

LABORATORY SAFETY

IESL-FORTH

Petros Samartzis
29/10/2020



<http://safety.iesl.forth.gr>

COVID-19 SAFETY

- Virus contracts through airborne droplets
 - Droplet source: nose, mouth
- Protection:
 - Distance: **>2m**
 - Masks: **MANDATORY when not alone**
 - Hygiene:
 - **Wash hands (20'' minimum)**
 - **Don't touch nose**
 - Gatherings: **the fewer the better**

<https://safety.iesl.forth.gr/index.php/home/covid-19/>



LABORATORY SAFETY

- GENERAL LAB SAFETY
- FIRE SAFETY
- ELECTRICAL SAFETY
- CHEMICALS & WASTE HANDLING
- PRESSURE SAFETY (HIGH & VACUUM)
- LASER & X-RAYS SAFETY
- CRYOGENICS SAFETY



LABORATORY SAFETY

GENERAL LAB SAFETY



RULE NUMBER ONE:

SAFETY
IS OUR FIRST
PRIORITY



GENERAL RULES

- **YOU** are responsible for your safety
- **Safety training mandatory before working in the lab**
 - Lab-specific training by PI/Group Safety Officer
- **Use of appropriate safety equipment is mandatory in the laboratories: get familiar with them**
- Consider SAFETY when designing an experiment
- Avoid working alone in the lab
- Keep labs clean and tidy
- No access of un-authorized personnel in the laboratory (especially kids)
- No food & drinks in the lab
- **Use common sense**
- **If in doubt, ASK!**



SAFETY CONTACTS

- **Group/Activity Safety Officer**
 - **Principal Investigator/Safety Officer**
- **Division Safety Officer**
 - **Lasers: Petros Samartzis (x1467)**
 - **Materials: Benoit Loppinet (x1465)**
 - **Microelectronics: Ilias Aperathitis (x4123)**
 - **Comp. Center: Vassilis Kirkinis (x1815)**
- **IESL Safety Officer: Petros Samartzis**
 - **Office: Γ260 – Phone: x1467**
 - **Lab: B217 – Phone: x1333**
 - **Email: sama@iesl.forth.gr**



Emergency Phone Numbers

ΤΗΛΕΦΩΝΑ ΑΜΕΣΗΣ ΑΝΑΓΚΗΣ – EMERGENCY PHONES

<u>Πύλη ΙΤΕ (Φύλακας)</u>	-1111	FORTH gate / Security
Υποδοχή	-1168	Reception
Πυροσβεστική	199*	Fire Department
Αστυνομία	100*, 2810-282316*	Police
ΕΚΑΒ	166*	Emergency (Ambulance)
ΠΕΠΑΓΝΗ	2810-392111*	University Hospital
<u>Βενιζέλειο</u>	2813-408000*	<u>Venizelio Hospital</u>
Τεχνική Υπηρεσία	-1094, -1095, -1455 -1574, -1570	Technical Service Department

Γραμμή άμεσης ανάγκης: 112 (κινητό ή σταθερό*) - Emergency number: 112 (mobile or fixed* phones)

*Για εξωτερική γραμμή πρώτα το 9 (Dial 9 to get an outside line)

Monday to Friday 08.00-15.30

Available 24/7



Lab Phone Numbers

ΕΡΓΑΣΤΗΡΙΟ (LABORATORY) : B-123 (tel: -1234)

ΥΠΕΥΘΥΝΟΙ ΕΡΓΑΣΤΗΡΙΟΥ : α) Δρ. Α. Υπεύθυνος *a) Dr. A. Ypeythinou*
LAB SAFETY OFFICERS β) Καθ. Β. Υπεύθυνος *b) Prof. B. Ypeythinou*
Τηλέφωνο (Tel.) : α) -1234 γρ. (office), 6944123456 κινητό (mobile)
β) -1234 γρ. (office), 6944123456 κινητό (mobile)

ΥΠΕΥΘΥΝΟΣ ΑΣΦΑΛΕΙΑΣ ΤΟΜΕΑ (ΟΝΟΜΑ_ΤΟΜΕΑ): Δρ. Ο. Επίθετο
DIVISION SAFETY OFFICER (DIVISION_NAME) *Dr. N. Lastname*
Τηλέφωνο (Tel.) : -1234 γρ. (office), 6944123456 κινητό (mobile)

ΥΠΕΥΘΥΝΟΣ ΑΣΦΑΛΕΙΑΣ ΙΝΣΤΙΤΟΥΤΟΥ (ΙΗΔΛ): Δρ. Π. Σαμαρτζής
INSTITUTE SAFETY OFFICER (IESL) *Dr. P. Samartzis*
Τηλέφωνο (Tel.) : -1467 γρ. (office), 6946280983 κινητό (mobile)

ΕΠΙΚΙΝΔΥΝΟΤΗΤΑ – HAZARDS:

Λείζερ (LASERS)*: P-UV EXCIMER: 248 nm; 193 nm, CW-VIS HeNe: 632 nm, P-UV Nd-YAG: 355 nm
*P=pulsed, CW=continuous, all lasers CLASS IV

ΧΗΜΙΚΑ: org. διαλύτες (μεθανόλη, αιθανόλη), χρωστικές λείζερ, ορυκτέλαια αντλιών

CHEMICALS: org. solvents (methanol, ethanol), laser dyes, pump oil

ΑΕΡΙΑ (GASES): He, Xe, N₂, F₂ (4 φιάλες (4 cylinders))

