



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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ALIGO Coordinate Systems

Luke Williams

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This is an internal working note
of the LIGO Project.

California Institute of Technology
LIGO Project – MS 18-34
1200 E. California Blvd.
Pasadena, CA 91125
Phone (626) 395-2129
Fax (626) 304-9834
E-mail: info@ligo.caltech.edu

LIGO Hanford Observatory
P.O. Box 1970
Mail Stop S9-02
Richland WA 99352
Phone 509-372-8106
Fax 509-372-8137

Massachusetts Institute of Technology
MIT NW22-295
185 Albany Street
Cambridge, MA 02139 USA
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

LIGO Livingston Observatory
P.O. Box 940
Livingston, LA 70754
Phone 225-686-3100
Fax 225-686-7189

<http://www.ligo.caltech.edu/>

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1 ALIGO Global Coordinate System

1.1 General

The LIGO global coordinate system was defined so that the global x-axis runs along the x-arm beam tube centerline and the global y-axis runs along the y-arm beam tube centerline. The global z-axis runs through the intersection of the global x and y axes, perpendicular to both, with positive direction going up. T980044-10-E gives more information.

The global coordinate systems at LLO and LHO are not perfectly level at the LVEA, and in fact the scale of the LIGO sites makes it impossible for the local level to be the same at LVEA and the end stations.

1.2 LLO

Figures 1 and 2 show the relationship between local level in the LVEA and the global coordinate system at LLO.

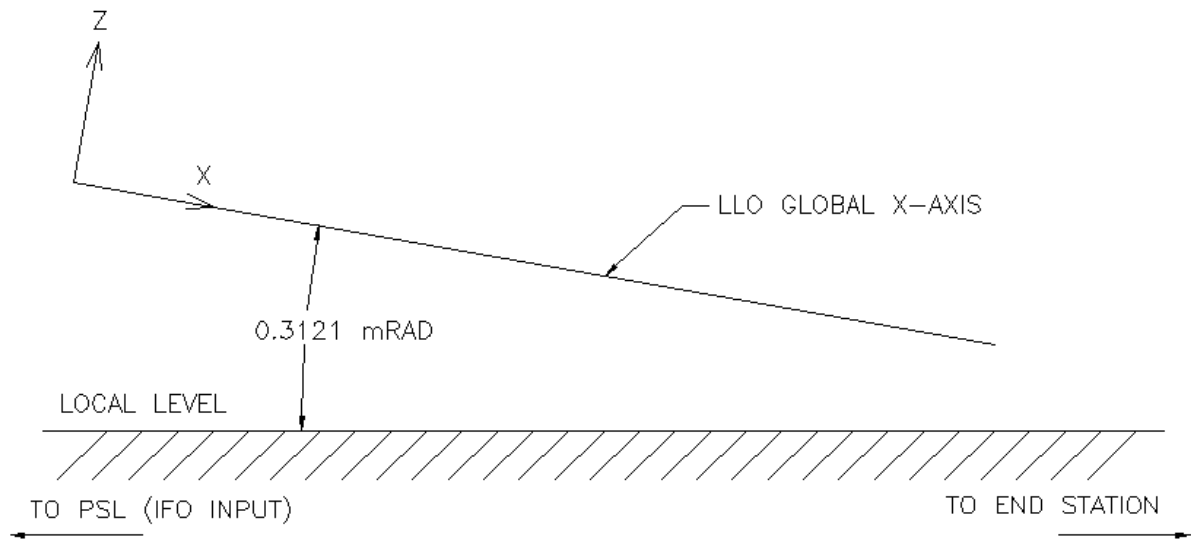


Figure 1. Angle between LLO global x-axis and local level in the LVEA.

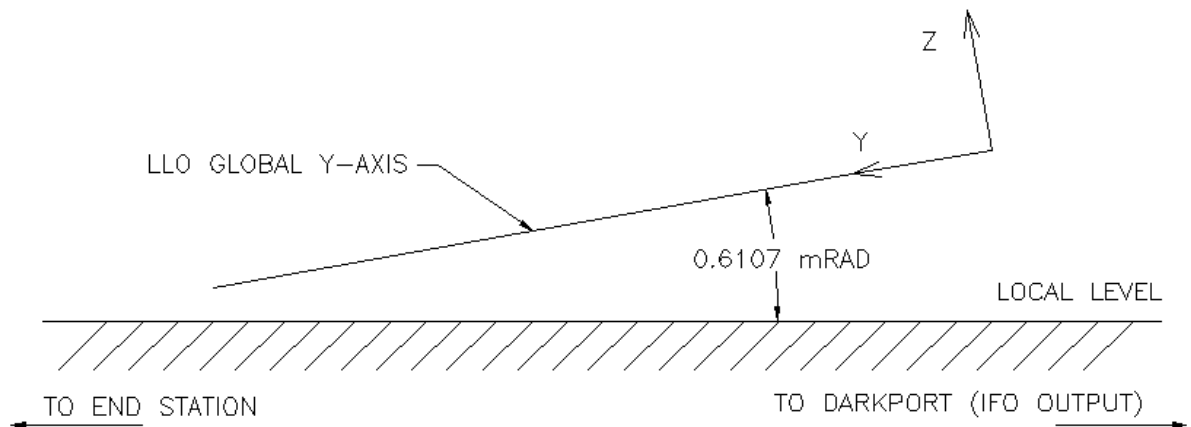


Figure 2. Angle between LLO global y-axis and local level in the LVEA.

1.3 LHO

Figures 3 and 4 show the relationship between local level in the LVEA and the global coordinate system at LHO.

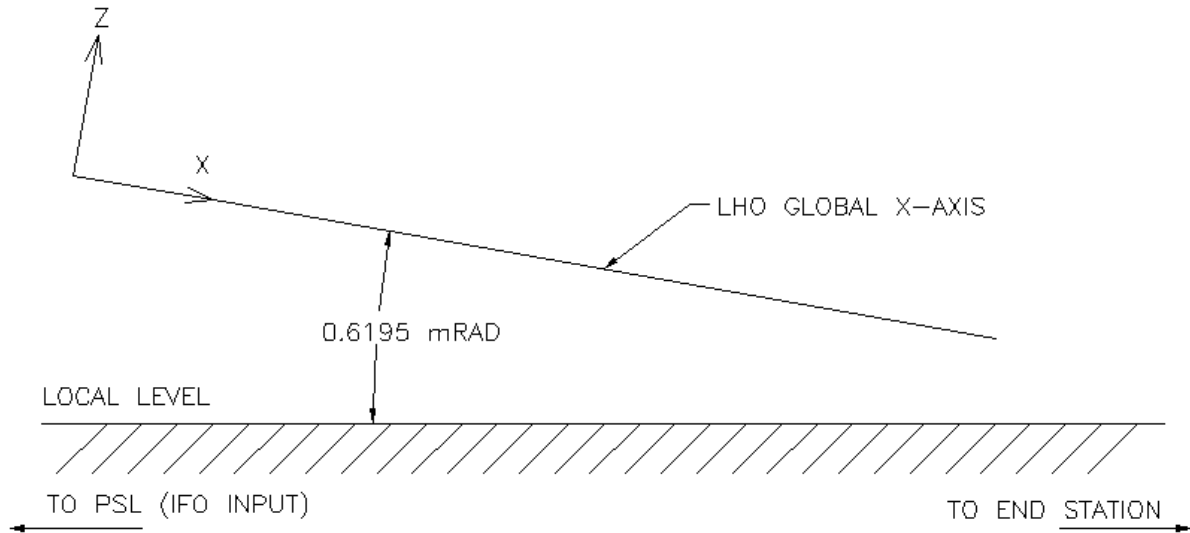


Figure 3. Angle between LHO global x-axis and local level in the LVEA.

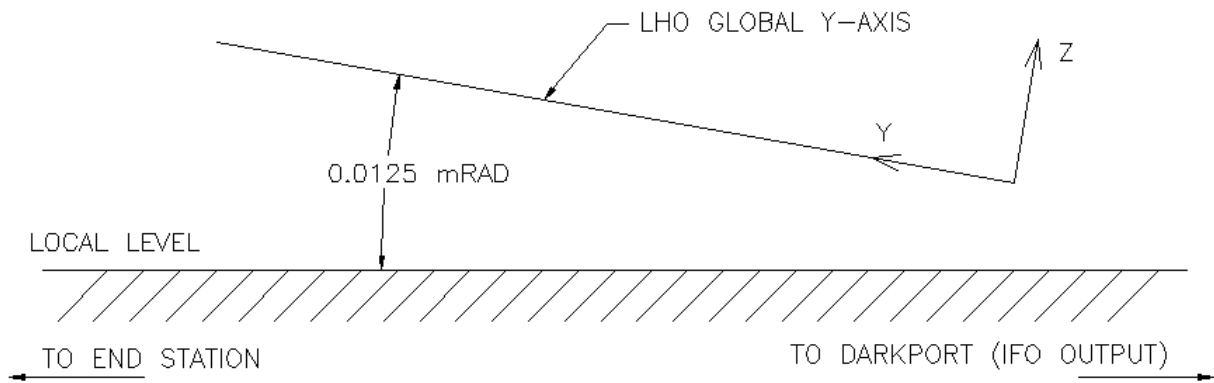


Figure 4. Angle between LHO global y-axis and local level in the LVEA.

2 ALIGO Building Coordinate System

2.1 General

The ALIGO building coordinate system (BCS) maintains the same origin location as the global coordinate system, but the xy-plane is defined to be level to local gravity in the LVEA.

In the LVEA the x and y coordinates are approximated to be the same in both building coordinates and global coordinates. The error from this approximation scales with the distance from the origin, but even 4km away the error is less than 1mm.

2.2 LLO

The transformation between z-coordinates depends on the x and y coordinates of the point, as well as the tilt angles.

$$\theta_{XLLO} = 0.3121 \text{ mrad}$$

$$\theta_{YLLO} = 0.6107 \text{ mrad}$$

$$z_{GLOBAL} = z_{BCS} + x \cdot \tan(\theta_{XLLO}) + y \cdot \tan(\theta_{YLLO})$$

2.3 LHO

The transformation between z-coordinates depends on the x and y coordinates of the point, as well as the tilt angles.

$$\theta_{XLHO} = 0.6195 \text{ mrad}$$

$$\theta_{YLHO} = -0.0125 \text{ mrad}$$

$$z_{GLOBAL} = z_{BCS} + x \cdot \tan(\theta_{XLHO}) + y \cdot \tan(\theta_{YLHO})$$

3 ALIGO Chamber Coordinate Systems

3.1 General

Points in the Chamber Coordinate Systems (CCS) are derived from the BCS coordinates of the point and the BCS coordinates of a reference point in the chamber of interest. For HAM chambers the reference point is located halfway between the large flanges and 300mm above the cylindrical axis of those flanges. For the BSCs the reference point is at the intersection of the cylindrical axes of large flanges.

$$X_{CCS} = X_{BCS} - X_{REFERENCE\ POINT}$$

$$Y_{CCS} = Y_{BCS} - Y_{REFERENCE\ POINT}$$

$$Z_{CCS} = Z_{BCS} - Z_{REFERENCE\ POINT}$$

3.2 LLO

CHAMBER	X _{REFERENCE POINT} (mm)	Y _{REFERENCE POINT} (mm)	Z _{REFERENCE POINT} (mm)
HAM1	-22726.83	0	6.28
HAM2	-20121.55	0	6.28
HAM3	-3830.64	0	1.20
HAM4	0	-3830.64	2.34
HAM5	0	-20121.55	12.29
HAM6	0	-22726.83	12.29
BSC1	0	4579.94	-2.80
BSC2	0	0	0
BSC3	4579.94	0	-1.43

Table 1. Reference point locations for chambers in LLO LVEA in BCS, x & y locations taken from D970220-B-S4.

3.3 LHO

CHAMBER	X _{REFERENCE POINT} (mm)	Y _{REFERENCE POINT} (mm)	Z _{REFERENCE POINT} (mm)
HAM1	-22726.83	0	12.47
HAM2	-20121.55	0	12.47
HAM3	-3830.64	0	2.37
HAM4	0	-3830.64	-0.05
HAM5	0	-20121.55	-0.25
HAM6	0	-22726.83	-0.25
HAM7	31947.03	9220.2	-18.06
HAM8	29341.75	9220.2	-18.06
HAM9	13050.84	9220.2	-7.97
HAM10	9220.2	13050.84	-5.55
HAM11	9220.2	29341.75	-5.35
HAM12	9220.2	31947.03	-5.35
BSC1	0	4579.94	0.06
BSC2	0	0	0
BSC3	4579.94	0	-2.84
BSC4	9220.2	9220.2	-5.60
BSC7	9369.42	0	-5.80
BSC8	0	9369.42	0.12

Table 2. Reference point locations for chambers in LHO LVEA in BCS, x & y locations taken from D970220-B-S4.