Safety Briefing
AG Fumagalli

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**
- **helpful link:**

  website of *Diensstelle Arbeitssicherheit* (only in German!)

  https://wikis.fu-berlin.de/display/dasi/Linksammlung+Info-Materialien+zum+Arbeitsschutz

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** if possible
- 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

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

- keep escape routes clean of fire loads
- put defective equipment immediately out of operation and report to ***Hans Badow*** or ***Paul Fumagalli***

- our fire extinguishers: **A, B, C powder**

A: solids,
B: fluids,
C: gases

- if a **person** is on fire:
  - *immediately extinguish the fire (extinguisher is faster than a fire blanket)*
  - *danger of suffocation or frostbite by using a fire extinguisher is negligible! (keep 1 – 2 m distance)*

How to act in case of an emergency

- keep calm!
- In case of fire, decide if you can extinguish the fire without endangering yourself

- warn endangered persons and get persons involved out of danger, shut fire doors, follow emergency routes
- report the emergency (fire, accident)

minor technical emergency: **55555**

major emergency: **112 (55112)**

- provide first-aid assistance

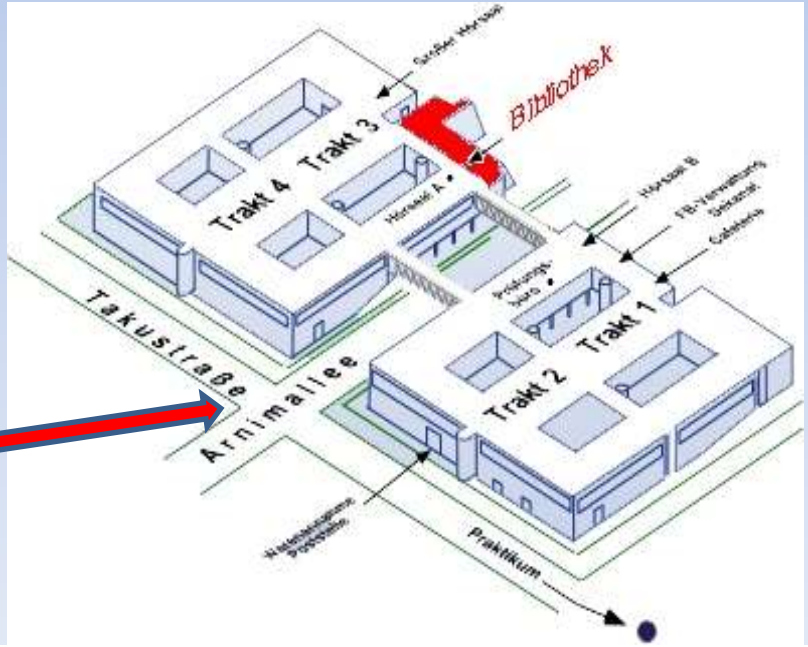
Emergency call

112
(55112)

- **where** did it happen
- **phone number** for call-back
- **who** is reporting
- **what** has happened
- **how many** people injured
- **which** injuries occured
- 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. chemical-waste disposal

1. Electric circuits and high voltage

Note: we already had a severe accident in the MBE lab!

- 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 can be harmed as follows:
  - **burnings**
  - **muscle cramps**
  - **unconsciousness**
  - **cardiac fibrillation, cardiac arrest**
  - **paralysis of respiration**
  - **state of shock**
  - **death**
- damage depends on
  - **intensity**, **path**, **duration** of current flow through human body
  - **frequency** of current
  - **health** constitution of the injured person

Damage thresholds

- under awkward conditions, alternating voltages of approx. **70 V** can lead to deadly accidents!
- low frequencies $\leq$ 100 Hz are the most dangerous
- threshold for contact voltage
  alternating voltage (AC): 50 V | direct voltage (DC): 120 V
- hazard of DC currents less harmfull than of AC current
- hazard decreases with increasing frequency

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

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, heating bands with temperature controller
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, heating bands
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 neighboring energized leads
- pinpoint and mark hazardous locations!

when repairing or installing:

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

2. Vacuum equipment

hazards: implosion due to cracking windows or desiccators

- **flying glass fragments**
- **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

Vacuum equipment

locations:

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

3. 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**

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

4. 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 N_2 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 N_2 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 the density is higher as compared to air, argon and cryogenic nitrogen will accumulate near the floor or in underground compartments

Cryogenic gases and liquids

locations:

liquid N_2 Dewar, liquid ^{4}He Dewar	 0.1.38, 0.1.34, 0.1.13
flow cryostat (UHV MOKE, laser system)	0.1.38, 0.1.34
liquid ^{4}He bath cryostat (MOKE)	0.1.13
liquid N_2 shield (MBE system, Balzers system)	0.1.38,

