LASER SAFETY DURING ALIGNMENTS

☞ **Most laser accidents occur while aligning an optical system. For example, when you first place a mirror in a beam, you do not know where the reflected beam will go. If the vertical adjustment happens to be near the end of its range from the last time it was used, the beam could be sent upwards - potentially to the level of your eyes. Fortunately, it is easy to align a laser system safely.**

WHEN ALIGNING OPEN BEAMS FROM HAZARDOUS LASERS (CLASS 3b OR CLASS 4), PLEASE FOLLOW THESE CHECKLIST ITEMS:

Initial Considerations and Area Preparations

- ☐ All laser users must receive initial laser safety training (from EH&S, etc.). Make sure you have also received sufficient on-the-job/hands-on training in the laboratory.
- ☐ Never operate a laser without the permission of your PI, or deviate from established standard operating procedures.
- ☐ **Access to laser rooms/areas is limited to authorized personnel only when lasers are in use.**
- ☐ A laser use area in a dual-purpose room must be isolated with laser barrier curtains.
- ☐ Cover windows or viewing ports on the perimeter of laser rooms/areas.
- ☐ Entrances to laser rooms/areas must be posted with "Notice" or "Danger" signs made in accordance with ANSI standards.
- ☐ If available, be sure that exterior warning lights/indicators are functioning.
- ☐ It is recommended that a risk assessment be done for new laser laboratories or new laser procedures. Appendix A is an example of a risk assessment form.

Equipment preparations

- ☐ Carefully diagram beam paths and optical components that are planned for a laser table.
- ☐ Have all equipment and materials needed before beginning the alignment. This will require the following items: targets, beam stops/blocks, power meter/detector, beam profiling system, etc. Use only non-reflective tools for all laser work.
- ☐ Pay attention to housekeeping; make sure the immediate work area/benchtop/optical table is free of combustible materials (if fire is a possibility) and opportunistic specular reflectors not need for alignment (e.g., computer monitors, glass items, forceps, etc.). Also clear away any potential trip hazards.

User Preparations

- ☐ Remove watches, rings, dangling badges, necklaces, reflective jewelry, etc. before any alignment begins.
- ☐ Skin protection should be worn on the face, hands and arms when aligning UV systems.

Protective Eyewear

- ☐ **Appropriate laser protective eyewear MUST be worn by all users whenever there is an open Class 3b or Class 4 beam!**
- ☐ Users must have the correct eyewear for the laser's wavelength(s) and power levels.
- ☐ If approved by your Laser Safety Officer (LSO), reduced optical density eyewear may be used to allow the beam spot to be seen. A return to the maximum OD eyewear will be made when the alignment is complete. The eyewear will be labeled as "Alignment Eyewear" and will be stored in a different location than the maximum OD eyewear for this operation.

Beam viewing

Remember that invisible-beam near-infrared lasers are the most dangerous!

- ☐ Direct (intrabeam) viewing by eye is prohibited. Intrabeam viewing is to be avoided by using cameras, or devices like handheld IR scopes.

- ☐ Invisible beams may be viewed with IR/UV cards, business cards or card stock, craft paper, 3x5 cards, thermal fax paper, Polaroid film or similar techniques. Operators are aware that specular reflections off some of these devices is possible, and that they may smoke or burn.

- ☐ When using viewing aids to visualize the beam, reach into the beam path slowly and deliberately with the card (for example) -- slightly angled so you can see the diffuse reflection. Adjust the optic so that the beam strikes the card just in front of the surface of the component.

Beam control

- ☐ Confine the beam to the optical table or benchtop. Be aware of the potential for errant reflections (stray beams) from components such as polarizers and dielectric mirrors. Check for stray beams at each step and again after completing all alignment steps. As you progress down the optical path, place beam blocks behind optics to be adjusted to stop errant (stray) beams.

- ☐ Have beam paths at a safe height, below eye level when standing or sitting, not at a level that tempts one to bend down and look at the beam. If necessary, place a platform around the optical table to raise one's height.

- ☐ Never direct beams upwards or across walkways.

- ☐ Label all areas where the beam leaves the horizontal plane. If the beam path changes elevation (+Z), be aware of the increased potential for vertical reflections.

- ☐ Enclose the beam as much as practical; close the shutter as much as practical during course adjustments; and secure optics/optics mounts to the table as much as practical; secure beam stops to the table or optics mounts.

- [ ] If the beam path to be aligned is located in different rooms, locate a beam block in the beam path between the rooms, and align one room, then the other. If line of sight with personnel in other rooms is blocked, use two-way, real-time communications. Be patient at each step.

Beam power reduction

- [ ] Perform the "rough" or coarse" alignment with the beam blocked.

- [ ] Whenever possible, co-axial low power lasers (such as a HeNe) should be used when practical for alignment of the primary beam.

- [ ] Reduce the beam power through the use of filters, beam splitters and dumps, or reducing power at the power supply. Avoid the use of high-power settings during alignment as much as is practical. If the alignment has been performed at lower power or with a low-power collinear beam but final steps will be performed at operational power levels, be sure and change to the appropriate eyewear for the high-power beam.

- [ ] For CW lasers with adjustable power, adjust the power to a minimum stable level.

- [ ] For pulsed lasers, do the alignment by firing single pulses when practical, and/or reduce the pump power.

- [ ] For Q-switched lasers, turn off the Q-switch and use in the low-power, CW mode.

- [ ] If the primary laser is optically pumped by another laser and alignment of the pump beam is necessary, block the primary beam to limit potential multi-wavelength exposure/eyewear concerns, align the pump beam, and then replace beam enclosure in the pump-to-laser beam path.