

STANDARD OPERATING PROCEDURES FOR RESEARCH LASER SAFETY



PRINCIPAL INVESTIGATOR:

DEPARTMENT:

BUILDING/ROOMS CONTAINING LASERS:

LASER SAFETY CONTACT:

DATE:

In some cases, your current laser inventory is on the attached Laser Registration Form(s).



A. LASER SAFETY TRAINING

There are two required components of laser safety training:

1. General laser safety training:

This is conducted by EH&S via the *Laser Safety [Online]* course (www.ted.uci.edu). *All persons on campus who will be operating Class 3b and/or Class 4 lasers are required to complete EH&S laser safety training before starting to operate lasers.* General laser safety principles are covered including engineering, administrative and personal protective laser safety controls, the biological effects of laser radiation, frequent causes of laser accidents, non-beam hazards, and human behavioral factors as they relate to laser safety. *Note: Classroom-type Laser Safety Seminars are still presented upon request.*

2. On-the-job/Hands-on training:

This is to be conducted by the Principal Investigator or an experienced senior researcher in the laboratory. All persons must be provided with adequate on-the-job training so that they are sufficiently competent to operate their lasers independently and safely, and feel comfortable doing so. All appropriate operational procedures (laser system startup, alignment, experimental techniques, shut-down, etc.) need to be covered in this training including the needed safety equipment and all other safety-related considerations.

UC Irvine Radiation Safety Division Laser Safety SOPs

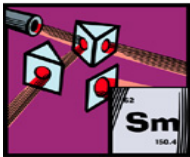


B. WARNING SIGNS AND ACCESS CONTROL

All rooms in which lasers are operated must be posted with permanent door-type laser warning signs that include all information appropriate to the lasers operated within the rooms (e.g., laser types and classes, output characteristics). Doorknob-type warning signs (“Do not enter”, “Alignment in progress”, “Laser operating inside”) should be temporarily posted in cases when persons intending to enter rooms or laser use areas need to be alerted regarding potentially enhanced hazards such as during beam alignments. *Both types of laser warning signs are available free of charge on request from EH&S.*

In cases in which illuminated “laser-on” warning signs are present outside laser laboratories, these should only be turned on during laser operation. Otherwise, they become part of the landscape and are ignored. *{Note: Illuminated “laser-on” signs are not required at UC Irvine.}*

Only persons needed to perform the studies are permitted in laser use areas during laser operation. All others, especially *casual visitors*, must be excluded.



C. BEAM ALIGNMENT PROCEDURES

Pre-alignment procedures

- ❖ Make sure that only persons who are authorized by the Principal Investigator or laser supervisor and who need to be there during the alignment process are present.
- ❖ Post a temporary beam alignment warning sign on the doorknob to the laser laboratory and lock the door.
- ❖ Remove all unnecessary reflective items from the optical table and your person (shiny tools, extra mirrors, jewelry, watch, plastic ID card, etc.).
- ❖ Put on protective eyewear with adequate optical density. In some cases (*low power visible beam only*), low optical density **alignment eyewear** can be worn. Contact EH&S with any questions concerning protective eyewear. *M-rated eyewear is needed for lasers with pulses < 1 nanosecond.*
- ❖ Reduce the beam power as much as possible. Use a low-power (< 5 mW) visible beam laser like a HeNe laser or a diode laser (*i.e., a laser pointer*) to align the optics, whenever possible.
- ❖ Make sure all materials needed for the alignment are readily available and that you have carefully thought through the alignment procedure in advance so there will be no surprises that could increase the likelihood of an accident.
- ❖ Isolate the beam from other areas of the laboratory using laser curtains, beam barriers, and beam stops. Enclose as much of the beam as you can to protect your eyes and skin.