ΑΝΤΛΙΑ ΔΙΑΧΥΣΕΩΣ (DIFFUSION PUMP)



Safety Incident



In Case of an Incident

- **Remain calm!**
- **Assess the situation**
- Call for help
- Seek medical attention
- Contact safety personnel

- **USE COMMON SENSE**

<http://safety.iesl.forth.gr>



A message from Technical Service

Don't abuse building facilities



LABORATORY SAFETY

FIRE SAFETY



Before the Fire

- Check **fire escape routes**
 - Memorize how to leave the lab in case of emergency
- Locate closest **fire alarm** and **fire extinguisher**
- Check that your fire extinguisher works for the materials you use
- Keep flammable materials as away from heat, fire and electricity as possible
- Don't block corridors inside and outside the labs
- **No smoking!**



In Case of a Fire

- Keep calm & assess situation
- **Activate fire alarm – Call for help**
- In danger: Leave immediately
 - Intervene ONLY if not in danger
- Intervene only if you know what you are doing
 - Priority 1: Injured people
 - Priority 2: Put out the fire
 - Use the **correct** fire extinguisher
- Do not open windows/doors
- **NO WATER ON ELECTRICAL FIRES**



LABORATORY SAFETY

ELECTRICAL SAFETY



ELECTRICAL HAZARDS

- Sources
 - Regular/generator electrical lines and outlets
 - UPS electrical lines and outlets (red OR labeled "UPS")
 - Equipment (e.g lasers, vacuum pumps, computers)
 - High voltage power supplies
- Hazards
 - Electrocution
 - Electrical Fires



ELECTRICAL SAFETY PRACTICE

- **Do NOT** use back to back power strips
- **Keep cables OFF** the floor
- **Keep water away** from electrical equipment
 - Water low – electricity high
- Beware of BARE cables
- Follow specifications
- Ground appropriately
- **DON'T** try to repair equipment
- **Turn OFF** power supply before touching “hot” parts
- **If in doubt, ASK!**



In Case of an Electrical Incident

- **Remain calm!**
- **Assess the situation**
- Cut off power supply (panel may be outside the lab)
- **No water** on electrical fires
- Seek help
- Seek medical attention in case of injury
- Contact safety personnel

- **USE COMMON SENSE**

<http://safety.iesl.forth.gr>



LABORATORY SAFETY

CHEMICAL SAFETY & WASTE HANDLING



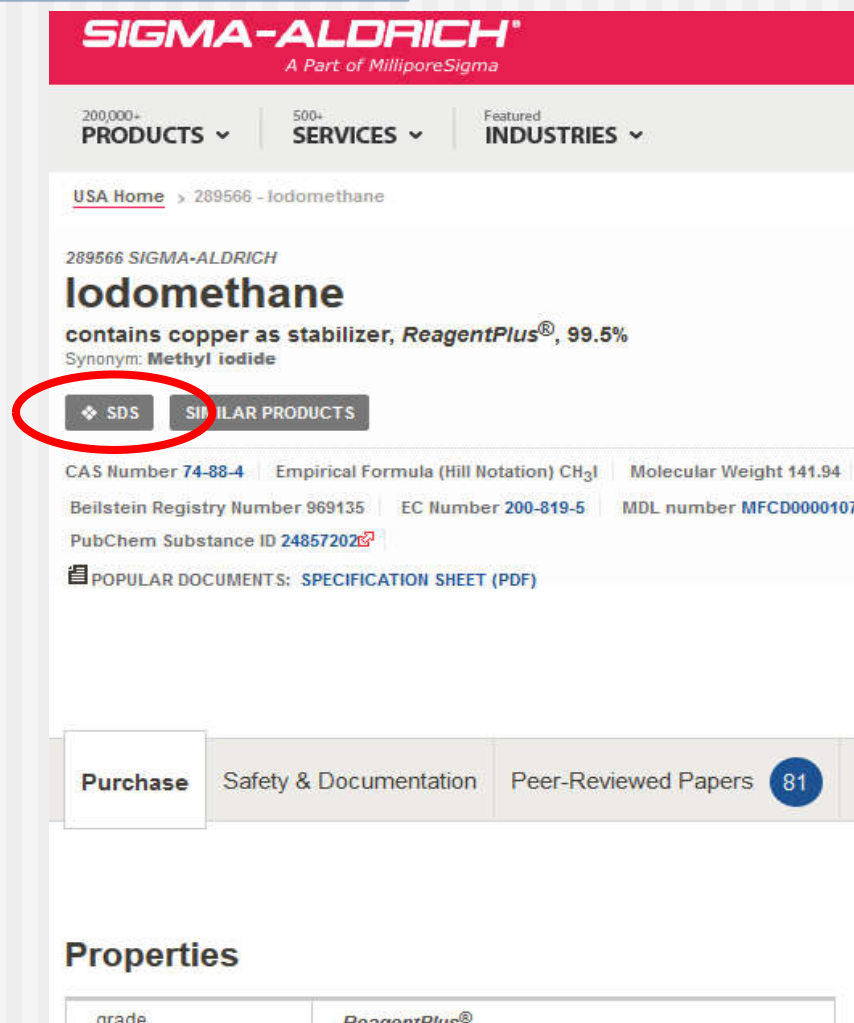
LAB CHEMICALS

- **Flammable:** e.g. organic solvents, H_2
- **Explosive:** e.g. acetylene, azides
- **Pyrophoric:** e.g. phosphor
- **Toxic:** e.g. chlorine, methyl iodide
- **Corrosive:** e.g. strong acids & bases
- **Carcinogenic:** e.g. benzene



