The University of Texas at Austin
Laser Safety Program

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:	Laser Safety Staff	Date:	9/11/2023
Department:	EHS Laser Safety	Revision #:	2
Building & Room #:	ECG 1.200	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.

The lab setup utilizes an Nd:YAG laser at 532nm, pulsed at 200mJ, 10ns at 15 Hz. The device has two shuttered laser cavities that produce two overlapping laser pulses separated by an adjustable timing. A second laser can be used, in addition, if a wider field of view is desired. The device is located below a running propeller and used to image airflow across the propeller. A light sheet producing cylindrical lens is attached directly to the laser head that provides a 20 degree (698 mrad) divergence on a single axis to produce a thin light sheet parallel to the flow direction of interest. A high-speed camera normal to the produced light sheet and direction of flow is used to capture images of particles moving through the flow. A fog generator produces seeding particles approximately 4 microns in size. The laser is Class 4 and produces a diffuse reflection hazard that extends approximately 6 meters from the propeller and ceiling. All personnel must be inside the control room behind the metal ballistic shield prior to starting the propeller. The “Laser In Use” sign outside the laboratory must be illuminated prior to operation. All users must complete university safety training as well as approved laboratory specific training prior to use. Aside from low power alignment operations, no personnel shall be inside of the laboratory with the laser active.

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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:	Quantel	Wavelength (nm):	532
Model:	EverGreen - EVG00200	Power Output (mJ):	200 mJ/pulse
Serial Number:	1512100131	Beam Diameter (mm):	6.35
Class:	4	Beam Divergence ($1/e^2$) (mrad):	4
Cont. or Pulsed:	Pulsed	Duration (ns) & Rate (Hz):	10 ns
Eyewear Make:	Thorlabs	Eyewear Wavelength:	190-534 nm
Eyewear Model:	LG10	Eyewear Optical Density:	7+

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 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. Ensure door is closed and unnecessary personnel are not in the room.
    2. Turn on the ‘Laser In Use’ sign outside the laboratory.
    3. Ensure all personnel are wearing approved protective eyewear.
    4. Turn on the AC mains power switch on the back of the chiller/power unit.
    5. Turn on the safety Key Switch to the on position located on the front panel of the chiller/power unit.

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6. The system will power on and the "FAULT" LED will begin to flash. The system will begin priming. Once the LED stops flashing, the system will be ready for operation.
7. Using the left and right buttons will cycle between laser cavity 1 and 2. The up and down buttons will control the laser power.
8. There is a button for the "TRIGGER SOURCE". Press it to cycle through the options until the desired option is selected. The options are as follows: INT LAMP/INT Q-SW, EXT LAMP/INT Q-SW, EXT LAMP/EXT Q-SW.
9. Make sure that both "Q-SWITCH 1" and "Q-SWITCH 2" buttons are selected.

If using the laser with the LaVision System follow these additional steps:

1. Set "TRIGGER SOURCE" to EXT LAMP/EXT Q-SW, and ensure the appropriate BNC connections for LAMP1/Q-SWITCH 1/LAMP 2/Q-SWITCH 2 have been made to the PTU (timing unit).
2. Set the "FREQUENCY" to the maximum using the toggle button on the front panel, and the laser power to the maximum for both cavities.

B. Target area preparation
   1. Ensure laser and camera are positioned appropriately to obtain desired flow plane for analysis.
   2. Start fog generator.
   3. Put on hearing protection.
   4. Ensure all personnel are inside the control room and behind the metal barrier.
   5. Start the propeller by turning the main power switch to the ON position.

C. Operation procedures are as follows:
   1. Check to make sure all laboratory personnel are wearing approved laser protective eyewear.
   2. Ensure nobody is in front of the laser aperture prior emission.
   3. On the top of the laser, open the shutters for both cavities by moving the switches to the open (I) position.
   4. When ready, press the "ENTER" button. The laser will begin to fire and the "EMISSION" LED will light up.
   5. Images are captured using the computer software in the adjacent laboratory control room.

D. Shutdown procedures for this laser are as follows:
   1. On the front panel of the chiller/power unit, push the "ENTER" button. This will stop laser emission and power down the laser cavities.
   2. Close the shutters for both laser cavities by moving the switches to the closed (0) position. Switches are located on the top of the laser.
   3. Let the chiller run for at least five minutes to allow the flash lamps to cool sufficiently before completely shutting down the laser.
   4. Turn off the safety Key Switch.
   5. Attach the laser cap to the output (aperture) of the laser cavity.
   6. Turn off 'Laser In Use' sign outside the laboratory.

