Jefferson Lab
Thomas Jefferson National Accelerator Facility

# Laser Operational Safety Procedure (LOSP) Form

(See ES&H Manual Chapter 6410 Appendix T1 Laser Operational Safety Procedure)

## Serial Number: _____

(Assigned by ESH&Q Document Control x7277)

***Attach the Task Hazard Analysis (THA) related to this procedure**

| | | | |
|---|---|---|---|
| **Issue Date:** | | **Expiration Date:** | |
| **Title:** | **LOSP for LAD detector calibration system** | | |
| **Location:** | Hall C beam left upstream of target | | |
| **Description of Project** | Class 3B laser is used as source of fiber distribution system for detector calibration purposes of LAD detector | | |
| **Document Owner(s):** | Florian Hauenstein / Holly Szumila-Vance | **Date:** | 07/17/20 |

**Laser Inventory**

| Laser Serial # | Laser Class | Wavelength(s) | Maximum Power/Energy |
|---|---|---|---|
| 1. GR1800568 | 3B | 355nm | 51uJ, max. 2kHz repetition rate |
| 2. | | | |
| 3. | | | |
| 4. | | | |

| Approval Signatures: | Print | Signature | Date: |
|---|---|---|---|
| **Laser System Supervisor:** | Dave Gaskell? | | |
| **Laser Safety Officer:** | Paul Collins | | |
| **Division Safety Officer** | Ed Folts? | | |
| **Department or Group Head:** | Cynthia Keppel | | |
| **Other Approval(s):** | | | |
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| | | | |

**Document History:**

| Revision: | Reason for revision or update: | Serial number of superseded document |
|---|---|---|
| | | |

**Distribution:** ESH&Q Document Control (x7277, MS6B); affected area(s); Document Owner; Division Safety Officer

**Introduction –** In areas containing more than one laser, define operational sequence or parameters.

This Laser Operational Safety Procedure Form describes the necessary controls and procedures during the work with and maintenance of the Laser Calibration System for the LAD detector in Hall C. The system is in an enclosed box and uses only optical fibers between components to ensure that no user is exposed to laser-related hazards during all phases of operation. This allow for classification as a Class 1 system, since the laser light can not escape the fiber.

The box contains a one class 3B picosecond diode laser (STV-01E-140) with 355nm wavelength, 0.3ns pulse width (FWHM), 51μJ pulse energy at 2kHz triggering which can be triggered externally by 10Hz – 2kHz. The output of the laser is directly coupled to a fiber through a mode scrambler which converts the single-mode output of the laser to multi-mode. Afterwards the signal is feed through a 90-10 splitter which 10% output is connected to a photodiode for monitoring while the 90% output is feed through an adjustable attenuator ($1\text{-}10^{-4}$). The attenuator output is connected via multi-mode fiber to the fiber distribution system. Each fiber of this system is connected via a patch panel to each scintillator bar of the LAD detector.

Jefferson Lab has developed engineering and administrative controls to control the hazard issues associated with the use of lasers. Please refer to Jefferson Lab's ES&H manual chapter 6410 for more information on the laser safety program and regulations.

The principal contacts:

1. Florian Hauenstein – laser setup operator
2. Tyler Kutz – laser setup operator
3. Dave Gaskell? – Hall C Laser System Supervisor (LSS)
4. Paul Collins – JLab Laser Safety Officer (LSO)

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| **Personnel**<br>Only those authorized by the LSS are permitted to enter the location noted on the cover sheet of this document. | List:<br>• Training and qualification requirements (including refresher training).<br>• Medical requirements.<br>• Spectator protection requirements. |

The laser system may only be maintained by personnel who have completed the following:

- The laser safety course SAF1140
- The laser-specific training course SAFxxx
- Read the ES&H Manual Chapter 6410 Laser Safety Program
- Read LOSP Form (this document)
- Signed the list of authorized laser personnel

| Laser | Define:<br>• Laser system specifications.<br>• Define laser system components.<br>• Copy of laser operating manuals or reference the location of the manual(s). |
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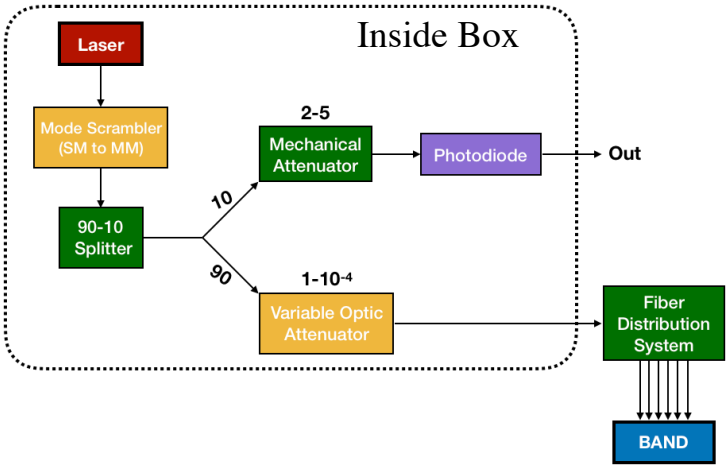
The main component of the system is the picosecond diode laser STV-01E-140 (Serial Number: GR1800568) which is classified as a class 3B laser product during all procedures of operation. It emits light with a wavelength of 355nm.

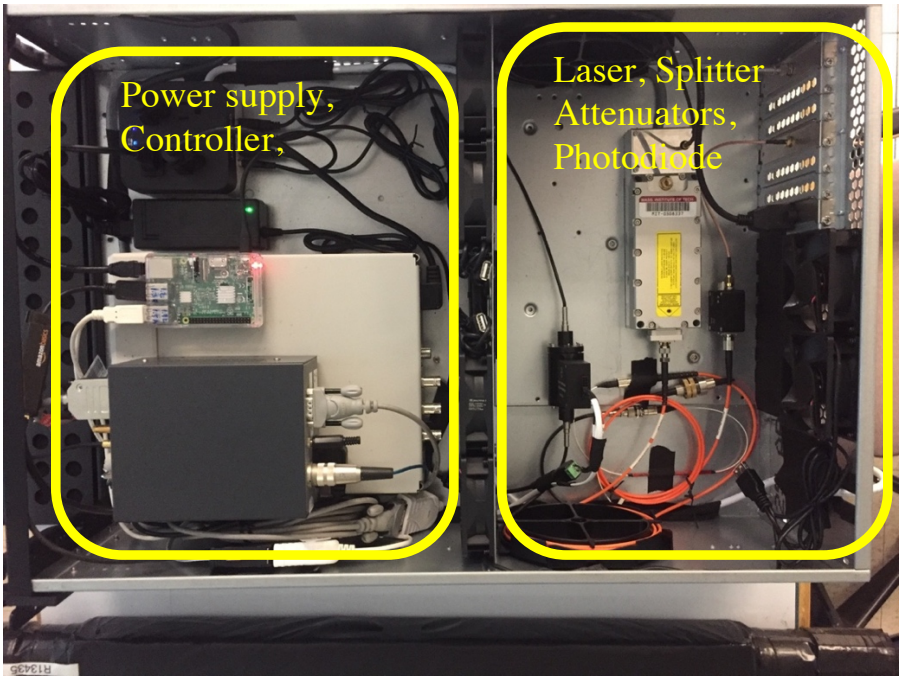
Each pulse has 51µJ energy and 0.3ns width (FWHM) at 2kHz triggering. The laser can be triggered externally between 10Hz – 2kHz.

Further components of the system are a mode scrambler, a 90-10 splitter which outputs connected to a mechanical attenuator and variable optic attenuator. The output of the mechanical attenuator is connected to the reference photo diode while the output of the variable optic attenuator (DD-100-MD) is connected to the fiber distribution system for LAD.

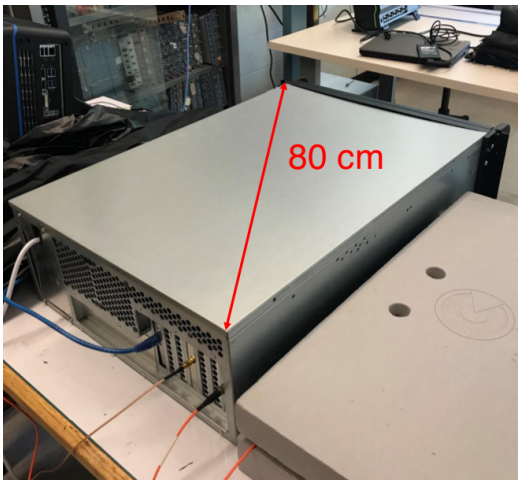
All connections between the different components are done by fibers with no free optical path. A schematic view of the full system is shown to the right.




The full system inside its closed box is shown below. The laser, splitter, attenuators and diode are sitting to the right in the box. On the left side the power supply, raspberry pi, temperature monitor, variable attenuator controller, laser driver and signal generator are located.




Closed box with laser system components



The Fiber distribution system itself is shown below. It is a compact unit which splits the input into 400 fibers with connectors. The box containing the system is installed at the LAD side. It is connected to fiber patch panels on the LAD side. From the patch panel a fiber is glued to every LAD scintillator bar. Each glue joint is covered so that no light can come out or stray light can come in.


| Hazards and Mitigation | Define:<br>• Laser-specific hazards.<br>• Occupational exposure hazards beyond laser light (e.g. fumes, noise, etc.).<br>• Credible non-beam hazards (e.g. environmental hazards).<br>• Describe all required personal protective equipment ES&H Manual Chapter 6410 Appendix T2 Laser Personal Protective Equipment (PPE) (include: clothing requirements (e.g.: no reflective jewelry, etc.). |
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## Laser Beam Hazards:

The close box in considered to be a Class 1 condition since the direct laser light can not leave the enclosure. All light is transported by fibers only. Specifically designed interlock automatically turns the laser off when the box is opened.

## Non-Beam Hazards:

Electric Shock: Before switching on the instrument, ensure that it has been properly grounded though the supplied AC power cable to a socket outlet with a protective earth contact. Electrostatic Discharge (ESD) on or near the connectors can damage electronic devices inside the instrument. Personnel should touch the metal frame of the box for a second before touching any connectors or instrumentation in the box.

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| **Laser Environment**<br>System designs, including interlocks, require hazard evaluation review by SME. | Define:<br>• Layout of the laser controlled area and/or table. (Show beam location in relation to user (waist height preferable).)<br>• Interlock schematic (or similar) (including smoke detector interlocks).<br>• Room lighting conditions during laser use and alignment procedure(s).<br>• Targets.<br>• Primary and all likely beam paths (open or enclosed). |

The enclosed box with the main laser and controllers is mounted in the SHMS hut. From there one multimode fiber connects the laser output after splitter and variable attenuator to the fiber distribution system next to LAD. The output of the distribution system in connected to a patch panel. From there a fiber is glued to each scintillator bar.

The enclosed box with the laser is interlocked such that the box can not be opened without having the laser off. All pathway of laser light is within fibers. There is no free pathway and there is no alignment necessary.
The box with the laser has some holes for airflow to cool the electronics inside. These holes are covered by light-tight, black tedlar foil which is also used for light-tight wrapping of scintillators bars. Therefore, no hole is visible from the outside. There will be warning signs installed on the outside of the foil.

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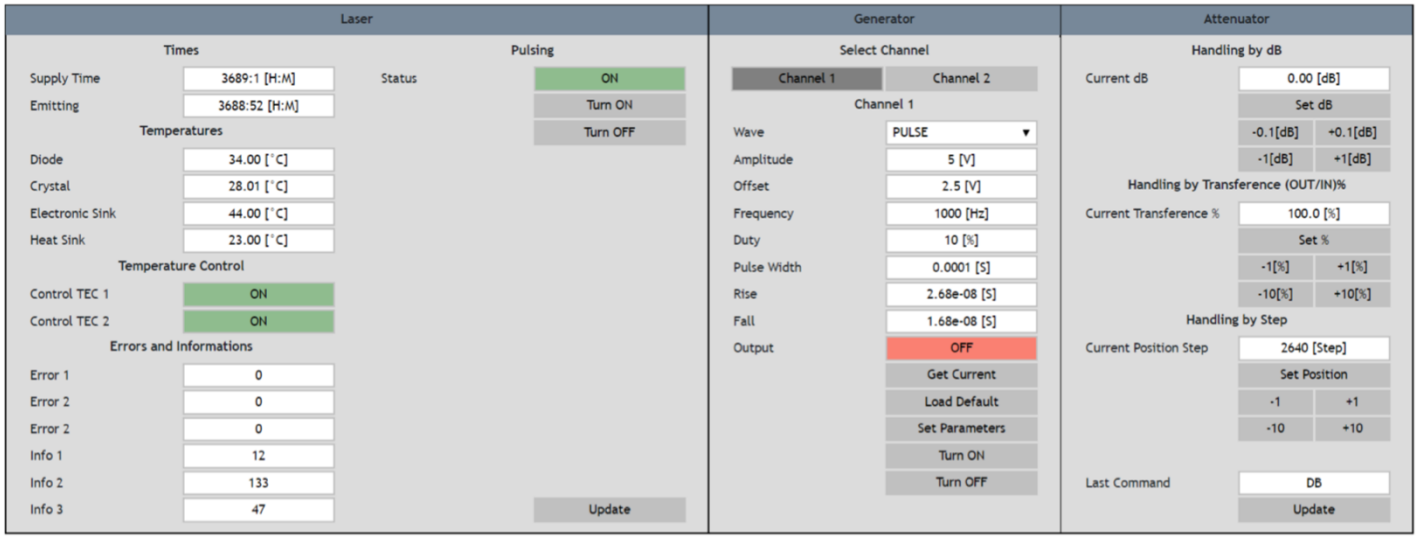
| **Written Procedure for Use and Alignment** | Provide:<br>• All process steps – including unattended operation controls.<br>• All process steps for detailed alignment – Include manufacturer's protocols for alignment.<br>• Maintenance and service.<br>• Off-normal and emergency procedures (e.g. beam loss, fire). |

There is no alignment necessary. The operation of the system is only performed by authorized and trained personnel with the control software via the raspberry pi (see figure below). In case the system is not used it is powered off.
For maintenance or service, the system is powered off and disconnected from the power supply. Only full components of the system are exchanged if repairs are necessary. For complicated maintenance guidance from the Laser Safety Officer is requested.




| Laser Controls | • Describe all controls (administrative and engineering). (If a different control is recommended the rationale for not using a typical/recommended control.) |
|---|---|

- The laser control area will be posted with a warning sign indicating the laser class.
- Only trained, authorized personnel are permitted to operate the laser equipment
- The interlock, installed by JLab's electronics group, is connected to the door sensor to prevent laser operation with an open box.

| Required Calculations | • Maximum permissible exposure.<br>• Optical density.<br>• Nominal hazard zone. |
|---|---|

OD, MPE and NHZ calculations are not required since the setup is always under Class 1 condition.

| Labeling/Posting<br>(See ES&H Manual Chapter 6410 Appendix T5 Laser Labeling/Posting Requirements | • Equipment/area labeling/posting requirements.<br>• Area signs. |
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The laser system components will have posting attached to it. Furthermore, there will be signs about the laser at the crate where the laser system is installed.

| Authorized/Trained Individuals | |
|---|---|
| **Print Name/Signature** | **Date** |
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| Authorized/Trained Individuals | |
|---|---|
| **Print Name/Signature** | **Date** |
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