NASA SBIR 2008 Phase I Solicitation

S2.04 Optical Devices for Starlight Detection and Wavefront Analysis

Lead Center: MSFC

Participating Center(s): GSFC, JPL

The planned Ares V vehicle will enable the launch of extremely large and/or extremely massive space telescopes. Potential systems include 12 to 30 meter class segmented primary mirrors for UV/optical or infrared wavelengths and 8 to 16 meter class segmented x-ray telescope mirrors. UV/optical telescopes require 1 to 3 meter class mirrors with < 5 nm rms surface figures. IR telescopes require 2 to 3 meter class mirrors with cryo-deformations < 100 nm rms. X-ray telescopes require 1 to 2 meter long grazing incidence segments with angular resolution < 5 arc-sec down to 0.1 arc-sec and surface micro-roughness < 0.5 nm rms. Additionally, missions such as EUSO and OWL need 2 to 9 meter diameter UV-transparent refractive, double-sided Fresnel or diffractive lenses.

In view of the very large total mirror or lens collecting aperture required, affordability or areal cost (cost per square meter of collecting aperture) rather than areal density is probably the single most important system characteristic of an advanced optical system. For example, both x-ray and normal incidence space mirrors currently cost $3M to $4M per square meter of optical surface area. This research effort seeks a cost reduction for precision optical components by 20X to 100X to less than $100K per square meter.

The primary purpose of this subtopic is to develop and demonstrate technologies to manufacture ultra-low-cost precision optical systems for very large x-ray, UV/optical or infrared telescopes. Potential solutions include but are not limited to direct precision machining, rapid optical fabrication, slumping or replication technologies to manufacture 1 to 2 meter (or larger) precision quality mirror or lens segments (either normal incidence for uv/optical/infrared or grazing incidence for x-ray).

An additional key enabling technology for UV/optical telescopes is a broadband (from 100 nm to 2500 nm) high-reflectivity mirror coating with extremely uniform amplitude and polarization properties which can be deposited on 1 to 3 meter class mirrors.

Successful proposals will demonstrate prototype manufacturing of a precision mirror or lens system or precision replicating mandrel in the 0.25 to 0.5 meter class with a specific scale up roadmap to 1 to 2+ meter class space qualifiable flight optics systems. Material behavior, process control, optical performance, and mounting/deploying issues should be resolved and demonstrated. The potential for scale-up will need to be addressed from a processing and infrastructure point of view.

The Phase 1 deliverable will be at least a 0.25 meter near UV, visible or x-ray precision mirror or lens or replicating mandrel, its optical performance assessment and all data on the processing and properties of its substrate materials. This effort will allow technology to advance to TRL 3-4.

The Phase 2 deliverable will be at least a 0.50 meter near UV, visible or x-ray space-qualifiable precision mirror or lens system with supporting documentation, optical performance assessment, all data on materials and processing, and thermal and mechanical stability analysis. Effort will advance technology to TRL 4-5.

The proposal must address the technical need of a recognized future NASA space science mission, science measurement objective or science sensor for a Discovery, Explorer, Beyond Einstein, Origins, GOESS, New Millennium, Landmark-Discovery, or Vision mission. Missions of interest include the following: Constellation-X (http://constellation.gsfc.nasa.gov/); Generation-X (http://www.cfa.harvard.edu/hea/genx.html); Single Aperture Far-Infrared (http://safir.jpl.nasa.gov/technologies.shtml); Terrestrial Planet Finder (http://planetquest.jpl.nasa.gov/TPF/tpf_index.cfm); Orbiting Wide Angle Light Collector (http://owl.gsfc.nasa.gov/); Extreme Universe Space Observatory (http://hena.lbl.gov/EUSO/).

Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program.Â

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