



UCI LASER SAFETY NEWSLETTER

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The purpose of this newsletter is to keep laser operators on the UCI campus informed regarding laser safety news, bargains on laser safety equipment (including protective eyewear), novel/inexpensive methods for controlling laser hazards, lessons learned (laser accidents), tips to improve safety, etc. These Newsletters are distributed approximately every 6 months, or whenever a laser safety issue with substantial immediacy arises.



MOST COMMON CAUSES OF LASER-PRODUCED EYE INJURIES

1. Unanticipated eye exposure during laser beam alignment.

Many of the documented laser accidents have occurred during beam alignment. That is because the hazards are at their highest when the optics (mirrors, etc.) are being manipulated, thus greatly increasing the likelihood of stray radiation. In addition, laser operators frequently like to be able to see visible beams during alignment in order to facilitate the process, so protective eyewear often is not worn.

Be sure to exercise sufficient caution while performing beam alignments. This includes: a) thinking the process through completely with safety in mind prior to performing the alignment; b) reducing the laser power as much as you can during the process; c) following established alignment procedures as dictated by your PI or supervisor; d) using a low power HeNe or diode lasers to align the optics; and e) wearing low optical density (~ 2) alignment eyewear (for visible beam lasers only; contact me for more information).

2. Fatigue, leading to carelessness or inappropriate shortcuts; horseplay.

Fatigue is a common cause of accidents of all types, including laser accidents. Personnel who are extremely tired must not be permitted to operate laser systems. Problems can occur when laser operators stretch their workdays beyond their physical limitations, making them much more susceptible to accidents.

Lasers are not toys, and they must not be used to play around. There have been reports of people using lasers on campus to pop balloons, light cigarettes, put on impromptu laser light shows, etc. These actions are dangerous and need to be strongly discouraged.

3. Upwardly-directed beams, and beams at eye-level.

Unshielded and accessible upwardly-directed laser beams are very dangerous, as are laser beams generated at normal (standing or sitting) eye levels. It is important to keep your eyes out of the line of fire!! Directing beams in an upwardly direction or positioning beam paths near eye level are asking for trouble. In fact, out the three laser accidents that we have had here at UCI since 1994, two of them involved upwardly-directed beams.

4. Available eye protection not worn, or the wrong eyewear worn.

There are many ways of controlling laser hazards, but the only way to virtually guarantee that an eye injury will not occur is to wear appropriate protective eyewear. Wearing incorrect eyewear that is not sufficiently protective (too low of an optical density) can in some cases be worse than not using eyewear at all, since it can give the wearer a false sense of security. If you need advice concerning the selection of eyewear for your laser applications, contact me.

Always make sure that your eyewear is sufficiently protective at all of the wavelengths of laser radiation generated. For example, eyewear made for use with Argon lasers (protection at 488 nm and 514 nm) is probably not sufficiently protective at 532 nm – the radiation generated by frequency-doubled Nd:YAG lasers!!

Eyewear has been readily available for use on the occasion of many of the laser accidents that have been reported in the U.S. However, the persons who were injured did not wear eye protection for one reason or another – generally because they honestly believed that the eyewear was not needed to ensure safety. They were wrong.

5. Overconfidence; feeling of complacency or invincibility.

Many persons tend to believe that accidents only happen to other people. This is true for all types of accidents (car accidents, accidents in our homes, etc.). The truth of the matter is that if we make mistakes or are particularly unlucky, accidents can happen to any of us. It is important to recognize your vulnerability to a laser accident and take all reasonable steps to keep it from happening.

6. Equipment malfunction or breakdown in a safety control.

Some accidents are caused by a breakdown in the laser system itself or in a laser safety control feature. It is always advisable to check the integrity of your laser setup prior to initiating your work.

Accidents in this category have been caused by issues such as optical components not properly secured to the optical table, using improper materials for constructing beam barriers/stops, failure of an optical component in the system, etc.

7. Operator unfamiliar with laser equipment (not sufficiently trained).

It is very important that lab-specific/hands-on laser training be conducted in a serious manner and be as thorough as necessary to properly instruct new laser operators regarding the safe performance of their laser studies. It is critical to instill good safety habits early on so that bad/unsafe habits are not propagated. For example, if the trainer does not wear protective eyewear while demonstrating the use of laser equipment, it is less likely that the trainee will use protective eyewear during subsequent laser studies.

8. Improper restoration of equipment following service.

Never leave a laser system in an unsafe configuration. That can be very dangerous since other people who use the system might assume that it is in its normal safe condition and initiate their studies. For example, removing optical components like mirrors from the system or removing safety features like beam stops and then leaving for the day or for lunch can sometimes lead to accidents for unwitting co-workers. Either restore the system to a safe condition, or leave prominent warning signs so that others will not be placed into harm's way.

9. Failure to follow standard operating procedures due to hurrying, etc.

Always take the time to do laser experiments safely. Hurrying them along and cutting out key steps in the process can sometimes lead to serious problems.

There should be written standard operating procedures present in the lab in cases in which the manipulations performed (laser system startup, alignment, shutdown) are intricate and there are key safety related-steps that if forgotten could lead to dangerous conditions (like stray radiation).

10. Manufacturer-installed safety features removed or bypassed.

The most common instance in this category involves removing the protective housing around a laser and then operating it like that. The housing is there for a reason – the optical and electrical hazards inside the housing can be substantially greater than those outside the housing. Never defeat safety features in a laser system unless absolutely necessary, and then only if other safety controls (safe standard operating procedures, adequate protective eyewear, etc.) are used to eliminate any hazards.



MEMORABLE QUOTE

Technology is the knack of so arranging the world that we do not experience it.

Max Frisch (1911-1991) Swiss Author



LASER ACCIDENTS AT UCI – COMMONALITIES

As was mentioned above, there have been 3 laser accidents reported at UCI during the past ten years or so. Although there were many things about the 3 accidents that were different, there were several factors that were common to all of them:

1. Experienced laser users were injured, not novices.

All three people had more than 5 years of laser experience, and two of them had more than that (perhaps approaching 20 years or so). Therefore, inexperience was not an issue here.

2. All of the accidents occurred outside of normal work hours.

Two of the accidents occurred at about 7 pm on normal workdays, and the other accident occurred during a weekend. It is possible that either fatigue or hurrying could have played roles in these incidents.

3. Invisible-beam (near infrared), repetitively-pulsed lasers were being used.

Q-switched Nd:YAG lasers (1064 nm radiation) were being operated when two of the accidents occurred, and a mode-locked Ti:Sapphire laser (800 nm) was being used in the other case. Repetitively-pulsed, short pulse duration, near infrared lasers seem to be the laser systems most commonly in use when accidents occur. Use a high measure of caution when operating one of these lasers!

4. No experiment-specific written standard operating procedures (SOPs) were available in the labs.

It is possible that had written SOPs been available and they included key safety related steps in the processes, at least two of the accidents could have been avoided.

5. Nothing could be done medically to reduce the impact of the accidents once they had occurred.

This is generally the case for accidents involving the retina of the eye. If the cornea or lens is damaged by laser radiation, occasionally something surgical can be done to reduce the extent of the injury. Note that the wavelengths of laser radiation that can impact the retina extend from 400 nm (blue light) up to about 1400 nm (near infrared radiation).

MEMORABLE QUOTE



Research is to see what everybody else has seen, and to think what nobody else has thought.

Albert Szent-Györgi (1893-1986) U.S. Biochemist



If you have any questions concerned with laser safety, please contact Rick Mannix from EH&S (949-824-6098; rcmannix@uci.edu).

 **BE SAFE!!!**