
NASA
National Aeronautics and Space Administration
2025
NASA
SCIENCE
Technology Development Presentation for Committee on Planetary Protection Spring Meeting
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Planetary Exploration Science Technology Office (PESTO)
April 4, 2025
PESTO
Planetary Exploration Science Technology Office

Planetary Science Technology Development for Planetary Protection Agenda

- **Planetary Science Technology Development**
  - **PESTO Overview**
  - **Planetary Science Technology Strategic Plan**
- **Technology Development Projects for Planetary Protection**

PESTO Overview

Planetary Exploration Science Technology Office

Planetary Exploration Science Technology Office (PESTO) is a NASA Headquarters office managed at GRC and chartered in 2017 to:

Recommend technology investment strategy for future planetary science missions, including:

- Instruments
- Spacecraft Technology
- Mission Support Technology

Manage planetary science technology development (non-mission specific, non-nuclear, competitively funded, TRL<6)

- Write solicitations
- Conduct review panels

Coordinate well-rounded, novel/high impact portfolio of planetary science-relevant technology needs & opportunities

- Within NASA
  - Supports Planetary Science Division (PSD) and the Exploration Science and Strategy Office (ESSIO)
- Within science community: outreach and partner with academic, small business, and technology groups

Promote technology infusion and technology pipeline

- Infusion starts before solicitations are written, ends with mission adoption
- Study infusion successes and obstacles; recommend changes

Planetary Science Technology Development Strategic Plan

Anchored in "Origins, Worlds, and Life A Decadal Strategy for Planetary Science and Astrobiology"

Tech Dev Strategic plan recently completed and available on PESTO website

Contents

Prioritized Technology Focus Areas*

Instrumentation, with an emphasis on:
- In Situ Search for Life/Astrobiology

Sample Containment and Return
- Planetary Protection and Contamination Control
- Thermal Protection and Control
- Sample Acquisition and Handling

Autonomy
- Global Positioning System (GPS) deprived navigation
- Surface (planetary) operations
- On-board science data processing
- Ground Operations

Robotics, with an emphasis on Advanced Mobility for:
- Aerial Platforms
- Subsurface Access**

Higher-efficiency power conversion technology for radioisotope system

Development typically occurs with:
- ROSES programs:
  - PICASSO
  - MatISSE
  - DALI
  - PSTAR
- SBIR
- Potential future focused programs

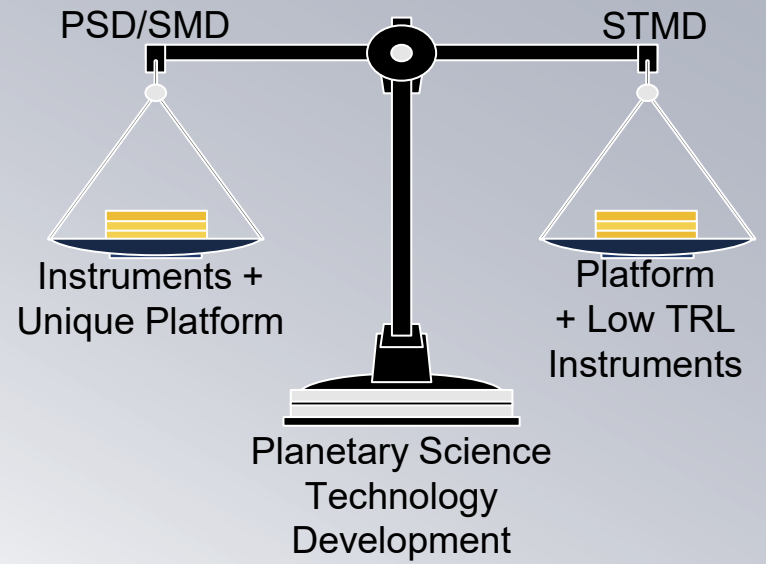
Development typically occurs with:
- STMD
- SBIR
- TP
- ACO
- RPS program (for last item)
- Potential future focused programs

*These are priority developments, however, future investments are not limited to these technologies
**Includes drilling

Planetary Science Technology Development Strategy

Science Mission Directorate (SMD) / Space Technology Mission Directorate (STMD) Interactions

- SMD is focused on technology development needed for future science missions, *including science instrument development (TRL1-6) and platform technologies (TRL1-6) unique to science applications*
- STMD focuses on ubiquitous platform technologies (TRL 1-7) and includes instrument investments (TRL1-3)
- SMD provides desired SMD Technology Priorities to STMD and invests across STMD programs
- Coordination between the two Mission Directorates is managed by SMD and STMD Chief Technologists
- STMD is in the process of reformulating their technology development structure



