



## NASA SBIR 2011 Phase I Solicitation

### S5.03 Surface and Subsurface Robotic Exploration

Lead Center: JPL

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

Technologies are needed to enable access, mobility, and sample acquisition at surface and subsurface sampling sites of scientific interest on Mars, Venus, small planetary bodies, and the moons of Earth, Mars, Jovian and Saturnian systems.

For planetary bodies where gravity dominates, such as the Moon and Mars, many scientifically valuable sites are accessible only via terrain that is too difficult for state-of-the-art planetary rovers to traverse in terms of ground slope, rock obstacle size, plateaus, and non-cohesive soils types. Sites include crater walls, canyons, gullies, sand dunes, and high rock density regions. Tethered systems, non-wheeled systems, and marsupial systems are examples of mobility technologies that are of interest. Mars is particularly interested in fast traverse capabilities aimed at a fetch rover that would potentially need to travel a long distance to retrieve a sample cache deposited by a prior mission. For small planetary bodies with micro-gravity environments, novel access systems are desired to enable exploration and sample acquisition. Small body missions include Comet Surface Sample Return, Cryogenic Comet Sample Return, and asteroid Trojan Tour and Rendezvous.

For surface and subsurface sampling, advanced manipulation technologies are needed to deploy instruments and tools from spacecraft, landers and rovers. Technologies to enable acquisition of subsurface samples are also needed. Technologies are needed to acquire core samples in the shallow subsurface to about 10cm and to enable subsurface sampling in multiple holes at least 1 - 3 meters deep through rock, regolith, or ice compositions. For Europa, penetrators and deployment systems to allow deep drilling are needed to sample and bore the outer water-ice layer and through 10 to 30km to a potential liquid ocean below.

Innovative component technologies for low-mass, low-power, and modular systems tolerant to the in situ environment are of particular interest, e.g., for Europa, the radiation environment is estimated at 2.9 Mrad total ionizing dose (TID) behind 100 mil thick aluminum. Technical feasibility should be demonstrated during Phase I and a full capability unit of at least TRL level 4 should be delivered in Phase II. Specific areas of interest include the following.

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- Steep terrain adherence for vertical and horizontal mobility.
  - Tether play-out and retrieval systems including tension and length sensing.
  - Low-mass tether cables with power and communication.
  - Sampling system deployment mechanisms such as tethers, booms, and manipulators.
  - Low mass/power vision systems and processing capabilities that enable faster surface traverse while maintaining safety over a wide range of surface environments.
  - Modular actuators with 1000:1 scale gear ratios.
  - Electro-mechanical couplers to enable change out of instruments at the end of a manipulator.s
  - Autonomy to enable adaptation of exploration to new conditions.

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.