*Black Text – is considered mandatory content (see footnote[[1]](#footnote-1))*

*Red text – fill in the appropriate information for factual accuracy*

*Blue Text – (sample text) may be retained, edited, or deleted as appropriate for factual accuracy*

Approved by Principal Investigator: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Standard Operating Procedure

Location

Type of Laser(s) or experiment

Date, version

# Purpose

This Standard Operating Procedure (SOP) applies to the operation of the following lasers: list of lasers if few or reference to laser list provided by EHS if many

This document is to be reviewed when changes are made to the laser or experimental setup.

1. **Personnel**
2. Authorized Personnel: The above lasers must be operated only by persons with full laser training. See the list of authorized personnel.
3. Persons working in the room when the laser is operated must have either the full laser training or Laser safety awareness training. See the list of authorized personnel.
4. Unauthorized personnel:

All persons present in the lab when the laser is operated and who are not trained (see points A and B) must be considered visitors. Visitors must:

1. Receive authorization from Prof. J. Doe
2. Be briefed on proper control measures and understand the hazards
3. Wear appropriate laser protective eyewear located on the premises.

# Hazards

1. Laser Hazards: Severe eye damage (including blindness) and skin damage can result from the direct beam and specular reflections. Eye damage can also result from diffuse reflections (Class 4).
2. Electrical Hazards: electrical shock or electrocution could result from direct contact with high voltage, either live contacts or charged capacitors. List types of electrical hazards associated with laser use, equipment, or experiment.
3. Chemical: List types of chemical hazards associated with laser use, equipment, or experiment.
4. Gas cylinders: List types of gas cylinders associated with laser use, equipment, or experiment.
5. Other (fire, animals, biological hazards, x-rays, etc.): List types of other hazards associated with laser use, equipment, or experiment.

# Hazard Controls

1. Lasers
	1. Laser eye protection (LEP) with proper OD for the lasers in the lab (*see the list of lasers*) is available and is located at (detail the location of where laser eye protection is in the lab and also describes the different types of eyewear if multiple pairs are needed). Laser eye protection is required to be worn by all personnel anytime there is an open beam that exceeds the maximum permissible exposure.

Please note: Laser Eye Protection is wavelength specific and proper selection is critical

* 1. Specular and diffuse reflections will be controlled using beam stops, beam barriers, beam housings, and enclosures.
	2. No jewelry or other reflective materials are to be worn while working with the laser.
	3. Personnel in the laser lab should avoid bending over or otherwise putting their eyes at the level of the beam path while the laser is in operation.
	4. Laser alignment must be performed only by following the steps outlined in Appendix C.
	5. Perform physical surveys to determine if there are stray beams (specular or diffuse) emanating from each laser and its optics, and then document the beam surveys noting the location of stray beams and the measures taken to control them. *Please indicate the method of documentation of survey (checklist or log, etc.)*
	6. If the beam path must be changed significantly by relocating the laser or optics, all users must be notified of the change.
	7. When a new principal researcher/experimenter takes over the use of the laser system, the new user must conduct a survey for unwanted stray or diffuse beams. Appropriate tools such as IR/UV sensitive cards or IR/UV viewer shall be used for locating the possibility of stray IR/UV light.
1. Electrical (List controls used to mitigate the hazard)
2. Enclosures for protection against the high voltages of the laser power supply or laser head may only be removed after the power supply has been unplugged from the outlets and after following the safety procedures outlined in the safety and operating manual provided by the manufacturer (charged capacitors).
3. Only qualified personnel may perform all internal maintenance to the laser and more than one user must be present when performing said maintenance.
4. Every portion of the electrical system, including the printed circuit cards, should be assumed to be at a dangerous voltage level.
5. Chemical List controls used to mitigate the hazard
6. Gas Cylinders must be kept upright and locked with a chain. When not in use or when they need to be moved from one location to another, the safety cap must be installed. The laser beam must not hit the cylinders. Empty cylinders must be stored in the unit/departmental designated space.
7. Other (fire, animals, biologicals, x-rays, etc.) List controls used to mitigate the hazard

# Normal Operation

(SAMPLE TEXT – text below may be retained, edited, or deleted as appropriate for factual accuracy)

