University of Latvia

Trends in Physics, Budapest, Hungary

Electro-optical solution for visual acuity and contrast sensitivity modeling

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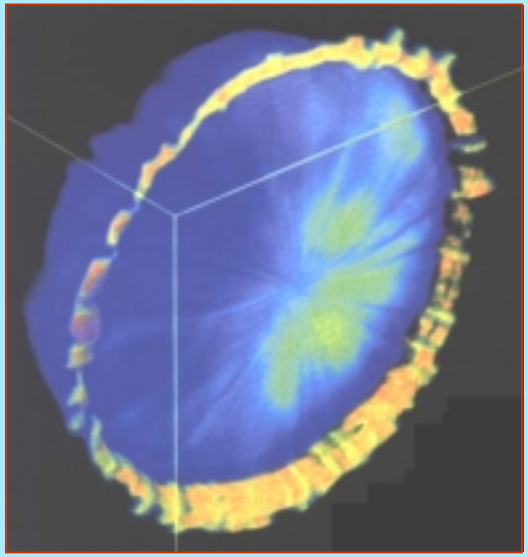
Outline

- Light scattering in human eyes
- Electro-optic ceramics in an eye model
- “Single-pass”experiments
- “Double-pass”experiments
- Final remarks

What happens in the eye?

During the lifetime, light scattering in the human eyes increases 2 to 3 times

7 of 10 people over 65 have opacities in the eye lens(es).
For 2 of the 7 opacities cause problems, the cataracts



Opaque eye lens (B.Masters, 2001)

Why modeling?

Modeling of light scattering could promote understanding of physical and physiological changes in the eye

In this way we could also assess the limits of diagnostical methods without a threat to harm or exhaust volunteers

How?

Where we are…

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We used PLZT….

PLZT ceramics is largely transparent for the visible light. *Applied electric field*, however, induces formation of polar regions that cause considerable light scattering

By changing the electric field that we apply, we can vary the amount of scattering induced

PLZT stands for $Pb_{0.91}La_{0.09}Zr_{0.65}Ti_{0.35}O_3$

To keep an eye on...

Scattering in the PLZT material is sensitive to the changes in temperature

The increase of scattering is reversible

Golden electrodes are applied in tiny islets on the surface. The plate with electrodes has stronger absorption in the blue spectrum. So does the cataract in the human eye, however

