study the nature of the Higgs boson and its connection with possible extensions of the SM. It is especially interesting to understand the relationship of the Higgs boson with the heaviest elementary particle, the top quark, and to measure the Yukawa coupling between the top quark and the Higgs boson. The only process which has a direct sensitivity to the top-quark Yukawa coupling is the production of a Higgs boson (H) in association with a top-anti-top pair (ttbar). This channel is one of the most challenging ones to be measured at LHC and is the topic of this internship.

Sujet détaillé

After two years of shutdown, the LHC has restarted in 2015 with higher instantaneous luminosities and a higher center of mass energy of 13 TeV. It is expected to deliver an integrated luminosity of more than 100 fb-1 by the end of 2018. With this amount data, it is expected that we will be able to observe the ttbar-H process and measure its production cross-section for the first time. The PhD candidate will be expected to take an important role in this new measurement.
Given the small expected ttH cross section, it is important to focus on the channel with the largest Higgs branching ratio. With a mass of 125 GeV, the more abundant Higgs decay channel is into a pair of b quarks. However ttH with H into b-bbar is one of the most challenging channels at the LHC because of the large background from tt+jets. Discovering the ttH channel will require an excellent understanding of the SM background and of the detector performance. The focus will particularly be on the reconstruction of the ttH final state and on the modeling of the ttbar+jets background.
Supersymmetric extensions of the SM predict additional Higgs bosons beyond the one of the Standard Model: one more neutral CP-even Higgs boson in the minimal extension (MSSM), and two more neutral CP-even Higgs bosons in the next-to-minimal extension (NMSSM). In these models the couplings of the Higgs boson with a mass of 125 GeV observed at the LHC can differ from the SM couplings, hence all of them must be measured as precisely as possible. Regarding the generic case of extra- fermions, that arise in most of the SM extensions the determination of their new loop-contributions to the Higgs couplings with gluons or photons is relying on the knowledge of the top and bottom

Yukawa couplings. This is an additional motivation for measuring the top and bottom quark Yukawa couplings to the Higgs.

- implement, study and validate techniques to reconstruct the ttH final state: multivariate b-tagging, top and Higgs boosted reconstruction.
- study the SM background of the ttH signal coming from tt+jets and tt+bbar.
- measure the ttH cross section with the LHC data delivered during the LHC Run 2 at 13 TeV.
- extract the top-Higgs Yukawa coupling and compare it with the predictions from the SM and BSM models.

Mots clés

hautes-énergies, LHC, Higgs

Compétences

Logiciels

Observation and measurements of the Higgs boson produced in association with a top-antitop pair in the ATLAS experiment

Summary

With the discovery of a new boson compatible with the Standard Model (SM) Higgs boson, a new era of particle physics has begun. One of the most important topics in particle physics for the incoming years is to study the nature of the Higgs boson and its connection with possible extensions of the SM. It is especially interesting to understand the relationship of the Higgs boson with the heaviest elementary particle, the top quark, and to measure the Yukawa coupling between the top quark and the Higgs boson. The only process which has a direct sensitivity to the top-quark Yukawa coupling is the production of a Higgs boson (H) in association with a top-anti-top pair (ttbar). This channel is one of the most challenging ones to be measured at LHC and is the topic of this internship.

Full description

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Given the small expected ttH cross section, it is important to focus on the channel with the largest Higgs branching ratio. With a mass of 125 GeV, the more abundant Higgs decay channel is into a pair of b quarks. However ttH with H into b-bbar is one of the most challenging channels at the LHC because of the large background from tt+jets. Discovering the ttH channel will require an excellent understanding of the SM background and of the detector performance. The focus will particularly be on the reconstruction of the ttH final state and on the modeling of the ttbar+jets background.
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Keywords

high-energy, LHC, Higgs

Skills

Softwares