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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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SURFACE CONTROL OF ACTIVE HYBRID SPACE MIRRORS

Abstract

In order for future imaging spacecraft to have higher resolution imaging capability, it will be necessary to build large space telescopes with primary mirror diameters that range from 10 to 20 meters and to do so with nanometer surface accuracy. Due to launch vehicle mass and volume constraints, these mirrors have to be deployable and lightweight, such as segmented mirrors using active optics to correct mirror surfaces with closed loop control. Application of active optics also has the potential to reduce the development costs and schedules for future imaging spacecraft. In addition, it provides a robust design. The Naval Postgraduate School (NPS) has a 3-meter diameter, six segments, active optics Segmented Mirror Telescope (SMT) as a research testbed to develop techniques for mirror surface control and segment alignment.

SMT uses Active Hybrid Mirror (AHM) technology for the active surface control of the segmented mirrors. Actuated hybrid mirrors are smart hybrid structures. They integrate a precision Nanolaminate foil facesheet with a Silicon Carbide (SiC) substrate embedded with Lead Magnesium Niobate (PMN) face sheet actuators (FSA). The SiC substrate is designed for lightweight, toughness, and smooth actuation. These actuators have very low hysteresis and are low creep devices. FSAs are used for surface control..

This paper presents recent research work on the surface control of mirror segments by using the SMT research testbed. Nastran is used to determine the influence coefficient matrix between actuator inputs and surface deformation. The SigFit program is used to convert surface distortions into wavefront errors. Experiments on surface control are done by performing Center of Curvature tests. In this test, an interferometer with a null corrector is mounted on the table at the center of curvature of the primary mirror and makes the primary mirror look like a spherical mirror. A laser beam from the interferometer passes through the null corrector out to the primary mirror segments. The reflected beam passes back through the null corrector and then into the interferometer. The interferometer measures the wavefront errors due to mirror surface errors. Influence coefficient matrix elements are determined by actuating one actuator at a time and determining the wavefront error from the interferometer. The actuation voltage limit for the FSA is 25V to 75V. The least square constraint optimization technique is used to determine required voltages for actuators to correct the mirror surface. The correlation between analytical and experimental results is good.