CALIFORNIA INSTITUTE OF TECHNOLOGY

Laser Interferometer Gravitational Wave Observatory (LIGO) Project

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Refer to: LIGO-T950107-00-E

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Subject: Orientation of the LIGO Beam Center Lines with respect to foundation slabs

This memorandum describes the relative orientations of the beam lines with respect to foundation slabs for each of the two sites and all stations along both arms at each site. This analysis follows from the coordinate system definition provided in LIGO-T950004-A-E and is available as a Mathematica Notebook model. The assumptions which go into this analysis are as follows:

[1] A spherical model of the Earth using a mean radius of 6378.2 km was used
[2] Mid station building center location of 2019 m from the vertex for Hanford
[3] As-graded interferometer plane orientation for Hanford (described in referenced LIGO document), and *anticipated* interferometer plane orientation for Livingston from preliminary survey data.

The convention is to view the beam line from the vertex looking toward the ends of the arms. In this perspective, if the beam line dips below local horizontal, it is given a *negative* dip angle. Angles are provided in Table 1 below in both radians and [degrees,minutes,seconds of arc]. Note that angles smaller than 10^{-5} radians are set to zero in the radians column, but are provided to arc-second accuracy for completeness.

The beam center line height is presently proposed to be located 6’4” (193.04 cm) above the LVEA/VEA floor slabs. The elevation for beam line center is referred to the location of the vertex beamsplitter chamber in the LVEA and to the location of the individual chambers located in the VEAs.

The information presented in this memorandum will appear in the VE-CC ICD.

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Table 1: Angular orientations of LIGO beam center lines with respect to local horizontal at each of the sites and stations

Site	Arm	Station	Radians	Degrees
WA	NW	Vertex	-6.2×10^{-4}	-0° 2′ 7.6″
WA	NW	Mid	-3.0×10^{-4}	-0° 1′ 2.3″
WA	NW	End	≈ 0	0° 0′ 1.8″
WA	SW	Vertex	≈ 0	-0° 0′ 1.8″
WA	SW	Mid	3.0×10^{-4}	0° 1′ 3.5″
WA	SW	End	6.2 X 10-4	0° 2′ 7.6″
LA	SW	Vertex	-3.1×10^{-4}	-0° 1′ 4.7″
LA	SW	End	3.1×10^{-4}	0° 1′ 4.7″
LA	SE	Vertex	-6.2×10^{-4}	-0° 2′ 7.6″
LA	SE	End	≈ 0	0° 0′ 1.8″

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