

Safety Instruction

AG Fumagalli –2011



Background

- An annual safety instruction is compulsory by law
- Participation has to be confirmed by your signature
- Observing the safety regulations is a prerequisite for insurance coverage



Part 1: General safety information

- **safety in laboratories**
- **behavior in case of an emergency**

How to conduct in the laboratory



- do not **eat, drink** or perform **beauty care** in a laboratory

- no **alcohol**



- **smoking ban** within the building

- do not work **alone**

- leave the **door open** if possible

Get informed about safety installations

- fire-protection installations



*fire
blanket*



*fire
extinguisher*



direction



*fire
hose*

- rescue installations



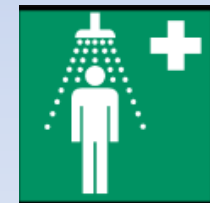
*emergency
exit*



*first-aid
kit*



*eye
shower*



*emergency
shower* ⁵

First aid facilities

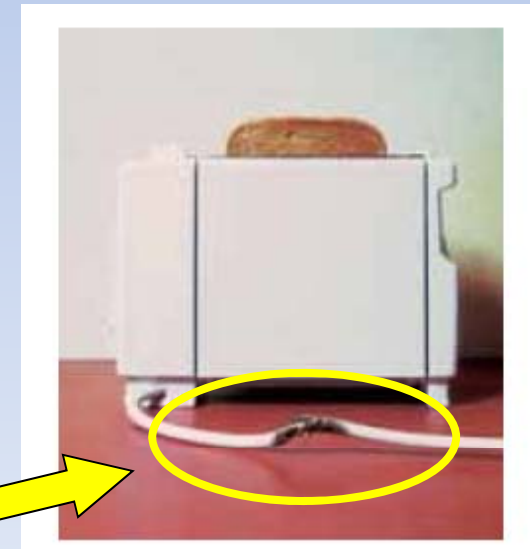


- first aid kits are located in every laboratory
- every incident must be reported in the first-aid log book located within the first-aid kit



Fire and health protection

- smoking ban within the whole physics department
- keep escape routes clean of fire loads
- put defective equipment immediately out of operation



Fire classes and extinguishing agents

- **powder** extinguisher: **A, B, C**
- **foam** extinguisher: **A, B**
 - A:** solids
 - B:** fluids
 - C:** gases
- **CO₂** extinguisher: **B**
- **person** on fire:
 - *immediately extinguish the fire*
 - *every extinguisher will do (faster than a fire blanket)*
 - *danger of suffocation or frostbite by using a CO₂ extinguisher is negligible! (keep 1 – 2 m distance)*

How to act in case of an emergency

- keep calm
- report the fire or emergency
- get persons involved out danger
- provide first-aid assistance
- undertake an attempt to extinguish the fire



112
55-112

warn endangered persons
Attend helpless people
shut fire doors
follow emergence routes



