LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Temporarily Standard Operating Procedure for In-vacuum Work for Squeezing Experiment

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1 Summary

This document is the Temporary Standard Operating Procedure (TSOP) governing the operation of H1 35W laser ('H1 PSL') during the in-vacuum work for the squeezing experiment.

The PSL is set up such that the laser power going through the power recycling mirror ('RM') never exceeds 1mW even if the mode cleaner is locked in air, allowing people in LVEA including inside HAM4/5/6 and potentially BSC1/2/3/7/8 to work in laser safe condition.

This is a companion document to LIGO-M960001 (LIGO Laser Safety Plan) and LIGO-M070393 ('Standard Operating Procedure: Enhanced LIGO 35-W Nd:YAG Laser for the H1 Interferometer').

2 Laboratory Layout

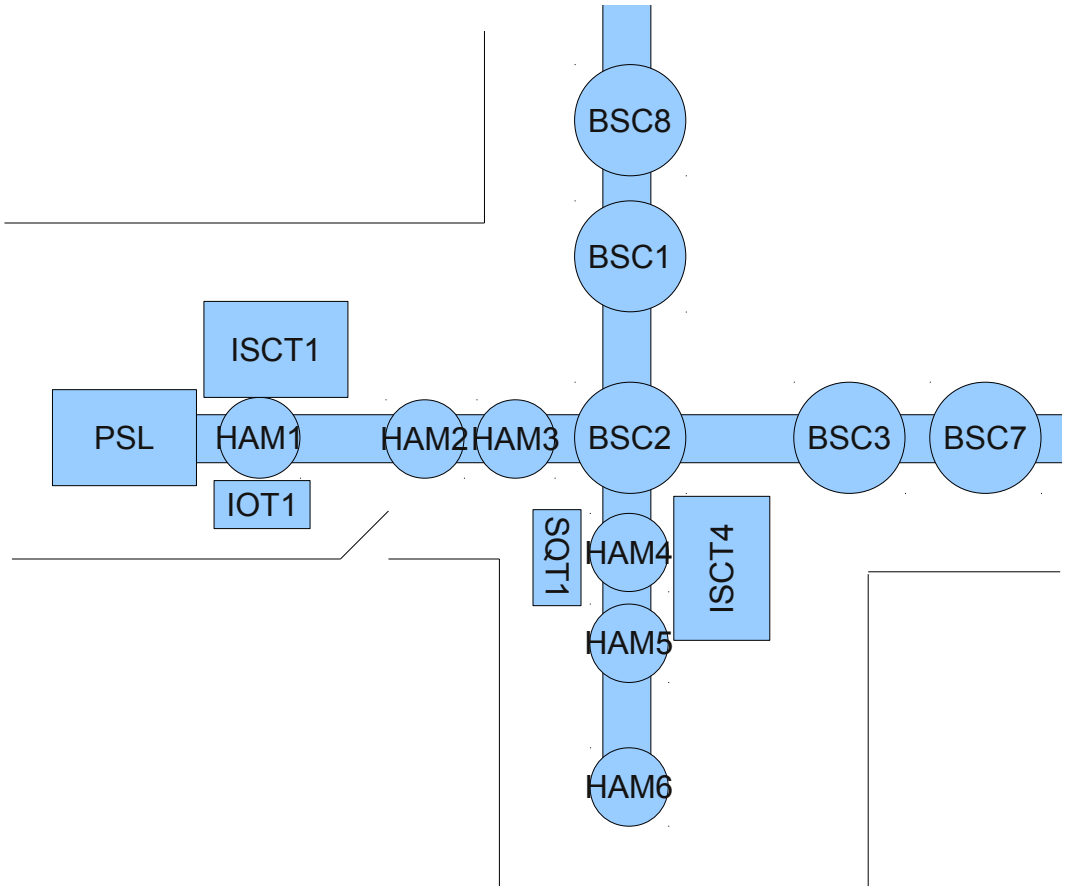

Figure 1. Location of the PSL laser and relevant vacuum chambers in the LVEA at LHO. The recycling mirror with a transmissivity of 2.3% is in HAM3.

Laser source relevant to this document is H1 PSL, which is located at the south side of the LVEA. The standard operation procedure of this laser is detailed in LIGO-M070393.

3 Safety Procedure

3.1 Alignment of the Recycling Mirror

Figure 2: H1 Bias slider MEDM screen. RM "Restore", "Misalign" and "Save" script are accessed from the pink "Save/Restore" button next to RM bias sliders (top right).

To prevent any accidental resonance of the power recycling cavity ('PRC'), RM should be misaligned at all times.

First align RM. Use "Restore" script from the bias sliders MEDM screen (Figure 2). Record the bias slider numbers for later use.

Next misalign RM. Use "misalign" script from the same MEDM screen.

Then use "Save" script to save the misaligned slider values as the aligned value.

This way, even if one accidentally runs "Restore" script, the RM remains at the misaligned position.

As an additional precaution, a piece of paper with a caution message is attached to the monitor of H1 work stations (control0 and control1) so people would know what is going on.

Even though RM is misaligned, as an additional precaution the LSC mode is set to “OFF”.

3.2 PSL

The laser power leaving the PSL table enclosure is set to 40 mW by adjusting the angle of the power adjustment wave plate on a motorized rotator.

To prevent any accidental increase in the power leaving the PSL enclosure, the controller for the motorized rotator is switched off. The cable connecting the controller and the motor is disconnected from the controller. The cable is then tagged off.

We also lower the alarm threshold of PSL power so people would immediately know if the power increases for any reason.

3.3 ISCT1 and IOT1

Both ISCT1 and IOT1 doors are locked out using tags and caution tapes.

3.4 HAM1, 2 and 3

All viewport covers and bellows are tagged.

3.5 HAM5 Power Measurement

After locking MC, misalign ITMY. A person inside HAM5 should measure the power of the laser beam reflected by ITMX.

The power should not exceed 1mW/4 = 250 uW. If it does, readjust the PSL power.

4 Power Budget

Assuming 40 mW from PSL and 2.7 % transmissivity of RM, **the maximum power in downstream of RM (HAM4/5/6, BSC1/2/3/7/8) will be about 1 mW** when RM is misaligned.

97.3% of the power is reflected by RM and falls on a beam dump inside HAM1.

When the mode cleaner is unlocked, almost 100% of **40 mW can come out into IOT1. Therefore IOT1 is locked by caution tape and a tag.**

Though there will be no beam on ISCT1 if RM is misaligned, as a precaution the ISCT1 will also be locked.

5 Safety Analysis

There are two lines of defense, one is the PSL wave plate controller and the other is the script setting for RM alignment, to ensure that the power budget holds true at all time.

As for the former, the controller is de-energized, the cable disconnected and tagged out. It's impossible for a person to accidentally increase the power.

As for the latter, because the “misaligned” slider values are saved as “aligned” in the procedure, it's extremely difficult for a person or a script to accidentally align RM to its nominally correct position.

There could be other causes than scripts, though, to cause RM aligned for a short period (e.g. a large earthquake nearby, an uninformed person moving sliders manually). If anybody notices that RM is even momentarily close to the correct alignment, the work should be stopped and the cause should be investigated.