SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Elementary Particle Physics

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

Quentin PYTHON

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Search for displaced Supersymmetry in events with two leptons with large impact parameters with the CMS detector at the LHC.

Promotor:

Prof. Dr. Freya Blekman

The defence will take place on

Tuesday May 07 2019 at 16:00h

in Auditorium D.0.07 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. dr. Jorgen D'Hondt (Chairman)
Prof. dr. Stijn Buitink (secretary)
Prof. dr. Alberto Mariotti
Prof. dr. Em. Theo D'Hondt
Prof. dr. Geacomo Bruno (UCL)
Prof. dr. Philippe Mermod (Univ. De Geneve)

Curriculum vitae

Quentin Python graduated as Master of Science in Physics from Ecole Polytechnique Fédérale de Lausanne (EPFL) in 2012. Afterwards, he enrolled as a PhD candidate at the Vrije Universiteit Brussel in the Particle Physics group.
His research was published in Phys. Rev. Letters, and he presented his work at the international Supersymmetry conference.
Besides the research covered in his thesis, Python has worked on the identification of bottom quarks for the CMS experiment at CERN.
He supervised VUB students during their bachelor and master theses.

Abstract of the PhD research

The Standard Model of particles physics describes the smallest known building blocks of matter and their interactions amongst each other. The predictive power of this theory has been astoundingly accurate, and the discovery of the long-sought Higgs boson in 2012 is probably one of its most notorious predictions. However, despite its success, it is known that the Standard Model cannot be the ultimate theory of nature. Indeed, some experimental facts remain unexplained, for example gravity is not included and the Standard Model does not provide a dark matter candidate.

To expand the boundary of our knowledge, physicists have proposed new candidate theories describing the physics beyond the Standard Model. These new physics theories make predictions on the behaviour of existing particles and occurrences of new particles that can be observed by the experiments at the Large Hadron Collider at CERN. Supersymmetry is one such theory that solves many unanswered questions in fundamental physics and gives all known particles a partner, called superpartner, or superparticle. This thesis focuses on so-called Displaced Supersymmetry, where the new particles will result in very striking signatures where the location of the superpartner's decay will be measurably distant from the collision.

In this thesis, the data collected by the Compact Muon Solenoid detector is used to test the validity of Displaced Supersymmetry, using data collected in 2012 and 2015. The data is examined for signs of displaced particles originating from Supersymmetry, focusing on collisions with one electron and one muon in the final state; this is the first result of this kind worldwide. Furthermore, this first search is extended using final states with same-flavour leptons. The combination of the two searches gives powerful constraints on the Displaced Supersymmetry model. The results focus on a lifetime of the order of few centimetres where the previous results were almost non-existent. The analysis topology is relaxed enough so that the signatures predicted by other models with similar properties can be tested with reasonable sensitivity, and tools are provided to do so.