Laser Alignment Guidelines

What is Laser Alignment?

- Laser beam alignment requires work with an open beam and involves directing the beam toward a series of reflective or partially reflective surfaces, such as mirrors or lenses, so that the beam follows some predetermined path. With respect to the laser, alignments may be internal or external.
- Internal alignments are those that occur within the laser cavity or head and often place the worker at increased risk of electrical accidents as well as beam exposure. The need for internal alignment arises most often because of problems associated with beam mode or power.
- External alignments are those that occur from the laser's end window to some terminal target (beam stop). In between these two locations may be a number of optical components (optics) arrayed in configurations that may be simple (few optics) or quite complex (many optics, multiple tables, extends outside primary area/room, etc.). The need for external alignment occurs because of requirements for an initial setup, reconfiguration of the optical setup, or replacement of components in the open beam path.
- External alignments include optical table (benchtop), laser-to-fiberport, fiberport-to-fiberport, free-space delivery, beam-to sensor (receiver), and laser therapy.

General Safety Guidelines

- Exclude unnecessary personnel from the laser area during alignment.
- Alignments should be done only by those who have received laser safety training.
- Post appropriate area warning signs during alignment procedures where lasers are normally Class 1 (enclosed).
- Use low-power visible lasers for path simulation of higher power visible or invisible lasers whenever possible.
- Perform alignment tasks using high-power lasers at the lowest possible power level for the alignment.
- Wear laser protective eyewear during alignment. Use special alignment eyewear when circumstances (e.g. wavelength, power, etc.) permit their use.
- When aligning invisible (e.g. UV, IR) beams, use beam display devices such as remote viewing devices, thermal paper, ceramic discs, IR/UV viewing scopes, paper cards, phosphor-viewing cards. If fluorescent viewing cards need optical charging, have a UV lamp on hand.
- Make sure tools or items used in and around the beam path have non-reflective, diffusing surfaces.
- Use a shutter or beam block to block high-power beams at their source except when actually needed during the alignment process.
- Use a laser rated beam block to terminate high-power beams downstream of the optics being aligned.
- Use beam blocks and/or laser protective barriers in conditions where alignment beams could stray into areas with uninvolved personnel.
- Place beam blocks behind optics (e.g.: turning mirrors) to terminate beams that might miss mirrors during alignment.
- Locate and block all stray reflections before proceeding to the next optical component or section.
- Be sure all beams and reflections are properly terminated before high-power operation.

Specific Alignment Issues

The following issues are typical problem areas. Lawrence Berkeley National Laboratory has developed an alignment course which addresses these issues and we provide a link below to the Powerpoint slides that specifically address how to deal with them *(Link to the Powerpoint slides).*

Wedge Window Alignment

- The alignment and setup of wedge window assembly presents high potential for laser eye injury and uncontrolled secondary back reflection as a wedge consist of two reflective surfaces and can potentially be oriented in such a way to expose directly the back reflection upward or towards an undesired path.

Beam Splitter Cube Alignment

- The alignment and setup of polarizing beam splitter cube presents high potential for laser eye injury and/or uncontrolled reflections as a polarizing cube consist of two polarized orthogonal reflections coming from two orthogonal surfaces. Typical mounting of such optic allows for 360^{o} rotation, therefore presenting high risks for upward and unsafe beam path.

Flipper Mirror Setup

- The alignment and setup of a flipper mirror assembly presents high potential for laser eye injury as it can be set improperly and provide a risk to redirect a laser beam at a multitude of upward angles during the flipping motion.
- Always mount the flip mirror to flip downwards!

Periscope Alignment

- The alignment of a periscope of any type (up-and-over or plane-vertical) present high potential for laser eye injury as it re-directs the beam in both the horizontal and vertical plane. A careful alignment process is required to ensure that all reflections are considered and controlled at all time.

Attenuation Filters

- Introduction of attenuator into the beam path may pose safety concerns as it generates back reflections that need to be controlled at all time.

IR Beams

- The alignment and manipulation of IR beams pose a practical and safety problem due to the fact that the beam is invisible to the human eye. Therefore, any unexpected beams or scattered light cannot be detected visually. It requires additional laser tools that students will get familiar with. Additionally, introduction of lenses into the beam path may pose safety concerns as it generates diverging and converging beams that need to be considered and controlled. See the section below about methods for visualization of invisible laser beams

Recommendations and different options for visualization of the invisible laser beams:

- Never move coated cards or optics in the beam: shutter the beam, and then move the card or optic.
- ALWAYS tilt the IR sensor card DOWN so that any reflection is directed downward and away from anyone standing in the area.
- The majority of IR sensor cards found in laser labs are covered with a plastic film to protect the fluorescent material from oxidation. They have the ability to scatter the light differently than expected, including specular reflection and should be used with caution.
- Use sensor cards with rough surfaces where possible. One suggestion is to peel off the coating or roughen the coating surface or use sensor cards without plastic film.
- Use coated cards only in low energy beams (where their high sensitivity may be required).

- The sensor cards present a fire hazard if positioned too close to a focus or left too long in the beam. While the cards rarely catch fire, smoke from burning can damage optics. Know your expected irradiance. As a general rule, NEVER leave an IR sensor card or any combustible card/plastic/beam blocks in a beam path unsupervised for an extended period of time.
- When possible, use an IR viewer but remember – use it with your laser protective eyewear!
- Consider using IR cameras for remote viewing. Commercial systems are available, homemade systems can use web cameras and monitor.