



NASA SBIR 2020 Phase I Solicitation

S2.02 Precision Deployable Optical Structures and Metrology

Lead Center: JPL

Participating Center(s): GSFC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Scope Title

Precision Deployable Optical Structures and Metrology

Scope Description

Future space astronomy missions from ultraviolet to millimeter wavelengths will push the state of the art in current optomechanical technologies. Size, dimensional stability, temperature, risk, manufacturability, and cost are important factors, separately and in combination. The Large Ultraviolet Optical Infrared Surveyor (LUVOIR) calls for deployed apertures as large as 15 m in diameter, the Origins Space Telescope (OST) for operational temperatures as low as 4 K, LUVOIR and the Habitable Exoplanet Observatory (HabEx) for exquisite optical quality. Methods to construct large telescopes in space are also under development. Additionally, sunshields for thermal control and starshades for exoplanet imaging require deployment schemes to achieve 30-70 m class space structures.

This subtopic addresses the need to mature technologies that can be used to fabricate 10-20 m class, lightweight, ambient or cryogenic flight qualified observatory systems and subsystems (telescopes, sunshields, starshades). Proposals to fabricate demonstration components and subsystems with direct scalability to flight systems through validated models will be given preference. The target launch volume and expected disturbances, along with the estimate of system performance, should be included in the discussion. Novel metrology solutions to establish and maintain optical alignment will also be accepted.

Technologies including, but not limited to, the following areas are of particular interest:

Precision structures/materials:

- Low Coefficient Thermal Expansion (CTE)/Coefficient of Moisture Expansion (CME) materials/structures to enable highly dimensionally stable optics, optical benches, metering structures
- Materials/structures to enable deep cryogenic (down to 4 K) operation
- Novel athermalization methods to join materials/structures with differing mechanical/thermal properties
- Lightweight materials/structures to enable high mass-efficiency structures
- Precision joints/latches to enable sub-micron level repeatability
- Mechanical connections providing micro-dynamic stability suitable for robotic assembly

Deployable Technologies:

- Precision deployable modules for assembly of optical telescopes (e.g., innovative active or passive deployable primary or secondary support structures)
- Hybrid deployable/assembled architectures, packaging, and deployment designs for large sunshields and external occulter (20-50 m class)
- Packaging techniques to enable more efficient deployable structures

Metrology:

- Techniques to verify dimensional stability requirements at sub-nanometer level precisions (10⁻¹²; 100 picometers)
- Techniques to monitor and maintain telescope optical alignment for on-ground and in-orbit operation

A successful proposal shows a path toward a Phase II delivery of demonstration hardware scalable to 5-meter diameter for ground test characterization. Proposals should show an understanding of one or more relevant science needs, and present a feasible plan to fully develop the relevant subsystem technologies and to transition into future NASA program(s).

References

Large UV/Optical/IR Surveyor (LUVOIR): <https://asd.gsfc.nasa.gov/luvoir/>

Habitable Exoplanet Observatory (HabEx): <https://www.jpl.nasa.gov/habex/>

Origins Space Telescope: <https://asd.gsfc.nasa.gov/firs/>

What is an Exoplanet? <https://exoplanets.nasa.gov/what-is-an-exoplanet/technology/>

NASA in-Space Assembled Telescope (iSAT) Study: https://exoplanets.nasa.gov/exep/technology/in-space-assembly/iSAT_study/

Expected TRL or TRL range at completion of the project: 3 to 5

Desired Deliverables of Phase II

Prototype, Analysis, Research

Desired Deliverables Description

A successful deliverable would include a demonstration of the functionality and/or performance of a system/subsystem with model predictions to explain observed behavior as well as make predictions on future designs. This should be demonstrated on units that can be scaled to future flight sizes.

State of the Art and Critical Gaps

The James Webb Space Telescope, currently set to launch in 2021, represents the state of the art in large deployable telescopes. The Wide Field Infrared Survey Telescope's (WFIRST) coronagraph instrument (CGI) will drive telescope/instrument stability requirements to new levels. The mission concepts in the upcoming Astro2020 decadal survey will push technological requirements even further in the areas of deployment, size, stability, lightweighting, and operational temperature. Each of these mission studies have identified technology gaps related to their respective mission requirements.

Relevance / Science Traceability

These technologies are directly applicable to the WFIRST CGI and the HabEx, LUVOIR, and OST mission concepts.