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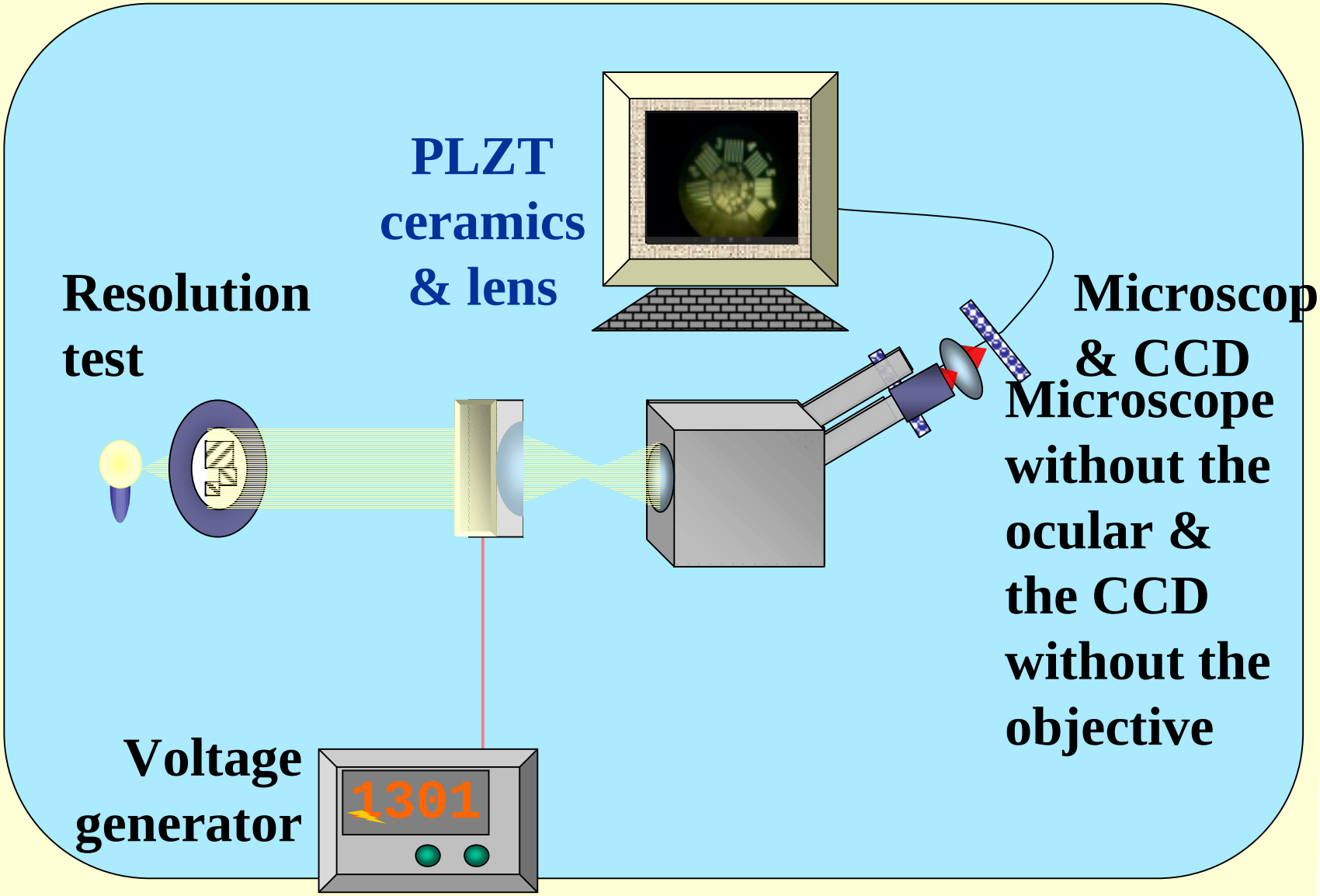
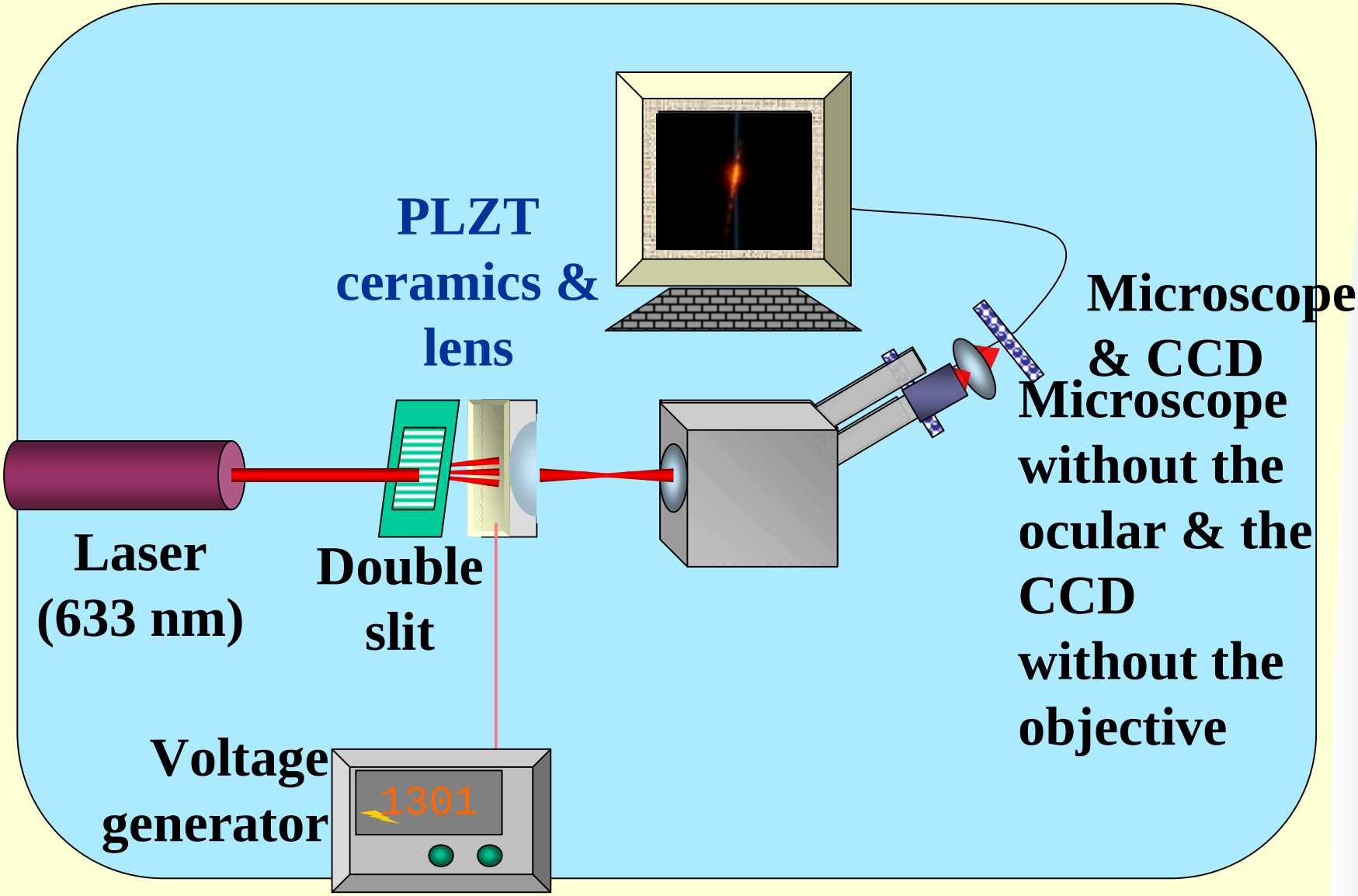
Single-pass method... incoherent light



