LASER BEAM

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UC IRVINE LASER SAFETY NEWSLETTER

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The purpose of this newsletter is to keep laser operators on campus informed regarding laser safety news, bargains on laser safety equipment (including protective eyewear), methods for controlling laser hazards, lessons learned from laser accidents, and other tips to improve safety. These newsletters are distributed approximately every 6 months or whenever a laser safety issue with significant urgency arises. For past issues of this newsletter, please visit the UC Irvine Environmental Health & Safety website (www.ehs.uci.edu) and look under "Radiation & Laser Safety".

"COLLATERAL" EYE INJURIES

In each of the 4 serious laser accidents that have occurred at UC Irvine since 1994, the person who suffered the eye injury was the laser operator. However, there have been many cases reported at other institutions in which somebody else in a laser lab who was not directly involved in the laser procedure was injured. These *"collateral" injuries* can be prevented by following some simple laser safety rules:

- Limit access to a lab during laser operation to personnel who *really need to be there* – exclude all others!
- Lock the doors to the laser lab and post a *"Laser in Use"* warning sign.
- Never direct a laser beam off the plane of the optical table. Minimize all stray reflections.
- Use beam-isolating curtains or barriers; always use beam stops or beam dumps to back up optics on the edges of optical tables.
- *Everyone* in the room who has a *reasonable* likelihood of being exposed to laser radiation needs to wear eye protection.
- Everyone who works in a room in which a laser is operated needs to be trained in laser safety even if he/she will not be working directly with the laser.


USE OF PROTECTIVE EYEWEAR

During my 14 years as UC Irvine Laser Safety Officer, I have been to all of the laser labs on campus at least annually. From my experience, I would say that about 50% of our laser operators use protective eyewear at all times that it is needed due to potentially hazardous conditions. Another 25% probably use protective eyewear much of the time. Sadly, I believe that the other 25% use protective eyewear occasionally or rarely - if ever. These percentages are based upon my intuition – almost all laser operators here report that they use eyewear whenever hazardous lasers are operated.

As a general rule, new laser operators are more likely to use protective eyewear. They initially often have a healthy respect for the damage lasers can do to their eyesight. However, as time passes and no accidents occur, laser users become more experienced and are much more likely to become complacent and stop using eyewear. That is one of the reasons why **all 4 of the laser eye injuries at UC Irvine involved experienced laser operators**. In most of these cases, eyewear was available but was not worn.

Please keep in mind that protective eyewear needs to be worn whenever lasers are operated such that there is a reasonable likelihood of exposure to a harmful level of laser radiation. If laser beams are fully enclosed, laser studies can be performed safely without the use of eyewear.

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MEMORABLE QUOTE

"The universe is a big place, perhaps the biggest."

Kilgore Trout [alter ego of American author KurtVonnegut (1922 – 2007)]

RAMPING DOWN LASER POWER/BEAM ALIGNMENT

Always operate your lasers at the lowest output power possible when performing your experiments. Operating the laser at a higher power does not help the experiment but it does increase the hazards attendant to laser use.

Nationally, about 40 % of laser accidents occur during beam alignments. Be sure to reduce the beam power as much as possible during alignments because that is when optics are manipulated and there is the greatest risk of stray radiation.

If a ***visible*** beam laser is aligned, reduce the power as much as you can so that you can still barely see the beam and/or wear "beam alignment eyewear" if it is available. That type of eyewear has a low optical density (OD ~ 2) in order to provide some protection while still allowing the beam to be visualized. Some examples of "beam alignment eyewear" can be found at this website:

http://www.noirlaser.com/lasershields/alignment.html

If the laser beam is ***infrared (IR)***, you need to always wear your protective eyewear and visualize the beam indirectly using beam detector cards or an infrared viewing scope. Links to examples of those products are below:

http://www.thorlabs.com/NewGroupPage9.cfm?ObjectGroup_ID=296&visNavID=898

http://www.eoc-inc.com/converters/IR_converter_08_04.pdf

http://www.cascadelaser.com/ir-findrscope.htm

http://www.kenteklaserstore.com/category.aspx?categoryID=10

If the laser beam is ***ultraviolet (UV),*** it is possible to use normal paper like a business card to visualize the beam. The card will fluoresce blue light when exposed to UV radiation. Since protective eyewear for use with UV lasers is generally clear in color (no absorptive colored dyes), the ability to see the blue light is not affected by the eyewear. Go to the website below for UV protective eyewear:

http://www.noirlaser.com/filters/exc.html

SKIN BURNS CAUSED BY LASERS

There are two different types of skin burns that can be caused by lasers. Visible and infrared (IR) lasers can cause ***thermal burns*** and ultraviolet (UV) lasers can cause ***photochemical burns*** much like a sunburn.

Thermal burns are apparent immediately after the exposure and depending upon the beam power, the burn can extend far into the skin. Due to the immediate sensation of heat and/or pain, exposure durations are typically short (e.g., as long as it takes to pull a hand or arm out of the beam). There might be skin charring or bleeding in some cases; medical attention is sometimes needed.

Photochemical burns are insidious as the full extent of the injury might not be known for many hours after the exposure. *Unlike an acute IR-produced burn, photochemical burns primarily affect the upper layer of skin (epidermis) and can be caused by hours of accumulated exposure to UV radiation.* That is why the safety standard for skin exposure to UV (termed the MPE = maximum permissible exposure) is based upon the entire laser on-time for the day – it assumes as a worst case, a skin exposure the entire time the laser is operating!

Always enclose as much of the laser beam path as possible to avoid skin burns. Fire resistant enclosure material (normally jet-black metal) is needed for visible and IR beams but paper such as posterboard can be used to enclose UV radiation since it does not present a fire risk. In addition, position the beam such that your hands or arms do not need to be directly adjacent to the beam while doing your manipulations/experiments.

During a laser lab visit on campus several years ago I determined that almost everybody in the lab had received a minor skin burn from a 10 Watt Argon laser beam. It was necessary for laser personnel to reach down over the corner of an optical table just inches from the beam to make an adjustment and burns to hands and forearms occurred. This safety problem was corrected by repositioning the beam further away from that edge of the table and improving shielding.

While eye injuries are usually much more serious than skin burns, sufficient attention must be given to the potential for skin burns and steps taken to avoid them.

MEMORABLE QUOTE

" Experimental science is the queen of sciences and the goal of all speculation."

Roger Bacon (1214 - 1294); English philosopher and scientist

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UPWARDLY DIRECTED LASER BEAMS

Please keep in mind that laser beams pointed in an upwardly direction in accessible areas can be *extremely dangerous*. This was a contributing factor in 3 of our 4 laser accidents. To avoid this hazard, follow the advice below:

- ***Reconfigure the laser setup*** so that the beam is not directed upwardly at all.
- ***Reduce the height of the upwardly directed beam segment*** so that it is not possible to expose your eyes by inserting your head into the beam (using a short "periscope" is fine – no eye exposure possible).
- ***Shield the upwardly directed beam at the top*** by backing up the optic (generally a mirror) with a beam stop/block *even if the mirror is 100 % reflective and is rarely removed from its position.*
- ***Completely enclose the beam*** on all accessible sides and the top if the upwardly directed beam spans more than about 6 inches.

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

BE SAFE!