SJCC LASER 102

Laser Test Manual

Laser Factory-Level Performance Tests

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05/21/2025

Procedure 1. Laser Crystal Spectrum Lab

OBJECTIVES

This procedure provides an outline on how to set up and test the wavelength absorption and transmission properties of various materials with the Shimadzu UV 1800 Spectrometer.

SCOPE

This procedure will focus on the Shimadzu UV 1800 Spectrometers; other spectrometers may have different guidelines. In particular, this focuses on scanning laser crystals.

REFERENCE DOCUMENTATION

Shimadzu UV-1800 Spectrometer (Phil).pdf

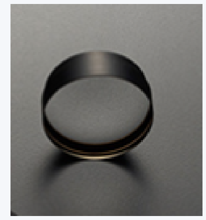
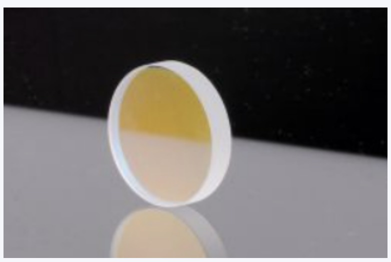
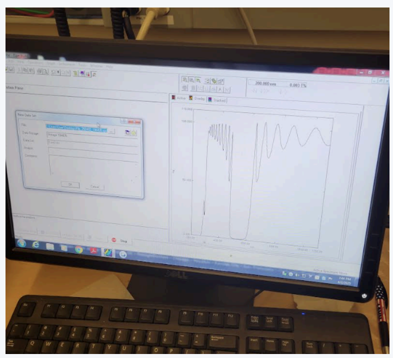
RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Spectrophotometer	An analytical device that measures how much light a sample absorbs at different wavelengths.
Wavelength (nm)	The specific color or energy of light, measured in nanometers.
Absorbance	A measure of how much light is absorbed by a sample. Higher absorbance means less light passes through.
Blank	A solution containing all components of the test sample except the substance being measured. Used to set a baseline.
Transmittance	The amount of light that passes through a sample. It is the opposite of absorbance.

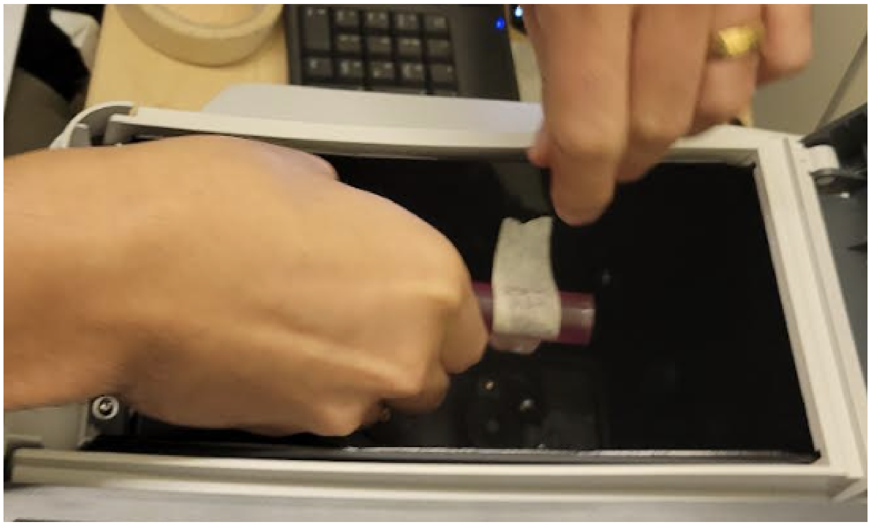
EQUIPMENT NEEDED

 **Shimadzu Spectrometer**	 **Laser Crystal**	 **Reference Optic**
 **HR/OC Optic**	 **PC**	

> ⚠ **WARNING: Wear the proper safety glasses. The laser involved has serious power output.**

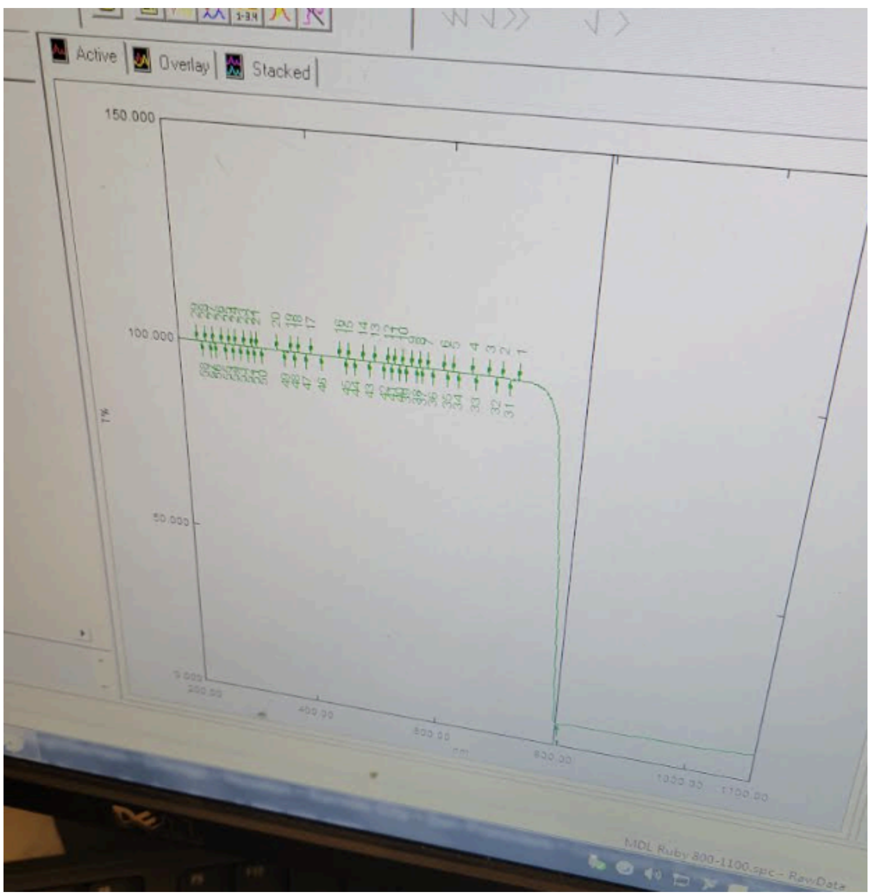
PROCEDURE

1. Follow Appendix A to set up and calibrate the Spectrophotometer.
2. Use any secure method to attach a laser crystal in front of the scanning side, without covering the reference side.



