



NASA SBIR 2016 Phase I Solicitation

S4.02 Robotic Mobility, Manipulation and Sampling

Lead Center: JPL

Participating Center(s): AFRC, ARC, GSFC, JSC

Technologies for robotic mobility, manipulation, and sampling are needed to enable access to sites of interest and acquisition and handling of samples for in-situ analysis or return to Earth from planetary and solar system small bodies including Mars, Venus, comets, asteroids, and planetary moons (both rocky and icy).

Mobility technologies are needed to enable access to steep and rough terrain for planetary bodies where gravity dominates, such as the Moon and Mars. Wheel concepts with good tractive performance in loose sand while being robust to harsh rocky terrain are of interest. Technologies to enable mobility on small bodies in micro-gravity environments and access to liquid bodies below the surface such as in conduits and deep oceans are desired, as well as associated sampling technologies. Manipulation technologies are needed to deploy sampling tools to the surface and transfer samples to in-situ instruments and sample storage containers, as well as hermetic sealing of sample chambers. On-orbit manipulation of a Mars sample cache canister is needed from capture to transfer into an Earth Entry Vehicle. Sample acquisition tools are needed to acquire samples on planetary and small bodies through soft and hard materials, including ice. Minimization of mass and ability to work reliably in the harsh mission environment are important characteristics for the tools.

Contamination control and planetary protection are important considerations for sample acquisition and handling technologies. Contamination may include Earth-source contaminants produced by the sampling tool, handling system, or deposited on the sampling location from another source on the rover or spacecraft. Cleaning to Sterility technologies are needed that will be compatible with spacecraft materials and processes. Surface cleaning validation methods are needed that can be used routinely to quantify trace amounts ($\sim\text{ng}/\text{cm}^2$) of organic contamination and submicron particle ($\sim 100\text{nm}$ size) contamination. Priority will be given to cleaning and sterilization methods that have potential for in-situ applications.

Component technologies for low-mass and low-power systems tolerant to the in-situ environment are of particular interest. Technical feasibility should be demonstrated during Phase I and a full capability unit of at least TRL 4 should be delivered in Phase II. Proposals should show an understanding of relevant science needs and engineering constraints and present a feasible plan to fully develop a technology and infuse it into a NASA program. Specific areas of interest include the following:

- Surface and subsurface sampling systems for planets, small bodies, and moons.
- Small body anchoring systems.
- Low mass/power vision systems and processing capabilities that enable fast surface traverse.
- Electro-mechanical connectors enabling tool change-out in dirty environments.
- Tethers and tether play-out and retrieval systems.
- Miniaturized flight motor controllers.
- Cleaning to sterility technologies that will be compatible with spacecraft materials and processes.

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- Surface cleaning validation technology to quantify trace amount ($\sim\text{ng}/\text{cm}^2$) of organic contamination and submicron particle ($\sim 100\text{nm}$ size) contamination.
 - Sample handling technologies that minimize cross contamination and preserve mechanical integrity of samples.