

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY  
- LIGO -  
CALIFORNIA INSTITUTE OF TECHNOLOGY  
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This is an internal working note  
of the LIGO Project.

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# 1 LIGO TOP-LEVEL DOCUMENTS

## 1.1. DCC Information

- T970050-xx DCC Document Listing
- L960641-05 Electronic Submissions to the Document Control Center (instructions)
- G960249-00 Electronic Submissions to LIGO Document Control Center (DCC) (flowchart)
- L970164-02 Procedures for Release of Controlled Drawings and Specifications

## 1.2. Management Documentation

### 1.2.1. Project Plans and Policies

- M950001-A LIGO PROJECT MANAGEMENT PLAN
- M950046-A LIGO PROJECT SYSTEM SAFETY PLAN

### 1.2.2. Annual Reports

- M970007-01 Annual Report (December 1995 through November 1996)

### 1.2.3. Quarterly Reports

- M960024-00 Quarterly Progress Report (December 1995 through February 1996)
- M960055-00 Quarterly Progress Report (March 1996 through May 1996)
- M970034-00 Quarterly Report (December 1996 through February 1997)

### 1.2.4. Monthly Reports

- M970017-01 Monthly Progress Report (End of December 1996)
- M970033-00 Monthly Progress Report (End of January 1997)

### 1.2.5. Proposals

- M950020-01 LIGO Operations, 1997-2001
- M960051-A LETTER OF INTENT FOR A RESEARCH AND DEVELOPMENT PROGRAM FOR ADVANCED LIGO DETECTORS BY THE LIGO MIT/CALTECH GROUPS
- M970001-01 Revised Proposal for a Research and Development Program For Advanced Detectors by the LIGO MIT/Caltech Groups - FY 1997 Proposal Budget

### 1.2.6. Reviews

#### 1.2.6.1 NSF Review April 13-17, 1997

- G970068-00 LIGO DATA PROCESSING
- G970071-01 BEAM TUBE BAKEOUT
- G970075-01 LIGO Project Cost/Schedule Status
- G970091-00 LIGO Control and Data System Control and Monitoring

## **1.3. Publications**

- P940008-00 Measurement of Optical Path Fluctuations due to Residual Gas in the LIGO 40 Meter Interferometer
- P960024-A PRINCIPLES OF CALCULATING ALIGNMENT SIGNALS IN COMPLEX RESONANT OPTICAL INTERFEROMETERS
- P960031-C The Laser Interferometer Gravitational Wave Observatory Project LIGO
- P960041-02 Recent Research on the LIGO 40 m Interferometer
- P960042-00 Development of Laser Interferometers for Gravitational Wave Detection: Abstract and Summary
- P970002-00 Modeling LIGO Data Analysis

## **1.4. System Engineering Documentation**

### **1.4.1. System Requirements**

- E950018-02 LIGO Science Requirements Document (SRD)
- E950111-A LIGO Naming Conventions
- E960036-A LIGO EMI CONTROL PLAN AND PROCEDURES
- E960010-A LIGO Sites Alignment Requirements
- E950083-B Science Requirements for the LIGO Beam Tube Baffles

### **1.4.2. Modeling**

- G970064-00 Modeling LIGO Data Analysis

### **1.4.3. Alignment**

- E960010-A LIGO Sites Alignment Requirements
- T950107-A Orientation of the LIGO Beam Center Lines with respect to foundation slabs
- T960176-C Determination of the as-built LIGO Global Coordinate Axes for Hanford, WA
- T960042-A Alignment Tolerances and Re-Alignment Criteria for the LIGO Beam Tubes

### **1.4.4. Analyses and Measurements**

- T960128-00 Radiation Pressure Noise in LIGO
- T970054-00 Beam Tube Dynamics

### **1.4.5. Layout Drawings**

- D970008-A Chamber & Rack Designations - WA (Corner Station)
- D970009-A Chamber & Rack Designations - WA (Mid Station)
- D970010-A Chamber & Rack Designations - WA (End Station)

## **2 FACILITIES DOCUMENTATION**

### **2.1. Vacuum Equipment**

#### **2.1.1. Design Requirements**

E940002-02 Vacuum Equipment Specification

### **2.2. Beam Tube**

#### **2.2.1. Design Requirements and Qualification**

T960042-A Alignment Tolerances and Re-Alignment Criteria for the LIGO Beam Tubes

T960125-00 Beam Tube Qualification Test

#### **2.2.2. Baffles**

E950083-B Science Requirements for the LIGO Beam Tube Baffles

E960028-A Specification, Porcelain Coating of Beam Tube Baffles

E960037-A COMPONENT SPECIFICATION: MECHANICAL FABRICATION OF BEAM  
TUBE BAFFLES

T970053-00 Baffle Glaze Shedding

#### **2.2.3. Bakeout**

E960123-01 Beam Tube Bakeout Design Requirements Document

T960124-00 ISSUES AND CONSIDERATIONS ON THE BEAM TUBE BAKE

T960178-01 Beam Tube Bakeout Conceptual Design

G960181-00 BEAM TUBE BAKEOUT

G960241-00 BEAM TUBE BAKEOUT DESIGN REQUIREMENTS REVIEW

#### **2.2.4. Analyses and Measurements**

T970054-00 Beam Tube Dynamics

### **2.3. Civil Construction**

#### **2.3.1. Design Requirements**

E950101-00 Telecommunications requirements for Hanford, WA Site.

E950106-00 LIGO Requirements and Options for Facilities Monitoring and Control System  
(FMCS)

## 3 DETECTOR DOCUMENTATION

### 3.1. Detector System Documentation

E960112-05	Detector Subsystems Requirements
E960022-03	LIGO Vacuum Compatibility, Cleaning Methods and Qualification Procedures
E960050-A	LIGO Vacuum Compatible Materials List
T950065-A	Guidelines for Design Requirement Documents
T960083-A	Derivation of CDS Rack Acoustic Noise Specifications
E960108-A	Recommendation of parameter choices in 2 km interferometer design.
T960019-00	Frequency, Intensity and Oscillator Noise in the LIGO
T960120-00	Misalignment-Beam Jitter Coupling in LIGO
T960122-00	Proposed initial detector MC and RC baseline lengths
T970068-00	Recycling Cavity and Mode Cleaner Cavity Baseline Dimensions
D970002-00	Recycling Cavity Dimensional Range
D970003-00	Recycling Cavity Layout
T960128-00	Radiation Pressure Noise in LIGO
T960136-00	Estimates for Motions due to Sound Fields
T960140-00	Fast Estimation of Transverse Fields in High Finesse Optical Cavities
T960189-A	LIGO calibration accuracy
T970007-00	Modelling the Performance of an Initial-LIGO Detector with Realistically Imperfect Optics
G960250-00	Modelling the Performance of an Initial-LIGO Interferometer with Realistically-Deformed Optics
L970042-00	Internal Modes of Testmasses
T970077-00	Gravitational Deflection of LIGO Optics in a 9-Point Hindle Mount
T970091-00	Determination of the Wedge Angles for the Core Optics Components
T952008-00	A Tutorial For the Fast Fourier Transform Interferometer Simulator
G950061-02	A Summary and Future Preview of the FFT Simulation Initiative in LIGO

### 3.2. Suspensions and Seismic Isolation

#### 3.2.1. Suspensions

T950011-14	Suspension Design Requirements
T960074-07	Suspension Preliminary Design
T960072-00	Beam Splitter and Recycling Mirror Suspension Controller Design Requirements
L960596-00	Cross-coupling in the suspension controllers
T960040-00	RESPONSE OF PENDULUM TO MOTION OF SUSPENSION POINT
T960126-01	Magnet size considerations; interference and coil power dissipation
T960137-00	Note on Electrostatics in the LIGO suspensions

#### 3.2.2. Seismic Isolation

T960065-03	Seismic Isolation Design Requirements Document
T960066-00	Seismic Isolation Conceptual Design

### 3.3. Lasers and Optics

#### 3.3.1. General Documentation

L970042-00 Internal Modes of Testmasses  
 T970077-00 Gravitational Deflection of LIGO Optics in a 9-Point Hindle Mount  
 T970091-00 Determination of the Wedge Angles for the Core Optics Components  
 G950061-02 A Summary and Future Preview of the FFT Simulation Initiative in LIGO

#### 3.3.2. Prestabilized Laser

E950081-06 Nd 3+ Laser Target Specifications  
 T950030-03 Prestabilized Laser Design Requirements

#### 3.3.3. Input Output Optics

T960093-01 Input Output Optics Design Requirements Document

#### 3.3.4. Core Optics

E950099-04 Core Optics Components Requirements (1064 nm)  
 T970071-01 Core Optics Support Design Requirements Document  
 T970072-01 Core Optics Support Conceptual Design  
 G970067-00 Core Optics Support Design Requirements Review

##### 3.3.4.1 Recycling Mirror Specifications

E960092-A COMPONENT SPECIFICATION: SUBSTRATE, RECYCLING MIRROR  
 D960785-A RECYCLING MIRROR SUBSTRATE  
 E960096-A COMPONENT SPECIFICATION: MIRROR BLANK MATERIAL, RECY-  
 CLING MIRROR  
 D960794-B CORE OPTIC BLANK

##### 3.3.4.2 Input Test Mass Specifications

E960093-A COMPONENT SPECIFICATION: SUBSTRATE, INPUT TEST MASS  
 D960787-A INPUT TEST MASS SUBSTRATE, 4K  
 D960803-A INPUT TEST MASS SUBSTRATE, 2K  
 E960095-A COMPONENT SPECIFICATION: MIRROR BLANK MATERIAL, INPUT  
 TEST MASS  
 D960794-B CORE OPTIC BLANK

##### 3.3.4.3 Beam Splitter Specifications

E960100-A COMPONENT SPECIFICATION: SUBSTRATE, BEAM SPLITTER  
 D960789-A BEAM SPLITTER SUBSTRATE  
 E960094-A COMPONENT SPECIFICATION: MIRROR BLANK MATERIAL, BEAM  
 SPLITTER  
 D960793-B BEAM SPLITTER BLANK

### 3.3.4.4 End Test Mass Specifications

E960102-A	COMPONENT SPECIFICATION: SUBSTRATE, END TEST MASS
D960791-A	END TEST MASS SUBSTRATE
E960097-A	COMPONENT SPECIFICATION: MIRROR BLANK MATERIAL, FOLDING MIRROR, END TEST MASS
D960794-B	CORE OPTIC BLANK

### 3.3.4.5 Folding Mirror Specifications

E960101-A	COMPONENT SPECIFICATION: SUBSTRATE, FOLDING MIRROR
D960790-A	FOLDING MIRROR SUBSTRATE
E960097-A	COMPONENT SPECIFICATION: MIRROR BLANK MATERIAL, FOLDING MIRROR, END TEST MASS
D960794-B	CORE OPTIC BLANK

### 3.3.5. Core Optics Components Carrying Case Drawings

D970085-A	Project Material List - Large Core Optic Component (COC) and Beam Splitter Optic Assemblies
D970064-B	COC Carrier Shipping Compartment Assembly
D970065-B	COC Carrier Shipping Compartment Details

#### 3.3.5.1 Large Core Optics Component Carrier Assembly

D961460-A	Large Core Optic Component (COC) Carrier Assembly
D970006-A	Material List - Large Core Optic Component (COC) Carrier Assembly
D961425-B	Core Optic Component (COC) Carrier, Base Assembly
D961421-B	Core Optic Component (COC) Carrier, Base Plate
D961422-A	Core Optic Component (COC) Carrier, Base Pad
D961424-A	Core Optic Component (COC) Carrier, Base Cover
D961451-A	Core Optic Component (COC) Carrier, Handle Plate
D961434-A	Large Core Optic Component (COC) Carrier, Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961432-A	Large Core Optic Component (COC) Carrier, Standoff
D961444-A	Large Core Optic Component (COC) Carrier, Hinged Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961440-A	Large Core Optic Component (COC) Carrier, Standoff Bracket
D961442-A	Large Core Optic Component (COC) Carrier, Hinged Standoff
D961473-A	Core Optic Component (COC) Carrier, Standoff Clevis Pin
D961454-A	Large Core Optic Component (COC) Carrier, Indexed Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961452-A	Large Core Optic Component (COC) Carrier, Indexed Standoff

D961450-A	Core Optic Component (COC) Carrier, Top Plate Assembly
D961449-A	Core Optic Component (COC) Carrier, Top Plate
D961466-A	Core Optic Component (COC) Carrier, Pad Guide
D970005-A	Core Optic Component (COC) Carrier, Toggle Screw, Modified
D961418-A	Core Optic Component (COC) Carrier, Foot Assembly
D961469-B	Core Optic Component (COC) Carrier, Foot
D961470-A	Core Optic Component (COC) Carrier, Foot Pad
D961471-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961447-A	Core Optic Component (COC) Carrier, Captive Screw Bracket
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D961472-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly, Locating
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961448-A	Core Optic Component (COC) Carrier, Captive Screw Bracket, Locating
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D961419-A	Core Optic Component (COC) Carrier, Cover Assembly
D961416-A	Core Optic Component (COC) Carrier, Carrier Cover
D970061-A	Core Optic Component (COC) Carrier, Seal Plate
D970004-B	Core Optic Component (COC) Carrier, Expansion Plug Installation Tool

### 3.3.5.2 Beam Splitter Optic Carrier Assembly

D961461-A	Beam Splitter Optic (BSO) Carrier Assembly
D970007-A	Material List - Beam Splitter Optic (BSO) Carrier Assembly
D961425-B	Core Optic Component (COC) Carrier, Base Assembly
D961421-B	Core Optic Component (COC) Carrier, Base Plate
D961422-A	Core Optic Component (COC) Carrier, Base Pad
D961424-A	Core Optic Component (COC) Carrier, Base Cover
D961451-A	Core Optic Component (COC) Carrier, Handle Plate
D961435-A	Beam Splitter Optic (BSO) Carrier, Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961433-A	Beam Splitter Optic (BSO) Carrier, Standoff
D961445-A	Beam Splitter Optic (BSO) Carrier, Hinged Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961440-A	Large Core Optic Component (COC) Carrier, Standoff Bracket
D961443-A	Beam Splitter Optic (BSO) Carrier, Hinged Standoff
D961473-A	Core Optic Component (COC) Carrier, Standoff Clevis Pin
D961455-A	Beam Splitter Optic (BSO) Carrier, Indexed Standoff Assembly
D961423-A	Core Optic Component (COC) Carrier, Side Pad
D961426-B	Core Optic Component (COC) Carrier, Pressure Disc
D961453-A	Beam Splitter Optic (BSO) Carrier, Indexed Standoff



D961450-A	Core Optic Component (COC) Carrier, Top Plate Assembly
D961418-A	Core Optic Component (COC) Carrier, Foot Assembly
D961469-B	Core Optic Component (COC) Carrier, Foot
D961470-A	Core Optic Component (COC) Carrier, Foot Pad
D961449-A	Core Optic Component (COC) Carrier, Top Plate
D961466-A	Core Optic Component (COC) Carrier, Pad Guide
D961471-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961447-A	Core Optic Component (COC) Carrier, Captive Screw Bracket
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D961472-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly, Locating
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961448-A	Core Optic Component (COC) Carrier, Captive Screw Bracket, Locating
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D970005-A	Core Optic Component (COC) Carrier, Toggle Screw, Modified
D961419-A	Core Optic Component (COC) Carrier, Cover Assembly
D961416-A	Core Optic Component (COC) Carrier, Carrier Cover
D970061-A	Core Optic Component (COC) Carrier, Seal Plate
D970004-B	Core Optic Component (COC) Carrier, Expansion Plug Installation Tool

### 3.3.5.3 Metrology Interface Top Plate Assembly

D961468-A	Core Optic Component (COC) Carrier, Metrology Interface Top Plate Assembly
D961418-A	Core Optic Component (COC) Carrier, Foot Assembly
D961469-B	Core Optic Component (COC) Carrier, Foot
D961470-A	Core Optic Component (COC) Carrier, Foot Pad
D961466-A	Core Optic Component (COC) Carrier, Pad Guide
D961467-A	Core Optic Component (COC) Carrier, Metrology Interface Top Plate
D961471-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961447-A	Core Optic Component (COC) Carrier, Captive Screw Bracket
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D961472-A	Core Optic Component (COC) Carrier, Captive Screw Bracket Assembly, Locating
D961431-A	Core Optic Component (COC) Carrier, Captive Screw
D961448-A	Core Optic Component (COC) Carrier, Captive Screw Bracket, Locating
D970001-A	Core Optic Component (COC) Carrier, Captive Screw Retaining Ring
D970005-A	Core Optic Component (COC) Carrier, Toggle Screw, Modified
D970006-A	Material List - Large Core Optic Component (COC) Carrier Assembly
D970007-A	Material List - Beam Splitter Optic (BSO) Carrier Assembly
D970085-A	Project Material List - Large Core Optic Component (COC) and Beam Splitter Optic Assemblies

## 3.4. Alignment and Length Sensing

### 3.4.1. Alignment Sensing/Control

T952007-04	Alignment Sensing/Control Design Requirements Document
T960134-00	Alignment Sensing/Control Conceptual Design
T970060-00	Alignment Sensing/Control Preliminary Design
T952013-00	Alignment Design Interfaces
T960103-00	ASC: Environmental Input to Alignment noise
T950049-00	ASC Centering Subsystem Description
T950069-00	Naming and Interface Definition for ASC Wavefront/Centering
T950073-00	Interferometer Requirement Flowdown To ASC
T950074-00	Naming and Interface Definition for ASC Initial Alignment
T970063-00	Response to Alignment Sensing and Control DRR2 Action Items
T970061-00	ASC CDS Design Requirements Document
T970062-00	ASC CDS Conceptual Design
T960138-00	ASC Channel Count

#### 3.4.1.1 Optical Lever

T950106-01	ASC Optical Lever Design Requirement Document
T950112-00	ASC Optical Lever Specification and Design Document
T950070-00	Naming Convention and Interface Definition for Optical Lever

#### 3.4.1.2 Wavefront Sensing

T960111-A	WAVEFRONT SENSOR
T960113-00	Modal Model Update 1: Interferometer Operators
T960114-B	Modal Model Update 2: GW-Sensitivity to Angular Misalignments
T960115-A	Modal Model Update 3: Small Angle Regime
T960116-00	Modal Model Update 4: Mode Mismatch
T960191-00	Modal Model Update 5 Large Angle Regime
T960118-00	Modal Model Update 6: Mode Cleaner
T970058-00	Modal Model Update 7 Angular Transfer Functions

### 3.4.2. Length Sensing/Control

T960058-00	Length Sensing and Control Design Requirements Document
T952109-01	LIGO Length Sensing System: Design considerations for a table-top prototype interferometer
T960067-00	Length Control RMS Deviations from Resonance
T960139-00	Shot noise sensitivity of the length control error signals

### 3.5. Control and Data System

T950054-02	CDS Control and Monitoring Design Requirements Document
T950120-01	CDS Control and Monitoring Conceptual Design
T960009-00	LIGO Data Acquisition System Design Requirements
T960010-00	CDS Data Acquisition System Conceptual Design
T970061-00	ASC CDS Design Requirements Document
T970062-00	ASC CDS Conceptual Design
T960107-00	LIGO Interferometer Diagnostics System Design Requirements
T960108-00	Interferometer Diagnostics Conceptual Design
T960024-A	Vacuum Control and Monitoring System (VCMS) Design Requirements
T960037-00	Vacuum Control and Monitoring System (VCMS) Design
T970001-00	Vacuum Control and Monitoring System (VCMS) Final Design
T950095-00	Vacuum Feedthrough and Cabling Design Requirements Document
T960014-00	Vacuum Feedthrough and Cabling Conceptual Design
T960177-00	LIGO Cable Numbering and Marking Standard
T970076-00	LIGO CDS VME Mainframe Specification
T960083-A	Derivation of CDS Rack Acoustic Noise Specifications

### 3.6. Physical Environment Monitor

T960127-02	Physical Environmental Monitor Design Requirements Document
T960145-00	Physical Environmental Monitor Conceptual Design
T970086-00	Physical Environmental Monitor Preliminary Design Document
G970026-00	Physics Environment Monitoring Preliminary Design Review
L970028-00	DESIGN REQUIREMENTS REVIEW Physics Environment Monitoring (PEM) Action Item Responses

## 4 R&D DOCUMENTATION

D961304-00	OPTICAL LAYOUT - 40m RECYCLING
T960073-00	40 Meter Recycling Electronics Design Requirements
T960162-02	Specifications of the 40m Test Mass Suspension Prototype
M960114-00	Statement of Work: Replacement of Vertex Masses at 40m
M960115-00	Statement of Work: Installation of Side Chamber and Reconfiguration of Associated Optics at the 40m
G960172-00	THE FMI ALIGNMENT EFFORT
T950137-00	Description of the Electronics for the FMI Wavefront Experiment
T960186-00	Procedure for Attaching the Fins and Hanging the PNI Mirrors