LIGO Laboratory / LIGO Scientific Collaboration

LIGO- T1000022-v4 *ADVANCED LIGO* 2/16/10

Viewports Subsystem Requirements Document

Michael Smith

Distribution of this document:
LIGO Science Collaboration

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

Massachusetts Institute of Technology
LIGO Project – NW17-161
175 Albany St
Cambridge, MA 02139
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

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

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

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

Table of Contents

Abstract

This document will present the design requirements for the Viewports Subsystem. The Viewports subsystem provides optical viewports for the passage of all optical beams in and out of the vacuum region(s) of the IFO. The optical beams include the following: optical lever beams, CO_2 laser beams for thermal compensation, chamber illumination beams, video camera beams, and optical beams used for interferometer sensing and control.

1 Introduction

The Viewports subsystem provides optical viewports for the passage of all optical beams in and out of the vacuum region(s) of the IFO. The optical beams include the following: optical lever beams, CO2 laser beams for thermal compensation, chamber illumination beams, video camera beams, and optical beams used for interferometer sensing and control.

1.1 Acronyms

LIGO - Laser Interferometer Gravity Wave Observatory

AR - Antireflection mirror coating

IFO - LIGO interferometer

HAM - Horizontal Access Module

TCS – Thermal Compensation System

PSL – Prestabilized Laser

TBD – To be determined

1.2 LIGO Documents

T980019-00, ASC Initial Alignment Subsystem Final Design

E070069-A, Specification Septum Window Polish, Enhanced LIGO

LIGO-D070082-A

2 General Description

Viewports are mounted to flanges in the nozzles of the vacuum chambers. The viewport material and the AR coatings on the viewport surfaces are chosen to maximize the transmissivity of the light passing through the viewport. Previous viewports from Initial LIGO may be re-used as appropriate.

2.1 General Constraints

The sizes and quantities of viewports are determined by the proposed nozzles on the vacuum chambers of Advanced LIGO.

Viewports that pass high power laser beams, such as the PSL viewports, shall have additional protective coverings to protect against heat-induced implosion of the viewport.

The viewport shall safely withstand a 1 ATM pressure differential across both faces.

Viewports shall have a sufficient wedge to avoid interference patterns wherever necessary.

3 Requirements

The viewports shall withstand extended vacuum bakeout at 200C.

3.1 Video Camera Viewport

Viewports shall be provided with transmissivity for visible light spectrum, with AR coating optimized at 1064 nm wavelength to reduce ghost reflections and improve visual discrimination of internal laser field scatter from IFO mirrors. The requirements are identical to initial LIGO and were taken from the ASC Initial Alignment Subsystem Final Design document, T980019-00.

3.1.1 Optical Distortion

The video camera viewport shall have minimum optical distortion so as to enable the video camera resolution to be > 250 TV lines resolution in the horizontal and vertical directions.

3.2 Chamber Illumination Viewport

Uncoated viewports shall be used for economy. The requirements are identical to initial LIGO and were taken from the ASC Initial Alignment Subsystem Final Design document, T980019-00.

3.3 Optical Lever Viewport

The requirements are identical to initial LIGO and were taken from the ASC Initial Alignment Subsystem Final Design document, T980019-00.

Viewports for most optical lever incident and reflected beams shall be standard zero-length kovar-sealed viewports, made of Corning 7056 glass, for direct mounting to vacuum equipment nozzles.

They shall be antireflection coated for minimum reflectance at the optical lever wavelength (BD). In some cases where the optical lever beam must pass close to the edge of a vacuum chamber nozzle, an AR-coated fused quartz viewports (Insulator Seal part no. 9722012 or equivalent) with 7.78” clear aperture shall be used.

All flanges of AR-coated viewports shall be edge-engraved with the nominal center wavelength to aid field identification.

3.4 Septum Plate Viewport

The requirements shall be the same as eLIGO, as specified in E070069-A, Specification Septum Window Polish, Enhanced LIGO.

3.4.1 Surface Quality

The Septum Plate viewport shall have a surface micro-roughness < 0.1 nm rms over the central 140 mm diameter.

3.4.2 Wavefront Distortion

The wavefront distortion across the clear aperture shall be <1/4 wave @ 1064 nm wavelength.

3.4.3 Optical Transmissivity

The transmissivity shall be > 99% @ 1064 nm wavelength, at 5 deg incidence angle.

3.5 TCS Viewport

The TCS ZnSe viewports shall be of comparable design to those currently installed in Enhanced LIGO.

3.5.1 Surface Quality

The TCS Viewport shall have a surface quality of at least scratch/dig 20-10.

3.5.2 Wavefront Distortion

The wavefront distortion across the clear aperture shall be < 1/4 wave @ 10.6 micron wavelength.

3.6 Hartmann Viewport

The BRDF of the Hartmann Viewport shall be the same as the measured BRDF of a super-polished window, 1E-6 sr^-1 to minimize scattering into the dark port.

3.6.1 Surface Quality

The viewports shall have a surface quality of at least scratch/dig 10-5.

3.6.2 Wavefront Distortion

The wavefront distortion across the clear aperture shall be <1/4 wave at the Hartmann beam wavelength.

3.6.3 Optical Transmissivity

The transmissivity shall be optimized at the Hartmann beam wavelength at normal incidence

3.7 Transmon Viewport

The viewport shall be of comparable design to those currently installed in Enhanced LIGO.

3.7.1 Surface Quality

The viewports shall have a surface quality of at least scratch/dig 10-5.

3.7.2 Wavefront Distortion

The wavefront distortion across the clear aperture shall be <1/4 wave at 532 nm wavelength.

3.7.3 Optical Transmissivity

The transmissivity shall be optimized at 532 nm and 1964 nm wavelength at normal incidence.