3. Close the compartment door.
4. Click Start.
5. Wait and Save.

Data to Collect



Identify at least 2 wavelengths for each of the 2 crystals where they absorb the most light/electromagnetic energy.

It is impossible to state two wavelengths where this crystal absorbs the most; however, it is clear it begins absorbing effectively after around 794 nm.

Note: This was the only graph that worked. The other crystal graphs produced had no peak whatsoever — they had a small slope that slowly increased from 200 nm to 1100 nm in T.

Procedure 2. Laser Mirrors Spectrographs

OBJECTIVES

This procedure provides an outline on how to set up and test the wavelength absorption and transmission properties of various materials with the Shimadzu UV 1800 Spectrometer.

SCOPE

This procedure will focus on the Shimadzu UV 1800 Spectrometers; other spectrometers may have different guidelines. In particular, this focuses on scanning laser optics.

REFERENCE DOCUMENTATION

Shimadzu UV-1800 Spectrometer (Phil).pdf

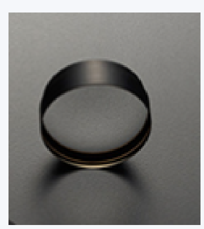
RESPONSIBILITIES

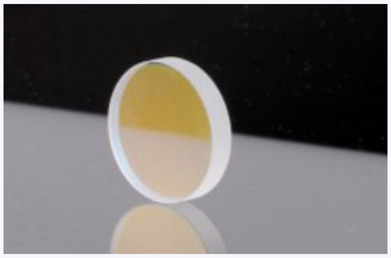
All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

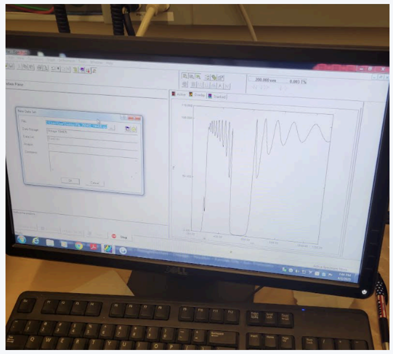
Spectrophotometer	An analytical device that measures how much light a sample absorbs at different wavelengths.
Wavelength (nm)	The specific color or energy of light, measured in nanometers.
Absorbance	A measure of how much light is absorbed by a sample. Higher absorbance means less light passes through.
Blank	A solution containing all components of the test sample except the substance being measured. Used to set a baseline.
Transmittance	The amount of light that passes through a sample. It is the opposite of absorbance.

EQUIPMENT NEEDED

 **Shimadzu Spectrometer**	 **Laser Crystal**	 **Reference Optic**



HR/OC Optic



PC

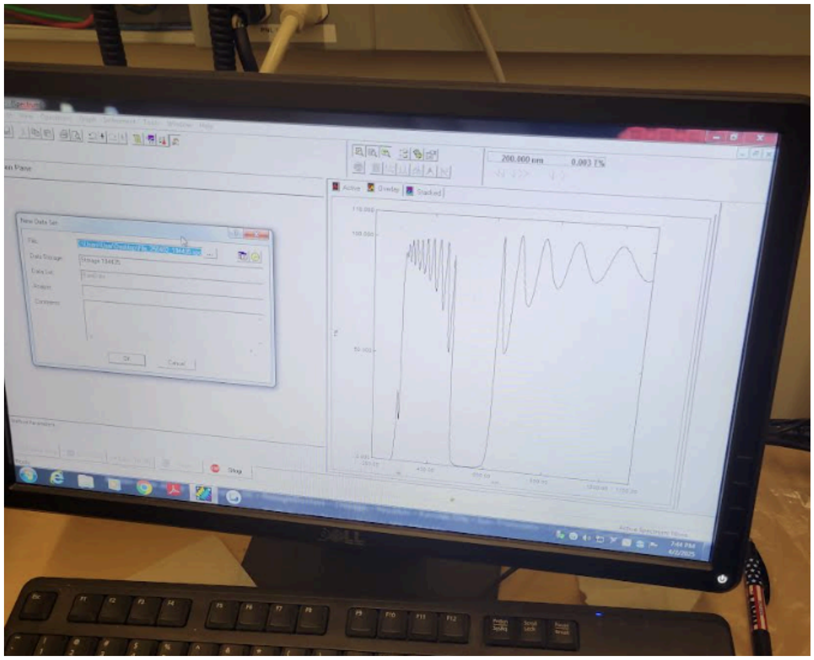
⚠ **WARNING: Wear the proper safety glasses. The laser involved has serious power output.**

PROCEDURE

1. Follow Appendix A to set up and calibrate the Spectrophotometer.
2. Open the compartment door.
3. Take out the laser optic container carefully.
4. Take out the optic closer to you and replace it with one whose properties you are interested in. Ensure the coated side faces toward the scanner.
5. Place the optic holder into the Spectrophotometer compartment.
6. Close the compartment door.
7. Click Start.
8. Wait and Save.

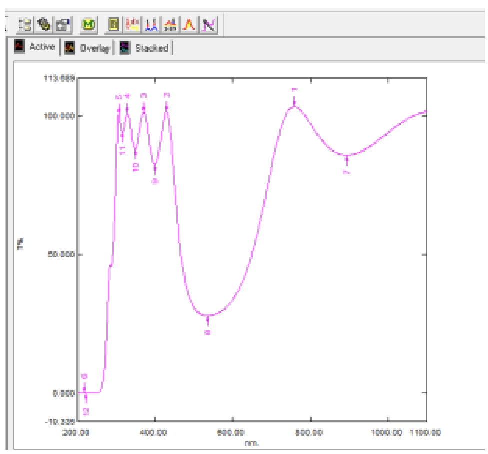
Data to Collect

Identify at least one HR optic and OC optic and their transmission (%) at 532 nm and 1064 nm.