Material Safety Data Sheets (MSDS)

- Physical & Chemical properties
- Hazards: Physical, Health, environmental
- First Aid & symptoms
- Fire fighting info
- Accidental release measures
- Safe handling and storage
- Disposal & transport info
- Exposure control & prevention
- Reactivity & stability
- Toxicological and ecological info



SIGMA-ALDRICH
A Part of MilliporeSigma

200,000+ PRODUCTS ▾ 500+ SERVICES ▾ Featured INDUSTRIES ▾

[USA Home](#) > 289566 - Iodomethane

289566 SIGMA-ALDRICH
Iodomethane
contains copper as stabilizer, *ReagentPlus*[®], 99.5%
Synonym: **Methyl iodide**

[SDS](#) [SIMILAR PRODUCTS](#)

CAS Number 74-88-4 | Empirical Formula (Hill Notation) CH₃I | Molecular Weight 141.94
Beilstein Registry Number 969135 | EC Number 200-819-5 | MDL number MFCD0000107
PubChem Substance ID 24857202

POPULAR DOCUMENTS: [SPECIFICATION SHEET \(PDF\)](#)

Purchase Safety & Documentation Peer-Reviewed Papers **81**

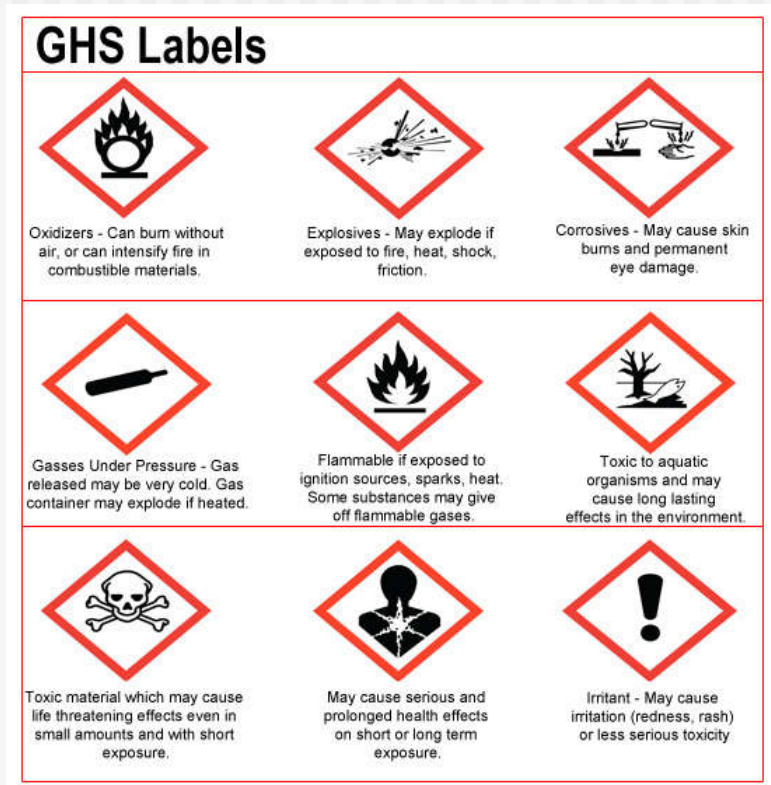
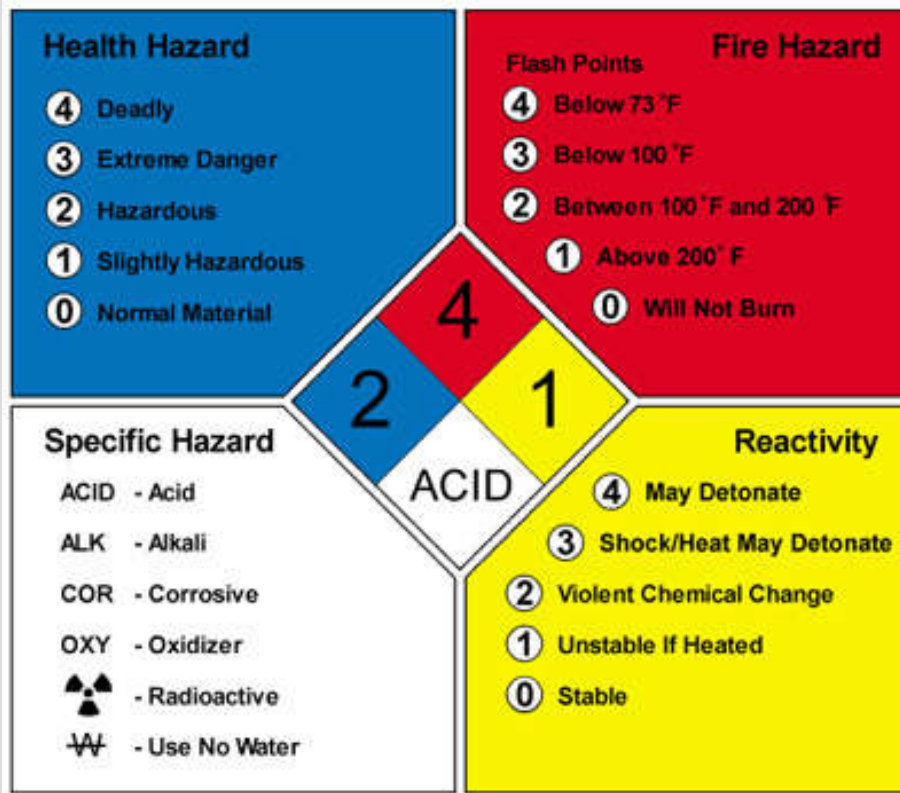
Properties

