Laser safety in medicine

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Things you
should know about
laser safety

bLz Bayerisches Laserzentrum

MOTIVATION

Lasers can do a lot of good in medicine, but if used improperly, they can also cause great harm. Although laser operators in Germany have a comprehensive set of rules and regulations for safety in the laser workplace in the form of the occupational safety regulation OStrV and the technical rules TROS Laserstrahlung, regulations and rules are only as good as their implementation in everyday working life.

It is therefore important to us to use this brochure to draw your attention to the necessity of laser safety in the medical environment and to give you an initial insight into the subject.

Of course, this complex subject can only be touched upon in our short guide, which does not claim to be exhaustive. However, it is certainly well suited as an initial source of information.

BAYERISCHES LASERZENTRUM

Contents

Basics laser radiation

- LASER is an artificial word that stands for "**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation".
- To amplify light and generate laser radiation, special materials are required, e.g., specially grown crystals.
- The "laser light" produced in this way has special properties that differ significantly from the light emitted by an incandescent lamp, for example.
- Unlike incandescent light, laser radiation has a specific wavelength, i.e., a defined color; the wavelength is specified in nanometers (nm), e.g., 532 nm for green laser radiation.
- There are lasers that emit visible radiation and lasers that emit radiation in the invisible ultraviolet or infrared range.
- Due to the directional emission with low divergence, the beam still has a high intensity even at greater distances from the laser beam source – unlike when looking at an incandescent lamp – which can cause injury and damage.

The laser beam – it can heal, but it can also hurt

Laser classes

- Laser devices are classified by the manufacturer into one of eight laser classes according to their hazard potential, starting with laser class 1 (eye safe) to laser class 4 (very dangerous to the eye and skin):
  1 ⇨ 1M ⇨ 2 ⇨ 2M ⇨ 3R ⇨ 3B ⇨ 4, plus 1C
- 1C is a laser class that has existed since 2015 for special medical or cosmetic laser products and is only considered safe when used correctly (contact with the skin or use inside the body); however, the built-in laser beam source belongs to class 3B or 4.
- The respective laser class determines the extent of the laser safety measures to be taken.
- When operating Class 3R, 3B, or 4 lasers in Germany, the employer must appoint an employee as a laser safety officer and have him trained in accordance with legal requirements.
- Warning signs indicate the laser class and important technical data so that the potential hazard can be assessed and appropriate protective measures taken.

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DANGER – LASER RADIATION
AVOID IRRADIATION OF THE EYES
AND SKIN BY DIRECT OR
SCATTERED RADIATION

LASER CLASS 4

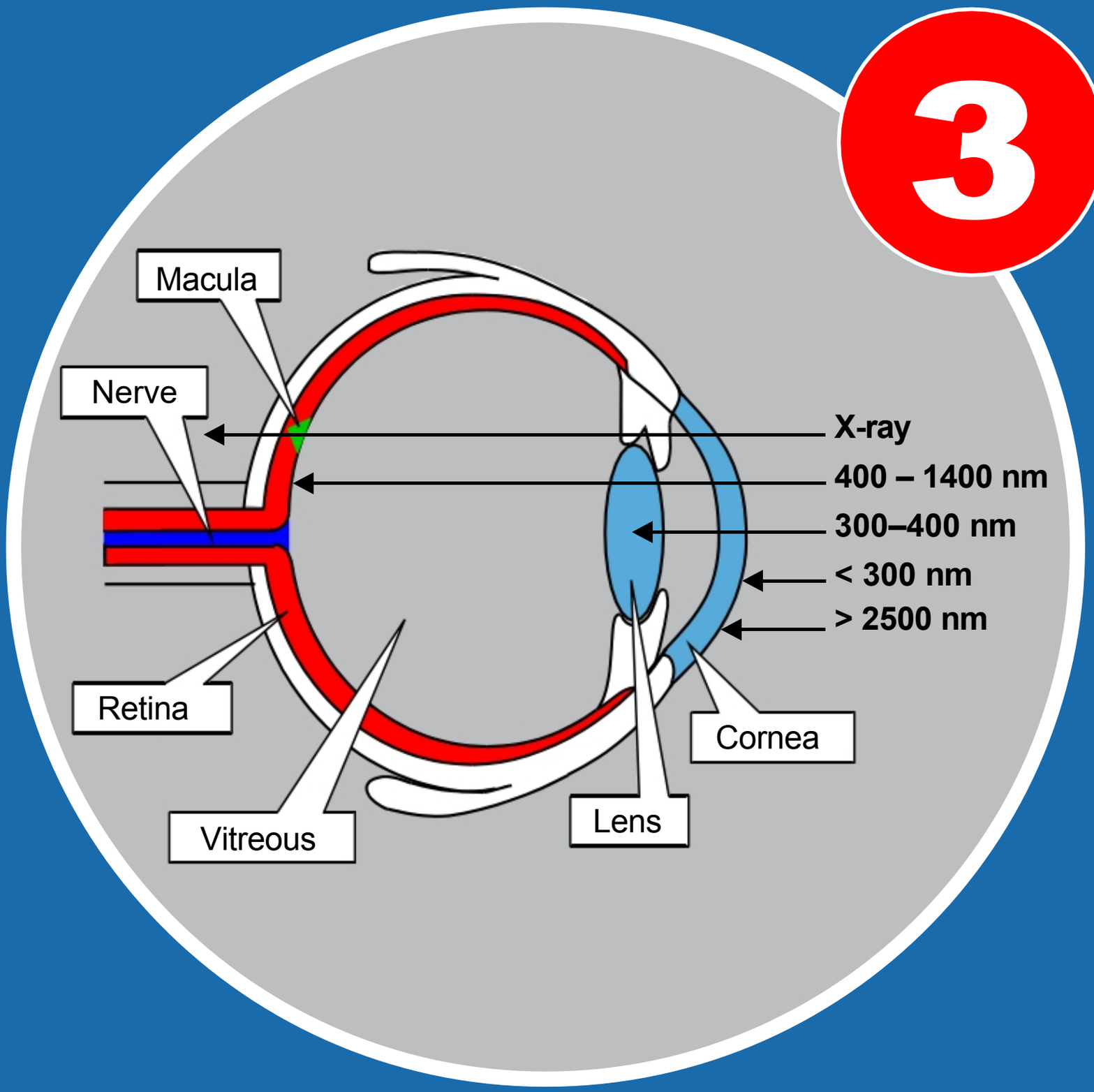
According to IEC 60825-1:2014

P_0	= 20 W
P_P	= 6 kW
t	= 350 µs
F	= up to 20 Hz
λ	= 2940 nm

Warning signs provide information about the laser class and laser data

Be aware of direct hazards

- Only Class 1 lasers are considered eye-safe, even if visible Class 1 laser radiation has the potential to cause temporary dazzling.
- If the laser beam hits the eye, the energy transported in the beam can cause damage to the eye (depending on the wavelength and laser power), which in the worst case can lead to blindness.
- Not only is looking directly into the laser beam dangerous for the eyes, but laser radiation reflected or scattered by instruments, for example, can also cause permanent damage to unprotected eyes.
- Class 4 laser radiation also poses a risk of injury to the skin, meaning that skin protection may also be required in addition to eye protection.
- Similar to the eye, the penetration depth of laser radiation into the skin and thus the potential for injury depends on the wavelength and laser power.
- There are exposure limits for the eyes and skin with regard to laser radiation, which must be observed (see Annex II of EC Directive 2006/25/EC).



Potential for injury to the eye depending on the laser wavelength

Be aware of indirect hazards

- Laser treatment can produce aerosols and gases that are hazardous to health; suitable extraction and room ventilation are therefore essential.
- In the peripheral areas of the tissue cut or ablated with the laser, the temperatures achieved are not sufficient for sterilization, so that larger fragments of cells can be torn from the tissue.
- Viruses and other pathogens can be deposited in the lungs and on the skin via the tissue particles scattered in this way, and infection is possible.
- When using ultra-short pulse lasers, aerosols can escape from the exposure zone at several times the speed of sound and be shot through the skin.
- Class 3B and 4 laser radiation can ignite flammable materials (e.g., tubes, hoses, probes, cover sheets that are not suitable for lasers) and cause explosions in oxygen-enriched environments in combination with flammable gases (e.g., intestinal and anesthetic gases, disinfectants).
- Laser devices may contain toxic substances such as chlorine or fluorine gas in excimer lasers or zinc selenide lenses in CO_2lasers.

Spraying tissue carries a risk of infection – personal protective equipment is therefore essential.

Take protective measures

- The TOP principle applies to occupational safety, i.e., technical protective measures have absolute priority and are supplemented by organizational and personal measures.
- Technical protective measures include shielding, warning lights, warning signs, emergency stop switches, and extraction systems.
- Organizational protective measures include access restrictions, training, appointment of a laser safety officer, risk assessment, and operating instructions.
- Personal protective measures include safety goggles, protective gloves and clothing, and respiratory protection.
- Laser safety goggles must be worn when laser radiation of class 3R or higher is accessible; eye protection goggles are available for patients.
- Only laser-compatible materials (non-flammable or flame-resistant, non-meltable) may be used in the immediate vicinity of the laser, e.g., non-combustible instruments, laser-compatible surgical drapes, adequately protected or specially designed tubes and probes.
- Spray bottle with sterile water for small fires and suitable fire extinguishers for larger fires.

Technical, organizational, and personal protective measures go hand in hand

We are here to help

The blz offers you a wide range of laser safety services:

- Consulting on all aspects of laser safety
- Assistance in setting up laser areas and determining suitable laser safety measures
- Assistance in selecting suitable laser safety goggles
- Support in carrying out risk assessments at laser workstations
- Training and further education for laser safety officers (also available as an in-house option at your location or online)
- Laser safety training for laser personnel
- Conducting annual laser safety training sessions

Feel free to contact us – we look forward to hearing from you!

Your path to greater safety in medical laser applications

Contact

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