This is clearly a great HR at around 532 nm. It only has a transmittance of 0.156% at that wavelength. At 1064 nm, it was a transmittance of 85%.

Note: An OC spectrograph was not captured directly; however, an example from the reference document is shown below.



This is a great OC at 532 nm with a transmittance of roughly 30%. At 1064 nm, this has a transmittance of nearly 100%.

Procedure 3. Laser Resonant Cavity Alignment

OBJECTIVES

The main objective of this lab is to align the HR and OC mirrors, generate a laser beam, and to optimize its power output.

SCOPE

This procedure goes over how to set up and align X-Y mirrors, how to turn on and operate the diode pump amplifier, and how to set and align the HR and OC mirrors.

REFERENCE DOCUMENTATION

LAS101_LAB 12 Mamba2.0 procedure-1.pdf

Proc 1. Laser Resonator and Mamba Amplifier Alignment Procedures.pdf

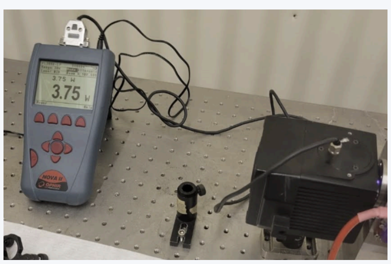
RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Power Meter	A device that measures laser power output, usually in Watts.
X-Y Alignment Mirrors	Mirrors which control the horizontal and vertical reflection of the laser beam.
HR Mirror	Mirror that reflects back nearly 100% of the laser light.
OC Mirror	Mirror that allows a small portion of laser light to pass through.
Power Supply	Supplies the power needed to amplify the seed laser.
Lytron Cooler	Cools the diode pump module so it does not overheat during amplification.
Alignment Disk Wand	A device that safely and visibly reflects the laser light, allowing for tracking of the beam.
Hene	A 632.8 nm wavelength visible light laser.

EQUIPMENT NEEDED

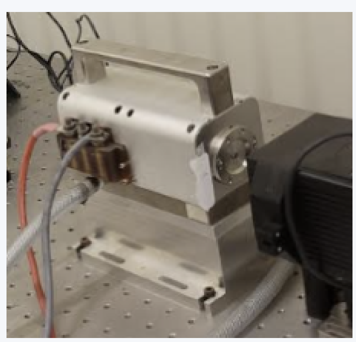


Power Meter

Hene Laser

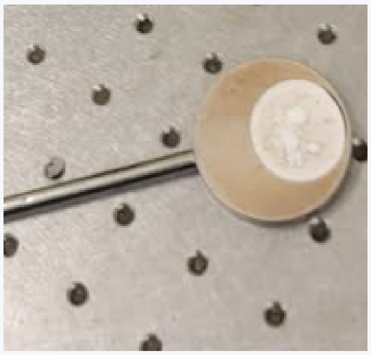
X-Y Alignment Mirrors

Safety Glasses



Diode Pump Module

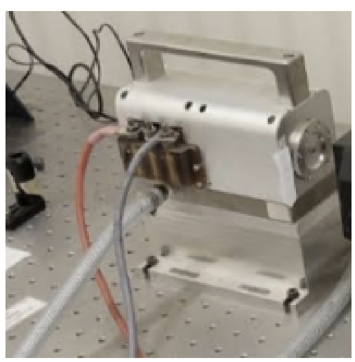
Lytron Chiller

 **Power Supply**	 **Hex Keys**	 **Bolts**
 **Alignment Disk Wand**		

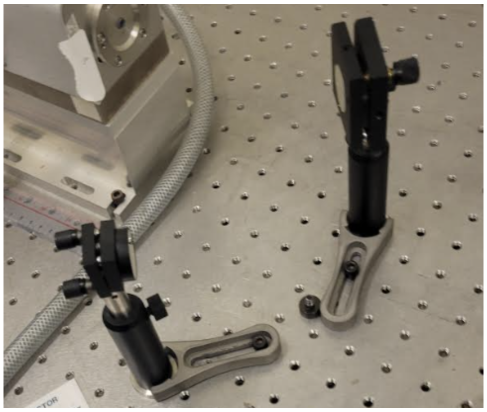
> ⚠ **WARNING: It is essential to have properly aligned X-Y mirrors. Imprecise alignment can cause large power losses. Ensure that the mirrors are clean.**

Initial Laser Alignment

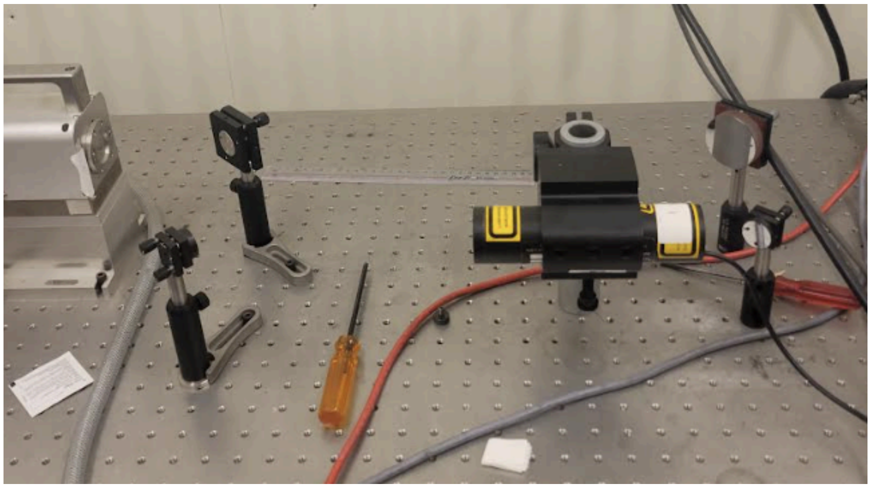
1. Use bolts to lock down the diode pump module in an open space; the diode will serve as a reference for other locations.