1. Ensure that all hazard controls (section IV of this procedure) are in place.
2. Inspect all electrical and water connections for damage and connectivity.
3. Check that the laser curtain is securely closed with no gaps.
4. Check for and remove any foreign objects in the beam path other than safety controls such as beam stops. Remove all unnecessary equipment, tools, and combustible materials from the laser table and immediate area to minimize the possibility of stray reflections and non-beam accidents.
5. Complete the “check-in” portion of the checklist included in this document as Appendix A. The checklist serves to confirm that all basic systems are operating within expected parameters and that basic safety mechanisms are in place. The laser run log is a set of forms adjacent to the experimental setup and is used to ascertain the current state of the laser. Log all use and add individual notes as necessary. Also, replacement of optics and other routine maintenance should be noted in the log. Once the checklist is complete, the laser may be turned on.
6. Turn the laser system on.
7. System alignment. See the attached alignment procedure Appendix C.
8. Shutdown laser system.
9. After a run is finished, complete the log entry and the checkout portion of the checklist in Appendix A.

# Emergency Procedures

1. Laser accidents: Follow the steps outlined in the Procedure for Laser Accidents in Appendix B.
2. Power outage: If there is a power outage, turn off the laser to avoid a hazardous situation when power is restored.
3. Fire alarm: if the fire alarm starts in the building, turn off the lasers and leave the building. If turning off the laser is not practical, block the beam with a shutter/beam stopper as close as possible to the exit of the laser. This will minimize areas of the lab where the irradiance is above the MPE.

**Appendix A** – Checklist for using Type of laser or experiment

Check-in: (SAMPLE TEXT – text below may be retained, edited, or deleted as appropriate for factual accuracy)

* The door is closed, laser sign is ON (Class 4 lasers) and all personnel is wearing the appropriate laser protective eyewear.
* Inspect the apparatus for any blockages or apparent misalignment.
* Confirm that the beam path is set up to hit the sample properly.
* Ensure that all beam enclosures and/or beam stops are placed properly in the work area.
* Record laser energy in the logbook.
* During the run, ensure that the laser is hitting the sample/target correctly.
* Record any anomalous behavior in the logbook.

Check out:

* Shut off the laser.

**Appendix B** – Procedure for Laser Accidents

In the event of a laser accident, follow the procedure below:

1. Ensure that the laser is shut off but do not change the settings.
2. Provide for the safety of the personnel (first aid, evacuation, etc.) as needed. Note — if an eye injury is suspected, have the injured person keep his/her head upright and still to reduce bleeding in the eye. A physician should evaluate laser injuries as soon as possible.
3. Obtain medical assistance for anyone who may be injured.
4. If there is a fire, pull the alarm, and contact the fire department by calling 911. Do not fight the fire unless you have been trained in firefighting techniques. Use only one fire extinguisher.
5. During normal working hours, call the following:

|  |  |
| --- | --- |
| Laser Safety Officer (Sandu) | 416-978-2028 |
| Laser Safety Officer (Gustavo) | 416-946-0530 |
| EHS office | 416-978-6011 |

After normal working hours, call UofT Police 416-978-2222 (St. George and Scarborough Campuses) or 905-569-4333 (Mississauga Campus).

1. Inform (***PI NAME)*** and the current group laser supervisor as soon as possible. If there is an injury, (***PI NAME)*** must complete and sign an “Accident/ Incident/ Report”.
	1. for U of T employees: <http://ehs.utoronto.ca/report-an-incident/online-accidentincident-eform-for-employees/>
	2. for students, contractors, visitors: <http://ehs.utoronto.ca/report-an-incident/online-accidentincident-eform-for-students-contractors-and-visitors/>
2. (***PI NAME)*** must notify
	1. Office of Environmental Health and Safety
	2. Joint Health and Safety Committee
	3. Union (if any)

**Appendix C** - Alignment Procedures

Note: Remember that most of the laser accident happen during the alignment. Alignment can be very long and tedious. If you are tired or impaired do not attempt to align the laser.

1. Post the “Laser Alignment in Progress” notice sign outside the laser lab before beginning any alignment procedure.
2. Alignment should only be performed when there are at least two authorized users present who have been trained to respond to a laser safety emergency.
3. General Alignment Safety Concerns
4. Use of non-reflective alignment tools should be considered. When reflective tools are required, be mindful to keep tools out of the beam path.
5. Never allow the beam to propagate beyond the point to which you have aligned and always be aware of the full beam path.
6. Always block the beam upstream when inserting/removing anything into/from the beam path, such as alignment irises.
7. Use a pair of index cards when checking the alignment of the beam so that you never have to leave the beam unblocked to move a card past a mirror.
8. As alignment proceeds down the table, a beam block should always be placed downstream in a position to catch the beam directly after the pair of mirrors being aligned, preventing the beam from propagating through an unaligned path.
9. Be aware that all transmissive optics generate back reflections and some reflective optics have a substantial leak through. When working with these components be sure to track, block, and record all stray beams. When reflections travel back upstream and encounter a beam splitting optic a new beam path can be formed in an unexpected direction.
10. When working with focusing elements, it important to be aware that there may be sufficient intensity at the focus to burn skin and/or ignite combustible materials, such as index cards. At sufficiently high powers the focus may create a plasma in the air resulting in a loud “popping” noise at the repetition rate of the laser, a glowing white spot at the focus where nonlinear optical processes are occurring, and the creation of ozone that smells like electric discharge. If this occurs simply block the beam upstream from the focusing element and either reduce the power of the beam or change the focusing element to a less tightly focusing optic.

## Internal alignment Mirrors

(SAMPLE TEXT – text below may be retained, edited, or deleted as appropriate for factual accuracy)

1. This procedure must be performed only by very experienced persons. Any attempt by inexperienced persons may result in serious eye or skin injuries, electrocution, severe damage of the laser, voiding manufacturer warranty, etc.
2. Ensure that all users are wearing appropriate laser protective eyewear, warning signs are posted, and laboratory doors are closed. Check that the laser path goes to the power meter and is enclosed.
3. Turn on the cooling water.
4. Turn on the power supply, checking that the water light comes on.
5. Turn to the current mode/full power; turn on the laser and press start.
6. Adjust vertical and horizontal knobs back to maximum power.
7. Turn off the laser and power supply.
8. Take off the lid and screw on safety overrides.
9. Test the power again (after turning the laser back on). Adjust to full power.
10. Use a non-reflective 7/16 wrench. Turn the vertical front knob to \_\_\_ power and adjust the back vertical knob in the opposite direction to see if power increases past the original power.
11. If so, repeat. If not, turn the front knob in the other direction and repeat.
12. When the power is maximized, turn off the laser.
13. Replace the laser covering and let the cooling water run for 30 minutes.
14. External Optics

(SAMPLE TEXT – text below may be retained, edited, or deleted as appropriate for factual accuracy)

1. Ensure that all users are wearing appropriate laser protective eyewear, warning signs are posted, and laboratory doors are closed. Check that the laser path will be blocked.
2. Turn on the cooling water.
3. Turn on the power supply, checking that the water light comes on.
4. Turn to the current mode/full power; turn on the laser and press start. *(LASER BEAM POWER SETTING-USE LOWEST POSSIBLE POWER FOR ALIGNMENT)*
5. Set up the first optic, block the beam path optic, and carefully release the original block to ensure that the beam will hit the center of the mirror.
6. Set up two targets in the beam path, unblock the beam, and center the beam using adjustments on the optic. Make sure that that beam does not “clip” (i.e. that part of the beam does not go past mirror, or strike the corner of another mirror and set sent off at unexpected angles. Use card held directly in front of the mirror to determine that the beam is centered, and directly after the mirror to check beam profile for “clipping”.
7. Continue until optics are set up properly. Check that all mounts are tightly in place and will not inadvertently shift, causing changes in alignment.
8. Check for stray beams at each step and again after completing all alignment steps, using IR/UV viewer or IR/UV card if necessary. Please indicate the method of documentation of survey (checklist or log, etc.) See section Appendix A.
9. Check that ALL laser beam enclosure and /or beam stops are in place.
1. If you consider that some parts in black typeface do not apply to your lab and want to remove or edit them, please contact LSO for approval [↑](#footnote-ref-1)