During the alignment

- ❖ Use an indirect means of viewing the beam (beam detector card, infrared viewer scope, Zap-it® paper) except when aligning low power (< 15 mW) visible beam lasers.
- ❖ ***Keep the beam on the plane of the optical table and well below normal sitting eye level. Never direct a beam upwards or across a walkway!***
- ❖ Do not leave a laser operating and unattended.
- ❖ Keep protective eyewear on during the entire process. Remember that special alignment eyewear is available for visible beam laser use (*only safe for output power up to about 100 mW*). Contact EH&S for information on this type of eyewear.
- ❖ Keep in mind that about half of all laser accidents occur during alignment. Be careful!
- ❖ **The most dangerous lasers are the near-infrared mode-locked and Q-switched lasers** – invisible or barely visible beams, very short pulse durations, and thus very high peak powers. Use a high degree of caution when aligning these lasers. [*Note: As mentioned above, M-rated eyewear is needed to absorb picosecond and femtosecond-pulse laser radiation. Contact EH&S for ordering information.*]

After the alignment

- ❖ Replace the enclosures or other safety barriers that were removed for the alignment.
- ❖ Remove the temporary alignment doorknob warning sign.
- ❖ Always store your protective eyewear near the lasers for which it is worn such that it will not get scratched or broken.



D. PROTECTIVE EYEWEAR

Eyewear must be worn whenever there is a reasonable likelihood of exposure to a harmful level of laser radiation. Remember that protective eyewear is your last line of defense against laser hazards – engineering controls (beam enclosures, beam stops, beam tubes, beam barriers, beam dumps, laser curtains, etc.) and administrative controls (like laser safety training and carefully following these laser safety SOPs) are the best ways to control hazards.

Contact EH&S for assistance in selecting eyewear including calculating the **optical density (OD)** needed for adequate protection. Complete the attached *Laser Safety Eyewear Evaluation* form and return it to EH&S for assistance in determining the needed OD.

The protective eyewear vendors below have good eyewear selections and excellent customer service. They supply standard laser eyewear and certified M-rated eyewear (in most cases) and they sometimes give discounts on eyewear to educational institutions like UC Irvine:

NoIR Laser Company

P.O. Box 159, South Lyon, MI 48178
Phone: 800-521-9746 ; Fax: 734-769-1708
Web: www.noirlaser.com

Laservision/Trinity Technologies

595 Phalen Blvd., St. Paul, MN 55101
Phone: 800-393-5565; Fax 651-357-1830
Web: <http://www.lasersafety.com/>

Glendale Eyewear Authorized Distributors

Mallory/ California Safety & Supply Co.

44340 Osgood Road, Fremont, CA 94539
Phone: 408-727-8530
Web: www.calsafety.com

Kentek Corporation

1 Elm Street, Pittsfield, NH 03263
Phone: 800-432-2323
Web: www.kenteklaserstore.com/

Newport Corporation

1791 Deere Avenue, Irvine, CA 92606
Phone: 949-863-3144
Web: www.newport.com

*** M-rated eyewear is needed for ultrafast lasers (pulse duration < 1 nanosecond).**



E. CONTROL OF NON-BEAM HAZARDS

1. Electrical hazards

Only persons experienced in electrical maintenance and repair may perform these tasks. EH&S offers a course in *High Voltage Safety*; interested persons can register at www.ted.uci.edu. High voltage power supplies must only be serviced when personnel knowledgeable in performing cardiopulmonary resuscitation (CPR) are present. The Anteater Recreation Center on campus offers CPR and First Aid classes (<http://www.campusrec.uci.edu/>).

2. Fire hazards

Class 4 visible and infrared beams with irradiances above 10 W/cm² can ignite combustible beam enclosure materials. Keep combustible materials, including organic solvents, away from laser use areas. Never use cardboard or paper for high power visible or infrared beam containment.

3. Chemical hazards

Fluorine and chlorine gases are used with excimer lasers. These need to be stored in approved ventilated gas cabinets. Dye solutions used with dye lasers need to be mixed in a properly functioning fume hood by personnel wearing a lab coat, impermeable gloves, and chemical safety eyewear. Material Safety Datasheets for toxic materials must be reviewed prior to using them:

<http://www.ehs.uci.edu/msds.html>

4. Laser-generated air contaminants

These are potentially toxic substances generated when high power laser beams strike target materials (plastic, tissue, etc.). General/dilution ventilation and local exhaust ventilation are two means of controlling this hazard. In rare cases, respirators need to be worn.

