

The Research Group
Elementary Particle Physics

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

Isis VAN PARIJS

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Search for tZq Flavour Changing Neutral Currents in top production and decays with the CMS experiment

Promotor:

Prof. Jorgen D'Hondt

The defense will take place on

Friday January 26 2018 at 16:00 h

in Auditorium E.0.12 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. Ben Craps (chairman)
Prof. Stijn Buitink (secretary)
Prof. Petra Van Mulders
Prof. Steven Ballet
Prof. Antonio Onofre
(University of Minho, Braga, Portugal)
Prof. Benjamin Fuks (UPMC, Paris, Fr.)

Curriculum vitae

Isis Van Parijs obtained her Master degree at the VUB in 2013. She started her PhD research at the VUB and joined the CMS collaboration. By taking up several responsibilities within the experiment, she contributed to data taking.

She has contributed to the FCNC/SM tZq search which had the most stringent limit in top-Z FCNC interactions at 8 TeV. Furthermore, she did a phenomenology study including all top-FCNC couplings which will be published in the near future. She was the convenor of the tZq searches at CMS, which produced two publications.

Her research has the most stringent limits on top-Z FCNC within CMS.

Abstract of the PhD research

The Standard Model (SM) of particle physics is a theory of fundamental particles and their interactions. This theory has been experimentally confirmed and all particles predicted by this theory have been found. Nonetheless, this theory has its shortcomings and cannot explain phenomena such as neutrino masses or gravity. The heaviest particle of the Standard Model is the top quark and physicists believe that it has an enhanced sensitivity to various new particles and interactions suggested by new physics theories. The Large Hadron Collider is a proton collider, producing a large number of events containing top quarks. At the proton collision points, experiments are placed to study the collisions. The search presented in this thesis is performed on data collected by the Compact Muon Solenoid (CMS) experiment at a centre-of-mass energy of 13 TeV, resulting in 35.9 fb^{-1} of integrated luminosity.

Flavour changing neutral currents (FCNC) are highly suppressed in the SM. However, many beyond the SM theories enhance their probability. In this thesis, a search in three lepton final states is performed for the production of single top quarks via the tZq vertex, with $q=c$ or u , for the top quark pair processes where one of the top quarks decays through this vertex. No significant deviation with respect to the predicted background is observed and upper limits at 95% confidence level (CL) are obtained. The observed (expected) upper limits at 95% CL on the branching fractions are: $B(t \rightarrow uZ) < 2.4 \times 10^{-4}$ (1.5×10^{-4}) and $B(t \rightarrow cZ) < 4.5 \times 10^{-4}$ (3.7×10^{-4}), assuming one non-vanishing FCNC coupling at a time.

Significant improvements are developed with respect to previous searches, namely by using other kinematic variables as well as a better handle on the not prompt-lepton background. The sensitivity of this search exceeds that of previous analyses at the CMS experiment, and is comparable to the sensitivity obtained at the ATLAS experiment. Although the limits on the FCNC interactions with a tZq vertex start to probe physics beyond the SM, the branching fractions predicted within the SM remain out of reach.