Aberrations vs enhancement in wavefront shaping through a multimode fiber

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Optical fibers have a broad variety of applications in biomedical imaging, communication and light guidance [1]. The inherent mode coupling between different spatial modes and fiber bending scramble the light transmission in a multimode fiber (MMF), which are obstacles to the image reconstruction. Recently, wavefront shaping (WFS) technique has been applied to generate diffraction limited focal spots at the output of a MMF for lensless imaging [2,3].

Here we investigate WFS through different types of MMFs [4] and the influence of light coupling on WFS efficiency. We demonstrate a trade-off between the quality of a focal spot and the local intensity enhancement.

The experimental setup is shown in Fig. 1(a). A digital micro-mirror device (DMD) is used to implement phase modulation of the input beam 532nm continuous wave laser for WFS by Lee amplitude holography method [5]. Five different input positions are investigated by changing the DMD grating direction. For each input position, 50 foci are generated with different number of active DMD segments. The level of aberrations is estimated as FWHM of short focal axis (ω_x) over long axis (ω_y) and enhancement is calculated as the intensity inside the focal spot over the total transmitted intensity. The results as functions of the number of segments on the DMD are shown in Fig. 1(c). The center input position is beneficial for high enhancement while edge input position helps to reduce aberrations.

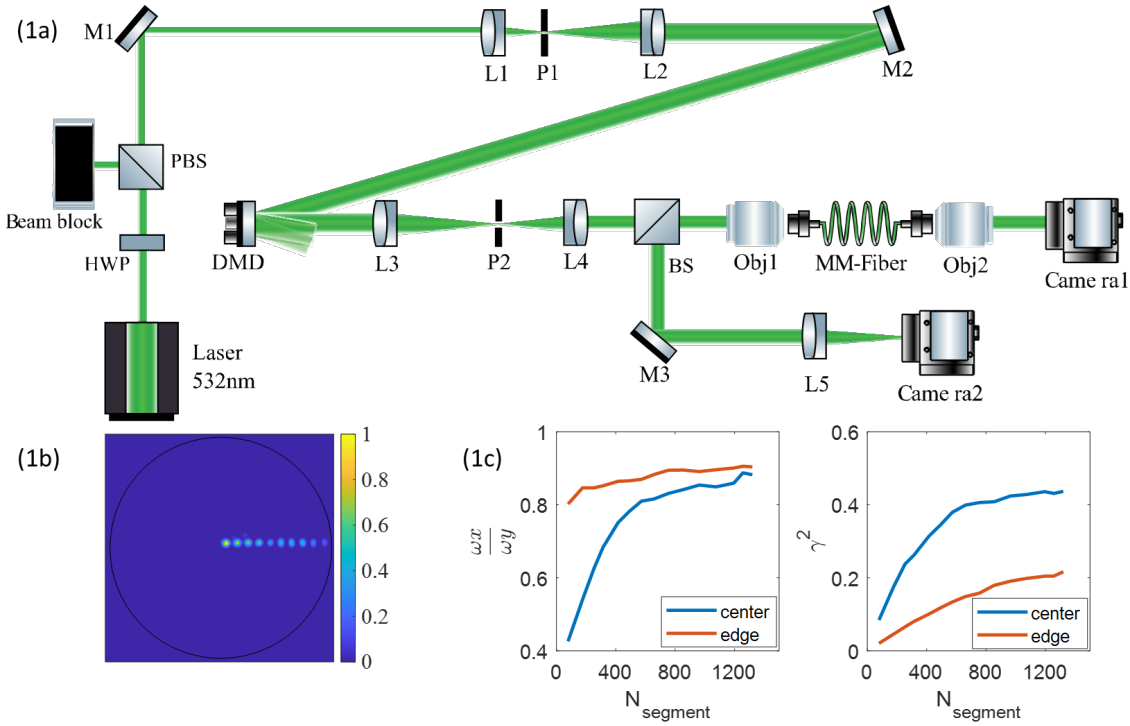

Fig. 1 (a) Experimental setup (b) Example of the output foci after WFS (c) Aberrations and enhancement as a function of number of segments for the central and edge input positions

References

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