2. Measure the height of the entrance or exit hole of the diode; this height will be the height of the center points of the mirrors, seed laser, and power detector. (In this case it was 5".)
3. Configure the X-Y mirrors in the Z-fold configuration.
4. Loosen the screw on the long axis to adjust mirror center height to 5", then tighten that screw to lock in that height.
5. Secure X-Y mirrors optical mounts in place with bolts and hex keys.



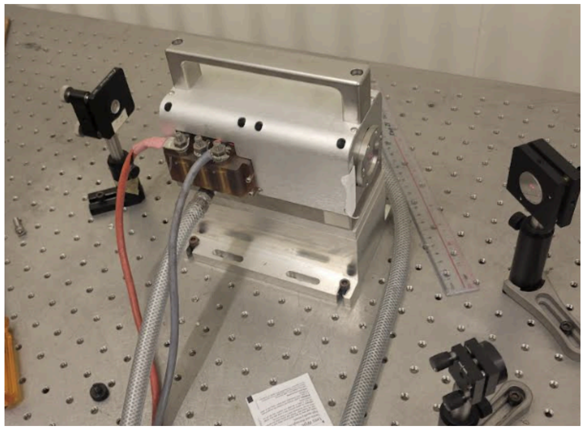
6. Place Hene laser onto mount, such that the output laser beam would make a 45° angle with the first X-Y mirror.



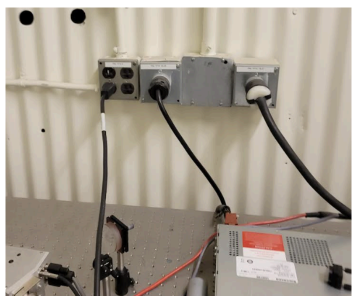
7. Loosen the long axis screw of the Hene laser mount, adjust height until the laser output hole is at a height of 5", then tighten the long axis screw to keep it at 5".

Alignment and Lasing

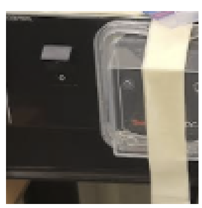
8. Put on safety glasses if you have not done so by this point.
9. Adjust the X-Y mirror closer to the seed laser until the laser beam hits the entrance of the diode pump module. You can test if it hits by using the infrared laser tracker.
10. Adjust the second X-Y mirror until the laser beam can be seen as a clear dot at least 5" after the diode pump module. You may need to adjust the first and second mirrors repeatedly to align fully.
11. Install the OC mirror after the diode pump. Adjust it until the laser light makes its way almost back to the center of the Hene.



12. Install the HR mirror right before the diode pump. Adjust it until the laser light makes it almost back to the center of the Hene. At this point there should be two dots at the Hene — one from the OC, and one from the HR. To get the most lasing, try to get both dots as close to the center as possible, and to get them to overlap.
13. You are now ready to lase.
14. Before turning on the power supply for the diode pump, make sure to plug in the power supply for the pump. Otherwise the pump will not work.



15. Twist both the "current" and "voltage" knobs counterclockwise until they stop.
16. Make sure "standby" button is pressed in before turning on power supply.
17. Turn on the power supply by flipping the switch on the left. Press firmly as it may bounce back to off.



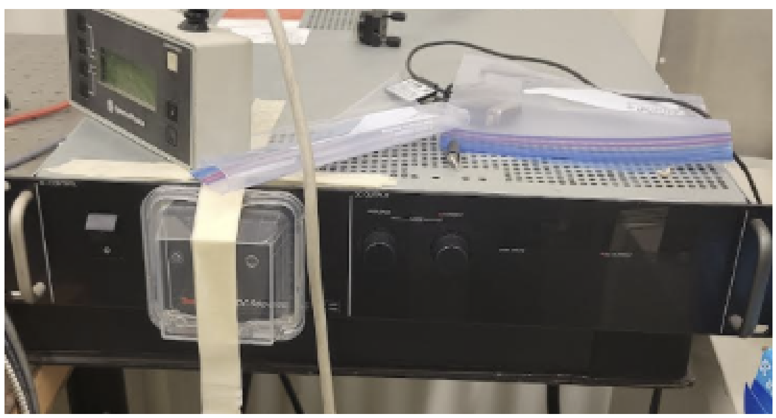
18. Press the "standby" button and make sure it is no longer pressed in.
19. Turn on the pump power supply by flipping the switch to on.
20. Rotate the "current" knob clockwise until it just stops glowing red.

21. Rotate the "voltage" knob until it stops glowing green.

22. Repeat steps 13 and 14 until the power supply maxes out.
23. Adjust HR and OC mirrors one by one to maximize laser power output.

Shutting Down

24. Turn the power supply current and voltage knobs counterclockwise until both hit 0. Set to "standby" mode.
25. Flip the switch to the power supply to off.



26. Wait about 10 minutes, then press the power button to turn it off.

27. Press power button to turn off the power meter.

Procedure 4. DPSS Laser Diode Pump Power Optimization: Current and Temperature Tuning

OBJECTIVES

The main objective of this procedure is to serve as a guide on how to effectively optimize the temperature and current of a laser to maximize its power output.

SCOPE

This procedure details how to record and utilize data from the power output of a laser at various temperatures and current flows to maximize its performance.

REFERENCE DOCUMENTATION

None.

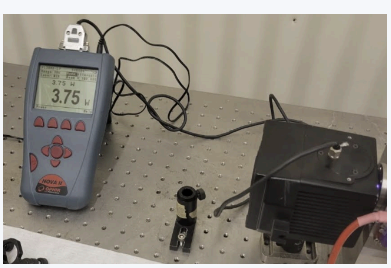
RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Power Meter	A device that measures laser power output, usually in Watts.
Power Supply	Supplies the power needed to amplify the seed laser.
Spectra-Physics V70	A VHead 1064 nm laser.

