

Visually relevant optical bench testing of intraocular lenses

diestia

Harilaos Ginis^a, Dimitrios Christaras^a, Spyridon Tsoukalas^a and Pablo Artal^b

^a Diestia Systems P.C., 77-79 Platonos str., 10441 Athens, Greece

^b Laboratorio de Optica, Campus Universitario de Espinardo, Edificio 34, 30100 Murcia, Spain



Purpose

To introduce a visually relevant optical bench testing method combining image analysis and a visual acuity-related quality metric to evaluate the through-focus performance of intraocular lenses (IOLs). Moreover, to apply the methodology to compare the performance of different types of commercially available IOLs.

Methods

The method involves recording series of optotype images in a realistic physical eye model (Fig. 1).

- The different stimulus vergence are produced using a focus-tunable optoelectronic lens. The eye model featured a PMMA cornea, an iris at a depth of 3.55 mm, and an IOL holder to position the IOL under testing 1mm from the pupil, simulating a pseudophakic anterior chamber depth of 4.55 mm (Fig. 2).
- A variety of IOLs (monofocal, enhanced monofocal, EDOF, and trifocal -diffractive) were measured.
- An image quality metric, Objective Letter Sharpness (OLS), was calculated as the normalized cross-correlation between the blurred letter image and its original, both filtered in the Fourier domain using a bandpass filter centered on the letter's fundamental frequency (Fig. 3).
- Depth of focus was defined as the dioptric range from infinity to the nearest point where the 0.5 VA(decimal) letters had OLS values exceeding 0.1.

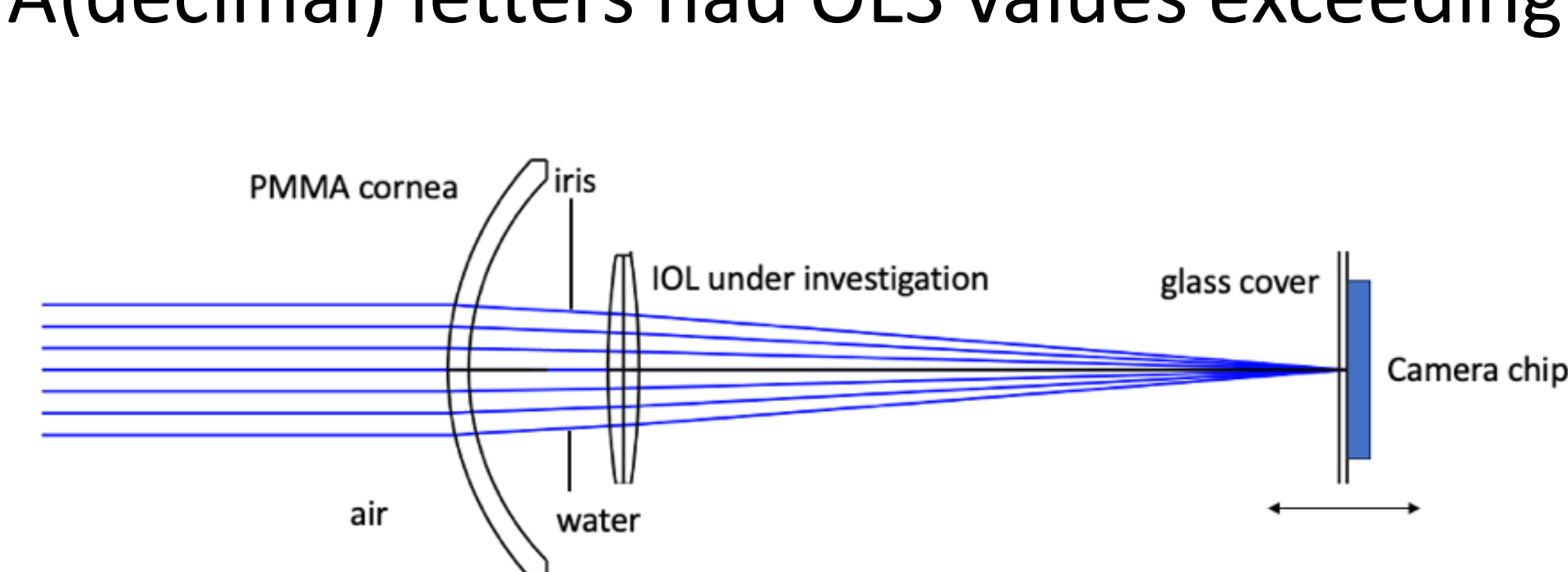


Fig. 1 Through-focus images were recorded using an eye model with an immersed camera and geometrical resemblance to that of the human eye.

