Single-shot quantitative polarimetric wavefront microscopy

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Phase and polarimetric imaging are separately used in many application fields in microscopy. Polarized resolved imaging can provide information about structural anisotropy at the molecular scale and is typically used for gems characterization in geology, healthy tissues identification in cancerology or fluorophore orientation determination in super-resolution microscopy [1]. Phase imaging gives access to the height profile of reflecting surface samples and the optical path difference through samples. In cell biology, the optical path difference has been shown to be proportional to the dry mass and thus allows monitoring the metabolism of cells [2].

Here, we introduce a polarimetric wavefront imager that provides both the phase and the full-Stokes polarimetric images in a single acquisition of a multiplexed image. The device, composed of a birefringent Hartmann mask placed in the close vicinity of a camera, is first calibrated by recording images obtained when illuminating with beams of known polarization state (Fig. 1A). Then a single intensity image of a sample is recorded and demultiplexed thanks to a numerical inversion step to retrieve the full-Stokes polarization information and the optical path difference.

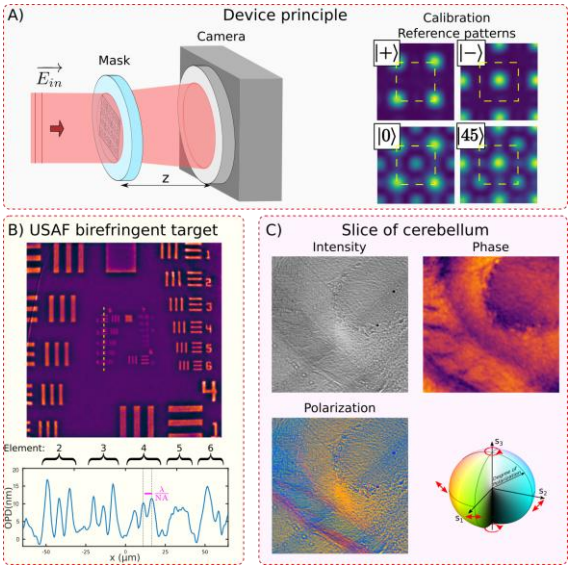

Fig. 1 A. Scheme of the polarimetric wavefront imager. B. Image of a birefringent resolution target. C. Image of a cerebellum slice

The device is shown to reach the diffraction limit (Fig. 1B) and to perform quantitative measurement of both the phase and the polarization [3]. Images of a cerebellum slice reveal both the dendritic structure of the slice and the Purkinje cells (Fig. 1C). We also demonstrate molecular orientation sensing of fluorescent marker in a polarized fluorescence microscope configuration.

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