EQUIPMENT NEEDED

 **Power Meter**	 **Spectra-Physics V70**	 **Power Supply**

 **Safety Glasses**		

⚠ WARNING: Wear the proper safety glasses. The laser involved has serious power output.

Startup

1. Place the power meter at a height of 6.25", and offset it so the effect of ambient light is minimized.
2. Place the VHead at a height of 6.25".
3. Press the switch to turn on the power supply for the VHead.
4. Turn the key to power it on.
5. Wait for the display to change from "Wait" to "Ready."
6. Long-press the top right button until "Laser Emission" stays red.
7. Turn off the gate by pressing the top left button. (The light will now be output to the VHead.)
8. Long-press the second-to-last button on the right and the second-to-last button on the left to control the current.
9. Set the current to the minimum value, record the corresponding power, and then increase the current in increments until it reaches the maximum. Record the corresponding power at each step.
10. To record the effect of temperature, press the third button from the left. Press the left buttons until "Temp" is selected.
11. Click and hold the bottom right button until the temperature reaches its minimum.
12. Wait for the temperature to stabilize, then record the corresponding power. Increment the temperature, allow it to stabilize at each step, and record the corresponding power. Increment more slowly when the power changes rapidly between steps.
13. Press the gate button (Top Left) to turn off the gate.
14. Long-press the top right button until "Laser Emission" turns off.
15. Flip the power supply switch off.
16. Turn the key to switch off the system.

Data to Collect

Temp. (°C)	Power (W)

Current (A)	Wavelength (m)	Power (W)

Procedure 5. Laser Beam Harmonics Conversion Efficiency

OBJECTIVES

The main objective of this procedure is to educate laser technicians on how to use a nonlinear crystal to lower the wavelength of laser light, and how to find the efficiency of such a process.

SCOPE

The scope of this procedure is limited to 1064 nm input and 532 nm output.

REFERENCE DOCUMENTATION

None.

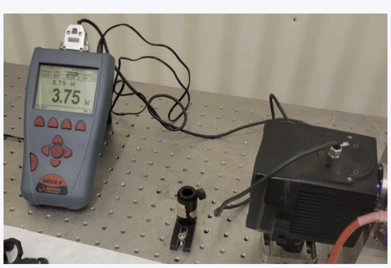
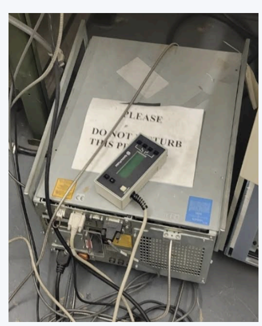
RESPONSIBILITIES

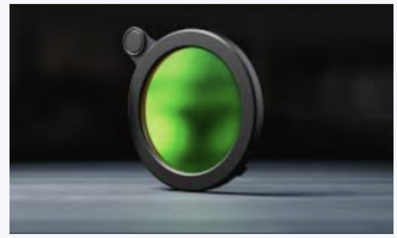
All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Power Meter	A device that measures laser power output, usually in Watts.
Power Supply	Supplies the power needed to amplify the seed laser.
Spectra-Physics V70	A VHead 1064 nm laser.
SHG	Second Harmonic Generation — using a nonlinear crystal to convert higher wavelength light to light with half the input wavelength.

EQUIPMENT NEEDED

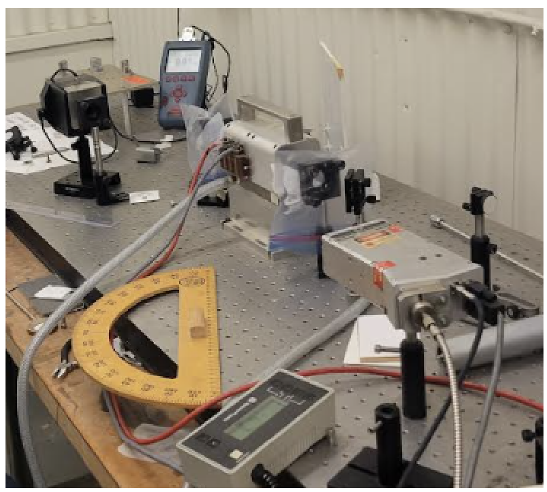
 **Power Meter**	 **Spectra-Physics V70**	

		Power Supply
 **Safety Glasses**	 **SHG Crystal**	 **Green Light Filter**

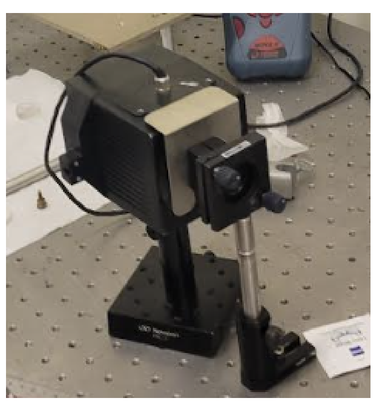
> ⚠ **WARNING: Wear the proper safety glasses. The laser involved has serious power output.**

PROCEDURE

1. Place the power meter at a height of 6.25", and offset it so the effect of ambient light is minimized.
2. Place the VHead at a height of 6.25".
3. Place an SHG crystal at the same height as the VHead output, and in the line of the output laser.



4. Place a power meter after the SHG crystal, with a green light filter in between.



5. Press the switch to turn on the power supply for the VHead.
6. Turn the key to power it on.

7. Wait for the display to change from "Wait" to "Ready."
8. Long-press the top right button until "Laser Emission" stays red.
9. Turn off the gate by pressing the top left button. (The light will now be output to the VHead.)
10. Measure and record the output power after the filter.
11. Press the gate button (Top Left) to turn off the gate.
12. Place the power meter before the LBO or KTP crystal.
13. Press the gate button again to let the laser out, and measure the power of the unconverted light.
14. Long-press the top right button until "Laser Emission" turns off.
15. Flip the power supply switch off.
16. Turn the key to switch off the system.
17. Divide the converted filtered power measurement by the direct power measurement.
18. Multiply by 100 to get the laser harmonic conversion efficiency (%).