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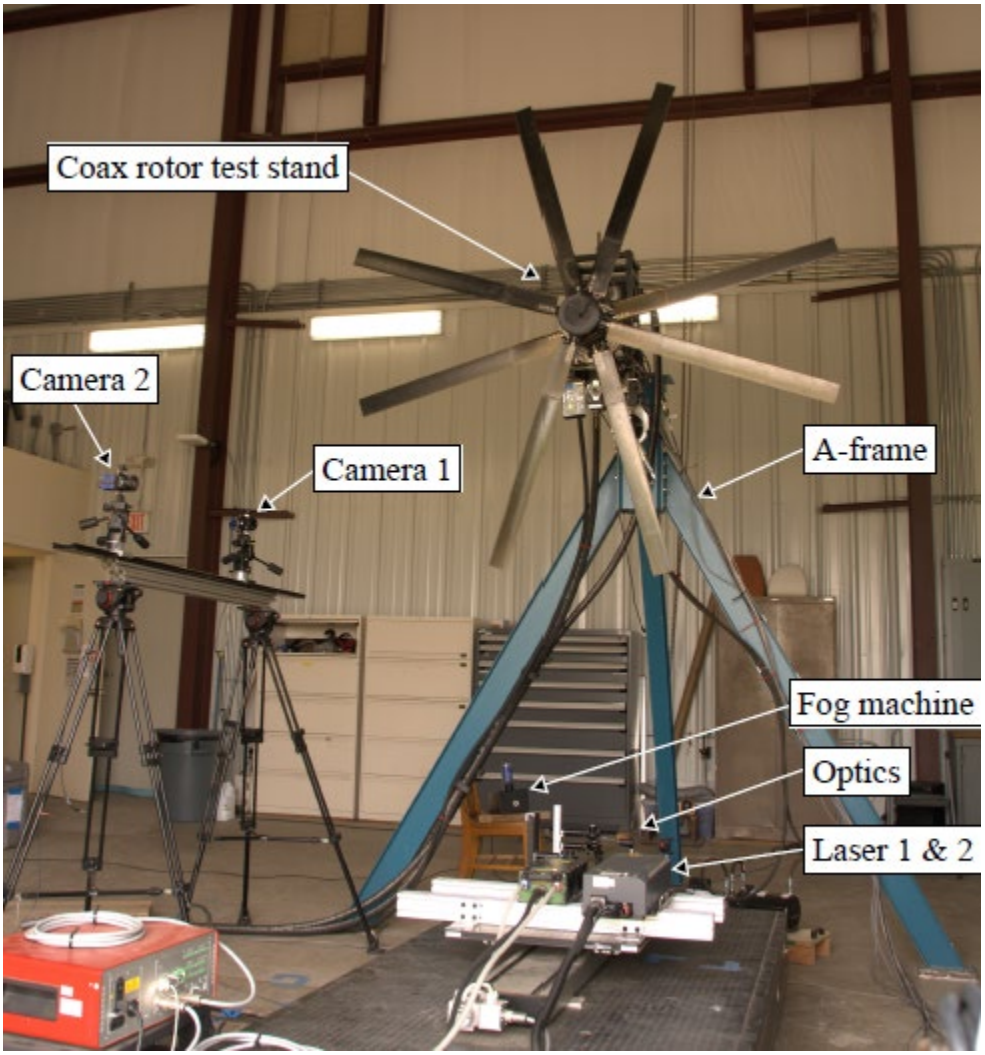
E. Alignment procedures (describe the specific steps and settings needed to reduce power before interacting directly with the beam path. For example, shuttering the pump laser, using ND filters, etc.)
   1. Roughly estimate and line up laser path using the screw holes on the optics table.
   2. WITHOUT THE LASER ON: align mirrors using the rough path based on the holes on the optics table.
   3. Start fog generator.
   4. Put on laser safety eyewear.
   5. Power laser on to the lowest possible power setting and do not enable q-switch to operate in a continuous wave.
   6. Adjust mirrors to achieve proper alignment.



