



Engineering School of Sustainable Infrastructure & Environment

Powell Family Structures & Materials Laboratory

UNIVERSITY of FLORIDA

STANDARD OPERATION PROCEDURE FOR PIV Laser Operation

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REVISION: 01

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Building 1626, Room 135
Gainesville, FL 32609



Description: This Standard Operation Procedure (SOP) establishes a set of instructions for experimental operation of the Class 4 laser and power supply used in the Boundary Layer Wind Tunnel (BLWT) for Particle Image Velocimetry (PIV) measurements. This document lists known hazards and safety procedures required to operate the laser. Read this document thoroughly prior to operating laser.

Scope: This document describes the normal operation of the Class 4 PIV laser located within the BLWT at the Powell Family Structures and Material Lab. The procedures below list how to safely power the laser up, how to safely operate the laser, and how to fully shut down the laser.

Training Required: This SOP is not a substitute for hands-on training. New PIV operators must receive hands on training by the research scientist or a lab member as assigned by the lab manager in addition to reading this SOP.

Additionally, all users must take the EH&S online laser safety training to learn about the potential harm from a laser. Once training is complete, print and sign the Laser Operator Document to be recognized as an authorized operator.

SAFETY

Hazards:



Safety glasses must be worn at all times in the lab.



Class 4 Laser radiation present, avoid eye or skin exposure to direct or scattered radiation.



Severe electrical shock hazard.



Fire Hazard

General Safety Notes:

Warning - Warnings are given relating to personal safety issues that may cause physical injury to persons performing a task and/or others around them.

Caution - Cautions are given relating to equipment and/or sample issues that may cause damage to or adversely affect the equipment, sample and/or test results. Always consult the Safety Data Sheet (SDS) prior to handling construction materials.

- **Warning** - Class 4 Laser radiation present; avoid eye or skin exposure to direct or scattered radiation. Direct and diffuse viewing of the beam may cause permanent eye damage. Direct Skin contact can cause skin damage.
 - ⇒ Before and during operation check the Laser Controlled Area (LCA described below) for pedestrians.
 - ⇒ All personnel entering the LCA shall be adequately trained and wear adequate PPE as required.
 - ⇒ All entryways into the LCA must be closed during operation of the laser.
- **Warning** – Laser interaction with matter can create hazardous airborne contaminants.
- **Warning** – Fire hazard, the laser may ignite non-suitable test material or the tunnel floor.
 - ⇒ Do not exceed 60% power.
- **Warning** – The seeding fluid coats the tunnel floor and causes a slipping hazard. Take caution when walking in the tunnel after operation of the seeders.
- **Caution** – Seeding fluid can ruin testing equipment. Cover exposed cobra probes and only operate seeders with fans running at least 600RPM.
- **Caution** – All other safety rules for the lab remain in place while using this machine. Disregarding any safety rules in place will result in immediate loss of laboratory privileges and disciplinary action.

Chemical Hazards:

