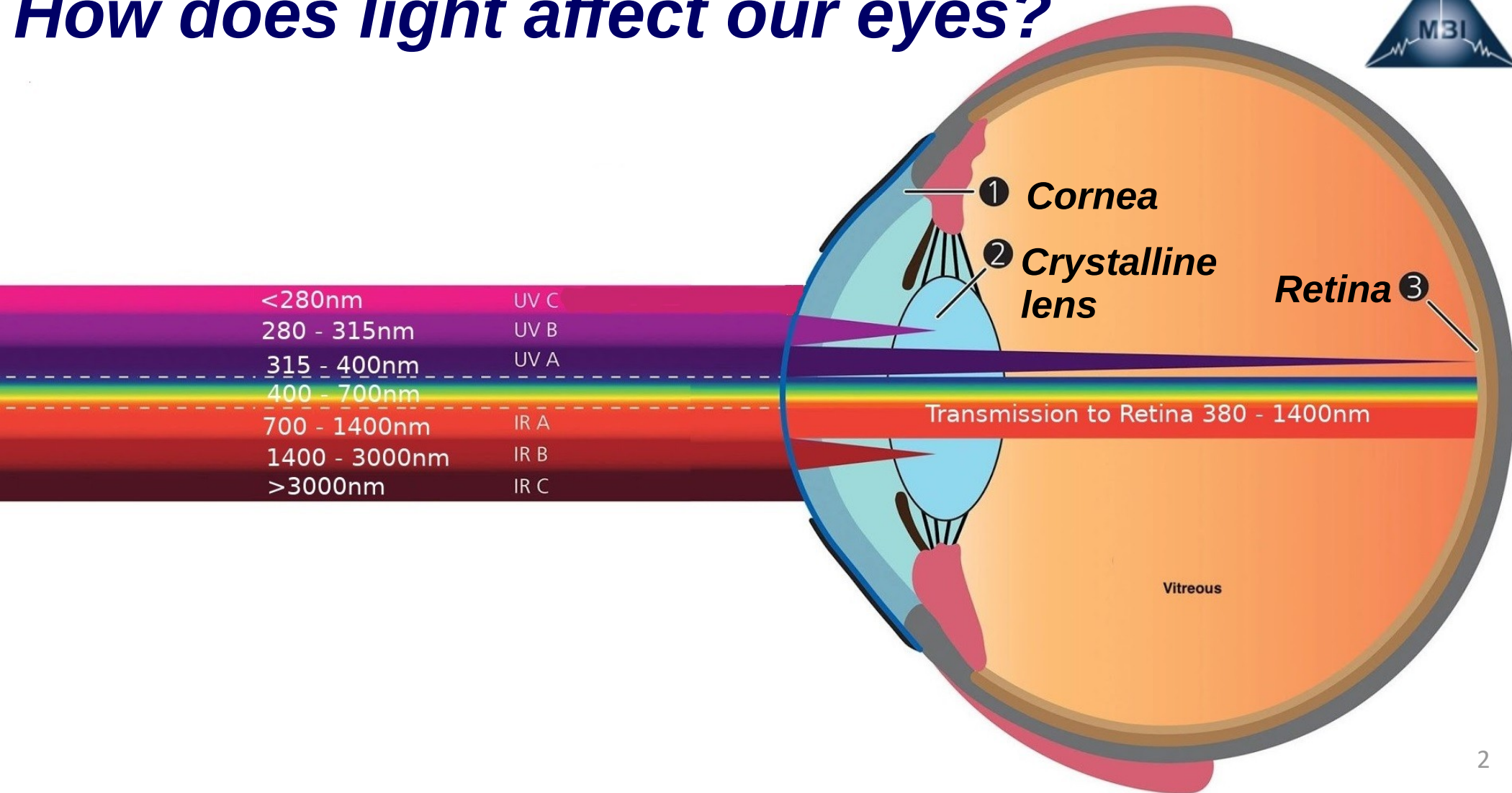


Laser safety topics

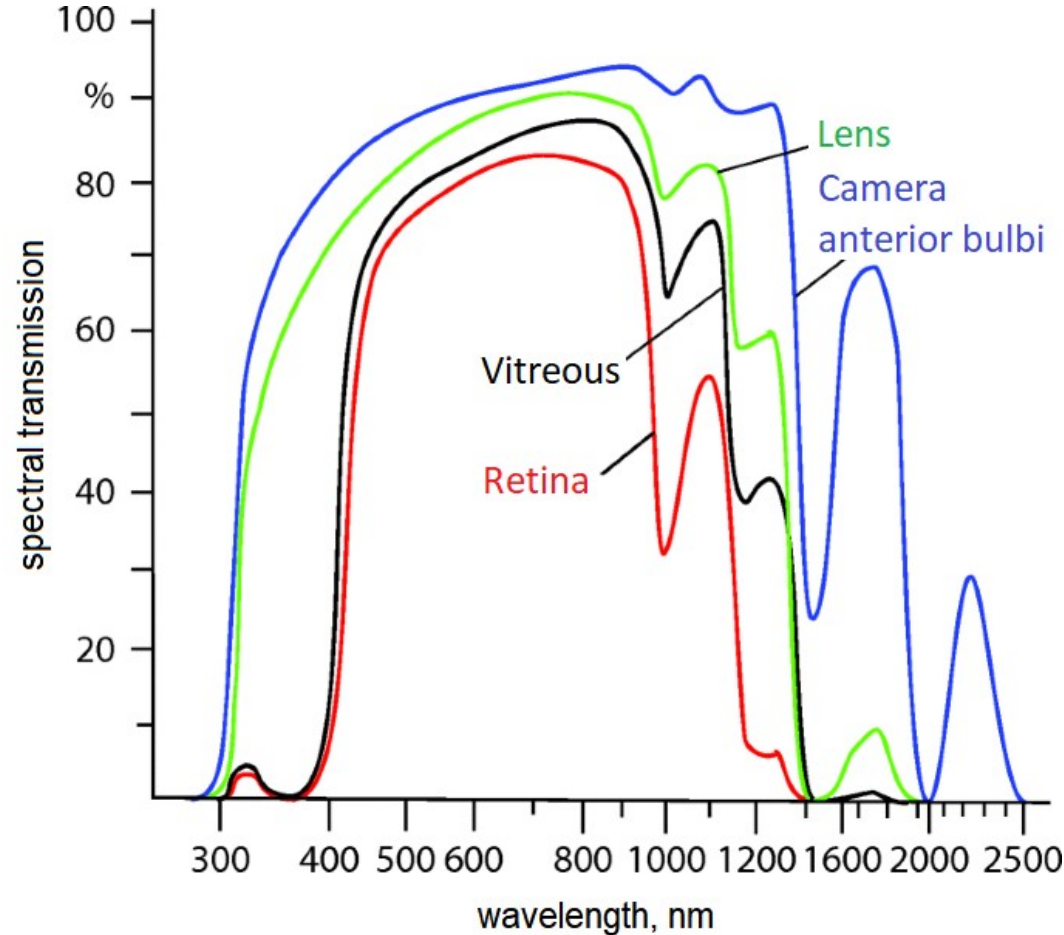


- 1. How does light affect our eyes and skin?*
- 2. Light-induced eye damages*
- 3. Particular risks due to laser radiation*
- 4. Safety goggles*
- 5. First aid instructions*

How does light affect our eyes?



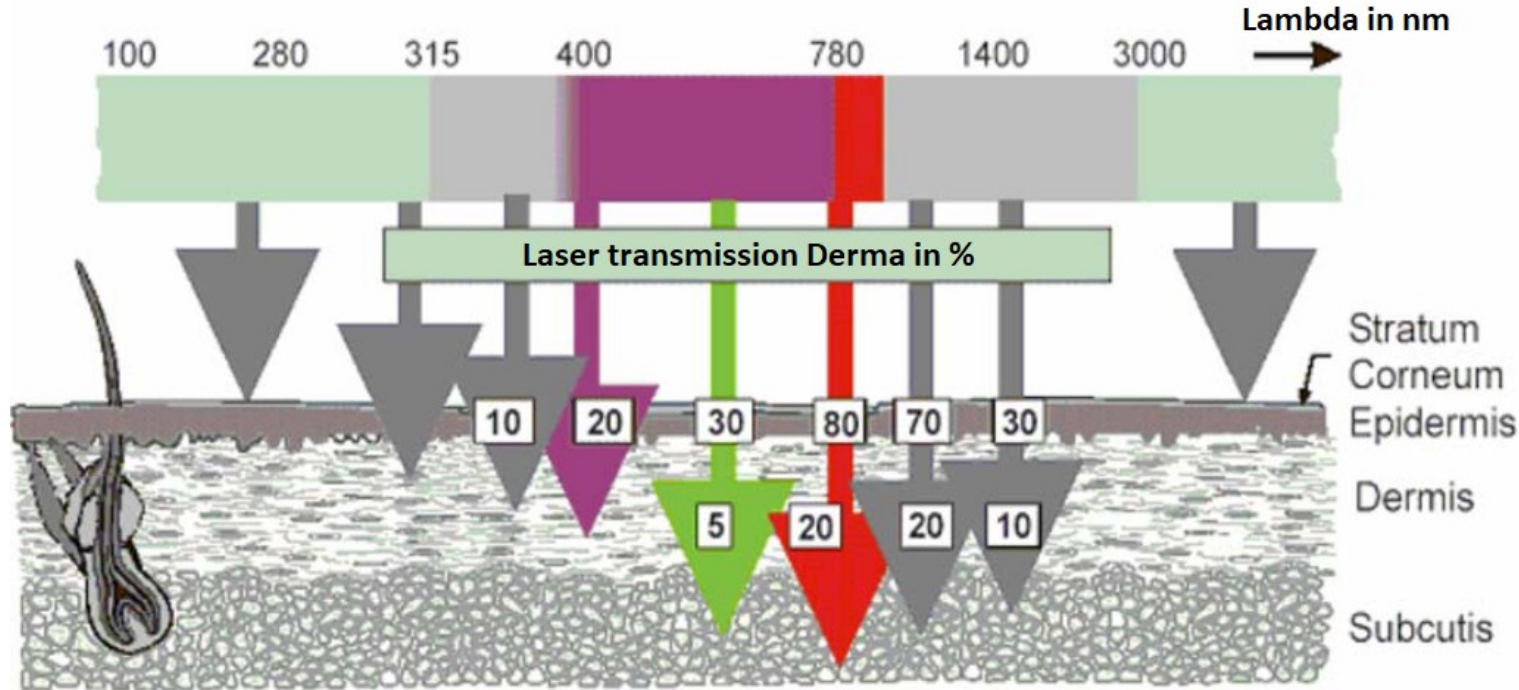
How does light affect our eyes?



Influence due to ...

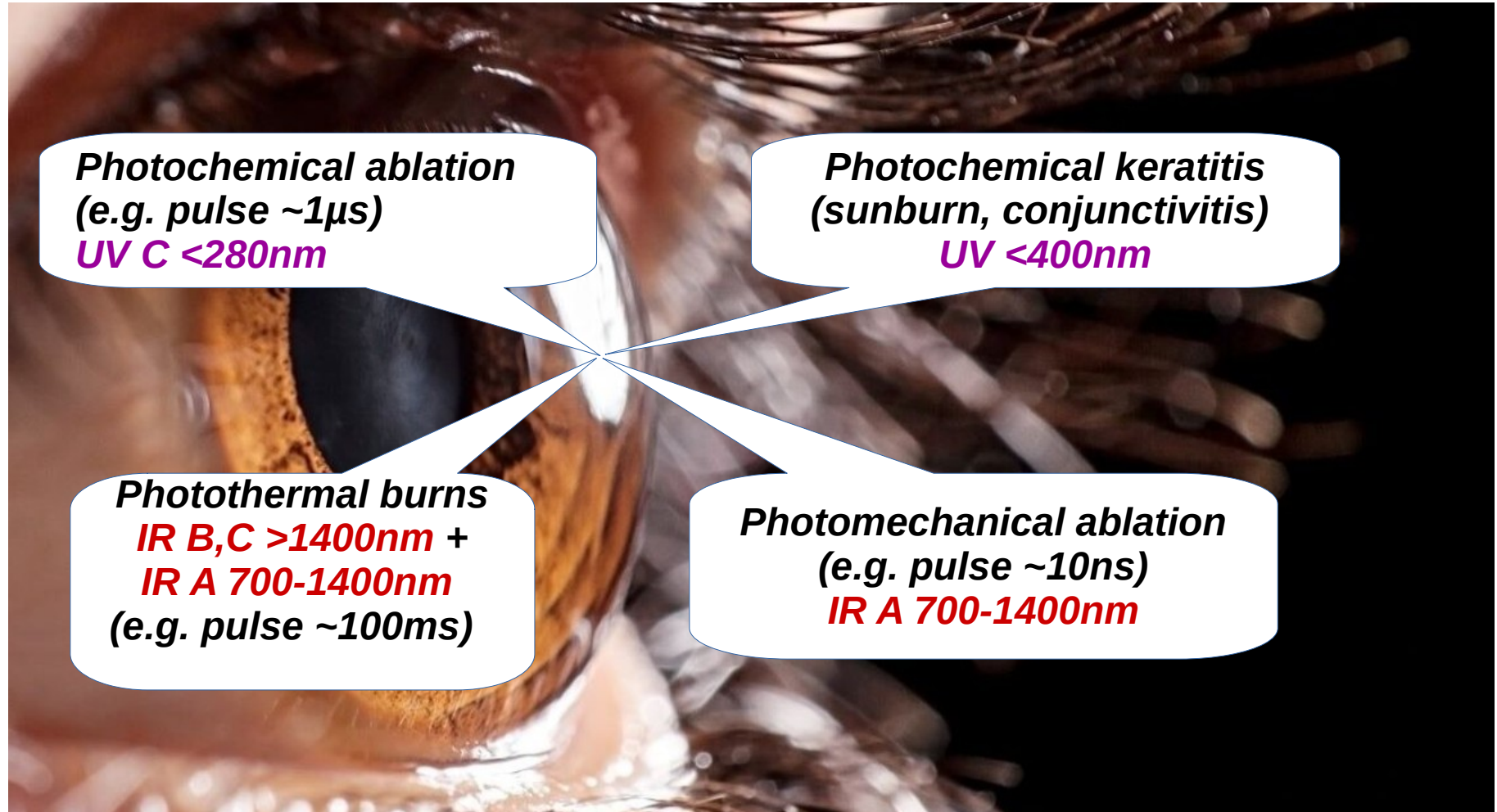
- *Transmission, absorption $f(\lambda)$,*
- *Quantum energy $f(\lambda)$,*
- *Power density [W/cm^2] , fluence [J/cm^2]*
- *Pulse duration,*
- *Nonlinear effects,*
- *Time of exposure,*
- *Beam parameters,*
- *Ambient lighting $\rightarrow$ pupil aperture ..*

Interaction with the skin



- **UVC** (100-280nm): **strong absorption**,
- **UVB** (280-315nm): **erythema** $\geq 0,1 \text{ J/cm}^2$,
- **UVA** (315-380nm): **pigmentation** $\geq 10 \text{ J/cm}^2$,
- **VIS** (380-780nm): **photochem. + therm. processes**,
- **IRA** (780-1400nm) + **IRB** (1400-3000nm): **burns**,
- **IRC** (3000nm-1mm): **burns on the outer epidermis**.

Light-induced damage of Cornea



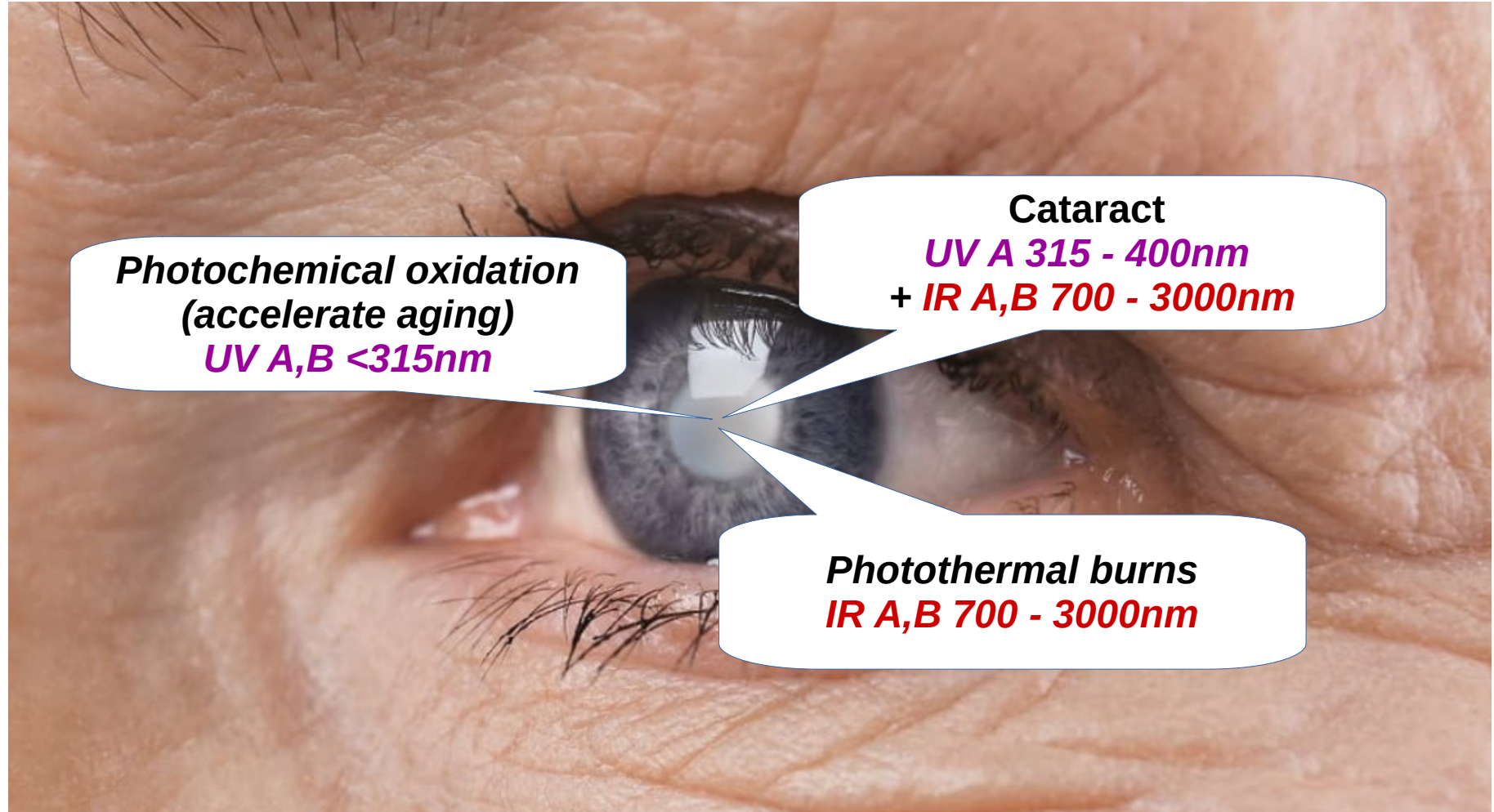
Photochemical ablation
(e.g. pulse $\sim 1\mu\text{s}$)
UV C $< 280\text{nm}$

Photochemical keratitis
(sunburn, conjunctivitis)
UV $< 400\text{nm}$

Photothermal burns
IR B,C $> 1400\text{nm}$ +
IR A $700-1400\text{nm}$
(e.g. pulse $\sim 100\text{ms}$)

Photomechanical ablation
(e.g. pulse $\sim 10\text{ns}$)
IR A $700-1400\text{nm}$

Light-induced damage of Crystal Lens



**Photochemical oxidation
(accelerate aging)**
UV A,B <315nm

Cataract
UV A 315 - 400nm
+ IR A,B 700 - 3000nm

Photothermal burns
IR A,B 700 - 3000nm

Light-induced damage of Retina

***No protective reflexes by
pupil or eye lid
IR A 700 – 1400nm***

***Focussing on retina:
irreparable damages,
makular degeneration and
vision loss !!!
UV A + visible + IR A
380-1400nm***

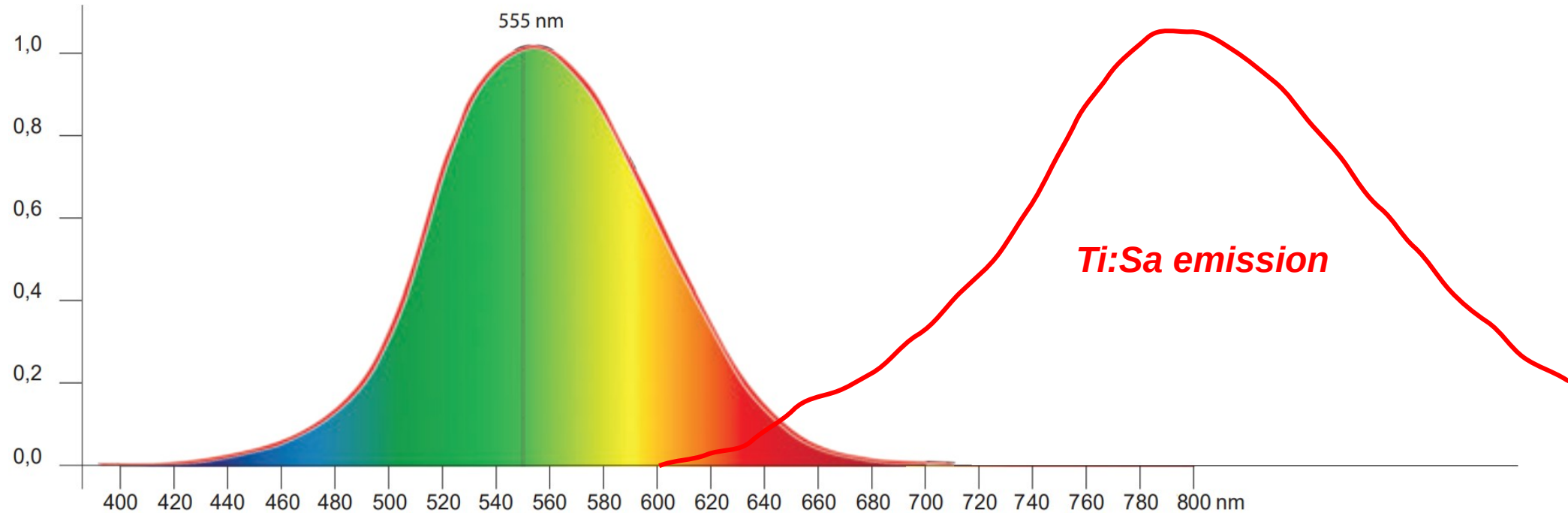
***Affected fovea centrales:
visual acuity of only 10 %
remains***

