SCIENCES & BIOENGINEERING SCIENCES

The Research Group

High-Energy Physics

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

Nicolas Stylianou

to obtain the degree of Doctor of Sciences

Joint PhD with University of Bristol

Title of the PhD thesis:
A search for four top quarks production at the CMS experiment via the single lepton channel

Promotors:
Prof. dr. Alberto Mariotti (VUB)
Prof. dr. Freya Blekman (DESY)
Prof. dr. Joel Goldstein (University of Bristol)

The defense will take place on
Thursday, February 16, 2023 at 15h in Promotiezaal D.2.01 of the VUB

(information on a possible live stream)

Members of the jury

Prof. dr. Krijn De Vries (VUB, chair)
Prof. dr. Konstantinos Petridis (University of Bristol, secretary)
Prof. dr. Joel Goldstein (University of Bristol)
Prof. dr. Clara Nellist (Amsterdam University)
Dr. James Howarth (University of Glasgow)

Curriculum vitae

Nicolas Stylianou graduated in 2018 with a Master of Science in physics at the University of Bristol. Later the same year he started as a joint PhD student in elementary particle physics at the University of Bristol and the Vrije Universiteit Brussels. He is a member of the CMS collaboration at the Large Hadron Collider at CERN, where he has contributed to colour reconnection studies, which were submitted to a journal for publication, in addition to being a CMS-author of about 90 publications. Furthermore, he has worked on test set-ups for pixel detectors and their software, where he has given talks in CMS tracker related workshops. His focus in the final years of his study was data driven predictions of four top quarks production backgrounds, such that backgrounds are independent of simulation uncertainties that would otherwise have a large impact on the search for four top quark production.

Abstract of the PhD research

While the Standard Model (SM) of particle physics has been incredibly successful in describing fundamental particles and their interactions, there are a few phenomena that remain without explanation in the current understanding of the building blocks of this world. These open questions are the source of new ideas and motivation for searches for new physics with experiments at the Large Hadron Collider at CERN. One search that is very interesting, as it is sensitive to new physics that can expand the current SM to a complete theory, is the search for a physics process known as four top quark production. This thesis presents the search for four top quark production using data collected at CMS.

The production of four top quarks is an incredibly rare process, yet to be observed, which has a large background originating from processes with similarly large jet multiplicity in their final states such as the production of a top quark and anti-top quark pair in association with extra jets from QCD radiation. The motivation for a study of the production of four top quarks at CMS is that its cross section may give indications of physics beyond the SM.

The focus of this thesis is one of the possible decay channels, the single lepton channel (e or μ), which is one with a high probability of occurring, at around 26%. In this channel each top quark decays to produce a W boson and a bottom quark, where only one of the W bosons must decay to a lepton and an anti-neutrino. The final study of this PhD proposes a data-driven method for the estimation of backgrounds to four top quark production in the single lepton channel that gives results of about the same magnitude but has different and fewer sources of uncertainty. In the future the data-driven method can also be applied to other decay channels. In addition, because the main limitation to this method is the statistical uncertainty from the input data, in the future with more data collected at CMS and minor adjustments to the method, the power of the search will increase.