

# MASTER PROJECT/ THESIS

in the EIT/ISE Master's course programs

for: **available**

Posed by: **Prof. Dr.-Ing. Jan C. Balzer**

Topic: THz SAR Imaging-Based Non-Destructive Testing of Material Defects

Terahertz (THz) Synthetic Aperture Radar (SAR) imaging has emerged as a powerful tool for non-destructive testing (NDT) of materials due to its high resolution and ability to penetrate dielectric media. This thesis explores the application of THz SAR imaging to detect internal defects in various materials without causing damage. Advanced imaging algorithms are employed to reconstruct high-fidelity images from radar data. Particular focus is given to accurately resolving targets embedded within dielectric objects, where refraction plays a significant role. A back-projection algorithm is used as the core reconstruction method. To enhance image quality and defect localization, ray tracing techniques are integrated for refraction compensation. The overall objective is to develop a robust imaging pipeline suitable for precise material inspection using THz radar.

The task entails the following:

- *Creating a time and work plan,*
- Implement the back-projection algorithm for THz SAR image reconstruction,
- Develop a simulation environment for radar data collection in linear or circular SAR configurations,
- Integrate ray tracing methods to model wave propagation through dielectric materials,
- Apply refraction compensation using geometrical optics to improve imaging accuracy,
- Evaluate the system's ability to detect and localize material defects using synthetic and/or experimental data,
- Analyze the effect of dielectric properties on image quality and defect visibility,
- Compare conventional reconstruction methods with the proposed refraction-compensated approach (i.e., Ray Tracing)
- *regular participation in group seminars,*
- *presentation of an interim report,*
- *documentation, and final presentation of the work,*
- *the submission of the documentation and the presentation in PDF format as well as the hand-in of the printed documentation to the Prüfungsamt according to the regularisation in the Prüfungsordnung.*

Second reviewer: Prof. Dr.-Ing. A. Czylik

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