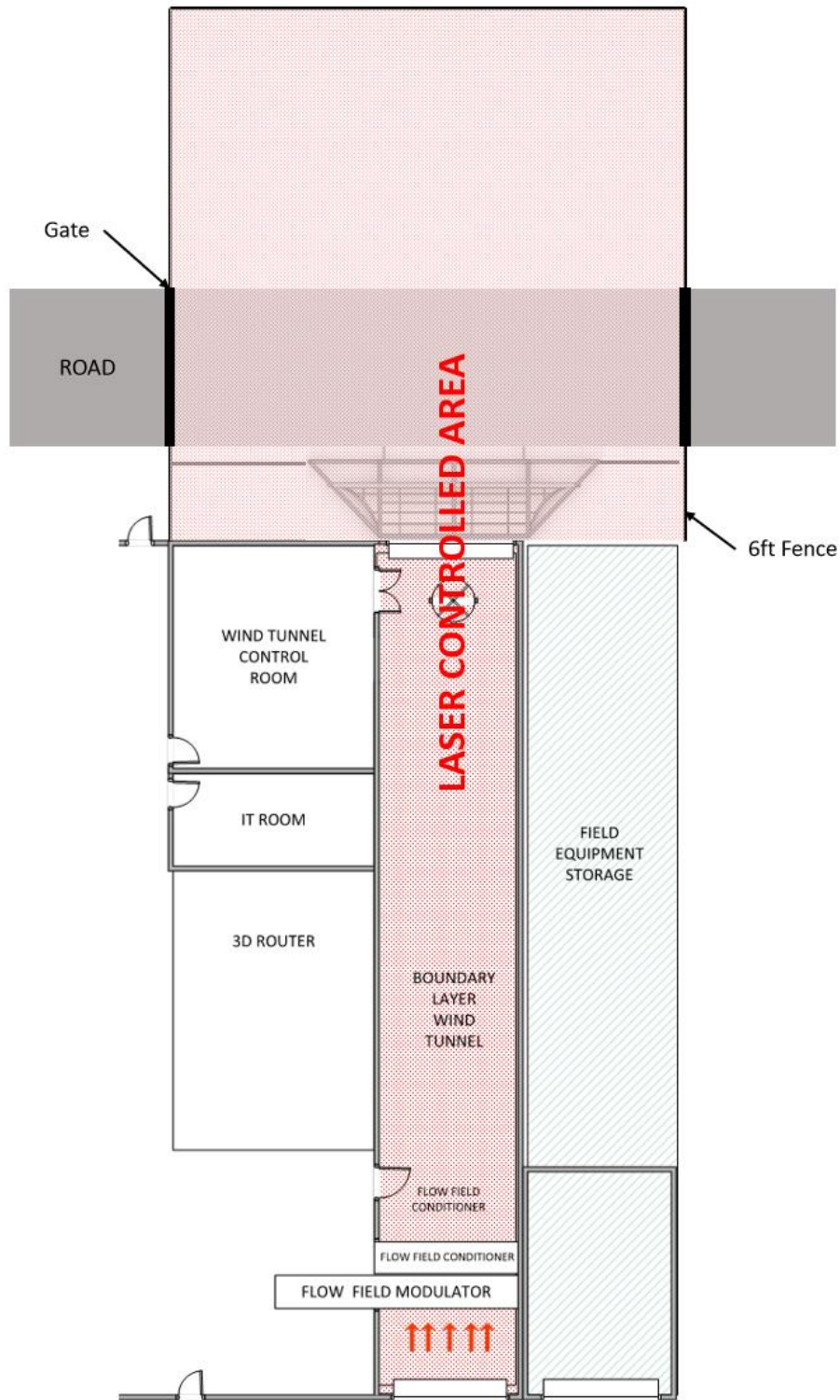
Operating the laser to conduct experiments requires the use of the below chemicals. No hazardous chemicals used; no hazard controls required. Do not drink chemicals used in the lab. Wear safety glasses at all times in the lab.

Chemical	Use	Hazard	Hazard Control
Deionized Water	Laser Cooling Liquid	Non-Potable	No Chemical Control Required
Extra Virgin Olive Oil	Seeder Fluid	Non-Hazardous	No Chemical Control Required
Black Paint 3.0	Painting the model	Non-Hazardous	No Chemical Control Required

Hazard Controls:

1. Laser eyewear certified for the wavelength(s) must be used in the LCA whenever the laser is active. The wavelengths used in this lab are: 527nm requiring minimum OD of 6. The eyewear can be found in the BLWT control room instrumentation cabinet.
2. No unauthorized persons will be allowed to operate the laser or aid with laser experiments. The laser control key is kept in the lab key safe by the front offices. Lab staff have the combination to this safe. Tunnel operators have the combination to the tunnel control key safe found in the BLWT control room but not the key safe if they are not trained on the laser. Only staff trained for operating the laser have access to both keys. The laser control key is turned off and removed from the power supply before anyone enters the controlled laser area.
3. The wind tunnel entryway must be closed for the interlocks to allow the laser to be active.
4. The "Laser in Use" light turns on via the laser power supply interlock when the laser is active.
5. Laser light is contained using enclosures, barriers and/or doors during normal use.
6. No jewelry or ties will be worn when manipulating objects near the beam path.
7. Tools and equipment near the beam path should be non-reflective if feasible. Reflective tools will be used carefully.
8. The main tunnel Emergency Power Off button which controls the laser as well as the main fans is accessible in the tunnel, control room and inside/outside of upwind door in case of accident or unexpected emission. In addition, all doors to the tunnel have interlocks that prevent the laser from firing if they are opened.
9. Custom fit laser curtains are velcroed to the 3 windows between the tunnel and control room when laser projects are expected to operate in the tunnel.
10. The exit wall is painted flat black and barriers are in place to prevent pedestrians from entering the exit area of the BLWT.

Laser Controlled Area:



START-UP

- Step 1:** Prior to powering on the laser, inspect the Laser Controlled Area to ensure that there are no unauthorized personnel. Check all of the entrances to the LCA and make sure they are locked. The entrance in the control room may stay unlocked as long as the operator maintains control of the door and does not allow anyone to enter.
- Step 2:** Inspect the surface that the laser will contact for reflective objects and material that may catch on fire.
- Step 3:** Retrieve laser key from lockbox. The operator is responsible for holding on to the key on them at all times.
- Step 4:** Check the water level on the laser power supply.
- Step 5:** Turn on power supply by pulling the emergency stop button out.
- Step 6:** Turn laser “on”
- Step 7:** Set Laser power level, mode, and frequency per operation and use of the laser.
- Step 8:** Prepare the wind tunnel for testing by following SOP-003 as applicable.

OPERATION

To operate the laser in Trig Q mode using Dynamic Studio 6.9, follow the below steps:

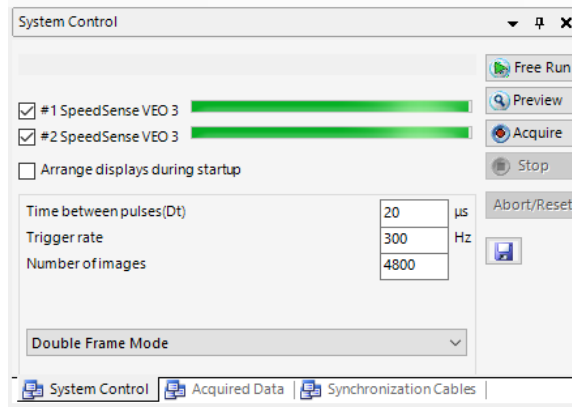


Figure 1 Dynamic Studio 6.9 Laser Control

- Step 1:** Follow steps in SOP-006 to set up Dynamic Studio, the laser power supply, and the highspeed cameras
- Step 2:** Set pump to “on”
- Step 3:** Set laser to “on”
- Step 4:** Set Shutter to “open”
- Step 5:** Using cameras, check to make sure the LCA is still clear and that it is not raining.

- Step 6:** Run fans/seeders per test matrix and SOP-006. Seeders must be on and have adequate flow across the test section to prevent laser from burning the floor or model.
- Step 7:** In dynamic studio, press the “acquire” button. A pop-up window will appear, press the “Start Acquisition and Fire Laser” button to acquire data with the cameras and fire the laser.

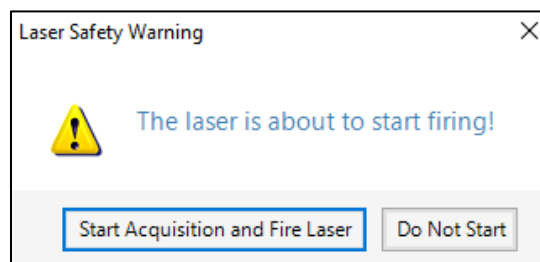


Figure 2 Step 7 Pop-Up Warning

- Step 8:** Dynamic Studio will automatically fire the laser for a set amount of time. Watch laser from cameras in the wind tunnel control room for anything unusual. When laser turns off you can either repeat above steps to continue testing or shut down laser per shutdown procedures below.

To Operate the laser in Int-Q mode using the power supply, follow the below steps:



Figure 3 Power Supply Control Panel

- Step 1:** Make sure LCA is clear of unauthorized personnel and position the gantry and laser as applicable per SOP-003. Check to make sure the laser is aiming at something that is non-reflective and will not catch on fire.
- Step 2:** Set both mode 1 and mode 2 to Int Q.
- Step 3:** Set laser frequency and power.
- Step 4:** Set pump to “on”
- Step 5:** Set Laser to “on”
- Step 6:** Using the cameras in the wind tunnel control room, check to make sure the LCA is clear of all unauthorized personnel.
- Step 7:** Set shutter to “open” to immediately fire the laser. Using the monitors, continually watch laser and target during operation. Turn off laser if there is any smoke visible.
- Step 8:** Turn off the laser by setting shutter to “closed”
- Step 9:** Repeat the above steps or continue to shutdown procedure as required.

SHUTDOWN

Before entering the tunnel or leaving the control room follow steps 1-4

- Step 1:** Set Shutter to “closed”
- Step 2:** Set Laser to “off”
- Step 3:** Allow cooling pump to run for at least ten minutes after operating the laser.
Then, set Pump to “off”
- Step 4:** Turn off and remove power supply key.

At the end of the day, or in order to leave the lab completely, follow all steps 1-8 to completely shut down the laser.

- Step 5:** Set System to “off”
- Step 6:** Push-Emergency stop button.
- Step 7:** Return Key to the key Lockbox
- Step 8:** Shut down tunnel as applicable per SOP-003

Document Information

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Revision History:

Revision	Description	Date	Revised By
A	First Draft	3/11/2021	J. Herrera
00	Initial Release	3/26/2021	J. Herrera
01	Revision per LSO redline. Mostly grammar corrections. Added new line to list on pg. 11.	3/29/20201	J. Herrera

Acknowledgement Form**Class 4 Laser Operation**

The Class 4 laser located in the Boundary layer wind tunnel is extremely dangerous piece of equipment that has a myriad of hazards. In order to operate the laser, you must print off this page, acknowledge all of the below statements by checking the boxes, and sign the bottom of the form. Turn in signed form to lab manager for approval.

- To operate the Class 4 laser, an individual must pass the laser safety course on MyTraining (EHS833), read and completely understand SOP-005, have in-person training from a qualified member of the lab staff, have approval from the lab manager, fill out and sign the University of Florida Laser User Statement of Training and Experience, and sign this form.
- Before each operation of the laser, open the latest version of SOP-005 from the lab documents folder, read all safety warnings, and follow the documents procedures for Start-up, operation, and Shut-down.
- The laser operator is responsible for ensuring that there is no unauthorized personnel in the Laser Safety Area. Anyone inside the LCA during laser operation must have completed this form and all required trainings. They must also wear the proper PPE at all times in the LCA when the laser power supply is on. Also, ensure that all doors into the LCA are locked and that the blackout curtains are correctly installed on the main control computer window and the two windows on the door leading to the tunnel.
- Never open or disassemble any component of the laser or power supply without the proper training.
- Only operate the laser within the limits described by the latest version of SOP-005.
- Keep the laser power supply key with you at all times during operation to ensure that no unauthorized personnel have access to the laser.
- Always consult with another lab member or the lab manager if there is any uncertainty about the procedure.

By signing below, you acknowledge that you will operate the Class 4 laser located in the Powell Family Structures and Material lab per the latest version of SOP-005 and will follow all safety procedures outlined above.

Name: _____ **UFID:** _____

Signature: _____ **Date:** _____

Lab Manager: _____ **Date:** _____