LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Test Plan for the Input Optics

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1 Introduction

This document presents a preliminary test plan for the Advanced LIGO Input Optics (IOO) with the purpose of verifying that all design requirements for the IOO are met. It will evolve as the design progresses.

1.1 Scope

The principal function of the IOO test plan is to define top-level test requirements insofar as practical using the IOO as a stand-alone system. This document is intended to cover a test plan for all of the IOO subsystems, including the RF modulation, mode cleaner, interferometer mode matching, optical isolation, and all of the functional components of each subsystem. Although the IOO has multiple interfaces with other subsystems, this document does not address tests which relate to global system testing.

1.2 Applicable Documents

1.2.1 LIGO documents

[1] LIGO-T010075, "Advanced LIGO Systems Design", P. Fritschel, et al.

[2] LIGO-M990288, "LIGO 2 Conceptual Project Book"

[3] LIGO-E990303, "Seismic Isolation Subsystem Design Requirements Document", P. Fritschel, et al.

[4] LIGO-T010076, "Optical Layout for Advanced LIGO", D. Coyne

[5] LIGO-T020022, "Pointing Requirements in Advanced LIGO, Part I", G. Mueller, et al.

[6] LIGO T020021, "Sideband Requirements in Advanced LIGO, Part I", G. Mueller, et al.

[7] LIGO T020025, "EO-Modulators for Advanced LIGO, Part I", G. Mueller et al.

[8] LIGO-T000053-01-D "Cavity Optics Suspension Subsystem Design Requirements Document, P. Willems, et al.

[9] LIGO-T???????-01-D "Input Optics Subsystem Design Document", …

1.2.2 Non-LIGO Documents

- ?

2 General Description

Please refer to the "Input Optics Subsystem Design Document".

3 Performance Requirements

3.1 Overall IOO requirements

3.1.1 Optical efficiency of Input Optics

The net efficiency of IOO TEM_{00} optical power transmission from PSL output to COC input shall be 0.75 or greater, determined by the requirement that at least 125.0 W of TEM_{00} light be coupled into the COC assuming > 165 W in TEM_{00} coming from the PSL. The output power is the sum for the carrier used for GW detection and sidebands on that carrier.

TEST: Calibrated power measurements and laser beam profiler measurements at the input of the IOO and at the input to the mode matching telescope (directed out of vacuum via steering mirror to IOT7). Losses from the MMT mirrors will be accounted for by separate measurements of reflectivity subsequent to vacuum installation. Final verification of coupling will be measured using the bullseye diode on the locked recycling cavity.

3.1.2 Output Beam In-band Alignment Stability (Jitter)[1]

Alignment fluctuations at the input of the COC couple to angular motion of the test masses to give in-band displacement signals. The (in-band) alignment stability of the entire IO subsystem shall not compromise that achieved directly after the mode cleaner, including the mode-matching telescope. For the output beam alignment stability requirement for the DC readout scheme we find that contributions from the carrier jitter coupled to ITM differential tilts dominate the noise contribution. This leads to:

$$\varepsilon_1(f) < \sqrt{\left(\frac{2.5\times10^{-5}}{f^2}\right)^2 + \left(5\times10^{-10}\right)^2}\,\frac{[2\times10^{-8}]}{\Delta\Theta_{ITM}}\,\frac{1}{\sqrt{Hz}}$$

where ε_1 is the amplitude of the 10,01 modes, and $\Delta\Theta_{ITM} = \Theta_{ITM1} - \Theta_{ITM2}$ is the total differential tilt of the ITMs.

TEST:

- Coarse: Using a Quadrant photodiode (to be shot-noise limited at 10 mA of photocurrent per segment) and a spectrum analyzer, mounted on IOT7 table, with measurements done at two distances from the output of the mode cleaner a measurement can be done to verify that the jitter noise is limited by the Quadrant diode and where it is mounted.
- Fine: Using a single arm cavity of the IFO (by misaligning PRM and BS) the remaining beam jitter with respect to the arm cavity can be measured.

[1] LIGO-T020022, "Pointing Requirements in Advanced LIGO, Part I", G. Mueller, et al.

3.1.3 Parasitic interferometers

Light which reflects or scatters into the Rayleigh angle of the beam contributes to the in-band signal directly (through phase modulation at GW frequencies) and indirectly (through frequency shifting of scattered and reflected light into GW band due to mirror motions). We require:

- For optical components located on the PSL table, the frequency noise must be limited to 10% PSL frequency noise specification:
  - $\delta\nu(f) < 1\ (10\text{Hz}/f)^2\ \text{Hz/Hz}^{1/2}$ $f<100$ Hz
  - $\delta\nu(f) < 10^{-2}\ (100\text{Hz}/f)\ \text{Hz/Hz}^{1/2}$ $f>100$ Hz
- For optical components located after the MC, the frequency noise must be limited to 10% of the MC requirement:
  - $\delta\nu(f) < 3 \times 10^{-4}\ \text{Hz/Hz}^{1/2}\ (10\ \text{Hz}/ f)$ to 1 kHz
  - $\delta\nu(f) < 3 \times 10^{-6}\ \text{Hz/Hz}^{1/2}$ $f > 1$ kHz

TEST: TBD

3.1.4 Availability

The IOO availability will be limited by the lock acquisition time of the mode cleaner, and any degradation in performance due to thermal stress or optical contamination. We require:

- Lock acquisition time to fully operational state < 20 sec

TEST: Lock Acquisition: statistics (~10 cycles) for the time to lock the system from cold start and from warm start; statistics for time between loss of lock (or evidence that lock exceeds 40 hours regularly); demonstration of ability to lock, unlock, and to determine the state of the sub-system via remote control functions stability of performance (pointing, intensity) over a 40 hour period. Stored Light Intensity: DC PD input power monitor; periodic cavity ringdown measurements to determine finesse.

3.2 RF Modulation

The IOO provides the optical modulation for the RF sidebands used in the length and alignment sensing. The requirements include modulation frequencies, modulation depths, and relative stability of the mode cleaner resonance and modulation frequency.

3.2.1 Modulation frequencies

We require a frequency which resonates in the recycling cavity and an additional frequency which is not resonant in the IFO. Both frequencies (chosen by LSC) must be passed by the mode cleaner and therefore be integral multiples of the mode cleaner free spectral range.

TEST:

1) Optical spectrum analyzer (OSA) measurements of the phase modulated laser light and frequency counter measurement of the residual RFAM using a broadband RF photodiode on the PSL table to verify frequencies.

2) Optical spectrum analyzer measurements of the transmitted mode cleaner light to verify transmission.

3) Measurement of the mode cleaner FSR using optical vernier technique.

3.2.2 Modulation depths

Modulation depths are set by GW shot noise considerations at the asymmetric port. In addition, the IO must provide for a range of modulations about the specified depths to accommodate diagnostic functions and potential degradation.

- The IO must provide for modulation depths in the range m = 0-0.5

TEST: Optical spectrum analyzer measurements of the light on the PSL table.

3.2.3 Modulation Amplitude Stability

Intensity fluctuations on the carrier and sidebands, caused by changes in the modulation index δm or by RFAM in the modulators can mimic a gravitational wave signal. For the LSC sidebands, we require:

- DC readout – laser RIN of the carrier couples to arm cavity imbalances producing displacement noise driven by radiation pressure. Fluctuations in the modulation index produce additional carrier RIN. This leads to a requirement of

$$\delta m < 10^{-10}/\mathrm{Hz}^{1/2}\ (1/\Gamma)\ (f/\mathrm{Hz}).$$

TEST: Needs to be done with the IFO. Using a LISA type phase meter on a beat between the analyzed sideband and an additional phase locked laser can give some insight on the intensity noise of the sidebands. More TBD.

3.2.4 Modulation Frequency Stability

Fluctuations in the modulation frequency due to oscillator phase noise beat at the asymmetric port photodetector produce technical noise. By computing the transfer functions of the phase noise to the dark port and setting equal to the allowed power fluctuation and converting to single sideband oscillator intensity noise, we find (for RF Readout):

- **I_{SSB} (10 Hz) < -92 dBc/Hz**
- **I_{SSB} (100 Hz) < -140 dBc/Hz**
- **I_{SSB} (1 kHz) < -163 dBc/Hz**

(See figure 1 LIGO-T020022, “Pointing Requirements in Advanced LIGO, Part I”, G. Mueller, et al for frequency dependence.)

TEST: Needs to be done with the IFO. More TBD.

3.2.5 Modulation Cross Products

The intermodulation phase sidebands (sidebands on sidebands) that would arise from serial modulation are avoided by using a parallel modulation scheme. Potential modulation cross products look like fluctuations in the modulation frequency and have identical requirements:

- **I_{IM} (10 Hz) < -92 dBc/Hz**
- **I_{IM} (100 Hz) < -140 dBc/Hz**
- **I_{IM} (1 kHz) < -163 dBc/Hz**

TEST: Use optical spectrum analyzer to verify that this requirement is satisfied.

3.3 Additional Active Jitter Suppression

The IO CD proposed high bandwidth active jitter suppression using electro-optic actuators (RTP-prisms) to complement the passive suppression provided by the IMC. We do not believe that these will be necessary.

In the even that more jitter suppression is needed, we will to develop and prototype an active jitter suppression system based on RTP prisms.

TEST: See section 3.1.2

3.4 Mode Cleaner

The mode cleaner provides frequency and spatial stabilization of the laser light, as well as intensity stabilization above its pole frequency.

3.4.1 Mode Cleaner Frequency and Intensity Stabilization

The SYS frequency noise requirement of ~3 x 10^{-6} Hz/$Hz^{1/2}$ (4 x 10^{-7} Hz/$Hz^{1/2}$) for DC readout (RF readout) on the light at the IFO input requires a mode cleaner frequency stability consistent with ISC loop gains and expected PSL frequency noise. We require:

- **$\delta\nu(f) < 3 \times 10^{-2}$ Hz/$Hz^{1/2}$ (Hz/ f) to 1 kHz**
- **$\delta\nu(f) < 3 \times 10^{-5}$ Hz/$Hz^{1/2}$ f >1 kHz**

This limits the changes in the mode cleaner length to be below:

- **$\delta L(f) < 3.6 \times 10^{-15}$ m/$Hz^{1/2}$ (Hz/f) f < 1 kHz**
- **$\delta L(f) < 3.6 \times 10^{-18}$ m/$Hz^{1/2}$ f > 1kHz**

The length changes caused by technical radiation pressure noise are:

- $\delta L(f) = 6.75 \times 10^{-14}$ m/$Hz^{1/2}$ x (kg/m) x ($RIN(f)/10^{-9}$) x (P/100kW) x $(Hz/f)^2$

The fused silica mirrors which comprise the mode cleaner have a mass of m=3.8 kg. The relative intensity noise limited by the assumed asymmetries in the arm cavities is:

- RIN(f) < 2 x 10^{-10} (f/Hz)   for DC-Sensing

corresponding to length changes of:

- 3.6 x 10^{-15} m/$Hz^{1/2}$ (Hz/f)

The requirements for the RIN for RF-Sensing are the same in the low frequency region (< 100 Hz) and even more stringent in the high frequency region (> 100 Hz). Subsequently, the radiation pressure noise in the mode cleaner is similar or lower than for DC-Sensing.

TEST:

- Use the mode cleaner error signal to measure the frequency noise as limited by that sensing system.
- Measure intensity noise after the MC using a broadband photodiode at max. allowed photocurrent and RF spectrum analyzer to establish an upper limit with the frequency dependence of the excess noise to allow an extrapolation to actual modulation frequencies.

3.4.2 Mode Cleaner Alignment[2]

The MC alignment requirement is given by:

- Low frequency – the frequency stability of the laser field must not be compromised by beam jitter, giving:

$$\mathbf{\Delta\Theta_{MC} < 10^{-7}\ rad(rms)}$$

These requirements can be viewed as a trade off between alignment of the MC and beam jitter. Relaxing the requirements on mode cleaner alignment will reduce our sensitivity, especially in the high frequency GW band, or require tightening the requirements on beam jitter in that frequency region. However, we note that a better mode cleaner alignment then the one given above would not result in relaxed beam jitter requirements unless we also tighten the requirements on the alignment of the core optical components.

- In-band - the MC jitter rejection must not be compromised by MC mirror angular fluctuation noise, giving:

$$\delta\Theta_{MC}(f) < \sqrt{\left(\frac{6.25\times10^{-12}}{f^2}\right)^2 + \left(5\times10^{-15}\right)^2}\ \frac{[2\times10^{-8}\,rad]}{\Delta\Theta_{ITM}}\ \frac{1}{\sqrt{Hz}}$$

TEST:

- Low frequency: Monitor DC control input voltage to pitch and yaw control coil actuators.
- In-band: use spectrum analyzer to monitor control input voltage to (summed) length control coil actuators

3.4.3 Mode Cleaner FSR stability

The requirements for oscillator phase noise and modulation amplitude stability presented above assume that the mode cleaner FSR matches the modulation frequency. Detuning of the modulation frequency from the mode cleaner FSR couples oscillator phase noise to produce modulation index instabilities. This will increase the intensity fluctuations in the carrier through the intensity feedback loop and would lead to even more stringent requirements for the modulation amplitude variations. The calculated requirements presented above are valid as long as the detuning between the FSR and the modulation frequency is below 14 Hz .

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[2] "Pointing Requirements in Advanced LIGO, Part I", G. Mueller, et al.

In addition, the optimum demodulation phases will depend on the relative phases between carrier and sidebands. Changes in the FSR require in principle a readjustment of the demodulation phases to zero offsets in the error signals. The effect on the signal cannot be evaluated without a detailed length sensing and control scheme (TBR).

Test: Use RF photodiode to monitor the amount of excess noise at the modulation frequency on the transmitted MC light. An optimal value can be found by tuning the MC length.

3.4.4 Mode Cleaner Beam Centering

The beam spot must be centered in the mode cleaner mirrors to a precision of 1 mm to avoid length-misalignment couplings.[3].

TEST: Use CCD cameras to monitor MC1, MC2, MC3 and the beam spot on those.

3.5 Faraday Isolator

3.5.1 Optical Isolation

Optical isolation is required to separate the PSL from IFO and IOO back reflected light. The required isolation level is taken to be 35 dB (TBR depending on PSL/IOO testing of allowed back propagating power levels at which PSL reacts). In addition, the ISC requires optical pick-off signals for controlling the length and alignment of the IFO. Specifically, the IO provides:

- the design, fabrication, and assembly of an in-vacuum Faraday isolator capable of functioning over the entire power range of operation, including ancillary optical and mechanical components.
- diagnostic beams for other subsystems, including
    - a portion of the transmitted mode cleaner light for intensity stabilization of the PSL.
    - the reflected light from the power recycling mirror.

TEST: Verification of the isolation ratio by using the PRM mirror and an otherwise misaligned IFO to reflect (nearly) all light back to the laser. The remaining back reflected power can be measured as reflection from MMC# (assuming that the PRM is not exactly aligned).

3.6 Power Control

The Input Optics shall provide adjustable power to the interferometer for diagnostic and operational functions. We require:

- power range: 0 – 165 W (full PSL power)
- that the rate of the power change (dP/dt) be sufficiently small so as to not break the MC or IFO lock via radiation pressure kicks (both length and alignment)

[3] LIGO-T000053-01-D “Cavity Optics Suspension Subsystem Design Requirements Document, P. Willems, et al.

- that the power control optics do not compromise the frequency or amplitude performance of the PSL.
- The power control system (hardware) will be designed with the flexibility to diagnostically vary the input power without substantial impairment of the interferometer's function, and without invasive alteration of the optics.

TEST:

- Use power meter and/or calibrated DC photodetector.
- Test the (remote) software control of the waveplate rotation.

3.7 IFO Mode Matching

The light must be delivered to the IFO with a proper Gaussian mode so that it will resonate in the IFO and not be rejected. Thus the IO provides for the mode matching of the light between the mode cleaner and the core optics components of the interferometer.
Specifically, the IO provides:

- the design, fabrication, and assembly of the mode-matching telescope (MMT) capable of accommodating small deviations from design specification in the core optics and providing optimal mode-matching for the different operational powers (currently 20 W and 125 W[4]).

3.7.1 Mode Matching Coupling Efficiency

The coupling efficiency from the Input Optics to the Main Interferometer GW carrier and sidebands TEM_{00}, mode parameters shall be 0.95 or higher. The telescope will provide this level of coupling for the optimal alignment.

TEST: $TEM_{01,10}$: ASC alignment signals for locked power recycling cavity.

$m + n = 2$: Bullseye mode matching measurement.

3.7.2 Beam Steering

The IO MMT is used to steer the main beam into the IFO. For alignment control purposes, we require that the MMT design

- Preserve orthogonal translation and angular adjustments into the IFO.

TEST: Ability to steer.

3.7.3 Mode Matching Telescope Alignment

Perturbations of the mode matching telescope may enhance the coupling of noise sources to gravitational wave noise (in band) and reduce coupling efficiency into COC (low frequency). We require that any pointing drift or jitter does not compromise the alignment stability of the IO output beam into the COC:

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[4] LIGO-T010075, "Advanced LIGO Systems Design", P. Fritschel, et al.

- Low frequency drift: telescope pointing must be consistent with COC coupling efficiency requirements of 0.95 or better:
    - the IO will furnish a diagnostic capability for measuring $\Delta\Theta_{MMT}$ for each MMT mirror at a level consistent with this requirement.
- Low frequency mode mismatch
    - the IO will furnish a diagnostic capability for determining Δw, the deviation from the ideal arm cavity beam waist size, and $\Delta\theta$, the deviation from the ideal arm beam divergence angle
- In-band noise: telescope angular and displacement fluctuations must be consistent with ASC requirements for beam jitter at the input of the COC:[5]
    - $\delta\Theta_{MMT}(f) < 10^{-12}/Hz^{1/2}$

TEST:

- Low Frequency: ASC IFO control signals from WFS on ISC7.
- In-band: Quadrant photodiode and spectrum analyzer, mounted on ISC7 table for monitoring light back reflected from the RM (unlocked IFO), at two distances from RM to be shot noise limited at10 mA photocurrent

4 Physical/Mechanical/Infrastructure Requirements

4.1 Diagnostics

The diagnostic mode will provide the means to determine the proper functioning of the IO, and provide measurement of the performance of other subsystems. The following diagnostic capabilities are required of the IO (does not include diagnostics for MC ISC):

- IO Diagnostics
    - internal Qs of MC mirrors
    - Qs of MC suspensions
    - diagonalization state of MC optics
    - MC spatial stabilization
    - MC alignment and leveling
    - MC storage time
    - MC response to laser light pointing, frequency and intensity modulation
    - modulation sideband amplitudes and frequencies
    - RFAM level
    - MC beam centering
    - IFO mode matching efficiency
    - MC FSR stability

- Diagnostic Services
    - open loop mode cleaner mirror seismic excitation
    - variations in RF sideband modulation depth

[5] LIGO-T020022, “Pointing Requirements in Advanced LIGO, Part I”, G. Mueller, et al.

