LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Procedure for in-chamber measurement of photon calibrator laser power reflected from test mass.

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1 Introduction

The photon calibrators (Pcals) provide an independent means of calibrating the LIGO interferometers. One of the key parameters affecting the accuracy of the photon calibrators is the absolute laser power reflected from the test mass. Without accessing the vacuum envelope, we are able to measure the photon calibrator power incident on the Pcal vacuum window and the power reflected from the vacuum window. We have also measured the transmission of similar vacuum windows in laboratory setups as well as the reflectivity of witness plates that were coated along with the test masses. While we expect that these measurements allow us to deduce the Pcal laser power reflecting from the end test masses with sufficient accuracy, we would like to take advantage of the vacuum incursion planned to replace earthquake stops to make in-situ measurements of the power incident upon and reflected from the test masses.

This document describes the procedure that will be followed for the in-chamber measurement of the photon calibrator laser power reflected from the end test masses of the H1 and H2 interferometers.

2 Description of measurements

The Pcal laser power incident upon and reflected from the end test masses will be measured using the Pcal "working standard" power meter. This system, described in LIGO-T070094-00-W, utilizes a 4" diameter integrating sphere and a temperature-stabilized InGaAs photodetector. The integrating sphere will be mounted on a tripod as shown in Figure 1, below. The feet of the tripod and the two cables that connect the integrating sphere to the working standard electronics will be wrapped in UHV aluminum foil. The tripod will be installed on the floor of the BSC chamber and positioned such that the integrating sphere will intercept the beam incident upon the test mass. It will then be moved to intercept the beam reflected from the test mass.

The working standard electronics consist of a Keithley model 428-prog fast current amplifier, a Keithley model 2100 voltage meter, a thermo-electric cooler controller, and a laptop computer for data logging. These components will be mounted on a cart as shown in Figure 2. This card will be located outside the vacuum chamber. The portion of the 10-ft.-long interconnect cables that will be inside the vacuum chamber will be wrapped in UHV foil. Only the laptop computer has a cooling fan and it will be situated to minimize the risk of dust being blown into the vacuum chamber by the cooling fan.

Once the integrating sphere has been positioned, data will be recorded by the laptop computer and by DTT (for the Pcal power sensor inside the Pcal box). We expect to make a maximum of four measurements inside the vacuum chamber – incident and reflected power levels for each of the beams in the two-beam photon calibrator configuration. H1 ETMX utilizes a single-beam Pcal, so only two measurements will be required there. Data will be recorded for approximately 120 seconds for each measurement.

We expect that the VEA will be in the LASER SAFE condition during the earthquake stop replacement work. Making the Pcal measurements will require transitioning to the LASER HAZARD condition so that the Pcal beam can be injected into the vacuum envelope.

Figure 1 Working standard mounted on tripod for in-chamber measurement.

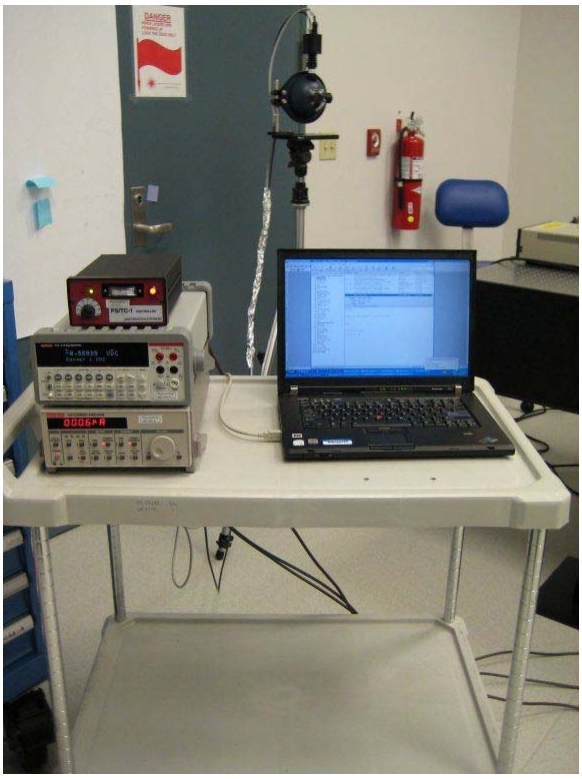

Figure 2 Pcal working standard electronics on the cart that will be located outside the BSC chamber.

2.1 Estimate of time required for measurements

Table 1 Time required for in-chamber measurements.

Activity	**Estimated time required**
Transition to LASER HAZARD condition	10 min.
Installation and positioning of integrating sphere for first measurement	15 min.
First measurement	5 min.
Repositioning integrating sphere for second measurement	5 min.
Second measurement	5 min.
Repositioning integrating sphere for third measurement	5 min.
Third measurement	5 min.
Repositioning integrating sphere for fourth measurement	5 min.
Fourth measurement	5 min.
Removal of measurement equipment (integrating sphere and tripod)	10 min.
Transition to LASER SAFE condition	10 min.
Total time required	**80 min.**

3 Measurement Procedure

1) Activate Pcal laser with beam blocked inside Pcal box such that laser can be in steady-state condition when measurements are made. This will require special arrangements if the VEA will be in the REDUCED LASER HAZARD condition while the Pcal is operating with the beam inside the Pcal box.
2) Transition to the LASER HAZARD condition in the VEA (see Section 4, below). All personnel must wear laser safety glasses.
3) Pass the integrating sphere, mounted on the tripod with the vertical stage at the lowest level, into the BSC. Note that the tripod feet and electronics cables must be wrapped in UHV foil and that everything should be wiped down with isopropanol according to standard in-chamber working practices.
4) Position the integrating sphere such that it intercepts one of the Pcal beams reflected from the ETM.
5) Record data for the first measurement and the time at the beginning of the measurement interval.
6) Position the integrating sphere such that it intercepts the second Pcal beam reflected from the ETM.

7) Record data for the second measurement and the time at the beginning of the measurement interval.
8) Position the integrating sphere such that it intercepts one of the Pcal beams incident upon the ETM.
9) Record data for the third measurement and the time at the beginning of the measurement interval.
10) Position the integrating sphere such that it intercepts the second Pcal beam incident upon the ETM.
11) Record data for the fourth measurement and the time at the beginning of the measurement interval.
12) Remove the integrating sphere and tripod from the BSC.
13) Transition back to the REDUCED LASER HAZARD condition (see Section 5, below), if required.

4 Procedure for transition to REDUCED LASER HAZARD in VEA

1) Submit work permit (hopefully at least one day in advance) and email lho-all stating intent to make the transition to REDUCED LASER HAZARD.
2) Verify that gate valve separating VEA from corner station if closed
3) Verify that a beam block is in place inside the photon calibrator box.
4) Disable the photon calibrator card reader
5) Change the state of the laser warning sign at the entrance to the VEA to the LASER SAFE state.

5 Procedure for transition to LASER HAZARD in the VEA

1) Email lho-all stating the intent to transition back to LASER HAZARD condition.
2) Change the state of the laser warning sign at the entrance to the VEA to the LASER HAZARD state.
3) Enable the photon calibrator card reader.