SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Elementary Particle Physics

has the honor to invite you to the public defense of the PhD thesis of

Lieselotte MOREELS

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Direct measurement of the top quark decay width in the muon+jets channel using the CMS experiment at the LHC

Promotor:

Prof. Petra Van Mulders

The defense will take place on

Wednesday 4th of April 2018 at 16:00 h

in Auditorium D.2.01 at the campus Humanities, Sciences and Engineering of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, and will be followed by a reception.

Members of the jury:

Prof. Nick Van Eijndhoven (chairman)
Prof. Alberto Mariotti (secretary)
Prof. Jorgen D'Hondt (co-promotor)
Prof. Philippe Claeys
Dr. Ivan Marchesini
Prof. Dirk Ryckbosch (Universiteit Gent)
Dr. Rebeca Gonzalez Suarez (University of Nebraska)

Curriculum vitae

After obtaining her Masters degree at the VUB in 2013, Lieselotte Moreels started a PhD in elementary particle physics. She performed the first direct measurement of the top quark decay width in the semileptonic decay channel using data collected by the CMS experiment, which is also the most precise measurement.

In addition, she took up several responsibilities within the experiment, where she became one of the experts on site, and contributed to data taking and data quality monitoring.

Abstract of the PhD research

The standard model (SM) of particle physics describes the fundamental particles and their interactions. It is one of the most extensively tested theories during the last century. However, several observations indicate that the SM is not the end of the story. Being the heaviest particle in the SM, the top quark is expected to be most sensitive to beyond the SM phenomena. Precise measurements of the properties of the top quark and its interactions can be compared to their predictions, thus favouring or excluding certain beyond the SM theories. This thesis investigates the top quark decay. In the SM the top quark decays almost uniquely into a W boson and a b quark. The probability for this process to happen is reflected in the top quark decay width, which is predicted to have a value around 1.33 GeV. If the top quark decays into other particles as well, the top quark decay width will be larger than the SM prediction.

A direct measurement of the top quark decay width is performed using proton collisions produced by the Large Hadron Collider (LHC) at a centre-of-mass energy of 13 TeV. The data were recorded by the CMS experiment and correspond to an integrated luminosity of 35.9 fb^{-1}. A dedicated selection process singles out events where top quarks are produced in pairs. Events are required to have exactly one muon and exactly four jets, whereof two should originate from b quarks. Additional selection requirements based on reconstructed variables are imposed to increase the fraction of well-reconstructed events. The simulated events are then categorised according to whether they are correctly reconstructed or not.

Several measurements of the top quark decay width are performed using a maximum likelihood method, where templates are constructed using the distributions of variables that are sensitive to the top quark decay width. The best measurement obtained in this analysis results in a top quark decay width of 1.12 +- 0.16 (stat.) +0.65 -0.54 (syst.) GeV, which is consistent with the value predicted by the SM. This result represents the most precise direct measurement of the top quark decay width in this decay channel, reducing the uncertainties of the previous best result by 30%. The measurement is consistent with the best result in the dilepton decay channel.