Single-pass method... laser source



As a result….

Changes in the quality of images were observed starting from E=5…7 kV/cm.

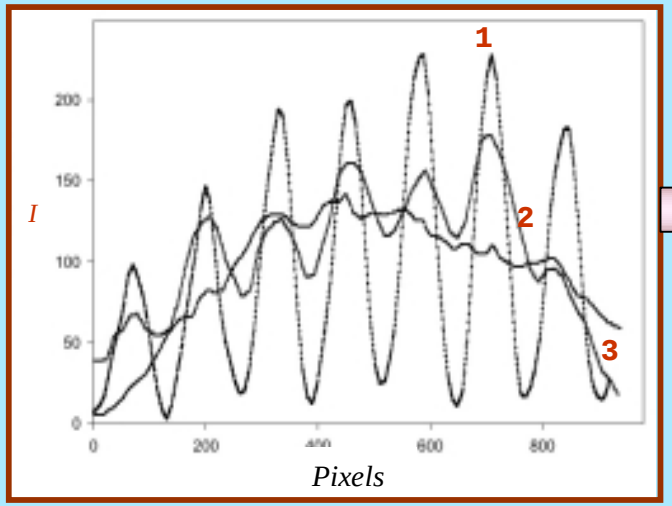
The range used does not harm the PLZT

Clinical applications

Alterations in intensity and contrast of the digital images were registered. At E=9 kV/cm the interference patterns for the conventional “good vision” (V=1.0 or 20/20) could be resolved no more.