Data to Collect

Converted Filtered Power (W)	Direct Power (W)

Procedure 6. Laser Wall-Plug Efficiency, Threshold and Slope Efficiency

OBJECTIVES

This procedure provides an overview of how to measure laser wall plug efficiency, threshold, and slope efficiency.

SCOPE

The scope of this procedure is limited to the VHead 1064 nm laser. However, the general principles apply to a larger class of lasers.

REFERENCE DOCUMENTATION

Appendix B: Getting Started with the S-P V-Head

Procedure 4: DPSS Laser Diode Pump Power Optimization: Current and Temperature Tuning

RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

VHead	A 1064 nm high-power laser.
Wall Plug Efficiency	Measure of output power over input power.
Threshold	The power at which a laser starts lasing.

Slope Efficiency	How quickly the output power rises with the input power.

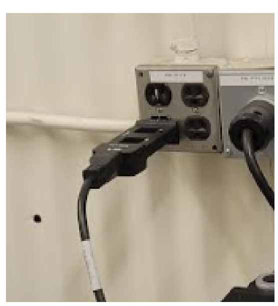
EQUIPMENT NEEDED

 **VHead**	 **Safety Glasses**	 **Power Meter**
 **DVM**	 **Line Splitter**	

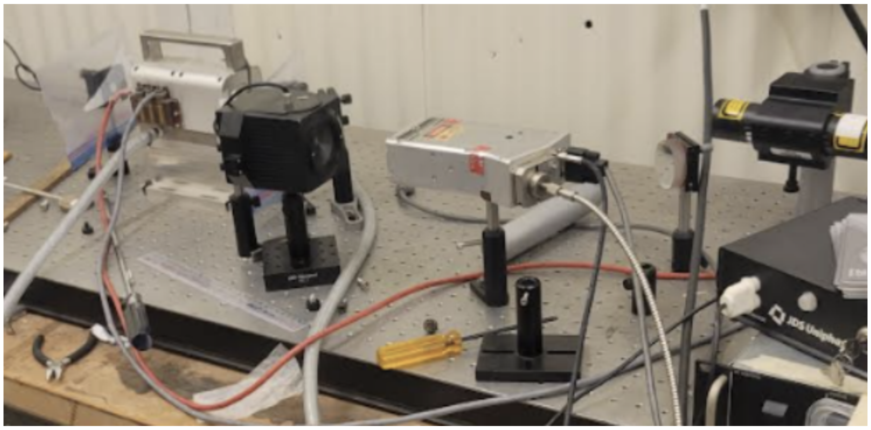
⚠ WARNING: Wear the proper safety glasses. The laser involved has serious power output.

PROCEDURE

1. Use the DVM to measure the voltage out of the power outlet.
2. Connect the Line Splitter to the power outlet, and then connect the VHead power supply to the line splitter.



3. Follow Appendix B to start up the VHead, and use the power meter to measure the output power.



4. Insert the current measuring device into the line splitter and measure the output current at its maximum.
5. Obtain the wall plug efficiency by dividing the output power by the product of the measured voltage and current. (Ideally this should be done after temperature and current tuning have yielded a maximum.)
6. Follow Procedure 4 details and decrease the current to the minimum, then increase the current until the laser starts lasing. Measure the output current, wall plug current, and voltage to determine the threshold current and power.
7. Likewise, follow Procedure 4 details to increase the current until it will not increase any further. Measure the input and output power at each increment. Finding the slope of that linear relationship (excluding flat slope up until the threshold current/power) will allow you to find the slope efficiency.

Data to Collect

Wall Plug Voltage (V)	Wall Plug Current (mA)	Laser Output (W)

Procedure 7. Collimation of Diverging Laser Beams

OBJECTIVES

This procedure provides an overview of how to collimate a diverging laser beam using a Keplerian Collimator.

SCOPE

The scope of this procedure is limited to the Keplerian Collimation strategy for a low to medium power laser.

REFERENCE DOCUMENTATION

Laser Beam Collimators20241127.pptx

RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Laser Profiler	A device that measures the spatial intensity profile of a laser beam to determine its shape, size, and quality.
Convex Lens	A lens that takes in a collimated beam and converges it to a point.
Hene Laser	Low power visible light laser that outputs 632.8 nm light.
X-Y Alignment Mirrors	Mirrors that allow for control of the horizontal and vertical reflections of a beam.

EQUIPMENT NEEDED

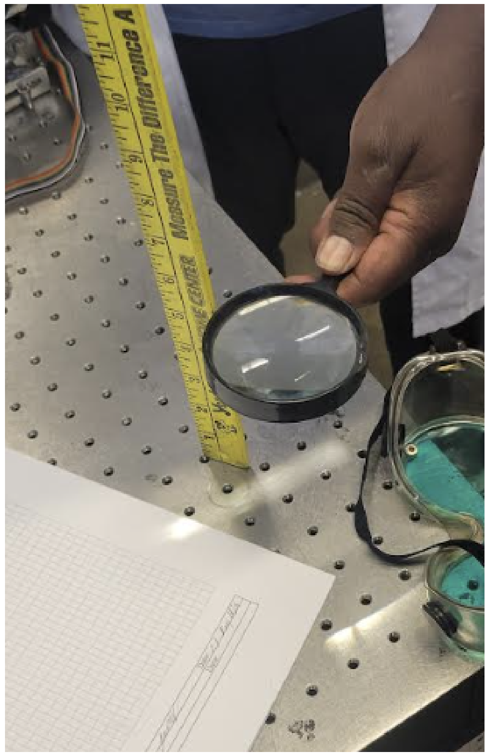
 **Laser Beam Profiler**	 **X-Y Alignment Mirror**	 **Convex Lens**
 **Safety Glasses**	 **Hene Laser**	

⚠ WARNING: Wear the proper safety glasses. The laser involved has serious power output.

