Baskin School of Engineering
University of California, Santa Cruz

Instructional
Instructional Optics Laboratory
(Baskin Engineering Room 148)
Safety & Hazard Awareness Notice

Prior to being allowed unescorted access to this laboratory, every person shall read and understand the safety procedures listed in this document. It is important for your safety as well as others, that every lab worker know the rules and regulations for safety and understand the hazards present in the laboratory. You and all others MUST follow these instructions while working present in the laboratories. After reading this document, you shall sign and date it. A copy of this document must remain on file in the Optics Lab Safety record book while you have key or keycode prelividges to this laboratory.

Instructional Optics Lab Worker Certification of Understanding

I have read the attached safety and hazard information, I fully understand the safety instructions and hazards present in the lab. I will follow all safety precautions listed in this notice and will do my best to ensure that others follow the safety precautions as well. **I understand that failure to follow safety precautions will be grounds for termination of lab access and may result in further displinary action.**

Name:___________________________________Assocation with UCSC__________________

Signature:____ Date:___________________

Note: The vast majority of accidents are fully preventable and are typically caused by people disregarding safety rules with the preception of saving time or effort. *In the long run, you will save time by following safety rules. All it takes is one accident to ruin your day or possibly effect your for the rest of your life.*

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I. General Information

A. Responsibility

The Dean has the ultimate responsibility for safety at the School of Engineering. The responsibility for ensuring safety is delegated to the faculty of each group. Safety regulations for working in this laboratory are stated in this document. Every member of the group (faculty, staff and students) is personally responsible for being aware of the hazards and risks involved in their work and following these regulations. Every lab worker also has a responsibility to report safety deficiences and areas for improvement in the procedures for this lab.

B. Good Safety Means Having Things in Good Order

This means keeping a reasonably tidy laboratory and ensuring that the walk ways, paths to emergency OFF buttons and especially paths to the room exit are kept clear. This is vital should an emergency develop. No items should block or be stored - even for a short time - in the walkways within this lab (this includes empty boxes).

C. In Case of Emergency

1. **Ensure the area is safe, if not GET OUT.**
   If the fire alarm sounds, immediately shutdown laser power (do not simply shutter) and ensure everone leaves the room. DO NOT WAIT TO SEE IF IT IS A FALSE ALARM OR DRILL. If the lab is not safe (e.g. fire, electrical arking), shutdown power to lasers (if possible) and get everyone out.
2. **Go or send someone to the nearest phone and have them dial 9-1-1.**
   Emergency services will respond immediately, stay on the phone and provide all information to emergency personnel. Do not hang up until emergency personnel tell you to.
3. **If you are trained in first-aid and CPR do what you can do**.
   If you perform First-Aid or CPR, you should have a current RedCross Certification. If you do not, it may be best to wait for trained emgerency personnel to arrive.
4. **Report all safety incidents immediately to the School of Engineering Lab Manager and Course Professor.**

Lab Manger:	Robert Vitale
Location:	Baskin Engineering Room 064
Phone:	(831) 459-3794
Email:	rvitale@soe.ucsc.edu

   School of Engineering officials need to be informed immediately of safety issues so corrective actions can be taken. They will let you know of further procedures that need to be followed.

II. Laser Hazards and Safety Regulations

In the Optics Lab several different lasers are used for various applications. They may differ in size, wavelength, power, etc, but they have one thing in common: The light they generate is a serious hazard and the dangers associated with this **must** be taken very seriously. Even a very short exposure to a fraction of a reflected laser beam may cause **permanent loss of vision**. Each person working with lasers must be aware of the dangers and adhere to the safety rules. Attached you will find some case histories which describe what happens when the eye is exposed to relatively weak laser beams.

