TITLE

Re-alignment of the 2 km Interferometer, Y-Arm, End Test Mass

APPROVALS:	DATE	APPROVALS:	DATE
DRAWN: Dennis Coyne	4/4/01	CHECKED: --	--
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Instructions on the use of this document:
1) Laminate this procedure (or place it in a plastic sleeve) and have it available at all times during the installation. Check off items as the installation proceeds. (Clean the plastic with isopropyl alcohol and handle it as a class B tool per M990034). Also laminate the LOS installation procedure for BSC chambers (E000062) and have it available during the installation to follow along.
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 re-installation and angular re-alignment of the End Test Mass (ETM) in the 2 km interferometer, on the Y-arm ($ETM_{y,2k}$). The following assumptions are made:

- the $ETM_{y,2k}$ 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),
- the $ETM_{y,2k}$ suspension assembly position on the BSC optics table was “recorded” with mechanical stops which are used to reset to the original position, prior to removal for rework
- 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 $ETM_{y,2k}$ telescope and beam dump) are adequately aligned,
- the optical lever and transmission monitor were installed and aligned prior to removal of the $ETM_{y,2k}$ for rework

The first application of this specification was a consequence of the February 28th, 2001 earthquake which caused a magnet/standoff sub-assembly to debond from the optic.

2 APPLICABLE DOCUMENTS

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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	Hanford Checklist - Isolatable Volume Pump Down
E000120-A	Hanford 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

3 PRE-REQUISITES

1. The optics should have already been positioned and aligned via T970151; This is a remedial alignment procedure.
2. The WBSC6 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 doors 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. If, and only if, the vacuum system is not already open and therefore exposed:
   Clean the VEA, particularly the floor adjacent to WBSC6. 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 both doors of chambers WBSC6.
4. Close gate valves to isolate the beam tubes and the cryo pumps. Vent chamber WBSC6 per M980133
5. Remove the flexible bellows and viewport cover between the ETM transmission monitor and the door viewport on the back side of the chamber.

6. Remove both doors of WBSC6 per E00120 with the engine hoist. In particular, when removing the back side door, do not disturb the alignment or position of the ETM transmission monitor and pier. Turn up purge air to a reasonable flow.
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!

7. Transport the following items to the Y Mid Station VEA:

Appropriate cleanroom garb, including gloves, in-chamber booties
Flashlights, radios, batteries
CLASS A 1/4-20x1/2" SHCS
Cloth Door Covers
COS Table Clamps
COS Tool pan (wrenches and allen keys)
Camera and lens
CO2 gun and portable bottle and portable N2 gun with ionizer.
Precision Bubble level
$ETM_{y,2k}$ suspension assembly (including Height Adaptor)
BSC work stool
LOS Table Clamps and Fasteners
LOS Installation Fixtures (Lazy Susan, Lift Truck, Straddle, etc.)
Oscilloscope and BNC Cables
Sony Nightshot Videocam
Foil, Ameristat, and Tape
Steering Mirror and Mount
Surveying equipment & laser/autocollimator equipment (including two Sokkia total stations and two LDS-1000 laser autocollimators)
In-chamber vacuuming system

5 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. Note that since this is a continuation of the rework of the ETM, the chamber entry check (E000065) i not performed at the start of this procedure.

1. Install the support beam and liftable through the front door.
2. Install the ETMy optic per E000062.

   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. Remove the support beam and liftable through the front door.
4. Check the OSEMs by performing all parameter measurements for each OSEM from the feedthrough connector at the chamber wall. Record data here:
   UL: Resistance (ohm) _____ Inductance (mH) _____ Capacitance (pF) _____
   UR: Resistance (ohm) _____ Inductance (mH) _____ Capacitance (pF) _____
   LL: Resistance (ohm) _____ Inductance (mH) _____ Capacitance (pF) _____
   LR: Resistance (ohm) _____ Inductance (mH) _____ Capacitance (pF) _____

   If any of the OSEMs have a measurable resistance to ground, then the OSEM must be replaced.
5. **Position the PLX** (Lateral Transfer Hollow Retroreflector) on a clean, stable mount in the 60 n diameter, vacuum manifold tube in front of ETMy,2k oriented horizontally (as shown in the attached figure).
   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,2k 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 autocollimator and PLX apertures are at the same elevation to within about 6 mm.
6. Setup the Brunson, for vertical reference for the total stations, at a location with convenient line of sight to both total stations (see figure for layout).

7. **Position the first Sokkia total station** (with the LDS-1000 laser autocolimator mounted on top) over IAS monument IAM501 on the 120 inch (3048 mm) offset line on the back side of chamber WBSC6.
   The local coordinates of IAM501 are {3048, 201680} 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, IAM50? and IAM50?
   Adjust the Sokkia so that it is pointing as follows:
   Yaw = 45 deg, 0', 0" (pointing -X, +Y direction)
   Pitch = 0 deg, 0', 0" (pointing level)

8. **Position the second Sokkia total station** (with the LDS-1000 laser autocolimator mounted on top) over IAS monument IAM502 on the 120 inch (3048 mm) offset line on the back side of chamber WBSC6.
   The local coordinates of IAM502 are {3048, 2019428} 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, IAM50? and IAM50?
   Adjust the Sokkia so that it is pointing as follows:
   Yaw = 90 deg, 0', 0" (pointing -X direction)
   Pitch = 0 deg, 1', 7" (pointing 67" down)

9. Position a precision flat on a tripod in WBSC6 in the location shown in figure 1. Adjust the position until the spots from both LDS-1000 laser autocollimators overlap each other near the center of the mirror. Adjust the pitch and yaw of the precision flat until the LDS-1000 over IAM501 retroreflects to within 5 microradians (1 arcsec)

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

11. **Adjust the PAM magnets of the ETMy,2k suspension** assembly until the LDS-1000 beam is autocollimated to within 10 microradians (2 arcsec).
    If a large yaw adjustment is required (greater than ~1 mrad), then first perform a coarse yaw alignment by shifting the suspension structure on the optics table as follows:
    a) clamp the suspended optics on the table
    b) position stops on two sides of the structure as a reference to the position, preferably with pusher screws to help rotate the structure
    c) loosen the dog clamps which secure the structure to the table
    d) rotate the suspension structure slightly, reclamp
    e) unclamp the optic and recheck the yaw error with the LDS-1000 autocolimator

12. Verify that the optical lever for ETMy is approximately aligned correctly.

13. Perform chamber exit procedure E000065
14. Replace WBSC6 doors. Turn off purge air.
15. Pump down per E000118

Figure 1: Optical alignment layout for the $ETM_{y,2k}$ is shown below.

E010066-A Figure 1: Optical Alignment Layout for the ETMy,2k