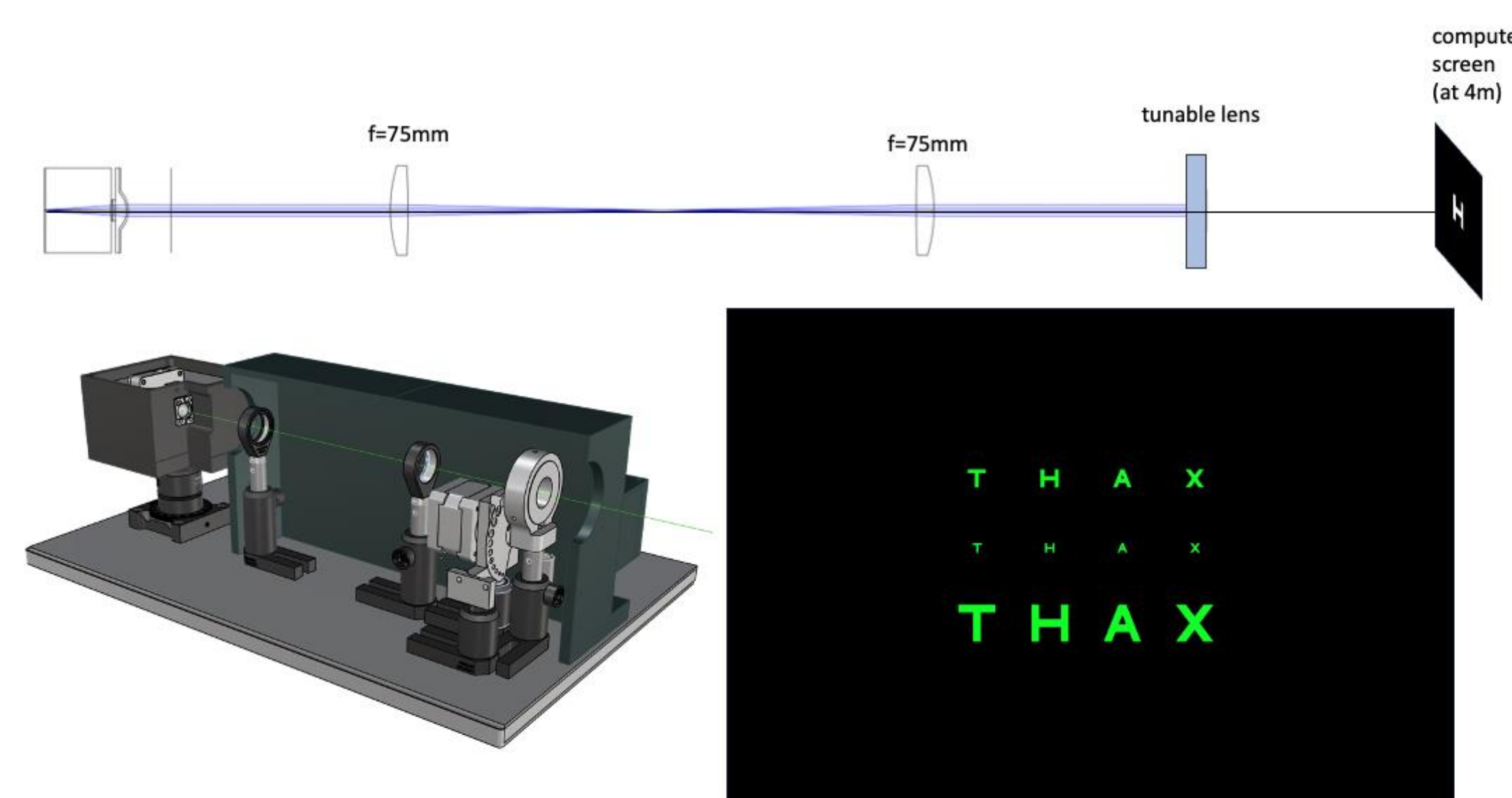


Fig. 2 Through-focus setup. Optical layout, schematic of the device and letter chart arrangement..

