Approved by Principal Investigator: _____ Date:_____

Approved by Laser Safety Officer: _____ Date:_____

Standard Operating Procedure
Hildebrand Hall Room B70
Coherent Genesis MX Optically Pumped Semiconductor (OPS) Laser (514 ± 3 nm)
August 4, 2014; Version 1

I. Purpose

This Standard Operating Procedure (SOP) outlines requirements to be considered by an authorized user of the 514 nm Coherent OPS Laser in the Cohen Lab Optical Trap as well as describes the normal operation of the laser and any hazards that may be encountered during normal operation. Finally, the SOP explains how to minimize any hazards and how to respond in an emergency situation. This document is to be reviewed one year from the date of approval or as conditions warrant, whichever is the shorter time period.

II. Personnel

A. Authorized Personnel: The 514 nm Coherent OPS Laser in the Cohen Lab Optical Trap may be operated only by authorized personnel who are fully cognizant of all safety issues involved in the operation of such a device. These personnel are to ensure that the laser is only operated in the manner laid out in this document. To become an authorized user, one must:

1. Complete Environment, Health & Safety (EH&S) training class (or LBNL equivalent).
2. Take a baseline ophthalmologic examination
3. Read and fully understand the SOP
4. Receive training on the 514 nm Coherent OPS Laser in the Cohen Lab Optical Trap by an authorized user.
5. Sign the authorized user sheet to affirm that the above steps have been completed.

B. Unauthorized Personnel: No unauthorized personnel may enter Hildebrand B70 during laser operation unless accompanied by an authorized user. All visitors must be briefed on proper safety protocol and must wear appropriate laser protective eyewear located on the premises.

III. Hazards

A. Laser Hazards: The 514 nm Coherent OPS Laser is a Class 4 laser. Severe eye damage (including blindness) and skin damage can result from direct beam and specular reflections. Eye damage can also result from diffuse reflections (Class 4).

B. Electrical Hazards: Electrical shock or electrocution could result from direct contact with high voltage. No high voltage risks are present. The laser unit is a fully contained commercial unit (Coherent Genesis MX-STM) with no user-

serviceable parts.

C. Chemical: There are no chemical hazards related to laser use.

D. Pressure Hazards: There are no chemical hazards related to laser use.

E. Other: None.

IV. Hazard Controls

A. Lasers:

1. Only authorized personnel will operate lasers.
2. The laboratory doors will be closed and locked whenever laser is operating.
3. During alignments, the laboratory doors will be closed, locked, and a sign posted stating "**Laser alignment in progress. Do not enter. Eye protection required."**
4. Unauthorized personnel will be only allowed entry to the laboratory during laser operation with the supervision of an authorized user under the terms specified in section 2.
5. Laser protective eyewear for sufficient protection against 514 nm is available and is located on the shelf to the right of the entrance to Hildebrand B70. **Laser protective eyewear must always be worn when the laser is in operation.** No filters or other optics will provide suitable protection; use only laser safety protective eyewear. PLEASE NOTE: Laser protective eyewear is wavelength specific and proper section is important.
6. Specular and diffuse reflections will be controlled using beam stops, beam barriers, beam housings and enclosures. All of these control methods must be in place during normal operation.
7. No jewelry or other reflective materials are to be worn while working with the Laser, especially on the hands and neck.
8. Personal 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.
9. Laser alignment must be performed only by following the steps outlined in the alignment procedure supplement or alignment section.
10. 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. See the documentation of the survey in the log book.
11. If the beam path must be changed significantly by relocating the laser or optics, all users must be notified of the change.
12. The same precautions that are taken for safe operation of the laser must also be followed when adjusting any of the optics in use with the apparatus.
13. When a new principal researcher/experimenter takes over use of the laser system, the new user must conduct a survey for unwanted stray or diffuse beams. Appropriate tools such as IR sensitive cards or IR viewer shall be

used for locating the possibility of stray IR light.

14. Experimental end stations should be treated the same as the laser system with regards to the proceeding safety procedures.

B. Electrical: No high voltage risks are present. The laser unit is a fully contained commercial unit (Coherent Genesis MX-STM) with no user-serviceable parts.

C. Chemical: There are no chemical hazards related to laser use.

D. Pressure Hazards: There are no chemical hazards related to laser use.

E. Other: None

V. Normal Operation

A. Inspect all electrical and water connections for damage and connectivity.

B. 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 set up 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.

C. Turn laser system on by turning the key on the power supply. The green Laser ON LED will illuminate. Change the system power with the knob on the power supply or remotely using the computer. CAUTION – the knob on the power supply is very coarse, so the power can change in large steps. Wear appropriate goggles when turning up the power using the knob.

