

# SAFETY AT LASER LABORATORIES IN



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Trieste, January 20 th 2017

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# 1. The world of the laser (1)

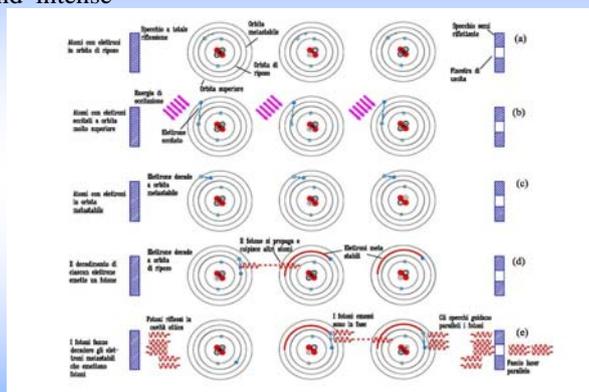


“A sharp, powerful radiation that can drill metals”, can be a scalpel in surgery or a blade of light in shows.

It can also be an optical instrument as well as a light in the field of the Research.

# 1. The world of the laser (2)

Laser "a light that does not exist in nature": atoms/molecules stand by at a metastable level, the decay is excited by the narrow decay. Mirror cavity photons are in phase and the emitted light wave in phase and intense

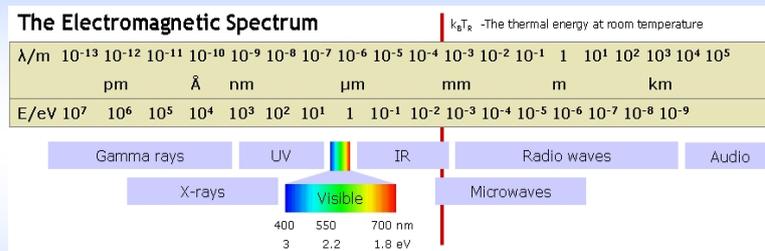


=> **parallel beam**, coherent light, monochromatic. can be focused in a very sharp spot, also can run **intense for long distance**.

# 1. The world of the laser (3)



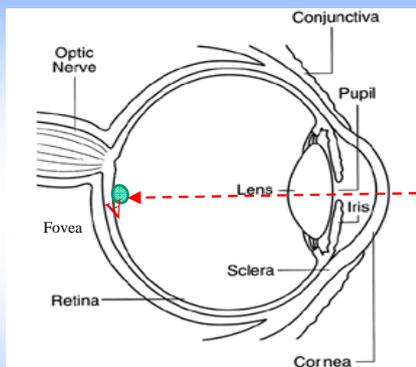
Any lasing material emits to specific wavelenght, for the safety Int.nal rules is important from **180 nm to 12000 nm**.



Some **laser beams** are **visible**, other in the **infrared** and in the **UV** emits then one has **no chance to see it in time**. The **near infrared lasers** are at the **top of the risk** as invisible for the eye but focused **to the retina**.  
 => the **eye risk** damages and **blindness when hit by a laser beam**.

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# 2. The EYE. The most delicate part of the body (1)



The light enters the cornea and the iris, the **lens focuses the image on the retina**.

A

The **fovea can see the details** as small objects or reading a text. The optic nerve send the info to the brain

Visible, near infrared and near ultraviolet can pass to the retina then  
 =>An **invisible laser beam** can enter the eye and damage the retina.  
 =>**Blindness risk**.

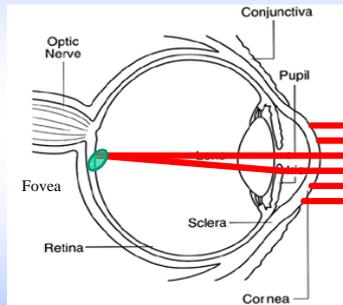
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## 2. The EYE. The most delicate part of the body (2)



If the focused laser beam cause overheat to the retina or to the fovea one can have scars, blindness. The laser is **dangerous in particular:**

- . When invisible (near infrared beam) .
- When **high energy pulses**.



UV lasers or far infrared lasers **scar the cornea**, give **erythema**, **reduces visus sharpness**.

No human reaction move the the eye in time. Burns (tenths of seconds) is possible, high risk of permanent damage or blindness

Shields, filters, safety glasses, upon CEI/IEC safety rules: care the protection of the people

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## 3. The risk classification of the laser and the Safety Rules. (1)



Lasers are classified at IEC/CEI 60825-1 Rules in accordance with the risk for the eye (and for the skin). It depends upon the wavelenght, the power or the pulse of the beam. A laser or an equipment containig laser il classified by the manufacuter. **HAVE A CLASS LABEL.**

### Class 2 and Class 3a Laser Signs



### Class 3b Laser Signs



### Class 4 Laser Signs



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### 3. The risk classification of the laser and the Safety Rules. (2)



Most important classes as laser risk.

- Class 1 intrinsically safe (the beam power is less than 1 mW)
- Class 2 visible beam, risk is limited as body reaction avoid long exposure
- **Class 3 B: the direct beam can cause eye hazard (relevant eye risk)**
- **Class 4: Direct beam or reflections cause heavy hazard for the eye or for the skin (plus burns and , fire object risk for high power)**



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### 4. Lasers in SISSA (1)



In the laboratories one can find

- . **lasers class 3B coupled to microscopes** (eye risk for direct beam in free space or through the eyepieces of microscopes),
- . **lasers class 4** as pump, coupled to microscopes, dangerous for direct viewing and for reflections of the beam.

Usually The laser systems/equipments are stable, not subject to change, prepared from specialist.

The Safety matters are based on the main reference Rules  
CEI EN 60825-1-4; CEI CT76 – 3850; UNI EN 207, 208  
regarding lasers, equipments, room and safety courses for  
the personnel.

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## 4.1. Lasers risk (2)

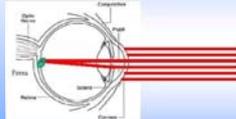
The risk occurs:

- . **When covers/protections are open,**
- . **During the adjustments** of the beam, of the microscope, of the sample
- . **During maintenance**/alignments/dismounting of the optics
- . **When parts**, as i.e. the laser type, or filter or optical path **are changed, missed, misadjusted**

For WHO:

- . **For the involved people as users,**
- . **For the people invited in the room.**

A class 3B and a class 4 **risk occurs for the eye.**



[plus the risks connected with the activity (biological, gases, electricity....)]

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## Five interesting minutes.

Please discuss about the lecture.

- i.e.
- . The laser light,
  - . The eye
  - . The rules



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## 5. The People hierarchy



- . **The Responsible** of the laboratory/equipment => (**MANAGER**).
- . **The Chief** of the laboratory (“preposto”) who run the laboratory (**LAB LASER OPERATOR**)
- . **Who USE the laser or the equipments, is authorized by the manager and trained by the chief of the laboratory. => (USERS)**
- . **The engineers** who maintain, align, implement and care the safety of the laser (**MAINTENANCE OPERATOR**).
- . **Technicians** occasionally working at other plants of the laboratory the presence of the Lab Laser Operator (**External people**)
- . **Invited People for scientific aspects etc. (GUESTS)**

The **manager authorize** any single person to access the laboratory

Focus: **The user** is authorized by the Manager and trained by the Chief of the laboratory. He shall learn rules for safety.

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## 6. The laboratory – equipments (1)



**Equipments in normal status.**

- . **Protections** as tunnels, pipes, boxes are **essential for safety. SHOULD BE CLOSED.**
  - . Automatic switching and interlock control inspection doors and shut down the beam/the shutter when open.
  - . The status of the shutter (beam open, beam closed) shall be alerted respectively by red lamp or by green lamp.
  - . When the beam is shut down, controls of the beam can be restarted only manually.
  - . **Windows, microscope eyepiece should be protected by optical filters** designed to **stop the specific laser radiation.**
- Note. The filters alters the vision and colors of the sample.

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## 6.1. Auxiliary equipments and laser room safety. (2)



To avoid other risks general plants should be in good conditions.

- . The laser supply switched on by keys (authorized by the manager)
- . The cables, connectors, parts properly used;
- . The connection of the optical fibers closed/connected, non damaged/broken

Care must be taken to avoid other risks. i.e. by chemicals, biologic, x-ray.

=> Gloves, lab coats, glasses, etc. shall be available for the **specific task**.

Laser safety eye **glasses should be available at the laboratory; be used before operating the laser.**



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## 6.2. Prevention - the room. (3)



- . **Keyed** from outdoor, opened from indoor (**emergency door** with external knob);
- . **Red light outside** the door, light on when laser is on;
- . Laser hazard **warning labels**;
- . Access only to **authorized persons**;
- . Use proper **waste/discards containers**;
- . **Safety/ emergency kit** available.

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### 6.3. Main cautions. (4)

**The skilled people reduce the risk.**

**THEN READ AND LEARN THE OPERATING METHODS AND THE USE OF THE OPERATING TOOLS.**

- . HAVE A CLEAN, ORDERLY LABORATORY
- . **BE SURE THAT INSTRUCTIONS BE UNDERSTOOD EACH OTHER WHEN YOU WORK IN TEAM.**
- . Prepare the experiment, the tools, the sample, the safety objects,
- . Use proper clothes, preventive and safety gloves, vacuum cleaner, ... dispose properly the waste..... ,
- . Clean desks, equipments, **MAKE BACK OBJECTS WHEN YOU FINISH A TASK BEFORE START A NEW CYCLE.** => avoid mistakes.

**THE LASER RISK GO AT THE TOP WHEN MISTAKES OCCUR.**

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### 7. Prevention and care – learn basic on emergency before it occur!!!

**The first 2-5 minutes the emergency evolves from fair to bad.**

**DON'T PANIC. PANIC INCREASE THE RISK.**

**To know what to do with emergency and the emergency tools, pay.**

**An immediate action pay.**

**Knowing how to act pay.**

Rarely to do the heroes pay, when you cannot afford emergency or the emergency goes bad, you **have a problem** and you **become a problem.**

**=> Then:**

- . Learn where are gangway, corridors, stairs to avoid elevators in case of emergency.
- . If there are multiple escape paths, know all paths.
- . Locate the fire buttons, extinguisher, locate exit door, emergency buttons, fast shut off specific emergency (i.e. gas valves shut off...)
- . Learn the reception, the emergency phone number.

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## 7. Prevention and care – general aspects in an emergency. (2)

Act as you feel. No heroes but no panic. Afford/hold emergency means:

- . Knowing to act the normal equipment turn off and the emergency stop;
- . Knowing how to turn off the electricity, the gas;
- . Knowing how to use fire extinguishers, preferably CO2 (or powder)
  
- . Know and be able to act at least the basic actions in case of emergency
- . Disconnect power in any case, best as one use extinguisher
- . Preferably use a CO2 fire extinguisher, quickly leave the room with colleagues, close windows and doors behind you.
- . Alert and help the neighbors colleagues
- . Never use elevators, also when the emergency occurs in other room.

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## 8. "The laser accident" (1)

- . The accident is instantaneous, the laser beam or a reflection suddenly enters the field of view (side or center) the eye.
  
- . If the **laser beam is visible**, a **flash** glare, with loss of vision, have a high risk of **injury** to the eye; (depending of beam time and intensity).
  
- . **If the laser is in the near infrared: sensation** of seeing something **strange**, indistinct, not clear, when the eye is hit, a black or red **cloud remains in the sight**, An intense pain may follow.

recommendations:

- . **Close IMMEDIATELY both eyes AND TURN THE HEAD;**
- . Look with one eye at a time, a bright wall, define the affected eye;
- . Do an immediate medical check, the eye damage can be limited.

