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Advanced UVOIR Mirror Technology Development for Very Large Space Telescopes

Project Manager(s)/Lead(s)

Mike Effinger/ZP21
(256) 961–7485

H. Philip Stahl/ZP10
(256) 544–0445

Sponsoring Program(s)

Science Mission Directorate
Cosmic Origins Program

Project Description

The Advanced Mirror Technology Development (AMTD) project is in phase 2 of a multiyear effort, initiated in FY 2012. This effort is to mature, by at least a half Technology Readiness Level step, the critical technologies required to enable 4 m or larger ultraviolet, optical, and infrared (UVOIR) space telescope primary mirror assemblies for both general astrophysics and ultra-high contrast observations of exoplanets. AMTD continues to achieve all of its goals and has accomplished all of its milestones to date. This has been achieved by assembling an outstanding team from academia, industry, and government with extensive expertise in astrophysics and exoplanet characterization, and in the design/manufacture of monolithic and segmented space telescopes; by deriving engineering specifications for advanced normal-incidence mirror systems needed to make the required science measurements; and by defining and prioritizing the most important technical problems to be solved. Our results have been presented to the CoPAG and Mirror Tech Days 2013, and proceedings papers of the 2013 and 2014 SPIE Optics & Photonics Symposia have been published.

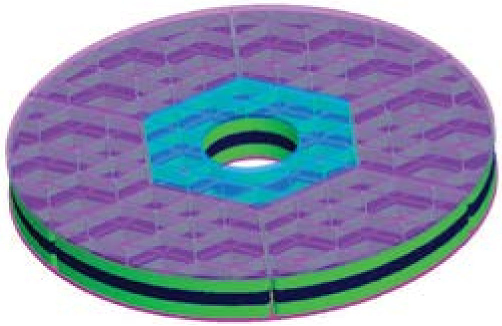
Key technology areas being pursued in phase 2 include large-aperture, low-areal density, high-stiffness mirror substrates; a support system; and integrated model validation.

Fine-scale actuator.

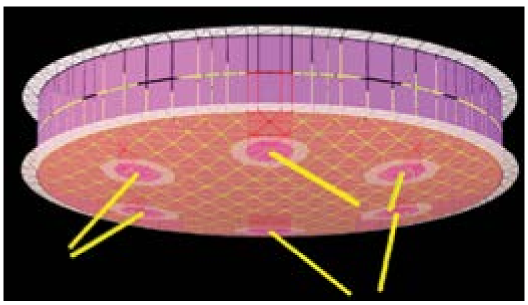
Actuator performance.

Property	Performance
Mass	0.313 kg
Axial Stiffness	40.9 N/μm
Test Range	14.1 μm
Resolution	6.6 nm (noise limited result; expected is 0.8 nm)
Accuracy	1.1 μm

MOR specimens in abrasive waterjet cutting.



Preliminary design for 1.5-m mirror.



Modeling tool with kinematic support mechanisms.

Anticipated Benefits

This project seeks to mature interlinked critical technologies such that 4 m or larger UVOIR mirrors could be produced by 2018 so that a viable mission can be considered by the 2020 Decadal Review. Because the future cannot be predicted, technologies that can enable either monolithic or segmented architectures are being pursued.

Potential Applications

This technology will be used in mirrors and its support structure for spacecraft and suborbital missions.

Notable Accomplishments

In FY 2013/2014, AMTD partner Exelis designed, built, and characterized the 'fine' stage of a low mass, two-stage actuator which could be used to co-phase mirror segments to the required tolerance. This effort is now complete and will not be continued in phase 2.

In FY 2013, Exelis tested the core-to-core low temperature fusion (LTF) bond strength using 12 modulus of rupture (MOR) test articles. Additional MOR testing was performed on 50 samples in FY 2014. The resulting Weibull 99% survival strength value was determined to be 50% above the most conservative design allowables used for margin of safety calculations at the core to plate LTF bond. The data on the 50 samples ranged from 60% to 250% above this design allowable.

The modeling tool is continually being developed in Visual Basic for ANSYS finite element modeling. This tool allows the rapid creation and analysis of detailed mirror designs. In FY 2013/2014 the ability to design a mirror support and integrate that support to the mirror substrate via kinematic and hexapod mechanisms was added. The result is a tool capable of rapidly designing complete mirror systems and transferring a high-resolution mesh to various mechanical and thermal analysis tools. Currently, exercising this tool by developing point designs for thermal and mechanical analysis is being done. For the duration of the effort, refining the tool and optimizing candidate point designs will be continued. Also in FY 2014, Exelis started designing a 1.5-m-diameter, 200-mm mirror to be fabricated via the deep core technology. The purpose of this mirror is to demonstrate lateral scalability of the process.

AMTD partner Goddard Space Flight Center continues to develop a suite of MATLAB® based tools for using structural-thermal-optical performance and jitter integrated models to calculate optical path length difference maps and line-of-sight errors. The AMTD project incorporated direct integration to transform the optical path difference to a point spread function (PSF) and between PSF to modulation transfer function.

References

Stahl, H.; Postman, M.; Mosier, G.; et al.: "AMTD: update of engineering specifications derived from science requirements for future UVOIR space telescopes," *Proc. SPIE*. 9143, doi: 10.1117/12.2054766, June 22–27, 2014.

Stahl, P.; Postman, M.; Abplanalp, L.; et al.: "Advanced mirror technology development (AMTD) project: 2.5 year status," SPIE Space Telescopes & Instrumentation Symposia, Montreal, Canada, June 22–27, 2014.