Optimization of a SS-OCT with a focus tunable lens for enhanced visualization of ocular opacities

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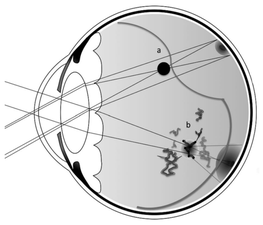
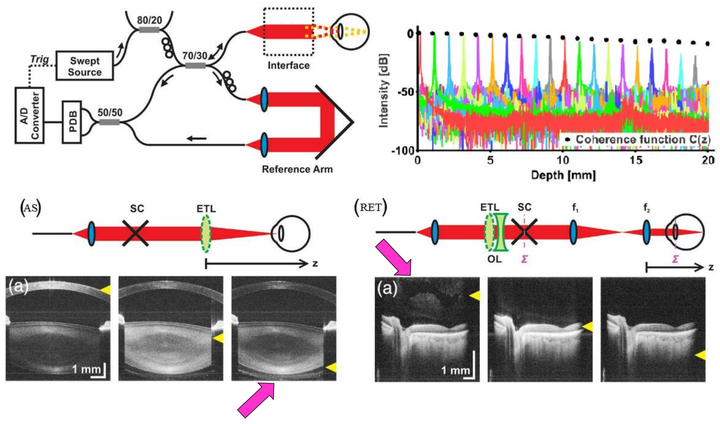
INTRODUCTION

OCT for visualization of ocular opacities and vitreous imaging.

The assessment of crystalline lens and corneal opacities with optical coherence tomography (OCT) instruments has attracted much attention. However the role of vitreous opacities in optical and visual quality has remained scarcely explored [1].

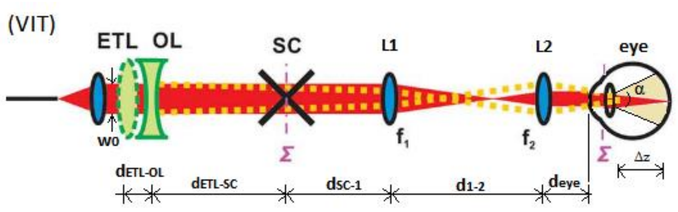


In vivo imaging of the vitreous is usually assessed in the clinical practice by means of ultrasonography and OCT, but with some limitations [1]. Recent works have shown that swept source (SS-OCT) systems combined with electrically tunable lenses (ETL) allow enhancing the visualization of the whole anterior segment –and hence the study of opacities in the cornea and the lens-, as well as vitreous structures both close to the posterior surface of the lens and to the retina [2,3].



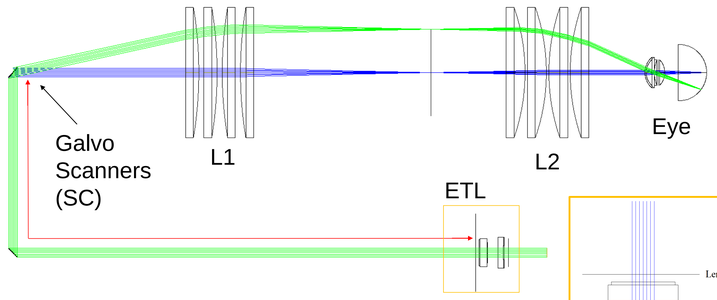
METHODS

In this work we describe the design of a sample arm specially dedicated to vitreous imaging to be included in the long depth range SS-OCT instrument described in [2,3].

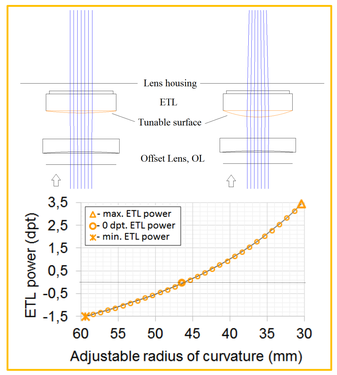


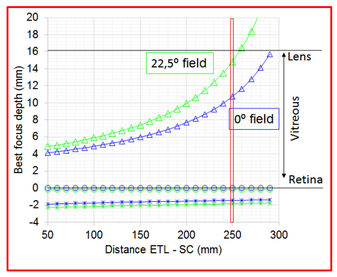
The conceptual design shown in the figure above has been simulated and optimized in optical design software (Zemax).

