

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
-LIGO-
CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Document Type LIGO-T020128-00-D 09-12-02
Standard Operational Procedure for the Pre-Stabilized Laser (PSL) for the Optic Test Facility (OTF) Laboratory
Lee Cardenas

This is an internal working note
Of the LIGO Project.

California Institute of Technology
LIGO Project – MS 18-34
Pasadena CA 91125
Phone (626) 395-2292
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project – MS 20B – 145
Cambridge, Ma 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW:<http://www.ligo.caltech.edu/>

1 General

1.1 Purpose

This document is the Temporary Operational Safety Procedure (TOSP) for the Optic test Facility (OTF) Laboratory. The OTF Laboratory is located in room 38 of the Lauritsen Laboratory. The Document outlines the safety procedures to be observed during the work on the LIGO 100-mW and 700-mW ND:YAG Lasers.

1.2 Scope

This TOSP contains the bare essentials related to safety in the OTF Laboratory. It is meant to serve as an interim procedure to allow work in the laboratory until a comprehensive laser safety program is adopted by the LIGO Project.

1.3 Authority and Responsibility

The LIGO Detector Group Leader has the authority to initiate implementation and termination of this TOSP. Implementation responsibility rest with the laser users.

2 Introduction

The OTF laser safety procedures are designed to ensure the safety of all personnel, equipment and visitors. They are based on the following documents:

I LIGO Laser Safety Program, LIGO – M960001-A-P

II American National Standard for Safe Use of Lasers, ANZI Z136.1-1993

The document describes the PSL laboratory and identifies any potential safety hazards.

2.1 OTF Location and Laboratory Layout

The OTF is located in room 38 of the Lauritsen Laboratory. The layout of the OTF Laboratory is shown in Figure 1. The shaded region in Figure 1 denote the area within the OTF Laboratory having its own diamond-shaped hazard symbol.

The laboratory is divided in two parts. Left and right.

The right side of the laboratory is occupied by a desk, file cabinet and a work bench.

The left side of the OTF laboratory is a designated Nominal Hazard Zone (NHZ).

The wearing of laser safety glasses inside the NHZ is mandatory unless the PSL is switched *off*. *Note* That this means that the laser safety glasses must be worn even when the laser is placed in stand-by mode. The status of the laser is indicated by an illuminated warning sign. When the sign is illuminated laser safety glasses must be worn. Entry into the NHZ is hindered by a curtain which has a standard laser warning sign situated at eyelevel, warning of the need for eye protection. Hazards in the NHZ include **Laser radiation, high voltage** and either a **Nitrogen** or **Helium** gas cylinder.

A sign identifying the current laser safety officer for the PSL laboratory will be posted in a prominent position in an area prior to entering the NHZ. In addition a list of approved users of the LIGO 700-mW Laser will be posted near the entrance of the NHZ.

2.2 Laser Description

The OTF laboratory contains three Class IV Nd³⁺:YAG Lasers. The output from these lasers is in the infrared region of the electromagnetic spectrum and is therefore *INVISIBLE*. The relevant specification for the LIGO 100-mW and LIGO 700-mW Model 126 NPRO laser is outlined in table 1.

3 Hazards

A Class IV laser is a hazard to the eye or skin from the direct beam, maybe a hazard from a diffuse reflection, and may also be a fire hazard. A Class IV laser, in the infrared region, is defined as being [1]:

- Visible (0.4 to 0.7 μm) and near-infrared (0.7 to 1.4 μm) lasers and laser systems which
- (a) emit an average accessible radiant power of 0.5 W or greater for periods ≥ 0.25 s or
 - (b) produce radiant energy in excess of 0.03 C_A J.

C_A is a factor related to the absorption of infrared radiation by the skin.

3.1 Identification of Safety Hazards

The following safety hazards are contained in the right half of the OTF Laboratory:

- N₂ gas cylinder(s).
- He gas cylinder.
- Cleaning compounds: methanol, ethanol and acetone.

The following safety hazards are contained in the left half of the OTF Laboratory:

- High voltage: the 150 V power supplies for the rf photodetectors and the ion pump power supplies.
- Nd:YAG laser

OTF Laboratory
Room 38, Lauritsen Laboratory

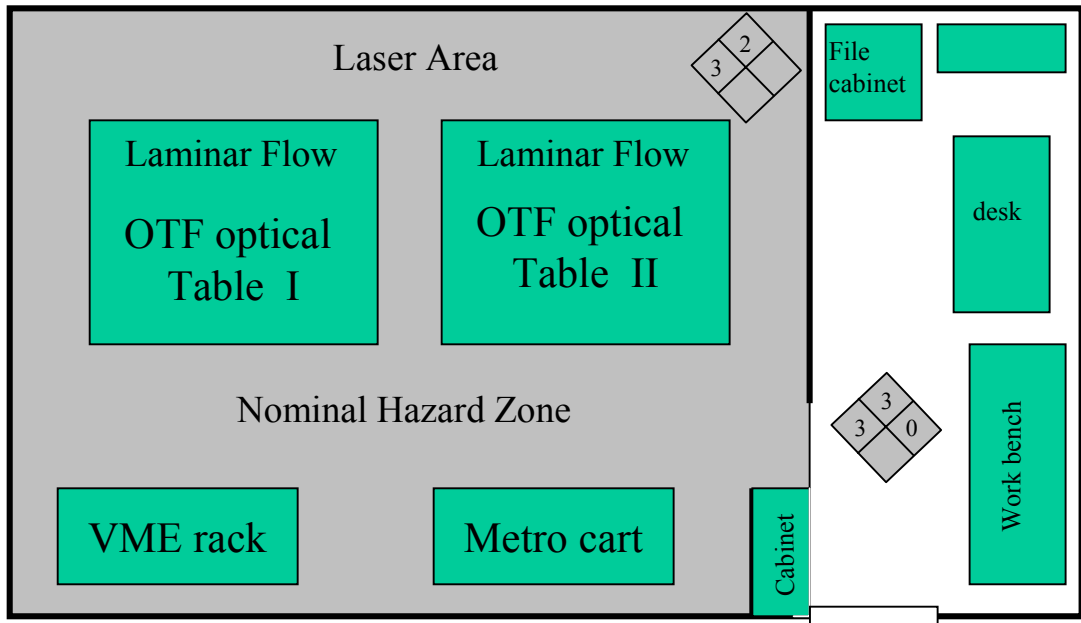


Figure 1: The OTF Laboratory Floor Plan

Laser	MODEL 126 NPRO	MODEL 126 NPRO
wavelength	1064	1064
max. output power	700 mW	100 mW
pulse duration	cw	cw
Beam divergence	3.1 mrad	3.1 mrad

Table 1: Laser specifications.

4 Controls

4.1 Access Controls

The OTF laboratory has no active access control devices. The laboratory relying instead on a number of physical barriers and warning signs. The door to the laboratory has the standard laser radiation safety warning sign, a map of the laboratory layout, and a notice identifying emergency contact people and listing the hazards that could be encountered in the laboratory.

Except for some chemicals stored in polyethylene wash bottles.

A curtain, which is to remain closed at all times, covers the entrance to the NHZ.

A 254 mm high x 356 mm wide illuminated laser warning sign alerts people to the need for eyewear protection prior to entering the laser area. The wording of the sign says:

EYE PROTECTION REQUIRED
BEYOND THIS POINT
LASER ON
CLASS IV LASER PRODUCT

Persons wishing to enter the laser area, should pay attention to the status of the illuminated warning sign. The sign shall be energized whenever the laser power supply for the Model 126-1064-700 is switched on, even in the standby mode.

4.2 Beam Controls

The optical table has a series of beam dumps mounted around the edge. These are meant to stop any stray beams leaving the vicinity of the optical table. In addition, beam dumps are placed at each location where there is known to be an unwanted beam.

An optical enclosure is positioned around the optical table. Laser is planned to operate with all the doors of the enclosure closed. This will form a physical barrier between the laser and any personnel.

4.3 Electrical Controls

Initially all electrical controls for the LIGO 100-mW and LIGO 700-mW Laser are to be accessed via the laser's power supply.

4.4 Other Controls

All gas cylinders in the OTF Laboratory are to be chained, top and bottom, in gas cylinder racks.

4.5 Eye Protection

All personnel in the NHZ, whilst the illuminated laser safety sign, shall wear protective eyewear suitable for ND:YAG lasers. It should be noted that the plastic laser safety eyewear provided is easily damaged by even momentary exposure to the high power laser beam. The wearer should still be extremely cautious.

5 Operating Procedures

Prior to powering on the laser, the operator shall visually confirm that no one is physically in the beam path. In addition, the operator must check that the laser safety warning sign is in operation.

5.1 Personnel Protection Requirements

Prior to powering on the laser the operator, and anyone else in the NHZ must be wearing laser safety eyewear. Watches, rings and any other jewelry should be removed.

6 Laser Operation Safety Rules

The Detector Group Leader will approve a list of people authorized to operate the LIGO 100-mW and LIGO 700-mW Lasers. The list will be revised and re-approved whenever necessary. Other people will only be allowed to work with the 100-mW and 700-mW Laser in the presence of at least one authorized person.

Under no circumstances are unauthorized personnel allowed inside the NHZ, without an escort. This includes, for example, custodians, maintenance personnel and inventory staff.

A flashing warning sign is to be placed in an area prior to the entrance of the NHZ.

A sign posted in an area prior to entering the NHZ, saying that entry into the NHZ is **prohibited**

Whenever the warning sign is on, except in the following cases:

- The person, or persons, wishing to enter the NHZ are wearing the protective eyewear provided and have announced their intention to enter the NHZ.

- The person, or persons, wishing to enter the NHZ have received and acknowledged approval from the operator of the 100-mW or the 700-mW Laser.

An up-to-date list of authorized users of the LIGO 100-mW and LIGO 700-mW Laser and the current version of this TOSP is to be posted outside the NHZ.

Personnel working with the LIGO 100-mW and/or LIGO 700-mW Laser are required to obey the following rules:

- Wear protective eyewear at all time when working in the NHZ, when the laser warning sign is flashing, including times when the laser is placed in **STANDBY** and the laser shutter is closed.
- Remove all forms of personal jewelry, such as watches and wedding bands.
- Do not look into the beam, even when wearing protective eyewear.
- When placing components, such as mirrors or lenses, in or out of the path of a beam, a visual check shall be made to see that no one will be in harm's way. In addition, a verbal message announcing the person's intent to install or remove a component shall be made.
- Take particular care when the person's eyelevel traverses the optical height of the laser beam. Situations when this may arise include, but are not limited to, bending down to pick up dropped objects and during the alignment of optical components.
- All beams are to be blocked with beam dumps or beam stops. Particular care should be taken that at no time will a laser beam hit the curtain at the entrance to the NHZ.
- Scattering of the laser light is to be minimized by maintaining proper alignment of the optics and thorough use of the beam dumps.
- All optical mounts are to be securely fastened to the optical table.
- Infrared viewing equipment is to be available on the optical table, to make it possible to check for the presence of stray beams and for use during alignment of optical components.
- The operator of the laser is to verbally announce whether the laser is to be powered on or off. Prior to powering on the laser or opening the shutter, the operator of the laser must visually confirm that no personnel will be in harms way or will be exposed to any direct laser radiation, and that all personnel present are wearing protective eyewear.

7 Training

7.1 Laser safety Orientation Requirements

All personnel are required to register with the LIGO Safety Office and receive laser safety training. All personnel shall review and be familiar with the LIGO safety program manual.

8 Responsibilities

8.1 Supervision

A list of emergency contacts for the OTF Laboratory is located on the door to the laboratory. The list includes contact telephone numbers for both during and after work hours.

8.2 Laser Safety Officer

There shall be a designed **Laser Safety Officer** (LSO) for the OTF Laboratory. The LSO has the authority and responsibility to monitor and enforce the control of the laser Hazards in the NHZ. In addition the LSO will be responsible for the following tasks:

- Maintaining an inventory of all lasers operational in the OTF Laboratory. Inform Project Management and the LIGO Safety Officer of any new laser installations.
- Maintaining an up-to-date listing of the personnel authorized to operate lasers in the OTF Laboratory. The LSO is responsible for informing the LIGO Safety Officer of any new Personnel working in the NHZ. The listing of authorized personnel is to be posted outside the NHZ, close to the entrance to the NHZ, on one of the partitions.
- Provide the necessary safety equipment for safe operation of the PSL.
- Being aware of the current operational status of the laser, so that warnings can be issued to visitors if necessary.

8.3 Laser Personnel

Registered laser personnel should assist the LSO in identifying any potential laser-related safety Hazards. Furthermore they are responsible for:

- Conducting all activities in accordance with the Safety Operating Procedure.
- Complying with all requirements of the LIGO Laser Safety Program.
- Inform the LSO or OTF Task Leader if they are not capable of performing a laser-related assigned task

9 Miscellaneous

The general rule for the NHZ is that if there is any doubt as to the status of the laser, Then safety eyewear shall be worn.

9.1 Rules For Visitors

No Visitors or unqualified personnel are allowed in the NHZ without an escort.

All visitors or unqualified personnel in the NHZ must wear laser safety eyewear.

No eating or drinking is permitted within the confines of the NHZ.

No smoking is allowed in the OTF Laboratory.

Footware is to be worn in the OTF laboratory at all times.

9.2 Emergency Procedures

The procedures to be followed in the case of an emergency are listed next to each telephone In the OTF Laboratory.

Additional procedural information is displayed around the partitions of the NHZ.

References

[1] American National Standards Institute

American National Standard for Safe Use of Lasers

ANSI Z136.1 – 1993

Published by the Laser Institute of America, Orlando, Florida.

[2] LIGO Laser Safety Program

LIGO – M960001-A-P