

The research group  
High Energy Physics

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

**Rose Stanley**

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

**The Radar Echo Telescope for Cosmic Rays**

### Curriculum vitae

Supervisor:  
**Prof. dr. Krijn de Vries (VUB)**

The defence will take place on  
**Wednesday, October 7, 2026 at  
4 p.m.**

VUB Etterbeek campus, Pleinlaan 2, Elsene,  
Auditorium D2.10 Promotiezaal

### Members of the jury

Prof. dr. Michael Tytgat (VUB, chair)  
Prof. dr. Nick van Eijndhoven (VUB)  
Prof. dr. Frank De Proft (VUB)  
Prof. dr. Simona Toscano (ULB)  
Prof. dr. Katharine Mulrey (RU Nijmegen, NL)

Rose obtained her Msci in Physics at the University of Bristol in 2019. Her Msci thesis concerned the detection of supernova neutrinos with the Deep Underground Neutrino Experiment.

In October 2019, Rose joined the VUB-IIHE in the group of Prof. Dr. Krijn de Vries, working on the Radar Echo Telescope (RET). Her thesis concerns the design, development, simulation, and installation of the Radar Echo Telescope for Cosmic Rays (RET-CR).

As part of her PhD, in 2023 Rose spent a month at Summit Station, Greenland as part of the installation team for RET-CR.

### Abstract of the PhD research

When ultra high energy neutrinos interact in ice, a cascade of high energy particles is formed, leaving a plasma in its wake. A transmitter can be used to illuminate a volume with radio waves and when a cascade is formed these waves are reflected by the plasma and detected by a receiver. This novel technique is called the radar echo technique. While the radar echo technique has been tested successfully in a laboratory setting, it remains untested using an in nature test beam. In order to test the radar echo technique it would be advantageous to find an alternative in-nature test beam to neutrinos.

When an ultra high energy cosmic ray air shower impacts a high altitude ice sheet, it induces a cascade in the ice that is very similar to a ultra high energy neutrino induced cascade. Additionally, cosmic rays can be detected on the surface, using known methods, and this detection can be used to trigger an in-ice radar detector. An independent reconstruction of the cosmic ray primary can then be performed using both parts of the detector.

The Radar Echo Telescope for Cosmic Rays (RET-CR) will enable the testing of the radar echo technique on the in-nature test beam of cosmic rays. This thesis concerns the design, development, simulation, and installation of RET-CR.

Beginning from a cosmic ray primary particle and ending with the expected signal in the in-ice radar detector, the whole simulation chain of RET-CR has been developed. This simulation chain allows the prediction of event rates within the different RET-CR designs considered in the development process, leading to the selection of the final RET-CR detector layout and a determination of the expected surface and in-ice event rates due to cosmic ray air showers of different energies.

This proof of principle detector was installed at Summit Station, Greenland in both May 2023 and May 2024. During the summer season, the installed detector ran successfully and triggered on cosmic ray air showers. RET-CR and its follow-up neutrino detector, the Radar Echo Telescope for Neutrinos (RET-N), represent a new era in the field of cosmic ray and neutrino detection. Detecting a cascade signal using the set up would provide the first ever detection of a high energy particle cascade in nature using the radar detection technique.