

SOP - Coherent Verdi V-5 Laser - Stevenson 6517

The American National Standards Institute (ANSI) Standard for Safe Use of Lasers requires that Standard Operating Procedures (SOP) be written and approved for Class 3B and 4 lasers or laser systems.

This SOP pertains to one of two Verdi lasers located in Stevenson 6517. This Verdi-V5 is located near the lab entrance and is enclosed in a shielded opaque box under normal operation. Output light is coupled into a fiber that runs directly to an upright confocal microscope. While the laser is classified as a Class IV laser according to its manufacturer, the output light from the microscope objective does not exceed 5 mW under typical operation with the surrounding enclosure intact.

System description

Type of laser	Diode-pumped, frequency-doubled Nd:YAG
Manufacturer	Verdi
Model	Verdi-V5
Serial Number	V5-G5403
Classification	Class 4
Wavelength	532 nm
Power	variable, up to 5 W
Energy per pulse	N/A (continuous)
Pulse duration	N/A (continuous)
Repetition rate	N/A (continuous)
Output beam diameter	2.25 mm \pm 10%
Beam divergence	< 0.5 mrad
Intended application	Excitation source for photoluminescence microscopy
Other system attributes not listed above	External water chiller required for use

Hazards

Beam hazards

None under typical use.

Alignment procedures dictate using low power (0.01 W) for beam alignment—in which case no additional beam hazards are present.

Non-beam hazards

Eye Avoid eye exposure to direct or scattered radiation within the enclosure box. Avoid eye exposure to the end of the output fiber. Do not use optical aids to look at the illuminated sample in the microscope.

Skin None under typical use.

Laser-generated air contaminants (LGAC) None under typical use.

Scattered radiation None under typical use.

Electrical None under typical use.

Other Potential for water leaks from coolant system.

Ensure that there is sufficient water in the external chiller and that there are no leaks during chiller operation. Spilled water presents an electrical hazard to nearby power supplies and a slip hazard to nearby operators.

Insufficient cooling of the laser will damage the diode. If leaks are detected, start the shutdown procedure immediately.

Control measures

Laser protective eyewear type(s) and requirements for use

During alignment, wear appropriate safety goggles that specifically cover 532 nm emission with OD > 4. Remove jewelry (e.g. watches, rings, earrings) to mitigate scattering risks. Use an alignment card to view the beam.

Laser control area

Under normal operation, the laser is enclosed in an opaque box that mitigates scattering hazards. Light is coupled to a fiber that runs directly to a confocal microscope. The total power of the focused laser light through the microscope objectives is nominally a few milliwatts, and varies slightly depending on specific microscope objectives and laser operation power.

If alignment to the output fiber is necessary, the enclosure box may be disassembled, in which case the system should be treated like a class IV laser that is capable of producing 5W laser light. Direct beam exposure at high power presents a fire hazard to flammable fabrics worn by users, burn hazards for unintentional skin contact, and eye hazards for **direct and scattered** radiation.

Protocols in this SOP dictate the laser be used in low-power mode (0.01 W) during alignment.

Entryway controls

Ensure the laser indicator light outside of the lab entrance is illuminated whenever the laser is on. The switch to control this indicator light is the right-most switch on the row of light switches near the entryway door and is labeled “Laser”.

Reference manual

These operating instructions are borrowed from a Verdi V-8 laser. An unofficial copy of the Verdi V-8/V-10 diode-pumped laser manual can be found at <https://vdocuments.net/operators-manual-verdi-v-8v-10-diode-pumped-lasers.html>.

An additional copy of the above referenced manual, along with manuals for accompanying equipment for this laser, can be found at <https://github.com/Stevenson6517/Witec> under the **docs** folder.

This document can be edited at https://github.com/Stevenson6517/Witec/blob/main/docs/verdi_SOP.md.

Procedures for safe alignment

Adjust the output on the power supply panel to its lowest setting (0.01 W). Remove any jewelry and reflective articles of clothing and tie back long hair. Remove all persons from the lab except for those actively involved in alignment. Each active participant should wear laser safety goggles appropriate for the laser (OD > 4 at 532 nm). Work with the room lights on if possible.

Remove the side panel of the lab-made laser enclosure, taking care not to pinch the optical fiber or water cooled lines that exit through a notch in the panel. Open the laser shutter and begin alignment. Use an alignment card to view the beam.

After alignment into the output fiber is complete, reassemble the laser enclosure system.