grade	<i>ReagentPlus</i> [®]
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All manufacturers are required to provide MSDS



Different labeling systems



www.nfpa.org

<https://www.osha.gov/dsg/hazcom/pictograms/index.html>



CHEMICAL SAFETY RULES

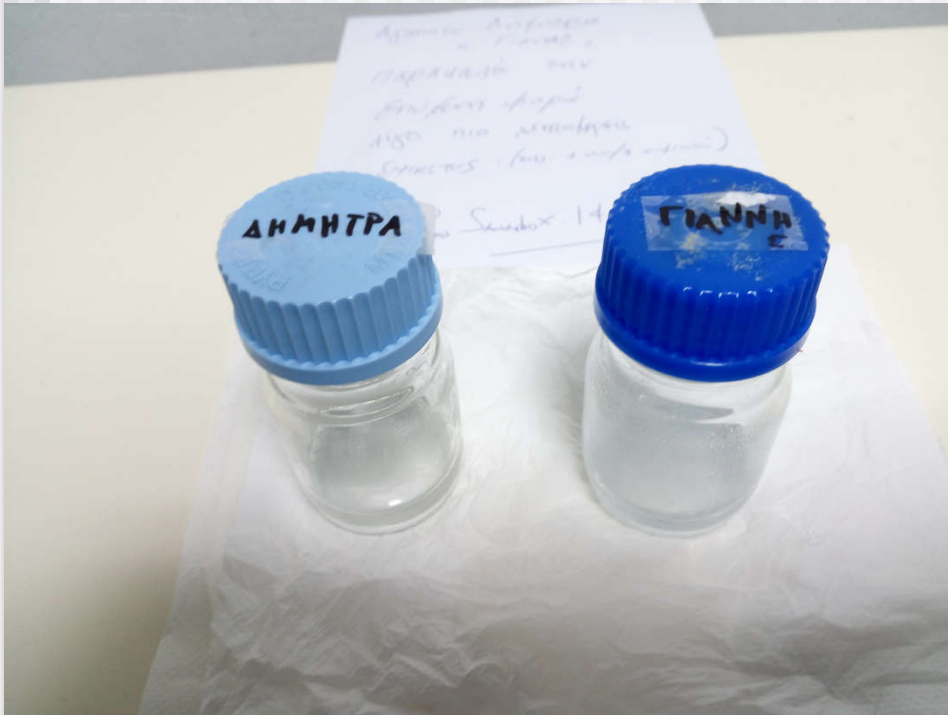
- Design your experiment carefully
- **Study Material Safety Data Sheets**
- Use smallest quantities allowed
- Use **APPROPRIATE** protective equipment
 - Gloves, lab coats, masks, goggles, hoods, glove box, inert environment,...
- **Store appropriately (MSDS)** if not in use
- Use appropriate **transport protection equipment & practices**
 - Rubber buckets, cardboard boxes, containers
 - Do not hold containers from lids



CHEMICALS TRANSPORT



LABEL APPROPRIATELY



- Chemical name or formula
- Owner/lab
- Phone
- Date

If not properly labeled, your containers will be treated as waste



BASIC WASTE HANDLING

- Follow **MSDS** instructions for disposal
- Follow/establish **lab rules** related to waste
- Sink: only for some salts, acids & bases if NEUTRALIZED and DILUTED with plenty of water
 - Sink if you can drink
- Liquid: organic (halogenated/non-halogenated), water solutions, inorganic salts, pump oil, ...
- Sharps/solid waste go to "**Solid Waste**", NOT "normal" trash
- Storage Space: Lab/Group → Facility → Pickup
- Label your waste containers when first drop is in
- **If in doubt, ASK!!!**



In Case of a Chemical Incident

- **Remain calm!**
- **Assess the situation**
 - Spill, glassware breaking, explosion, fire,...
- Call for help
- Seek medical attention
- Contact safety personnel

- **USE COMMON SENSE**

<http://safety.iesl.forth.gr>



LABORATORY SAFETY

HIGH PRESSURE & VACUUM SAFETY



PRESSURE SAFETY PRACTICE

- **Secure gas cylinders on wall/heavy tables correctly**
- **Always** use appropriate regulator
- Move gas cylinders safely
 - Do **NOT** hold it by the valve or regulator
 - Leak-check gas/vacuum lines/chambers safely
- Beware of vacuum implosions
- Beware of pressurized cooling water network
 - Water low – electricity high
- Report any problems
- **If in doubt, ASK!**