PROCEDURE

1. Set the Hene up at a height of 5".
2. Set up an X-Y alignment mirror at a 45 degree angle with the Hene laser light.
3. Set up another X-Y alignment mirror at a 45 degree angle to the reflected Hene laser light.
4. Set up a profiler at a far away distance from both mirrors. Ensure all objects are at the same height.
5. Adjust the far-field X-Y alignment mirror to align the laser onto the profiler.

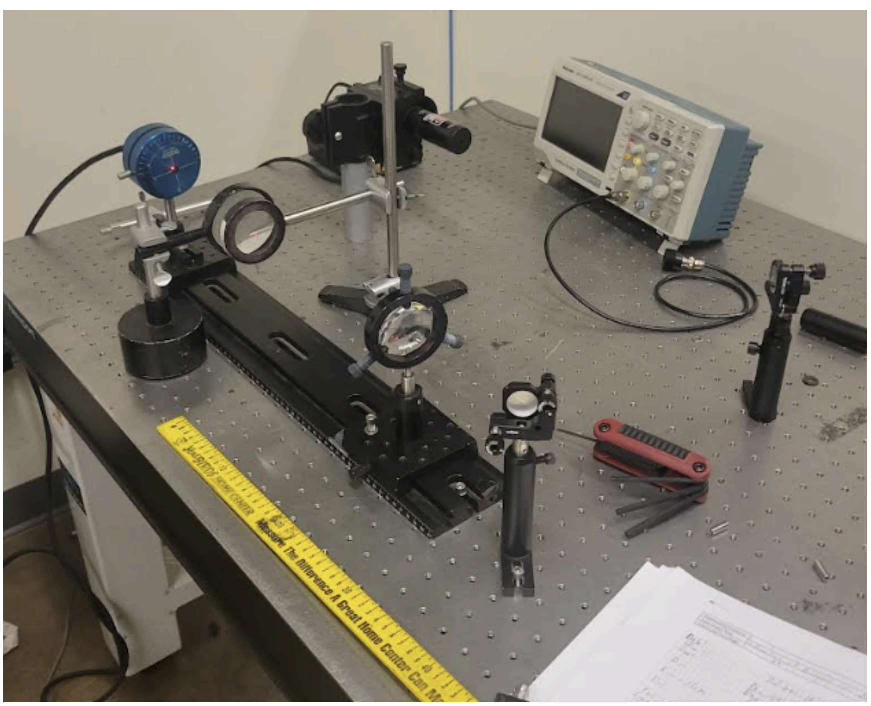
6. Move the profiler closer to the far-field mirror, and adjust the near-field mirror until the laser light is focused on the center of the profiler.
7. Measure the focal length of the test convex lens.



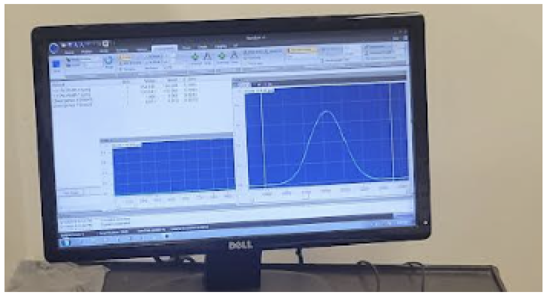
8. Place the convex lens between the far-field mirror and the profiler.
9. Place the profiler at the focal point of the focal lens.

10. Measure the beam diameter and beam divergence angle with the profiler software.
11. Grab two more convex lenses. Ideally, one should have twice the focal length of the other.
12. Remove the test convex lens.
13. Install the convex lens with the shorter focal length.
14. Place the convex lens with the longer focal length at a distance equal to the sum of the two focal lengths away from the shorter focal lens.

15. Place the test focal lens between the profiler and the convex lens with the larger focal length.



16. Measure the beam diameter and beam divergence.



Data to Collect

Uncollimated Beam Diameter (µm)	Uncollimated Beam Divergence Angle (mrad)

Collimated Beam Diameter (µm)	Collimated Beam Divergence Angle (mrad)

"Test" Lens Focal Length (m)	"Short" Focal Length Lens (m)	"Long" Focal Length Lens (m)

Appendix A: Getting Started with the Shimadzu UV 1800 Spectrometer

OBJECTIVES

This procedure provides an outline on how to set up and test the wavelength absorption and transmission properties of various materials with the Shimadzu UV 1800 Spectrometer.

SCOPE

This procedure will focus on the Shimadzu UV 1800 Spectrometers; other spectrometers may have different guidelines.

REFERENCE DOCUMENTATION

Shimadzu UV-1800 Spectrometer (Phil).pdf

RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

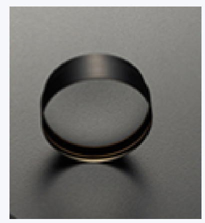
DEFINITIONS

Spectrophotometer	An analytical device that measures how much light a sample absorbs at different wavelengths.
Wavelength (nm)	The specific color or energy of light, measured in nanometers.
Absorbance	A measure of how much light is absorbed by a sample. Higher absorbance means less light passes through.
Blank	A solution containing all components of the test sample except the substance being measured. Used to set a baseline.
Transmittance	The amount of light that passes through a sample. It is the opposite of absorbance.

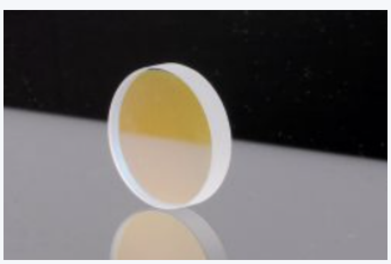
EQUIPMENT NEEDED

Shimadzu Spectrometer

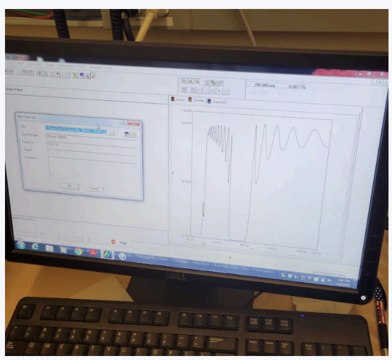
Laser Crystal



Reference Optic



HR/OC Optic



PC

⚠ WARNING: Wear the proper safety glasses. The laser involved has serious power output.

