SEIBERSDORF LABORATORIES – LASER RETINAL HAZARD EVALUATION TOOL

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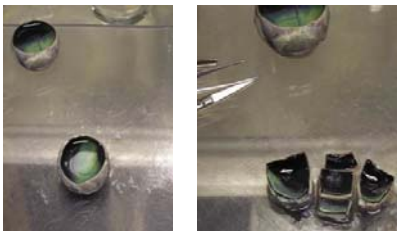
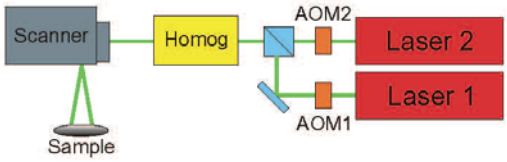
IN-VITRO RETINAL MODEL

Fresh retinal samples from bull's eyes



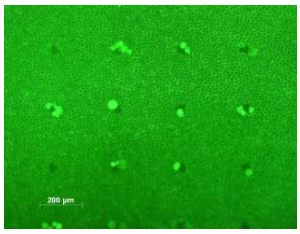
Exposure of retina with laser beam
20 Watt power, 532 nm wavelength



Control of power and pulse duration with **AOM**
Control of position on sample with **scanner**

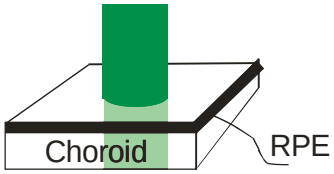
Automatic exposure system

Viability Analysis



Calcein staining; fluorescent microscopy
30 min after exposure

COMPUTER MODEL



Absorbing layers:
retinal pigment epithelium, choroid

$$div(\kappa gradT) + H = \rho C \frac{\partial T}{\partial t}$$

Solve heat flow equation

- Finite difference method
- Finite element method
- Superposition method

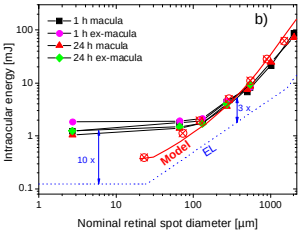
→ Temperature as function of time

$$\Omega = C_1 \int_0^{t\max} \exp\left(\frac{C_2}{T(t)}\right) dt$$

Arrhenius integral for determination of thermal damage

VALIDATION AND APPLICATIONS

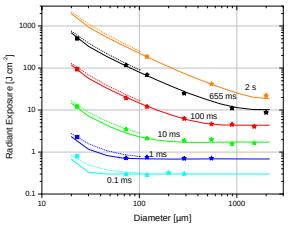
Validation against Rhesus monkey damage threshold data (514 nm)



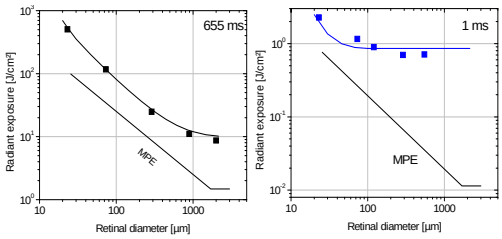
Cooperation with
US Army Research
Detachment, San Antonio

→ **Hazard evaluation tool valid for pulse durations between 100 µs to 1 s**

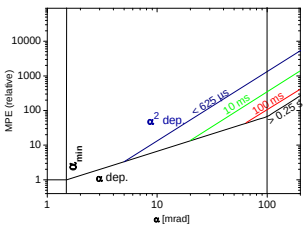
New Spot size dependence



Large safety factor for short pulses and large spots

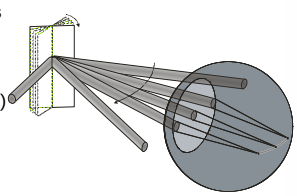


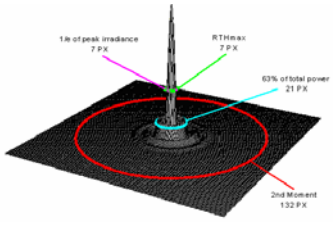
Proposed change for international exposure limits (ICNIRP) – time dependent amax = 200 t0.5



Product safety analysis

- Photo-Flashes
- Special irradiance profiles (apparent source)
- Multiple pulses
- Scanning radiation





LITERATURE

Ex-vivo and computer model study on retinal thermal laser induced damage in the visible wavelength range: K Schulmeister, J Husinsky, B Seiser, F Edthofer, B Fekete, L Farmer, D J Lund: Journal Biomedical Optics 13, 054038 (2008)

Variation of Laser-induced retinal injury thresholds with retinal irradiated area: 0.1 s duration, 514 nm exposures: David J. Lund, Peter Edsall, Bruce E Stuck and Karl Schulmeister: Journal Biomedical Optics 12, 024023 (2007)

Review of thresholds and exposure limits for laser and broadband optical radiation for thermally induced retinal injury: K Schulmeister, BE Stuck, DJ Lund, DH Sliney: submitted to Health Physics 2010

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