LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
-LIGO-
CALIFORNIA INSTITUTE OF TECHNOLOGY
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Procedure	**LIGO-M1200283-v1**	**20 Aug 2012**

Standard Operating Procedure (SOP) for End Station Optics Labs at LHO

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1 PURPOSE AND SCOPE

This document is the Standard Operating Procedure governing the operation of lasers in the End Station (EX and EY) at LIGO Hanford Observatory (LHO). This SOP is designed to ensure the safety of all personnel and equipment in and around the experiment while it is operating. Its role falls within the overall laser safety plan is described in LIGO-M960001, LIGO Laser Safety Plan.

This SOP contains some information migrated from LIGO-M1100040, SOP for Arm Length Stabilization Setup in LVEA and VEA, as the End Station Optics Lab share the same kill switch with the VEA for arm length stabilization.

2 LHO End Station LAYOUT

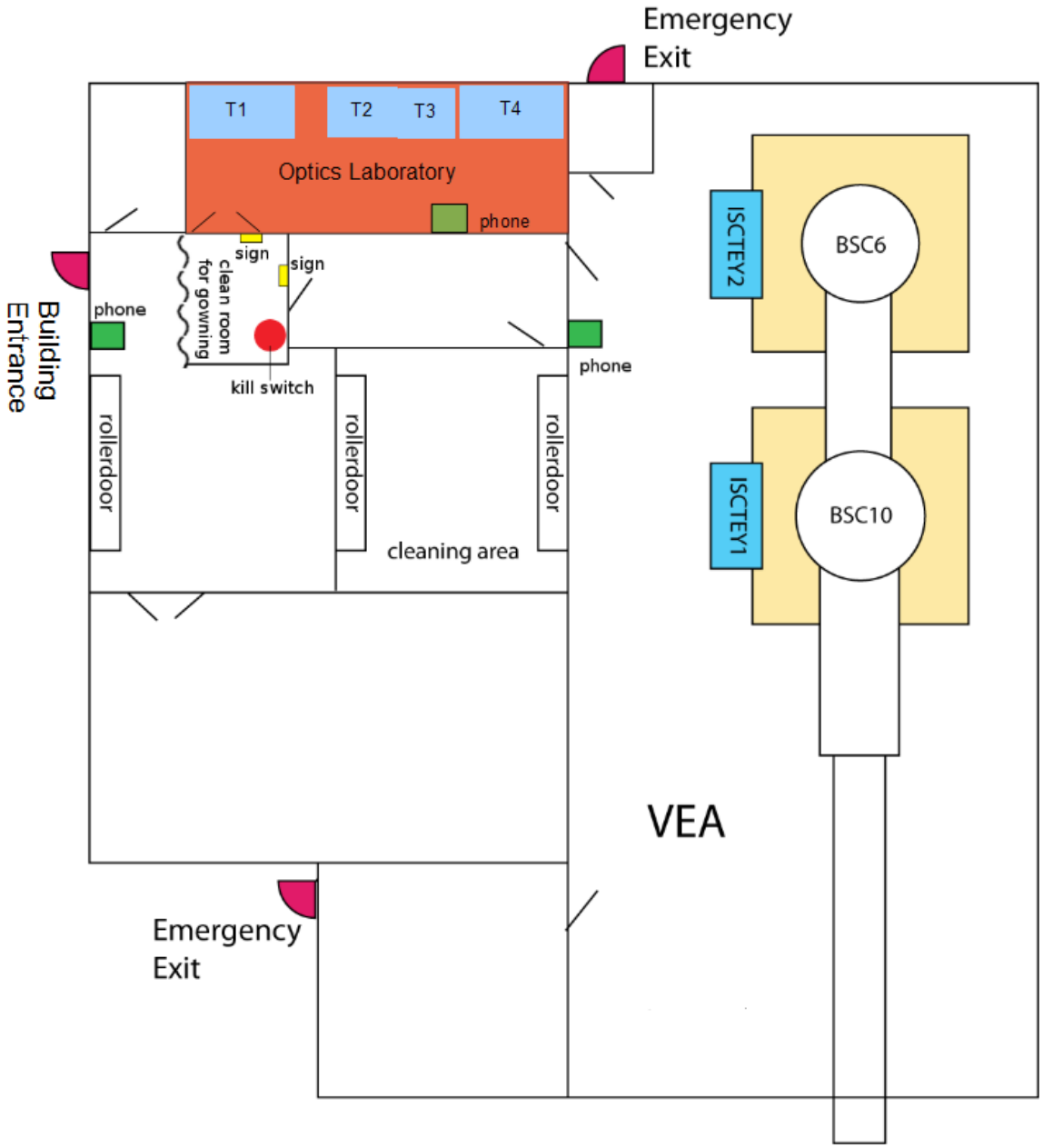

Figure 1: EY LHO VEA layout. EX is a mirror image of EY. The red area (Optics Laboratory) indicates the NHZ.

The End Station Optics Lab is intended as a clean lab suitable for aLIGO Class A assembly. As such, a clean room is placed in front of the entry door to the lab as a gowning room for the workers to change to suitable cloths. This clean room is also used as a gowning room for the VEA.

3 LASER DESCRIPTIONS and LOCATIONS

We need at least two lasers, one IR (1064 nm) and one green (512 nm), for the alignment on the TMS telescope and the alignment of the QPD sleds for advanced LIGO at the end station lab. We have used three sources (two IR and one green) in the past for this purpose, and any of these may be used in the lab. All of these are fiber coupled and has relatively large diameter (1 mm to 6 mm in diameter) once the beam is collimated.

The first one is a class 3B 1064 nm laser with 130 mW nominal output power from Axcel Photonics Inc. (BF-A64-0130-PPA). This is packaged in a butterfly module and mounted on a Thorlabs butterfly mount (Figure 2) and is driven by Thorlabs laser diode controller (LDC205C). The output of the fiber is connected to a telescope to form a beam that is about 6 mm in diameter.

Figure 2: Thorlabs butterfly mount used for the main laser (product picture taken from Thorlabs catalog, Copyright 1999-2012 Thorlabs).

OZ Optics OZ-2000-1064-6/125-S-40-3A-3-1-10 is a 1064 nm laser with 10 mW nominal output. This is considered class 3B.

Oz Optics OZ-2000-532-3.5/125-S-40-3A-3-1-5 is a 512 nm laser with 5 mW nominal output. This is a class 3R laser.

Figure 3: OZ Optics OZ-2000-532-3.5/125-S-40-3A-3-1-5 is a class 3R green laser (product picture taken from OZ Optics catalog).

There are four tables in the lab (labeled T1 to T4 in Figure 1): T1 and T4 are large optics tables, T2 is a smaller one but the height is similar to T1 and T4, and T3 is small and very low. Lasers are used mainly on T2 though they might be occasionally put on T4 or T1.

The entire lab will become Nominal Hazard Zone (NHZ) when any of the Class 3B lasers are in operation.

4 HAZARDS

There are two class 3B infrared lasers and one class 3R green laser in the lab.
Class 3R lasers are potentially hazardous under some direct and specular reflection viewing conditions, but the probability of an injury is small. Class 3R lasers do not pose either a fire hazard or diffuse-reflection hazard.
Class 3B lasers are hazards to the eye via direct exposure and/or specular reflection. The 1064 nm light poses an additional hazard as it is infrared and not visible to the unaided human eye.

5 CONTROLS

5.1 Access Controls

The entrance door to the lab is auto-locked, so it is not possible to open the door accidentally. There is a sign on the entrance door which is used when in laser hazard to notify workers that the lab is in laser hazard.

5.2 Electrical Controls

There is a mains outlet in the lab which is connected to the central laser kill circuit that is common to the lab and the VEA. The lasers will be plugged into the kill

circuit and may be deactivated by one of the `emergency kill' button located around the end-station (see Figure 1), which will kill all the class 3B lasers in the end station lab as well as all the lasers in the VEA connected to the kill circuit.

5.3 Eye Protection

Eyewear with an OD of **1.9 or greater at 1064nm**. This eyewear is ***never*** intended for intra-beam viewing. (OD is calculated for intra-beam exposure of 10s for IR beams at laser aperture diameter.) Only approved aLIGO glasses may be used in this lab. Appropriate laser glasses are available at the entrance of the NHZ.

6 GENERAL OPERATING PROCEDURES

1. When any of the End Station Lab class 3B laser sources are capable of being energized (power is being supplied), the laser warning sign must show that the lab is in laser hazard condition, and all persons entering the NHZ are required to wear protective eye wear as described in section 5.3 above. The lasers are considered capable of being energized if the controller is connected to the mains power.
2. Prior to powering up the laser, the Responsible Laser Operator (RLO, the person actively in charge of the laser) shall ensure that all persons in the NHZ are aware of his/her intent to power up the laser and that they are in compliance with all laser safety requirements, eye protection in particular.
3. When work is required in the NHZ, the RLO is the person who activates the laser(s). If they are already activated on entering, those present should decide who will assume the role of RLO.
4. The RLO shall coordinate activities on or in the vicinity of the laser optical table. Multiple independent activities involving manipulation of the laser beams shall only occur simultaneously when the RLO deems it safe to do so.
5. If the laser will be run unattended a sign will be posted at the entrance to the door containing laser and contact information.
6. All eyewear must be compatible for all laser systems running concurrently. When in doubt, check with the Laser Safety Officer. When multiple lasers are being used, the governing SOP must consider safety compatibility.
7. Before and during insertion or removal of any optical component, the power of all affected laser beams shall be reduced to the lowest working power setting or be blocked upstream by an appropriate device, such as a ceramic wand.
8. 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 paths, must remove all jewelry such as wrist watches and rings.
9. 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.

It is the responsibility of each person with within and in the vicinity of the NHZ to ensure that LIGO standards for safe laser operation are being followed at all times.