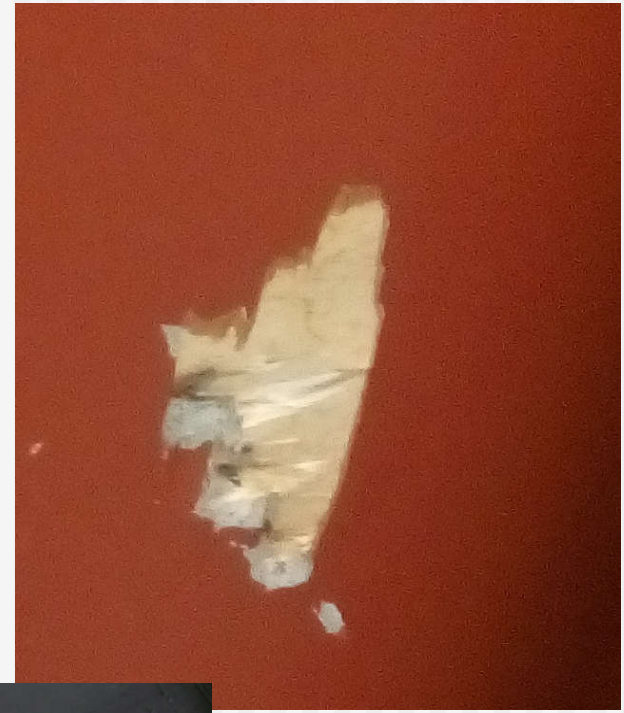
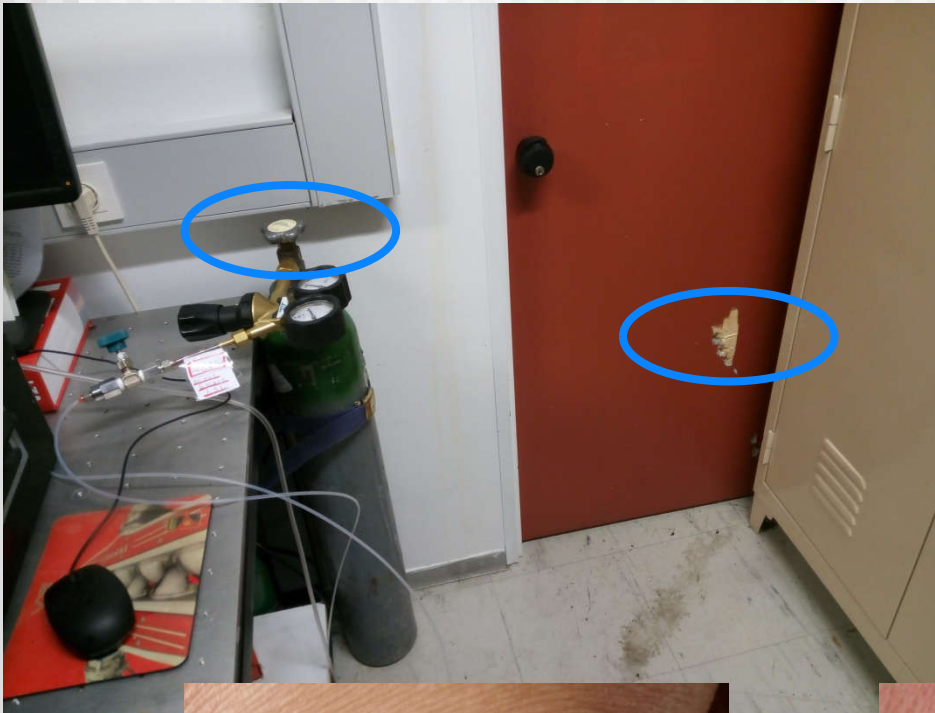
Handling & Storing Cylinders Safely

- 1 SECURE cylinders properly at all times.
- 2 STORE cylinders in cool, well-ventilated, fire-resistant areas in compliance with local, state and federal regulations.
- 3 PLACE cylinders where they will not be damaged by forklifts, knocked over or hit by falling objects.
- 4 CLOSE valves and TIGHTEN caps when not in use.
- 5 INSPECT cylinders for leaks and CHECK support brackets regularly for strength and integrity.
- 6 MOVE cylinders using hand trucks designed for the purpose.
- 7 REPORT leaks or any damage to your supervisor immediately.

EMERGENCY EQUIPMENT LOCATED AT:

SmartSign.com • 800-952-1457 • S-2074

IESL cylinder 2019



In Case of a Pressure Incident

- **Remain calm!**
- **Assess the situation**
- Seek help
- Seek medical attention in case of injury
- Contact safety personnel

- **USE COMMON SENSE**

<http://safety.iesl.forth.gr>



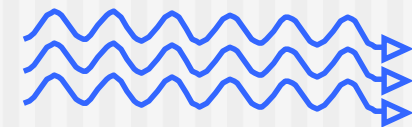
LABORATORY SAFETY

LASER SAFETY



IESL LASER SOURCES

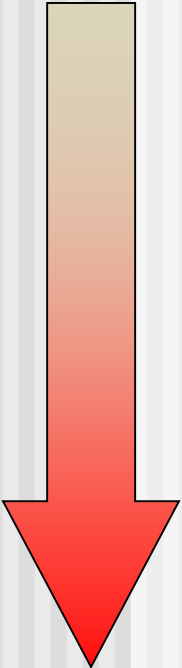
- Solid state (Nd:YAG: 1064/532/355/266 nm, TiSapph: 800 nm)
- Gas lasers (HeNe: 632.8 nm)
- Excimer (KrF:248 nm, ArF:193 nm, XeCl:308 nm)
- Dye lasers (220-800 nm)
- Diode lasers (e.g. femto lasers pump units)



