



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

*LIGO Laboratory / LIGO Scientific Collaboration*

LIGO-E1600164-v1

*LIGO*

May 29, 2016

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*Overall procedure for OMC DCPD replacement*

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## 1 Overview

This document provides an overall view of the existing procedures for OMC DCPD replacement, as well as the complimentary information that has not been covered by the existing procedure documents.

It is assumed in this document that the HAM6 door is already open and the OMC Black Glass Shroud ([E1500214](#)) is already in place.

The replacement procedure takes the steps in the following order:

- a) Preparations
- b) Locking the OMC suspension EQ stops
- c) Partial removal of the OMC Black Glass Shroud
- d) Removal of the OMC breadboard from the OMC suspension
- e) Replacement of the photodiodes
- f) Cleaning of the OMC cavity mirrors
- g) Restoration of the OMC into the OMC suspension
- h) Restoration of the OMC suspension
- i) Restoration of the OMC Black Glass Shroud
- j) Check lists after the in-chamber work

## 2 Required number of the personnel

The required number of the personnel during the in-chamber action is **three**. Two persons work in the chamber, and another suited-up person helps them outside the chamber.

## 3 Related documents

### Related to the OMCS locking

[T080117](#) Output Mode Cleaner Suspension (OMCS) Assembly Procedure

### Related to the OMC Black Glass Shroud

[E1500214](#) Assembly procedure - OMC stray light baffle aka Black Glass Shroud

[D0900295](#) aLIGO OMCS Overall Assembly

[D0901811](#) aLIGO Systems, HAM6-L1 Top Level Chamber Assembly

### Related to the OMC removal

[T1200525](#) User Instructions for D1201515 OMC Transport Fixture

### Related to the PD replacement

[E1300201](#) Output Mode Cleaner Assembly

[E1600013](#) aLIGO OMC: Handling procedure for high quantum efficiency photodiodes

### Related to the cavity mirror cleaning

[E1000079](#) First Contact Brush and Pour Application Procedure

### Related to the suspension EQ stop setting

[E070271](#) OMCS Installation Procedure

## 4 Procedure

### 4.1 Preparations

#### Facility

- A clean booth next to the open door of HAM6: We should be capable to carry removed components (black glass plates and the OMC breadboard) without exposing them to unfiltered air.
- Two clean tables
- A cleaned staircase for climbing up to the chamber

#### EQ stop locking

- [CLASS B] Allen keys
- [CLASS B] Needle-nose pliers (Sent from Caltech)
- [CLASS B] Wrenches (for hex nuts #8-32 & 1/4-20)

#### Shroud removal/restoration

- [CLASS B] Allen keys
- [CLASS B] 2~3 Large metal pans
- Dry wipes
- Tools associated with Shroud tools

#### OMC removal

- D1201515 OMC Transport fixture: already CLASS B, Stored in a cabinet at the next room to the optics lab.

#### OMC DCPD replacement

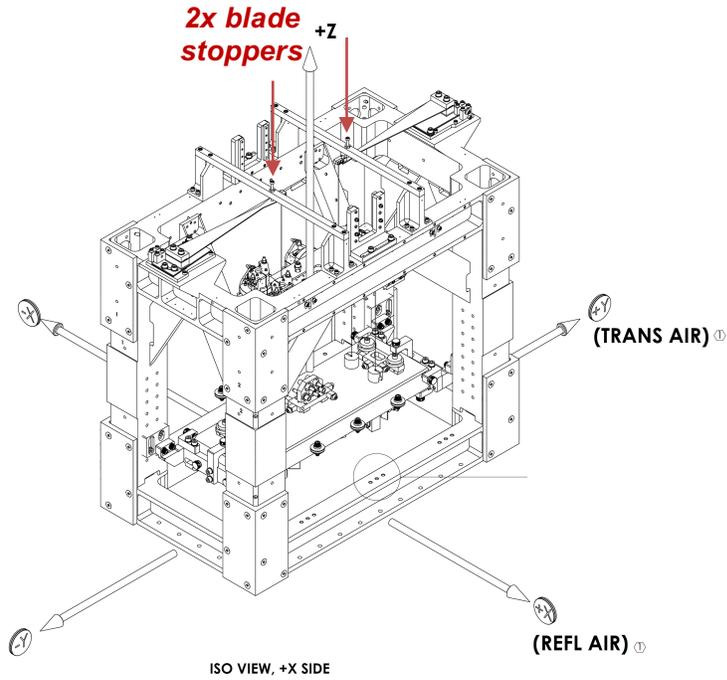
- Nitrile gloves (Sent from Caltech)
- Sharp flat head screwdrivers (~2mm width) (Sent from Caltech)
- DCPD in a cage (Sent from Caltech)