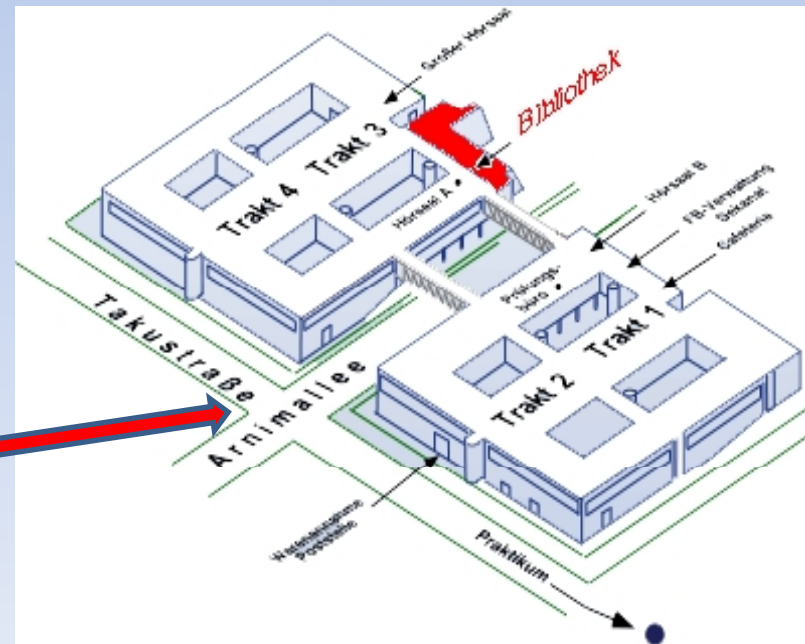
Emergency call



- **who** is reporting
- **what** has happened
- **where** did it happen
- **how many** people injured
- wait for **further inquiry**

Meeting place in case of emergency (fire alarm)

- location: corner Takustr./Arnimallee
- escape in groups, help the injured, ascertain completeness
- keep escape routes free, instruct fire fighters and rescue teams



Part 2: Hazard areas

1. electric circuits and high voltage
2. vacuum equipment
3. cooling water
4. cryogenic gases and liquids
5. gases and liquids under high pressure
6. High magnetic fields
7. laser exposure
8. x-ray exposure
9. chemicals

1. Electric circuits and high voltage

- electric appliances must only be operated in faultless condition
- defective appliances must be discarded.
- maintenances on the electric power system (power outlets, switchboards, etc.) must only be performed by specialized staff.

you must immediately report and remove safety-related shortcomings.

Hazards of electric currents

- danger of fire and toxic vapours
- a person in contact with an electric circuit can be harmed as follows:
 - **burnings**
 - **muscle cramps**
 - **unconsciousness**
 - **cardiac fibrillation, cardiac arrest**
 - **paralysis of respiration**
 - **state of shock**
 - **death**

Damage depends on

- **intensity** of current flow through the human body
- **path** of the current flow through the body
- **duration** of current flow
- **frequency** of current
- **health** constitution of the injured person

Damage thresholds

- under awkward conditions, alternating voltages of approx. **70 V** can lead to fatal accidents.
- threshold for contact voltage
 - alternating voltage (AC): 50 V**
 - direct voltage (DC): 120 V**

Table of threshold values

threshold	alternating current (50/60Hz)	direct current
perceptibility	0.5 – 1 mA	2 mA
cramp threshold	10 – 15 mA	300 mA
fibrillation threshold	50 mA	300 mA

Influence of the frequency

- low frequencies up to approx. 100 Hz are the most dangerous for hazards due to electric currents
- up to a few 100 mA, hazard of direct currents is less harmful than of alternating currents
- hazard decreases with increasing frequency

Location of high currents and high voltages in the laboratories

MBE system:
(0.1.38)

Oxford evaporator, RHEED, SPA-LEED, AES, sputter gun, mass spectrometer, cold-cathode gauge, Ti sublimation pump, ion-getter pump

Balzers evaporation system (0.1.38)

electron-beam evaporator, RHEED, mass spectrometer, cold-cathode gauge

small evaporation system (0.1.38)

electron-beam evaporator, cold-cathode gauge

optical setups:
(0.1.38, 0.1.34, 0.1.13, 0.1.42)

photo-elastic modulator, photomultiplier, CCD camera

Safety rules

- no open electric leads (attach a shielding!)
- replace defective cables immediately
- secure loose cables
- insulate neighbouring energized leads and pinpoint and mark hazardous locations!

when repairing:

- switch off all energized leads!
- secure appliance against resetting!
- test for zero potential!
- ground and short-circuit!