5. Gases and liquids under high pressure

hazards:

may **explode** when heated

can **fly through concrete walls** 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

Gases and liquids under high pressure

locations:	transportable gas cylinders	0.1.38, 0.1.34, 0.1.13 0.1.27

High-pressure xenon lamps

hazards:

may **explode** in operation or when replaced

causes **sunburn** when exposed to radiation

ozone leads to **strong irritation** of respiratory system, possibly **carcinogenic!**

prevention of accidents:

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

never replace a **hot** lamp

do **not** store in **open space**

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 is 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

Note: ozone is believed to be carcinogenic

High-pressure xenon lamps

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

6. High magnetic field

hazards:

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

disturbes **cardiac pacemakers**

hazard of **fire** when magnet coils are 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

High magnetic fields

locations:		
	MOKE	0.1.13
	UHV-MOKE	0.1.38
	Laser system	0.1.34

7. Laser exposure

hazards:

irradiation damages of the **eyes**

burns of the **skin**

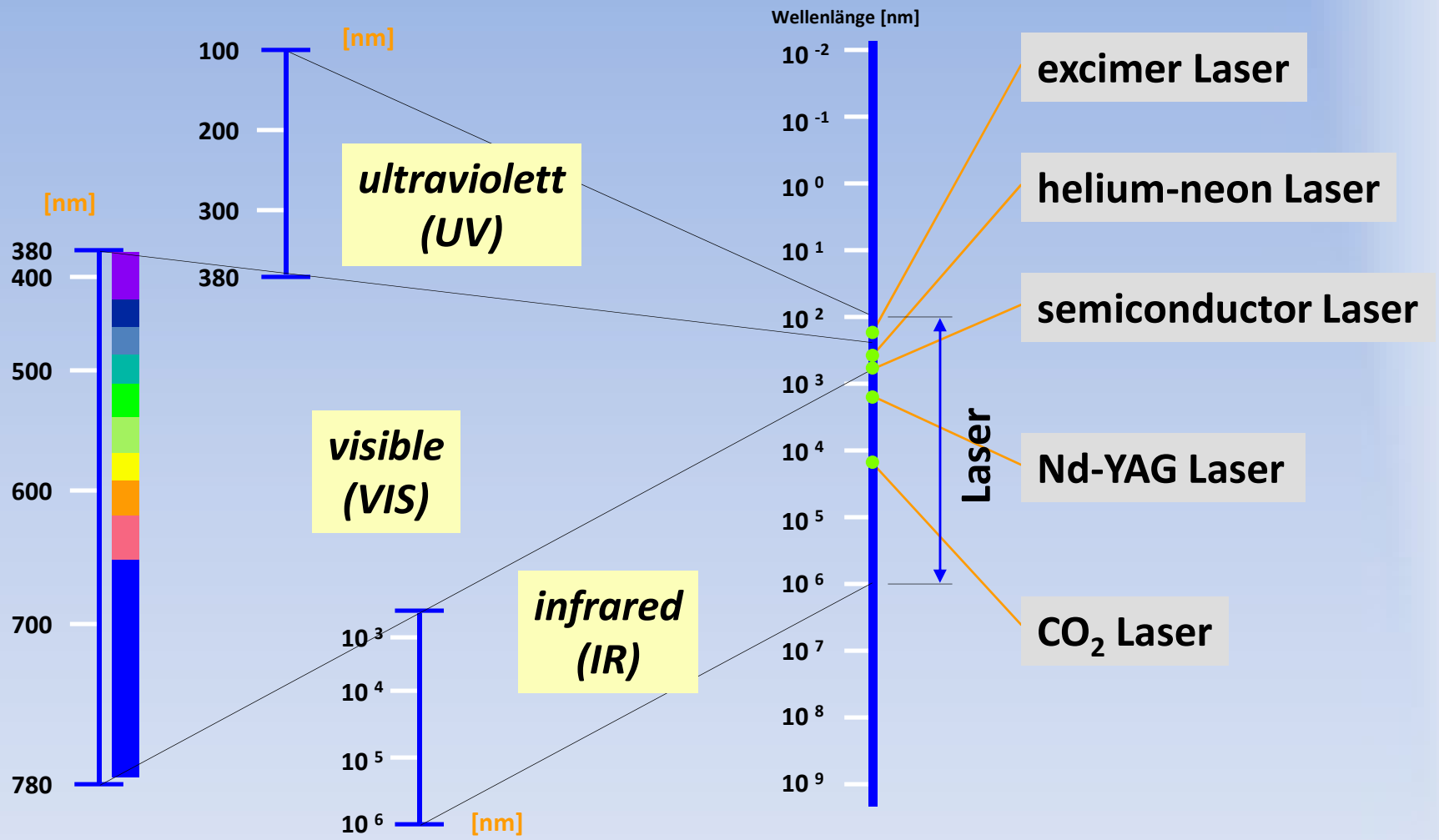
prevention of accidents:

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

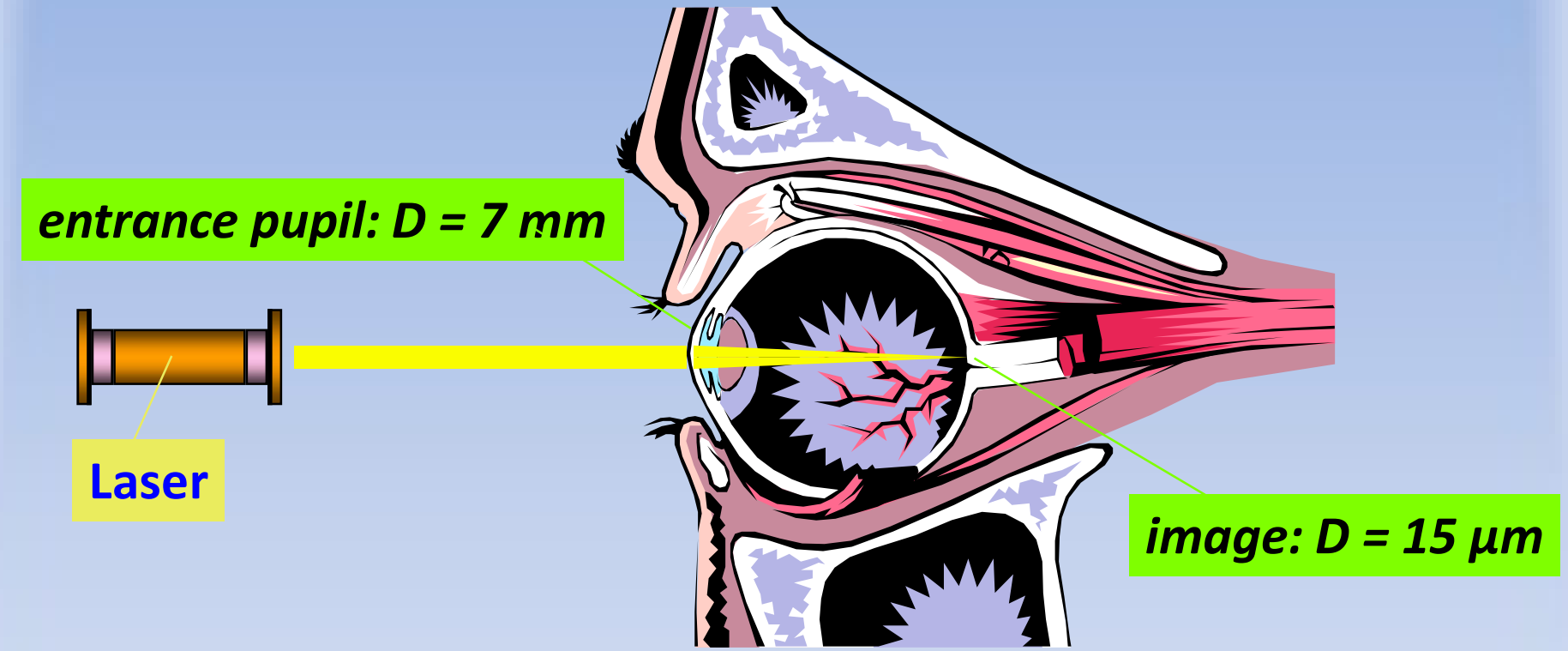
Laser wavelength ranges



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	*UV*	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	*IR*	cataract, burn of the cornea	burns	high-power diode laser
3000-100.000 nm	*IR*	burn of the cornea		CO_2 Laser

Effect of laser irradiation - eye

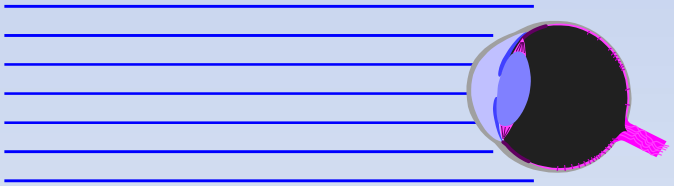


Example:

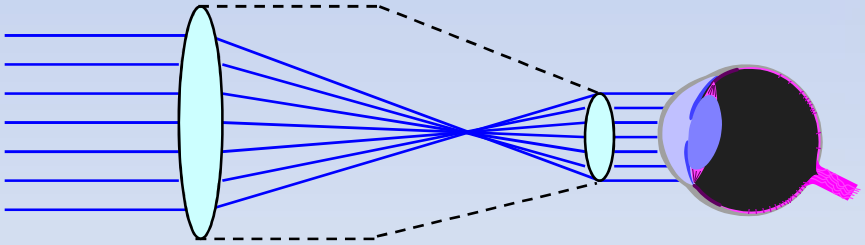
energy density of 1mW/cm² (approx. 50% of the threshold of laser class 2) at the entrance pupil will be focused to 200 W/cm² on the retina!

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**.

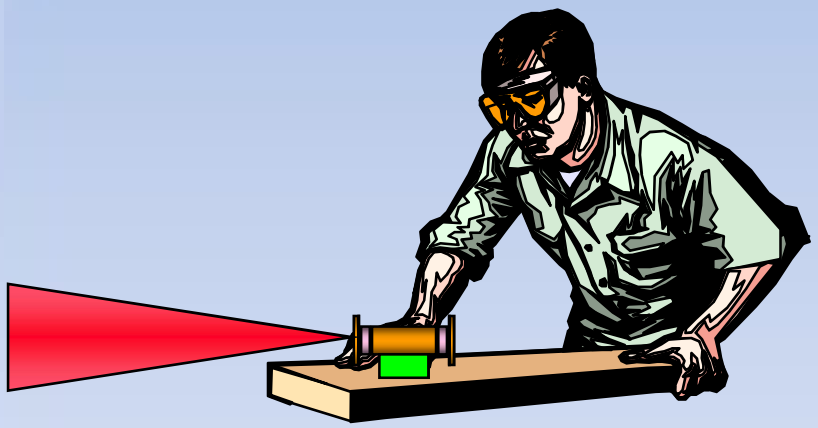
Labeling of laser systems

danger sign

add-on label with laser 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

mark laser area

attenuate laser power to the actually required value

avoid entering the area of laser activity

use personal protective equipment (PPE)

never bring the head to beam level!!