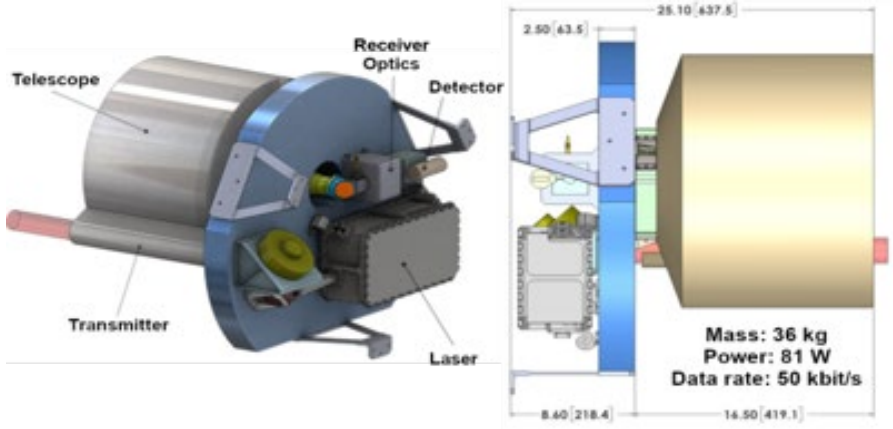
Instrument Programs

New spacecraft-based instrument that enhance or enable scientific return

- Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO):
  - All destination in solar system except Earth and Sun
  - Enter TRL 1-3; Advance TRL by at least 1 level
  - Solicited yearly, No Due Date (NoDD) and DAPR Program
  - Typical awards are $1M for 3 years

- Maturation of Instruments for Solar System Exploration (MatISSE):
  - All destination in solar system except Earth, Sun, and Moon
  - Enter TRL ≥ 4; Advance TRL by at least 1 level
  - Solicited every EVEN year (‘20,’22,’24)
  - Typical awards are $1M/year for 3 years

- Development and Advancement of Lunar Instrumentation (DALI):
  - For lunar missions including expected commercial ventures and NASA’s Artemis Program
  - Enter TRL ≥ 4; Advance TRL by at least 1 level
  - Solicited yearly
  - Typical awards are $1M/year for 3 years



Mars Lidar, PI James Abshire/NASA GSFC

Vehicle Technology Program

Planetary Science and Technology from Analog Research (PSTAR)

- Testing and application of technologies for remote searches for, and identification of, life and life-related chemistry in extreme environments (including lunar and planetary surfaces)
- These technologies include, but are not limited to:
  - Sample acquisition and handling techniques
  - Sample manipulation
  - The use of mobile science platforms
  - Techniques for autonomous operations
  - Self-contained deployment systems
  - Intelligent systems and human/robotic interfaces
  - Communication and navigation systems
  - Instrument packages
- Technology development is not required in PSTAR and only makes up a small percentage of the portfolio

PESTO Team

Erica Montbach
Manager PESTO, COLDTech

Michael Lienhard
Program Officer, MatISSE, HOTTech

Anna Maria Pal
Program Officer, DALI

Nalin Ratnayake
Program Officer PICASSO

Becky McCauley Rench
Astrobiology Program Scientist, Program Officer, PSTAR

Majd Mayyasi
Participating Scientist

Jeffrey Hall
Associate Directorate Technologist at JPL

J. Michael Newman
MEP Program Executive

Summary of Planetary Science Technology Symposium

The first Planetary Science Technology Symposium was held at Glenn Research Center (GRC) as a hybrid event October 21-24, 2024

- The symposium showcased a wide array of technology research and development for NASA's Planetary Science Division
  - Session topics included; Lunar, Mars, Outer Planets, Icy Worlds, Venus/Mercury, Small Bodies, and Agnostic Destinations
  - Annual events in planning

Planetary Protection Technology Development Projects

Planetary Protection Tech Dev Projects

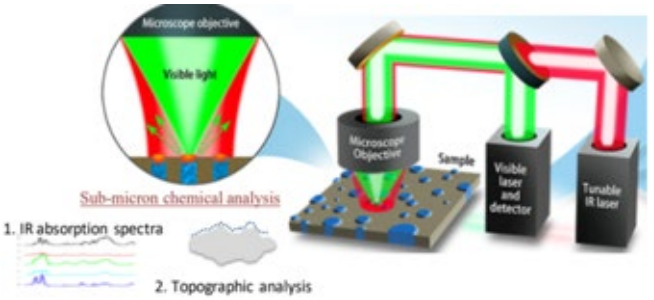
These are projects that are developing technology to enable Planetary Protection in the following general areas:

Detection

ORIGINS: Photothermal Spectroscopy for Planetary Science

PI: Julie Brisset / U of Central Florida / PICASSO

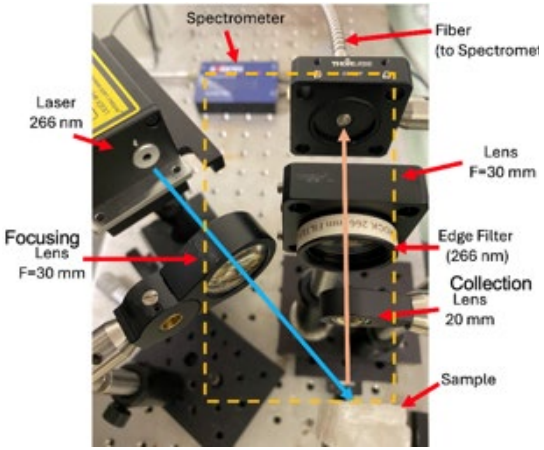
- Detects organic compounds and pre-biotic molecules
- Photothermal IR spectroscopy to analyze dust grains
- Chemical and structural analysis at sub-micron resolution



A Miniaturized, Multifunctional, Microscopic Organic/Inorganic Composition Analytical Probe for Planetary in situ Spectroscopy (MOCAPS)

PI: Mool Gupta / U of Virginia / PICASSO

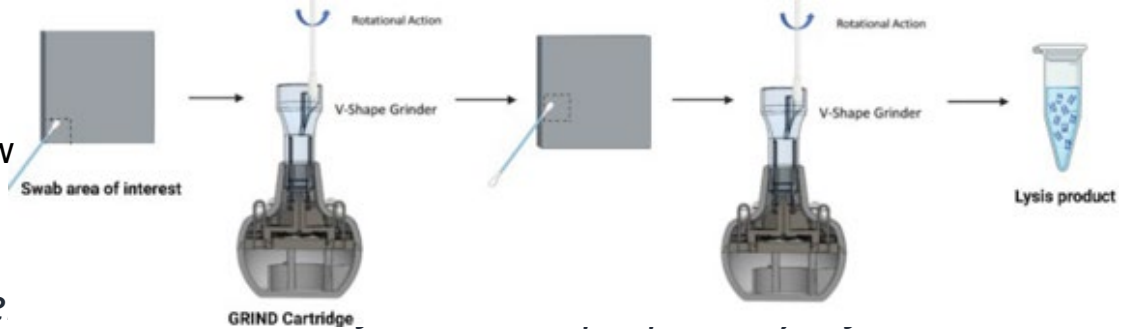
- Detect potential biosignatures or prebiotic chemistry and geologic evolution
- Florescence, Laser Induced Breakdown Spectroscope (LIBS), Laser Ablation Molecular Isotopic Spectrometry (LAMIS)



GRIND: Genomic Rapid Inspection of Non-abundant bacteria after Decontamination

PI: David Gaddes / CFD Research / SBIR Phase I

- Develop an automated grinding lysis system for spore-forming bacteria
- Optimization of sample collection and lysis procedure with high sensitivity for low bio-mass applications
- Mechanical lysis w/auto cartridge w/ abrasive surface



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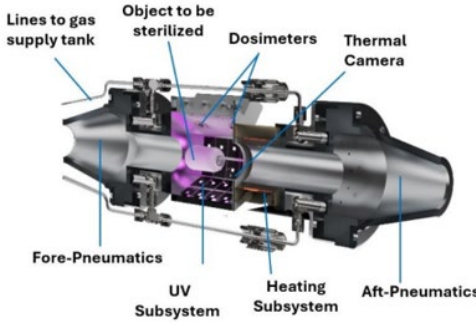
Planetary Protection Tech Dev Projects

These are projects that are developing technology to enable Planetary Protection in the following general areas:

Sterilization Techniques



Sterilizing Heat Infrared Emitting LED Device (SHIELD)