A. Background (refere to Figure 1.)

If a laser beam strikes your eye, the eye lens will focus the light to a small spot on your retina. The collimated laser light is focused down to a 10 micron spot that will quickly burn a hole in the tissue and damage the nerves. Bleeding and haemorrhage can give severe complications that might lead to permanent loss of vision. **Nothing can be done to repair retinal damage!** The eye lens transmits and focuses light in the ocular focus range 350 - 1400 nm. Intense light outside this range can still damage the surface of the eye but light inside the ocular focus range will be focused 10 5 times on the retina. Especially dangerous is light inside the ocular focus range but outside the visible range (400 - 750 nm) since it is invisible but still will be focused in the eye.

Viewed head-on, the light is focused onto the fovea, which is responsible for the most accurate vision. When exposed from the side, parts of the retina responsible for the peripheral vision are struck. If the beam strikes the blind spot, where the optic nerve enters the eye, loss of vision is complete.

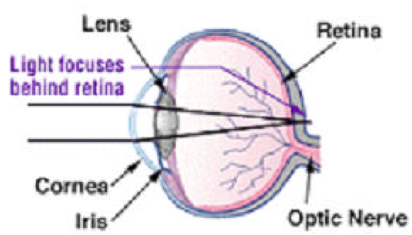

Figure 1: Optics of a human eye.

Since the eye will focus the laser beam so tightly, **exposure to a weak reflection is enough to cause permanent damage.** The time you need to close your eye (blink) when exposed to a bright light is approx. 0.15 s. The maximum permissible exposure during this time for a cw He-Ne laser is 1 mW. The burn-threshold (permanent damage) exposure for the retina is only about 30 mW. Lasers are classified from safety class I (eye safe) to IV (hazardous to both eye and skin). In our lab, all lasers are class IV except the low-power HeNe lasers that are class IIIb.

B. Safety Contacts and Regulations

Ken Smith, RRPT
Radiation Safety Officer
UCSC Enviromental Heath & Saftey Office
(831) 459-3911
ksmith@cats.ucsc.edu

All work with lasers is governed by the regulations laid down by the National Institution of Radiation Protection and in the legislation governing working environment. These regulations must be applied at the Optics Lab. This legislation states that the employer (University of California, Santa Cruz) shall appoint one person who is responsible for laser safety and well acquainted with the regulations and use of the lasers. This person is the UCSC Radiation Safety Officer.

If you have questions or comments about the laser safety in your lab, you should first talk to SoE Lab Manager (Robert Vitale) or your professor. If you are unhappy with the outcome of these discussions you should address Ilse Kolbus (the EH&S Director) at the department. A copy of the UCSC Laser Safety Manual should be on file in the Optics Lab.

C. Laser Beam Dangers

In a well designed optical system, laser beams are confined to specific areas where personnel are not. However during setup and adjustment one cannot be certain that beams are well confined. Hence the risk of accidental exposure is greatest during set-up and alignment of the system. The major dangers are:

- Horizontal stray beams at table height.
- Beams traveling out of the plane of the table.
- Reflections off optical components in the set-up.
- Reflections off watches, rings, etc, during set-up.
- Uncontrolled, "wandering" beams during alignment.

D. Laser Operation Rules

These are rules designed to minimize the risk of accidental laser exposure and ensure the safety of people working in the lab.

1. Illuminated Warning Signage

An exterior sign to the lab shall be illuminated stating that lasers are or will become operational. This is to ensure that any persons entering the room know that the lasers are or may be firing. The warning sign must always be turned on before the lasers are started.

2. Jewelery, Watches, Rings and other personal effects

All personal items that may cause reflections must be taken off any work in the lab. These include things like watches, rings, jewelry, belt buckles, etc. If you cannot remove them, then the item must be fully covered to ensure that no incidental reflections can occur. *Please ensure this applies to piecing jewlery on your face as well. Although it is unlikely that your head would be in the beam path, a secondary reflection off your ear/nose/lip ring could end up in someone's eye – perhaps yours.*

3. Laser start

Always start the laser with the exit aperture blocked by a power meter or a beam blocker (matte black) that withstands high power.

