SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Elementary Particle Physics

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

Isabelle DE BRUYN

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Search for dark matter in the monojet and trackless jets final states with the CMS detector at the LHC

Promotor:

Prof. Steven Lowette

The defense will take place on

Monday January 22 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. Alexander Sevrin (chairman)
Prof. Jorgen D'Hondt (secretary)
Prof. Dominique Maes
Dr. Krijn De Vries
Prof. Albert De Roeck (CERN, UA)
Prof. Fabio Maltoni (UCL)

Curriculum vitae

Isabelle De Bruyn obtained her Master degree at the UGent in 2013 and subsequently started her PhD research at the VUB. She joined the CMS collaboration and took up several responsibilities contributing to data taking. She helped improving a flagship analysis searching for dark matter and in addition developed an original and complementary search, allowing the exclusion of more dark matter scenarios.
A feasibility study of this new search has already been published, and the new results with data from the CMS experiment will be published in the near future.

Abstract of the PhD research

Although the Standard Model of particle physics is an extremely successful theory, multiple cosmological observations indicate that the known matter described by this framework only contributes 15% of all the matter in the universe. The remaining matter is observed through gravitational interactions, but is not visible in observations of light at any wavelength, implying it is electrically neutral. Only very little is know about this so-called dark matter, and many theoretical models exist to explain its origin. Depending on their exact nature, dark matter particles might be produced in high-energy collisions at particle colliders.

This thesis covers two searches for dark matter performed at the CMS experiment at the CERN Large Hadron Collider. In the first search, the dark matter particles are expected to leave the CMS detector undetected. They can however be observed due to an imbalance of energies measured in the detector when they are produced in association with other particles, in this case one or more collimated sprays of particles emerging from the collision, so-called jets. The work in this thesis refined the background prediction for this monojet analysis, and thus increased the sensitivity of the search. No significant excess above the predicted background was observed, setting new, stronger limits on several dark matter models, and excluding a larger part of the available parameter space. A second, more unusual search was performed as well, looking for strongly interacting candidates. The investigated signature is a pair of neutral or so-called trackless jets, which can efficiently be differentiated from the background consisting of charged jets. The result of this search is compatible with the predicted background, and again a part of parameter space was excluded.

The two searches covered in this thesis are very complementary, as the missing transverse energy signature used in the monojet search can transform into a trackless jets signature when the interaction probability becomes large enough. Although no sign of new physics was observed, these searches have led to the exclusion of more dark matter scenarios.