SCIENCES & BIOENGINEERING SCIENCES

The Research Group
High Energy Physics

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

Zhe Wang

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Development and Reconstruction Study of a Plastic Scintillator Detector Array System for Cosmic-Ray Muon Transmission Radiography

Promotors:
Prof. Dr. Bangjiao Ye (USTC, China)
Prof. Dr. Michael Tytgat (VUB)

The defense will take place on **Monday, June 15, 2026 at 11am in Room A505, Material Science Research Building, East Campus, USTC, China**

Online participation is possible via
https://us06web.zoom.us/j/3599951713?pwd=Sfu0UZLwR6XEhVm8pwKL6oK8-su2o3g.1&omn=79435997390

Members of the jury

Prof. Dr. Zhiyong Zhang (USTC, chair)
Prof. Dr. Nick Van Eijndhoven (VUB)
Prof. Dr. Guy Verschaffelt (VUB)
Prof. Dr. Shubin Liu (USTC, China)
Prof. Dr. Changqing Feng (USTC, China)
Prof. Dr. Feng Zhang (CAEP, China)
Prof. Dr. Ioana Maris (ULB)

Curriculum vitae

Zhe Wang obtained his Bachelor's degree in Physics from Zhengzhou University in 2019. He then joined the University of Science and Technology of China (USTC) as a PhD student in Particle Physics and Nuclear Physics under the supervision of Prof. Bangjiao Ye, and later became a joint PhD student at VUB under the supervision of Prof. Michael Tytgat.
His doctoral research focuses on cosmic-ray muon imaging with plastic scintillator detectors, covering Geant4-based detector simulation studies, scintillator characterization, detector-array development, and 2-3D image reconstruction. He also contributed to the ScIDEP muon radiography project for the Pyramid of Khafre in Egypt and to related studies on scintillator-based muon detectors and muography reconstruction methods.

Abstract of the PhD research

Cosmic-ray muons constitute a naturally available, highly penetrating and non-invasive probe for the inspection of large-scale targets, including geological formations, civil-engineering structures and cultural-heritage monuments. This PhD work develops a plastic-scintillator-based detector array for cosmic-ray muon transmission imaging, with emphasis on the full chain from detector response and system construction to quantitative image reconstruction.

The study first establishes a detector-design procedure based on Geant4 simulations of particle transport and optical-photon propagation. The effects of scintillator groove geometry, wavelength-shifting fiber configuration, optical coupling conditions and SiPM readout scheme on light collection and spatial response are investigated in a systematic manner. A quantitative scaling relation between light-collection efficiency and array position resolution is proposed, providing a practical link between the optical performance of individual scintillator strips and the detector parameters relevant to muographic imaging.

A meter-scale plastic scintillator tracking array is subsequently constructed and characterized. The detector quality-control procedure includes Compton-edge-based light-yield calibration, attenuation-length measurements and channel-response uniformity screening. A 1 m × 1 m three-layer X/Y scintillator array, instrumented with SiPM readout and operated with a multi-layer coincidence trigger, is assembled and tested using laboratory flux-ratio imaging measurements.

Finally, two-dimensional transmission imaging and three-dimensional ART/SART density reconstruction are implemented for limited-angle muography, with application to the ScIDEP Pyramid of Khafre case study. Region-of-interest metrics, including $\Delta\rho$, C_{rel}, CNR and Z^{ROI}, are used to evaluate the detectability, contrast and reconstruction stability of low-density anomalies.