P37

Modified Keplerian lens system for efficient signal coupling in sub-THz free-space communication

Marta Kurowska[1], Paweł Komorowski[2], Mateusz Kaluza[1] and Agnieszka Siemion[1,3]

[1]Faculty of Physics, Warsaw University of Technology, 00-662, Warsaw, Poland
[2]Institute of Optoelectronics, Military University of Technology, 00-908 Warsaw, Poland
[3] Center for Advanced Materials and Technologies CEZAMAT, Warsaw University of Technology, Poleczki 19, 02-822 Warsaw, Poland
Email: marta.kurowska2.dokt@pw.edu.pl

As global communication networks transition toward the 6G standard, exploiting the sub-terahertz (sub-THz) spectrum has become essential to meet the demand for ultra-high data rates. Within this regime, particularly around 100 GHz, free-space communication (FSC) links suffer from significant beam divergence caused by diffraction, making efficient energy collection a primary challenge [1]. In this work, we present a compact quasi-optical dual-lens system based on a modified Keplerian beam reducer, tailored for 95.75 GHz FSC links.

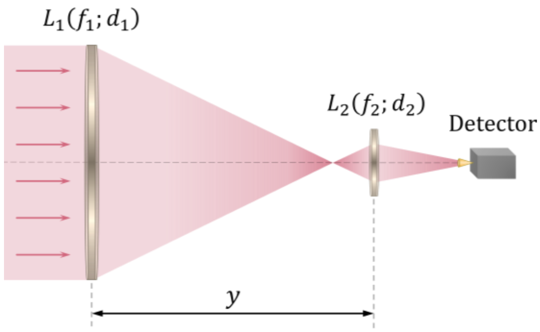

Fig. 1 Schematic of the proposed Keplerian dual-lens system.

The system comprises a primary diffractive lens L_1 with a focal length f_1=150 mm and a diameter d_1=187 mm, and a secondary diffractive lens L_2 with f_2=21.65 mm and d_2=76 mm, separated by a distance of y=175 mm, as illustrated in the schematic layout (Fig. 1). The lenses are designed to collect and shape the radiation into a converging cone that matches the WR-10 horn antenna of the receiver. To minimize absorption losses and reduce weight, the diffractive optical elements were fabricated using Fused Deposition Modeling (FDM) 3D printing technology with Cyclic Olefin Copolymer (COC) [2].

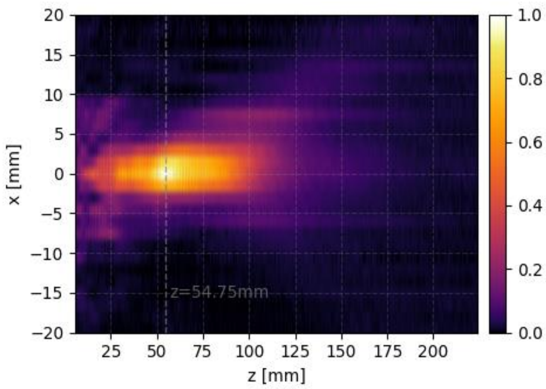

Fig. 2 Experimental xz-plane intensity scan.

Experimental verification of the fabricated structure was conducted using a 95.75 GHz IMPATT diode source and a THz camera mounted on a motorized 3-axis scanning stage. The laboratory measurements successfully confirmed the operation of the beam-shaping system and the formation of the intended focal spot. However, the experimental evaluation also revealed the system's high sensitivity to even minor levels of convergence in the incident wavefront. Ultimately, these results demonstrate that maximizing coupling efficiency in such systems requires rigorous control over the incident wavefront.

REFERENCES

[1] H.-J. Song and N. Lee; *IEEE Transactions on Terahertz Science and Technology* **12** (2022) pp. 105–117
[2] S. F. Busch, M. Weidenbach, J. C. Balzer, and M. Koch; *Journal of Infrared, Millimeter, and Terahertz Waves* **37** (2015) pp. 303–307