Characterization of progressive addition lenses by measurement of the modulation transfer function using experimental ray tracing

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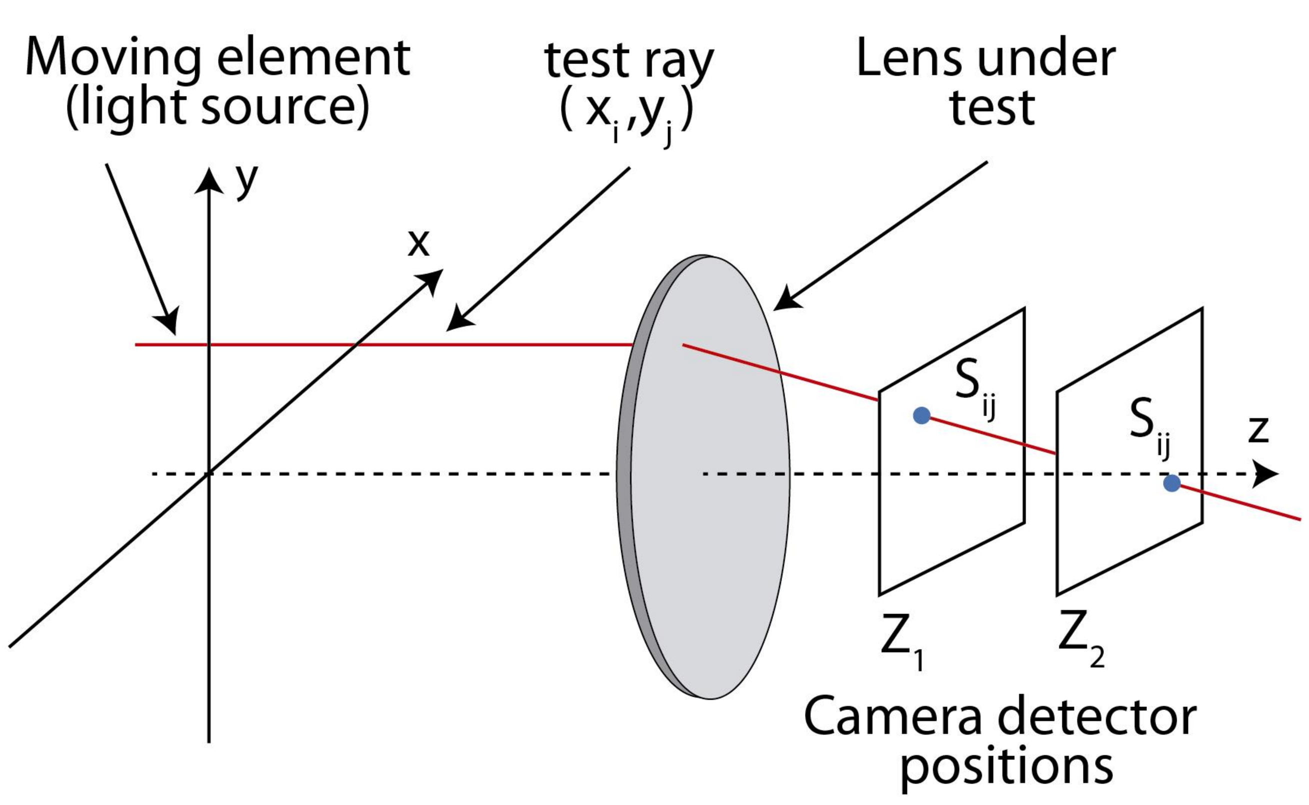
INTRODUCTION

The analysis of the Optical Transfer Function (OTF), has been adopted as a tool to study the response of an optical system for a sinusoidal light distribution input versus the spatial frequency [1]. More specifically, the calculation of the Modulation Transfer Function (MTF), which is the modulus of the OTF, brings the opportunity of representing the modulation contrast ratio between object and image, into just one graph.

GOAL

Characterization of PAL lenses by calculation of the MTF using Experimental Ray Tracing.

