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# Measuring and modeling intraocular forward light scattering: preliminary results

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## 1. Introduction

In contrast to other optical factors that also affect vision, such as high order aberrations, forward light scattering (FLS) is still difficult to measure accurately and objectively. In addition, measurements obtained with existing instruments cannot be related precisely to any physiological factors.

The purpose of this study was to develop an instrument together with a model to obtain accurate and reliable measurements of intraocular forward light scattering (FLS) and to be able to relate them to the source of scattering.

## 2. Methods

We set-up an optical bench where a subject, or an artificial eye, looks at a LED ring placed at a fixed distance and the retinal image of the ring is recorded with a CCD camera. The artificial eye is made of a mirror, a 64D lens and a microscope plate covered with a layer of silica particles whose properties are known (index of reflection, diameter). 4 microscope plates with increasing levels of particles density were used to simulate increased levels of scattering.

A non-sequential Zemax model of this set-up (with the artificial eye or a Liou-Brenman eye) was also developed. Mie scattering was introduced in these two models: at the microscope slide or at the cornea level.

For both eyes, we analysed the light distribution within the retinal image of the ring as well as the amount of light scattered (i.e. the fraction of light not participating to the image of the ring) and compared it to Zemax simulations.

## 3. Results

The amount of light scattered in the artificial eye was successfully recorded with the CCD (figure 1) and is in good agreement with our model's predictions (figure 2).

Although retinal images of the LEDs ring could be recorded in an artificial eye several practical issues (e.g. head alignment) led so far to a poor agreement with Zemax simulations.

## 4. Conclusions

Results with the artificial eye suggest that the optical set-up could provide a mean to assess objectively FLS and that the FLS measurement could be related to a physical parameter through our

Zemax model (e.g. scattering particle density). The experimental set-up needs improvement to achieve positive results in the human eye, for instance introducing a central LED to match the veiling illuminance created by the LEDs ring as an adaptation of the nulling flickering technique.

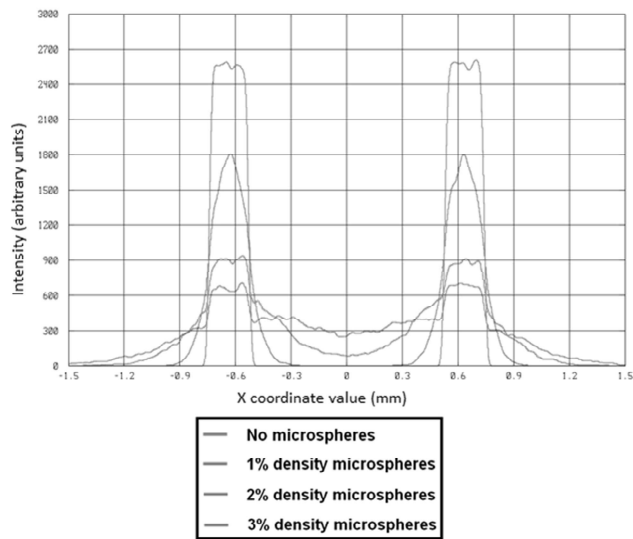


Figure 1: Experimental results with the artificial eye. Light distribution over a diameter of the LEDs ring retinal image. As the density of scattering particles increase, the amount of light participating to the LEDs image decrease and the amount of light at the centre of the ring increases.

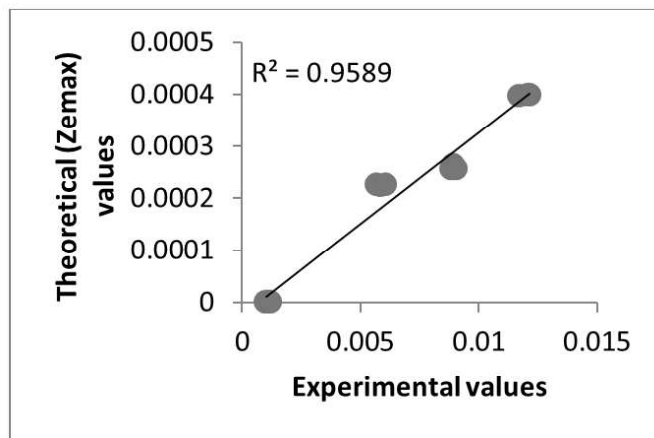


Figure 2: Comparison between the scatter values simulated and measured in the artificial eye for the four densities of microsphere (no microsphere, 1%, 2%, 3%). The scatter value is the fraction of light not participating to the image of the ring and so is dimensionless.