4. Safety goggles

Always WEAR the appropriate laser safety eyewear (goggles) when the exit aperture of the laser is uncovered. Safety eyewear must match the laser source being used. This eyewear attenuates the wavelength that is being used, so often you may find it hard to see the laser beam. **DO NOT REMOVE LASER EYEWEAR TO CHECK BEAM ALIGNMENT**. There have been many cases of laser workers receiving eye damage when removing eyewear for short peroids to check alignment. Different eyewear is available for each laser used in the lab. Check the laser chart at lab entry for the correct eyewear. Wearing the wrong eyewear can leave you vuniable to eye damage since those wavelengths may not be attenuated.

5. Set-up

During set-up, never let the laser beam free. Always block the beam path with the beam-blocking screens (beam stops) that are available in the lab. Always use lowest possible power level during set-up. When introducing a new optical component in the optical path, follow this procedure:

- Block the beam.
- Introduce the new component and align it roughly so you know approximately where the beam will travel.
- Put a beam stop immediately after the component.
- Remove the first blocker. The beam should now be blocked by the second beam stop.
- During alignment, keep the beam blocked by the stop. When the beam is positioned correctly for the next component, repeat the procedure. Do **not** use the black cardboard as a beam blocker, it will easily burn and cause a fire hazard as well as an unblocked beam.

6. Alignment

Keep your optical path in the table plane and as low as possible. If you need to change the height of the system, always lift the beam vertically at 90 degrees?to the table. For vertical beams, be very careful to terminate the beam path as soon as possible. Always observe your optical system at 90 degrees to the beam plane, never lean down and look in the plane.

7. Stray beams

After introducing a new optical component, always be sure to track down stray beams and block them off with beam stops. Typical stray beams emerge from lenses and windows (4% retro-reflection) or polarisers. When your set-up is complete, turn the lights off and turn away from the system. Look for any possible stray beams on the walls by lifting your goggles. Be sure to keep your back to the system and never turn around without wearing the goggles. **Note:** This is only a final check, you should foresee and block off all stray beams **before** you perform this. You will also find a lot of diffusely scattered light in the room. This light is normally not hazardous.

8. Chambers and cells

Before looking into a chamber or cell, all laser beams traveling into it must be blocked.

9. Skin hazards

Never block the beam with your hand, always use a beam stop. A 1 W laser beam will give a nice, circular burn after a few seconds of exposure. High power pulsed UV-sources may also be harmful to the skin.

10. Leaving room

When leaving the room, make sure that all doors are **locked** and the warning light on. **Note:** Do not forget to shut off the warning lights when the lasers are off and do not leave doors open with the warning light on. Such behavior, although not hazardous in itself, will deteriorate the safety conscience.

11. Visitors

All persons who have not read and signed the safety notice are considered visitors. Vistors must always be escorted/accompanied by a trained lab worker. Visitors should wear the appropriate safety/lasers goggles and they should be informed about laser hazards (loss of vision) and the rules of the lab (no bending, sitting down, leaning over optical table, etc.). Be careful with short people where with the optical system at eye level. Children are not be permitted within this laboratory, there are many hazards not all are from lasers.

E. Laser Classifications:

Classification	Power Range(Watts)	Specification of hazards	Example
Class I	1 µW	Closed system, not accessible during operation	Laser printers
Class II	1 mW	Aversion response, 0.5 sec exposure	Laser pointers
Class IIIA	1-5 mW	Visible laser (400-700nm wavelength)	Construction sight leveler
Class IIIB	5-500 mW	Direct and specular reflections	
Class IV	0.5 W	Direct, specular, & diffused. Eye, skin, & fire hazard	Industrial cutting lasers

Table 1: Laser Classification and some common examples.

F. Our laser systems

Approved laser systems operated in this lab are listed in Table 2 along with the specific laser eyewear required and pertainent safety issues. All are Class IV or IIIb (3B) lasers that can permanently damage the eyes and have adverse affects to the skin if proper precautions are not taken. In addition, some of these lasers may use high electrical voltages. Electrical safety precautions should be taken when setting-up and operating each laser to ensure avoidance of electrical shock. Detailed specifications with UCSC EH&S Hazard Analyzis of all lasers are provided in the Instructional Optics Laboratory Manual, which should be available at all times in the lab.