EXPERIMENTAL RAY TRACING PRINCIPLE



- Determination of the ray slopes from the calculated centroid positions [2]

$$T_x = \frac{\partial S_x}{\partial z},\; T_y = \frac{\partial S_y}{\partial z}$$

- Gradient of the wavefront from ray slopes [2]

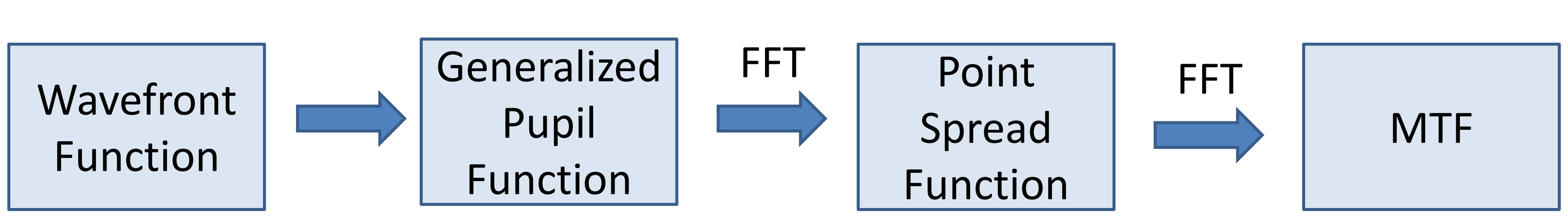
$$\vec{\nabla} W = \begin{Bmatrix} \frac{\partial W(x,y)}{\partial x} \\ \frac{\partial W(x,y)}{\partial y} \end{Bmatrix} \approx \begin{Bmatrix} T_x \\ T_y \end{Bmatrix}$$

WAVEFRONT ESTIMATION FROM RAY SLOPES

Wavefront gradient fitting with the partial derivatives of the Zernike coefficients [3]

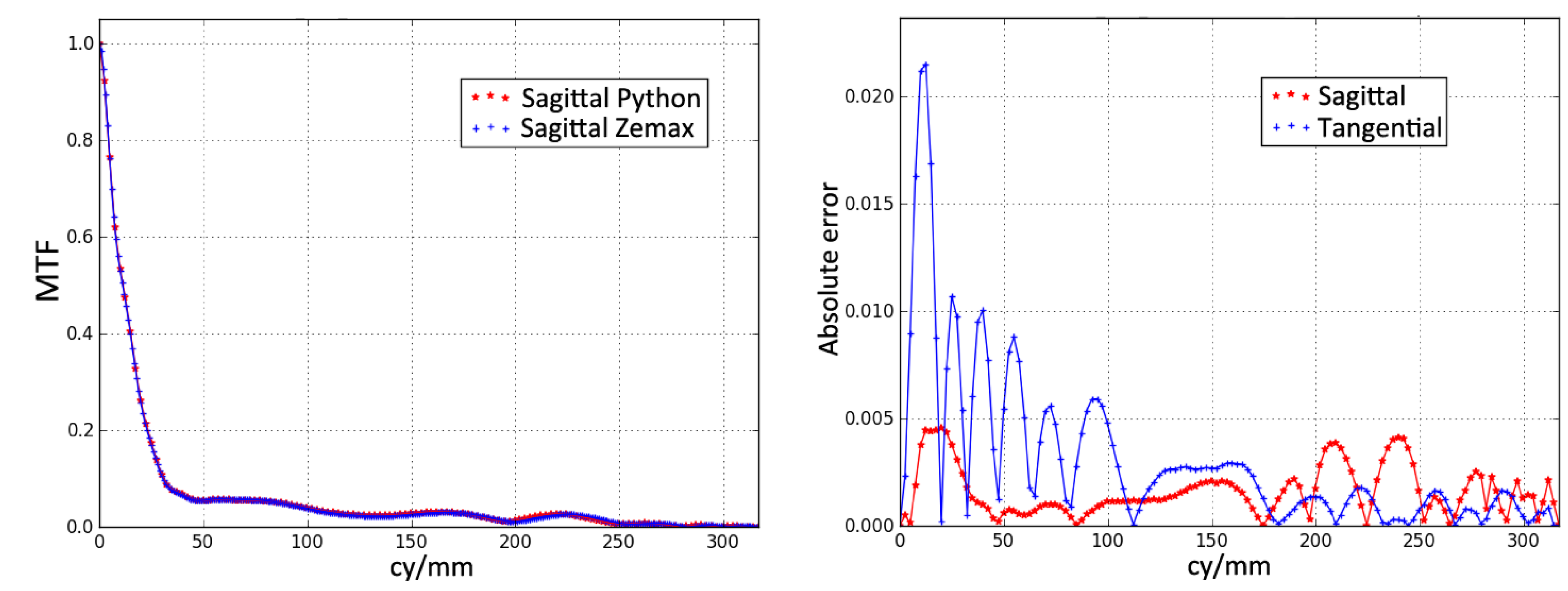
$$\frac{\partial W}{\partial x} \approx \sum_{j=0}^{n} C_j \frac{\partial Z_j(x,y)}{\partial x},$$
$$\frac{\partial W}{\partial y} \approx \sum_{j=0}^{n} C_j \frac{\partial Z_j(x,y)}{\partial y}$$

