

## EYE REFRACTION DISTRIBUTION: STUDIES WITH *TRACEY-1*

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### ABSTRACT

Principles of measurement of eye refraction distribution with new spatially resolved refractometer *Tracey-1*, developed in Ukraine, and the results of preliminary experimental studies at VEIC, Greece, are reported. 20 pseudophakic eyes were subjected to 30 consecutive measurements each, in order to test the reproducibility. Measurements were provided in three zones: 0-3 mm, 3-5(6) mm and 0-5(6) mm. For each zone, parameters of astigmatism were calculated and accuracy of measurements was evaluated. Standard statistical procedures show that 95% of all measured values are within  $\pm 0.20$  diopter of declination from the mean value.

### INSTRUMENT AND METHODS

*Tracey-1* is based on retina ray-tracing method<sup>1</sup>. A thin laser beam of the diameter 0.3 mm is directed into the eye in parallel to the visual axis. A 10 mW diode laser (wavelength: 650 nm) is used, its irradiation being laterally displaced over the entrance aperture of an eye, remaining parallel to the visual axis of the examined eye (fig. 1). This procedure is performed with acousto-optic deflector and corresponding forming optics (fig. 2). Laser beam is focused by the eye at a particular point on the retina having the shape of a spot. Laser exposure levels comply with the known safety standards<sup>2</sup>. The light spot from retina is imaged by special optics on the position sensitive detector (PSD). In the process of scanning,  $x$  and  $y$  coordinates of the spot's centroid on retina are measured, thus giving information on ray aberration caused by local non-homogeneity of refraction of any origin. We have designed scan trajectories in the shape of four circles. Spot's trajectories on retina form retina spot diagrams, each of them corresponding to its own entrance trajectory (fig. 3). For each entrance point, declination of the spot's centroid is measured. From these data, refraction map is reconstructed (fig. 4). An accommodation target is included into the instrument to enable examinations of accommodation functions of the eye. Current *Tracey* configuration has a measurement range of 6 diopters. ( $\pm 3D$  from emmetropia). Higher ametropia is examined with inserting standard trial lenses into a special receptacle of the instrument.