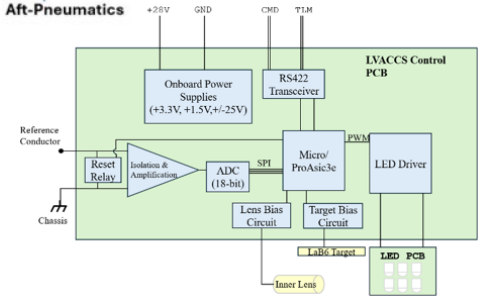
PI: Emily Seto / Honeybee Robotics / MatISSE

- In-situ microbial sterilization device (forwards and backward)
- Consists of pneumatics to remove particles and UV LEDS plus heaters for microbial sterilization
- Optimizing temperature, time and dose

Lunar Vehicle Active Charge Control System

PI: Omar Leon / University of Michigan / PICASSO

- Develop charge control and monitoring system for a vehicle surface to mitigate electrostatic attraction of charged dust particles for complete knowledge of vehicle potential relative to ambient plasma environment
- Particulate has potential of biologics contamination with long-term space survivability, as was seen on the International Space Station



Development of a Modular Plasma-Activated Fog System for Enhanced Planetary Protection and Contamination Control

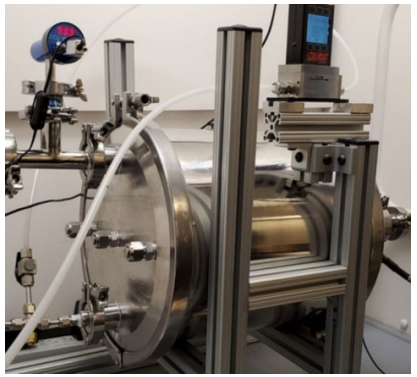
PI: Gregory Fridman / AAPlasma LLC / SBIR Phase I

- Plasma-activated fog for sterilization and contamination control
- Generates cold atmospheric-pressure neulizer plasma to generate reactive oxygen and nitrogen species for microbial deactivation

Cold Plasma Sterilization for Contamination Control

PI: Martin Toomajian / MagPlasma Inc. / SBIR Phase I

- Sterilize spacecraft components, onboard systems, and bodies prior to launch
- Dry plasma process that sterilizes sensitive materials, electronics, and instruments without damage that is typically seen from heat, steam, or corrosive chemicals



Planetary Protection Tech Dev Projects

These are projects that are developing technology to enable Planetary Protection in the following general areas:

Cleanroom Monitoring and Control

Microorganisms Genome Enrichment and Amplification Sequencing (MGEAS)
PI: Arturo Torres Ortiz / ChromoLogic / SBIR Phase II

- Detect microbial populations in cleanroom
- Metagenomics test for microbial taxonomic classification for ultra-low biomass samples
- Includes: sample concentration, DNA extraction, whole genome sequencing, microbial classification

Planetary Protection Technology Development Projects

	Project title	PI	Focus Area	Anticipated Completion Date	TRL (current)	Program
Detection	ORIGINS: Photothermal Spectroscopy for Planetary Sciences	Julie Brisset	All Planetary Bodies	7/31/2025	4	PICASSO
	A Miniaturized, Multifunctional, Microscopic Organic/Inorganic Composition Analytical Probe for Planetary in situ Spectroscopy (MOCAPS)	Mool Gupta	All Planetary Bodies	6/30/2025	4	PICASSO
	GRIND: Genomic Rapid Inspection of Non-abundant bacteria after Decontamination	David Gaddes	All Planetary Bodies	2/6/2025	4	SBIR_24_P1
Sterilization	Sterilizing Heat Infrared Emitting LED Device (SHIELD)	Emily Seto	Mars	12/31/2027	4	MatISSE
	Lunar Vehicle Active Charge Control System	Omar Leon	Earth's Moon	10/31/2026	5	PICASSO
	Development of a Modular Plasma-Activated Fog System for Enhanced Planetary Protection and Contamination Control	Gregory Fridman	All Planetary Bodies	2/7/2025	5	SBIR_24_P1
	Cold Plasma Sterilization for Contamination Control	Martin Toomajian	All Planetary Bodies	2/6/2025	4	SBIR_24_P1
CR Control	Microorganisms Genome Enrichment and Amplification Sequencing (MGEAS)	Liangliang Gao	All Planetary Bodies	6/13/2026	9	SBIR_23_P2

Projects with Planetary Protection Considered

- These are projects that meet the solicitation requirements for considering Planetary Protection during the development phase of hardware
  - Less time and cost required to ensure the hardware meets Planetary Protection requirements if manifested on a mission

- Typical implementation per proposals includes:
  - Description of Spacecraft Cleanliness and sample handling
  - Description of Sample handling and cross-contamination prevention
  - Description of protocols anticipated for future utilization of hardware

- Requirements of proposals submitted to PICASSO, MatISSE, and PSTAR, information provided in solicitations:
  - To address this requirement the proposal shall, at a level appropriate to the exit TRL:
    - Establish whether the instrument will require planetary protection protocols.
    - If the instrument requires planetary protection protocols, describe which specific components could pose a challenge.
    - Describe possible mitigation strategies to meet planetary protection requirements.