2. Vacuum equipment

locations:	MBE system, Balzers evaporation chamber, small evaporation chamber	0.1.38
	flow cryostat (laser system)	0.1.34
	liquid ^4He bath cryostat (MOKE)	0.1.13
	desiccators	

Vacuum equipment

hazards:

implosion due to cracking windows or desiccators

- flying glass splinters
- suddenly evaporating cold gases

prevention of accidents

open vacuum valves **slowly**

act with **caution** near **windows**

regularly test windows and desiccators for **cracks**

never evacuate the He bath of cryostats without an intact isolation vacuum

avoid moving a cryostat when it is cold

3. Cooling water

locations:	MBE system, Balzers evaporation chamber, small evaporation chamber	0.1.38
	electromagnet (magnet itself and power supply)	0.1.13, 0.1.34, 0.1.38
	laser system	0.1.34

Cooling water

hazards:

water damage

short circuits

fire due to blockage

prevention of accidents

check operability of **water monitor**

check **water flow** within the cooling circuits

regularly **check hose clamps** for tightness

shut down cooling circuits not in use

use only **fabric tubes** and always secure with **hose clamps**

4. Cryogenic gases and liquids

locations:

liquid N₂ Dewar,
liquid ⁴He Dewar



0.1.38,
0.1.34,
0.1.13

flow cryostat (UHV MOKE,
laser system)

0.1.38,
0.1.34

liquid ⁴He bath cryostat
(MOKE)

0.1.13

liquid N₂ shield (MBE
system, Balzers system)

0.1.38,

Cryogenic gases and liquids

hazards:

extreme **frostbites**

danger of **suffocation**



prevention of accidents

wear always safety **goggles**, protective **gloves**, and **mid-height** footwear, no shorts!



secure Dewars against **tilting**

keep liquid N₂ or ⁴He vessels closed, check for ice blockage, check operability of overpressure valves



when refilling cryostat, beware of spilling liquid and keep door open (danger of **suffocation**)



never use **elevator** with a Dewar, a liquid N₂ or ⁴He vessel inside (danger of **suffocation!**)

mark **cold areas** (exhaust pipes, feed lines)

Hazard in handling cryogenic liquids: danger of suffocation

evaporating cryogenic liquids will displace oxygen in enclosed and poorly ventilated spaces.

danger will not be noticed because of the odorless nature of cryogenic gases

as a result, victim will first not suffer from shortage of breath

because of the higher density as compared to air, argon and cryogenic nitrogen will accumulate near the floor or in underground compartments

5. Gases and liquids under high pressure

locations:

transportable gas cylinders

0.1.38,
0.1.34,
0.1.13
0.1.27



Gases and liquids under high pressure

hazards:

exploding when heated

flying like a bomb when valve head is knocked off

prevention of
accidents

never transport a gas cylinder **without relief cap!**

always use the **transport cart**



always **secure** gas cylinders **when standing** in place of location

never use a gas cylinder **without pressure reducing valve** (check for the correct type!)

if main valve **cannot** be **opened by hand**, return gas cylinder immediately

do **not completely empty** the gas cylinder and **mark** them as empty

High-pressure xenon lamps

locations:	UV lamps (MOKE, UHV- MOKE, SNOM)	0.1.38, 0.1.13, 0.1.42
	data projectors	

High-pressure xenon lamps

hazards:



exploding in operation or when replaced
sun burns when exposed to radiation
ozone leads to **strong irritation** of respiratory system, possibly **carcinogenic!**

prevention of accidents



wear always **safety goggles**, protective **gloves** when handling high pressure lamps

never replace a **hot** lamp

do **not** store in the **open**

do **not** operate with an **open casing**

do not look into the beam without **UV goggles**

do not expose **bare skin** to the UV light

pay attention to **sufficient ventilation**

Hazard with ozone

danger will not be noticed because ozone will be smelled only during a few seconds

this leads to a long exposure to ozone without noticing it

as a consequence, strong irritation of the respiratory system will take place

ozone is believed to be carcinogenic

6. High magnetic fields

locations:

MOKE

0.1.13

UHV-MOKE

0.1.38

Laser system

0.1.34

High magnetic field

hazards:

strong attraction of paramagnetic metallic objects (screwdrivers, wrenches, Allen keys)

disturbs **cardiac pacemakers**



hazard of **fire** when coil not cooled

prevention of accidents

when in operation, check that **cooling water** is flowing through the magnet

when in operation, **never** approach with a **cardiac pacemaker**

shut off magnetic field when working with tools close to the magnet

7. Laser exposure

locations:

Laser system

0.1.34

SNOM laboratory

0.1.42

Laser exposure

hazards:

irradiation damages of the eyes

burns of the skin

prevention of accidents

do **not enter** the laser laboratory **without invitation** when the warning light is switched on

wear always **safety goggles** when the laser is switched on

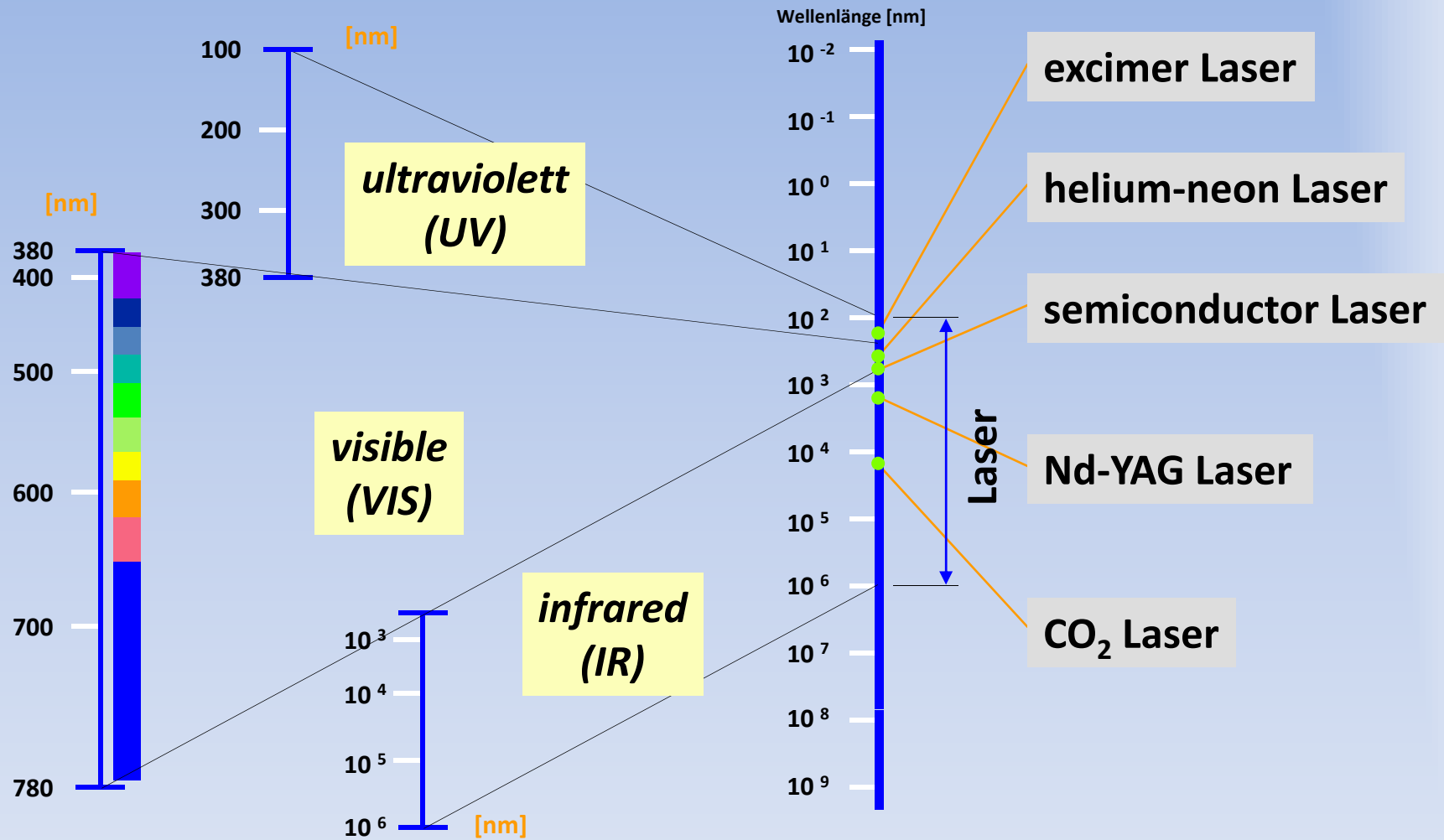
do not expose **bare skin** to the laser light



