Centre for Sensors, Instruments and Systems Development
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NEW COMPACT OPEN-FIELD DOUBLE-PASS SYSTEM WITH ASYMMETRIC FOCUS

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INTRODUCTION

Presbyopia is an age-related visual dysfunction [1] undergone by all the population since their mid-late-40s. Due to this fact, every day more people are using multifocal systems to correct presbyopia, as for example contact lenses or intraocular lenses. As a consequence, the necessity to do an appropriate characterization of their optical quality has increased.
Multifocal contact [2] and intraocular [3] lenses (MCLs / MIOLs) have very complicated designs that makes difficult to characterize their optical quality in an objective way, especially in "*in vivo*" conditions. Therefore, the purpose of this study is to develop a new compact open-field double-pass system with asymmetric focus that has the capacity of characterizing objectively "*in vivo*" the optical quality of multifocal systems.

EXPERIMENTAL SETUP

The customized experimental set-up is based on double-pass technique [4]. The implemented system differs mainly from the conventional double-pass designs by the fact that the first pass and the second are independent from each other. Other improvements added to this system are the use of Electro-Optical Lenses (EOLs) instead of Badal's system to compensate the spherical refraction of the measured eye and its open field configuration. Both improvements contribute to downsize the set-up (Fig. 1 and 2).

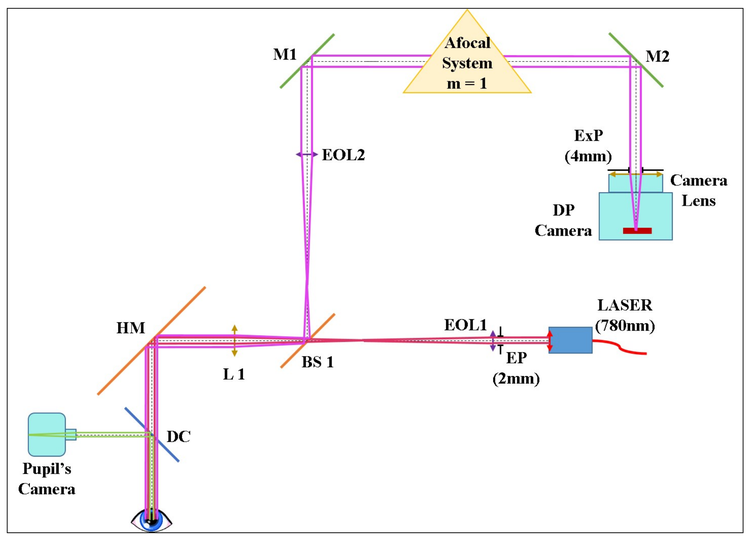
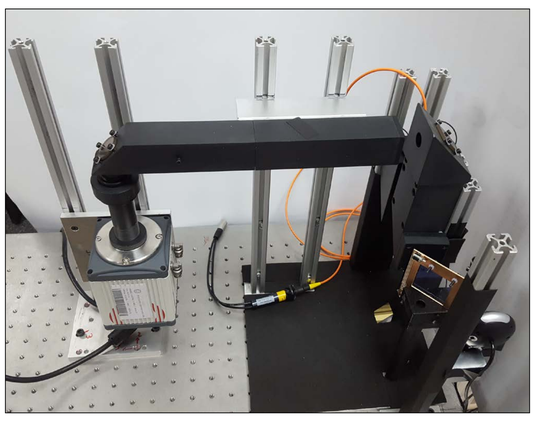


Fig.1: Optical System Design composed by LASER, EP (entrance pupil), EOL1, BS1 (beam splitter 1), L1 (lens 1), HM (hot mirror), DC (dichroic filter), Pupil`s Camera, EOL2, M1 (mirror 1), Afocal System, M2, ExP (exit pupil), Camera Lens and DP Camera (double-pass camera).

Fig. 2: Picture of the experimental set-up.



METHODOLOGY

Model Eye and Multifocal Intraocular Lenses

A customized wet model eye (Fig. 3) based on 11979 ISO's regulation [5] and two MIOLs were used to test the functionality of the set-up. The MiOLs included in this study were one concentric diffractive MIOL (AcrySof® IQ ReSTOR® SN6AD1, Alcon Novartis Company) and one non-concentric refractive MIOL (MIOL in commercialization process).

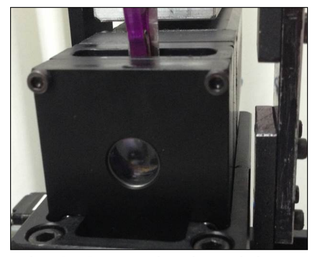
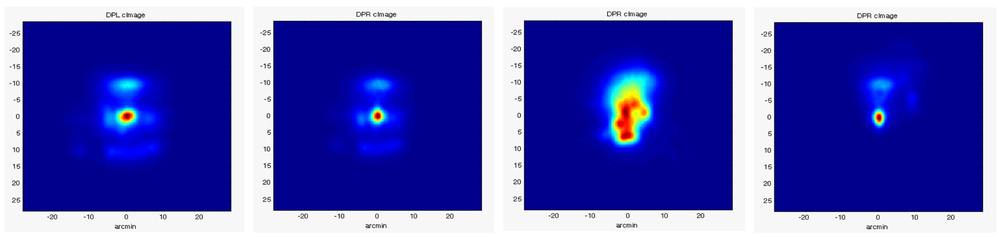


Fig. 3: Customized model eye.

