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FOR 2863 Meteracom Metrology for THz Communications

METERACOM

Philipps Universität Marburg

B1: How do objects in the beam affect terahertz communication channels?

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1. Introduction

- Future telecommunication channels in WiFi and cellular are anticipated to approach the THz range to satisfy increasing bandwidth needs.[1]
- These communication links will need to be based on highly directional beams due to high path loss.[2]
- Therefore, blockage effects and diffraction by objects and people become increasingly relevant.[3,4]
- → Treatment with methodology of optics.

2. Experimental Setup

- A commercial THz-TDS spectrometer was modified for two-way path measurements using a spherical mirror (d = 0.6 m, r = 1.75 m) custom made by us.
- The N-th reflected THz pulse is detected by the N+1 laser pulse.
- 2.5 THz bandwith are obtained with 100 TDS scans.
- Beam diameters are in the 10s of cm range.

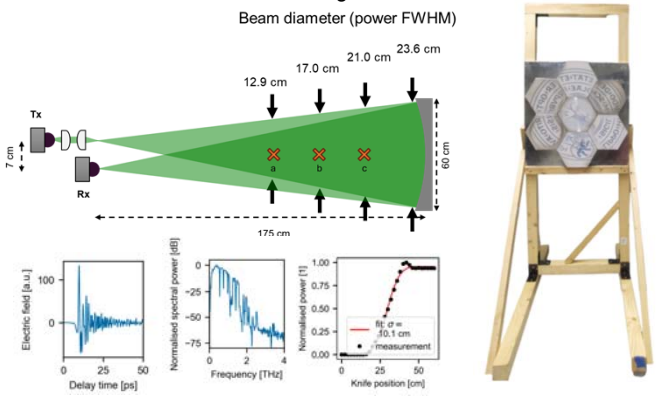

Figure 1. (A) Optical setup of the two way path TDS measurements, (B) photograph of the mirror producing an optical image, (C) time domain trace and (D) spectrum of the system, as well as € a razer blade measurement of the beam diamter.

3. Theoretical Modelling

- The experiment was modelled by solving the Fresnel diffraction integral
  → Evolution of the electric field from plane to plane
- Cross section of the image is obtained from a photograph and converted to an amplitude mask.

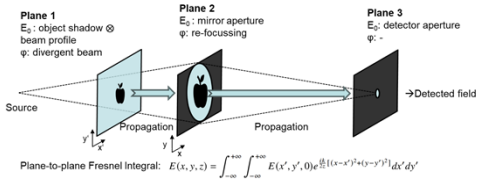

Figure 2. Visualization of the theoretical modelling of the plane.to plane evolution of the electric field by the Fresnel diffraction integral.

4. Items in the THz Beam

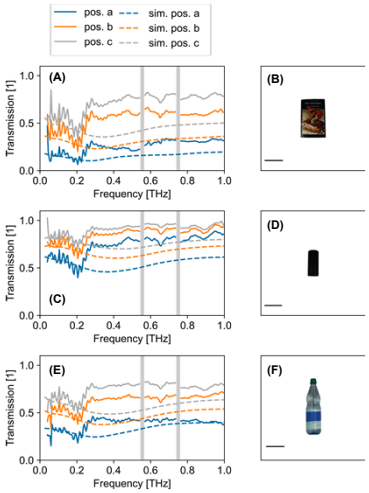

Figure 3. Power transmission obtained with and photograph of (A) and (B) a book, (C) and (D) a metallic tube, (E) and (F) a water bottle at different axial positions in the THz beam together with the corresponding results from the simulation of the Fresnel diffraction integral.

- Item closer to emitter and receiver → less transmssion.
- Reproducible transmission dip is found around 200 GHz. We attribute this to diffraction side lobes coupling less efficiently into the small detector aperture at this frequency.
- Qualitatively, the spectra are reproduced well, some discrepancies remain, which are likely due to small differences in the placement of the objects in the beam.

5. Person in the THz Beam

- See animation

6. Conclusions

- Blockage introduced to the directed THz beam by everyday objects is strongly frequency dependent.
- The Fresnel diffraction formula provides an adequate theoretical tool to model this interaction.

7. References

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- [3] T. Doeker, M. Eggers, C. E. Reinhardt, et al., IEEE Access (2025).
- [4] B. De Beelde, E. Tanghe, C. Desset, et al., Electron. (Switzerland) 10, 1–15 (2021).