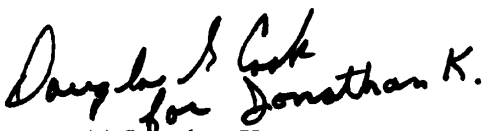
LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SOP	LIGO-M000178-B-L	6/4/01
Standard Operating Procedure: 4Watt COS Infrared Alignment Laser Operation in the LLO LVEA		
SPONSOR Mike Smith		



(s) Jonathan Kerm
LLO Laser Safety Officer

(s) Gerry Stapfer
LLO Site Safety Officer

LIGO Hanford Observatory
P. O. Box 1970; Mail Stop S9-02
Richland, WA 99352
Phone (509) 372-8106
Fax (509) 372-8137
E-mail: info@ligo.caltech.edu

LIGO Livingston Observatory
19100 LIGO Lane
Livingston, LA 70754
Phone (225) 686-3100
Fax (225) 686-7189
E-mail: info@ligo.caltech.edu

California Institute of Technology
LIGO Project - MS 18-34
Pasadena CA 91125
Phone (818) 395-2129
Fax (818) 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 INTRODUCTION

This Document is the Standard Operating Procedure (SOP) for COS Infrared Alignment Lasers when operated in the Laser and Vacuum Equipment Area (LVEA). It is designed to ensure the safety of personnel in the area where this laser is operating.

The COS infrared alignment lasers are diode lasers emitting at a wavelength of 940 nm and 990 nm. They are used primarily to align optics (Core Optics and COS optics) within the vacuum chambers and onto the Interferometer Sensing and Control (ISC) optics tables. Such lasers are not normally active during observatory operation and are used temporarily during times of installation and alignment of optics.

2 LASER DESCRIPTION & LOCATION

The COS Infrared Alignment laser (referred to subsequently as "laser" in this document) uses a Class IIIb continuous-wave semiconductor laser diode emitting either at a wavelength of 940 nm or 990 nm. The equipment used in this application consists of a fiber-coupled laser diode, which is used to illuminate the reticle of the autocollimator; an autocollimator with a 0.9 in diameter output aperture; and a video camera. The return beam collected by the autocollimator is viewed through the eyepiece by means of a camera lens and a CCD camera.

- configuration — output fiber-coupled
- laser power, at fiber — <4 W
- wavelength — 940 - 990 nm
- output beam diameter, at fiber — 100 micro-meter
- divergence angle, at fiber — 23 deg, full angle
- output beam diameter, output of autocollimator — 0.9 in
- divergence angle, output of autocollimator — 0.2 deg, full angle

The alignment laser is portable and will be used on optics tables within the vacuum chambers or in two designated beam manifold spool areas in the LVEA used for aligning the COC optics, as shown schematically in Figure 1. The laser light will also be propagated onto IO and ISC tables located adjacent to WHAM3, WHAM4, WHAM9, and WHAM10 at Hanford; LHAM3 and LHAM4 at Livingston.

3 HAZARDS

This Class IIIb laser is a hazard to the eye or skin from direct beam exposure. Diffuse scattered light is not normally hazardous. Infrared lasers pose an additional hazard because the output radiation is not visible to the unaided human eye. The COS assembly area does not have opaque enclosures so radiation from the laser which is incident on reflective and focussing optics within the assembly area of the LVEA with a line of sight to the chambers in which the beam can propagate or personel undergoing work may be exposed to the beam. Whenever laser operation is enabled, the LASER HAZARD condition (see below) shall exist and the entire LVEA shall be declared a Nominal Hazard Zone (see below).

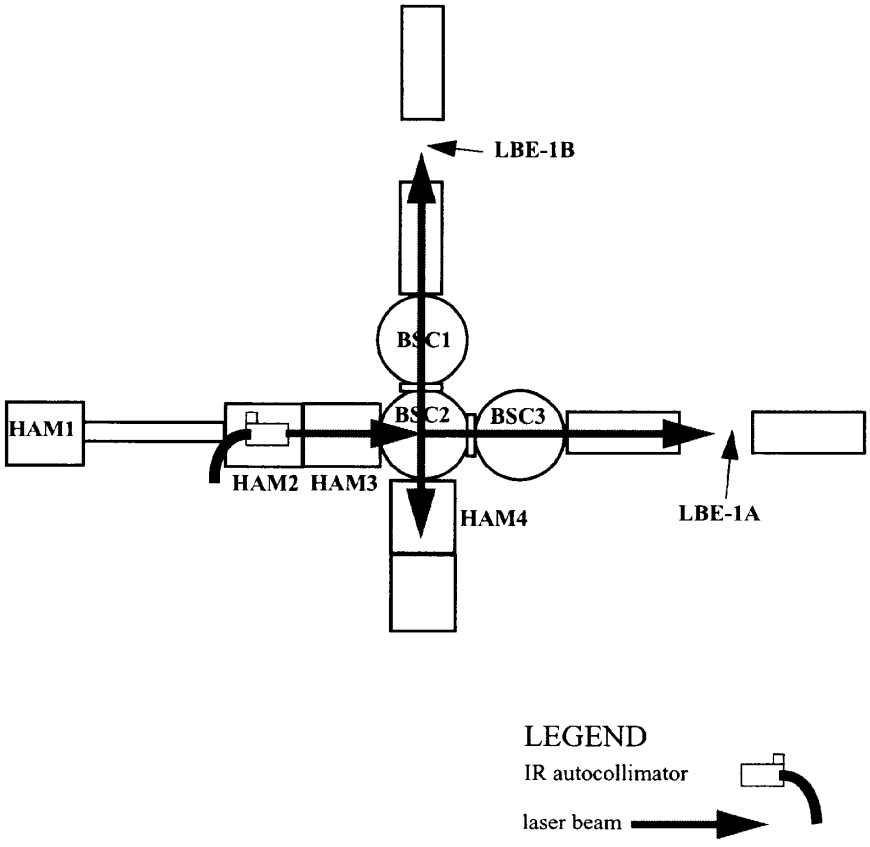


Figure 1: Location of areas in which the COS infrared lasers will be located and areas where the COS laser beams will intentionally propagate.

4 CONTROLS

Controls for operation of this laser shall conform to guidelines provided in ANSI Z136.1 for lasers used without protective housings, in research and development environments, and by highly trained personnel.

4.1. Administrative Controls

For the purpose of laser safety, two operating conditions have been defined for the LVEA and VEAs: LASER HAZARD and LASER SAFE.

The LASER HAZARD condition shall exist any time the laser is capable of operating and emitting a beam of laser light in the LVEA.

The LASER SAFE condition shall not exist when the laser is in use.

The procedure for transitioning to the LASER HAZARD condition is in *Procedure for Transition to the LASER HAZARD Condition* (LIGO-M990152). The procedure for transitioning to the LASER SAFE condition is in *Procedure for Transition to the LASER SAFE Condition* (LIGO-M990153).Warnings and Access Controls

4.2. Warnings and Access Controls

A portable laser warning sign will accompany the laser to its operating location within the LVEA. This sign will be placed in a visible location on or near the optical table under work. The laser and the warning sign will be powered from dedicated AC power lines which are connected to the Emergency OFF switches (see below).

Power to the laser power supply is provided only by dedicated power cords, located at each ISC table location and at the assembly areas designated in Figure 1. The power cords are to have a Lock and Tag boot installed and must signed off by the laser Safety Officer prior to energizing the laser.

Illuminated laser safety warning signs with the message, "DANGER VISIBLE AND/OR INVISIBLE LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION. EYE PROTECTION REQUIRED," are mounted at the entrance of the LVEA. These signs are illuminated only when the LASER HAZARD condition exists. A portable laser safety warning sign will be placed in the vicinity of the laser.

All other outside access doors to the LVEA and the doors accessing the LVEA from the Large Item Access Area (including the roll-up door) are for emergency egress only and are equipped with non-illuminated signs with the message "DANGER VISIBLE AND/OR INVISIBLE LASER RADIATION - AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION."

Access to the LVEA and VEAs is strictly controlled when the LASER HAZARD condition exists. Only Registered Laser Personnel are authorized to enter the ISC Laser Control Area (restricted access area), without an escort. The names of all Registered Laser Personnel are posted near the the entrance of the LVEA. Names can be added to the list only by the sponsor of this SOP or by the LLO Laser Safety Officer and only after training which satisfies the requirements detailed in LIGO-M990148, *LIGO Livingston Laser Safety Plan.*

4.3. Emergency OFF Switches

Emergency OFF switches are located as follows: one in the control room, one at the entrance to the 4k Ifo. Laser Safety Enclosure, and one near the laser warning sign at the entrance of the LVEA. Activation of any Emergency OFF switch shuts down the laser. Emergency shutdown from the End-stations require communication with the control room via telephone or radio.

4.4. Beam Blocks

All optical ports through which the laser beam can exit the vacuum enclosure and cause a hazard condition will be blocked.

Beam blocks will be provided to prevent access of the laser beam to regions inside the vacuum enclosure where concurrent tasks are being performed, unrelated to the COS alignment procedure.

4.5. Cordoned Off Areas

Specific areas will be appropriately cordoned off with yellow caution tape in those regions where it is necessary to direct the laser beam outside of the vacuum enclosure, or where the chamber enclosures are necessarily removed to enable the alignment procedure, e.g. in the vicinity of HAM1, HAM2, HAM3 and HAM4 or in the vicinity of spool pieces LBE-1A and LBE-1B of the x-arm and y-arm manifolds.

Cordoned off areas are to warn of elevated laser dangers only and are not meant to restrict access. Personnel should proceed with added caution.

4.6. Eye Protection

Protective eyewear for users and operators of this laser must have an optical density (OD) of 4.03 or greater for 940 and 980 nm wavelength radiation.

5 OPERATING PROCEDURES

1. The COS Alignment laser may only be operated by qualified technicians and operators familiar with the design, geometry and construction of the COS alignment equipment and the LIGO optical configuration and trained in the safe use of infrared solid-state lasers. An individual's qualification must be approved jointly by the COS Task Group Leader (or his/her designee) and the site laser Safety Officer (or his/her designee), in accordance with training classification guidelines outlined in ANSI Z136.1. If more than one individual is required to work with the laser, ONE person shall be designated the "Responsible Laser Operator." The name of the Responsible Laser Operator shall be posted near the laser warning sign and noted on the site Work Permit authorizing the operation.
2. The laser shall not be connected to the autocollimator unless the video camera is in place over the eyepiece.
3. The procedure described in *Procedure for Transition to the LASER HAZARD Condition* (LIGO-M990152) must be executed before the laser is operated. Prior to the transition, a safety walk through must be conducted by the LLO Laser Safety Officer or the LLO Site Safety Officer. And the transition to laser hazard is to be done only by the LLO Laser Safety Officer or the LLO Site Safety Officer.
4. When the laser is operated, the LASER HAZARD condition shall apply.
5. The Responsible Laser Operator shall coordinate activities in the vicinity where the laser is operating. Multiple independent activities involving manipulation of the laser beam shall not occur simultaneously. Any time laser beams will be manipulated, e.g. by inserting, removing, or adjusting optical components, persons not directly participating in the beam manipulation activity will move to a safe location until the activity is completed.
6. All persons manipulating the laser beams, e.g., by placing objects such as mirrors, lenses, power meters, or beam dumps, into or near the laser beam paths, must remove all jewelry such

as wrist watches and rings.

7. Immediately after inserting, removing, or making significant adjustments to any optical component, the vicinity of the beam path shall be scanned using an infrared viewer or other suitable beam-finding device to ensure that all stray beams are dumped.
8. Scattering of laser light shall be kept to a minimum at all times by maintaining proper alignment of optics, by utilizing beam dumps and by ensuring that optics are securely fastened.
9. The laser shall not be left running unattended.

It is the responsibility of each person working within the LVEA to ensure that LIGO standards for safe laser operation are being followed at all times.

APPENDIX 1 APPLICABLE DOCUMENTS

ANSI Z136.1-1986, *American National Standard for the Safe Use of Lasers* American National Standards Institute (1986).

LIGO-M960001, *LIGO Laser Safety Program.*

LIGO-M990148, *LIGO Livingston Laser Safety Plan.*

LIGO-M990152, *Procedure for Transition to the LASER HAZARD Condition*

LIGO-M990153, *Procedure for Transition to the LASER SAFE Condition*