



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

*LIGO Laboratory / LIGO Scientific Collaboration*

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*Notes on Output Faraday Isolator Installation and Final  
Alignment Procedure*

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## 1 Overview

In this document, we collected remarks on the OFI installation procedure that needs to be done in addition to the current procedure document E1300056-v4. The overall flow of the installation work remains the same as described in the procedure document. We, however, need to consider some difference due to the fact that we already have the OFI installed, have alternative tools than the originally prepared, need optical measurement to ensure the in-situ performance, and need to consider the extended function of the OFI for squeezed light injection. The remarks cover these differences.

In the following section, “Section X.X.X” corresponds to the section in E1300056-v4.

## 2 Remarks

### 2.1 In the optics lab

#### Section 3.1.1 Attachment OFI Spacer

This step can be done in the optics lab.

#### Section 3.1.2 Attaching Transport Brackets and Locking Shims

This process has already been done: The locking transport shims have already been attached during Feb visit of us. The transport brackets are not necessary as we don't use the installation arm.

#### Section 3.2 Transport of OFI

During the transport, the entire OFI structure should be covered with a proper size of C3 cover.

### 2.2 In HAM5 before removing the current OFI

#### Beam alignment:

The beam from the IFO needs to be aligned on the center of the ASC\_C QPD

#### Optical test 1: In-situ measurement of the current OFI transmission

Measure the transmission of the OFI using the PSL beam. The beam power before and after the OFI are to be measured.

Equipment: Power meter at an appropriate height. Expected beam radius ~2mm.

The beam from the IFO could be shaking more than the aperture size of the OFI. In the case, you may need a lens and a photodetector that has reasonably fast response to look at the maximum number on an oscilloscope.

If the transmission is low (<95%), check if there is an S-polarization rejected from the input polarizers. This requires to remove the steel beam dumps on the input polarizer crystals.

**Optical test 2: In-situ measurement of the current OFI optical isolation**

Use the NPRO laser installed on the ISCT6 table. Measure the incident power on the output port of the OFI. Measure the transmitted power from the input. This ratio gives us the optical isolation.

**Section 3.1.3 Placement of AOS-FI Pre-Installation Plate D1200047 on HAM5 Optical Table**

The cookie cutter should be attached on the ISI table along with the present OFI position. This means that we can also use other type of hardware to mark down the current OFI locations instead of the cookie cutter (e.g. dog clamps).

Clamp the current OFI with the transport shims as described in Section 3.1.2. The clamps can be found on the wire rack in the optics lab.

**Remove the current OFI from the ISI table**

Bring this OFI to the optics lab for the optical testing

**2.3 Installation of the new OFI in HAM5****Section 3.3 Insertion of OFI with Spacer into HAM Chamber**

I believe that we don't use the installation arm

Here is the summary of the equipment required in this step

- Quad BS Mover Assemblies D1100018 (Qty.3)
- Genie lift
- Teflon Highway

**Section 4 OFI Optical Alignment in HAM5****Section 4.1 Equipment List**

Item 1 and 2 (input/output apertures) have already been attached on the new OFI.

Item 4 and 5 (pliers and wrench) can be found in the clean tool boxes on the optical bench in the optics lab.

**Section 4.2.3 Vertical Alignment**

The set screws to clamp the wire split clamp and the wire adjustable adapter have already been fastened. If you need to change the adapter height, you need to loosen two set screws, and then turn the adjustable adapter while the wire split clamp is held with a plier so that the wire is not twisted. **The wire should not be damaged during the adjustment.**

Changing the wire height significantly changes the lateral alignment of the OFI table. Also, fastening the set screws on the adjusters changes the lateral alignment too. In the end, the table height needs to be correctly adjusted for the beam, and the table needs to be located at the middle of the EQ stop ranges.

We don't have the guitar tuner. We are supposed to use a guitar/base pickup instead.

Equipment list:

- A guitar pick up
- a cleaned BNC cable
- an oscilloscope

#### **Section 4.2.4 OFI Damper Holder Height Alignment**

If the vertical height of the table was changed in the previous step, the height of the OFI eddy current damper has to be changed too. **We don't use the height gauge to adjust the height of the damper plate shown in Fig 13. Instead, we want to use a scale to make the gap between the copper plate and the bottom of the OFI table to be 22.0 +/- 0.25 mm.**

There are sixteen 1/4-20 screws which are holding the damper plate on the welded structure. Among these, eight of them clamps the plate from the top side, and the other eight are used for the height adjustment. Note that the screw arrangements are not symmetric. Since the plate is a bit over-constrained, one has to understand which screws are the adjustment screws and how much you need to move. A single full turn of 1/4-20 screw changes the height 1.3mm. A quarter (1/4) turn corresponds to about 0.3mm, and this is a useful unit for the adjustment.

#### **Optical test 1: In-situ measurement of the current OFI transmission**

In a same as the old OFI, the in-situ transmission should be measured.

#### **Optical test 2: In-situ measurement of the current OFI optical isolation**

In a same as the old OFI, the in-situ isolation should be measured.

#### **2.4 After all optical adjustment (including squeezer path alignment)**

**DO NOT FORGET TO REMOVE THE TWO APERTURES AND THE TEMPORARY HALF-WAVE PLATE before closing the door!!!**