



COMPONENT SPECIFICATION

End Test Mass Telescope Requirements

APPROVALS:	DATE	REV	DCN NO	BY	CHK	DCC	DATE
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CHECKED:							
APPROVED:							
DCC RELEASE:							

1 SCOPE

This is a specification for the requirements of the optical system known as the ETM telescope. This device is an afocal, 3-element Galilean 8x beam reducer, which in combination with an optical relay system produces an image of the entrance pupil of the ETM PO telescope on the ISC quad photodetector. This detector is located on the ISC optical table adjacent to the BSC at the mid station and end station.

2 APPLICABLE DOCUMENTS

2.1. LIGO Documents

- LIGO-960641-05, Electronic Submissions to the Document Control Center
- LIGO-E960022, Vacuum Compatibility, Cleaning Methods and Compatibility Procedures
- LIGO-E960050, Vacuum Compatible materials list

3 REQUIREMENTS

3.1. Performance characteristics

3.1.1. Optical Characteristics

The ETM telescope shall have the following optical specifications.

- 1) Entrance aperture = 156mm
- 2) exit aperture = 19.5mm
- 3) Wavelength = 1064nm
- 4) Transmissivity = >90%
- 5) Wavefront distortion = < 1wave p/v at 1064nm

3.1.2. Mechanical Characteristics

The optical center line of the ETM telescope (Fig 2) will be suspended by a vertical support column below an optical table. The ETM telescope shall be attached to the support column so as to enable 4 degrees of freedom. That is, the optical barrel shall be moveable transverse to the optical axis in the horizontal and vertical planes, and shall tilt in pitch and yaw to the following limits:

- V-plane: +/- .5 inches total, +/- .020 inches fine adjustment
- H-plane: +/- .5 inches total, +/- .020 inches fine adjustment
- Yaw axis: +/- 2 degrees total, +/- 1minute fine adjustment
- Pitch axis: +0.0/-3 degrees total, +/- 1minute fine adjustment
- Position of optical axis below optical table: 500mm



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A removable bracket shall be provided at the output of the ETM telescope, for attaching a commercial mirror mount to be oriented at 45 degrees. (see Fig. 2)

3.1.2.1 Mechanical Tolerances

The assembly shall be designed to maintain the optical element's mounting tolerances (Fig 1) as follows

- Mounting ID, Lens 1= 176.05mm +0.05 / -0.00mm
- Mounting ID, Lens 2= 74.05mm +0.05 / -0.00mm
- Mounting ID, Lens 3= 44.05mm +0.05 / -0.00mm
- Tilt = 0.056 degree max
- Mechanical decenter = 0.2mm

3.1.2.2 Focus compensation

- Separation between elements L1 and L2 = 369.476mm, +/-12mm
- Separation between elements L2 and L3 = 81.523mm, +/-5mm

3.1.2.3 Mechanical Vibration Characteristics

The telescope, and its associated mounting structure shall have no internal mechanical resonances <100Hz.

3.1.2.4 Size and Weight

- Maximum size envelope - 30l x 10w x30h inches
- Maximum weight of telescope, and its associated mounting structure- <45 pounds

3.2. DESIGN AND CONSTRUCTION

3.2.1. Materials

It is desired that aluminum be used for all metal components, to the greatest extent possible. All materials must conform to LIGO document "LIGO-E960050, Vacuum Compatible materials list". No anodizing, lubricants or elastomers are permitted, and all machined parts must be machined dry (no coolants, except water). Care must be taken in selecting materials which are threaded or slide against one another, to prevent galling.

3.2.2. MARKING

3.2.2.1 Optical Alignment Marks

Edge tick-marks shall be placed so as to indicate correct orientation of assembled optical elements so as to minimize the residual wedge of the combined elements:

- 0.24 +/- 0.05 mm wide x edge thickness long.

3.2.2.2 Optical Serial Number

A serial number identifying a component set of optical elements L1, L2 & L3 shall be etched, ground or sand-blasted next to the alignment mark. The serial number shall be of the format ETM-XX-LY-Z, where



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- XX is incremental for each optic set starting at 01
- Y is incremental for each optic starting at 1
- Z is the current revision letter of this specification

3.2.2.3 Mechanical Serial Number

A serial number shall be etched, ground or sandblasted on each barrel assembly. The serial number shall be of the format ETM-YY-Z, where

- YY is incremental for each barrel assembly starting at 01
- Z is the current revision letter of this specification

4 TEST PROCEDURES

The assembled telescope performance shall be verified by the following test procedures

- TBD

4.1. WAVEFRONT DISTORTION

Interferogram of transmitted wavefront across clear aperture, @1064nm wavelength

4.2. Transmissivity

Transmissivity measurement across clear aperture, @1064nm wavelength

4.3. Vibration Test

- TBD

5 DOCUMENTATION

- 1) Vibration analysis
- 2) Working drawings for component parts, in AutoCad 14 format on LIGO title block
- 3) Top assembly drawing, in AutoCad 14 format on LIGO title block
- 4) DOD-STD-100, MIL-STD-1000 and ANSI-Y14.5M 1982 standards applied where appropriate
- 5) Compliance Certification for items 3.1, 3.2, 3.3 and 4.0

6 ENVIRONMENTAL CHARACTERISTICS

The ETM Telescope will operate in an ultra high vacuum environment, at room temperature (68F,+/-4F). The device shall be fabricated of UHV compatible materials. Acceptable materials are detailed in LIGO Document E960022-03

7 DESIGN OF ETM TELESCOPE

The optical design of the ETM Telescope is shown in Fig.1. A conceptual mechanical design is shown in Fig 2. An AutoCAD 14 file containing these two designs may be found at:

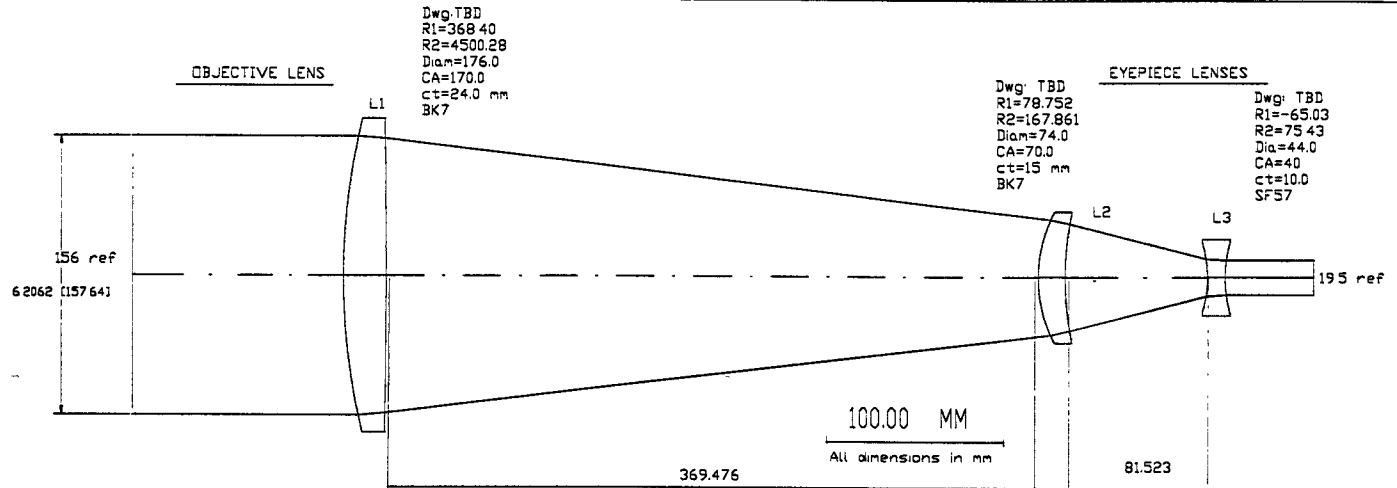
ftp://ligo.caltech.edu/pub/COS/8-27-98/END_TEST_MASS_TELESCOPE_ETM_1.dwg



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7.1. Optical design



SURFACE QUALITY:
 <1/2 Fringe @ 0.633 um over ca
 Irregularity 1/8 Fringe @ 0.6328 um over ca
 Surface Finish: 40/20
 Surface Roughness: <100 Ang
 Vendor to supply coatings
 Coatings: 99.5% transmission @ 1.064um
 Dielectric coating over clear aperture

FABRICATION:
 Surface TOLERANCES mm: L1, L2, L3
 All Raail = 1.0 %
 Thickness= 0.2
 Surface Tilt L1= 0.03 deg
 Surface Tilt L2= 0.06 deg
 Surface Tilt L3= 0.06 deg
 Surface Decenter all 0.025 mm
 Index of Refraction 0.003
 Lens Diameter +0.00 -0.10 mm

MECHANICAL MOUNTING
 Lens TOLERANCES mm: L1, L2, L3
 Mounting ID= +0.10 - 0.00 mm
 Til= 0.056 deg
 Mechanical Decenter: 0.2
 Focus Compensation
 L1-L2= +-12, L2-L3= +-5
 Focus

FINAL DESIGN

Description:
 Galilean Beam Reducer
 w/ doublet eyepiece
 For 1.06 Laser 8x

Contact Dennis Rose
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 File: endtripR.awg

Telescope, End Triplet, 8x mag, 0.5m

Design	Approve	Date	California Institute of Technology
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			June 7, 98 Dwg: T3D Rev C

Figure 1: ETM Telescope, optical layout



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7.2. Conceptual mechanical Design

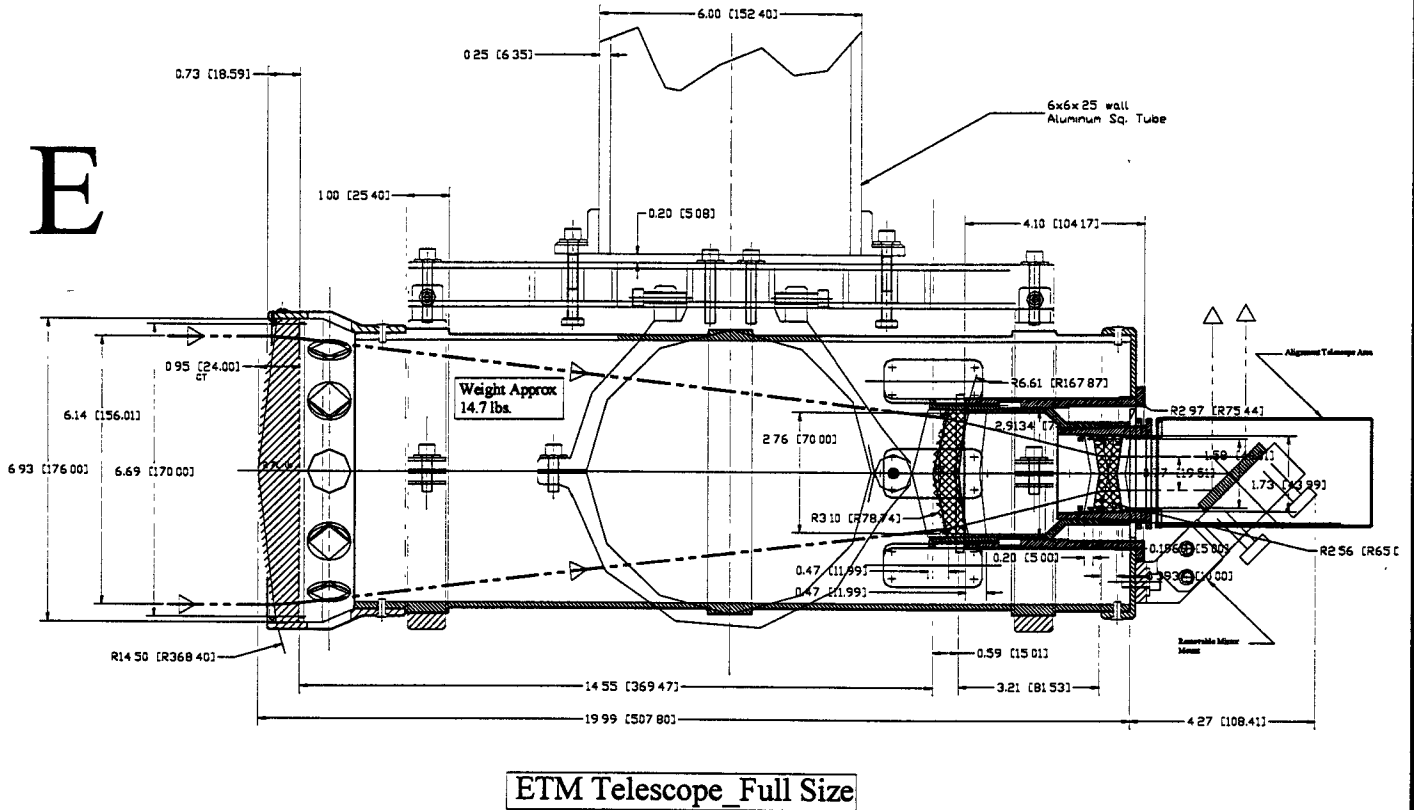


Figure 2: ETM Telescope, Conceptual mechanical layout