Fermilab	Number	Revision 2
	Effective 02/17/2018	Page 1

Fermilab Class 3B/4 Laser Standard Operating Procedure

System Description: MicroBooNE UV laser calibration system: Normal Operation

FNAL Laser ID Number: 293,308

Location: LArTF

AUTHORIZATION

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Revision History

Author	Description of Change	Revision Date
Thomas Strauss	First draft	11/25/2014
Thomas Strauss	Separate into Alignment and Operation, update by experience from the lessons learned in Dec'14	04/17/2015
Michele Weber, Sam Zeller	Major revision	1/26/2018

Laser Hazards

Laser Radiation Hazard

Under normal operations the laser is operated in a closed box and the laser light is contained to the boxes and the MicroBooNE cryostat, which are optically isolated at the single photon level for PMT operation. The opening of the box is only possible with mechanical tools. Therefore, under normal operation NO LASER HAZARDS are involved.

For special alignment and maintenance (typically yearly), the laser needs to operate with the laser box opened. In this situation laser beam of **Class 4** pose a hazard. This operation mode is not considered standard operating procedure. The document "Fermilab Class 3B/4 Laser Alignment and Maintenance Procedure for FNAL Laser ID 293,308" describes the additional steps and safety precautions that must be followed in this case.

Class 4 Lasers: Are hazardous under direct, specular, and diffuse reflections. They can also be skin hazards and may pose a fire hazard.

The following table summarizes the laser light wavelength and pulse power. Two such laser boxes with a laser system each are present at LArTF.

Laser	Wavelength	ANSI Class	Average Output Power	Peak Power	Repetition Rate	Pulse Width	Energy/ pulse	OD
(2) Continuum Surelite I-10	**266nm**	4	-	-	10Hz	4-6ns	60 mJ	4.8
	355						65	2.3
	532						200	6.3
	1064						450	5.7

Cryogen Use

No cryogenic use intended for laser operation.

Chemicals & Compressed Gasses

No chemicals or compressed gas use intended.

Electrical Hazards

The lasers use commercial power supplies. Under normal operating conditions, these power supplies do not pose a hazard. No work may be done on power supplies without additional procedures that comply with Fermilab ES&H Manual (FESHM) requirements for electrical work.

Changing of harmonic generation crystals must be done according to Continuum "Operation and Maintenance Manual for Surelite Lasers."

No components may be worked on while the system is energized.

Other Special Equipment

In normal operation mode, the system is fully enclosed and sealed light tight, so no special equipment is needed.

A low power green alignment laser of Class 2 or 3a is used, which poses no particular hazard. **It has to be ensured that this alignment laser is turned off for normal operation.**

System Configuration

There are two independent (but identical) laser systems consisting of:

1. A laser rack, with power supplies, cooling, UPS, laser controls and laser data acquisition
2. A connection corrugated pipe with laser power and trigger cables and cooling water for the laser head
3. An enclosing laser box with the laser head and optical systems (frequency doubler, filters, collimator, beam dumps, extraction mirror)
4. A connection pipe to the cryostat, attached to the laser box and the laser feedthrough on the cryostat.

There are two configurations with specific Hazard Zones: one for normal laser operation, and one for maintenance and alignment.

Nominal Hazard Zone for normal operation

In normal operation there are no accessible zones with a relevant laser hazards.

The Nominal Hazard Zone is restricted to the non-accessible areas in the enclosed boxes, connections and the MicroBooNE cryostat.

The laser boxes cannot be opened without tools and configuration control locks are placed on the box covers. There is no access (nondestructive) to the connections. Access to the MicroBooNE cryostat is not possible, as it is a sealed pressure vessel filled with liquid argon. It is optically sealed for single photon PMT operation.

Nominal Hazard Zone for maintenance and alignment

Periodically, the UV lasers boxes will be opened for checks and the laser alignment checked. For these operations with access to the laser boxes the Hazard Zone is extended to the LArTF building.

Engineering Controls

X Beam Enclosures

☐Protective Housing Interlocks

X Beam Stop or Attenuator

X Key Controls

☐Activation Warning System

X Room Interlocks

☐Ventilation

☐Other

Engineering Controls Description

Beam Enclosure:

The UV laser is completely enclosed by a light tight housing. Access is only possible by means of mechanical tools and the opening of hardware (screws and locks). Four padlocks secure the laser box.

Prior to operation of the UV laser system, the light-tightness of the system will be checked using the internal PMT system of the MicroBooNE experiment. The PMTs are highly light sensitive detectors that will allow identification of any light leaks before laser operation. The PMT rate is checked before any laser operation, and while the PMT are on, a dry interlock prevents the UV laser from turning on.

The MicroBooNE cryostat is filled with ultra-pure liquid Argon. The cryogenic system is automatized and runs 24/7. Internal sensors control the pressure in the tank (slightly over atmosphere, to avoid the seeping in of contaminations from air). In case of a leak, the whole system will send out an automated alarm that will be signaled in the MicroBooNE slow controls system (monitored 24/7 by MicroBooNE shifters) and distributed to on-call cryogenics experts. If any such event occurs, data-taking will be stopped, including any laser operation.

Key Controls:

There are two sets of keys: keys (A) to access the configuration control locks on the laser boxes and keys (B) to the laser power supplies to start operation.

Keys (A) ensure that the laser boxes are closed for normal operation, and therefore the Nominal Hazard Zone limited to non-accessible space. The ELO usually hold these keys when no maintenance is underway.

Keys (B) are used as a supplemental control for the normal laser operation. These keys are stored and locked in a special cabinet in the ROC-W control room when the laser is not used. They are used to activate the laser power supply either for each single laser calibration run or for a period of laser runs.

Powering Interlock

In order to protect the light-sensitive PMT system in the MicroBooNE cryostat, the laser system is interlocked with the High Voltage of the PMT system. The laser power supply is enabled, if the PMT HV is turned off.

Room Interlocks:

During data taking of the experiment, access to the MicroBooNE LArTF building will be possible only on the loading dock and the DAQ room areas. Access to the platform where readout crates and the DAQ crates are situated, as well as access to the lower level with the cryogenic system is restricted by keyed access doors with access permission granted by the MicroBooNE Run Coordinator in compliance with MicroBooNE rules. This interlock system is used to comply with the ODH regulations of the LArTF building.

Access to the LArTF building is only possible with keycard and access rights.

Administrative Controls

SOP for normal operation

Specific laser operation will be done in accordance with Continuum "Operation and Maintenance Manual for Surelite Lasers."

The purpose of the normal operation is to take regular calibration data for the MicroBooNE experiment. For this the lasers can be turned on and controlled remotely by means of the UV laser rack. This action requires the DAQ to be in laser mode and the PMT HV to be turned off.

To ensure that the UV laser is operated not accidentally, the keys (B) to the UV laser power supply will be stored in a locked cabinet in the ROC-W control room.

When the laser heads are triggered an internal photo diode will provide feedback to MicroBooNE trigger system and laser steering sequence. The mirror steering sequence will then be executed and their resultant movement will provide the scan of the experimental active volume via software interface circuits. The laser is operated in pulsed mode, each laser shoot is performed with a RS232 command from the laser control rack. If the server hosting the remote operation crashes, the system will not be 'firing' and can be switched off/on after a reboot. This operation mode ensures that no accidental exposure to the UV laser beam is possible.

Only trained UV laser experts will operate the system, having completed the Laser Training (no eye exam needed) and instructions for the operation of the MicroBooNE UV laser system.

The procedure to perform a laser calibration in normal operation mode is the following:

1. Run Coordinators request or give permission to perform a laser calibration run and document in the MicroBooNE elog.
2. Check the light tightness of the detector by cross checking the PMT event rate and document in the MicroBooNE elog.
3. Obtain keys (B) from ROC-West. Only approved personnel by the laser owner and Run Coordinators are allowed to obtain the keys (B)
4. Check that no person is on the platform or lower levels at LArTF
5. Check the mechanical integrity of the laser boxes at LArTF including verifying that the locks are in place on the laser boxes and document in the MicroBooNE elog
6. Check that the PMT HV is turned off (PMT experts) and document in the MicroBooNE elog
7. Insert and turn the key to allow remote access to the UV laser power supplies.
8. Turn on the UV laser remotely, and wait for the warming up of the device (about 25 minutes).
9. Set the DAQ system to UV Laser mode.

10. Start the UV laser run.
11. Stop the UV laser run.
12. Turn off the UV laser.
13. Leave the UV laser mode.
14. At the end of the DAQ run period, remove the key to the UV laser power supplies at LArTF and return the key to the locked cabinet in the ROC-W control room. Document this in the MicroBooBNE elog.

No access to the UV laser box or laser alignment will be involved or allowed in any of this operation. Thus the system is light tight at all times and NO LASER BEAM outside the closed box and cryostat will be present.

Personal Protective Equipment

As no laser can escape the enclosed box, no specific laser PPE is required.

Additional PPE requirements to access the platform at LArTF exist.

SOP Signatures

The signatures of the users listed in the following table indicate that they have read and understood the contents of this SOP and agree to adhere to the requirements and guidelines contained within. Only persons who have signed below and have been authorized by the Owner may operate lasers covered by this SOP. Additional authorization may be required to perform items listed in the SOP. Other required training and authorization are detailed in the Laser System-Specific Training Checklist.

User	Signature	Date	Owner Signature
Weber M 13491V		7/24/18	
Yifan Chen 34320V		7/24/18	

Laser System–Specific Training Checklist

Laser User:	
Laser Owner:	Michele Weber, Igor Kreslo
Laser System:	Continuum Surelite I-10

Topic	User Signature/Date	Owner Signature/Date
General Laser Safety • Hazards in LArTF • Good practice in LArTF • Laser Training class • Operation of the MicroBooNE laser system		