Laser safety (BGV B2 / GUV2.20)

- effect of laser irradiation on skin and eye
- safety regulations
- safety measures, safety rules in the lab
- personal protective equipment
(*PPE, German: PSA*)

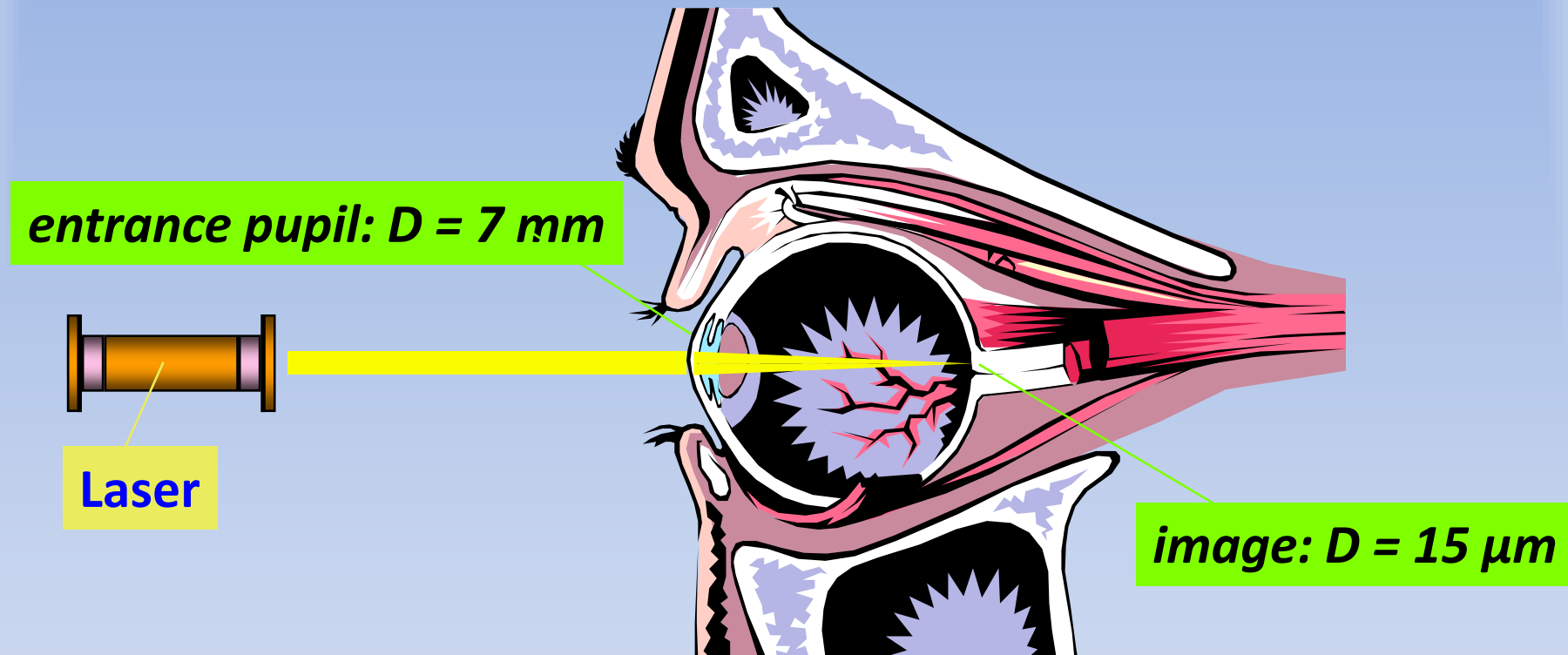
Wavelength range



Effect of laser irradiation

wavelength range		effect on the eye	effect on the skin	
100-315 nm	UV	keratitis	sunburn, accelerated aging	excimer laser
315-380 nm		cataract	increased pigmentation	
380-780 nm	VIS	lesion of the retina	shading of pigmentation, burns	He-Ne laser
780-1400 nm	IR	cataract, lesion of the retina		Nd-YAG laser
1400-3000 nm		cataract, burn of the cornea		high-power diode laser
3000-100.000 nm		burn of the cornea		CO ₂ Laser

Effect of laser irradiation - eye

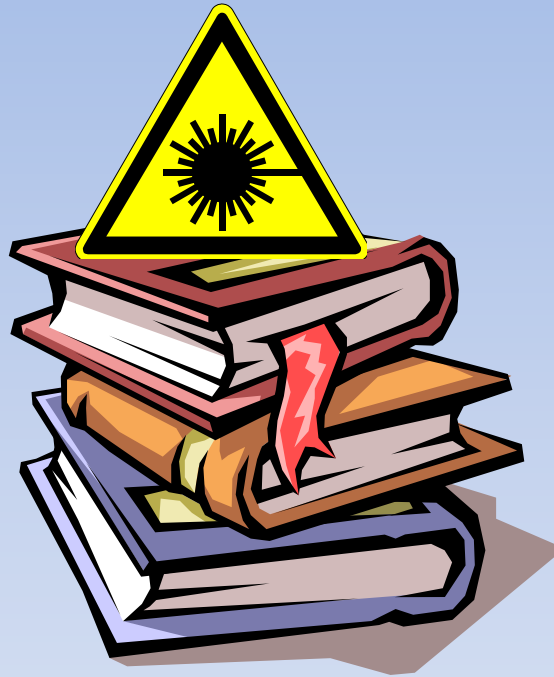


Example:

energy density of 1 mW/cm^2 (approx. 50% of the threshold of laser class 2) at the entrance pupil will be focused to 200 W/cm^2 on the retina!

Safety regulations

rules for accident prevention BGV B2
laser irradiation



classification of lasers

Discrimination and labeling

safety measures

technical equipment

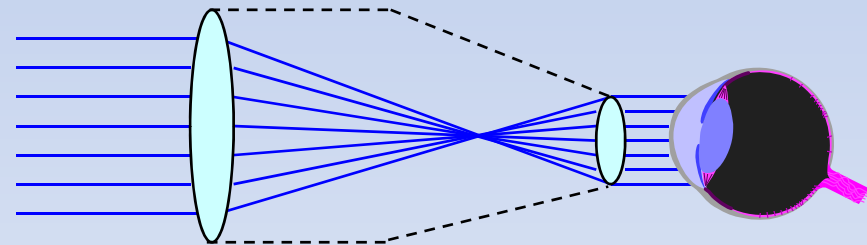
safety instruction

Laser classes (1)

laser	risk potential
class 1	laser irradiation is not dangerous
class 1M	laser irradiation is not dangerous as long as no optical instruments such as magnifying glass or telescope are used.
class 2	laser irradiation is in the visible range and by momentary irradiation not dangerous for the eye (eyelid-closure reflex).
class 2M	like laser class 2 as long as no optical instruments are used.



class 1,2 und 1M, 2M: safe



class 1,2: safe,
class 1M,2M: dangerous

Laser classes (2)

laser

risk potential

class 3R

laser irradiation is dangerous for the eye.