5. Collateral radiation

Some laser systems can generate x-rays, ultraviolet radiation, intense non-coherent visible radiation or radiofrequency radiation. Contact EH&S if you have any concerns regarding this issue.

6. Noise

Some lasers can emit loud noise during pulsing. Contact the Industrial Hygiene Division of EH&S at 949-824-6200 for assistance with hearing protection and noise control methods.



F. SUPERVISOR JUDGEMENT IN LASER SAFETY

An intangible but critically important laser safety issue has to do with the mental readiness of laser operators to perform their studies. If a graduate student was awake the entire night studying for a final examination, that person would be a poor choice to operate a hazardous open-beam laser the following day. If a technician enters the laboratory very upset because another vehicle just side-swiped his new car, he will likely not be in a proper state of mind to perform operations in which a high level of concentration is needed. If a laser technician appears to have a health condition such that he/she may be on a drowsiness-inducing medication, it would be best to have him/her do less hazardous work.

The common thread among these examples is that not all persons who show up at a laser laboratory are fit for duty. **It is up to the judgment of the Principal Investigator or laser supervisor to prevent those who are temporarily impaired from operating hazardous lasers and possibly injuring themselves.**



G. EMERGENCY PROCEDURES

In the event that you or somebody else in your laboratory suffers an eye or skin injury:

1. Turn off the laser involved in the accident immediately and unplug it. Post a “Do not use!” sign on the laser to ensure it is not used again until it can be determined that it is safe.
2. Keep the injured person calm. If an eye injury is suspected, keep the person in an upright position.
3. ***Make sure the injured person receives immediate medical treatment if the injury is serious – injured persons need to be seen by a doctor as soon as possible.***
4. Arrange for transportation of the seriously injured person to a medical facility. The victim might be in shock or have impaired vision so self-transportation is contraindicated. See the attached *UC Irvine Injuries and Medical Treatment* poster for locations for emergency treatment.
5. If the injury is life-threatening (electrocution), ***call 911 immediately***. Call the UC Irvine Police at 949-824-5222. Perform CPR if you are trained to do so.
6. Minor skin injuries can often be treated by rendering First Aid in the laboratory.
7. Call the UC Irvine Laser Safety Officer, Rick Mannix (949-824-6098 office; 949-293-7021 cell) or contact him through the UC Irvine Police. If the Principal Investigator responsible for the laser involved is not present at the time of the injury, he/she must also be notified as soon as possible.




H. MOST COMMON CAUSES OF LASER EYE INJURIES

1. Unanticipated eye exposure during beam alignment.
2. Fatigue, carelessness, inappropriate shortcuts, or horseplay.
3. Upwardly-directed beam, beam at eye-level, or beam crossing walkways.
4. Eye protection not worn or the wrong eyewear worn.
5. Overconfidence; feeling of complacency or invincibility.
6. Beam not sufficiently enclosed or isolated.
7. Laser operator not sufficiently trained.
8. Laser use area not optically isolated from other lab areas, walkways, and entryways.
9. Failure to follow standard operating procedures due to hurrying, etc.
10. Manufacturer and laser user installed safety features removed or bypassed.

If you have any questions related to these laser safety SOPs or any other laser safety matter, contact Rick Mannix, UC Irvine Laser Safety Officer, at 949-824-6098 or rcmannix@uci.edu.



I. LAB-SPECIFIC LASER SAFETY PROCEDURES

 *Please add below any appropriate laser safety-related procedures specific to your laser operations that are not covered by the above general SOPs. This should include any special laser system startup, alignment, and shutdown procedures including all safety-related steps:*



