LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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LLO DRMI In-air Check List

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1 Introduction

This document outlines the steps that will be performed to check the alignment of the optical components of the dual recycled Michelson (DRMI) interferometer at LLO:

- the input test masses (ITM), the beam splitter (BS), the power (PRM, PR2, PR3) and signal (SRM, SR2, SR3) recycling optics, the output Faraday Isolator (OFI)
- the reflected and output beams exiting through the septum windows between HAM1 and 2 and HAM5 and 6 respectively
- the ALS and POP beams transmitted through the PR2
- the input optics: input mode cleaner (IMC), input steering mirrors (IM1-4), input Faraday Isolator (IFI) , parking beam

This work is expected to begin in the first half of June, 2013 and to continue for one to two weeks. The goal of this testing period is to verify and adjust the relative alignment of core optics using light flashes in various interferometric sub-configurations, to center the beams on the mirrors, apertures (including the FIs), and photodetectors.

2 Overview of the Plan

2.1 Assumptions and dependencies

We expect that before this work begins:

- The initial alignment of the DRMI optics has been completed. The First Contact has been removed from all optics. All optics are released from their EQ stops and damped. The phase 3a testing has been completed on all optics.
- All BSC doors have been replaced. The HAM2,3,4,5 doors have been removed. The HAM1 and 6 chambers septum plates and windows have been installed. The installation and alignment of the components on the HAM1 and 6 tables will continue during the pumpdown.
- The ISI tables have been balanced. The HAM ISI tables have been placed on their hard stops. The BSC ISI damping loops have been commissioned and engaged.
- All HEPI stages have been floated and properly positioned and either placed on their hard stops or controlled with position sensor loops (integrator with ~100 mHz ugf).
- The ISS photodetector array has been delivered to LLO and is ready for installation.

2.2 Input optics alignment (2 days)

The installation and testing of the input optics has been mostly completed during the integrated testing period ending in January, 2013. We expect that the following sequence of steps will make the input beam available for the DRMI flashing without significant delays:

- Set the PSL output power to 100 mW. Disable the waveplate rotation.
- Check the IMC input beam optical path
- Reestablish the IMC flashing by adjusting the input beam and/or the IMC mirrors
- Realign the IMC reflected beam. The first periscope in this path was moved and likely misaligned during the SiC plate installation in March, 2013.
- Check the beam propagation through the IFI and centering on IM1,2,3,4
- (Mis)align the PRM to direct its reflected beam to the parking beam dump
- Block the beam transmitted through MC1 to prevent the IMC from flashing. Install and align the steering mirrors after the second IMC reflected beam periscope to provide that the beam is collinear with the IMC transmitted beam.
- Enable the PSL waveplate and increase the power to 1 W. Disable the waveplate.
- Align the input beam to go through the center of PRM and PR2 by adjusting the IM3 and 4
- Monitor the centering of the IM4 transmitted beam on its QPD

2.3 ITMX,Y and BS alignment (0.5 day)

The ITMs and BS are initially aligned with a tolerance of 100 urad with respect to the global coordinate system. This configuration (SRM and PRM misaligned) provides a consistency check

of the relative differential ITM and BS alignment. If the BS needs pitch or yaw adjustment to overlap the ITM reflected beams that is significantly larger than the above alignment tolerance this may indicate that one or both ITMs are not properly aligned and may not have enough range (quad top driver ranges are +/-610 urad in yaw and +/-440 urad in pitch) for the arm cavity alignment. The BS top driver range is +/-3 mrad in yaw and +/-0.9 mrad in pitch.
Steps to perform in this configuration:

- Misalign the PRM to prevent the PRC flashes. Misalign or block the SRM to prevent the SRC flashes.
- With 1 W input beam power the power going to the BS is about 30 mW. The Michelson flashes can be easily observed on a card in front of the SRM.
- Adjust the BS pitch and yaw to achieve the best overlap of the ITM reflected beams. Do not change the ITMs alignment. We assume that ITMs are the most carefully aligned optics at this time.

2.4 PR2 and 3 alignment (0.5 day)

To check the alignment of PR2 and 3 the configuration from 2.3 can be used. With 1 W input beam power the bright PRC flashes will go up to 1 mW. This beam should overlap with the input beam and be rejected by the IFI.

2.5 SRM, SR2,3, and output beam alignment (0.5 day)

The configuration from 2.3 can be used. Alternatively one of the ITMs can be misaligned to obtain a steady beam with power of 7.5 mW.

- Use an IR card with a viewer to check the centering of the beam on SR3. The beam is large at this optic and may not be easy or even possible to see. If the beam is not visible check for clipping down stream.
- Center the beam on SR2 with SR3. The beam in front of SR2 should be visible on the IR card.
- Center the beam on the SRM with SR2.
- Check that the beam is going through the center of the OFI apertures.
- Adjust the OFI vertical and horizontal position if necessary.
- Check that the output beam is going through the center of the septum window.
- With a single bounce from one of the ITMs align the SRM to obtain the flashes in transmission.

2.6 PRM and reflected beam alignment (0.5 day)

- Misalign the SRM and one of the ITMs
- Align the PRM to obtain flashes
- Align the beam reflected by the PRM and rejected by the IFI to go to HAM1 through the septum window

2.7 ALS and POP beams alignment (1 day)

These beams had already been aligned but it is believed that during the initial alignment of PR2 the 3" mirror behind PR2 was moved. To check/align these beams:

- Setup the green alignment laser on the center line between the PRM and PR2
- Check that the PR2 transmitted beam is properly aligned to go to the ISC POP QPD sled
- Setup the green alignment laser on the center line between PR3 and PR2
- Check that the PR2 transmitted beam is properly aligned to go to HAM1 through the ALS septum window

2.8 ISS PD array alignment (2 days)

The alignment of the ISS PD array can begin once the 1 W input beam is setup and can proceed in parallel with other alignment provided that there is simultaneous access to HAM2 for all parties. Checks to perform:

- The beam is centered on the ISS QPD and the array entrance aperture
- No ground connections
- Obtain signals from all photodiodes on the array

3 Test Equipment

- Two CDS workstations: one near HAM2 and another near HAM5
- IR viewers and cards
- Power meter in PSL room
- IMC alignment apertures Class B
- Steering mirrors for IMC reflected beam Class B
- Fiber coupled 532 nm alignment laser Class 3R with post and mount Class B