

**Approved by Principal Investigator:**

**Date:** June 8, 2021

**Approved by Laser Safety Officer:**

Date: \_\_\_\_\_

## Standard Operating Procedure

**McCone Hall, Room 349**

## Diode-Pumped Solid-State Laser

2021

## I. Purpose

This Standard Operating Procedure (SOP) outlines requirements to be considered by an authorized user of the **Diode-Pumped Solid-State laser** 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 **Diode-Pumped Solid-State laser** 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 “EHS 301 – Laser Safety Training Initial” e-Course.
  2. Read and fully understand the SOP
  3. Receive hands-on training on the **Diode-Pumped Solid-State laser** by an authorized user.
  4. Sign the authorized user sheet to affirm that the above steps have been completed.
- B. Unauthorized personnel: No unauthorized personnel may enter **room 349** 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: This Laser Quantum Gem Diode-Pumped Solid-State 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.
- C. Chemical: N/A
- D. Pressure Hazards: N/A

E. Other: fire hazards could result from active laser beams focusing on flammable material.

#### 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. Laser 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 eye protection (LEP) for sufficient protection against 532 nm is available and is located below the laser warning sign at the entrance of the lab. Laser eye protection is required to be worn for all beam alignments/beam manipulations or anytime there is an open beam that exceeds the maximum permissible value.

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

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. **Make sure to document each survey in the lab notebook.**

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

1. 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 operations manual provided by the manufacturer.
2. Only qualified personnel may perform all internal maintenance to the laser and more than one user must be present when performing said maintenance.
3. Every portion of the electrical system, including the printed circuit cards, should be assumed to be at dangerous voltage level.

#### C. Chemical

#### D. Pressure

#### E. Other

1. Only qualified personnel may perform beam alignment and more than one user must be present when performing such operations. Flammable materials shall all be kept away from the laser source.

### V. Normal Operation

- A. Inspect all electrical 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.

D. System alignment. See the attached alignment procedure supplement/alignment section for details.

E. Shutdown laser system.

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 using the QDM lab Diode-Pumped Solid-State laser.

Name (print)	Signature	Date	PI Initial

**Appendix A** – Checklist for using the QDM lab Diode-Pumped Solid-State laser.

Check in:

- Door is closed and all personnel are 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 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.
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.

Optometry Clinic (Normal Hours)	
Optometry Clinic (24 Hour Emergencies)	
University Health Services (Emergency)	
Ambulance (urgent medical care)	

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	642-3073
Radiation Safety Officer	642-3073

After normal working hours, call 642-3073 to contact the ### who can contact the above using their emergency call list.

7. Inform **PI Nicholas Swanon-Hysell** and the current group safety officer as soon as possible. If there is an injury, **PI Nicholas Swanon-Hysell** 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 are 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 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.



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. At sufficiently high powers the focus may create 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. This can be disconcerting when unexpected. 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.

### C. External Optics

15. 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.
16. Turn on the power supply.
17. Turn to current mode/ full power; turn on the laser and press start. (*LASER BEAM POWER SETTING-USE LOWEST POSSIBLE POWER FOR ALIGNMENT*)
18. 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.
19. 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”).
20. Continue until optics are set up properly. Check that all mounts are tightly in place and will not inadvertently shift, causing changes in alignment.
21. Check for stray beams at each step and again after completing all alignment steps, using IR viewer or IR card if necessary. Please indicate method of documentation of survey (checklist or log, etc.) See section IV.A.8
22. Check that ALL laser beam enclosure and /or beam stops are in place.