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

Laser exposure

locations:		
	Laser system	0.1.34
	SNOM	0.1.42
	MOKE (longitudinal)	0.1.13

8. 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**

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

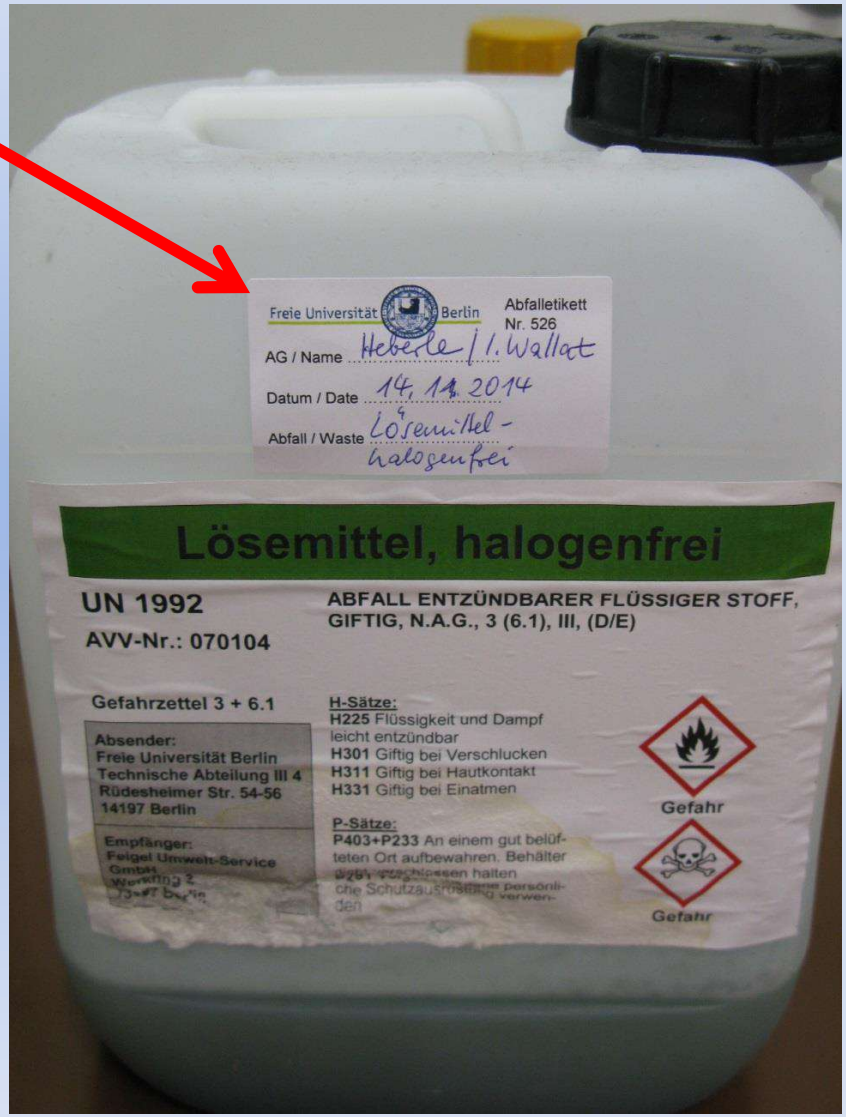
9. Chemical-waste disposal

- responsible person for chemical waste disposal: ***Annegret Sachse***
- two bunker rooms: **combustible** and **noncombustible** chemicals
- **solvent** waste is collected in the chemical lab of the work groups in **5 l bins**
- **do not mix different types of solvents** as chemical violent chemical reactions may occur
- **every bin must be labeled with a proper label!** (labels are issued by ***Annegret Sachse***)

Chemical-waste disposal

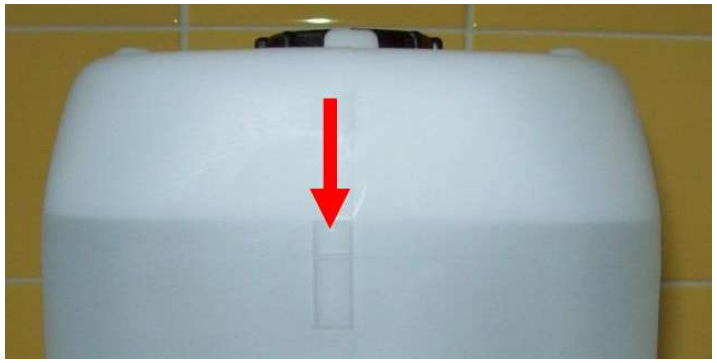
Example of a waste label

name of the work group and person and date of disposal for better backtracking of origin of waste



Chemical-waste disposal

- full bins are then transferred to the chemical waste bunker.
- bins **without labels** or **improper** bins must not be placed in the chemical waste bunker! Please, contact ***Annegret Sachse*** in this case
- bins **must no be filled beyond 90%** of the container volume in order to provide enough space for expansion of reaction gases



- do **not close the cap tightly** as long as chemical reaction are possible (in order for the reaction gases to be relieved)
- close tap **tightly before transferring** to the chemical waste bunker
- important: **don't hurry**, take your time
- further information:

https://www.physik.fu-berlin.de/en/service/chemie/Disposal-of-chemical-and-hazardous-waste/index.htm

Chemical-waste disposal

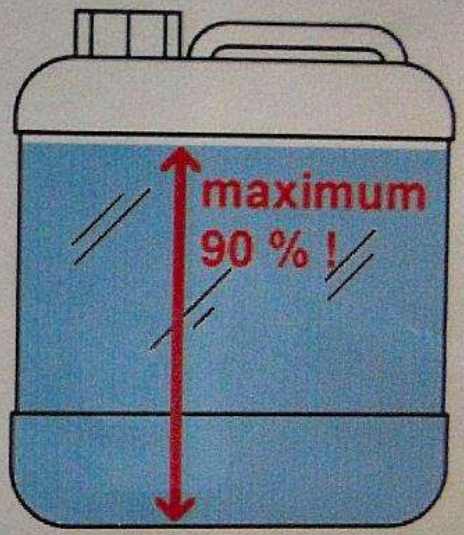
How to deliver bottles with waste solvents

Never fill in more than 90 % of the total volume!

Collected waste solutions may still react. Then a minimum of 10 % of the volume is needed as an expansion space.

Ensure that there is not reaction potential of your waste bottle:

1. Close it tightly and then agitate it forcefully.
2. Then open the cap a little to enable any developed gas to escape. Leave the bottle standing overnight.
3. Close the cap tightly. Ensure that the bottle is clean and not leaking. Deliver it to the “Materialverwaltung”



Never put even traces of halogenated compounds to halogen-free waste solvents!

Chemical-waste disposal

What to do if a bin is too full?

use a wash bottle with inverted ri-sing pipe

or use a commercial filling tap provided with threads and pour the excess solvent out