

Experimental characterization of spiral lens behaviour at high field angles

Yara ABI RAAD¹, Jean AUGEREAU¹, Bertrand SIMON¹

Laboratoire Photonique numérique et Nanosciences-Talence (UMR 5298)

Spiral lenses represent a novel approach to freeform optical design that utilizes optical vortices to achieve multifocality and extended depth of field behaviors within a compact single element. Recently introduced by Galinier et al. (Optica, 2024) [1], this concept distributes optical power according to a spiral pattern on the lens diopter, enabling control over focal positions and depth of field through a small set of geometrical parameters.

While the initial work demonstrated the theoretical framework and core multifocal characteristics, the behavior of spiral lenses in off-axis imaging scenarios—a critical requirement for practical optical systems—had not been experimentally explored. Traditional approaches to correcting field aberrations typically require multiple lens elements, increasing system complexity and size.

This work experimentally investigates the performance of the spiral lens at high field angles, addressing this gap. By measuring the radius containing 80% of the encircled energy from the point spread function, the spiral lens is compared to conventional plano-convex lenses (300 mm and 400 mm) with tilts up to 15°.

Our measurements demonstrate that spiral lenses can maintain a compact and stable PSF over a larger axial range, offering an extended depth of field and improved off-axis resolution at significant field angles while effectively controlling field aberrations. These findings suggest that the spiral lens concept merits continued investigation as a design approach for compact imaging systems requiring controlled off-axis performance. We will later discuss implications for applications in ophthalmic optics and miniaturized imaging systems.

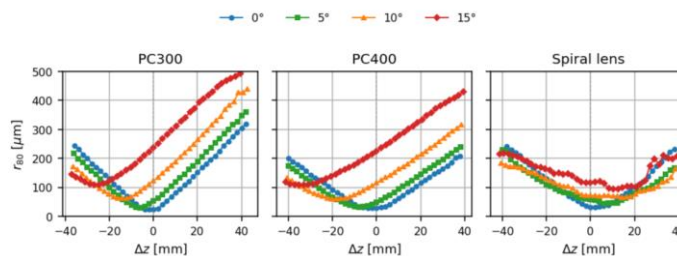


Figure 1: plots of the radius containing 80% of total energy of the three different lenses

REFERENCES: [1]: L. GALINIER, P. RENAUD-GOUD, J. BRUSAU, L. KERGADALLAN, J. AUGEREAU, AND B. SIMON, “SPIRAL DIOPTR: FREEFORM LENSES WITH ENHANCED MULTIFOCAL BEHAVIOR,” *OPTICA* **11**(2), 238–244 (2024).