Evaluation of reliability and comparison of diagnostic methods could be made

Changes can be visualised...

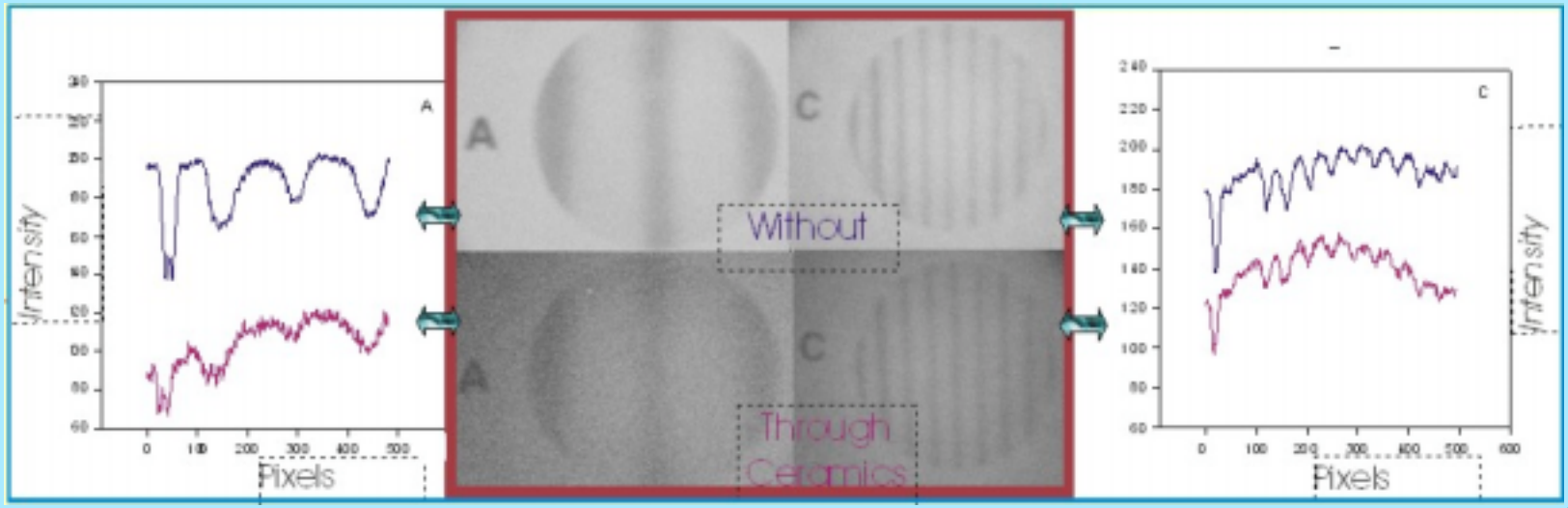


One bit scans of interference images: E=0; E=8.4 kV/cm; E=9.0 kV/cm

Interference patterns are used in clinics to evaluate the neural functions of the eye with a cataract

Standard tests can be tried...

The system can visualize the changes in contrast and intensity of contrast sinusoids and bright incoherently illuminated objects



(Vistech Consultants, Inc.)