***Retina exposure limit
only 1 mW for a wink (0,25s)
e.g. laserpointer class 2***

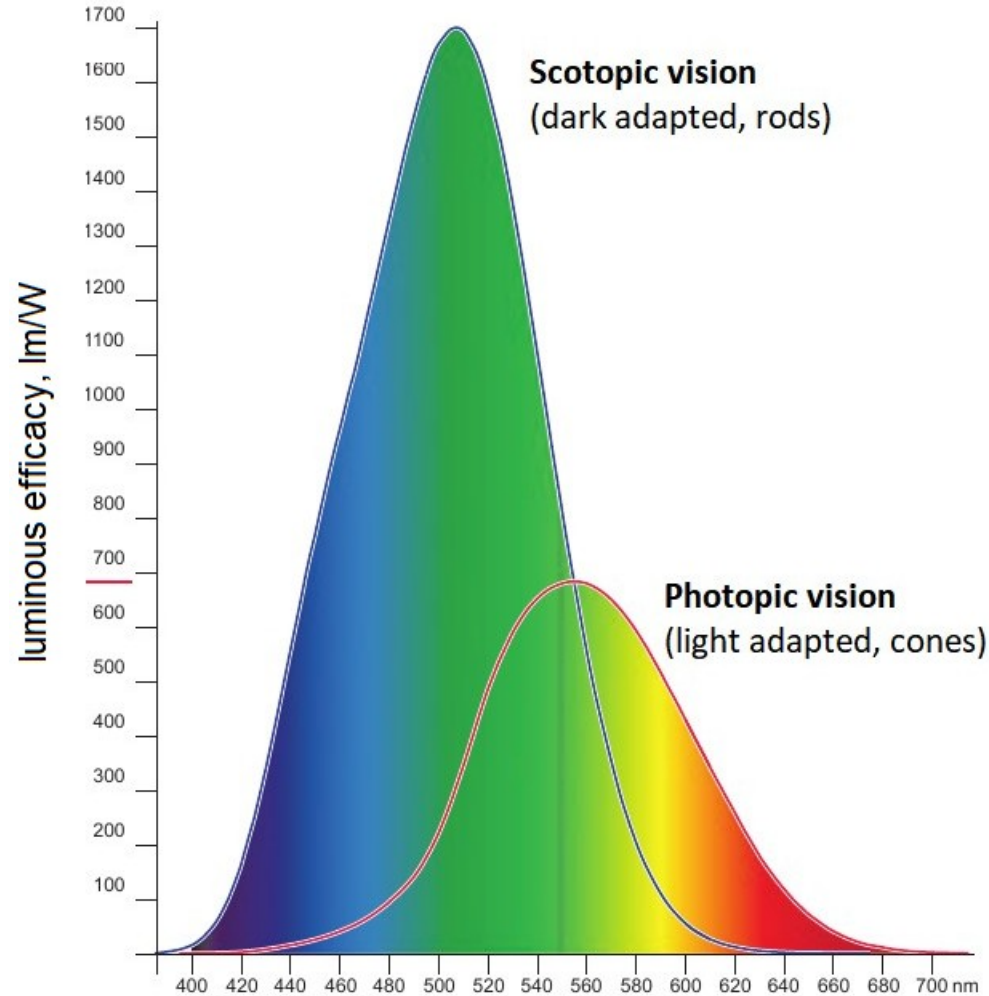
Risk due to invisible radiation



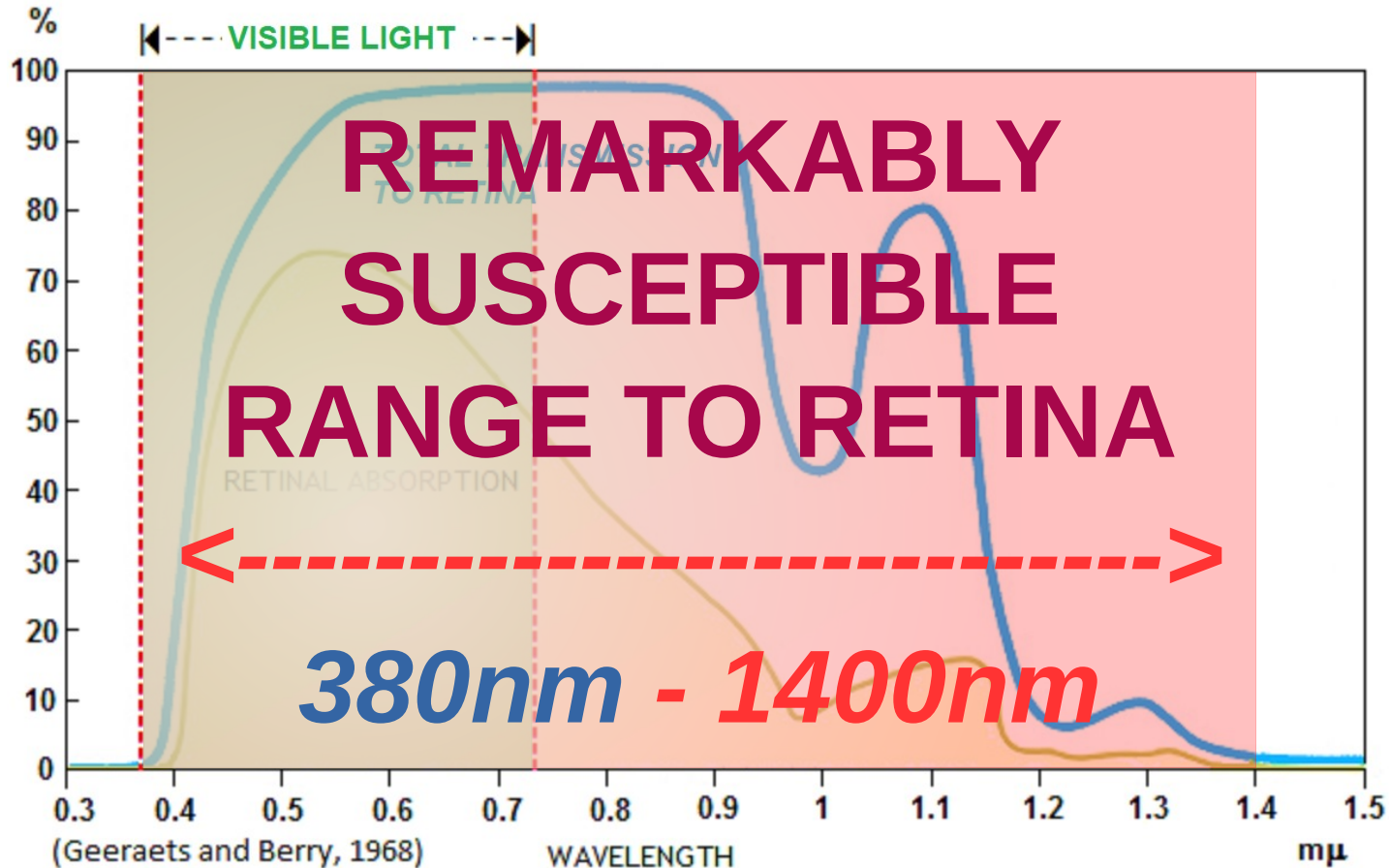
luminosity function – photopic vision



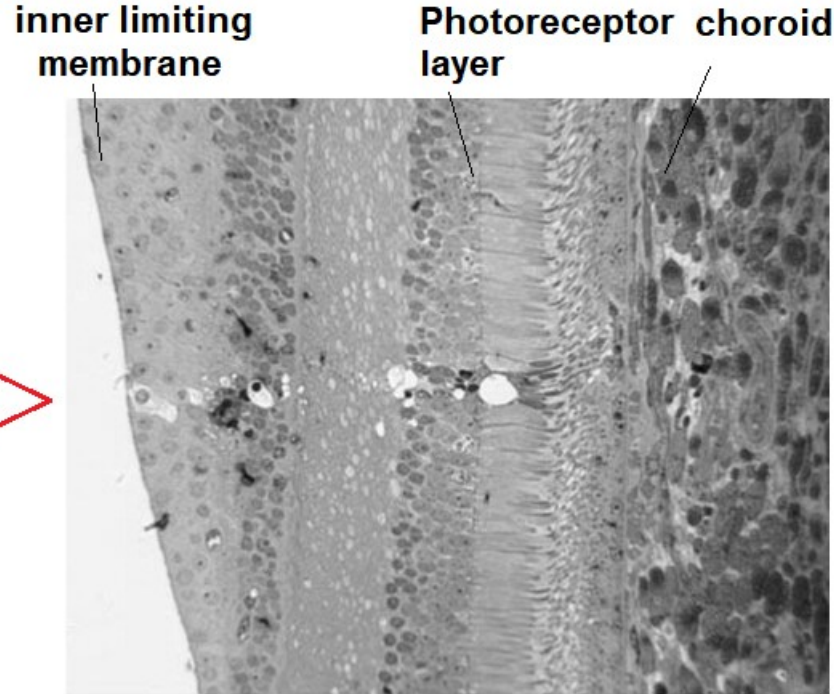
Photopic and scotopic vision



Damage caused by retinal absorption



Increased risk due to fs-pulses



“... Below 1 ns, the damage threshold is lowered by a combination of stress confinement in microgranules of melanin (pigment cells) and self-focusing, resulting in a smaller beam on the retina. ...”

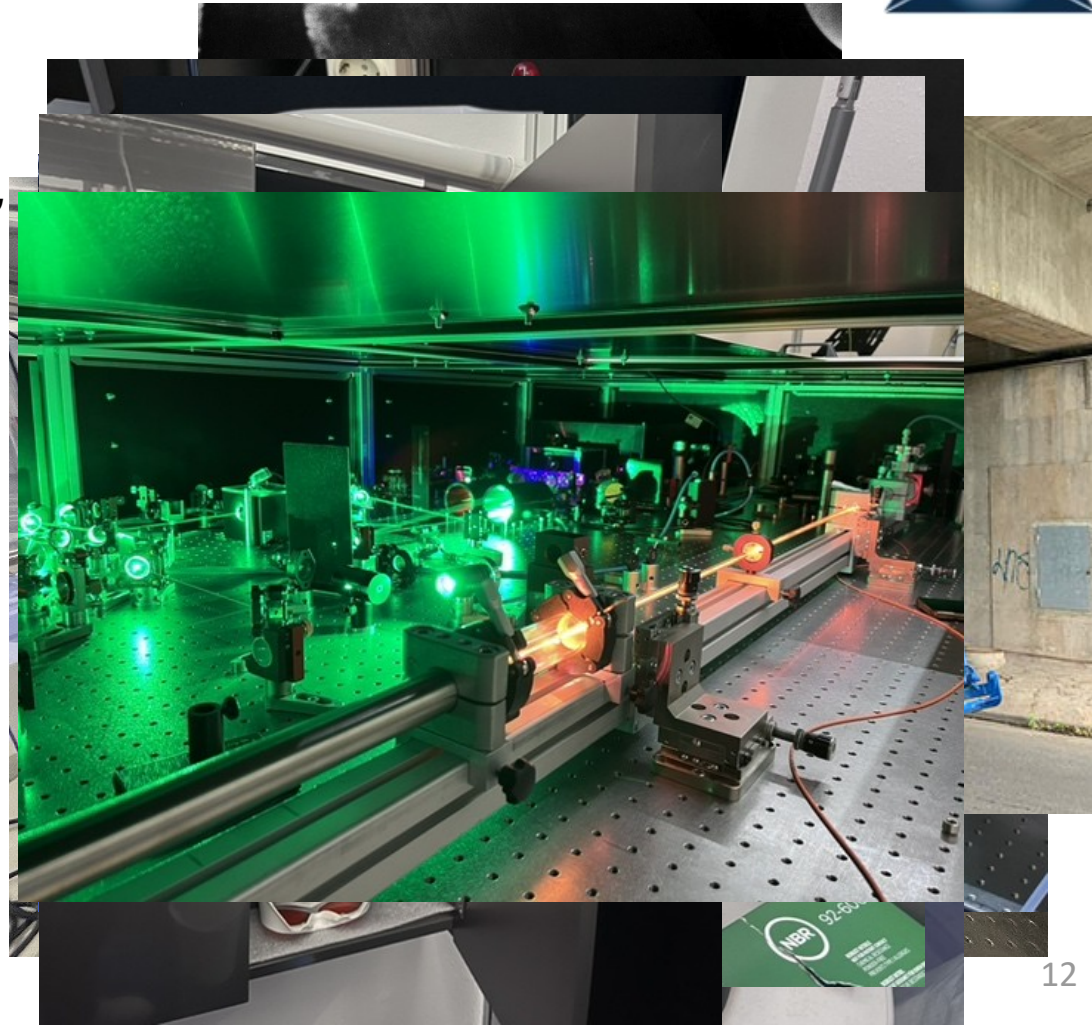
Medical Laser Application
Volume 25, Issue 2, April 2010, Pages 84-92

Histopathology of fs-laser exposure to the retina (200 μm), nonhuman primate (courtesy Cynthia Toth, M.D., Duke Eye Center).

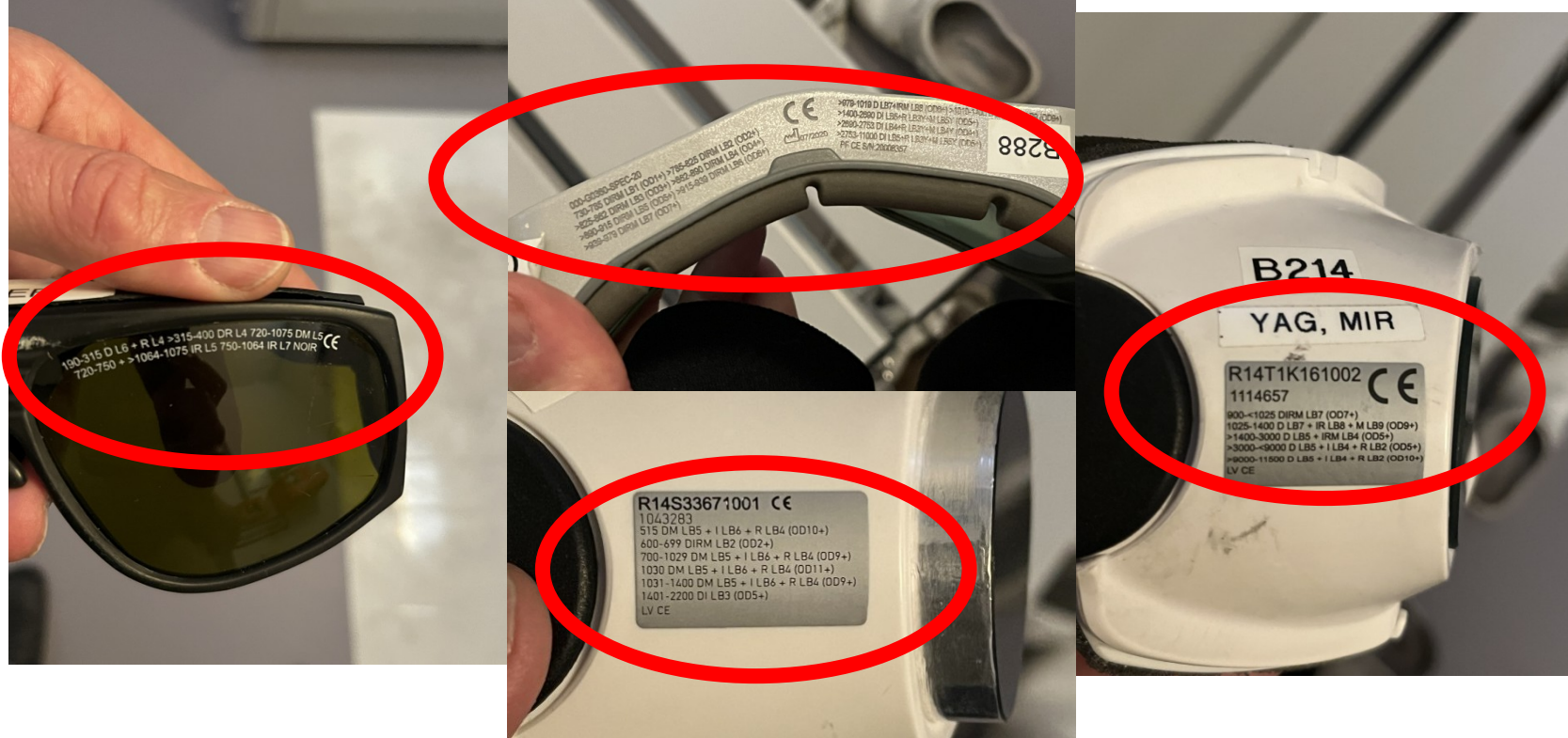
Further risk factors



- *Changes over large distances,*
- *Handling of beam stabilization systems,*
- *Scattered or reflected light,*
- *Missing shielding, beam blocks, etc.,*
- *Routine works, inattention,*
- *Mental stress, sickness, hectic,*
- *Mess at the workplace,*
- *Inattention towards others,*
- *Flammable substances,*
- *Incorrect goggles ..*



Safety goggles



Safety goggles



Schutz- stufe	Maximaler spektraler Transmissionsgrad bei den Laserwellenlängen	Leistungs- (E) bzw. Energiedichte (H) zur Prüfung der Schutzwirkung und der Beständigkeit gegen Laserstrahlung im Wellenlängenbereich								
		Power (E) and energy (H) density for testing the protective effect and resistance to laser radiation in the wavelength range								
		180nm → 315nm			>315nm → 1400nm			>1400nm → 1000µm		
		Für Prüfbedingung/Impulsdauer in Sekunden (s) For test condition/pulse duration in s								
Scale number	Maximum spectral transmission for laser wavelength τ(λ)	D	I, R 10 ⁻⁹ ... 3*10 ⁴	M	D	I, R 10 ⁻⁹ ... 5*10 ⁻⁴	M	D	I, R 10 ⁻⁹ ... 0,1	M
		≥ 3*10 ⁴		< 10 ⁻⁹	≥ 5*10 ⁻⁴		< 10 ⁻⁹	≥ 0,1		< 10 ⁻⁹
		E _D W/m ²	H _{I,R} J/m ²	E _M W/m ²	E _D W/m ²	H _{I,R} J/m ²	H _M J/m ²	E _D W/m ²	H _{I,R} J/m ²	E _M W/m ²
LB1	10 ⁻¹	0,01	3*10 ²	3*10 ¹¹	10 ²	0,05	1,5*10 ⁻³	10 ⁴	10 ³	10 ¹²
LB2	10 ⁻²	0,1	3*10 ³	3*10 ¹²	10 ³	0,5	1,5*10 ⁻²	10 ⁵	10 ⁴	10 ¹³
LB3	10 ⁻³	1	3*10 ⁴	3*10 ¹³	10 ⁴	5	0,15	10 ⁶	10 ⁵	10 ¹⁴
LB4	10 ⁻⁴	10	3*10 ⁵	3*10 ¹⁴	10 ⁵	50	1,5	10 ⁷	10 ⁶	10 ¹⁵
LB5	10 ⁻⁵	10 ²	3*10 ⁶	3*10 ¹⁵	10 ⁶	5*10 ²	15	10 ⁸	10 ⁷	10 ¹⁶
LB6	10 ⁻⁶	10 ³	3*10 ⁷	3*10 ¹⁶	10 ⁷	5*10 ³	1,5*10 ²	10 ⁹	10 ⁸	10 ¹⁷
LB7	10 ⁻⁷	10 ⁴	3*10 ⁸	3*10 ¹⁷	10 ⁸	5*10 ⁴	1,5*10 ³	10 ¹⁰	10 ⁹	10 ¹⁸
LB8	10 ⁻⁸	10 ⁵	3*10 ⁹	3*10 ¹⁸	10 ⁹	5*10 ⁵	1,5*10 ⁴	10 ¹¹	10 ¹⁰	10 ¹⁹
LB9	10 ⁻⁹	10 ⁶	3*10 ¹⁰	3*10 ¹⁹	10 ¹⁰	5*10 ⁶	1,5*10 ⁵	10 ¹²	10 ¹¹	10 ²⁰
LB10	10 ⁻¹⁰	10 ⁷	3*10 ¹¹	3*10 ²⁰	10 ¹¹	5*10 ⁷	1,5*10 ⁶	10 ¹³	10 ¹²	10 ²¹

