Measurement of the top quark mass in dilepton channels with 13 TeV data with the ATLAS experiment at the LHC

- Thèses, Stages, Formation et Enseignement - Propositions de thèses antérieures - Propositions de thèses 2016 -
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Equipe thématique â€œMasses et Interactions Fondamentalesâ€•; expérience: ATLAS

Directeur de thèse: Frédéric Derue

tél : 01 44 27 47 03

e-mail: derue lpnhe.in2p3.fr

Co-directeur de thèse: Tristan Beau

tél : 01 44 27 41 94

e-mail: beau in2p3.fr

Title : Measurement of the top quark mass in dilepton channels with 13 TeV data with the ATLAS experiment at the LHC

The PhD subject is about the measurement of the top quark mass in in dilepton channels with 13 TeV data with the ATLAS experiment at the LHC. The student will work on the all data taken during the Run2 with an energy in the centre of mass of 13 TeV. He/She will work in a dedicated working group of the collaboration. Stress will be put on the decrease of the systematic uncertainties by using different measurement methods and by specific studies on the reconstruction of jets or hadronization of b-quarks.

The ATLAS experiment is one of the major experiments at the CERN LHC proton-proton collider. A first data taking period (Run 1) occured with an energy in the center of mass of 7 TeV in 2010-11, of 8 TeV in 2012 collected respectively 5 fb-1 and 20 fb-1 of integrated luminosity. After a shutdown in 2013-14, needed to upgrade the accelerator, LHC restarted collisions with an energy of 13 TeV (Run 2) in march 2015. In 2015, already 3-4 fb-1 of integrated luminosity were taken. It will continue data taking until 2018 for a total integrated luminosity expected to be in the 100 fb-1 range.

The group of LPNHE is made of 28 members among which 18 are seniors. it has a strong expertise in the domain of electromagnetic calorimetry and tracking. It participated to the development and the analysis of data taken during test beams, commissioning and colliding periods. The group is now involved in the upgrade of the pixel detector to be put in place during the very high luminosity period, and to the development of computing and storage facility for the collaboration. The group is participating to the study of the electroweak symmetry breaking through studies on the Higgs boson, precision measurements on the Standard Model and search for New Physics. In particular, a group of five senior physicists and a post-doc are working on the top quark and jet physics, such as the measurement of production cross section of top-antitop pairs and the top quark mass.

The quark top is the only elementary fermion with a mass of the order of the electroweak scale. It is thus an important sector to study the electroweak symmetry breaking. The mass of the top quark is a fundamental parameter of the Standard Model. The radiative corrections to the top quark mass are sensitive to the mass of the W boson, the Higgs boson but also to the predictions of the stability of the Universe. It is thus important to be able to compare with a high precision the different mass measurements to search for evidence of possible effects not predicted by the Standard Model.

The PhD project will initially focus on the measurement of the top quark mass with the 2015 data. With an increased cross section production at 13 TeV, it is already half of the statistics of top-antitop pairs available during the Run 1. The measurement of the top quark mass being limited in precision by systemtic uncertainties an early measurement will be done using the template method, based on the comparison between data and simulation of observables sensitive to the top quark mass. During this first year, the student will work also on the jet calibration or hadronization phenomena of b-quarks, both being among the largest systematic uncertainties on the mass measurement. This part of the work will be qualifying for ATLAS authorship in agreement with the collaboration management.

The PhD work will then include the analysis of the all data accumulated during the Run 2. The sample of top-antitop events will be about twenty times larger than the one accumulated during the Run 2. This will allow to do stricter selection cuts to minimize the systematic uncertainties. Another method to measure the mass measurement will be also explored, based on a method giving an event-by-event probability based on the calculation of the associated matrix element and cross-section. This method is potentially more precise but is very computing demanding. The development of the method on parallel computing ressources such as a supercomputer UV2000 of the University UPMC and/or GPU/XeonPhi processors will be explored.

The PhD project will include all necessary parts for a good understanding of the mass measurement :

- good understandind of the detector and combined reconstruction of physical objects (leptons, jets, b-jets);
- selection (and optimization) of events based on a priori knowledge based on simulation of the expected signal and background events;
- measurement of the top quark mass with different methods;
- quantification of the systematic uncertainties, in particular the jet calibration, hadronization of b-jets, initial and final state radiation etc... Lieu de travail : LPNHE - Paris

Internship in spring 2015 at CERN and LPNHE Paris

Déplacements éventuels: CERN Genève

Documentation:

- http://lpnhe.in2p3.fr/atlas
- rapport d'activité pages 17 et 18
- http://atlas.web.cern.ch/Atlas/Collaboration/

Contact:

- Frédéric Derue, 01 44 27 47 03 ou derue lpnhe.in2p3.fr
- Tristan Beau, 01 44 27 41 94 ou beau in2p3.fr

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