



IDENTIFICATION				
ALM-B				
TITLE ALIGNMENT MAINTENANCE USING GLOBAL POSITIONING SYSTEM (GPS) PRODUCT LIGO BEAM TUBE MODULES CALIFORNIA INSTITUTE OF TECHNOLOGY	REFERENCE NO. 930212		SHT <u>1</u> OF <u>2</u>	
	OFFICE RSE		REVISION 2	
	MADE BY SDH	CHKD BY SWP	MADE BY SWP	CHKD BY WLR
	DATE 12-21-93	DATE 12-29-93	DATE 5/17/95	DATE 5/17/95

1.0 SCOPE:

This procedure defines the method of maintaining the LIGO tube alignment using the Global Positioning System(GPS). Detailed are procedures for reference verification, set-up and inspection of tube positions at each support.

2.0 REFERENCES:

The alignment methods and tolerances are based on the data contained in the following references:

- 1) Summary of concepts and Reference Design for a Laser Gravitational-Wave Observatory, Caltech; Feb-92.
- 2) LIGO Project Safety Manual.
- 3) Manufacturer's Procedures for Global Positioning System (GPS) Equipment and Computer Software.
- 4) As-Built Beam Tube coordinates converted from WGS-84 to State/Plane Rectangular System (N-E-Up).

3.0 EQUIPMENT:

The following is a listing of alignment equipment selected for use in maintaining the LIGO beam tube clear aperture of 1.07 meter diameter.

- 1) Global Positioning System Package consisting of following:
 - a. Base Station Receivers
 - b. Radio, Software, Modem System, Stands, Etc.
 - c. Antenna Accessories
 - d. 386(min) Computer, DOS Format
- 2) Target Reference Rod and antenna adapter
- 3) Depth Micrometer 0,00 to 75mm..
- 4) Inside Micrometer for 50mm - 200mm.
- 5) Master Machinist Level, 15" Length with 10 second accuracy minimum.
- 6) Alignment work sheet and data recorder.
- 7) Miscellaneous Tools including flashlights, shop lights, wrenches, screwdrivers, etc.



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4.0 EXECUTION:

The Inspection and Maintenance of Beam Tube alignment is divided into two steps. These are (1) verification of Reference Rod positions (2) inspection and adjustment of Beam Tube Supports.

4.1 Verification of Reference Rod is performed in the following steps:

- 1) Set-up receiver base station and log in for satellite communication.
- 2) Attach Leveling Plate to Beam Tube Reference Rod and level rod using adjuster bolts inside cover area and Master Machinist Level to 1 min arc Max.
- 3) Mount the GPS antenna to the Primary¹ Reference Rod and level the rod to Earth.
- 4) Input Reference Rod data into GPS computer and record location.
- 5) Calculate position location with Beam Tube Reference Pin Location and determine theoretical off-sets.

4.2 Inspection of Beam Tube Alignment and Adjustment of Beam Tube Supports shall be performed per the following steps:

- 1) Verify Beam Tube rotation by checking the flat level using the Master Machinist Level. Adjust support to re-level tube.
- 2) Measure elevation of Beam Tube Reference Pin using inside micrometer. Adjust Beam Tube Support for achieve proper elevation.
- 3) Measure off-set from Primary Reference Rod to Beam Tube Reference Pin. Adjust support to achieve proper location.
- 4) Record all adjustments and final off-sets for purpose of tracking beam tube and cover movements.

5.0 CALIBRATION:

Equipment Shall be handled, calibrated and stored per manufacturer's requirements. All calibration shall be traceable to national and international standards. All equipment shall be inventoried with serial numbers, calibration dates, and logs detailing operation and duration of equipment use.

¹ Primary refers to current Reference Monument being measured.