Measurement Protocol

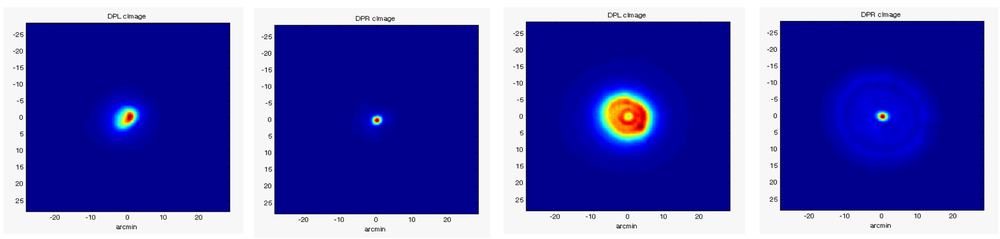
Once the far focus was found, a through-focus from +0.75 to -4.00D in steps of 0.25D were performed per each MIOL by the second pass, while the first pass remained fixed.

RESULTS



a) -0.75D b) 0.00D Far Focus c) +1.25D d) +2.25D Near Focus

Fig.4: Double-pass images of a non-concentric refractive MIOL (Power = +20.00D / Addition = +2.75D). The power indicated in the images is the value of the accommodative stimulation per each one.



a) -0.75D b) 0.00D Far Focus c) +1.75D d) +3.50D Near Focus

Fig.5: Double-pass images of the concentric diffractive MIOL (AcrySof® IQ ReSTOR® SN6AD1) (Power = +21.00D / Addition = +3.00D). The power indicated in the images is the value of the accommodative stimulation per each one.

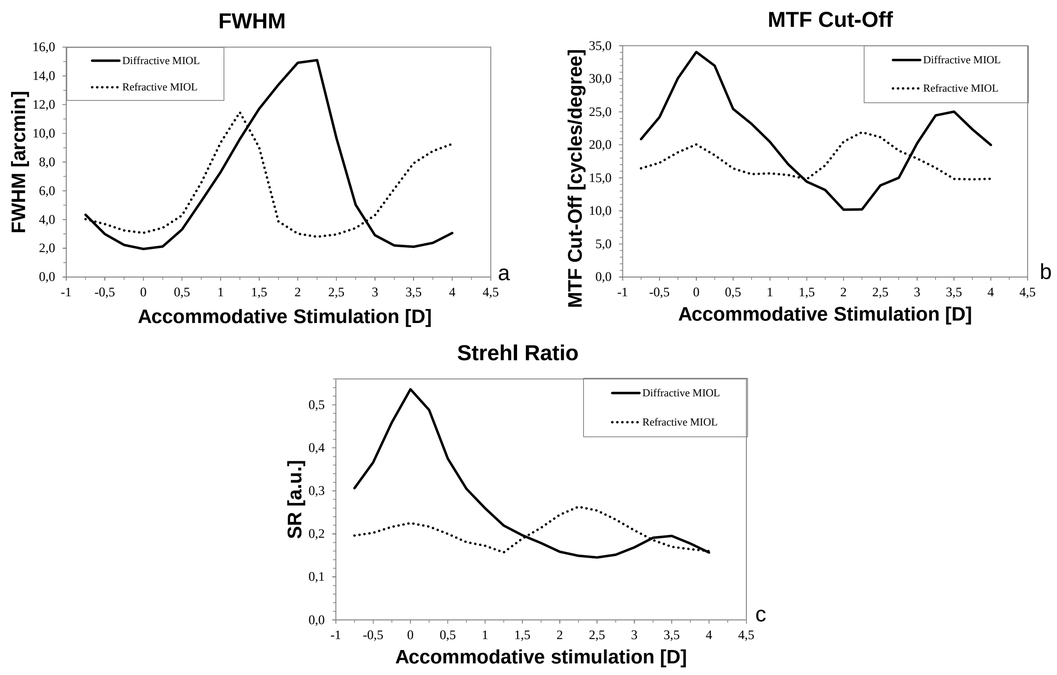


Fig.6: (a) FWHM values of the concentric diffractive and the non-concentric refractive MIOL along the through-focus; (b) MTF cut-off values of the diffractive and the refractive MIOL along the through-focus; (c) Strehl ratio values of the diffractive and the refractive MIOL along the through-focus.

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CONCLUSIONS

The main conclusion of this study is that the developed new compact open-field double-pass system with asymmetric focus is suitable to evaluate the optical quality of multifocal systems adapted or implanted in the eye. Nevertheless, this study is the first step of the validation of the system. Consequently, a future work with "*in vivo*" measurements should be performed.

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