



NASA STTR 2007 Phase I Solicitation

T4.02 Space Science and Exploration Sensors and Instruments

Lead Center: GSFC

This subtopic focuses on key component and subsystem technologies for space science and exploration sensors and instruments. The focus is on innovative, lower TRL technologies which may have a longer term development time. The technology focus in this solicitation is for cryogenic cooling technologies, in situ sensors for miniaturized planetary instruments, optical subsystems and wavefront sensing and control, and detectors for the IR, far IR, submillimeter, and millimeter wave regions.

Cryogenic Cooling Technologies for Space Science and Space Exploration

Cryogenics systems are enabling technologies for cutting edge space science including infrared imaging and spectroscopy and x-ray spectroscopy. Cryogenic cooling is also needed to enable the long term storage of the cryo-propellants needed for space exploration missions. Improvements in cryogenic technologies enable space science and exploration missions at lower cost with reduced mass, reduced volume and reduced risk.

New concepts that would provide cooling with improved thermodynamic efficiency for the following applications are sought.

- Coolers for long term cryo-propellant storage with cooling power in the range of 50 to 100 Watts at 100 K and 20 Watts at 25 K to 30 K;
- Low vibration coolers for space science instruments with approximately 0.1 Watt of cooling power at 4 K;
- Highly efficient sub-Kelvin cooling technologies capable of cooling detectors to 50 milliKelvin.

In Situ Sensors for Planetary Science

Instruments for in situ investigations are required for NASA's planned and potential planetary science missions. Instruments are required for the characterization of the atmosphere, surface and subsurface regions of planets, satellites, and small bodies. These instruments may be deployed for in situ measurements on surface landers and rovers, and airborne platforms. These instruments must be capable of withstanding operation in space and planetary environmental extremes, which include temperature, pressure, radiation, and impact stresses. A focus is on developing components and subsystems for miniaturized instruments.

- Enabling instrument component and support technologies for a miniaturized mass spectrometry/gas chromatography instrument with improved capabilities over the SAM instrument on the Mars Science Laboratory. These include miniaturized pumps, sample inlet systems, valves, integrated bulk sample handling and processing systems, and microfluidic technologies for sample preparation.

Optical Subsystems and Wavefront Sensing and Control

This subtopic solicits technology for collecting and controlling star light with advanced optical telescopes and telescope arrays. This topic includes innovative optical subsystems, devices and components that directly collect and process optical signals and images for all regions of the electromagnetic spectrum from X-ray to UV to Visible to Far-IR/Sub-MM. Pre-detection technologies of interest include capabilities to preprocess or analyze an optical wave front or signal to extract time-dependent, spectral, polarization and spatial information from scenes or signals prior to detection. Specific technology areas of interest include: high reflectance UV coatings and uniform polarization coatings for all wavelengths; high angular resolution imaging enabled via large-baseline segmented-aperture telescopes and sparse aperture telescopes/interferometers. Component-level technology needed to enable the characterization and combination of wavefronts from multiple apertures. Innovative technology needed to integrate, assemble, align and control test large aperture segmented mirrors for x-ray, ambient and cryogenic applications.

Proposals in the following areas are specifically solicited:

- Optical coatings: broad-band polarization preserving and polarizing for UV to Far-IR/Sub-MM; high-reflectivity EUV; large area, high acceptance angle narrow-band optical filters; broad-band wide-acceptance angle UV anti-reflection on PMMA substrates; environmentally stable protected silver.
- Innovative mounting/support and metrology/control technologies to integrate, assemble, align and control large aperture lightweight low-cost segmented mirrors for x-ray, ambient and cryogenic normal incidence applications - also, systems with extreme alignment tolerances such as PIAA.
- Techniques to mitigate optical surface errors includes phase retrieval and wavefront sensing and control techniques and instrumentation, optical systems with high-precision controls, active and/or adaptive mirrors, shape control of deformable telescope mirrors, and image stabilization systems; techniques to sense/control segmented primary mirrors.

Detector Technology for IR, far IR, Submillimeter, and Millimeter

Advances in detectors, readout electronics, and other technologies enabling polarimetry and large format imaging arrays for the IR, far submillimeter and millimeter and spectroscopy with unprecedented sensitivity are sought.

Innovations are sought in detector capability for the following wavelength ranges:

- 1-30 microns: Increased sensitivity and larger array size; Large format cryogenic readout multiplexers; large format (>1000 x 1000) array hybridization techniques. Technologies for assembly of large format focal plane arrays. Photon counting detector arrays with fast readout electronics.
- 100 microns - 3 mm: Noise equivalent power (NEP) of $10e^{-20}$ W/Hz $^{-1/2}$ in a 1,000 pixel spectroscopic array with low-power readout electronics, and NEP $10e^{-18}$ W/Hz $^{-1/2}$ in a 10,000 pixel photometric imaging array. Capabilities for photon counting, polarimetry, and energy resolving detection.
- RF (GHz to THz) MEMS switches with low insertion loss.
- (18 dB), capable of switching with speeds of >100 Hz at cryogenic temperatures (below 10 K) for $10e^8$ or more cycles.