SCIENCES & BIOENGINEERING SCIENCES
The Research Group

Elementary Particle Physics

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

Simon VERCAEMER

to obtain the degree of Doctor of Sciences

Joint PhD with Universiteit Antwerpen

Title of the PhD thesis:

Commissioning of the SoLid experiment for the observation of electron antineutrinos at the BR2 reactor

Promotors:

Prof. Petra Van Mulders
Prof. Nick van Remortel (Universiteit Antwerpen)

The defence will take place on

Monday November 5 2018 at 16:00h

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. Nick van Eijndhoven (chairman)
Prof. Stijn Buitink (secretary)
Prof. Wim De Malsche
Prof. Ioana Maris (ULB)
Dr. Mathieu Bongrand (LAL – Univ. Paris Sud, Fr.)

Curriculum vitae

Simon Vercaemer obtained his master's degree at Ghent University in 2014.
He then started a joint PhD at the University of Antwerp and the VUB in the context of the SoLid experiment. Simon contributed to all aspects of the experiment, from the construction and commissioning to the daily operation and data analysis of two generations of detectors.
His research results led to the observation of antineutrinos with the SoLid detector, essential for the success of the experiment.

Abstract of the PhD research

Many of the open questions in particle physics are related to neutrinos. One of the enigmas related to neutrinos is the observed deficit in the number of anti-neutrinos produced by nuclear reactors w.r.t. the prediction. To explain this anomaly theorists hypothesized a new fundamental particle, the so-called 'sterile' neutrino. This sterile neutrino does not interact with matter like ordinary neutrinos. If it exists, its presence could be inferred from the variation of the detected number of anti-neutrinos as a function of their energy and travelled distance from the reactor. Distances below 10 m are particularly interesting.

In order to solve the reactor anti-neutrino anomaly, the SoLid collaboration constructed an anti-neutrino detector capable of accurately measuring both the position and energy of each interacting anti-neutrino. This detector was placed next to SCKºCEN's BR2 reactor in Mol, Belgium, at a distance of only 6.2 m between the reactor core and the detector.

Anti-neutrinos interact with the detector material via inverse beta decay interactions, producing a neutron and a positron. It is the coincidence between these two particles that indicates the presence of neutrinos. The SoLid detector is a voxelised hybrid solid scintillator detector. The voxelisation into cubes allows for the determination of the interaction position of the anti-neutrino. The use of solid scintillators is new in the field and led to an extensive commissioning period for the detector.

The research presented in this thesis is performed on the prototype SM1 detector and the full scale Phase 1 detector. The studies performed with the SM1 detector led to several design changes for the Phase 1 detector to increase the efficiency to detect anti-neutrinos. The analysis performed on the first data collected by the Phase 1 detector demonstrates the capability of the SoLid experiment to detect anti-neutrinos despite the large background, which is essential for the success of the experiment as it is the first step towards solving the reactor anti-neutrino anomaly.