First aid in case of injuries



→ **Keep the eye calm and consult an eye specialist asap.
Do not drive! Have someone accompany you.**

+ Vivantes Hospital Neukölln - Clinic for Ophthalmology +

Rudower Str. 48, 12351 Berlin, Phone : +49 30 130 14 3135

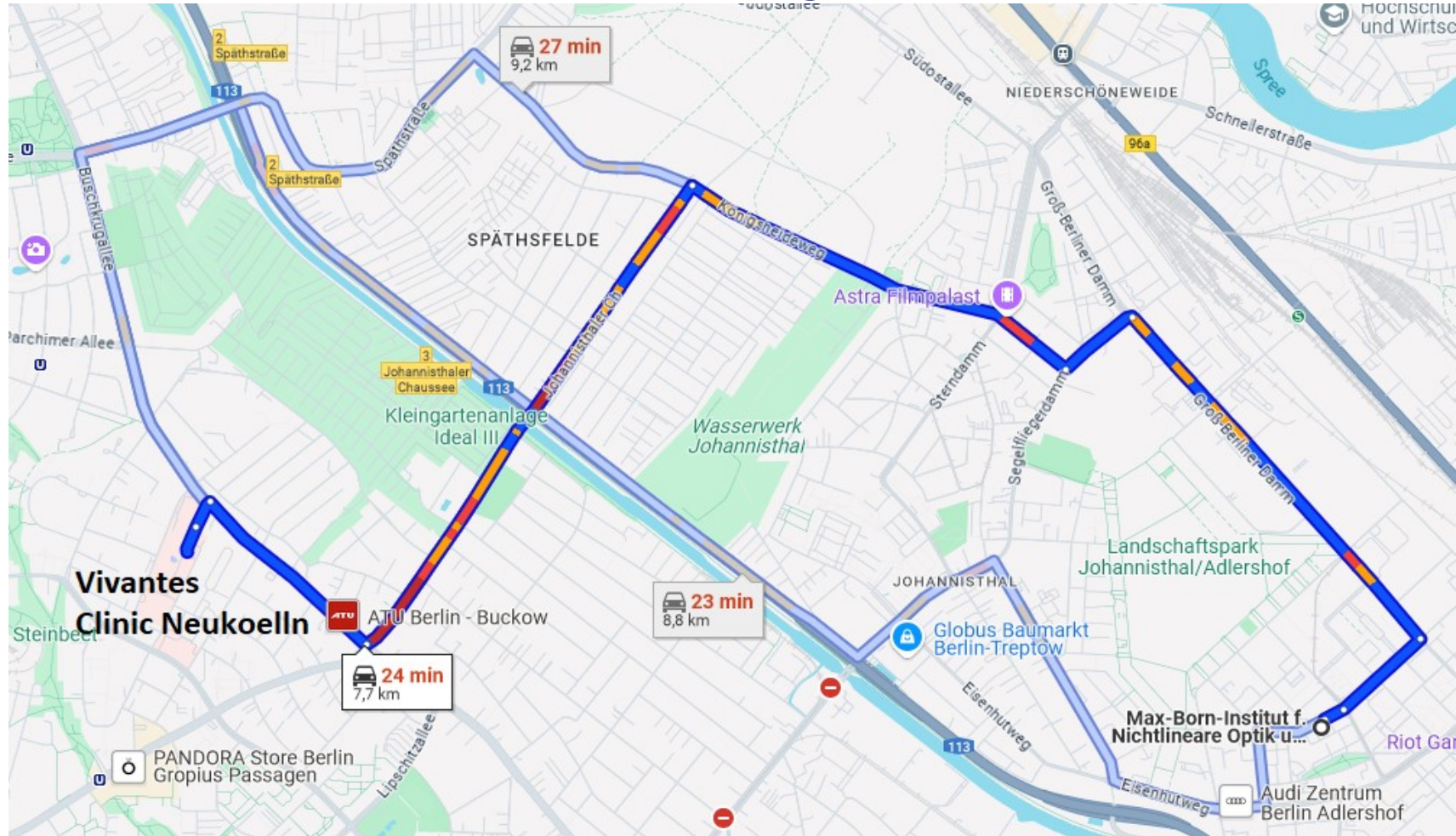
<https://www.vivantes.de/klinikum-neukoelln/augenheilkunde>

24/7 available

→ **Diagnostics + Therapy**

- *Checking visual acuity,*
- *Checking the visual field (perimetry),*
- *Slit lamp exam,*
- *If required removal of blood,*
- *Individually injection of medication.*

First aid in case of injuries



Laser safety officer of MBI



Dr. Martin van Moerbeck-Bock

Building C, 2.5

mbock@mbi-berlin.de

Phone : 1442



***Thank you and
take care!***