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IMPACT OF LARGE FIELD ANGLES ON THE REQUIREMENTS FOR DEFORMABLE MIRRORS IN IMAGING SATELLITES

Abstract

For several missions for imaging satellites, large aperture with wide field of view is needed. In order to achieve diffraction limited performance, the mirror surface Root-Mean Square (RMS) error has to be less than 0.05 wave- length. In case of visible light, it has to be less than 30 nm. This requirement is very difficult to meet as the large aperture will need to be segmented in order to fit in a launch vehicle shroud for launch. These mirrors suffer from surface errors of the segments and errors due to phasing of the segments. Naval Postgraduate School (NPS) has performed research on 3 meter 6 segments Segmented Mirror Telescope. This telescope has actuators for surface control and for phasing the segments. This approach has been found to complex due to large number of actuators, more than 900, for surface control and related power drivers. Recent research efforts at NPS is to put deformable mirror in aft optics to correct surface errors instead of actuators on mirror surface. This approach results in major reduction in complexity in mirror design and related mass and power. This paper presents the results of this effort.

MEMS deformable mirrors are considered for aft optics. These deformable mirrors consume low power, but are very small in size, such as Boston Micromachines Corporation mirror with 7 mm diameter with 492 actuators. Due to major reduction in pupil size, this approach will require relay optics. For on axis imaging, this approach works well. However for wide field of view imaging, effective field angle is magnified by the ratio of diameter of the primary mirror and the deformable mirror. This results in complexity in adaptive optics. For a given primary mirror surface error, the correction by deformable mirror will be different for each field angle. One approach is to achieve best performance across field of view by using least squares techniques. Another complexity is that optical beam will be on the deformable mirror at an angle instead of normal to the surface. All these consideration impact the required parameters of deformable mirror, such as size, number of actuators and actuator stroke. This paper will discuss the results of this study.