Design of a sample arm for vitreous imaging based on ETL technology

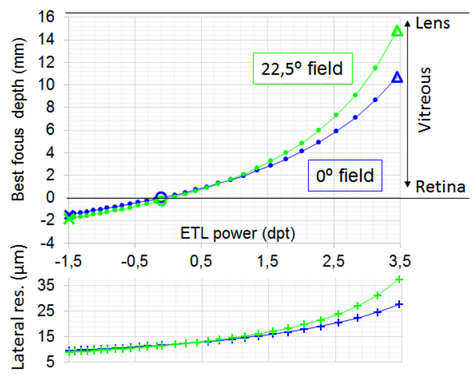


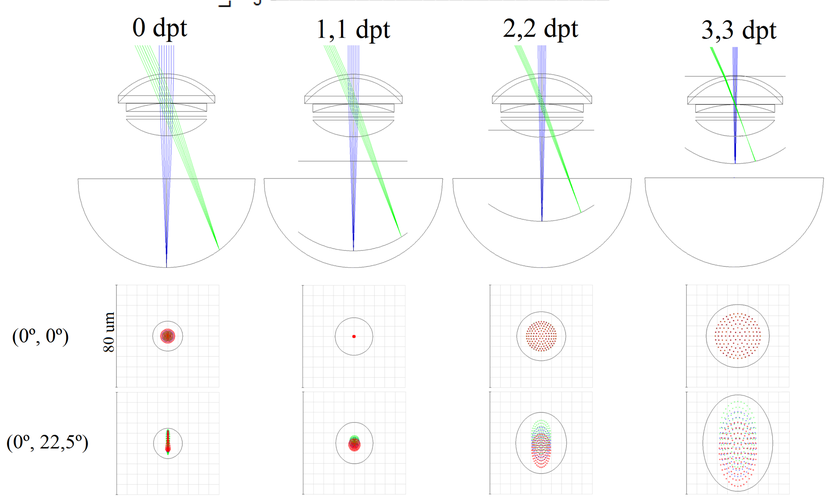
- Lens groups L1 and L2 have effective focal lengths of 80 mm and 40 mm, respectively, and 2” diameters. Based on [4].
- 45º FOV in the retina with 12 µm lateral resolution.
- Scanning pivot relays on the pupil plane.
- Tunable lens EL-10-30-C-NIR-LD-MV (Optotune) includes an offset lens that provides a tuning range from -1,5 to 3,5 dpt.
- Distance ETL-SC is chosen to be 250 mm, in order to maximize the volume of vitreous that can be scanned.





Optical performance of the design:

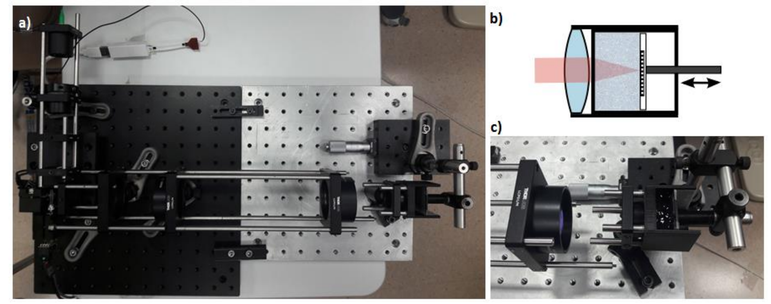




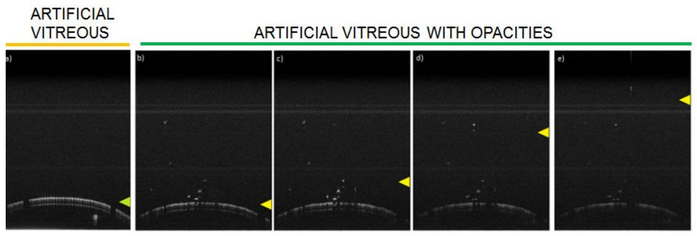
The designed interface for vitreous imaging allows a FOV in retina of 45º and permits to tune the focal plane towards the lens to an extent of about 12 mm, covering a large area of the vitreous with good optical quality.

RESULTS

A laboratory prototype based on the described design has been implemented and validated using a custom made 3D printed eye model containing artificial vitreous.



A calibrated target was imaged through the artificial vitreous with and without simulated opacities.



Focus tuning allows highlighting opacities at different depths of the artificial eye posterior chamber.

CONCLUSIONS

Preliminary results show that the designed system allows for enhanced visualization of simulated opacities at different depths within artificial vitreous in an eye model.

In future works, the clinical potentiality of the system will be further explored. The designed interface will be used to image healthy eyes and patients suffering from vitreous related symptomatology.

REFERENCES

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