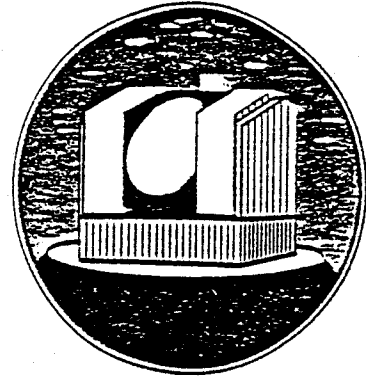
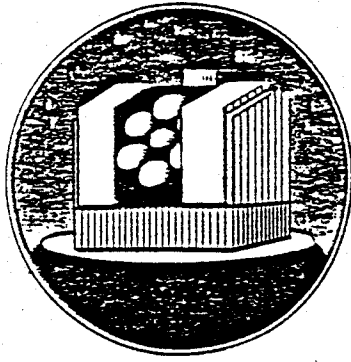


6.5 METER TELESCOPE



MMT Conversion Technical Memorandum #92-4

Interferometric Metrology for a 6.5-meter
F/1.25 Paraboloidal Mirror

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Introduction

Optical tests have been designed and analyzed for the interferometric testing of the highly aspheric 6.5-meter F/1.25 primary mirror which was recently cast at the University of Arizona to upgrade the Multiple Mirror Telescope (MMT.) An infrared interferometer using a CO₂ laser, a null corrector, and a pyroelectric vidicon will test the surface during loose-abrasive grinding. Precision metrology for the testing of the polished surface will use a visible Shack-cube interferometer co-aligned with a BK7 null corrector, a HeNe laser source, imaging optics, and a CCD array. Both the infrared and visible systems have been carefully designed to give excellent performance in terms of wavefront correction, alignment sensitivity, imaging of the mirror to the detector, diffraction effects, ghost reflections, and ease of use.

Optical Metrology Using Null Correctors

The principle behind both interferometric systems is the same. The laser light is split into a reference beam, which is shifted in phase using a piezo-electric transducer, and a test beam. The null corrector¹ is constructed to modify the test beam to produce a wavefront that matches the desired shape of the mirror. This wavefront reflects off the mirror, picking up any figure errors, and reverses its path through the null corrector to the interferometer. The test beam is coherently added to the reference beam resulting in an interference fringe pattern that corresponds to the phase difference between the two beams. The interference fringes are projected onto a detector and

digitized for analysis. By simultaneously shifting the reference beam and measuring the change in intensity at each pixel, the phase difference, which is proportional to the surface error of the mirror, is calculated at each sampled location.

Since this process measures phase difference between two wavefronts and attributes it entirely to the surface of the mirror under test, errors in both wavefronts are kept to an absolute minimum. The null correctors were designed such that they can be fabricated and yield an uncertainty within an allotted error budget.

During grinding and polishing, the metrology data will be used to direct the figuring. It is important for the mapping distortion of the mirror through the null lens to be minimal so that the opticians can accurately address the figure errors. The infrared null lens was designed to have minimal mapping error and the visible system uses relay optics to correct the distortion introduced by the null lens.

Since the interferometry requires coherent light, diffraction from the edge of the mirror (which is the system aperture) can cause errors in the measurement. This error is minimized by focusing the image of the aperture onto the detector array. Since the very edge of the mirror is often rolled, defining this focus is difficult in practice. Both of the interferometers will use apertures at intermediate images of the primary to help define the focus. Also, a rotating ground glass disk correctly positioned in the visible system will eliminate Fresnel noise which is caused by scatter of the coherent laser light by dust particles. Both null correctors were designed so that no ghost reflections will cause troublesome spurious fringes.