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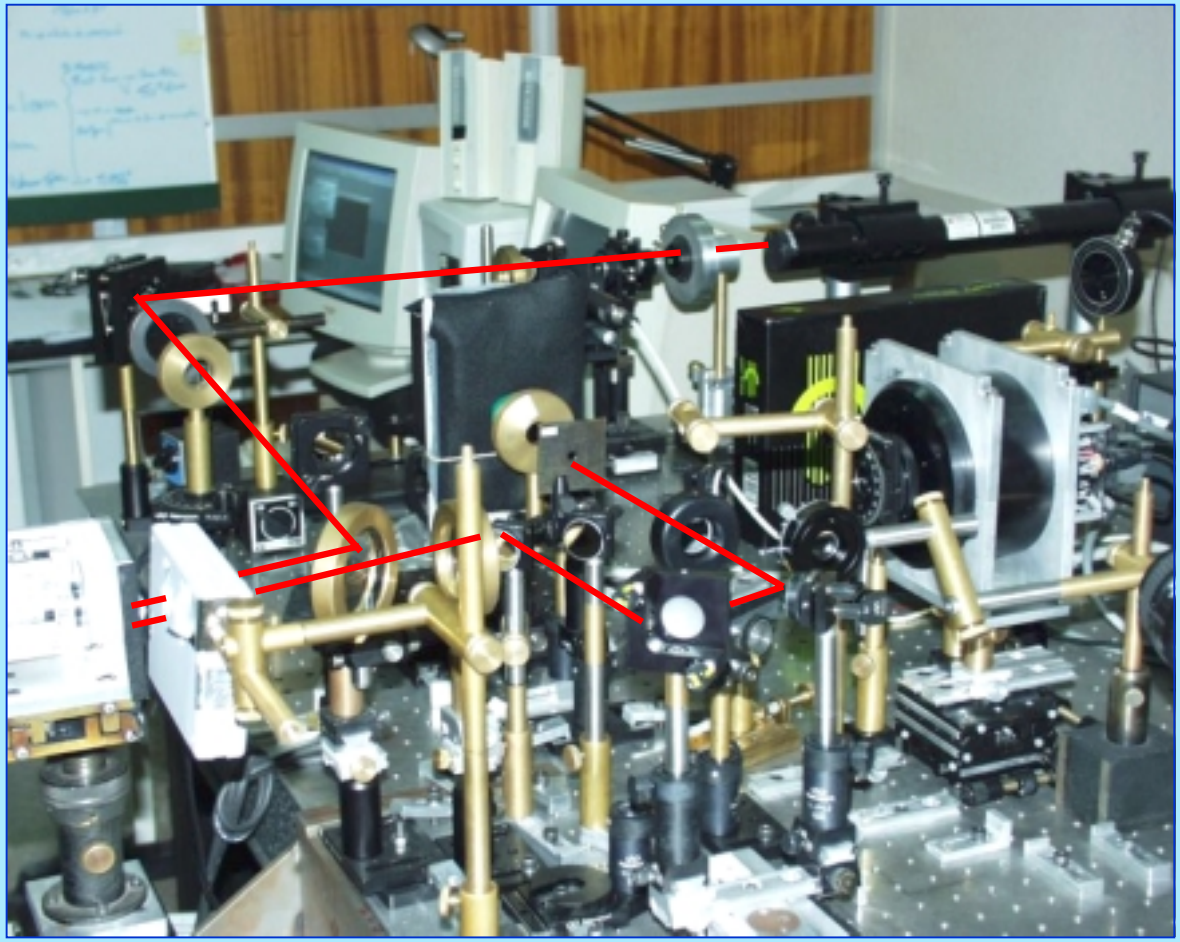
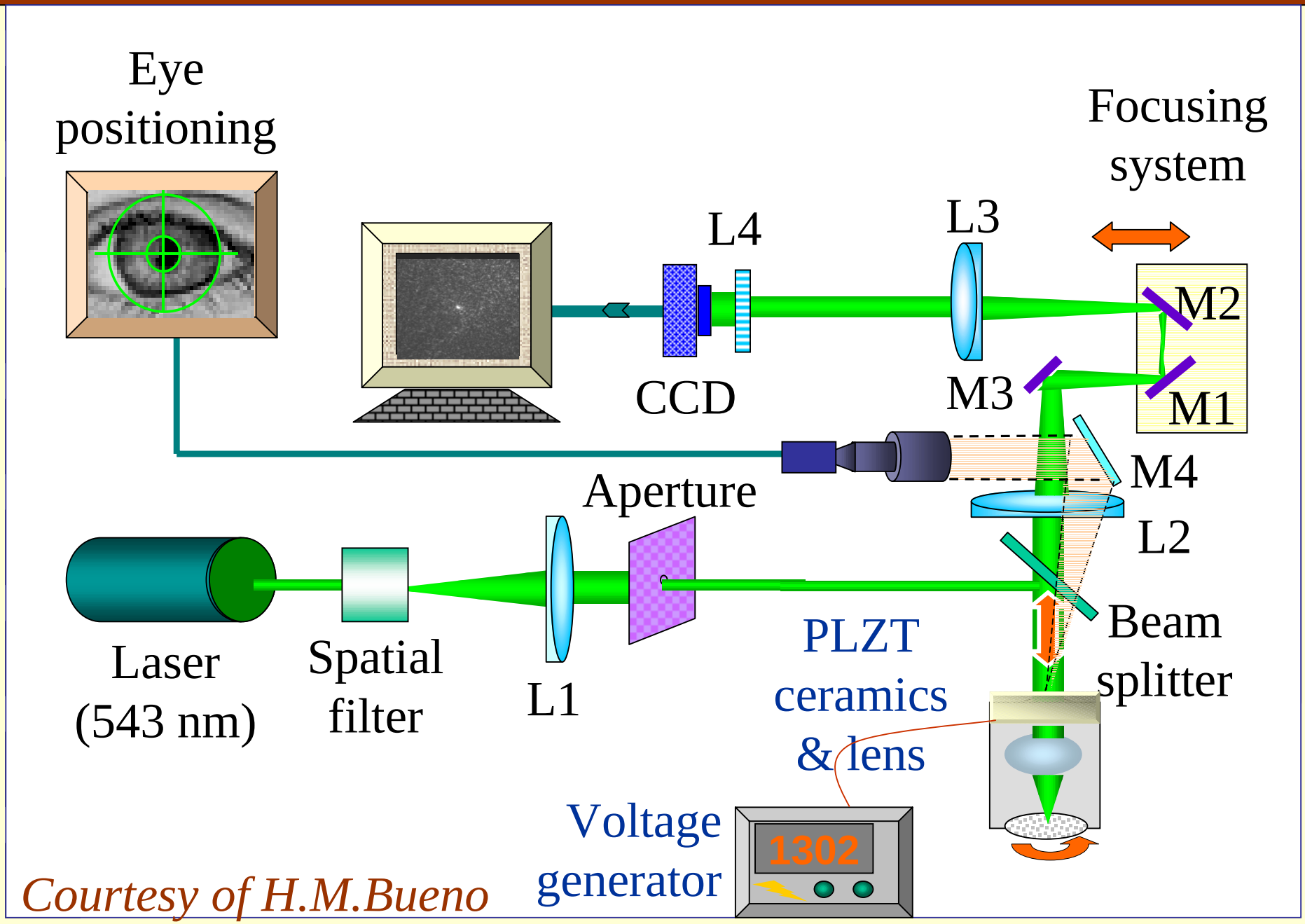
Double-pass optical set-up