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## Questions and comments.

Some ideas for conversation

The subjects  
Protections  
Prevention and care.  
Emergencies.



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## 9. To prevent eye hazard. (1)

Use **protective eyeglasses designed for the specific laser/room.**

**Private protective glasses** are allowed only **if controlled** by SISSA

. **Eyeglasses mitigate the risk:** are added cautions in addition to right filters and right covers.

They are **NOT SUFFICIENT TO PROTECT EYES FROM STRAYGHT BEAM TO THE EYE.** See in the laser output path is forbidden and hazardous in any case, without or with the glasses.



**Filter type and density according to the specific laser.**

*Example: read on glass O.D 6@700-1200 nm for a 1064 nm beam (ND-Yag laser)*

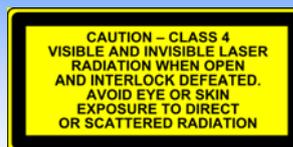
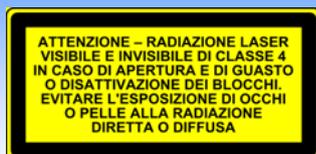
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## 9.1. To prevent hazards in general. (2)

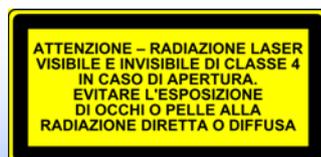
Here you will read a summary:

- **Learn** the machine and his use;
- Make sure that the **shutter is closed (the laser power off)** from before **preparing the equipment**;
- **Make sure you have the safety and filters positioned**;
- **Take caution for other risks**;
- **Use safety glasses** when **prepare** the equipment, the sample, **at maintenance, at shields open, when required**;
- **Restrict** the room **access** to the people in charge
- **Do** near the equipment only **what** the experiment **need**;
- **Remove the switch-on key** daily or as needed
- **Open the shutter only when** the equipment **need** the beam.

## 9.2. Caution labels. (3)



Hazardous Laser beam. Do not open. Do not see inside Can be opened only with the approval of your manager wearing protective glasses



Area at risk of stray laser beams. Restrict the access when the laser is on.

### 9.3. Alerts (4)



Equipment with laser.  
risk for eye



Laser beam active inside the  
room. Entrance restricted.

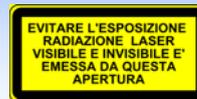
Indicates room/covers with risk of permanent blindness. Wear the safety glasses, act as rules and training.

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### 9. Top risk labels. (5)



THE BEAM APERTURE IS SIGNED BY LABELS LIKE:



**YOU SHOULD NEVER LOOK INSIDE, GLASSES NOT SUFFICIENT TO PROTECT YOU. INDICATES 'THE MAXIMUM RISK OF BLINDNESS' WITHOUT NOTICE.**

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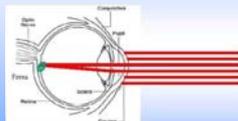
## 10. Emergency pushbutton. (at last)

If an emergency happens and you push the emergency button, **maybe** limit the future damages and the emergency problems, but damages was happened.

=> **prevention and care of the people are the best.**

**Emergency change the situation**

- . Alert emergency staff, the chief, reception
- . Evaluate how to deal the situation
- . go away and help other people.



In case of eye pain, clouds, or flash by laser beam, to push the emergency button is too late,  
**Have an immediate medical care to limit the visus/eye damage.**

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## Questions and additional informations

Ask to your chief, is your reference for information, to improve knowledge  
He will ask a discussion with the Safety Dept.

Thanks for your attention,

2 course participants are invited to summarize the lecture and open questions.

The lecturer will emphasize aspects of your interest about laser safety.



Giorgio MAREGA

January, 20 th 2017

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