SCIENCES & BIOENGINEERING SCIENCES

The Research Group
High Energy Physics

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

Soumya Dansana

to obtain the degree of Doctor of Sciences

Joint PhD with Université libre de Bruxelles

Title of the PhD thesis:
Search for light scalar particles in exclusive final states with two muons and two hadrons at the CMS experiment

Supervisors:
Prof. dr. Steven Lowette (VUB)
Prof. dr. Barbara Clerbaux (ULB)

The defence will take place on
Monday, December 15, 2025 at 3 p.m. in Jean Sacton room, IIHE, G/1-G.1.03

The defence can be followed through a live stream:
https://cern.zoom.us/j/8142610091?omn=61266338070

Members of the jury

Prof. dr. Pascal Vanlaer (ULB, chair)
Prof. dr. Alberto Mariotti (VUB)
Prof. dr. Markus Klute (Karlsruher Institut für Technologie, DE)
Prof. dr. Anna Benecke (UCLouvain)

Curriculum vitae

Soumya Dansana graduated with his Master of Science degree, from IISER Kolkata, India in 2020. He started his PhD on Beyond Standard Model physics as a doctoral candidate at the VUB and ULB in 2021.

His research focuses on searches for new particles that can travel some distance before decaying to displaced Standard Model particles, that can be detected in the CMS experiment at the LHC.

Abstract of the PhD research

The Standard Model of particle physics has been remarkably successful in describing matter and its interactions at the subatomic scale. There are, however, few key observations that do not fit within the framework of the Standard Model, such as the existence and the nature of dark matter. Theoretical extensions, termed as Beyond Standard Model (BSM) theories, often propose new particles that can be produced in high-energy experiments such as CMS at the LHC collider.

In this thesis, a search for new scalar particles of O(GeV) mass in exclusive final states with muons and light hadrons is presented. The search targets exotic decays of the Higgs boson to a pair of prompt or long-lived identical scalar bosons with proper decay lengths up to 100 mm and masses within the range of 0.4–2.0 GeV. This mass window corresponds to a unique phase space where hadronic decays mostly consist of only pairs of light hadrons. The analysis uses proton-proton collision data produced at the LHC in 2016– 2018 at a center-of-mass energy of 13 TeV and collected by the CMS detector. The analysis achieves unique sensitivity to very light scalar boson masses and demonstrates a novel approach to probe hadronic decays of light scalar bosons.

In parallel, a study of the jet energy resolution at the CMS experiment is carried out using the 2018 dataset to contribute to ongoing jet calibration efforts. A validation study comparing two different methods used within the CMS Collaboration is also performed as part of this work.