Coherence,
Monochromaticity,
Directionality



LASER CLASSES

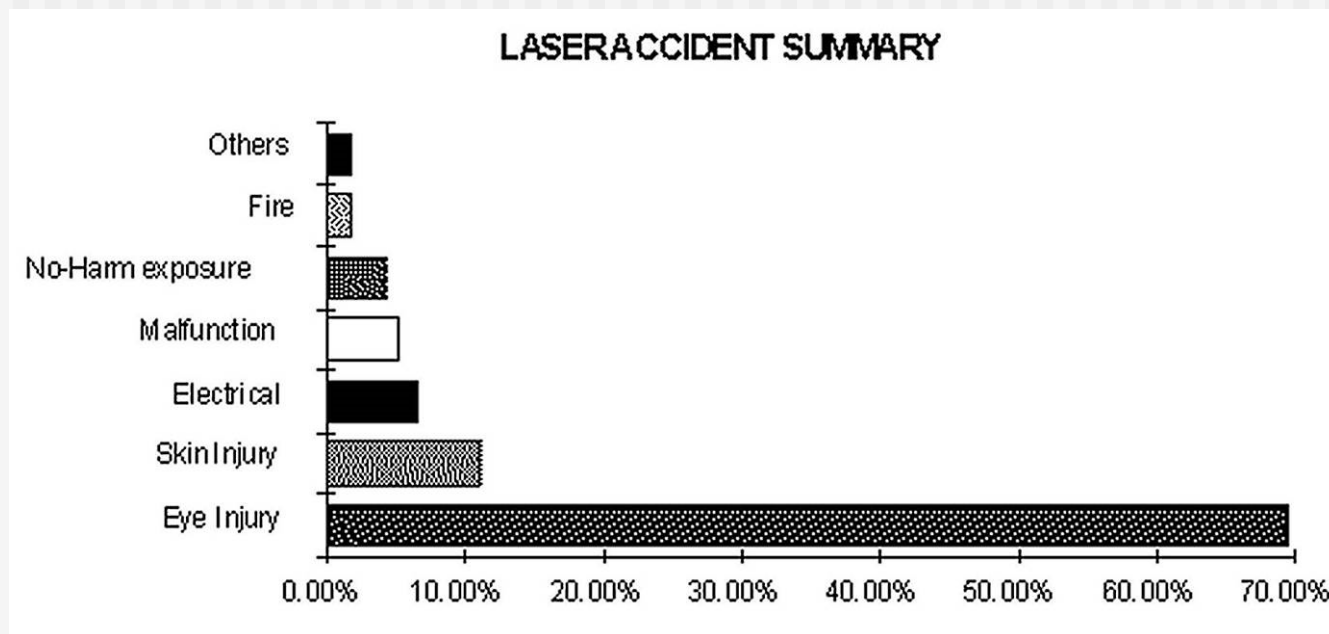
- 
- **CLASS 1** harmless
 - **CLASS 2** visible radiation
momentary exposure (0.25s)
 - **CLASS 3** 3a (1 – 5 mW)
3b (5- 500 mW)
no direct exposure
 - **CLASS 4** Pulse or cw (>500 mW)
Extremely hazardous

ALL lasers in IESL labs are CLASS 4



LASER ACCIDENT STATISTICS

Laser accidents (USA, 1964-1992)



Most accidents involve **eye injuries**

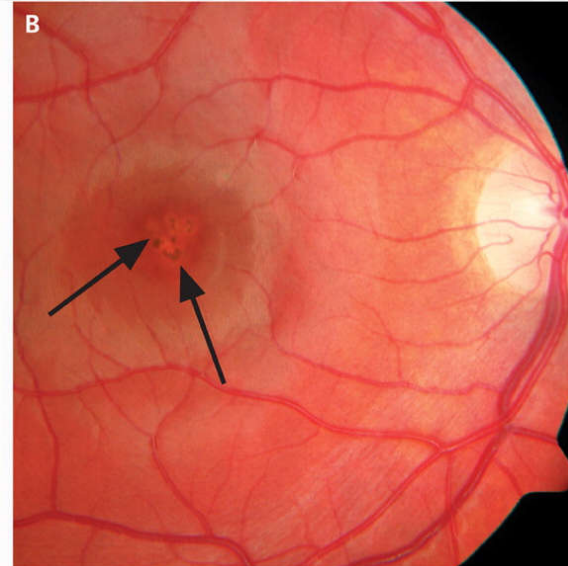
<http://www.adm.uwaterloo.ca/infohs/lasermanual/documents/section11.html>



LASER RADIATION DAMAGE

■ EYES

150 mW
green laser pointer
(532 nm)



<http://www.nejm.org/doi/full/10.1056/NEJMc1005818#t=article>

■ SKIN

5W/cm² for 1 sec
CO₂ laser
(10,6 μm)



