

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
- LIGO -  
CALIFORNIA INSTITUTE OF TECHNOLOGY  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

<b>Document Type</b> <b>LIGO-E000002-B - D</b> 1/14/00
<b>Z Pivot Procedures</b>
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This is an internal working note  
of the LIGO Project..

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# 1 SCOPE

The purpose of this document is to specify the procedures to be used for installation and adjustment of the Z Pivot units on LIGO HAM and BSC chambers.

The purposes of the Z Pivot units are to:

- hold the position of the support table (in addition to frictional and inertial resistance) against external forces, including earthquakes, and
- provide for X & Y coarse adjustments of the support table where no CAS stages have been installed. The Z Pivot units are intended to be installed at each of the HAMs using air bearings and each of the BSCs at mid and end stations

Z Pivot component parts are detailed as follows:

D990538: weldment (skirt & yoke)

D990539: bearing plate

D990540: bracket

D000002: shim

# 2 INSTALLATION

## **WARNING!**

**Assure that installation will not interfere with test activities or critical alignment setups before proceeding with installation.**

**2.1 Install dial indicator trees (DITs) (this step is necessary only if optics have been installed in the chamber; otherwise, it can be skipped and the DIT readings called for in this Installation section can be ignored):**

- a. Install a DIT at each of the air bearings: bolt the bars to the air bearing mounting plates and set up the dial indicators to indicate the position of the crossbeam bolting flange, in both the X and Y directions. Arrange the dials for convenient readings and confirm plungers are visually aligned properly with regard to all axes. If necessary, this procedure can be accomplished with only two DITs installed, with loss of confirming readings.
- b. Zero all dials; do not touch the DITs again until the time for their removal, to prevent erroneous data.
- c. Record all DIT readings, with plan view layout for correlation.

## 2.2 Confirm/setup air bearing symmetry:

- a. Confirm the four air bearing caps are positioned with their bolt patterns symmetrical to both the beam centerline and the chamber's door centerline. If confirmed, skip step k below.
- b. Confirm air bearing bases are positioned so that one of the flats for each base is directly below the center of the bolt pattern of its cap, and so that the pattern of the flats on the bases are symmetrical to both the beam centerline and the chamber's door centerline. If confirmed, skip step l below. If all of both a and b are confirmed, skip all of steps c-p.
- c. Install crossbeam bracket base weldments (D972433, D972437) on the two piers supporting the crossbeam supported by the first selected air bearing needing rotation.
- d. Rotate the weldment's adjustable locating button (one only) next to the selected air bearing to contact the square backing plate under the crossbeam
- e. Connect clean air supply lines to the two air bearings near the weldments; confirm bottle pressure > 1500 psig.
- f. Slowly increase air pressure to both air bearings simultaneously, to 100 psi for HAM chambers or 140 psi for BSC chambers.
- g. Confirm proper floatation by checking each air bearing mid section for easy rotation (wiggle air line). If resistance is felt, check for obstructions (such as rubbing against centering brackets, which should have been removed). If necessary, increase air pressure in increments of 20 psi until easy rotation is achieved. Do not exceed 160 psi.
- h. Record all DIT readings.
- i. Elevate crossbeam end above selected air bearing by turning adjustable locating button one full turn (1.5 mm) upward.
- j. Record all DIT readings.
- k. **(Cap Rotation Only)** Release bands on rubber bellows, remove crossbeam/air bearing bolts and rotate air bearing cap as required to produce the symmetry described in a above. Replace bolts and torque to 10 ft-lb.
- l. **(Base Rotation Only)** Release bands on rubber bellows, remove air bearing/mounting base bolts and rotate air bearing base as required to produce the symmetry described in b above. Note: if a helicoil galls on a bolt, it may prevent bolt removal, necessitating removal of the air bearing mid section to allow lifting of the base for repair and rotation. In this case, special care must be taken to assure adequate air supply and to maintain air bearing cleanliness. Replace bolts and torque to 7 ft-lb.
- m. Lower crossbeam by turning adjustable locating button free of the square backing plate.

- n. Record all DIT readings.
- o. Repeat steps c-n for all air bearing rotations required by the inspections in steps a and b.
- p. Remove the crossbeam bracket base weldments and the air supply lines.

### **2.3 Install bearing plates:**

- a. Release lower bands for rubber bellows, if installed.
- b. Attach two Z Pivot bearing plates to each air bearing base (machined flat goes inward and down) using two 1/4-20 x 3/4" SHCS; tighten snugly.
- c. Reinstall lower bands for rubber bellows, positioned above bearing plates.

### **2.4 Install brackets:**

- a. Attach a Z Pivot bracket to each air bearing cap using four 1/4-20 x 3/4" SHCS; tighten snugly, taking care to back up torque to minimize potential for shifting cap.
- b. Install upper bands for rubber bellows, if not already installed.
- c. Record all DIT readings.

### **2.5 Install weldments:**

- a. Install two left hand and two right hand weldments so that the holes for the locking screws at the bottom of the skirts align with the position of the bearing plates. Attach with four 1/4-20 x 3/4" SHCS to each bracket and add shims between the bracket fork ends and the yoke. Tighten screws snugly, taking care to back up torque to minimize potential for shifting cap.
- b. Record all DIT readings.
- c. Install two 1/4-20 screws of appropriate length and jam nuts in each skirt: apply 5 in-lb of torque to each screw before snugging jam nut to lock.
- d. Record all DIT readings.
- e. Remove DITs.

### **2.6 Log:**

- a. Record activities in the e-log; record activities and data in the written log.

### 3 ADJUSTMENTS

**WARNING!**

**Assure that adjusting will not interfere with test activities or critical alignment setups before proceeding with adjustments.**

#### 3.1 Install dial indicator trees (DITs):

- a. Install a DIT at each of the air bearings: bolt the bars to the air bearing mounting plates and set up the dial indicators to indicate the position of the crossbeam bolting flange, in both the X and Y directions. Arrange the dials for convenient readings and confirm plungers are visually aligned properly with regard to all axes. If necessary, this procedure can be accomplished with only two DITs installed, with loss of confirming readings.
- b. Zero all dials; do not touch the DITs again until the time for their removal, to prevent erroneous data.
- c. Record all DIT readings, with plan view layout for correlation.

#### 3.2 Remove all preloads:

- a. Loosen jam nuts and back off 1/4-20 x 3" locking screws; confirm DIT readings have not changed.
- b. Using fingers only, advance locking screws to touch bearing plates.
- c. Record all DIT readings.

#### 3.3 Energize air bearings:

- a. Connect clean air supply lines to the two air bearings near the weldments; confirm bottle pressure > 1500 psig.
- b. Slowly increase air pressure to all four air bearings simultaneously, to 100 psi for HAM chambers or 140 psi for BSC chambers.

c. Confirm proper floatation by checking each air bearing mid section for easy rotation (wiggle air line). If resistance is felt, check for obstructions (such as rubbing against centering brackets, which should have been removed). If necessary, increase air pressure in increments of 20 psi until easy rotation is achieved. Do not exceed 160 psi.

d. Record all DIT readings.

### **3.4 Stage for movement:**

a. Position a person at each air bearing, with instructions as to which locking screw they will be operating, which direction it will be moving and the amount of motion to be expected, referencing the respective dial indicator.

### **3.5 Move support table:**

a. Back off the appropriate locking screws the approximate amount of travel desired in the first direction chosen.

b. Move the support table by turning the appropriate locking screws until the desired dial indicator readings are achieved.

c. If motion in a second direction is desired, repeat steps a-b above for that direction.

### **3.6 De-energize air bearings:**

a. Close valve at air source to lower air bearings; back off regulator.

b. Record all DIT readings.

c. If desired movement was not achieved, repeat steps 3-6 above until successful.

### **3.7 Re-establish preloads:**

a. Apply 8 in-lb of torque to each Z Pivot locking screw before snuging jam nut to lock.

b. Record all DIT readings. If this disturbed the support table position beyond acceptable tolerances, repeat steps 2-7 until successful.

c. Remove DITs and air supply lines.

### **3.8 Log:**

a. Record activities in the e-log; record activities and data in the written log.