PROCEDURE

1. Turn on the PC and Spectrometer.
2. Wait for the Spectrometer to initialize — this is complete when every item on the Spectrometer's screen says "OK."
3. Press "Enter" to continue, and press "F4" on the spectrometer to start the connection with the PC.
4. Double-click "UV-Probe" on the Windows desktop.

5. Press "Connect" at the bottom of the screen to establish the connection with the spectrometer. Select "Spectrum" from the toolbar.
6. Open the sample compartment door and insert the reference lens into the lens holder. Close the door.
7. Note: If scanning unknown optics, perform baseline calibration with air (no lens).
8. From the menu, go to "Edit" > "Method." Set the wavelength range: Start = 200 nm, End = 1100 nm, then click OK.
9. Right-click on the graph and choose "Customize." Ensure the Y-axis minimum is 0 and maximum is 110. Click OK.
10. Click the "Baseline" button to begin baseline calibration. Ensure calibration spans the full 200–1100 nm range.
11. After the scan completes, click "Start" to view the transmission band for the reference lens (should show 100% transmission across all wavelengths).
12. Save the data via "File" > "Save As." Enter a filename and confirm the file type is "Spectrometric (*.spc)."

Data to Collect

Item	Wave Peak Ranges (nm)	Wave Minimum Ranges (nm)

Appendix B: Getting Started with the S-P V-Head

OBJECTIVES

The main objective of this procedure is to understand how to properly operate the Spectra-Physics VHead.

SCOPE

This procedure covers V-Head startup, shutdown, and configuration settings.

REFERENCE DOCUMENTATION

None.

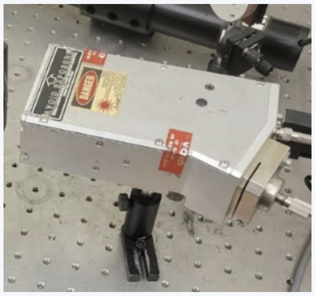
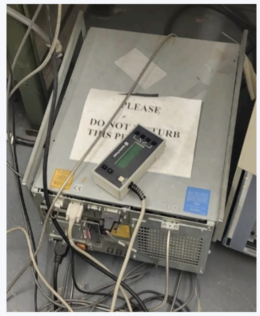
RESPONSIBILITIES

All individuals are responsible for proper operation of laser equipment, properly turning equipment on and off, wearing safety goggles, and writing documentation.

DEFINITIONS

Power Meter	A device that measures laser power output, usually in Watts.
Power Supply	Supplies the power needed to amplify the seed laser.
Spectra-Physics V70	A VHead 1064 nm laser pumped with 808 nm fiber diodes.

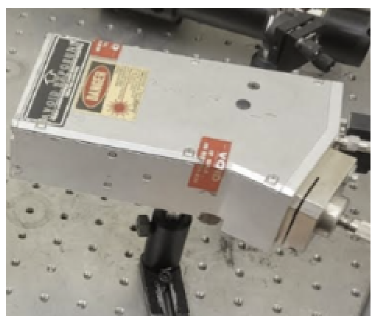
EQUIPMENT NEEDED

 **Spectra-Physics V70**	 **Power Supply**	 **Safety Glasses**

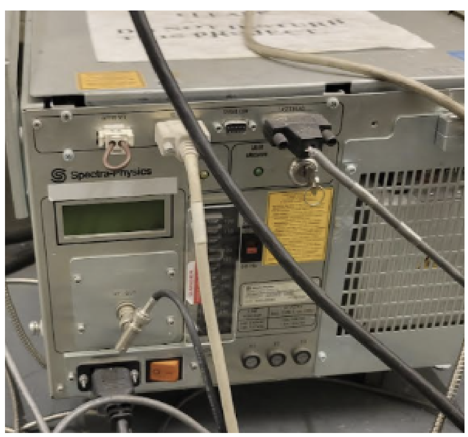
> ⚠ **WARNING: Wear the proper safety glasses. The laser involved has serious power output.**

Startup, Configurations, and Shutdown

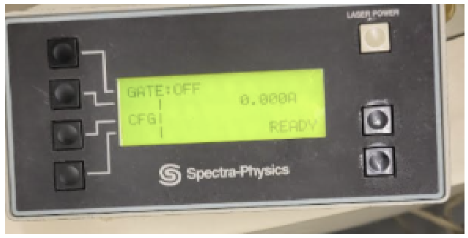
1. Place the VHead at a height of 6.25".



2. Press the switch to turn on the power supply for the VHead.



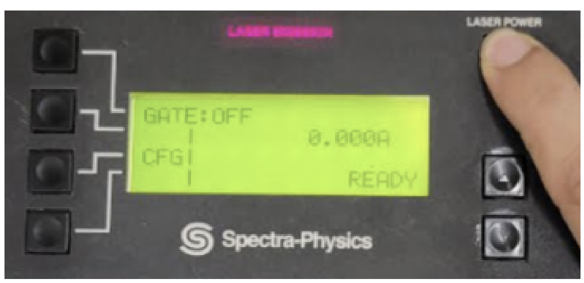
3. Turn the key to power it on.
4. Wait for the display to change from "Wait" to "Ready."



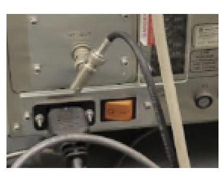
5. Long-press the top right button until "Laser Emission" stays red.

6. Turn off the gate by pressing the top left button. (The light will now be output to the VHead.)
7. Long-press the second-to-last button on the right and the second-to-last button on the left to control the current.
8. To record the effect of temperature, press the third button from the left. Press the left buttons until "Temp" is selected.
9. Temperature takes longer to stabilize, so if you are measuring, ensure you give ample time for the temperature to stop fluctuating.
10. Press the gate button (Top Left) to turn off the gate.

11. Long-press the top right button until "Laser Emission" turns off.



12. Flip the power supply switch off.



13. Turn the key to switch off the system.