Laser Manufacturer/Model	Type	Class
COHERENT, Verdi	**Nd:YVO Freq Doubled GREEN (5W at 532nm)**	**Class IV**
Laser Eyewear Required:		
This is our most dangerous laser. An all-solid state, diode-pumped, frequency doubled laser providing single-frequency green output (532nm) at power levels up to 5W. This is a very high-powered laser that can burn holes in walls. Proper laser eyewear is absolutely essential and must be worn at all times of operation. Personnel should also be highly aware of incidental burns to skin, clothing and nearby equipment & walls.		
MELLES GRIOT	**HeNe Laser RED (17mW at 632.8nm)**	**Class IIIb**
Laser Eyewear Required:		
This is our second most dangerous laser. A plasma tube assembly contains Neon as the active lasing medium that produces wavlength outputs of 632.8nm at powers of 17mW. Proper laser eyewear is absolutely essential and must be worn at all times of operation.		
AGILENT	**Tunable Laser (1520-1570nm)**	**Class IV**
Laser Eyewear Required:		
This is our least hazardous laser, however due to power levels it is still a Class IV. It is less hazardous only because the interface is via fiber. The end of fibers tend to disperse light widely making a less focused hazard. This is a tunable laser that is typically used for fiber optics communciations experiments		

Table 2. Approved Lasers for Use in the Instructional Optics Lab

III. ELECTRICAL AND HAZMAT SAFETY

A. Electrical Safety

1. Shocked Electrically, What to do

- First disconnect the electrical device or turn off the breaker. DO NOT TOUCH OR GRAB THE PERSON otherwise you may get shocked too.

- Once electrical power is no longer shocking the person, ask and find out if person is ok. If not send someone to call 9-1-1. Lab next door has a phone. When speaking with emergency dispatch, calmly and clearly state your name, the address of the building (Baskin Engineering RM 148) and the whereabouts of the lab in the building. Send someone to meet the ambulance at the entrance.

- If person is unconsious and conduct CPR if you are trained. If not try to find someone who can do CPR. Yell down the hall for help if needed.

- Report all accidents immediately to the School of Engineering Lab Manager, the faculty in charge of course/work, and the Dean. Do not touch anything in the lab until an investigation has been carried out.

Lab Manager: Robert Vitale
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Optics Lab Faculty:
Prof Claire Gu
Phone (831) 459-5296
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Dean of Engineering:
Dean Steve Kang
Phone: (831) 459-4877
Email: kang@soe.ucsc.edu

2. General Electrical Shock Information

The following are typical current values for electrical shock of the average human:

0.5 mA	Threshold value for feeling the current
10 mA	Muscular spasms can develop, you may not be able to let go from an object you are holding.
>50 mA	Risk for heart fibrillation which can be fatal.

Rules for good safety:

- When working with high voltage, at least two people should be present in such a way that they can see and hear each other.
- Construction parts and test objects should be regarded as if they were connected to a voltage until the opposite has been confirmed.

- Re-couplings on a central coupling board must be performed by qualified personnel.
- Always disconnect power supplies and discharge capacitors before attempting to carry out any work on electrical equipment.
- Metal items should be kept away from electrical circuits that are not isolated.
- Avoid huge metal constructions.
- Metal constructions should always be grounded.
- Ensure that HV/current connections to vacuum apparatus are protected to avoid anyone from accidentally coming into contact with them.

B. Hazardous Chemicals and Biological Material

Before working with any chemicals (this includes e.g. solvents and laser dyes) make sure that you have read the relevant material safety data sheet and are aware of how to handle the material in a safe way. Your immediate supervisor should be able to supply you with this information or tell you where it can be found. Some of this material is toxic and/or carcinogenic.

Please refer to the Chemical Hygiene Plan of the Optics Safety Manual.