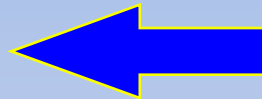
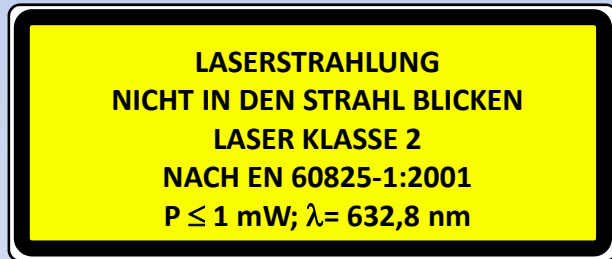
class 3B

laser irradiation is **dangerous** for the **eye** and in **special cases** also for the **skin**, **diffuse** reflections are **not** dangerous.

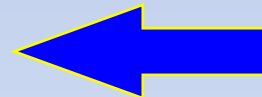
class 4

laser irradiation is **very dangerous** for the **eye** and for the skin, even **diffuse** reflections can be **dangerous**.

Labeling of laser systems



danger signal



**add-on label with
power specifications**

for laser class 1 and 1M: instead of add-on label, power specifications can be incorporated in the operating manual

Protection from laser irradiation



screen laser beam

encompass laser area

**attenuate laser power to
the actually required value**

**avoid entering the area of
laser activity**

**use personal protective
equipment (PPE)**

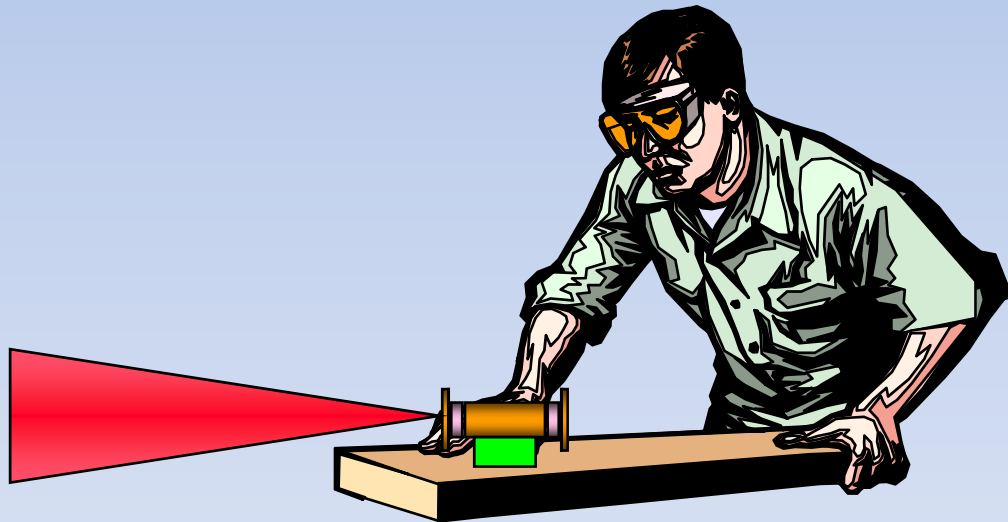
never lift the head to beam level!!

**Never carry metals (ring, wrist watch, jewellery etc.)
within the laser area, especially with laser class 3 and 4**

Obligation of usage

UVV BGV B 2, § 8 Abs.4

*the necessary protection measures and the personal protection equipment according to paragraph 2 *) must be used*



*) eye protection, protective clothing or safety gloves

8. X-ray exposure

locations:	electron-beam evaporators (MBE system, Balzers system, small evaporation chamber)	0.1.38
	RHEED electron guns (MBE system, Balzers system)	0.1.38
	SPA-LEED electron gun (MBE system)	0.1.38
	sputter gun (MBE system)	0.1.38

X-ray exposure

hazards:

irradiation damage of the human body

prevention of accidents

never remove protective **lead glass** on the UHV windows

regularly check X-ray source

do **not** operate when **pregnant**