Projects with Planetary Protection Considered

Project title	PI	Focus Area	Anticipated Completion Date	TRL (current/end)	Program
ExCALiBR: Extractor for Chemical Analysis of Lipid Biomarkers in Regolith	Mary Beth Wilhelm	Mars sampler/extractor/concentrator	2/1/2028	4/5	MatISSE
Microfluidic Icy-World Chemistry Analyzer	Richard Quinn	Icy moons	2/1/28	4/5	MatISSE
Plume Ice Capture of Organics (PICO): Sample collection for in situ biosignature analyses	Anna Butterworth	Icy moons	2/1/28	4/6	MatISSE
UMIS: The Ultraviolet Micromirror Imaging Spectrograph	Amanda Hendrix	All planetary bodies	9/1/27	4/6	MatISSE
Luminescence Imager for Exploration	Richard Quinn	Icy moons	1/31/26	4/5	MatISSE
Saltation Sensor to TRL6	Don Banfield	Mars	6/30/26	4/6	MatISSE
Extraterrestrial Molecular Indicators of Life Investigation (EMILI)	William Brinckerhoff	All airless planetary bodies	1/31/26	5/6	MatISSE
OrganiCam: A Light-Weight Standoff Time-Resolved Fluorescence Imager and Raman Spectrometer	Patrick Gasda	Mars	1/31/26	4/6	MatISSE
Lunar Meteoroid Monitor	Mihaly Horanyi	Earth's Moon	4/3/25	5/6	DALI
Multispectral Imaging Compact Radiometer (MICR)	Benjamin Greenhagen	Earth's Moon	6/30/25	4/6	DALI
Lunar Raman Deep-Ultraviolet Visible Spectrograph (LR-DUV-VIS_	Matt Seigler	Earth's Moon	3/8/26	4/6	DALI
LASVEGAS on the Moon: A Hypertunable IR laser Spectrometer for tha Analysis of Volatiles	Scot Rafkin	Earth's Moon	3/8/26	4/6	DALI

Projects with Planetary Protection Considered

Project title	PI	Focus Area	Anticipated Completion Date	TRL (current/end)	Program
Lunar Heat Flow Radiometer	Kurt Retherford	Earth's Moon	3/8/26	4/6	DALI
Revelio: An Autonomous High Dynamic Range Camera for Polar Science and Exploration	Rebecca Schindhelm	Earth's Moon	3/22/26	4/6	DALI
PLASMA: Pulsed Laser Ablation Sampling and Mass Analysis	Ricardo Arevalo	Earth's Moon	6/15/26	4/6	DALI
In-situ and Remote Characterization of Lunar Surface Using Standoff micro-Raman (SUCR) Sensor	M. Nurul Abedin	Earth's Moon	1/31/28	4/6	DALI
The Biomass Enumerator and Geochemical/Limnological Explorer (BEAGLE) in an Europa-analog Environment.	Hazel Barton	Ocean Worlds	11/28/25	4/6	PSTAR
ORCAA: Ocean Worlds Reconnaissance and Characterization of Astrobiological Analogs	Samuel Howell	Ocean Worlds	9/30/25	N/A	PSTAR
Mars Exploring by Analog Drilling (MEAD)	Brian Glass	Mars	10/1/27	4/6	PSTAR

Per the PICASSO and MatISSE solicitation requirements there are 38 additional PICASSO projects

Summary

- PESTO manages technology development for PSD and ESSIO
- A Technology Development Strategy was developed by PESTO (per National Academies of Science's "Origins, Worlds, and Life A Decadal Strategy for Planetary Science and Astrobiology") outlining the goals and processes for Technology Development
    - A Technology Development pipeline was laid out in the Technology Development Strategy that includes programs funded by PSD, ESSIO and STMD
- There are currently eight ongoing Planetary Protection technology development projects focused on hardware maturation funded by PICASSO, MatISSE, and SBIR
- There are many ongoing technology development projects developing hardware with Planetary Protection considered in the design process per the ROSES solicitation and funded by PICASSO, MatISSE, DALI, and PSTAR

Thank you!