Turn-On (Cold Start)

1. Ensure the keyswitch is in the STANDBY position.
2. Set the power switch on the power supply rear panel to ON. The AC power and LASER EMISSION indicators will light. The power supply display will then indicate “System warming up”.
3. Turn on the chiller. Verify there are no cooling line connection leaks at the Verdi riser/heat sink and at the chiller.
4. Verify the chiller water temperature is set to approximately 20°C. Adjust the temperature setpoint as required.
5. Set the output power to the desired level using the POWER ADJUST knob. The output power can be adjusted to 0.01 watts to facilitate beam alignment.
6. Allow 30 minutes for the heaters and thermo-electric coolers (TECs) to achieve operating temperature. The status of all servos can be viewed by scrolling to the Servo Status screen. Once this process is complete, the system is now ready for key on.
7. Ensure the laser output is blocked or directed at an intended target. If the shielded box surrounding the laser is disassembled, **ensure all personnel in the area are wearing laser safety glasses.** Turn the keyswitch on the power supply front panel to ON.
8. Open the shutter by pressing the SHUTTER OPEN pushbutton on the power supply front panel.
9. Laser light will emit from the laser head after the current ramp-up.

Daily turn-on (warm start)

A warm-start can be performed when the Verdi power supply rear panel power switch has been on for more than 30 minutes (laser in standby).

1. Verify there are no cooling line leaks at the Verdi riser/heat sink and at the chiller. Verify the chiller water temperature is set to 20°C. Adjust the setpoint temperature as required.
2. The LASER EMISSION indicator should be on. Ensure the laser output is blocked or directed at an intended target. Turn the keyswitch on the power supply front panel to ON.
3. Open the shutter by pressing the SHUTTER OPEN pushbutton on the power supply front panel.
4. Laser light will emit from the laser head after the current ramp-up.

Daily turn-off (standby)

When the Verdi is being used on a daily basis, turn-off consists of turning the keyswitch to the STANDBY position. This shuts off the laser diodes and places the Verdi in standby. This method avoids the heater ramp-up cycle described in the “Turn-On (Cold Start)” section. The system water chiller should be left on during short-term shut downs.

Do not turn the power switch on the power supply rear panel to the OFF position.

Complete shut down

1. Turn the keyswitch power supply on the front panel to STANDBY.
2. Access and select the LBO Settings submenu. Press the MENU SELECT push button to start the LBO cool-down cycle. **This cycle takes approximately 30 minutes.**
3. During the cool-down cycle, the LBO temperature can be monitored from the main screen or the LBO Settings submenu. When the LBO temperature decreases below 30°C, turn the AC power switch on the power supply rear panel to the OFF position¹.
4. Turn off the chiller.

¹The Verdi instruction manual suggests waiting until the system reaches 40°C, but this assumes a functional backup battery whereby the power reserve from the battery maintains the cooldown procedure after the power is turned off. As of September 2023, the battery fails to maintain a sufficient charge to run this procedure. These instructions can be updated to reflect the suggested 40°C temperature when the battery is replaced.

Emergency shut down

In the event of an emergency, turn the keyswitch on the power supply front panel to STANDBY.

If circumstances allow, begin the LBO cooldown procedure.

In the event where immediate evacuation is necessary but no lab hazards exist (e.g. during a fire alarm), the laser may be left on STANDBY, skipping any LBO cooldown procedure.

In the event of a water emergency that poses an electrical risk, turn the keyswitch on the power supply front panel to STANDBY and the AC power switch on the power supply rear panel to OFF without waiting for the LBO cooldown procedure, **but beware that this will significantly damage the laser diode**. Also turn off the chiller.

If the electrical risk is resolved shortly after the above emergency shutdown, you may leave the front panel keyswitch on STANDBY, turn the AC power back to ON, and trigger the LBO cooldown in an effort to mitigate damage caused by a rapid, uncontrolled cooldown of the laser diode. You may and should also turn on the chiller if it is safe to do so.

Other notes

- The water in the chiller should be changed approximately every 6 months. Use only distilled water.
- Maintain a weekly log of the diode current (read from the front screen on the power supply) vs. output power. If the diode current increases 10% or more over the initial installation value (or current baseline value) to achieve the same output power, use the LBO optimization menu as outlined in the manual.

Lab-specific training requirements

- Complete and pass Laser Safety Training: <https://www.vanderbilt.edu/ehs/training/#Laser-Safety-Training>
- Complete Chemical Safety Training: <https://www.vanderbilt.edu/ehs/training/#Chemical-Safety-Training>
- Complete a safety walkthrough of laboratory hazards in Stevenson 6517

Emergency procedures

For medical emergencies, call 911.

For lab-related emergencies, contact Richard Haglund.

Emergency contact 1

Richard Haglund

Cell: (615) 720-2355

Emergency contact 2

Sergey Avanesyan

Phone: (615) 343-2336

Principal investigator

Name: Richard Haglund

Title: Professor

Office: Stevenson 6422

Phone: (615) 322-7964

E-mail: richard.haglund@vanderbilt.edu

Approved personnel

The following individuals are approved to use this system as of September 21, 2023:

- Richard Haglund
- David Curie
- Alexander Klapowitz

This Safety Procedure was reviewed and approved by

Name:

Title:

Date of approval: