

# DEVELOPMENT OF THZ METALENS AND APPLICATION FOR BEAM SHAPING AND IMAGING

Karolis Redeckas<sup>1,2</sup>, Kasparas Stanaitis<sup>1,2</sup>, Vladislavas Čižas<sup>1</sup>, Rusnė Ivaškevičiute-Povilauskienė<sup>1</sup>, Linas Minkevičius<sup>1,2</sup>

<sup>1</sup>Center for Physical Science and Technology

<sup>2</sup>Vilnius University

karolis.redeckas@ftmc.lt

Terahertz (THz) radiation, spanning frequencies from 100 GHz to 10 THz, has low non-ionizing energy and can penetrate various dielectric materials [1]. This property makes it valuable in fields like security screening, quality control in manufacturing, imaging, and bio-fabric analysis [2]. Traditionally, these applications have depended on large, costly lenses or mirrors to control beam propagation, limiting their practicality. A promising approach to miniaturizing these systems is the use of metalenses. These lenses integrate a phase profile with metaatoms—sub-wavelength geometric structures like split-ring resonators—to manipulate phase delay and polarization rotation effectively.

This research covers numerical simulations conducted to determine the appropriate complementary split-ring resonators (CSRR) metaatoms for integration into a 253 GHz metalens design. Non-paraxial and axicon metalenses were created with  $F=30$  mm focal length and  $d=60$  mm focal depth, respectively. Both lenses were designed with 2 and 4 subzones and evaluated numerically. Results led to the selection of two metalenses for physical fabrication by laser ablation method.

Firstly, the non-paraxial and axicon metalenses focusing performance was experimentally evaluated (Fig. 1). Then applied in direct imaging setup, where USAF 1951 resolution evaluation target was used. System with focusing non-paraxial metalens achieve high:  $0.63\lambda$  resolution, while focusing with axicon metalens reaches  $0.85\lambda$  resolution and allows to position target not so precisely or even cover focusing element.

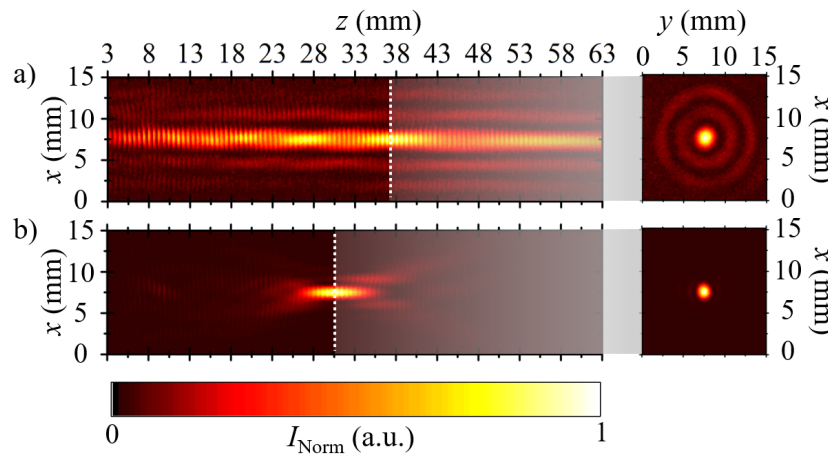


Fig. 1. Bessel beam shaped by axicon metalens a); Gaussian beam shaped by non-paraxial metalens b).

## Acknowledgements

Research was funded by Lithuanian Science Council, project number: P-ST-24-54

[1] Nagatsuma, T. (2011). Terahertz technologies: present and future. *IEICE Electronics Express*, 8, 1127-1142.  
[2] Mittleman, D. M. (2018). Twenty years of terahertz imaging. *Optics Express*, 26, 9417-9431.