<http://www2.lbl.gov/ehs/safety/lasers/bioeffects.shtml>



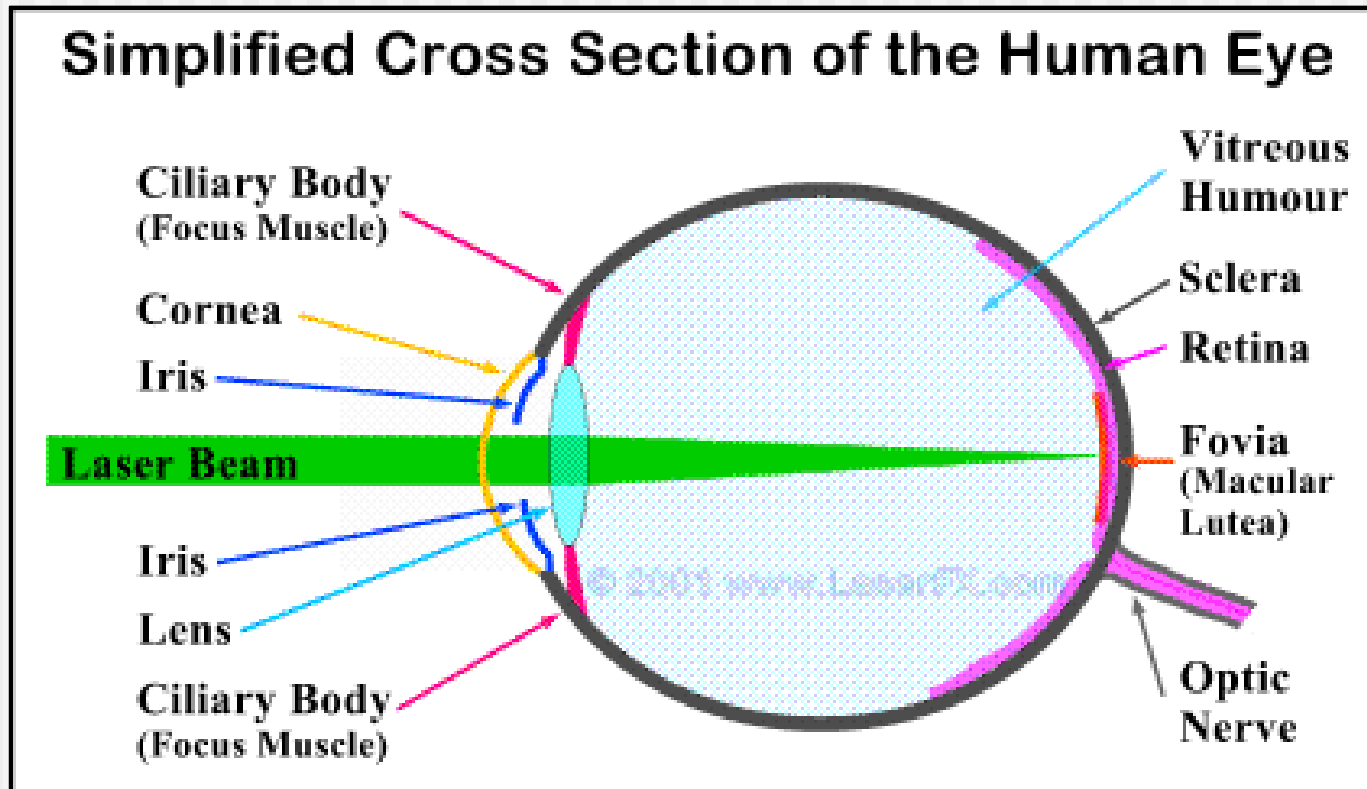
LASER PARAMETERS I

- Emission wavelength (UV, Visible, IR)
- Output power/energy (mW-W, nJ-kJ)
- Pulse duration (cw, ns, ps, fs)

Band		Wavelength
Ultraviolet (UV)	UV-C	200 – 280 nm
	UV-B	280 – 315 nm
	UV-A	315 – 400 nm
Visible (VIS)		400 – 700 nm
Infrared (IR)	IR-A	700 – 1400 nm
	IR-B	1400 – 3000 nm
	IR-C	3000 – 1 mm



