Laser Safety Standard Operating Procedure

Forward:

This procedure shall be reviewed annually by all persons who use Class 3B & 4 lasers or laser systems listed in this SOP. This procedure shall also be reviewed every two years by the Permittee or Laboratory Laser Safety Supervisor (LSS) to ensure it reflects the most current conditions. Changes in the operating procedure shall be forwarded to EHS – Laser Safety for review and approval.

Laboratory Information:

Laboratory PI Name:	DeWayne Holcomb	Date:	4/2/24
Department:	EHS	Revision #:	1
Building & Room #:	ECG 2.200	Author:	Matthew Kennington

Contact Information:

Laboratory LSS:	John Snow	Phone #:	512-471-2042
University LSO:	DeWayne Holcomb	Phone #:	512-471-2038
Maintenance/Repair:	Facilities Services	Phone #:	512-471-2020
Medical Emergencies	1. Call 911 for medical emergencies and shut down all laser operations. 2. Notify the Laboratory LSS and University LSO of all laser-related injuries and near misses as soon as possible.		

Laser Description: Describe the laser(s) setup and how it is used including general beam parameters, optics, and equipment. Include a diagram or picture with the beam path depicted. This may be included as an attachment if necessary.

Two laser devices are used to perform broadband coherent anti-Stokes Raman scattering microspectroscopy. A picosecond pulsed Nd:YAG laser at 1MHz and 1064nm (pump and probe) and a broadband supercontinuum laser across 420nm to 2400nm (Stokes) are used for excitation. A delay stage in the pump path is used to tune temporal overlap of the pump/probe and Stokes beams. The beams are spatially overlapped using a 1100nm longpass filter. The beams are focused to the sample plane via a 100X, 0.85 NA objective. In a transmission configuration CARS photons are collected with a 20X, 0.4 NA objective. The CARS photons are filtered from the excitation beams using a 1000nm shortpass filter before being measured with a spectrometer and a back illuminated deep-depletion CCD. Hyperspectral images are collected by stage-scanning the sample. Users must wear appropriate laser safety eyewear during laser operation. Only trained individuals are allowed in the area during laser operation.

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Laser Parameters: Complete the table below using the operating conditions (power output, pulse energy, duration, etc.) of the laser. If more than one laser is used, copy and paste this table to complete the laser parameters for the other lasers. Laser eyewear is to be inspected by the user for lens applicability and integrity prior to each use.

Make:	Leukos	Wavelength (nm):	1064 and 420-2400 nm (supercontinuum)
Model:	Opera HD	Power Output (W):	1 W
Serial Number:	201905-484	Beam Diameter (mm):	2 mm
Class:	4	Beam Divergence ($1/e^2$) (mrad):	<1.5 mrad
Cont. or Pulsed:	Pulsed	Duration (ns) & Rate (Hz):	<50 ps @ 1 MHz
Eyewear Make:	Edmund Optics	Eyewear Wavelength:	190-1800 nm
Eyewear Model:	LS9	Eyewear Optical Density:	>5

Make:	Spectra-Physics	Wavelength (nm):	1045 and 680-1300 (tunable)
Model:	Insight X3 Dual	Power Output (W):	4 W
Serial Number:	2279	Beam Diameter (mm):	2 mm
Class:	4	Beam Divergence ($1/e^2$) (mrad):	< 1.5 mrad
Cont. or Pulsed:	pulsed	Duration (ns) & Rate (Hz):	< 120 fs @ 80 MHz
Eyewear Make:	Edmund Optics	Eyewear Wavelength:	500-1800 nm
Eyewear Model:	LS16	Eyewear Optical Density:	>5

Laser Safety Program Resources:

EHS has several resources on their website at: https://ehs.utexas.edu/programs/lasers/ including information regarding laser safety training and program requirements. The Laser Safety Program Manual can also be found here and should be referred to for:

- Lab PI roles and responsibilities
- Laser User roles and responsibilities
- Laser permits and registration
- Program requirements (SOP, Training, etc.)
- PPE requirements (eyewear and inspections)
- Signs and Labeling
- Non-Radiation Hazards
- Procurement and Disposal Requirements

Operating Procedures:

All Class 3B and 4 lasers and laser systems shall have a documented operating procedure that provides the end user the necessary instruction for completing their experiment safely. The operating procedure shall include instructions for all times it is necessary for the laser to be powered on including normal operation, alignments, service, and repairs as applicable. The procedure shall incorporate all safety measures including when to don/doff eyewear, room securement, signs and warning labels, housekeeping, and other control measures

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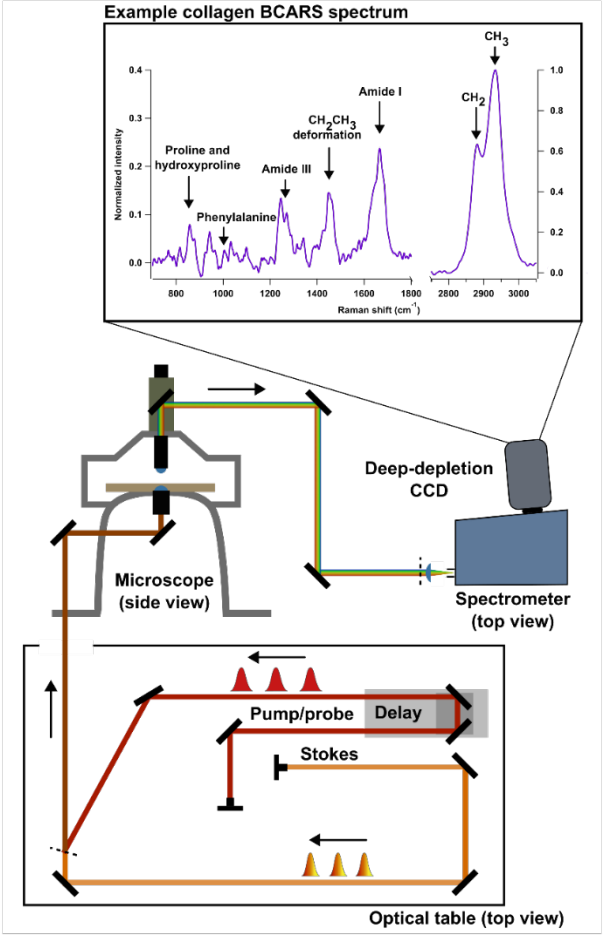
identified in the hazard section above. This procedure shall be updated to reflect current operations prior to commencing the experiment.

A. Initial preparation of lab environment for normal operation (lab security, warning light on, keys, interlocks and guards, identification of personnel, etc.)

1. Switch on the laser warning sign outside the laboratory.
2. Close the door of the room where the laser is going to be operated.
3. Ensure only individuals with the appropriate safety training and goggles are in the lab.
4. Ensure the laser head is directed towards a beam dump (non-reflective, non-flammable dark surface).
5. Verify that fiber optic cables are secured and in good condition.
6. **Take off wrist watches and rings. High danger of reflections!**
7.



B. Target area preparation
1. Verify beams are off/shuttered.
2. Prepare slide with sample.
3. Insert slide onto the sample stage.
4. Verify appropriate positioning of optics and beam blocks prior to starting laser devices.

C. Operation procedures are as follows:

PUT ON YOUR SAFETY GOGGLES BEFORE OPERATING THE LASER

1. **Insight X3**
   - **i. Cold Start:**
     1. Verify all persons in lab have properly donned the laser protective eyewear.
     2. Put a beam block in front of both free space outputs.
     3. Turn on chiller that is outside the laser area and next to the fume hood.
     4. Once the laser is warmed up, double click the software on the computer called "Insight X3". It should recognize the laser on COM 7. If it does not, try all the COM ports until it does.
     5. In order to turn on the laser, click and hold down the power button on the software. There is a countdown for > 3s. This powers up the pump diodes and the laser starts lasing.

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6. To allow laser radiation out of the laser box you have to click and hold the shutter button for the beam you want to allow to exit the box. There is again a countdown for > 3s. Now laser light is coming out of the box, and hitting your beam block.
7. Remove the beam blocks as necessary from either output.

ii. **Warm Start:**
1. Verify all persons in lab have properly donned the laser protective eyewear.
2. Put a beam block in front of both free space outputs.
3. Double click the software on the computer called "Insight X3". It should recognize the laser on COM 7. If it does not, try all the COM ports until it does.
4. In order to turn on the laser, click and hold down the power button on the software. There is a countdown for > 3s. This powers up the pump diodes and the laser starts lasing.
5. To allow laser radiation out of the laser box you have to click and hold the shutter button for the beam you want to allow to exit the box. There is again a countdown for > 3s. Now laser light is coming out of the box, and hitting your beam block.
6. Remove the beam blocks as necessary from either output.

2. Leukos Opera HP

i. Verify all persons in lab have properly donned the laser protective eyewear.
ii. Put a beam block in front of both fiber outputs. DO NOT EVER TOUCH the FIBERS with anything.
iii. Turn on the Power Switch, rotate the Key Switch "1", and wait for the display to load.
iv. Turn up the "Boost" to max power
v. Remove the beam blocks as necessary from either fiber and make sure beam is contained in the black metal enclosure

D. Shutdown procedures for this laser are as follows:

1. **Insight X3**

i. Click the shutter button on the Insight X3 software for both beams so that both shutter look closed. Note there is NO timer for closing the shutters.
ii. Click the Power button. Note there is NO timer to turn off the laser emission.
iii. Close the program on the computer by clicking on the "X" in the top right corner of the program window. Upon closing program, you will see three options:
1. **Standby** – use this if you or someone else is coming back with in the next 4 hours to use the laser
2. **Hibernate** – use this if no one will use the laser until the next day/week
3. **Shutdown** – use this option if the laser will not be used for months.

iv. Put a beam block in front of both fiber outputs. DO NOT EVER TOUCH the FIBERS with anything.
v. Turn off the laser warning sign only if the Leukos laser in the area is not use. Otherwise, leave the laser warning sign illuminated.

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2. **Leukos Opera HP**
    i. Turn the "Boost" knob to the minimum value.
    ii. Press the Power Switch, rotate the Key Switch to "0". All lights on the laser box should be off at this point. At this point, the laser is no longer powered.
    iii. Put a beam block in front of both fiber outputs. DO NOT EVER TOUCH the FIBERS with anything.
    iv. Turn off the laser warning sign only if the Insight laser in the area is not use. Otherwise leave the laser warning sign illuminated.

E. Alignment procedures (describe the specific steps and settings needed to reduce power before interacting directly with the beam path. For example, shuttering the pump laser, using ND filters, etc.)

F.

1. **Take off wrist watches and rings. High danger of reflections!**
2. Use the "Alignment mode" on the software. This is on the last tab where you can click it. It reduces the power by 90% for each beam.
3. Use a neutral density filter to attenuate the power as little as possible using Neutral Density filters or the Neutral Density filter wheel. There is NEVER any reason align the laser with full power. If you must insert neutral density filters, must block the beam first before inserting the filters.
4. Always wear laser safety goggles during alignment. All of our goggles can be used for alignment or normal operation; if you find a pair they MUST have OD > 4 for use during alignment at the primary wavelength.
5. You can NEVER leave the room with the laser on if you are aligning.
6. You must alert everyone in the laser area that you are aligning the laser and they must as a result put on goggles or leave the laser area
7. NEVER under any circumstances look directly into a laser beam.
8. NEVER under any circumstances move your eyes to the height of the laser beam. If you have to pick up something off the floor, you must close your eyes to avoid any possible stray beam.
9. Laser beams may leave the laser table only if and when it is absolutely necessary for alignment or measurement purposes. Reflections must be stopped by apertures, beam blocks or dumps on the table. DON'T LET THIS HAPPEN.
10. Shutter or block all beams whenever inserting new optics!
11. Crystals are intrinsically dangerous. Take special care of any reflections when mounting or adjusting angles and block all reflections since they may leave the beam plane.
12. Power and in particular energy heads may reflect beams. These reflections need to be blocked.
13. All reflections from beam-splitters and mirrors must be blocked or routed to the black metallic enclosure! Stray beams reflecting outside the enclosure and not on the microscope are never allowed
14. Particular care has to be taken for experiments that require off-optical-plane beams, like periscopes and microscope setups. It must be assured that potential beams leaving the optical plane cannot endanger any person.

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Physical Controls: Describe the physical controls of the laser setup in the condition which the setup is intended to be operated. Edit the comment section as necessary to depict the lab specific controls implemented. EHS will review and approve the described control measures.

