



Technology Focus: Test & Measurement

Multi-Segment Radius Measurement Using an Absolute Distance Meter Through a Null Assembly

This system can be used by fabricators or optics integrators for telescopes or other imaging systems.

NASA's Goddard Space Flight Center, Greenbelt, MD

This system was one of the test methods considered for measuring the radius of curvature of one or more of the 18 segmented mirrors that form the 6.5 m diameter primary mirror (PM) of the James Webb Space Telescope (JWST). The assembled telescope will be tested at cryogenic temperatures in a 17-m diameter by 27-m high vacuum chamber at the Johnson Space Center. This system uses a Leica Absolute Distance Meter (ADM), at a wavelength of 780 nm, combined with beam-steering and beam-shaping optics to make a differential distance measurement between a ring mirror on the reflective null assembly and individual PM segments. The ADM is located inside the same Pressure-Tight Enclosure (PTE) that houses the test interferometer. The PTE maintains the ADM and interferometer at ambient temperature and pressure so that they are not directly exposed to the telescope's harsh cryogenic and vacuum environment.

This system takes advantage of the existing achromatic objective and reflective null assembly used by the test interferometer to direct four ADM beamlets

to four PM segments through an optical path that is coincident with the interferometer beam. A mask, positioned on a linear slide, contains an array of 1.25 mm diameter circular subapertures that map to each of the 18 PM segments as well as six positions around the ring mirror. A down-collimated 4 mm ADM beam simultaneously covers 4 adjacent PM segment beamlets and one ring mirror beamlet. The radius, or spacing, of all 18 segments can be measured with the addition of two orthogonally-oriented scanning pentaprisms used to steer the ADM beam to any one of six different sub-aperture configurations at the plane of the ring mirror.

The interferometer beam, at a wavelength of 687 nm, and the ADM beamlets, at a wavelength of 780 nm, pass through the objective and null so that the rays are normally incident on the parabolic PM surface. After reflecting off the PM, both the ADM and interferometer beams return to their respective instruments on nearly the same path. A fifth beamlet, acting as a differential reference, reflects off a ring mirror at-

tached to the objective and null and returns to the ADM. The spacings between the ring mirror, objective, and null are known through manufacturing tolerances as well as through an *in situ* null wavefront alignment of the interferometer test beam with a reflective hologram located near the caustic of the null. Since total path length between the ring mirror and PM segments is highly deterministic, any ADM-measured departures from the predicted path length can be attributed to either spacing error or radius error in the PM. It is estimated that the path length measurement between the ring mirror and a PM segment is accurate to better than 100 μm .

The unique features of this invention include the differential distance measuring capability and its integration into an existing cryogenic and vacuum compatible interferometric optical test.

This work was done by Cormic Merle, Eric Wick, and Joseph Hayden of ITT Corp. for Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-15674-1

Fiber-Optic Magnetic-Field-Strength Measurement System for Lightning Detection

Fiber optics used for signal paths provide enhanced immunity from electromagnetic radiation incident in the vicinity of the measurements.

John F. Kennedy Space Center, Florida

A fiber-optic sensor system is designed to measure magnetic fields associated with a lightning stroke. Field vector magnitudes are detected and processed for multiple locations. Since physical limitations prevent the sensor elements from being located in close proximity to highly conductive materials such as aluminum, the copper wire sensor elements (3) are located inside a

4-cubic-in. (≈ 66 -cubic-cm) plastic housing sensor head and connected to a fiber-optic conversion module by shielded cabling, which is limited to the shortest length feasible. The signal path between the conversion module and the avionics unit which processes the signals are fiber optic, providing enhanced immunity from electromagnetic radiation incident in the vicinity

of the measurements. The sensors are passive, lightweight, and much smaller than commercial B-dot sensors in the configuration which measures a three-dimensional magnetic field. The system is expandable, and provides a standard-format output signal for downstream processing.

Inside of the sensor head, three small search coils, each having a few