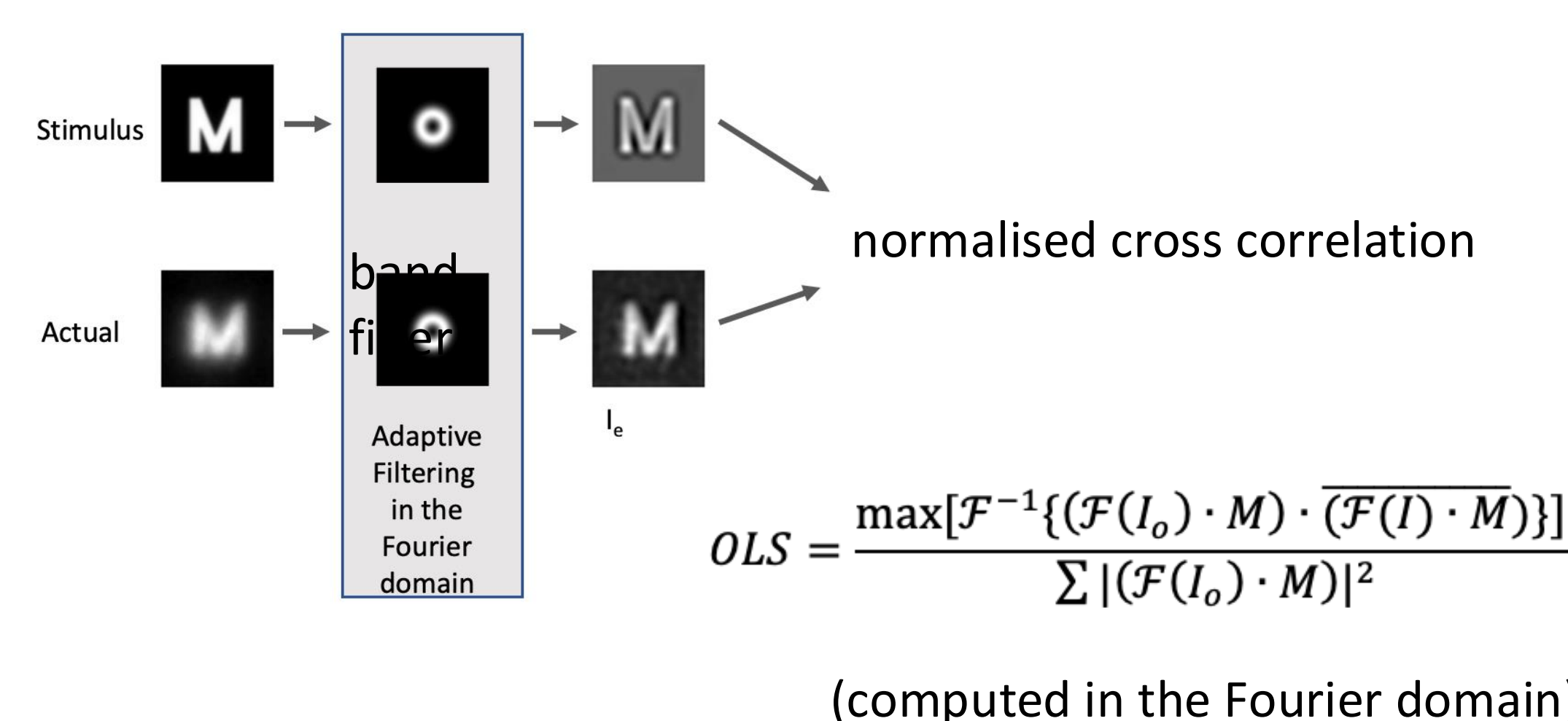


Fig. 3 OLS definition and example of OLS calculation in letters of different sizes with the same blur. Note how the effect of the same blur (convolution with the same PSF) is affecting the OLS calculated for different sizes.

Results

Results are presented in Figs 4-6. The greatest depth of focus (3.57 D), was achieved by the AT LISA tri (trifocal, ZEISS0). The best far image quality was provided by the monofocal AcrysofIQ (Alcon), which achieved an OLS value of 0.66 at infinity. Additionally, the Art70 (inverted meniscus shape-refractive, VOPTICA) lens demonstrated a substantial full range of functional vision, with the highest mean OLS value of 0.34 maintained across distances.

