Curricular Unit

Advanced Physics Topics 1

Module

Data Analysis in Particle Physics

Type

Lecture Coursework

Contact hours

18 (8 T, 10 P)

Professor/Researcher in charge

Nuno Castro

Summary of Contents

With the data collected during the first operation phase of the Large Hadron Collider (LHC) at CERN, the Standard Model of Particle Physics and many new physics models beyond it were tested at an unprecedented energy at colliders. This required the use of advanced statistical techniques capable of dealing with the huge amount of collected data. This course aims at providing an overview of the main experimental tests of the Standard Model at the LHC and previous colliders, and to provide a comprehensive and practical approach to the various analysis methods typically encountered in particle physics. Searches for new physics beyond the Standard Model will also be discussed.

The course is divided in theoretical and practical lectures. In the theoretical lectures (8 hours) the fundamental concepts and techniques are introduced while in the practical lectures (10 hours) important tools for simulation and data analysis will be exercised with realistic use cases in the context of different analysis relevant for the LHC physics program.

Topics of the theory lectures:
1. The Standard Model of Particle Physics
2. Electroweak Precision Measurements
3. The Search for the Higgs Boson
4. Precision Measurements of the top quark
5. Searches for Physics Beyond the Standard Model

Topics of the practical lectures:
1. Introduction to Monte Carlo Simulation
2. Analysis tools
2.1 ROOT
2.2 Madgraph
2.3 Madanalysis
2.4 TMVA

Evaluation

1. Students are expected to follow at least 2/3 of the theoretical and practical lectures.
2. The evaluation will be done based on the attendance and participation in discussions as well as individual and team works.
The weight of the different components in the final grade is as follows:

      Participation in class 10%
      Individual work and exercises 25%
      Final work (presentation) 65%

Bibliography

- The Standard Model and Beyond, P. Langacker, CRC Press (2011).
- Data Analysis in High Energy Physics, O. Behnke, K. Kroeninger, G. Schott and T. Schoener-Sadenius, Wiley-VCH Verlag (2013).
- Workshop on Confidence Limits, F. James, CERN-2000-005 (2000).
- ROOT – Data Analysis Framework, http://root.cern.ch/drupal
- Madgraph 5, http://madgraph.hep.uiuc.edu
- Madanalysis, https://launchpad.net/madanalysis5
- TMVA – Toolkit for Multivariate Data Analysis, A. Hoeker, CERN-OPEN-2007-007 (2007).