# A Comet Surface Sample Return System, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)


## ABSTRACT

The proposed Phase II investigation will focus on the development of spacecraft systems required to obtain a sample from the nucleus of a comet, hermetically seal the sample within a capsule, and return the sealed sample to an orbiting spacecraft which can return the sample to Earth. A systems level concept for the Comet Surface Sample Return Probe has been developed in Phase I. This concept will be refined during the proposed Phase II investigation, including high fidelity prototypes and analyses of critical subsystems. These high fidelity prototypes will include the sample acquisition and handling subsystem, a hermetically sealed sample return canister, and a full scale mockup of the Comet Surface Sample Return Probe. Orbital mechanics calculations were completed in Phase I based on simplified geometry assumptions of the comets shape and density in order to determine the feasibility of orbiting, impacting and ascending from the comets surface with a small scale spacecraft. During Phase II, these analyses will be refined to include uneven geometry and inconsistent density.


## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: The acquisition of surface samples from small interplanetary bodies such as comets and asteroids, as well as small moons like Mars' Phobos, and Deimos holds great scientific interest. Under the NASA Authorization Act, Congress instructed NASA to "plan, develop, and implement a Near-Earth Object (NEO) Survey program to detect, track, catalogue, and characterize the physical characteristics of NEOs equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth." In 2010, President Obama called for a new approach to space exploration, which would include human and robotic exploration of asteroids. In the latest Decadal Survey, the committee recommended selecting a Comet Surface


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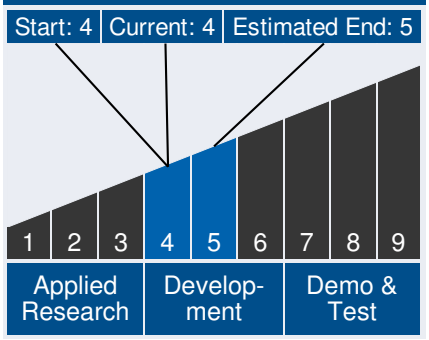
### Technology Maturity




### Management Team

**Program Executives:**

- Joseph Grant
- Laguduva Kubendran

**Program Manager:**

- Carlos Torrez

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Sample Return mission as one of the five New Frontiers 4 (NF4) missions, solidifying the importance of studying returned physical samples from a comet. The other four included Lunar South Pole-Aitken Basin Sample Return, Saturn Probe, Trojan Tour and Rendezvous, and Venus In Situ Explorer. The Lunar and Venus missions could also benefit from the development of this sampling approach. The sampling probe in the proposed effort could be applied to any number of planetary bodies with a microgravity environment where sample return is desired.

**To the commercial space industry:**

Potential Non-NASA Commercial Applications: Non-NASA applications for this technology include sampling of contaminated soils and liquid from hazardous environments (near nuclear reactors, oil spills, chemical spills etc). Key subsystems such as the sampling probe, flipper mechanism and hermetic sealing canister could be re-purposed for sampling terrestrial sites. These systems could potentially be deployed from a helicopter with a tether, acquire a sample, hermetically seal it on the ground, and be reeled in with the sample inside the sealed canister. This would reduce the risk of sending personnel into contaminated environments. In addition, commercial companies such as Planetary Resources and Deep Space Industries, who are interested in asteroid mining for economic gains, would use this technology. It would be extremely useful to conduct reconnaissance of target bodies in order to determine their composition (e.g. fraction of water-ice, Platinum Group Metals, Rare Earth Elements etc) and in turn evaluate economic potential for mining the bodies.

## Management Team *(cont.)*

**Project Manager:**
- Joseph Nuth

**Principal Investigator:**
- Philip Chu

## Technology Areas

**Primary Technology Area:**
Robotics and Autonomous Systems (TA 4)
└ Manipulation (TA 4.3)
  └ Sample Acquisition and Handling (TA 4.3.6)
    └ Surface/Shallow Robotic Sample Acquisition (TA 4.3.6.3)

**Secondary Technology Area:**
Robotics and Autonomous Systems (TA 4)
└ Autonomous Rendezvous and Docking (TA 4.6)
  └ Relative Navigation Sensors (TA 4.6.1)

**Additional Technology Areas:**
Robotics and Autonomous Systems (TA 4)
└ Autonomous Rendezvous and Docking (TA 4.6)
  └ Docking and Capture Mechanisms and Interfaces (TA 4.6.3)

