

The Research Group
Elementary Particle Physics

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

Kevin DEROOVER

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

A search for flavor changing neutral currents involving a top quark and a Higgs boson with the CMS experiment

Promotor:

Prof. Jorgen D'Hondt

The defense will take place on

Friday 15 September 2017 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. Freya Blekman (secretary)
Dr. Kirill Skovpen (co-promotor)
Prof. Alberto Mariotti
Prof. Nathalie Vermeulen
Prof. Pascal Vanlaer (ULB)
Prof. Nuno Castro (Univ. do Minho, Portugal)

Curriculum vitae

After obtaining his Master degree at the VUB in 2013, Kevin Deroover started his PhD research in experimental particle physics. He is member of the CMS collaboration at the Large Hadron Collider at CERN where he takes responsibility in developing heavy flavour reconstruction techniques. He developed the worldwide best analysis to search for the FCNC interaction of the top quark and Higgs boson. These results are approved by the CMS collaboration and are to be published soon. The results will be shown publicly for the first time at the yearly international top quark conference.

Abstract of the PhD research

Since the discovery of the Higgs boson in 2012 by the ATLAS and CMS experiments, the Standard Model of elementary particle physics is completely validated at Electroweak scales. However, many phenomena are yet unexplained by the Standard Model, such as the existence of dark matter and dark energy. All in all, the Standard Model is able to account for only 4% of the universe's energy content.

A whole series of not yet refuted theories, like Supersymmetric extensions to the Standard Model or including extra dimensions, can account for phenomena like dark matter, though have no experimental evidence so far. The search for such new physics in current experiments is not straightforward, as its characteristics are often hard to disentangle from those of the Standard Model. However, processes where new physics could be significantly enhanced with respect to the Standard Model are so-called Flavour-Changing Neutral Currents (FCNC). These processes change the flavour of quarks, by means of a neutral boson, without changing their charge and are highly suppressed in the Standard Model, far beyond the sensitivity of current experiments. The observation of such processes would be clear evidence of new physics, which makes the search for FCNC vital in the quest for solving the mysteries of the universe.

In this thesis, FCNC are investigated in high-energy proton-proton collisions at a center-of-mass energy of 13 TeV, produced by the Large Hadron Collider (LHC) and recorded by the CMS experiment at CERN in 2016 with an integrated luminosity of 36/fb. More specifically the coupling of top quarks (t) to up (u) or charm (c) quarks and a Higgs boson (H), decaying into a pair of bottom quarks, is investigated. By means of kinematic event reconstructions, event categorisations and machine learning techniques, an optimal discrimination power between the signal processes and Standard Model background processes is obtained. The most stringent limits to date are set on these processes, with expected (observed) upper limits at 95% confidence level on the branching ratios of $B(t \rightarrow uH) \leq 0.34\%$ (0.44%) and $B(t \rightarrow cH) \leq 0.47\%$ (0.47%).