- variations in IFO mode matching efficiency
- sideband detuning from mode cleaner resonance
- variation in optical power

Test:

- complete servo loop transfer function measurements: RF photodiode, spectrum analyzer measurements of rejected, transmitted MC light at suitable
- photodiode sensitivity and noise for all IOO sensors: spectrum analyzer
- mode cleaner storage time: fast photodiode, oscilloscope, spectrum analyzer
- IOO response to laser light pointing, frequency and intensity modulation - see above tests
- open loop mode cleaner mirror seismic excitation: Monitor control input voltage to (summed) coil actuators using spectrum analyzer
- variation in RF sideband modulation depth: optical spectrum analyzer on IOT7
- variation in IFO mode matching efficiency: periodic bullseye measurements
- sideband detuning from mode cleaner resonance: RF photodiode monitor of the amount of excess noise on 50 mW picked off light induced by a laser frequency dither coupled to a MC frequency detune.

4.2 Suitability of In-Vacuum components

The in-vacuum components of the IO must be contained in the current LLO and LHO vacuum envelopes (subject to the replacement of the HAM1,2 and 7,8 beam tube with a LIGO beam tube) and within the footprints of the Advanced LIGO seismic platforms.[6]

TEST: All in-vacuum components are checked for vacuum compatibility. RGA data from vacuum bake-outs; cavity ringdown and mode-spacing changes from optical contamination studies

4.3 Interfaces to other LIGO detector subsystems

IOO provides frequency stabilization feedback to the PSL. It has an optical interface with COC at the recycling mirror input to the IFO. It provides the reflected IFO light to LSC and ASC. Finally, IOO also accepts and provides monitor and control inputs to LSC and PSL.

4.3.1 Mechanical Interfaces

- Optical table
- HAM chamber bottom

TEST: See documentation

[6] LIGO-T010076, “Optical Layout for Advanced LIGO”, D. Coyne

4.3.2 Electrical Interfaces

The IOO provides for the following signal interfaces, illustrated in figure 1. They are listed as control loop and monitor / diagnostic interfaces in tables 1 and 2 below.

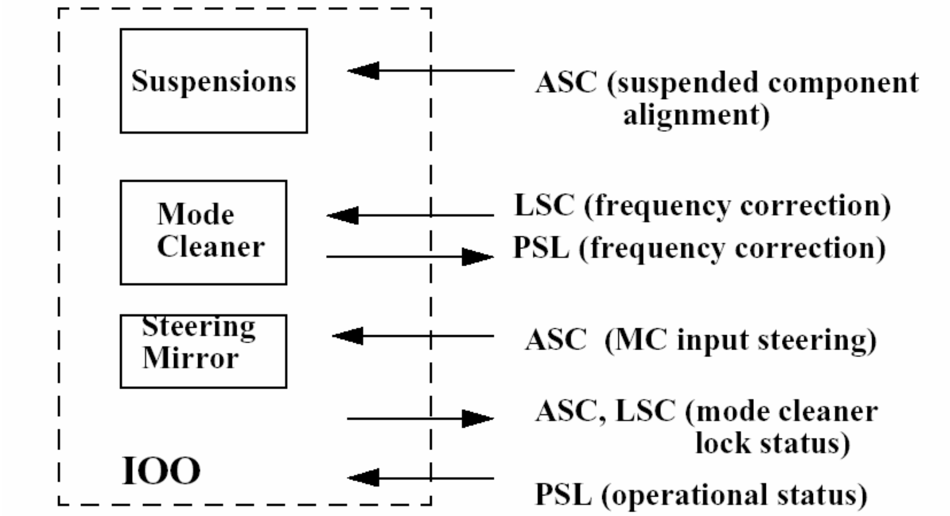

Figure 1 Signal Interfaces between IOO and other Detector subsystems

Subsystem	*Function of Interface*	*Signal Direction*
PSL	Frequency correction feedback	To PSL
LSC	Modulation drive	To IOO
LSC	Frequency correction feedback	To IOO
SUS	Lock acquisition actuation	To SUS
SUS	Length control actuation	To SUS
ASC	Mode cleaner input beam steering	To IOO
ASC	Suspended component alignment	To IOO

Table 1 Control Loop signal Interfaces

Subsystem	*Function of Interface*
PSL	Monitor of lock status
PSL	Light Modulation (frequency, intensity, pointing)
LSC	Monitor of lock status
ASC	Monitor of lock status

Table 2 Monitor Interfaces

TEST: Show documentation

4.3.3 Optical Interfaces

The IOO optical interfaces are shown in figure 2 and table X shows the interface properties.

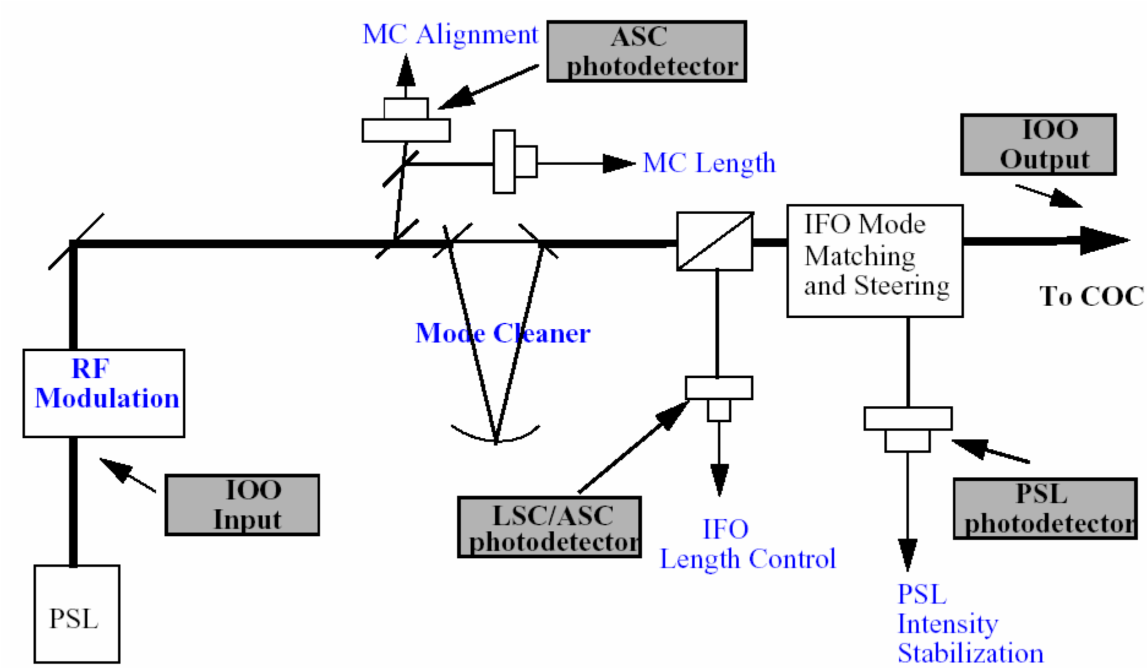

Figure 2 IOO Optical Interfaces

IOO Interface	*Other Subsystem Interface*
IOO Input	PSL output beam
Input MC mirror	ASC Wavefront Sensor
Telescope	PSL photodetector
Faraday Isolator	LSC, ASC photodetector
Output beam	COC

Table 3 IOO Optical Interfaces

TEST: See documentation

4.3.3.1 Stay Clear Zones

The stay clear zones required for the IOO are shown in figure Y. The dimensions and locations are d1=3 ft, Other stay clear dimensions are TBD.

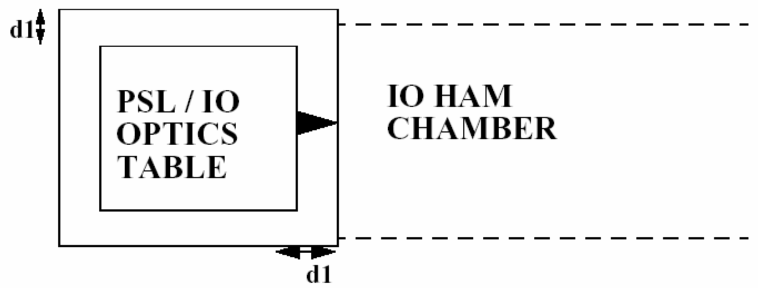

Figure 3 Stay clear dimensions

TEST: Physical Measurement

4.3.4 Reliability

Mean Time Between Failures (MTBF) (TBD SYS).

TEST: Do "burn in" tests for all components that could fail and demonstrate that they have a reasonable MTBF.

4.3.5 Environmental Conditions

The facility requirements are adequate for the proper functioning of the IOO subsystem.

4.3.6 Transportability

All items shall be transportable by commercial carrier without degradation in performance. As necessary, provisions shall be made for measuring and controlling environmental conditions (temperature and accelerations) during transport and handling. Special shipping containers, shipping and handling mechanical restraints, and shock isolation shall be utilized to prevent damage. All containers shall be movable for forklift. All items over 100 lbs. which must be moved into place within LIGO buildings shall have appropriate lifting eyes and mechanical strength to be lifted by cranes.

4.3.7 Component Naming

All components shall be identified using the LIGO Detector Naming Convention. This shall include identification physically on components, in all drawings and in all related documentation.

TEST: Certification

4.3.8 Safety

All items shall meet all applicable NSF and other Federal safety regulations, plus those applicable State, Local and LIGO safety requirements. A hazard/risk analysis shall be conducted in accordance with guidelines set forth in the **LIGO Project System Safety Management Plan** LIGOM950046-F, section 3.3.2.

TEST: Certification by relevant LIGO safety officers.

5 Documentation

5.1 Design Documents

Design documents of the IOO will be provided throughout the requirements and preliminary and final phases.

TEST: Show documentation

5.2 Engineering Drawings and Associated Lists

Any drawings to be provided and any standard formats that they must comply with, such as shall use LIGO drawing numbering system, be drawn using LIGO Drawing Preparation Standards, etc.

TEST: Show documentation

5.2.1 Procedures

Procedures shall be provided for, at minimum:

- Initial installation and setup of equipment
- Normal operation of equipment
- Normal and/or preventative maintenance
- Troubleshooting guide for any anticipated potential malfunctions

TEST: Certification

5.2.2 Documentation Numbering

All documents shall be numbered and identified in accordance with the LIGO documentation control numbering system LIGO document.

TEST: Show documentation

5.2.3 Test Plans and Procedures

All test plans and procedures shall be developed in accordance with the LIGO Test Plan Guidelines, LIGO document.

TEST: Show documentation

6 Logistics

The design shall include a list of all recommended spare parts and special test equipment required.

7 Quality Assurance Provisions

7.1 Responsibility for Tests

IOO.

TEST: Show documentation.

7.2 Quality conformance inspections

Design and performance requirements identified in this specification and referenced specifications shall be verified by inspection, analysis, demonstration, similarity, test or a combination thereof per the Verification Matrix (See example in Appendix A). Verification method selection shall be specified by individual specifications, and documented by appropriate test and evaluation plans and procedures.

7.3 General Constraints

7.3.1 Reliability

This subsystem must be designed with high reliability and low mean time to repair.

TEST: A reliability analysis report shall accompany the test report; any data available on reliability should also be summarized.

Appendix A Quality Conformance Inspections Verification Matrices

Table 4 Quality Conformance Inspections

Paragraph	Title	I	A	D	S	T
3.2.1	Performance Characteristics					X
3.2.1.1	Controls Performance		X			
3.2.1.2	Timing Performance‘		X			X