Laser-Based Optical Trap for Remote Sampling of Interplanetary and Atmospheric Particulate Matter

Completed Technology Project (2011 - 2012)

Project Introduction

Phase 1 of this study intends to leverage advances in laser optical trapping technology in order to study the feasibility of a system that could remotely capture a quantity of particulates over a period of time. These particulates would be delivered to instruments on a spacecraft or lander for continual analysis. Therefore, instead of recording data from one pass of an orbiter or being at the mercy of a solid sample inlet, scientists could choose their targets over a wider range, bringing significantly more value to planetary missions.

Anticipated Benefits

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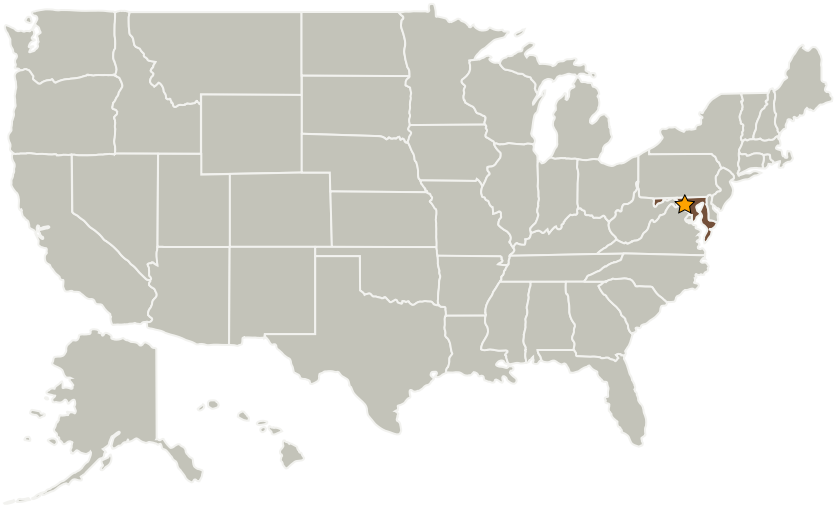
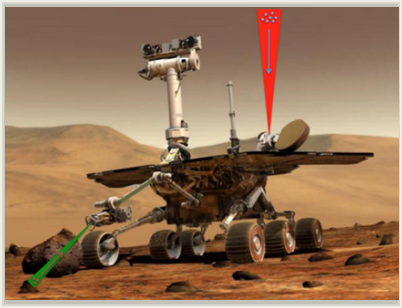
Primary U.S. Work Locations and Key Partners





Project Image Laser-Based Optical Trap for Remote Sampling of Interplanetary and Atmospheric Particulate Matter

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Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
American University	Supporting Organization	Academia	Washington, District of Columbia
SRI International	Supporting Organization	Industry	Menlo Park, California

Primary U.S. Work Locations
Maryland

Project Transitions

September 2011: Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

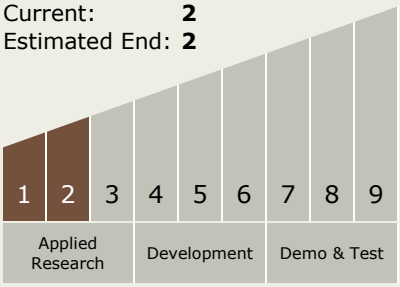
Eric A Eberly

Principal Investigator:

Paul Stysley

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



September 2012: Closed out

Closeout Summary: The study of interstellar and planetary particles is a primary goal of NASA's high profile space and Earth science programs. Planetary and interstellar missions such as Pioneer, the Viking Lander, and Cassini have relied heavily on in situ particle collection and analysis [1]. These and more recent instruments like Sample Analysis on Mars (SAM) on the Mars Science Laboratory (MSL), OSIRIS-REx, and Stardust have deployed several different in situ techniques such as Faraday traps, ablation and collection, or trapped matter in aerogel, yielding samples that are then returned to Earth [2,3]. Although these techniques have been successful, the type of particles that can be captured, how often the particles can be captured, the operational range of a lander, or the flight path of a spacecraft have severely limited available data sets. This coupled with instrument complexity and safety concerns can drive up costs and delay schedules. Innovative technologies are required to control costs and increase the viability and capabilities of critical particle collection and analysis missions. This proposal focused studying state-of-the-art laser-based tractor beams to determine their suitability for use on future Decadal Survey missions that require sample collection. Through the Phase I study we demonstrated that, though the technology is in its infancy, tractor beams do exist but can only move a limited number of targets over micron-level distances. Available technologies are not sufficiently developed such that they would be practical for future NASA missions. In the future, we hope to apply the most promising optical trapping technology, and develop a system that could remotely optically capture a quantity of particulates and transport them back towards the direction of laser propagation over a range of millimeters, while working towards achieving meter-scale operation. The captured samples will also need to be studied to understand the effect the trapping beam has on the particulates. For flight missions these particulates would be delivered to instruments on a spacecraft or lander for continued analysis. Therefore, instead of recording data from one pass of an orbiter or being at the mercy of a solid sample inlet, scientists could choose higher quality targets over a wider range and time period while simultaneously reducing risk and complexity, bringing significantly more value to planetary missions. If properly designed and implemented, a laser-based optical trapping system can fundamentally change the way scientist's design and implement NASA missions that require spectroscopy and particle collection.

Technology Areas

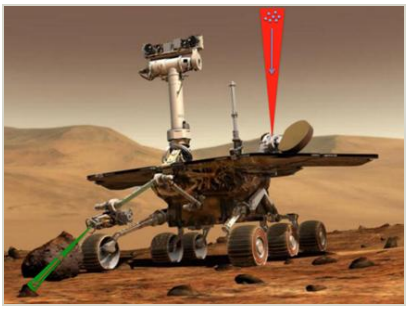
Primary:

- TX11 Software, Modeling, Simulation, and Information Processing
  - └ TX11.1 Software Development, Engineering, and Integrity
    - └ TX11.1.2 Verification and Validation of Software systems

Target Destinations

Foundational Knowledge, Others Inside the Solar System

Images



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Project Image Laser-Based Optical Trap for Remote Sampling of Interplanetary and Atmospheric Particulate Matter
(https://techport.nasa.gov/image/102196)