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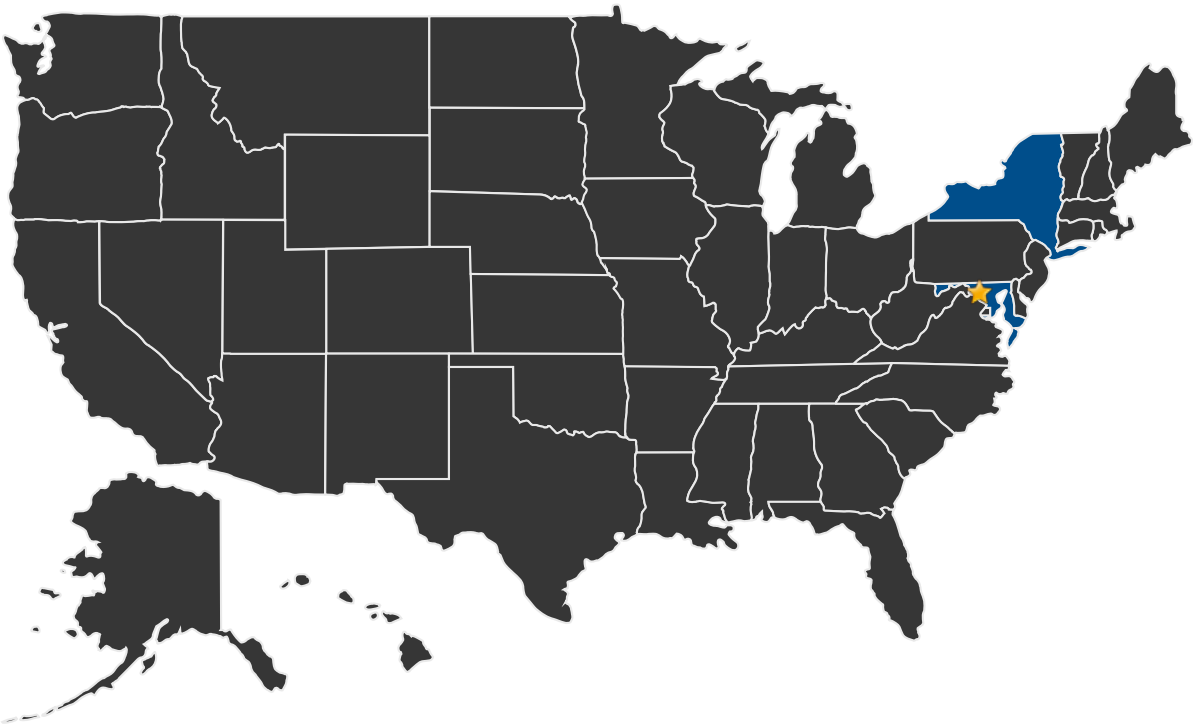
## U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

**Lead Center:**
Goddard Space Flight Center

**Other Organizations Performing Work:**

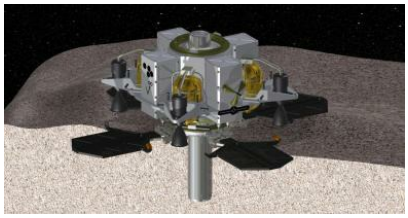
- Honeybee Robotics, Ltd.  (New York, NY)

## PROJECT LIBRARY

**Presentations**

- Briefing Chart
  - (http://techport.nasa.gov:80/file/22939)

## IMAGE GALLERY



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## DETAILS FOR TECHNOLOGY 1

### Technology Title

A Comet Surface Sample Return System

### Potential Applications

The acquisition of surface samples from small interplanetary bodies such as comets and asteroids, as well as small moons like Mars' Phobos, and Deimos holds great scientific interest. Under the NASA Authorization Act, Congress instructed NASA to "plan, develop, and implement a Near-Earth Object (NEO) Survey program to detect, track, catalogue, and characterize the physical characteristics of NEOs equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth." In 2010, President Obama called for a new approach to space exploration, which would include human and robotic exploration of asteroids. In the latest Decadal Survey, the committee recommended selecting a Comet Surface Sample Return mission as one of the five New Frontiers 4 (NF4) missions, solidifying the importance of studying returned physical samples from a comet. The other four included Lunar South Pole-Aitken Basin Sample Return, Saturn Probe, Trojan Tour and Rendezvous, and Venus In Situ Explorer. The Lunar and Venus missions could also benefit from the development of this sampling approach. The sampling probe in the proposed effort could be applied to any number of planetary bodies with a microgravity environment where sample return is desired.