

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

SOP	LIGO-M990316-00	10-15-99
Standard Operating Procedure: COS Infrared Alignment Laser Operation in the Midstation and Endstation		
<u>SPONSOR</u> Mike Smith		

Distribution of this draft:

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1 INTRODUCTION

This Document is the Standard Operating Procedure (SOP) for COS Infrared Alignment Lasers when operated in the Midstation and Endstation. 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 | <500 mW |
| • 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 Midstation and Endstation used for aligning the End Test Mass Telescope and optics, as shown schematically in Figure 1. The laser light will also be propagated onto the ISC platform located adjacent to BSC5, BSC6, BSC9, and BSC10.

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 vacuum chambers and the ISC optics tables are equipped with opaque enclosures but will typically have chamber doors, viewports, the table enclosure or some enclosure panels removed during operations involving this laser. Radiation from the laser is incident on reflective and focussing optics within the chambers and/or on the ISC tables so any region of the Midstation or Endstation with a line of sight to the chambers in which the beam can propagate or an ISC table undergoing work may be exposed to the beam. Whenever laser operation is enabled, the LASER HAZARD condition (see below) shall exist and the entire Midstation or Endstation shall be declared a Nominal Hazard Zone (see below).

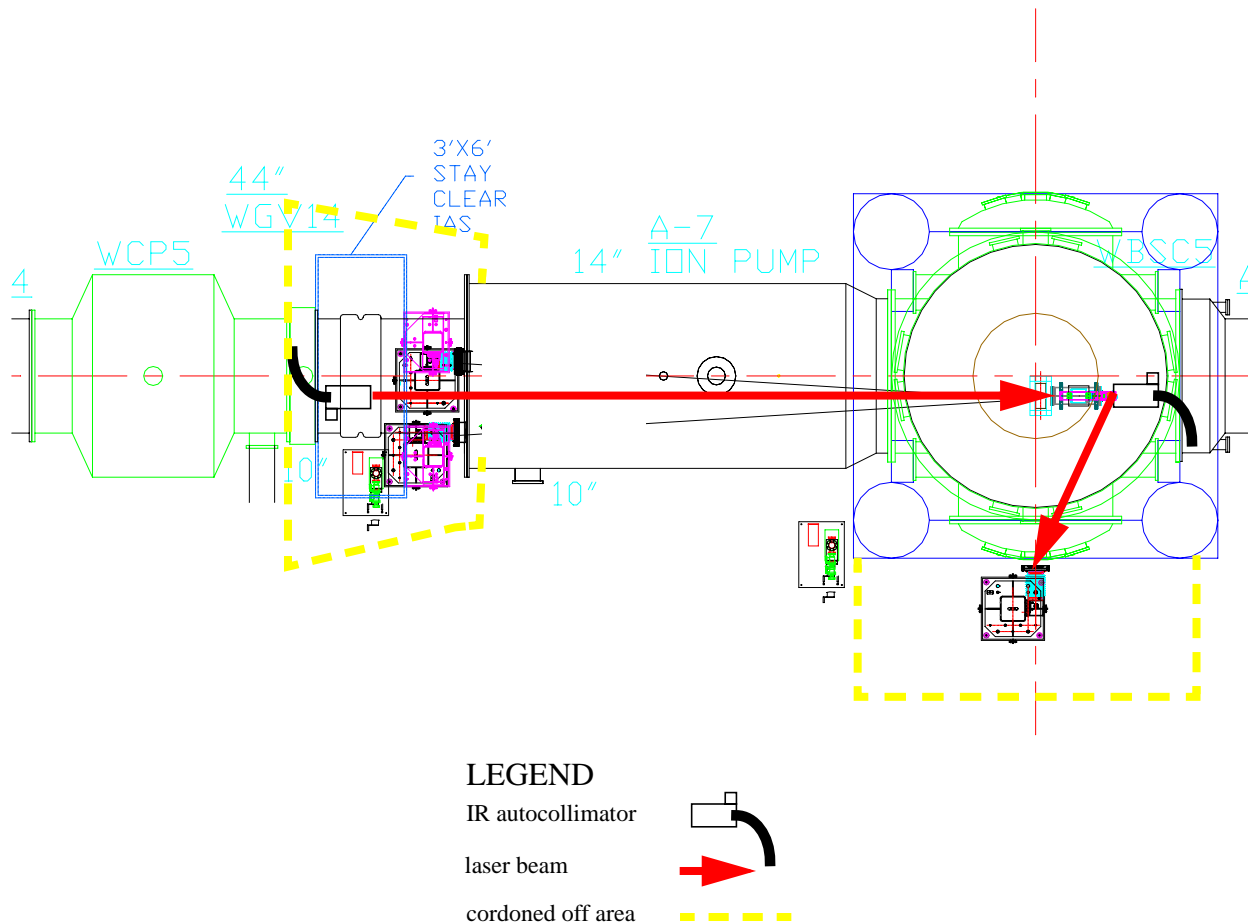


Figure 1: Location of areas in which the COS infrared lasers will be located and areas where the COS laser beams will intentionally propagate.

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 Midstation or Endstation: 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 VEA of the Midstation or Endstation.

The LASER SAFE condition shall not exist when the laser is capable of producing laser light.

The procedure for transitioning to the LASER HAZARD condition is in *Procedure for Transition to the LASER HAZARD Condition* (LIGO-M9800047-C-W). The procedure for transitioning to the LASER SAFE condition is in *Procedure for Transition to the LASER SAFE Condition* (LIGO-M980048-C-W).

4.2. Warnings Controls

Power to the laser power supply is provided only by a red dedicated power cord, located at each location designated in Figure 1. This cord has an Emergency “Kill” button in series in the cord which sits on the floor near the control. The power cords are to have a Lock and Tag boot installed and must be 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 on the Change Area side of the doors leading from the Change Area to the Midstation or Endstation. These signs are illuminated only when the LASER HAZARD condition exists.

All other outside access doors to the Midstation or Endstation and the doors accessing the Midstation or Endstation 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.”

Additional illuminated signs are mounted near the laser safety warning signs with the message “LASER HAZARD - AUTHORIZED LASER PERSONNEL ONLY EXCEPT WHEN GREEN LIGHT ILLUMINATED.” These signs are illuminated when the LASER HAZARD condition exists.

4.3. Access Controls

Access to the Midstation or Endstation is strictly controlled when the LASER HAZARD condition exists. Only Registered Laser Personnel are authorized to enter the Midstation or Endstation without an escort. The names of all Registered Laser Personnel are posted near the illuminated warning signs in the Change Area. Names can be added to the list only by the sponsor of this SOP or by the LHO Laser Safety Officer and only after training which satisfies the requirements detailed in LIGOM980042-A-W, *LIGO Hanford Laser Safety Plan*.

4.3.1. Isolation of Laser Beam Access Volume

4.3.1.1 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.

4.3.2. 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 gate valve GV10 and between BSC6 and the ISC optical pillar.

4.4. Emergency OFF Switches

The laser will be powered only by the dedicated Red AC power connected to an Emergency OFF switch in series which will sit on the floor near the laser controls.

All control and monitoring functions for the laser are accessed via the laser power supply front panel.

4.5. Eye Protection

Protective eyewear for users and operators of this laser must have an optical density (OD) of 2.7 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-M980047-B-W) must be executed before the laser is operated in the Midstation or Endstation. When the laser is operated within the Midstation or Endstation, the LASER HAZARD condition shall apply.
4. 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.
5. 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.
6. Immediately after inserting, removing, or making significant adjustments to any optical com-

ponent, 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.

7. Scattering of laser light shall be kept to a minimum at all times by maintaining proper alignment of optics, utilization of beam dumps, and ensuring that optics are securely fastened.
8. The laser shall not be left running unattended.

It is the responsibility of each person working within the Midstation or Endstation 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-A-P, *LIGO Laser Safety Program*.

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LIGO-M980047-B-W, *Procedure for Transition to the LASER HAZARD Condition*

LIGO-M980048-00-W, *Procedure for Transition to the LASER SAFE Condition*

LIGO-D9xxxxx-xx-D, *Optomechanical Layout Drawing, Corner Station, Washington Site*

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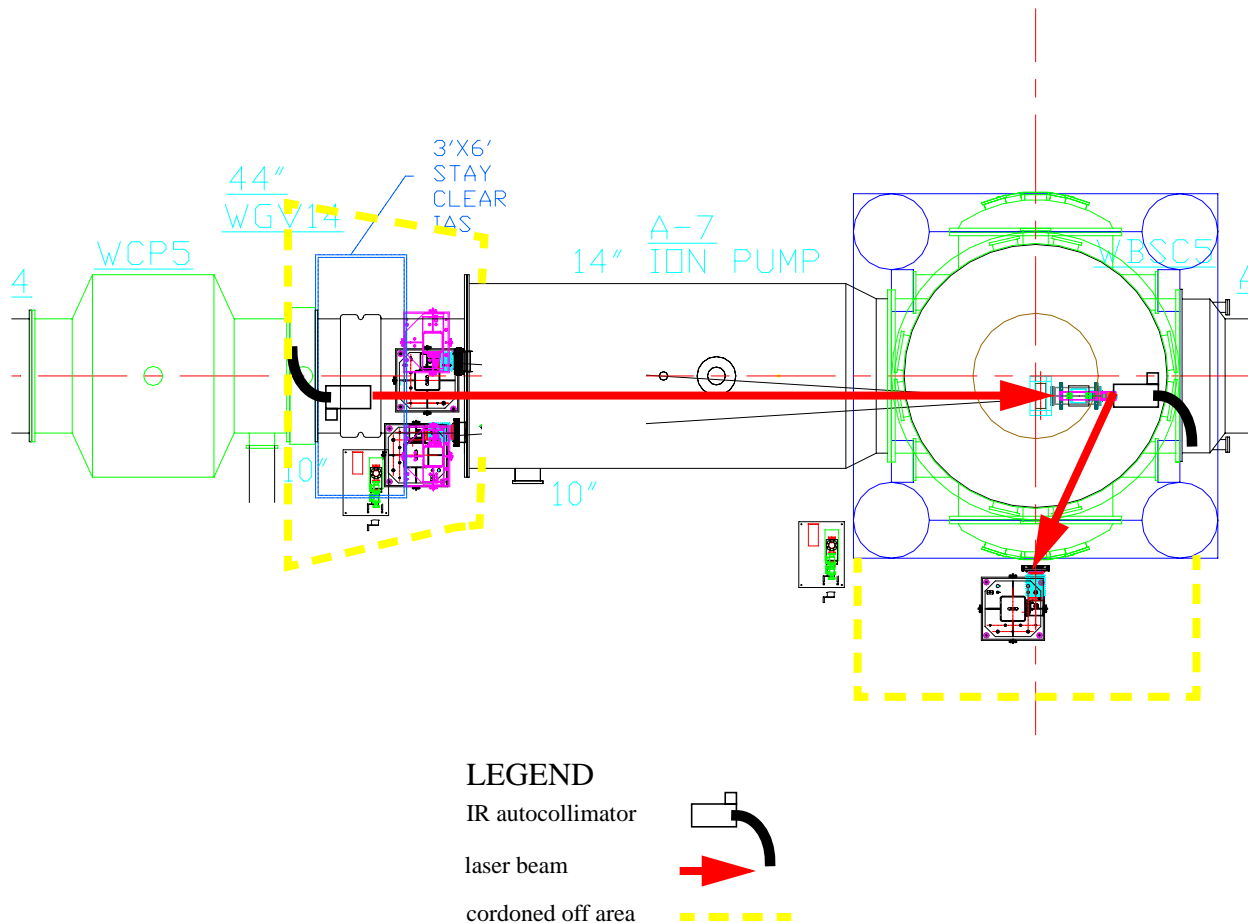


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