Standard Operating Procedure:

**Modulated 980 nm RF Detector Test Laser Operating at LLO**

SPONSOR

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1 INTRODUCTION

This Document is the Standard Operating Procedure (SOP) for the 980 nm modulated laser diode test laser. It is designed to ensure the safety of personnel where these lasers will be used. The Modulated RF Detector Test Lasers are diode injection lasers emitting at a wavelength of 980 nm. They are used primarily to tune RF traps and filters in the ISC Wavefront Sensor and Length Sensing Detector heads, either in the optics laboratory or in situ on Interferometer Sensing and Control (ISC) optics tables. These lasers are not normally active during observatory operation and are used temporarily during times of detector test, installation, diagnostics and maintenance.

2 LASER DESCRIPTION & LOCATION

The Modulated RF Detector Test Laser is a Class IIIb continuous-wave diode-pumped solid state laser emitting at a wavelength of 980 nm. The laser consists of two parts, a commercial power supply (Wavelength Electronics LFI-4502) and a LIGO-built laser head, connected by a shielded umbilical power cable. The laser head incorporates a commercial laser diode (Fermionics LCX-980), electrical socket and collimator (ThorLabs S8060 and LT220P-B, respectively) and an integrally fixed optical attenuating (Thorlabs ND-20A or equivalent). An RF bias tee and Lemo or SMA coaxial connector on the head allow connection of RF excitation sources for high-speed modulation of the diode current at bandwidths up to 100 MHz.

The alignment lasers are portable and will be used on IO and ISC tables in their installed positions and in designated ISC assembly areas in the LVEA or the Optics laboratories.

The laser diode is intrinsically capable of up to 40 mW laser output. The ND-20A filter (transmission 1.0% at 980 nm) is a REQUIRED piece of safety equipment limiting output to 0.4 mW maximum. THIS COMPONENT MAY NOT BE REMOVED.

3 HAZARDS

This Class IIIb laser is a hazard to the eye 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 eye, so the protective blinking reflex is inoperative. ISC and IO optical tables are equipped with opaque enclosures but will typically have the enclosure or some enclosure panels removed during operations involving these lasers. Radiation from the laser is incident on reflective and focussing optics on the ISC tables, so any region with a line of sight to the table undergoing work may be exposed to the beam.

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

Only personnel with training and familiarity with this specific equipment may be permitted to operate or manipulate it. Approval of the ISC system site liaison, site installation director AND site laser safety officer (or their approved designees) is required for any task involving operation of this equipment.

4.2. Warnings and Access Controls

A portable laser warning sign will accompany the laser to its operating location within the LVEA, or in the Large Equipment Airlock adjacent to 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 in the LVEA will be powered from dedicated AC power lines which are connected to the Emergency OFF switches (see below). For use in the Large Equipment Airlock adjacent to the LVEA, the signs and laser will be powered from baseboard outlets.

Power to the laser power supply in the LVEA is provided only by dedicated power cords, located at each ISC table location and at the assembly areas. 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. Baseboard outlets will provide laser power in the Large Equipment Airlock adjacent to the LVEA.

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. Two portable laser safety warning signs will be used, one at each of the man doors when the laser is used in the Large Equipment Airlock adjacent to the LVEA.

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 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. Electrical Controls

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

4.5. Engineering controls

The output power of this device is limited to 0.4 mW by design. This is insured by the integrated neutral density filter and the maximum rating of the laser diode.

4.6. Eye Protection

Protective eyewear for users and operators of this laser must have a minimum optical density (OD) of 2.5 or greater for 980 nm wavelength radiation. Since the LASER HAZARD condition will apply when this equipment is used within the LVEA, eyewear must simultaneously satisfy protection requirements for 1064 nm radiation as outlined in LIGO-M990151-L. Most protective eyewear used on site satisfies both requirements; however, it is each individual operator’s responsibility to verify that his/her eyewear, and any eyewear provided for guests and visitors he/she sponsors, meets all applicable specifications.

5 OPERATING PROCEDURES

1. ISC RF Detector Test lasers may only be operated by qualified technicians and operators familiar with the design, geometry and construction of ISC sensors and trained in the safe use of infrared diode lasers. An individual’s qualification must be approved jointly by the ISC 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 portable laser warning sign and noted on the site Work Permit authorizing the operation.

2. Before operation, the laser head must be inspected to insure the protective power-limiting neutral density filter is securely in place. The laser MAY NOT BE OPERATED if this filter is damaged or missing.

3. The procedure described in Procedure for Transition to the LASER HAZARD Condition (LIGO-M990152-L) must be executed before the laser may be operated in the LVEA. When the laser is operated within the LVEA, the LASER HAZARD condition shall apply.

4. The portable laser warning sign (Section 4.2.) must be energized and all persons entering the work area are required to wear eye protection as described above at all times within the nominal hazard zone.

5. The Responsible Laser Operator shall coordinate activities in the vicinity of the ISC optics table 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
this 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 optical table 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, utilization of beam dumps, and ensuring that optics are securely fastened.

9. THIS LASER MAY NOT BE LEFT ENERGIZED WHILE UNATTENDED

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

APPENDIX 1   APPLICABLE DOCUMENTS

LIGO-M990148-L LIGO Livingston Observatory Laser Safety Plan
LIGO-M990151-L SOP-LIGO 10-W Laser Operating in the LVEA
LIGO-M990152-L Transition to the LASER HAZARD Condition Procedure
LIGO-M990153-L Transition to the LASER SAFE Condition Procedure
LIGO-Dxxxxxx-xx-D, ISC Layout Drawing, Corner Station, Livingston Site