UC IRVINE LASER SAFETY CHECKLIST

- LASER OPERATOR RECEIVED EH&S LASER SAFETY TRAINING AND ADEQUATE ON-THE-JOB/LAB-SPECIFIC TRAINING CONDUCTED BY PI**
- PERMANENT DOOR-TYPE AND TEMPORARY DOORKNOB-TYPE WARNING SIGNS POSTED AND DOOR TO LAB LOCKED DURING LASER OPERATION**
- BEAM NOT AT EYE LEVEL, NOT DIRECTED UPWARDLY, AND NOT CROSSING WALKWAYS TO AVOID EYE AND SKIN HAZARDS**
- OTHER AREAS OF LAB ISOLATED FROM LASER USE AREA BY BEAM BARRIERS, LASERS SAFETY CURTAINS, BEAM TUBES, ETC.**
- BEAM POWER REDUCED AS MUCH AS POSSIBLE**
- BEAM ENCLOSED TO EXTENT POSSIBLE, BEAM STOPS USED TO BACK UP OPTICS, AND OPTICS TIGHTLY SECURED TO OPTICAL TABLE**
- UNNEEDED REFLECTIVE ITEMS REMOVED FROM TABLE AND HANDS**
- PROTECTIVE EYEWEAR AVAILABLE AND USED**
- INDIRECT BEAM VIEWING SUPPLIES AVAILABLE AS NEEDED (VIEWER SCOPE, BEAM CARDS, ZAP-IT PAPER®, ETC.)**
- EXPERIMENT COMPLETELY THOUGHT THROUGH PRIOR TO ENERGIZING LASER TO PREVENT SURPRISES**
- SUPERVISOR APPROVED PROCEDURE TO BE PERFORMED**
- NON-BEAM HAZARDS PROPERLY CONTROLLED (ELECTRICAL, ETC.)**
- OTHER LASER PROCEDURE-SPECIFIC SAFETY CONTROLS IN PLACE**



UC IRVINE LASER SAFETY GUIDELINES POSTER



WHEN WORKING WITH HAZARDOUS LASERS, ALWAYS FOLLOW THESE GUIDELINES:

- ❖ Make sure you have received EH&S laser safety training (www.ted.uci.edu) and sufficient on-the-job/hands-on training in the lab.
- ❖ Never operate a laser without the permission of your PI or deviate from established standard operating procedures.
- ❖ **Always wear protective goggles or spectacles when operating an open-beam laser!**
- ❖ Remember that invisible-beam near-infrared lasers are the most dangerous.
- ❖ Make sure all reflective items are removed from your hands (jewelry, wristwatch) and keep unused optics and shiny tools well away from the beam.
- ❖ Always enclose as much of the beam as possible using beam barriers, beam stops, etc.
- ❖ Never direct beams upwards or across walkways.
- ❖ Keep beams below sitting eye level at all times -- do not sit at an optical table.
- ❖ Think through your laser procedure completely beforehand to avoid surprises. If you have questions, get answers before proceeding. Trust your intuition!
- ❖ Reduce the laser output power as much as possible especially during beam alignments.
- ❖ Use indirect beam viewing techniques like beam cards, beam paper like Zap-it® paper, and infrared viewer scopes.
- ❖ Do not operate a laser when tired, rushed, sick, angry, preoccupied, etc.
- ❖ Remain vigilant regarding safety even if you are an experienced laser operator.
- ❖ Be a good example to others in your lab regarding laser safety (bad habits are contagious).

☎ Contact the UC Irvine Laser Safety Officer (Rick Mannix; 949-824-6098; rcmannix@uci.edu) if you have any laser safety questions or concerns. ☒



LASER SAFETY EYEWEAR EVALUATION

Person Requesting Evaluation _____ Date _____

Principal Investigator _____

Department _____

LASER DATA	Laser 1	Laser 2
<i>Type of Laser</i> (Nd:YAG, Argon, HeNe, etc.)		
<i>Class of Laser</i> (3b or 4)		
<i>Wavelength(s) Produced</i> (nm)		
<i>Operation:</i> Continuous Wave, Single Pulsed, Repetitively-pulsed, Q-Switched, Mode-locked (<i>more than one may apply</i>)		
<i>For Continuous Wave Laser:</i> Maximum Power (mW or W)		
<i>For Pulsed Laser:</i>		
Maximum Pulse Energy (μ J, mJ or J)		
Pulse Duration		
Pulse Repetition Frequency (Hz)		
<i>Maximum Exposure Duration*</i>		
<i>Optical Density (OD) Needed*</i>		

*** To be determined by EH&S**

Return to Rick Mannix, EH&S, Zot Code 2725
(Or call 949-824-6098 if you have any related questions)