#### Optics cleaning

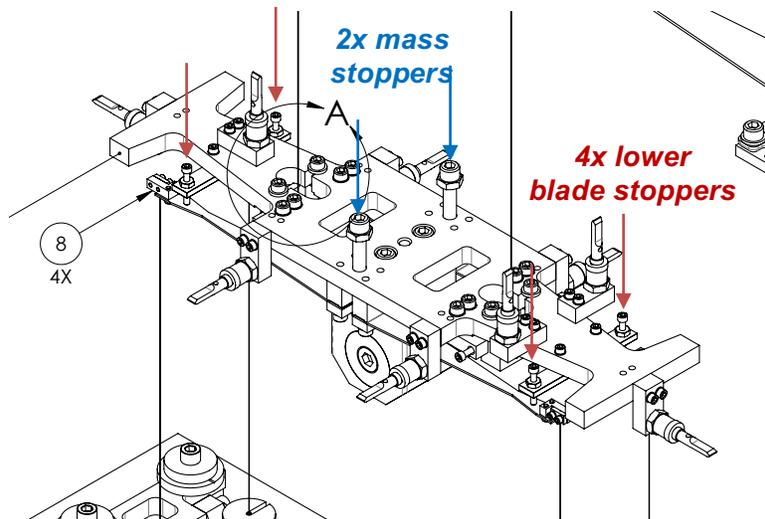
- FirstContact kit (liquid, PEEK sheet)
- Ionized air + UHP N2 bottle
- Green light for inspection
- Scissors (Sent from Caltech)
- Forceps (Sent from Caltech)

### 4.2 Locking the OMC suspension EQ stops

- Fix the top blade bending by two blade stopper screws on the Top Blade Guards of OMCS until they touch the vertical blades (Figure 1 and T080117 Section 8).
- Fix the upper suspended mass with two mass stoppers and four lower blade stoppers (Figure 2).



**Figure 1: Blade stoppers on the Top Blade Guards (D0900295)**



**Figure 2: Stoppers on the upper suspended mass (D1201212)**

### 4.3 Partial removal of the OMC Black Glass Shroud

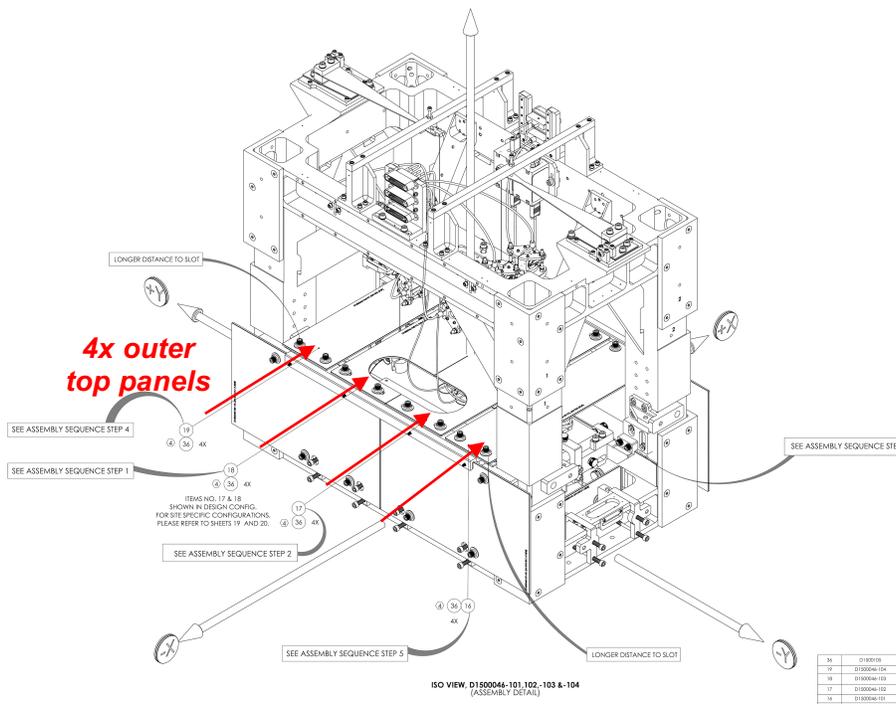
#### General remarks

- Each panel has a coated side labeled “S1” (E15000214 P.4).
- Each time when a panel is removed, pass it to the outside helper to store it in metal pans with wipes.

#### Removal procedure

- Remove four top glass panels (D1500046-101/102/103/104) (Figure 3). The screws are designed not to fall from the closed slot of the glass plates (i.e. they are captive).

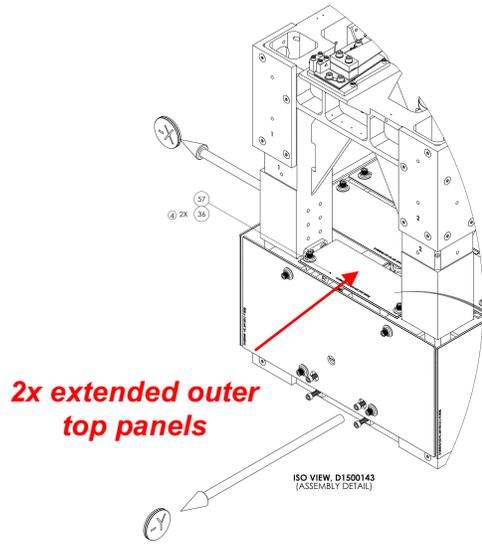
**CAUTION: Clearances between the glass plates and the suspension wires are very tight. Be careful not to scratch the wires with the edge of the glass plates.**



**Figure 3: Outer top glass panels (D0900295 Sheet 16)**

- Remove two extended top panels (D1500143) to allow us to remove the top EQ stops (D1201475 x 2, See D1201441) (Figure 4).

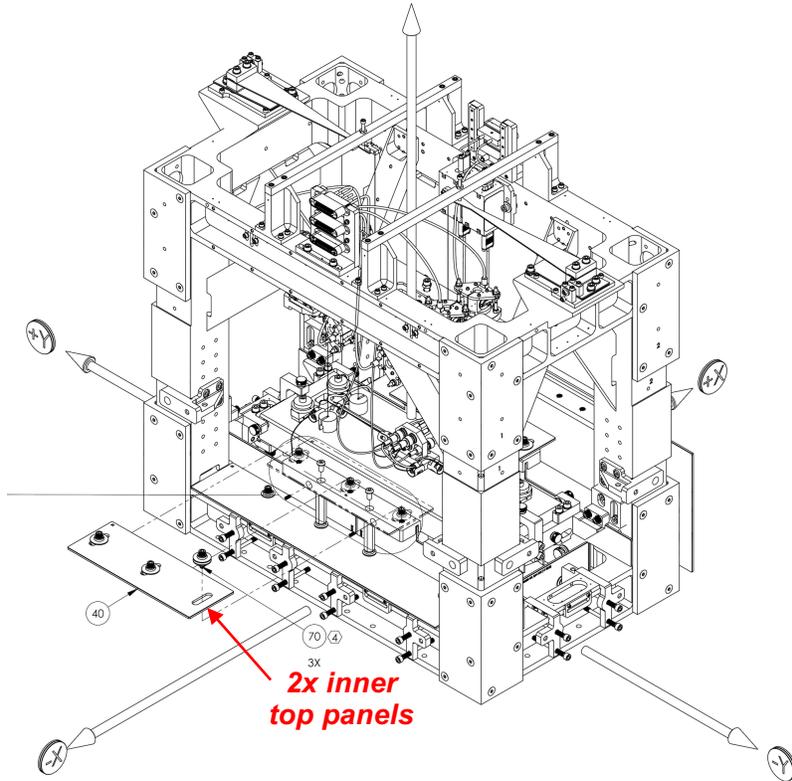
**CAUTION: The screws may fall because these panels have open slots for the screw holes.**



37	D1500143
36	D1500100

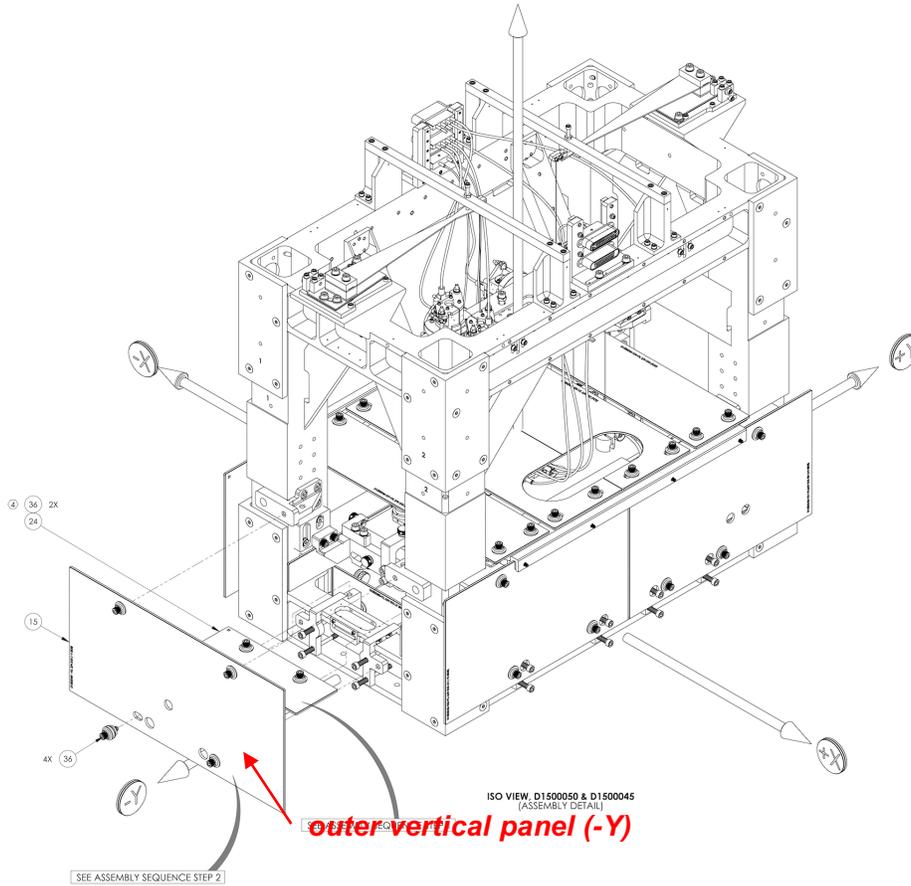
**Figure 4: Extended top glass panels (D0900295 Sheet 17)**

- Loosen three screws of each inner top panels (D1500116) (Figure 5). Slide the panels outward to allow us to access the OMC breadboard.



**Figure 5: Inner top panels (D0900295 Sheet 15)**

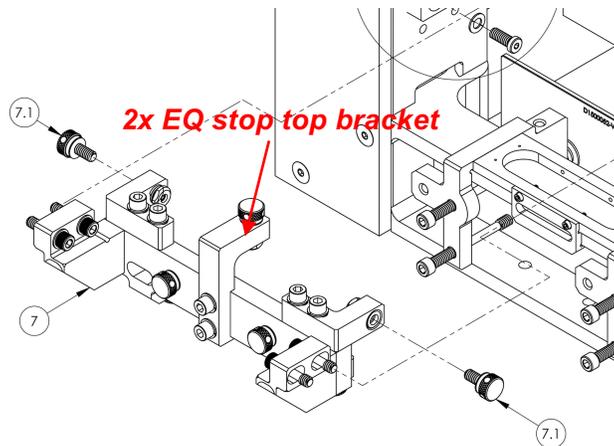
- Remove -Y side (WFS side) vertical panel (D1500045) to allow us to remove the OMC breadboard from this side (Figure 6).



**Figure 6: Outer vertical panels (-Y) (D0900295 Sheet 17)**

- Remove two top brackets of the OMC EQ stop modules (Figure 7).

**CAUTION: Do not drop the screws on glass panels.**

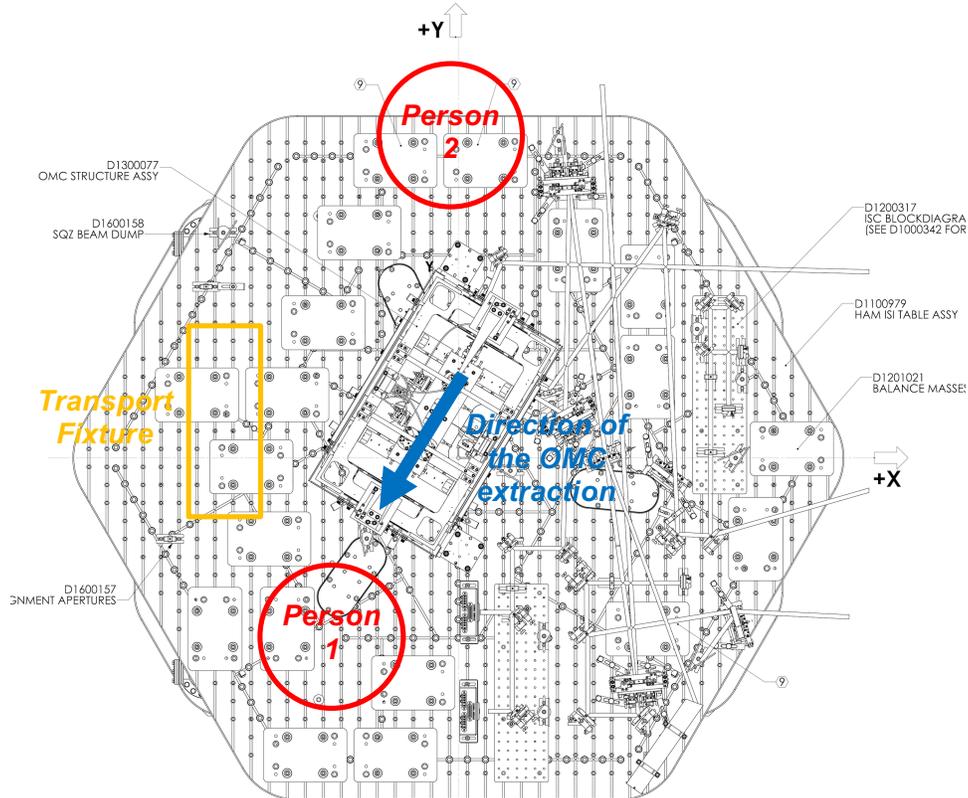


**Figure 7: Top Bracket of the OMC EQ stop module (D0900295 Sheet 7)**

#### 4.4 Removal of the OMC breadboard from the OMC suspension

This step is a reverse procedure of T080117 Sec 21 Sec 23.2 Sec 24. In practice, executing this step in the vacuum chamber makes it more complicated. Therefore the following additional care should be taken.

- Turn off the interface electronics units of the OMC DCPDs and DCQPDs. **Confirm if the PZT HV power supply is turned off.**
- Place the OMC transport fixture (D1201515) next to the OMC suspension cage (Figure 8).



**Figure 8: HAM6 layout, personnel/item arrangement, and OMC extraction**

- Remove the electrical connections of the OMC breadboard. Since their shapes have an effect to the breadboard DC positions, cares should be taken not to bend the cables as much as possible. It may be a good idea to put wipes on the outer vertical panels (+X/-X) so that the cable connectors can be placed on the wipes without scratching the glass panels.
- Next, the lower suspension wires are unhooked from the breadboard with the following steps.

**CAUTION:**

- The OMC breadboard is heavy (~7kg) and fragile. It should be gripped firmly at the +/-X side of the breadboard.
- Two persons should be around the OMC at +Y and -Y directions (Figure 8).

- The -Y side person lifts up the +Y side of the OMC. The other person unhooks the lower wires at the +Y side.

**CAUTION: Be careful not to damage the wire assembly. Do not drop the clamp on the breadboard.**

- The +Y side person lifts up the -Y side of the OMC. The other person unhooks the lower wires at the -Y side. The +Y person keeps holding the OMC with the wire set a side from the breadboard.

- The +Y person lifts up the OMC entirely and slide it toward the -Y person.

**CAUTION: Be careful not to drag the wire with the OMC.**

- Once the center of the OMC breadboard cleared the OMC EQ Stop, the -Y person receives the OMC and continue to extract.

**CAUTION: The OMC optics is at the bottom side of the OMC breadboard. Do not touch the optical surfaces with hands. Also do not allow any metal parts touch the optical surfaces.**

- Place the OMC breadboard into the OMC transport fixture. Put the lid of the OMC transport fixture. Secure the lid by turning the locks. (See also T1200525 for instruction)

#### 4.5 Replacement of the photodiodes

- Follow the instruction on E1300201 Section 6.10.
- For handling of the high QE DCPDs, special care is required due to their preciousness. Follow the handling procedure of the DCPDs E1600013.

**CAUTION:**

- The DCPD housings should not be moved at all. Just remove the cap of the photodiodes.
- Photodiodes should be shorted with short plugs until the momento of the installation.
- They also should be handled with Nitrile gloves in order to avoid ESD damage.

- The previous PD should be accommodated in the PD cage, for the post-deinstallation tests at Caltech.

#### 4.6 Cleaning of the OMC cavity mirrors

- Inspect every surface of every optics with a green flash light to find any dirt, dust, or damage.
- Apply FirstContact cleaning on the cavity mirrors even if there is no feature on the surface. Follow the cleaning instruction E1000079.
- If any particular feature on the optics is found, apply FirstContact cleaning.
- After the cleaning, check the optical surfaces thoroughly with the flash light to find any residues.

## 4.7 Restoration of the OMC into the OMC suspension

Reverse procedure of section 4.4

- Bring the transport fixture on the ISI table.
- Open the locks and remove the lid.
- Bring the OMC breadboard in the OMC EQ stops.
  
- Connect the electrical cables.
  
- Raise the OMC breadboard one side each time.
- Hook the lower wires to the breadboard.
- Hook the lower wires at the other side.
  
- Once the breadboard is suspended, turn on the DCPD interface and check the response of the DCPDs (and re-identify which PD is DCPDA or DCPDB).

## 4.8 Restoration of the OMC suspension

Reverse procedure of section 4.2

- Back off the SUS EQ stops to leave a 0.75mm gap (E070271-v2 OMCS Installation Procedure P.6 Step 21)
- Back off the OMC EQ stops by fully unscrewing the EQ stops (E070271-v2 OMCS Installation Procedure P.6 Step 22)

## 4.9 Restoration of the OMC Black Glass Shroud

Reverse procedure of section 4.3.

**CAUTION: Be careful not to drop the screws or other components on the OMC optics or black glass pieces.**

- Restore the outer vertical panel at the -Y side, and the two extended top panels. Refer E15000214 Step 108~114 (P.81-82) and follow the instruction there.
- Restore the inner top panels (D1500116). Refer E15000214 Step 95 (P.76) and follow the instruction there.
- The top outer panels D1500046-101&-104 could be easily incorrectly installed. Refer Step 103 (P.79) of E15000214 and follow the instruction there.

## 4.10 Check lists after the in-chamber work

- Once the PSL beam is restored, check the alignment of the OMC. If the beam is completely missing, the OMC shroud needs to be removed and more thorough check of the beam position is required. This alignment work induces rechecking of the OM1~3 bias adjustment and checking as well as the OSEM position check.

- OMC SUS transfer function check, as well as OM1~3 transfer function check should be done