

Purchase Order No. PC237352  
LIGO-C971314-00-I

**Exhibit I**  
IR Interferometer Configuration  
and  
Specifications  
LIGO-T970146-00-I

## Configuration and Performance Specifications

1. Wavelength is 1.064  $\mu\text{m}$  (YAG laser)
2. Fizeau type, phase measuring interferometer
3. Maximum output diameter is 150 mm
  - Additional fixed "zoom" position at approx. 25.4mm (fixed)
  - Additional fixed "zoom" position at approx. 76.2 mm (fixed) (optional)
4. Package to fit in a 24" wide x 11" high x 32" deep (parallel to output beam) volume (Excluding the Phase Modulation portion)
5. Focus adjust must be instrumented with good resolution and repeatability, or have detents for at least 2 positions:
  - 3 cm spacing from the TF to the test optic
  - 30 cm spacing from the TF to the test optic
6. Must be able to accurately measure 4% surfaces and 100% surfaces without addition of any other pellicle or optic. (This could involve changing the TF for each of the two reflectivities)
7. Optical centerline approximately 5.25" (plus or minus .5 inches) above mounting surface
8. All functional commands for performing measurements and setting parameters must be callable via GPIB interface. An external computer (PC) will be used to command the interferometer's controller to take data, change parameters, etc. for all measurements.
9. Camera shall be 256 x 256 or higher resolution. The camera and digitizer shall be of a design that optimizes the signal to noise ratios. 10 bit digitization is preferable.
10. Bayonet mounts for the TF and RF to the interferometer housing shall be 3 point mounts to minimize mounting distortions
11. System shall be designed to be thermally and vibrationally stable for measurement time periods of 1 minute to 1 hour in a normal laboratory environment (+/- 1 Degree C).
12. System must be capable of measuring absolute focus and astigmatism to  $\lambda/80$  P-V @  $\lambda = 1064$  nm and after focus and astigmatism have been removed, measuring absolute residuals to  $\lambda/1600$  rms. at  $\lambda = 1064$  nm
13. System shall be designed to measure optical surfaces, to full specification, with reflectivities of 4% and 100% (normal incidence) and both 100% and 50% reflectors at 45 degrees (in double pass configuration). This is applicable on 150 mm diameter only.
14. System must be able to make ROC measurements (using standard 3 flat test) on ROCs from 7.4 Km to 14.5 Km (150 mm beam only)
15. System shall NOT have a rotating ground glass screen
16. System shall be optimized to minimize aberrations (i.e. Spherical, Coma, etc.) due to retrace errors caused by flat TFs measuring long ROC (ROC=7.4 Km to 14.5 Km) concave curves. This is critical in the 150 mm beam train only. Ray tracing analysis shall be provided to quantify the theoretical values of the proposed design.
  - At wavenumber  $k = 6.5 \times 10^{-4}$  microns<sup>-1</sup>, this instrument shall be able to measure true surface PSDs down to  $8 \times 10^{-6}$  microns<sup>3</sup>. This corresponds to a lower limit of what we saw in Pathfinder data near the NYQUIST limit for an unzoomed  $256^2$  pixel instrument over 15 cm diameter.)
  - At wavenumber  $k = 1.4 \times 10^{-3}$  microns<sup>-1</sup>, this instrument shall be able to measure true surface PSDs down to  $2 \times 10^{-6}$  microns<sup>3</sup>. (This corresponds to near NYQUIST for a 2x zoom).
17. System shall be optimized to provide very good mid and high spatial frequency (1 mm - 2 cm spatial frequency) response (Optical Transfer Function or MTF) throughout the entire optical system. This is critical in the 150 mm beam train only. Additional P-V measured distortion when measuring any test surface (e.g. a high quality reference flat) under conditions of 4 fringes of deliberate tilt, shall not exceed 3 nm.

## Required Inspections and Tests

1. On-Site Inspection: The following tests/measurements will be performed by the vendor at vendor's facility to verify the performance of the instrument prior to shipment to Caltech's delivery site. These tests will determine the ability of the instrument to achieve the required measurement accuracy. These tests may be witnessed by Caltech representatives.
  - Three flat test on the 3 TFs for the 2 different reflectivities (150 mm diameter only)
  - Perform the camera calibration to calibrate camera pixel locations and dimensions to location in image plane (1 cm square grid pattern with 2.5 mm sphere) of optical system. (150 mm Diameter only) This test, as outlined in the offer, is subject to Caltech's approval.
  - Demonstrate repeatable performance to spec for measurements taken up to 1 hour apart.