In collaboration with the Laboratory of Optics, the University of Murcia, Spain

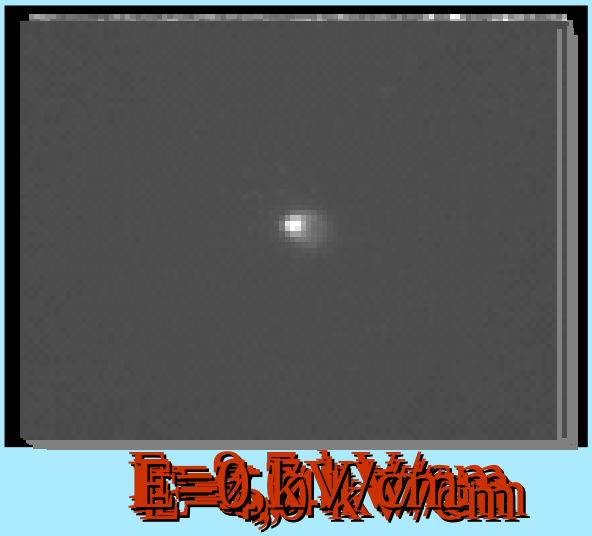
Double-pass scheme



Courtesy of H.M.Bueno

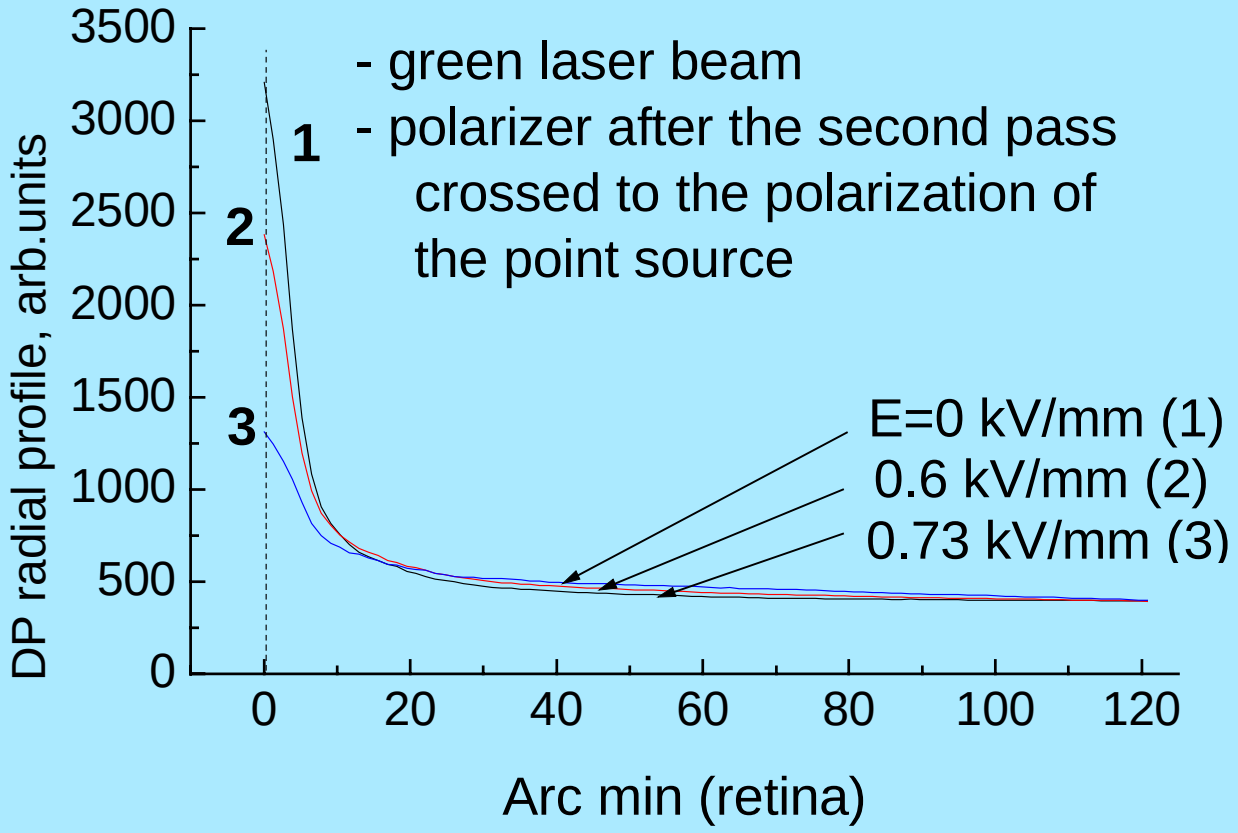
The centre loses energy...