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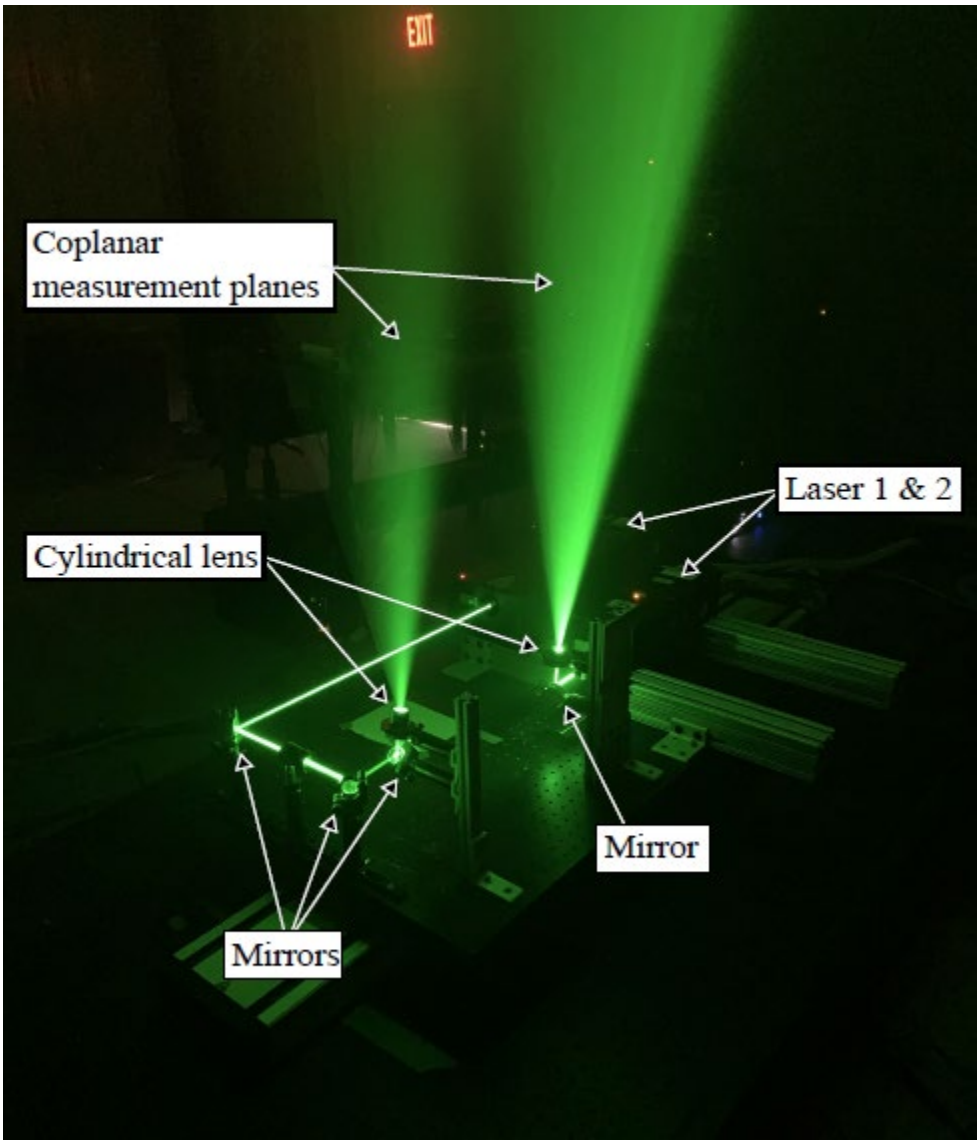

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Physical Controls: Describe the physical controls of the laser setup in the condition which the setup is intended to be operated. Edit the comment section as necessary to depict the lab specific controls implemented. EHS will review and approve the 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 keyed door. The lab door is to remain closed at all times unless the laser is shutdown and under the direct supervision of an authorized person.
☐	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 stop button is located in the control room to immediately cease laser emission in the event of an emergency. Use of the emergency stop button may cause damage to the laser and should not be used as a means to terminate emission in a non-emergency situation.
☐	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 with the key switch turned to the position for operation.

Hazards & Controls:

Check If Applicable:	Hazard:	Controls:
☒	Housekeeping	The beam path and surrounding areas will be kept free of clutter, obstructions, and reflective materials.
☒	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 the laboratory during use. Personnel inside the laboratory are within the Nominal Hazard Zone and must wear protective eyewear.
☐	Fumes/Vapors	Any fumes/vapors generated during operation will be exhausted through a fume hood or local ventilation apparatus.

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☐	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	The laser is secured to the experimental setup by means of allen screws.

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Operator Review:

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: