TITLE

Re-alignment of the Livingston Observatory, Y-Arm, End Test Mass

APPROVALS:		DATE	APPROVALS:		DATE
DRAWN:	Dennis Coyne	6/21/01	CHECKED:	--	--
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CHECKED:			E010120-00-D	Dennis Coyne	6/21/01

Instructions on the use of this document:
1) Have this procedure available at all times during the installation. Also have the LOS installation procedure for BSC chambers (E000062) and the Chamber Entry & Exit Procedure (E000065) available during the installation to follow along. Check off items as the installation proceeds. (If it is desired to have these procedures in the chamber, or cleanroom, then laminate the procedure and clean the plastic with isopropyl alcohol and handle it as a class B tool per M990034).
2) Use this installation procedure as a check list for preparation and during the installation. Note any discrepancies or deviations and augment with any missing definition. File any significant notes or data from the completed procedure in the electronic logbook (such as any deviations); as a minimum note in the electronic logbook that the installation was completed in accordance with this procedure (cite document number and revision).

1 SCOPE

This installation specification covers the Sensor/Actuator Assembly (OSEM) replacement and angular re-alignment of the End Test Mass (ETM) in the Livingston Observatory 4 km interferometer, on the Y-arm ($ETM_{y,LLO}$). The following assumptions are made:

- the $ETM_{y,LLO}$ suspension assembly had already been positioned and initially aligned based on the Initial Alignment System (IAS) procedures (T970151) and Core Optics Support (COS) initial alignment procedures (T990088),
- removal of the $ETM_{y,LLO}$ suspension assembly from the BSC chamber is not required
- required angular adjustments are generally within the range of the Pitch and yaw Adjustment Magnets (PAMs)
- the COS optical elements in the chamber (i.e. the COS $ETM_{y,LLO}$ telescope and beam dump) are adequately aligned,
- the optical lever and transmission monitor are installed and aligned

The first application of this specification was a consequence of the June 2001 re-trofit of the sensor/actuator (alias OSEM) replacement which requires a re-alignment of the optic.

2 APPLICABLE DOCUMENTS

Listed below are all of the applicable and referenced documents for this installation procedure. This list gives the latest revisions of the documents; Within the installation steps, only the document number (and not the revision) is quoted.

M990034-B	Contamination Control Plan
M980133-B	Vent Isolatable Volumes
M980101-B	Procedure for Isolatable Volume Pump Down
E000118-A	Checklist - Isolatable Volume Pump Down
E000120-A	Checklist - BSC Door Removal
M980132-B	O-Ring Installation and Flange Assembly Procedure for HAM and BSC Doors
T970151-C	Initial Alignment Procedures (Reference only: The alignment procedures defined within this procedure supersede the initial alignment procedures defined in T970151.)
E000065-04	Chamber Entry/Exit Checklist
E000062-C	LOS Installation Procedures
E000116-00	Procedure for Realignment of Large Suspended Optics
D970308-B	Interferometer Optomechanical Layout - Hanford Site
D000180-A	Sensor/Actuator Assembly, Short, SMD (“short OSEM”)
D000069-A	Sensor/Actuator Assembly, Long, SMD (“long OSEM”)

3 PRE-REQUISITES

✍ 1. The optics should have already been positioned and aligned via T970151; This is a remedial alignment procedure.

✍ 2. The LBSC5 optics table should be verified to be level and counterweights adjusted if/as required.

✍ 3. Follow all contamination control procedures. In particular a cleanroom must be placed over the open chamber door and the purge air must be flowing into the vented vacuum envelope.

✍ 4. The Suspension assemblies and control electronics should be confirmed to be operating correctly (per E970154) prior to initiating this procedure.

4 PREPARATION

All preparation must be in accordance with the Contamination Control Plan (M990034).

✍ 1. <u>If, and only if, the vacuum system is not already open and therefore exposed:</u>
Clean the VEA, particularly the floor adjacent to LBSC5. Particulates and dust should be removed by mopping with clean water.
Clean the BSC chamber (wipe or mop with clean water) from the stiffening ring above the door down, as well as the floor in the vicinity of the chamber well in advance of the opening of the vacuum system.

✍ 2. Insure that there are no large openings to the exterior or the beam tube enclosure where insects or dust can get into the VEA.

✍ 3. Arrange for clean room coverage over the rear door of chamber LBSC5.

✍ 4. Close gate valves to isolate the beam tubes and the cryo pumps. Vent chamber LBSC5 per M980133

✍ 5. Remove the end door of LBSC5 per E00120 with the engine hoist.
Turn up purge air to a reasonable flow; The cloth cover over the opening should puff out.
NOTE! It is very important that we limit exposure of the vacuum surfaces to atmospheric moisture, to minimize pumping time required before gate valves can again be opened. This is largely a function of purge air flow volume and the duration of chamber open times. This procedure is written to minimize the durations of removal. **Fabric door covers afford a surprising amount of shielding (with purge), so they should be installed whenever access through the door opening is not required within a short time period. This includes the practice of installing a cover when workers are inside a camber.**
Cover the openings with cloth covers and ensure adequate purge air flow.
Reminder: cover open doors when access is not immediately required!

6. Transport the following items to the Y End Station VEA:

- Appropriate cleanroom garb, including gloves, in-chamber booties
- Flashlights, radios, batteries
- Cloth Door Cover
- Foil, Ameristat, and Tape

- CO2 gun and portable bottle and portable N2 gun with ionizer
- In-chamber vacuuming system

- Precision Bubble level
- BSC work stool
- Class B tools (including 3/16" allen wrench)

- 6 (or more) new, tested Sensor/Actuator Assemblies ("OSEMs")
- 6 (or more) new, tested Sensor/Actuator Cable Assemblies ("Pigtails")
- Sensor/Actuator Assembly (OSEM) Test Box

- Oscilloscope and BNC Cables
- Sony Nightshot Videocam
- Steering Mirror and Mount
- Surveying equipment & laser/autocollimator equipment
  (including two Sokkia total stations and two LDS-1000 laser autocollimators)

5 OSEM REPLACEMENT & RE-ALIGNMENT STEPS

All work must be in accordance with the Contamination Control Plan (M990034).

Sequence: The following steps are in a logical and workable sequence. However some of the steps can be done in parallel and some steps can be done at other points in the sequence.

✍ 1. Perform the **chamber entry check** (E000065)

✍ 2. **Replace the OSEMs:**
a) Secure the optic by adjusting the stops up against the optic gently. Try to maintain roughly the same position and orientation of the optic when it is freely hanging.
b) Remove the stainless steel wire which secures the pigtail cabling to the LOS structure.
c) Disconnect all pigtail cabling from the connector mounted on the optics table.
d) Disconnect the satellite electronics module and replace it with a modified (high current) version suitable for the new OSEMs.
e) Remove each old OSEM one at a time by removing the set screw and ensuring that the OSEM does not tilt.
f) Install the new OSEMs, one at a time, carefully in the OSEM mounting bracket on the LOS structure using the spring loaded ball plunger set screw to secure it. Take care not to tilt the OSEM head.
g) Connect the each OSEM pigtail cable assembly, one at a time, into the connector in the positions indicated in the LOS Installation Procedure (E000062). Ensure that the Epics Suspension Control Screen indicates that the sensor is connected (non-zero voltage) and that the coil is connected (coil monitor voltage is not railed at the supply voltage) for the OSEM position just connected.
h) Dress the pigtail cables away from the optical paths and secure them to the LOS structure with the stainless steel wire.
i) Carefully adjust each new OSEM to approximately 50% of the open light level.

CAUTION: The OSEM is cantilevered and can knock off a magnet/standoff assembly if it slips.
Reminder: Always level the optics table and ensure proper payload weight at all times, especially when the optic is released from it's stops.
Reminder: cover door opening when access is not being required.

✍ 3. **Check the OSEMs** by performing all parameter measurements for each OSEM from the cable connector at the satellite box. Record data in the table below.
Measure OSEM values using MIT breakout box at feedthrough port; see section 6.3 "OSEM Test Box" of E000388 for instructions. Complete the table below and file in the elog.
Note: If any of the OSEM parameters are out of the acceptable range, then the OSEM must be replaced.

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✍ 4. **Position the PLX** (Lateral Transfer Hollow Retroreflector) on a clean, stable mount in the 60 in diameter, vacuum manifold tube in front of ETMy oriented horizontally and centered in the tube. Note: The PLX aperture center height is nominally the same as every other survey instrument to be used and the same as the center of the ETMy optic, or -100 mm from the center of the chamber (as determined, for example, from scribe marks on the 60 in. diameter flanges). Centering is not very important. If instrument mount considerations require a different height to be used, this is acceptable if the LDS-1000 laser autocolimator and PLX apertures are at the same elevation to within about 6 mm.

✍ 5. **Setup the Brunson(s), for vertical & yaw reference** for the total station, at a location along a surveyed offset line parallel to the global y-axis and close to an X-global location of 4002365 mm The X-position needs to be within ~+/-10 mm so that the Brunson mirror is within range for autocolimation with the LDS-1000

✍ 6. **Position the Sokkia total station** (with the LDS-1000 laser autocolimator mounted on top) over IAS monument with global coordinates {200.6, 4002365} mm
Set the height so that the center of the LDS-1000 aperture is at -100 mm in local coordinates (nominally, but see the note above about instrument aperture heights.)
Align the Sokkia zero yaw reference by backsighting the IAM monuments high on each end wall.
Adjust the Sokkia so that it is pointing as follows:
Yaw = 270 deg, 0', 0" (pointing -Y direction)
Pitch = 90 deg, 0', 4" (pointing 4" down)

✍ 7. **Adjust the PLX** if/as required so that the LDS-1000 beam is centered in both apertures.

✍ 8. **Adjust the PAM magnets of the ETMy suspension** assembly until the LDS-1000 beam is autocollimated to within 10 microradians (2 arcsec). Recheck the sensor voltage and re-adjust the positions of the OSEMs to achieve ~50% of the open light voltage level. Iterate until converged.

✍ 9. **Verify the optical lever** for ETMy is approximately aligned correctly.

10. **Clean and De-Ionize the Optic** per the procedure E000062

11. Set safety stops ?? 0.5mm

12. Check optical lever screen and bias pitch and yaw for full travel at max gain settings.
Reduce gains to 10%, invert signal temporarally add observe ringdown for possible railing of optic against safety stops.

✍ 13. Perform chamber exit procedure E000065

✍ 14. Replace LBSC5 doors. Turn off purge air.

✍ 15. Pump down per E000118

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Table 1: Sensor/Actuator ("OSEM") Parameters
Satellite Module Serial No. _____ Controller Serial No. _____

Measurement	UL	UR	LL	S	LR	Acceptable Limits
LED (mA)						50 +/- 1
PD (? A)						30 - 60 ? A (> 90? A open light)
R (ohms)						13-14 ohms, or 17-19 with cable
L (mH)						2.9-3.3 [a]
Leakage Current (? A)						<= 0.01 ? A
OSEM Voltage (V)						-0.8 to -1.2

a. with test box switch set to "ON w/ L" or "L" position