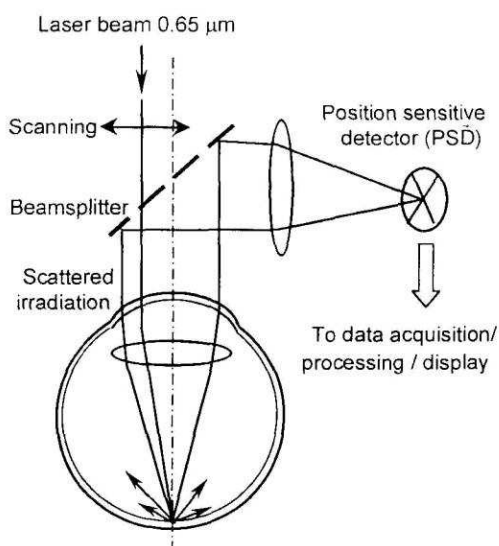


Figure 1. Principle of *Tracey*

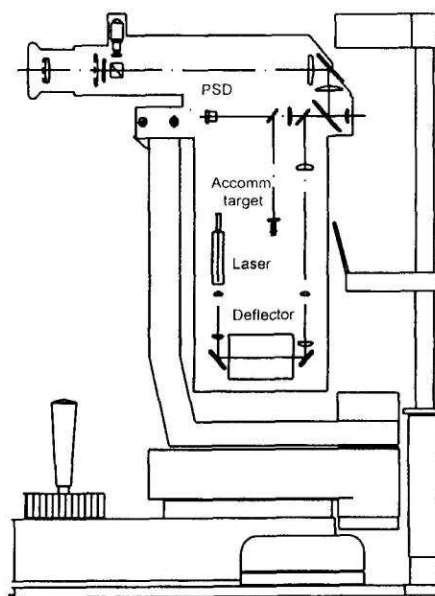


Figure 2. Principle of *Tracey* design

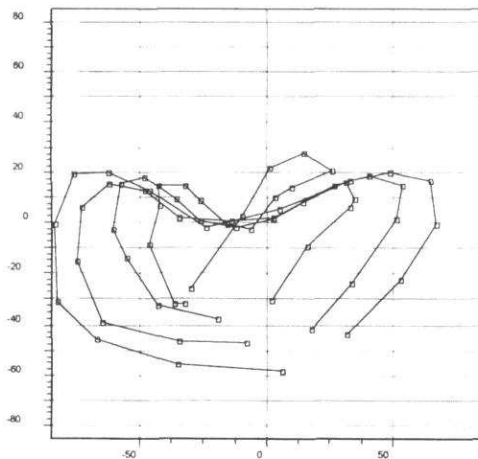


Figure 3. Retina spot diagram

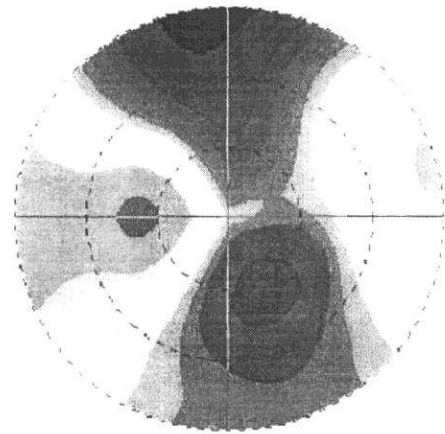


Figure 4. Reconstructed refraction map of the eye

### PRELIMINARY CLINICAL EVALUATION

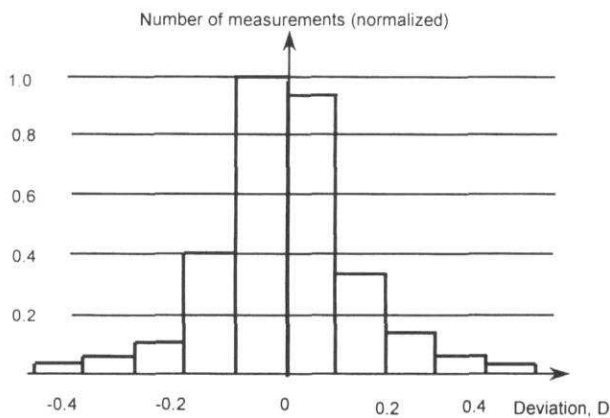


Figure 5. Reproducibility of astigmatism measurements

Preliminary clinical trials with *Tracey-1* included twenty pseudophakic eyes (in order to exclude accommodation related refractive changes) with clear cornea and no visible fundus irregularities. IOL was centered and aligned in all cases. 25-30 consecutive measurements of each eye were performed in order to test the instrument's reproducibility. Head positioning and eye alignment were made for each examination separately. Results of reproducibility study are shown in fig. 5 for astigmatism parameters. Measurements were provided in three zones: 0-3 mm, 3-5(6) mm and 0-5(6) mm. For each zone, accuracy of measurements was evaluated. Standard deviation 0.11 D (diopter) was got for the zone 0-6 mm, being 0.14 D and 0.15 D for the zones 3-5 mm and 0-3 mm respectively.

### DISCUSSION AND CONCLUSIONS

*Tracey-1* measures the refraction distribution, including the corneal, lenticular, and fundus shape related (e.g. staphyloma) refraction. Information derived from examination with *Tracey-1* could be implemented for the evaluation of lenticular astigmatism, accommodation parameters, testing the IOL alignment and evaluation of fundus shape related refractive irregularities.

### ACKNOWLEDGMENTS

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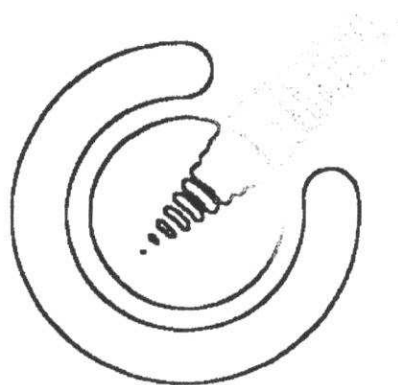
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1. V.V. Molebny, I.G. Pallikaris, L.P. Naoumidis, I.H. Chyzh, S.V. Molebny, V.M. Sokurenko, "Retina ray-tracing technique for eye-refraction mapping", *Proc. of SPIE*, **2971**, pp. 175-183, 1997.
2. *American National Standard for the Safe Use of Lasers: ANSI Z-136.1 (1993)*, American National Standards Institute. Publisher: Laser Institute of America, Orlando, FL, 1993.

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