ETH zürich

Laser safety at D-PHYS

General remarks

Lasers are widely used at the Department of Physics at ETH Zurich. Without the correct precautions, operating a laser can result in severe eye and skin injuries. Besides these primary risks, lasers are also sources of secondary risks, such as fire hazards or high voltages. This leaflet contains recommendations, which precautions should be made when installing and operating lasers.

The main source of information is the leaflet "Caution: Laser beam!" by SUVA (66049), which covers details of laser safety, especially also for the operation of laser laboratories. We here recall the most important topics and the recommendations of the Department of Physics.

The laser safety coordinator of D-PYHS advises project leaders regarding guidelines and safety measures when operating lasers. For further questions and concerns, you can also contact SGU at ETH Zurich.

Laser classes

Lasers are divided into eight different classes which require respective safety measures, as listed below.

Class	Description	Safety measures at D-PHYS
Class 1	No danger emanates from Class 1 lasers under reasonable operating conditions. Accessible radiation is weak enough that serious injury is impossible (e.g. less than 0.39 mW in the wavelength range 500 – 700 nm, or less than 40 uW in the range 400 – 450 nm). Completely encapsulated high-power lasers, where no radiation can escape, are included in Class 1, too.	– Do not stare into the beam, do not direct beam at another person.
Class 1M	The beam of a class 1M laser has a larger diameter than the pupil of the eye. Thus, only a fraction of the beam corresponding to a class 1 laser can hit the retina. Class 1M lasers (restricted to 302.5 – 4000 nm) are harmless to the eye, even after long-term exposure. However, injuries are possible if the beam is focused through additional optical elements (eyeglasses excluded).	– Do not stare into the beam, do not direct beam at another person. – Specifically warn persons who might use optical instruments (lenses, telescopes, microscopes).
Class 1C	Specific class of medical lasers used to treat skin or tissue. Although it can emit radiation corresponding up to class 4, the accessible radiation complies with Class 1 lasers.	– Follow the manufacturer's safety instructions.

Class	Description	Safety measures at D-PHYS
Class 2	Class 2 lasers only emit light in the visible spectrum (400 – 700nm). No damage is to be expected for short exposures of less than 0.25 s, during which the eyelid closing reflex typically acts. In continuous wave mode, Class 2 lasers emit less than 1mW power.	– Do not stare into the beam, do not direct the beam at other persons.
Class 2M	The beam of a class 2M laser has a larger diameter than the pupil of the eye such that only a fraction of the beam can hit the retina. Class 2M lasers (restricted to 400 – 700 nm) are harmless to the eye for short (<0.25 s) exposures. However, injuries are possible if the beam is focused through additional optical elements (eyeglasses excluded).	– Do not stare into the beam, do not direct the beam to other persons. – Specifically warn persons who might use optical instruments (lenses, telescopes, microscopes).
Class 3R	Class 3R lasers may not emit more than five times the maximum output power of a Class 1 laser of the same wavelength. The maximum power in the visible range is 5mW. Class 3R lasers can damage the eye.	– Operating personnel has to be trained. – The accessible beam must not pass at eye level (sitting or standing), otherwise the application range must be shut off. – Warning signs required at entrance to lab. – The laser must be protected against unauthorized use by a key switch. – Laser safety goggles are recommended.
Class 3R	Class 3R lasers may not emit more than five times the maximum output power of a Class 1 laser of the same wavelength. The maximum power in the visible range is 5mW. Class 3R lasers can damage the eye.	– Operating personnel must be trained. – The accessible beam must not pass at eye level (sitting or standing), otherwise the application range must be shut off. – Warning signs required at entrance to lab. – The laser must be protected against unauthorized use by a key switch. – Laser safety goggles are recommended.
Class 3B	Class 3B lasers emit at most 0.5 W in continuous wave mode. Even brief, accidental exposure of the eye to a Class 3B lasers is dangerous and can cause severe eye damage. Scattered radiation at non-reflecting surfaces usually does not lead to eye injuries.	– Operating personnel must be trained. – A laser safety officer has to be commissioned by the research group. – The research group needs to develop a safety concept in a written form. – Operation only in a well delimited laser area, from which no radiation can escape. Used materials must not be reflective and must withstand the radiation. – Laser safety goggles are required. – Restrict access to the laser. – Protect laser against unauthorized use by a key switch. – Laser warning signs and laser warning light must be installed outside.
Class 4	All other lasers, which cannot be allocated to a lower class. Direct and indirect radiation of Class 4 lasers can cause severe injuries of eye and skin. Class 4 lasers also often represent a fire hazard.	

Laser safety eyewear

Laser goggles are required when operating Class 3B and Class 4 lasers and are recommended in general, while operating lasers. The goggles must be chosen so that they protect against the main laser beam, not only against scattered light. Laser safety goggles must be selected specifically for the laser in question, taking into account the following parameters: mode of operation (CW, pulses, …), wavelength range, and protection level. When working with different lasers, the safety goggles must be clearly identifiable (e.g. by a colour scheme).

General rules of conduct

When operating lasers, the following rules of conduct apply:

- **Never** stare into a laser beam.
- Avoid working alone with lasers (see also information of SGU).
- Always wear laser safety goggles for the correct wavelength range when working with Class 3B / Class 4 lasers.
- Provide sufficient illumination of the room, since the laser safety goggles might absorb a large fraction of light.
- Check your lab with an IR viewer for unwanted reflections when working with invisible radiation.
- Put away all jewellery, watches, etc. which could reflect a laser beam. Do not cross a laser beam with reflective tools.
- Organise your lab and keep escape routes free.
- Don’t install laser beams at the height of your eyes when standing or sitting in the lab.
- Laser beams must stay in the defined area (typically the optical table). Use beam dumps and non-reflective panels to block the beam.

Accident

Since a laser accident can cause bleeding into the retina of the eye, it is important to act quickly. Call for help via the internal ETH emergency number (888). Escorted by a colleague. go immediately to the emergency room of the eye clinic:

Ophtalmic Clinic
University Hospital Zürich
Frauenklinikstr. 24
8091 Zürich
Phone: +41 44 255 49 49

Laser safety officer

Each research group operating Class 3B or Class 4 lasers must commission a laser safety officer. He or she is making sure that staff members and students are trained accordingly before commencing any task at a Class 3B/4 laser. This training must be documented and has to be repeated periodically, at least once a year. The laser safety officer makes sure that the required laser safety measures and protective goggles are in place. He or she also defines the safety concept within the specific group and writes it down. The laser safety officer has to be trained in a formal course, e.g. organised by SGU.

Installation of lasers

Before commissioning a new laser, all safety measures must first be taken according to the table above. Do not forget to install a box where to store the keys for the switches of the lasers. The signs and warning lamps required for signalling at the doors can be obtained from the D-PHYS Shop.

Homebuilt and modified lasers

If you are operating a homebuilt laser, it has to comply with national safety rules. Make sure the appropriate labels are attached to the laser. Also, a manual has to be created and stored with the laser. The manual of a commercial laser is a good starting point when writing the manual.

When modifying a commercial laser, even minimally, becomes the legal distributor of the laser. Here too, care must be taken to ensure that the laser is correctly labelled and that the operating instructions are adapted accordingly.