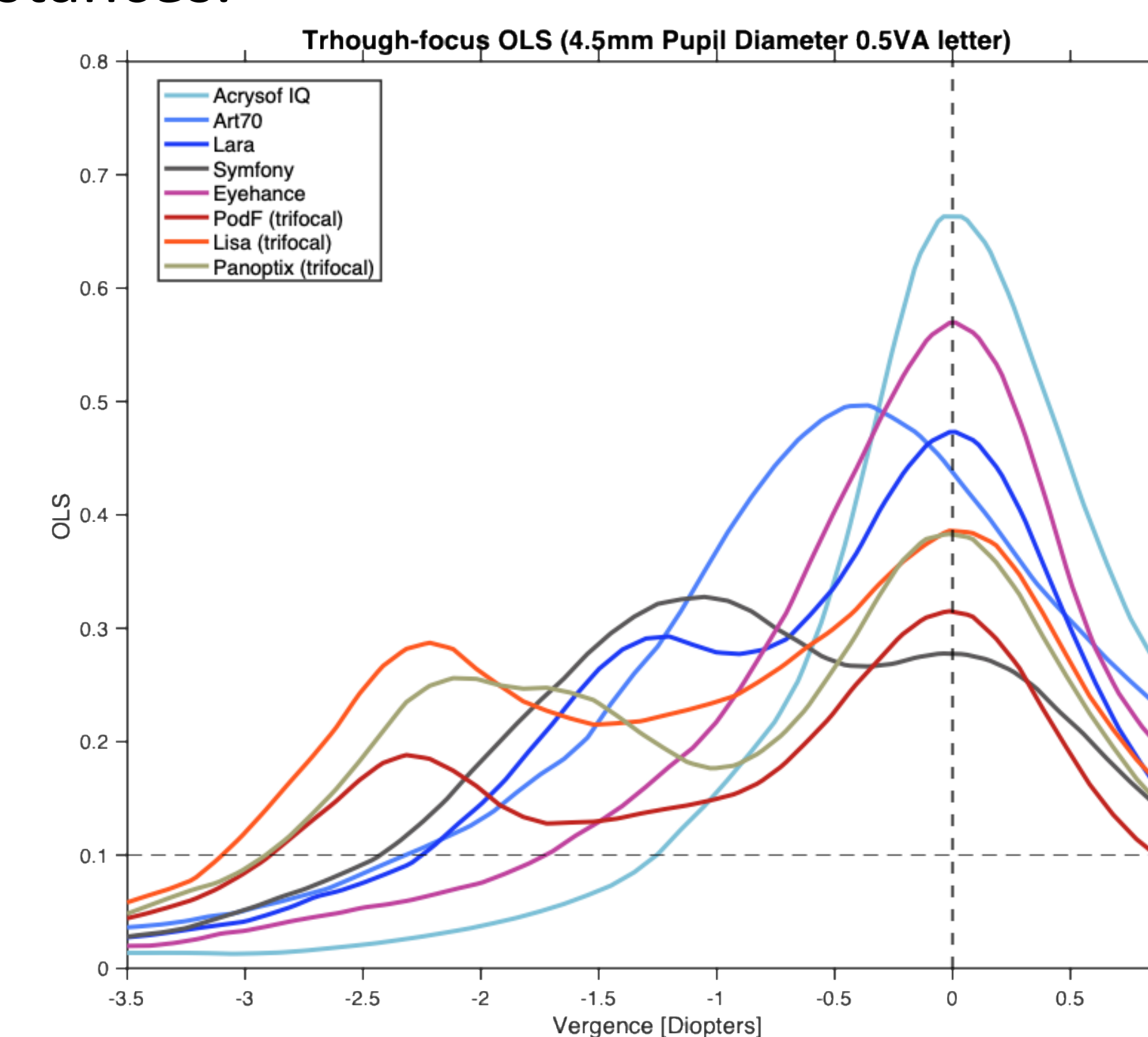


Fig. 4 Through-focus OLS curves for all tested lenses, measured for a 4.5 mm pupil diameter and calculated for the letters subtending angle of 10 arcmin (0.5 decimal acuity line).

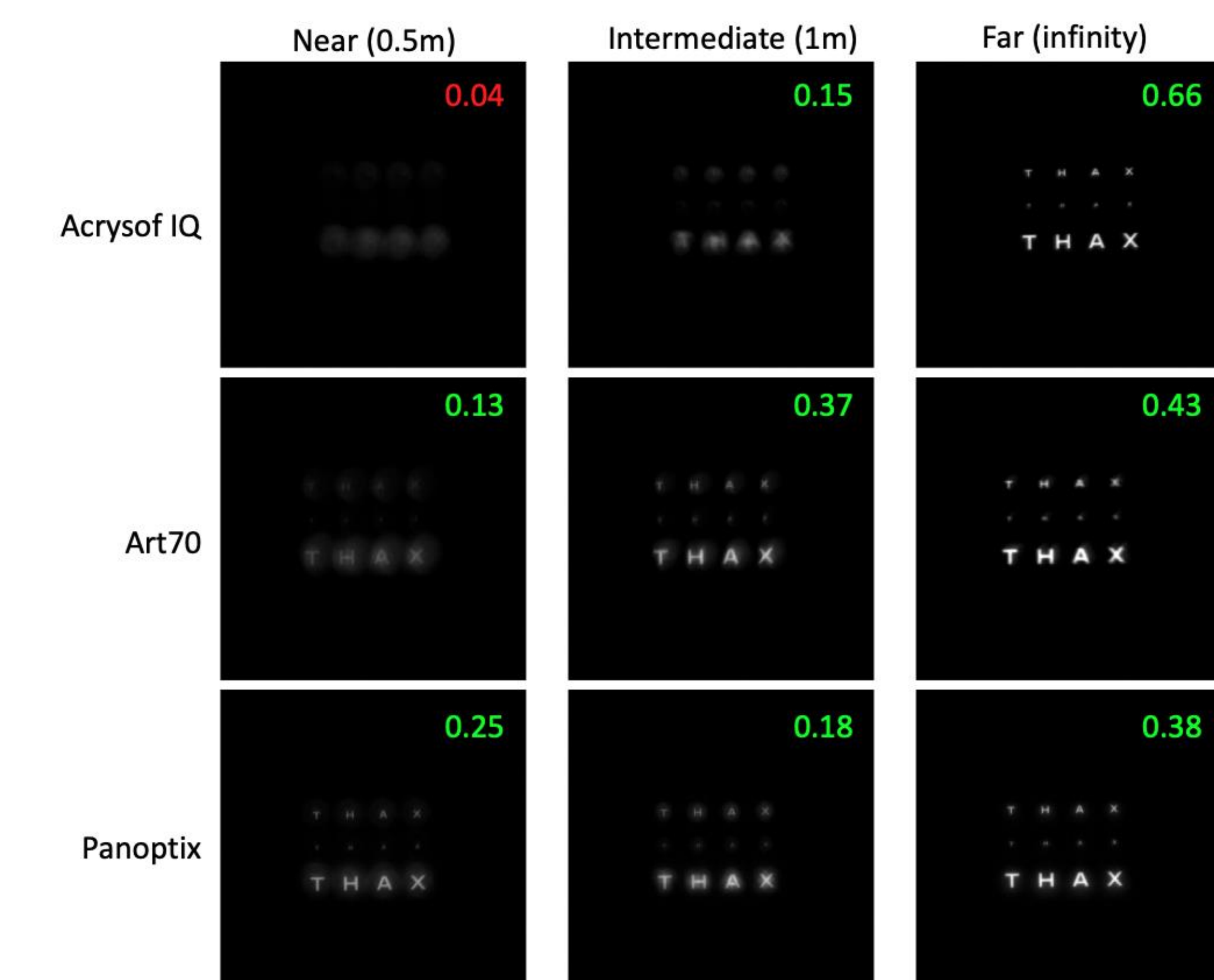


Fig. 5 Through-focus images recorded at near (50 cm), intermediate (1 m) and at infinity for three different lenses (AcrysofQ, Art70 and Panoptix).