Check If Applicable:	Control:	Comments:
☐	Entryway (door) Interlocks or Controls	Entry to the lab is restricted to authorized and properly trained lab personnel only with an active keypad lock. The lab door is to remain closed at all times unless the laser is shutdown and under the direct supervision of an authorized person. Illuminated laser signs/placards are provided at the entrance to the laser control area/nominal hazard zone. A laser curtain is provided at the nominal hazard zone perimeter.
☐	Laser Enclosure Interlocks	Any laser enclosure interlocks will be engineered to fail safe and require manual re-activation if defeated.
☐	Laser Housing Interlocks	Fail-safe or redundant interlocks shall be provided if they can be removed or displaced during operation and still allow access to Class 3B or 4 laser radiation. Warning labels shall be provided near the interlock if it can be defeated or by-passed.
☒	Emergency Stop	An emergency E-stop button shall be provided or the master key/power switch shall be designated at the emergency stop as applicable and clearly labeled as such.
☒	Beam Stops	The beam terminates in an aluminum beam block capable of withstanding the heat from the laser setup without degradation.
☒	Master Switch	The laser is only operable via a switch key. When the key is in standby mode, the laser is inactive.

Hazards & Controls:

Check If Applicable:	Hazard:	Controls:
☒	Housekeeping	The beam path and surrounding areas will be kept free of clutter and obstructions. Hand clearing of clutter from the optical table and beam area will be performed prior to each laser operation.
☐	High Voltage	The building manager and facilities electrical shop shall be consulted prior to operation/maintenance involving high voltage exposure including any adjustments needed.
☐	Capacitors	Any capacitors will be enclosed within a protective panel during operation and fully discharged prior to maintenance.
☒	Unenclosed Beam Access to Beam	The beam is contained within a curtained area. The outside door will also be closed as a secondary protection. Appropriate laser eyewear protection shall be worn in all areas with open, accessible laser radiation.

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☐	Fumes/Vapors	Any fumes/vapors generated during operation will be exhausted through a fume hood or local ventilation apparatus.
☐	Ultraviolet Radiation or Blue Light	Appropriate barriers and PPE to protect skin and eyes from UV and eyes from blue light will be in place upon consultation with EHS if needed. This may include lab coats, eyewear, gloves, fade shields or topical sunblock applications.
☐	Compressed Gases	Compressed gases will be properly secured and labeled. Safety caps will be in place for unused cylinders. Flammable and oxidizing cylinders shall be stored at least 20 feet apart unless specifically required for an experiment upon consultation with EHS. OH 204 compressed gas cylinder training from EHS should be taken and is available in UT Learn.
☐	Hazardous Chemicals/Waste	No hazardous waste is expected to be made during ordinary operation. If hazardous waste is generated, training course OH 202 should be taken (available in UT Learn) and all waste properly handled, labeled and stored per EHS guidelines.
☒	Reflective Material in Beam Path	The open beam paths will be kept free of clutter to prevent inadvertent ignition of materials, specular and diffuse reflections, and laser generated airborne contaminants.
☐	Fire	A fire extinguisher is located within a few steps of the table. Laser operators will ensure familiarity with its location and complete FF 205 hands on fire extinguisher training from Fire Prevention Services. Beam blocks will be used to absorb laser energy capable of generating hazardous levels of heat.
☐	Laser at eye level of person sitting or standing	The laser is mounted below the eye level of a person sitting normally. Beam blocks and additional barriers will be used to prevent the cohesive beam from travelling beyond the limits of the optical table.
☒	Infrared Lasers	Invisible lasers will be properly blocked and attenuated. Adequate viewing equipment such as IR viewers, cards, cameras, etc. must be available to the end user to ensure reflections are minimized.
☒	Correct Eyewear	Appropriate EHS approved laser eyewear protection with labelling of wavelength and optical density will be present and worn by all lab personnel working in rooms with accessible laser radiation. The eyewear will be made readily available prior to entering a nominal hazard zone at the door or curtain entrance, properly maintained, cleaned, and stored per manufacturers recommendations.
☒	Secured Laser	Lasers shall be secured to the operating surface during operation to prevent movement of the beam while the laser is on. The method of securing should be robust enough that if the laser is incidentally bumped or contacted, the beam does not lose contact with the target surface.

Operator Review:

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By signing this form, I agree that I have read and understand the contents of this SOP and will adhere to it' instructions. Furthermore, I agree that I have successfully complete the University's Laser Safety Training and I am aware that it is my responsibility to operate in a safe manner.

Name:	EID:	Signature:	Date: