

Lens-less terahertz 3D imaging using intensity-only detection

Breakthrough terahertz imaging delivering high-resolution 3D internal imaging without complex phase-sensitive hardware.

Benefits

- Low-cost, scalable hardware
- High-resolution, non-destructive 3D imaging
- No ionising radiation
- No lenses or phase-sensitive electronics
- Real-time imaging
- Security, industrial and biomedical applications

Background

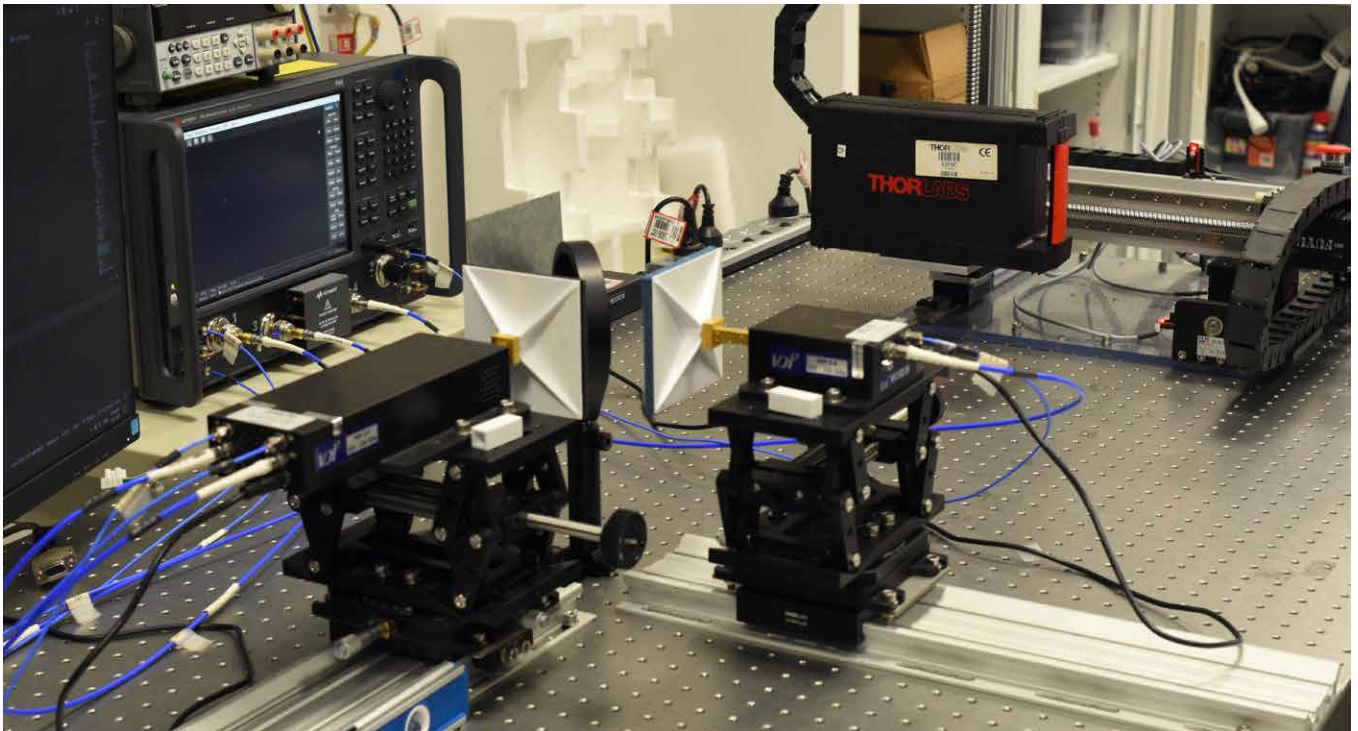
Terahertz (THz) imaging enables non-destructive inspection using electromagnetic waves that penetrate many non-metallic materials. Conventional systems are expensive because they require phase-sensitive detection, precision optics and complex calibration.

This invention replaces complex hardware with a software-driven approach that uses intensity-only measurements and a fixed reference plate to reconstruct high-quality 3D images, making THz imaging more affordable and scalable.

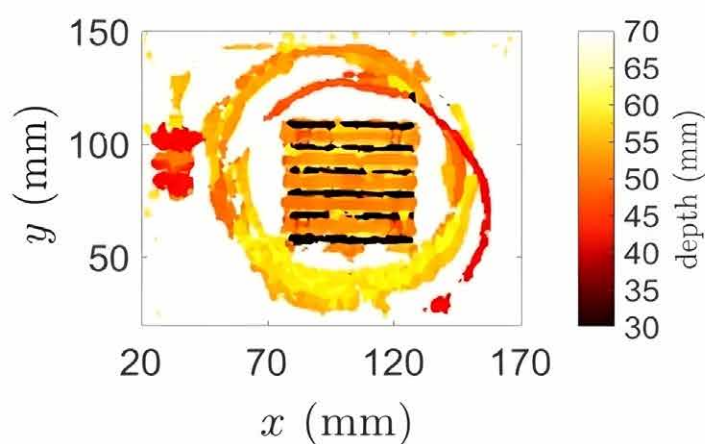
Technology Overview

The system transmits THz pulses towards an object while recording reflections from both the object and a fixed reference plate using simple intensity-only detectors. Reconstruction algorithms use the reference signal to recover depth information and generate high-resolution 3D images.

The approach eliminates phase measurements, lenses and complex optics while maintaining image quality comparable to advanced THz systems.



Proof of concept THz imaging setup to demonstrate phase less synthetic aperture radar. The setup comprises a source and detector arranged in an interferometric configuration to exploit depth sensitive interference across 220–330 GHz. Although the setup relies on a conventional phase sensitive system, the processing requires no phase information and therefore enables less complicated and less costly apparatus. The phase sensitivity provides a ground truth for validation purposes.



Resulting THz depth imaging without the need for phase information. Enabled by phase less synthetic aperture imaging, terahertz penetration through non-metallic objects reveals the contents inside the closed toolbox with an extended depth of field, unconstrained by the focal depth of the optics.

Applications

- Security screening
- Industrial inspection
- Manufacturing quality control
- Biomedical imaging
- Pharmaceutical inspection
- Electronics inspection
- Cultural heritage conservation

IP status

Provisional Patent Filed 18 August 2025 – Application number: 2025903745

Title: *Terahertz Imaging with Phase-Less Synthetic Aperture Radar System and Method*

Opportunity

Seeking licensing partners, commercial collaborators and investment to accelerate development and deployment across industrial, security and biomedical markets.

Inventors

Adelaide University:

Professor Withawat Withayachumnankul & Dr Harrison Lees

Universität Duisburg-Essen:

Prof. Dr.-Ing. Jan C. Balzer, Dr.-Ing. Lars Häring, Tobias Kubiczek, & Ekrem Emir Yildiz

Commercial Contact

**Aisha Sirop, Senior Commercialisation Manager
Research & Innovation, Adelaide University**

Email: Aisha.sirop@adelaide.edu.au

Phone: +61 8 8313 3283

Web: adelaide.edu.au/research/partnered-research