

MEASUREMENT OF THE COMPLEX AMPLITUDE POINT SPREAD FUNCTION BY A DIFFRACTING CIRCULAR APERTURE

Yann Cotte and Christian Depeursinge
Institute of imaging and applied optics
EPFL, 1015 Lausanne, Switzerland
E-mail : yann.cotte@epfl.ch

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1. INTRODUCTION

We present a simple method of directly measuring the amplitude point spread function (APSF). The setup is based on Digital Holographic Microscopy (DHM), an interferometric method providing access to the complex wave front. It has been previously successfully applied to (APSF) measurements [1]. The originality of this setup consists in its point source which is created by sub-wavelength nanometric hole. The field is emanated from a single circular aperture on an opaque metallic film. Aluminium is selected as film material in order to avoid plasmonic effects ($\lambda_{\text{laser}}=680\text{nm}$) and to enhance the free propagation. The film's thickness of 120nm is chosen to minimize undesired bias while the transmission properties set limits on its maximal dimension. Similarly, the size of the hole (100nm in diameter) was elected so as to maximize the transmission level but without compromising the point-like behaviour. Theoretical as well as practical work on transmission properties of apertures confirms that assumption. However, certain apodization effects for different polarizations may be encountered [2].

As substrate a conventional microscope slide, common in bio microscopy, of nominal thickness 0.15 mm is used. The thin film is evaporated on the substrate and the circular structures are grinded with focused ion beam (FIB).

In order to demonstrate the effectiveness of our method we measure the amplitude point spread function of a Zeiss 63x, 0.95-NA Air objective lens. Full simulations from the Debye model allow comparisons. In particular, the influence of incorrect cover glass thickness compensation is demonstrated.

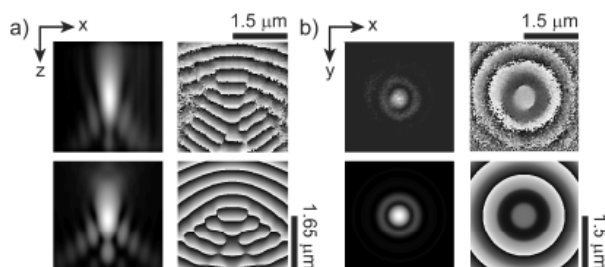


Figure: Axial (a) and radial (b) comparisons in amplitude and phase between experimental APSF measurement (up) and simulated APSF.

2. RESULTS

The amplitude and phase of the point spread function is extracted from the z-scan holograms. Point spread functions of different diameters of holes are compared in phase and amplitude. In the same way, the APSF is compared to simulations from the Debye theory shown in the figure.

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