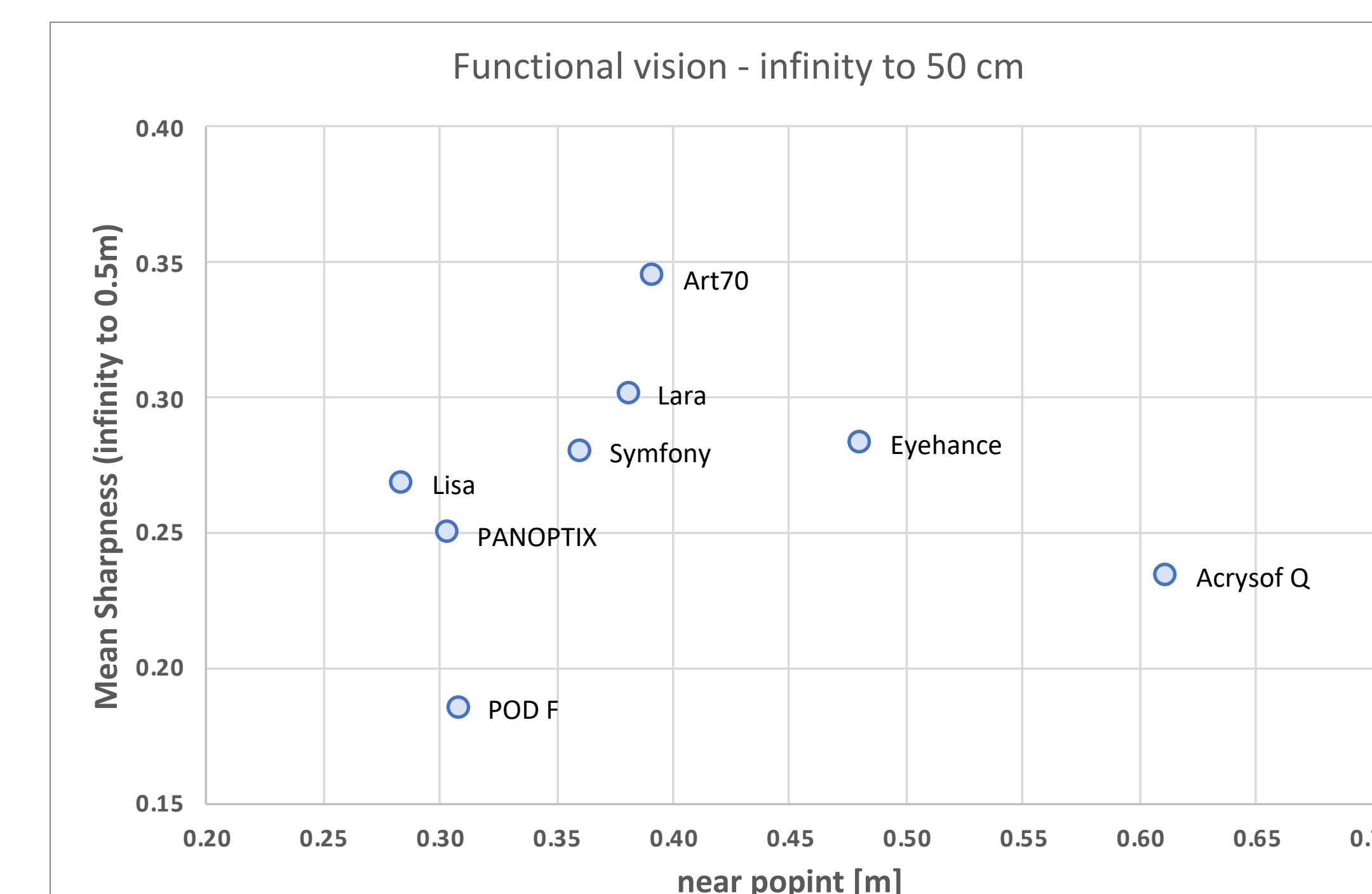


Fig. 6 Mean OLS parameter (infinity to 50cm) and near point for all lenses tested, plotted against their near point (in m). Data for 4.5mm pupil diameter are shown.



electronic version of this poster

Conclusions

Optical evaluation methodologies based on visually relevant metrics may be useful in bridging the gap between standard optical bench measurements and real-world clinical outcomes, offering valuable insights to predict post-surgical visual performance.

Funded by the European Union's Horizon Europe programme under the Marie Skłodowska-Curie Actions, Grant Agreement No 101119695 - ACTIVA