D. System alignment. See Appendix C for details.

E. Shutdown laser system by lowering the power, turning the key off, turning the power supply off, and turning off the water cooler.

F. After a run is finished, complete the log entry and the checkout portion of the checklist in Appendix A.

VI. Emergency Procedures

A. Laser accidents: Follow the steps outlined in the Procedure for Laser Accidents in Appendix B.

B. Power outage: If there is a power outage, turn off the laser to avoid a hazardous situation when power is restored.

Authorized Users

I have read and understood the Standard Operating Procedures for the 514 nm Coherent OPS Laser

Name (print)	Signature	Date	PI Initial

Appendix A
Checklist for using the 514 nm Coherent OPS Laser

Check in:

- Make sure the room door is closed and locked and the curtain is drawn.
- Confirm that all personnel are wearing the appropriate laser protective eyewear.
- Inspect the table 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.
- Turn on the ThermoTek water cooler. Confirm the set point is at 20°C. Listen for the water circulating through the laser head and confirm the fans in the ThermoTek are running. (The water level should remain constant, but once a month, follow the procedure on the back of the system and in the manual to replace the *distilled* water in the system.)
- Turn on the power source and wait for the yellow Interlock OK LED to light up.

Check out:

- Shut off the laser using the key on the power supply.
- Turn off the water cooler.

During the experiment:

- Record the laser power
- Ensure that the laser is hitting the sample correctly.
- Record any anomalous behavior in the logbook.
- Record any changes to the optical path or the set up in the log book.

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.
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.

UC Optometry Clinic (Normal Hours)	642-2020
UC Optometry Clinic (24 Hour Emergencies)	642-0992
University Health Services (Emergency)	642-3188
Ambulance (urgent medical care)	9-911

4. If there is a fire, pull the alarm, and contact the fire department by calling 9-911. Do not fight the fire unless it is very small and you have been trained in fire fighting techniques.
5. Inform the Office of Environment Health, & Safety (EH&S) as soon as possible.
6. During normal working hours, call the following:

EH&S Office	642-3073
Laser Safety Officer	643-9243
EH&S Health & Safety Manager	642-3073

   After normal working hours, call 642-6760 to contact the UC Police Department who can contact the above using their emergency call list.
7. Inform Ron Cohen and the current group safety officer as soon as possible. If there is an injury, Ron Cohen will need to submit a report of injury to the Worker's Compensation Office.
8. After the incident, do not resume use of the laser system until the Non-Ionizing Radiation Safety Committee has reviewed the incident and approved the resumption of research.

Appendix C
Alignment Procedures

A. Pre-Alignment Safety
    1. Post the "Laser Alignment in Progress" notice sign outside the laser lab before beginning any alignment procedure.
    2. Check that the laser curtain is securely closed with no gaps.
    3. Only authorized personal are allowed in the laser lab during alignment.
    4. All personal in the room must wear the appropriate laser protective eyewear during alignment.
    5. To reduce accidental reflections, watches, rings, dangling badges, and other reflective jewelry or materials must be taken off before any alignment activity begins.
    6. Alignment should only be performed when there is at least *two* authorized users present who have been trained to respond to a laser safety emergency.
    7. Check for and remove any foreign objects in the beam path other than safety controls such as beam blocks. 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.

B. General Alignment Safety Concerns
    1. Use of non-reflective alignment tools should be considered. When reflective tools are required, be mindful to keep tools out of the beam path.
    2. Never allow the beam to propagate beyond the point to which you have aligned and always be aware of the full beam path.
    3. Always block the beam upstream when inserting/removing anything into/from the beam path, such as alignment irises.
    4. 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.
    5. As alignment proceeds down the table, a beam block should always be placed down stream in a position to catch the beam directly after the pair of mirrors being aligned, preventing the beam from propagating through an unaligned path.
    6. Be aware that all transmissive optics generate back reflections and some reflective optics have substantial leak through. When working with these components be sure to track, block, and record all stray beams. This is a particular concern with filters (We currently use both ND and Bandpass filters), which generate strong specular reflections that can propagate back up stream a long way before diverging off the beam path due to very slight miss alignments. When such a reflection travels back upstream and encounters a beam splitting optic a new beam path can be formed in an unexpected direction.
    7. 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.

C. Internal alignment Mirrors – Not applicable

D. External Optics

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. Complete the laser Check-In procedure of Appendix A.
3. Turn on the laser system by turning the key on the power supply. The green Laser ON LED will illuminate. Change the system power with the knob on the power supply or remotely using the computer.
4. For alignment, use the lowest possible power.
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 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 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 ad 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 viewer or IR card if necessary. Record the check for stray beams in the documentation of survey section in the log book
9. Check that ALL laser beam enclosure and/or beam stops are in place.