Intensity distribution of a point image



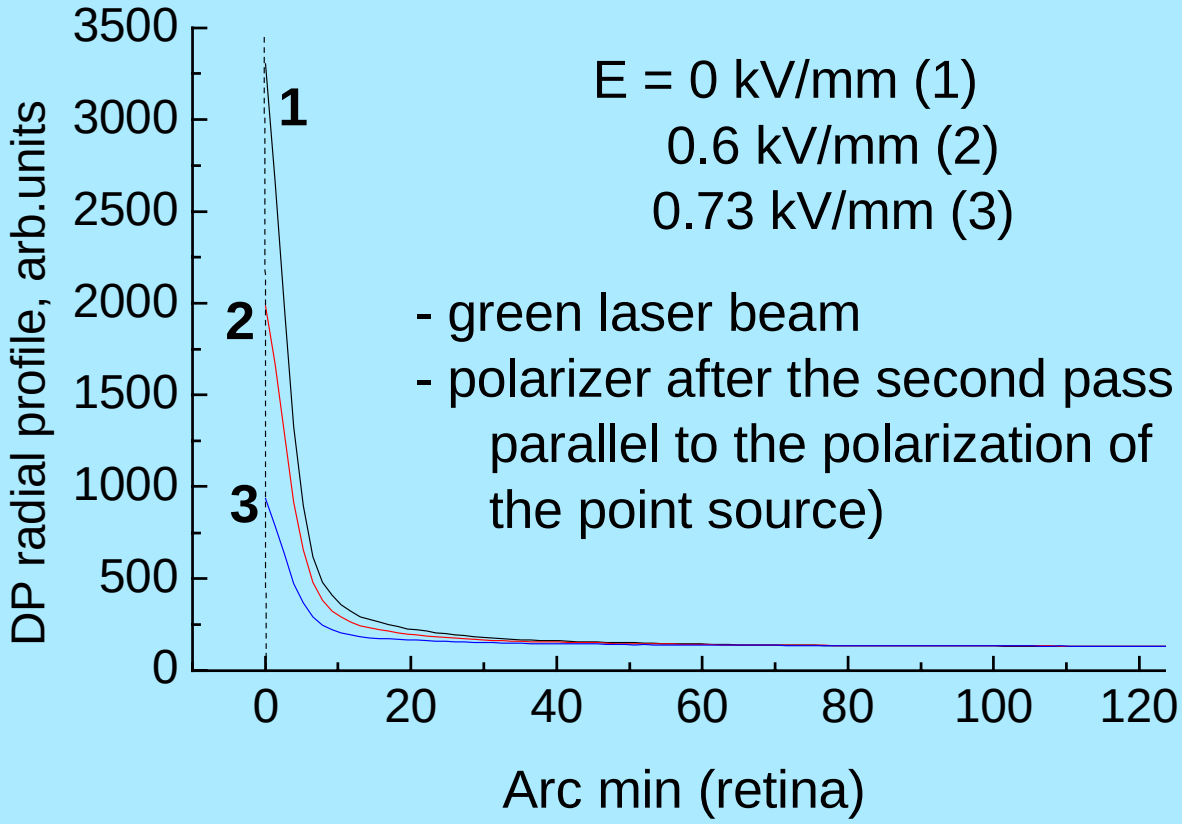
Electric field

…higher spatial frequencies gain the energy



We can register the "migration" of energy to the tails...

Light maintains polarisation...



Depolarisation of light in the model and the eye differ…

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Finis coronat opus

In brief,

A device consisting of PLZT ceramics, a +55.6 D lens, a microscope and a CCD can visualize the changes in images that are caused by light scattering

Reliability and the limits of interferometry diagnostics can be studied

Furthermore…

Interdependence of scattering and ocular aberrations, and their impact on the image can be explored with a PLZT plate in the double-pass setup

Light of high energy can be used to see the effects more profoundly

However...

Resolution can be limited by high aberrations of the optical device (chromatic aberrations, coma), CCD geometry and digital processing

Scattering effects are temperature-dependent

Thank you!

HAVE I LEFT ANY TIME FOR QUESTIONS?