NASA SBIR 2010 Phase I Solicitation

S5.04 Rendezvous and Docking Technologies for Orbiting Sample Capture

Lead Center: JPL

Participating Center(s): GSFC, JSC

NASA seeks an innovative suite of products or technologies that will enable and enhance the successful tracking and capture of a sample canister in Mars orbit in anticipation of the start of a Mars Sample Return (MSR) mission in the next decade.

The principal means of detection and tracking of the Orbiting Sample Canister (OSC) is optically with visual-band cameras. The challenging technology of long-range optical sensors for detection and distant tracking is not part of this call, however, short-range optical (or other) sensors and an on-sample radio-metric-based back-up detection and tracking method is desired, including a low-power, low-mass illuminator for short-range imaging of up to 0.5km.

Sample capture mechanisms are sought, of very low mass and volume, and of low complexity and extremely high reliability, including detection of contact with the capture mechanism. Appropriate on-sample radio-beacons are sought that are compatible with NASA’s radio systems, in particular, the Electra onboard programmable radio system; requirements for these beacons are for long life, and independent initiation of on-orbit operation. Solutions are sought that are either battery powered or via solar cells that do not reduce the overall OSC outer shell visual albedo below 0.5. Sample capture mechanisms should include close-proximity/contact sensors, including immediate-field imaging.

Methods are sought to provide a practice mechanism for testing rendezvous and proximity operations with a test sample canister in Earth or Mars orbit. The test carrier and release mechanism must be of very low mass and volume, and the test sample canister(s) should carry a radio beacon. Test OSC canisters should be of limited life after release, ceasing broadcast, and degrading in surface reflectance in approximately one month after release to avoid confusion with the actual canister. The test articles may be deployed and used on a previous mission to MSR, or on the actual MSR mission for operational readiness testing.

Products or technologies are sought that can be made compatible with the environmental conditions of interplanetary spaceflight and the rigors normal Mars orbits. Proposals should show an understanding of proposals and plans for previous NASA-supported Mars Sample Return relevant missions and mission concepts, and present
a feasible plan to fully develop a technology and infuse it into a NASA program. Successful candidate products or technologies can address this call by providing one or more of the following functions, and giving estimated expected performance capabilities of the approach, including, but not limited to, accuracies, ranges, limits of operation, references to previous or related flight experience:

- **Autonomously actuated mechanisms for orbiting sample capture of the OSC**
  - Mechanical capture mechanisms
  - Transfer mechanisms from capture device to containment transfer mechanism

- **Optical and contact sensors**
  - Near field imagers (optical or other) (e.g. 10m to 1km)
  - Immediate field imagers (optical) (0.25 to 10m)
  - Detection of OSC for triggering capture mechanism
  - Near field illuminator

- **Coherent Radio Doppler and range beacon (high-performance)**
  - Low power, low mass and long life beacon for detection aid
  - 2-way communication for activation, ranging and coherency via NASA's Electra radio interface
  - Programmable intermittent transmission for power saving and very long dormancy period
  - Battery or solar powered, preserving 0.5 visual albedo of OSC

- **Simple Radio beacon (low-performance)**
  - Simple 1-way beacon, for long-range detection and 1-way Electra Doppler extraction
  - Timer activated, multi-year dormant life, and long active life battery, or solar powered - preserving 0.5 visual albedo of OSC

- **Low-mass, low-cost sample OSC for proximity operations operational readiness tests**
  - A simple, low-cost, low-mass practice sample canister that could be deployed in Earth or Mars orbit and provide low-risk practice runs, either for a precursor mission, or with the actual MSR.
  - The readiness test exercise would not necessarily capture the test article in the capture mechanism for the actual MSR flight, but only perform the rendezvous and proximity ops operations sufficient to demonstrate very high likelihood of actual OSC capture.