



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Starting full time from April 2025

Presentation at the end of July or beginning of September 2025

Laboratory: GOAPI - Applied Optics and Image Processing Group

Institution: Universitat Politècnica de Catalunya - BarcelonaTECH

City, Country: Terrassa (Spain)

Title of the master thesis: (Tentative) Optical imaging performance of intraocular lenses

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Keywords: intraocular lens, multifocality, optical image quality, optical bench testing, energy efficiency, high-order aberration

Summary of the subject (maximum 1 page):

In cataract surgery, the crystalline lens is removed and an intraocular lens (IOL) is implanted in the capsular bag. Monofocal IOLs provide excellent postoperative far vision, but the patient usually requires spectacles for closer object distances. Within presbyopia-correction IOL designs, multifocal lenses, which are nowadays mostly based on diffractive optics, overcome the spectacle dependence by providing two or three differentiated peaks for far, (intermediate) and near vision but are associated with a higher risk of dysphotopic phenomena (e.g., glare, halo), lower contrast sensitivity, and alterations in spatio-chromatic vision. Extended depth of focus (EDOF) technology ideally bridges the clinical shortcomings between monofocal and multifocal designs. EDOF IOLs aim to increase the depth of field while minimally affecting the quality of far vision and minimizing dysphotopic phenomena. It is essential to optically characterize new IOL designs with respect a monofocal reference of the same base lens platform for quantitative comparison and objective interpretation before clinical assessment. This methodological approach is incorporated in the international standards that describe methods for the image quality evaluation of IOLs (ISO 11972-2:2014, ANSI Z80.35-2018)

Objectives

This project aims to theoretically describe and experimentally measure the optical imaging performance of a commercial IOL that can be used as a reference for comparison with other presbyopia-correction IOL designs. The IOL will be studied using in-vitro technique with the lens immersed in an on-bench model eye, illuminated with 550nm light wavelength, which is the design wavelength. The imaging performance will be tested for different pupil sizes and object distances using through-focus axial scanning. The quality metrics are based on the modulation transfer function and the energy efficiency. The results will be interpreted taking into consideration the available technical information about the IOL design.

Experimental method: The compound system of microscope objective, filters and camera is aimed to serve as the image acquisition unit placed in an optical setup for on bench in-vitro IOL testing (see figure). More specifically, it would acquire the aerial image of a target formed by a model eye where an IOL is inserted.

The project involves the stages of device initialization and alignment on optical bench, use of extensive options for measurement acquisition, logging and analysis via own software application.

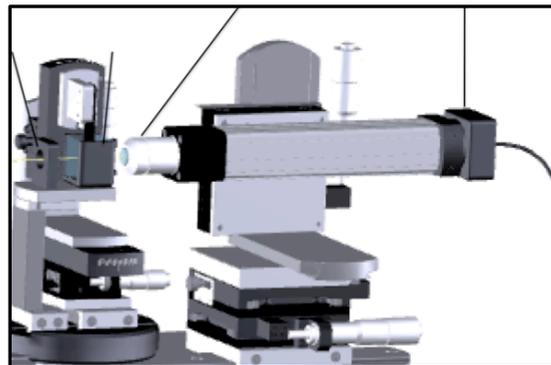


Figure. Scheme of the experimental setup (partial) for IOL testing on optical bench. A model eye unit (left), with an intraocular lens is inserted in a wet cell, forms an aerial image (retinal plane) that is captured by an image acquisition unit (center) consisting of a microscope objective assembled to a CCD sensor camera.

Additional information (if needed):

- Required skills: Experimental experience in optical laboratory. Most part of the project is experimental, but some theoretical background on imaging systems, diffractive optics and vision is necessary. Team working and autonomous self-working.
- Miscellaneous: All the optical components, opto-mechanic elements, opto-electronic devices and other resources will be provided by the laboratory of the Group of Image Processing and Applied Optics on the premises of the Faculty of Optics and Optometry (TR8-UPC).