LASER vs HUMAN EYE



Cornea (κερατοειδής) : 1400 nm – 1mm & 180 nm – 315 nm

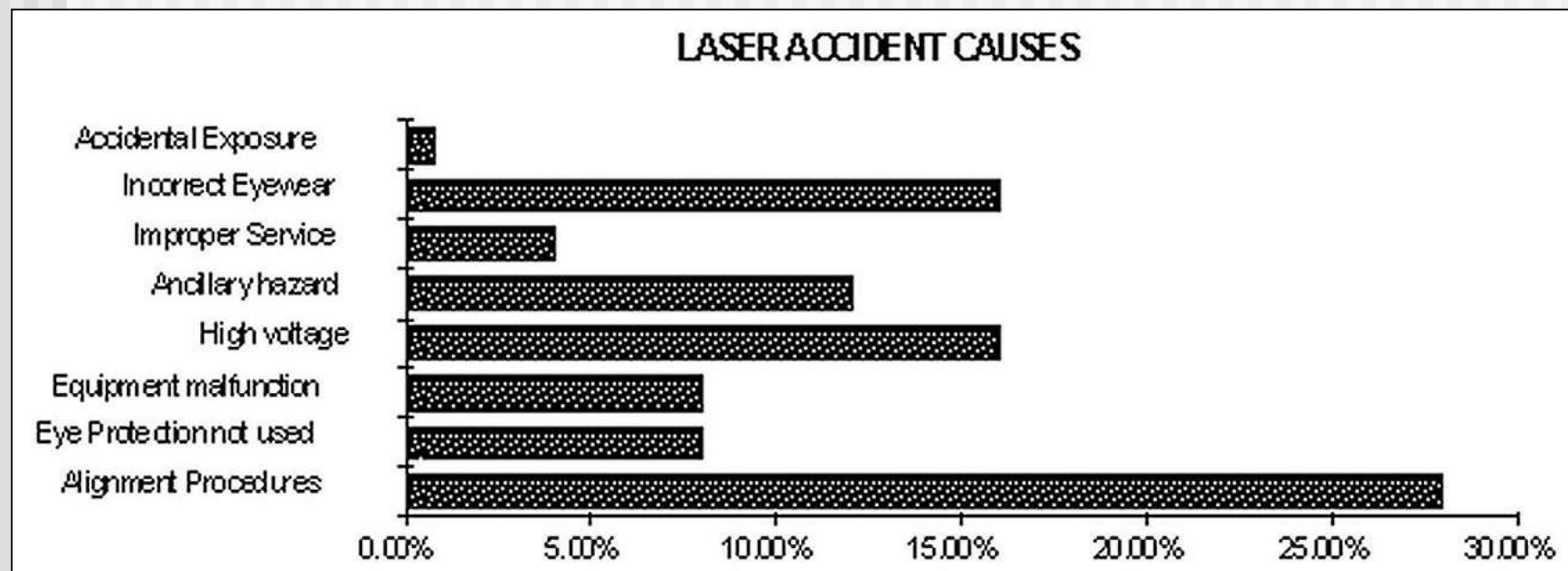
Lens (Φακός): 315 nm – 390 nm & 700 nm – 3000 nm (sel.)

Retina (αμφιβληστροειδής): 400 nm – 1400 nm



LASER ACCIDENT CAUSES

Cause of Laser accidents (НПА, 1964-1992)



Most accidents take place during **beam alignment**
or/and because **no proper eyewear was used**

<http://www.adm.uwaterloo.ca/infohs/lasermanual/documents/section11.html>



REFLECT ON THIS

Small fraction (4%) of pulsed laser beam, diameter 2 mm, with energy of 2.5 mJ/pulse, reflected from a piece of optic has energy density of :

$$(0.04 \times 2.5 \text{ mJ}) / (\pi \times (0.1)^2 \text{ cm}^2) = 3.2 \times 10^{-3} \text{ J /cm}^2$$

This exceeds the damage threshold of the cornea ($\sim 10^{-7} \text{ J/cm}^2$) by a factor of 3.2×10^4 .

Protection for this level of exposure requires the use of appropriate laser eye-ware with optical density at the laser wavelength :

$$(\text{OD}) = \log(3.2 \times 10^4) = 4.5$$



LASER SAFETY PRACTICE

- **USE APPROPRIATE LASER PROTECTION EQUIPMENT**
 - **GOGGLES**
 - **LAB COATS**
- **NEVER look directly at the laser beam**
- **Beware of & minimize/block REFLECTIONS**
- **Always know where your beam (and reflection) is**
- **Keep experiment WAY BELOW eye level**
- **Protect others around you**
 - **Laser light ON**
 - **Use protective panels**
- **If in doubt, ASK!**



In Case of a Laser Incident

- **Remain calm!**
- **Assess the situation**
- Call for help
 - Turn laser off if you can
- Seek medical attention
- Contact safety personnel
- File an accident report

- **USE COMMON SENSE**



X-rays: XRD special rules

- Main X-ray source: XRD
- Training in using XRD safely
- Use of dosimeter is **MANDATORY**
 - **No dosimeter – No XRD**
- Keep your dosimeters near the XRD – not at the office or in the pocket
- Wear it on the way in, leave it on the way out
- New dosimeter each month
- If dosimeter not needed notify IESL secretariat (Lia)



LABORATORY SAFETY

CRYOGENICS SAFETY



CRYO HAZARDS

- Explosion
- Frostbites
- Asphyxiation
- Burns
- Fire (liquid O₂)



<http://ehs.ucsf.edu/cryogenic-liquids>



CRYO SAFETY PRACTICE

- Use appropriate handling equipment
 - Gloves, apron, mask
- DO NOT TOUCH cold containers with bare hands
- Vent containers appropriately
- Do not play with cryo-liquids
- L. O₂: no flame/heat/fuel
- Learn how to use cryo-equipment (valves, dewars, hoses) safely
- If in doubt, ASK!



In Case of a Cryogenics Incident

- **Remain calm!**
- **Assess the situation**
- Seek help
- Seek medical attention in case of injury
- Contact safety personnel

- **USE COMMON SENSE**

<http://safety.iesl.forth.gr>



Location of First Aid Kits

- **FORTH Main Building (B)**
 - Basement: **Near gas storage room**
 - Ground Floor: **Near main entrance**
 - 1st floor: **Meeting room**
- **STEP C: Basement, Ground floor**
- **Microelectronics: Kitchen**
- **FORTH Building C:**
 - Main Secretariat
 - Magda's Office
 - Comp. Center



LABORATORY SAFETY

ANY QUESTIONS?

<http://safety.iesl.forth.gr>