MTF CALCULATION FROM WAVEFRONT FUNCTION

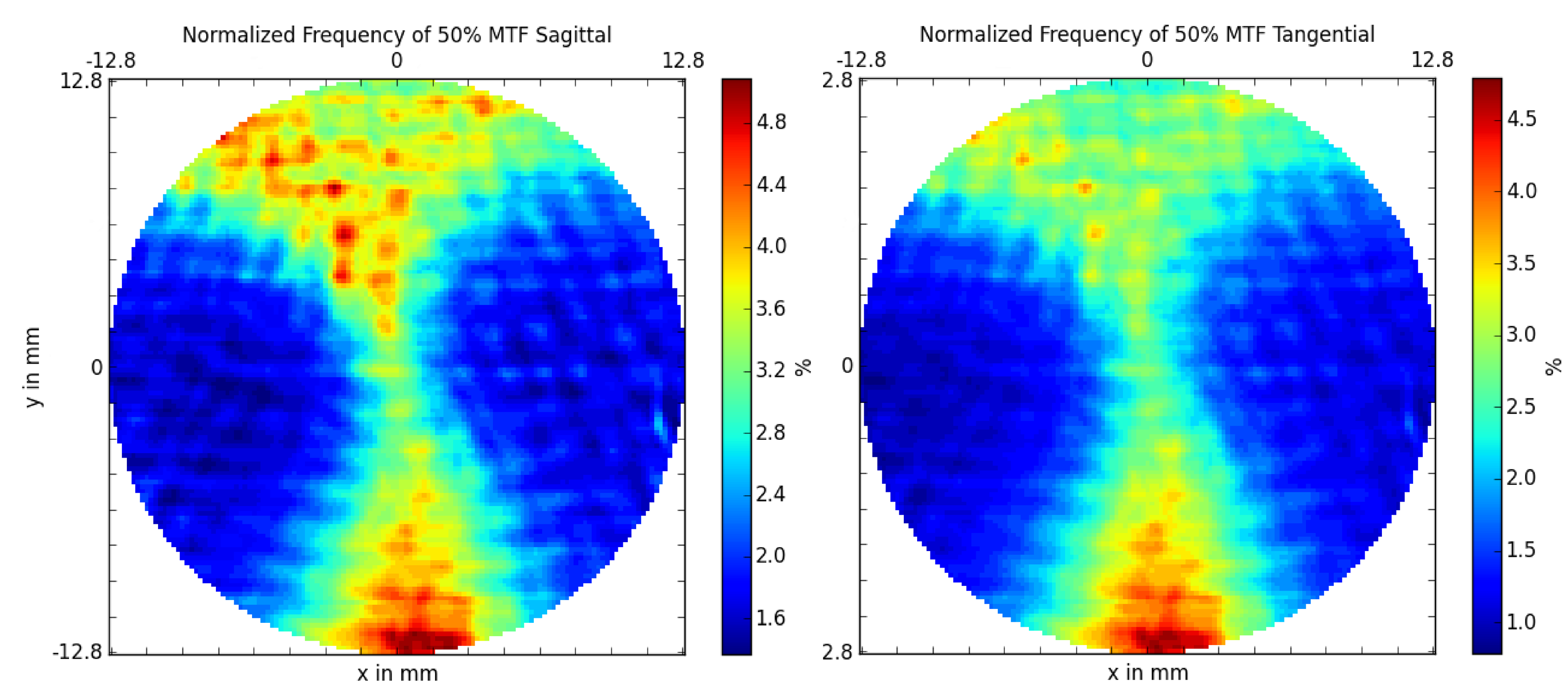


RESULTS

Simulated and calculated MTF of a plano-convex lens for a decentered subaperture of 10 mm



PAL lens Obtained 2D 50% MTF normalized spatial frequency



CONCLUSION

In this work, a method for characterizing PAL lenses, by means of the MTF has been developed. The wavefront aberration function is calculated through ERT and the MTF is obtained using the fast Fourier transform. Two dimensional MTF maps were generated, showing the contrast resolving capabilities of the lens.

REFERENCES

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[3] Liang J et al. (1994)."Objective measurement of wave aberrations of the human eye with the use of a Hartmann-Shack wave-front sensor," J. Opt. Soc. Am. A 11, 1949-1957

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