CLASS 3b AND CLASS 4 LASER REGISTRATION FORM

Principal Investigator:

Department:

Date:

Page:

	<i>SPECIFIC LASER INFORMATION</i>					
	Laser 1	Laser 2	Laser 3	Laser 4	Laser 5	Laser 6
SYSTEM I.D.						
<u>Location of laser</u> Building						
Room Number						
<u>Type of Laser</u> (Argon, Nd:YAG, Diode, etc.)						
Laser Class (3b or 4)						
Laser Manufacturer						
LASER SPECIFICATIONS						
Operation Mode* (CW, SP, RP, QS, ML)						
Maximum Power (mW or W) or Pulse Energy (μJ, mJ or J)						
<i>For RP laser only:</i> Pulse Repetition Frequency (Hz)						
<i>For pulsed laser only:</i> Pulse Duration						
Wavelength(s) Produced (nm)						
<u>Optical Density Required</u> <i>(EH&S to determine)</i>						

* CW = continuous wave; SP = single pulsed; RP = repetitively pulsed; QS = Q-switched; ML = mode locked {Note: More than one category might apply such as RP, QS.}

UC IRVINE INJURIES & MEDICAL TREATMENT

 **CALL 911 IF THE CONDITION IS LIFE THREATENING OR REQUIRES IMMEDIATE MEDICAL ATTENTION** 

Notify your supervisor or faculty staff if condition is not life threatening. Seek medical attention as follows:

Graduate Students (non-UCI employees)

Campus: Gottschalk Medical Plaza, Primary Care Clinic on campus 824-8600. Hours: Mon-Fri 8-12 & 1-5

UCIMC: Call the UCIMC Referral Center 714-456-7001. Hours 8-5:30

Or contact Beth Laham with the GSHIP program (see below)

After hours: Call the UCIMC Referral Center 714-456-7890. Open 24 hours daily.

The Gottschalk Medical Plaza ([map](#)) is the primary care facility for students covered by the Graduate Student Health Insurance Plan (GSHIP). **Graduate students with private HMO health insurance instead of GSHIP will be directed to their plan's urgent care facilities. Private PPO insurance may be accepted.** Graduate students can be seen at Student Health Center by special referral and only with prior authorization from the GSHIP Coordinator.

For further information, contact Beth Laham with the GSHIP office at (949) 824-2388 or see the GSHIP web site <http://www.gship.uci.edu/>.

Undergraduate Students (non-UCI employees)

Campus: Student Health Center on campus 824-5304. Hours: Mon-Fri 7:30-5:30

After hours: Go to the nearest urgent care center or hospital emergency room.

Be sure to contact Student Health Center for follow-up care as soon as possible.

The Student Health Center ([map](#)) is the primary care facility for students covered by the Undergraduate Student Health Insurance Plan (USHIP). **Undergraduate students with private health insurance instead of USHIP will be charged for services provided at the Student Health Center and provided a receipt to obtain reimbursement.**

For further information, see the Student Health Services website www.shs.uci.edu.

Employees, all student-employees, and volunteers with work-related injuries

Employees or their supervisor must contact UCI Worker's Compensation Desk at 949-824-7008 during regular working hours to obtain medical authorization within 24 hours of any injury.

ALL WORK RELATED INJURIES MUST BE REPORTED via the On-line Incident Form available at the Human Resources website at www.hr.uci.edu, and link to [Workers Compensation](#) or call (949) 824-7008

Newport Urgent Care (949) 752-6300

Located off campus ([map](#)) - 1000 Bristol Street North, Suite 1-B, Newport Beach
Mon-Fri 8am-8pm; Sat & Sun 9am-5pm; Call for after-hours physician.

Occupational Health Clinic at UCI Medical Center (714) 456-8300

Located on campus ([map](#)) - Pavilion III, Building 29
Mon-Fri 7am-9pm, Closed Sat & Sun; After hours - Go to UCIMC emergency room

Occupational Services at Long Beach Memorial Hospital (562) 933-0085

Mon.-Fri. 7am-9pm; Sat. 9am-5pm; Call for after-hours physician.