



1

NASA's FY 2024 Budget

- NASA's budget is \$24.875 billion for FY 2024.
- A 2% cut relative to 2023

NASA's budget by major program. Source: Space Policy Online FY2020 Fact Sheet.

For additional info visit:
[NASA's FY 2024 Budget - Planetary Society](#)

	2023 Enacted	2024 PBR	% Change
NASA	\$25,384	\$27,185	+7.1%
Science	\$7,795	\$8,261	+%6
↳ Planetary Science	\$3,200	\$3,383	+%5.7
↳ Earth Science	\$2,195	\$2,473	+12.7%
↳ Astrophysics	\$1,510	\$1,557	+3%
↳ Heliophysics	\$805	\$751	-6.7%
↳ Biological & Physical Science	\$85	\$97	+%13.5
Exploration	\$7,469	\$7,971	+6.7%
↳ Orion Crew Vehicle	\$1,339	\$1,225	-8.5%
↳ SLS	\$2,600	\$2,506	-3.6%
↳ Human Landing System	\$1,486	\$1,881	+27%
Space Technology	\$1,200	\$1,392	+16%
Space Operations	\$4,250	\$4,535	+6.7%
↳ Commercial LEO Development	\$224	\$228	+1.8%
Aeronautics	\$935	\$996	+6.5%
STEM Engagement	\$143.5	\$157.8	+10%
Safety, Security, & Mission Services	\$3,130	\$3,369	+7.7%
Construction and Environmental Compliance	\$414.3	\$454	+9.5%
NASA Inspector General	\$47.6	\$50.2	+5.5%

2

NASA On-orbit Missions Update

3

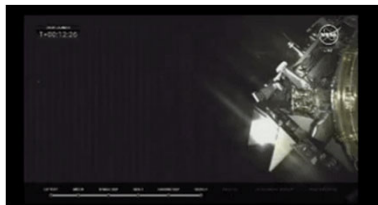
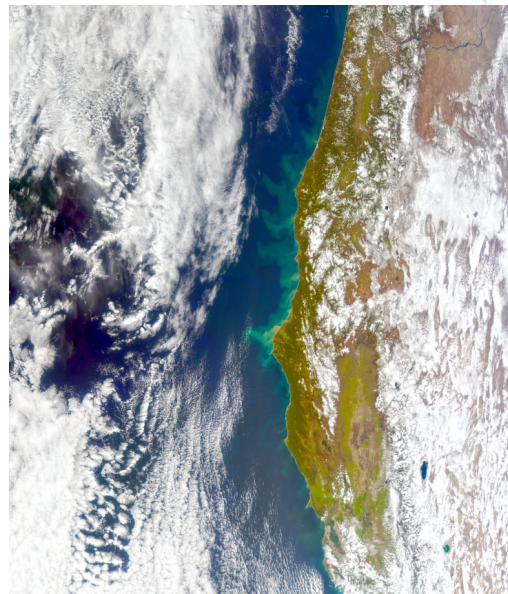
3

Plankton, Aerosol, Cloud, ocean Ecosystem (PACE)



Science goals:

- To extend key systematic ocean color, aerosol, and cloud data records for Earth system and
- climate studies, and to address new and emerging science questions using its advanced instruments, surpassing the capabilities of previous and current missions.

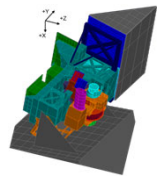
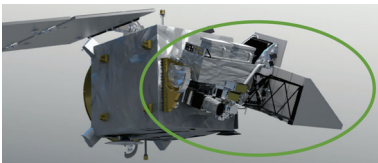
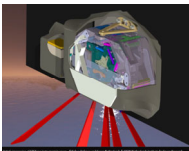
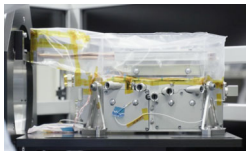
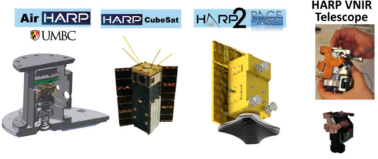


PACE satellite launched aboard a SpaceX Falcon 9 rocket at 1:33 a.m. EST, Feb. 8, 2024

4

PACE Instruments

- **Ocean Color Instrument (OCI)**, primary sensor, is a highly advanced optical spectrometer that will be used to measure properties of light over portions of the electromagnetic spectrum. It will enable continuous measurement of light at finer wavelength resolution than previous NASA satellite sensors, extending key system ocean color data records for climate studies. It is capable of measuring the color of the ocean from ultraviolet to shortwave infrared.
- **Spectro-Polarimeter for Planetary Exploration (SPEXone)** is a multi-angle polarimeter that provides continuous wavelengths coverage in the range 385-770 nm. It measures the intensity, Degree of Linear Polarization (DoLP) and Angle of Linear Polarization (AoLP) of sunlight reflected back from Earth's atmosphere, land surface, and ocean.
- **Hyper-Angular Rainbow Polarimeter #2 (HARP2)** is a wide angle imaging polarimeter designed to measure aerosol particles and clouds, as well as properties of land and water surfaces.

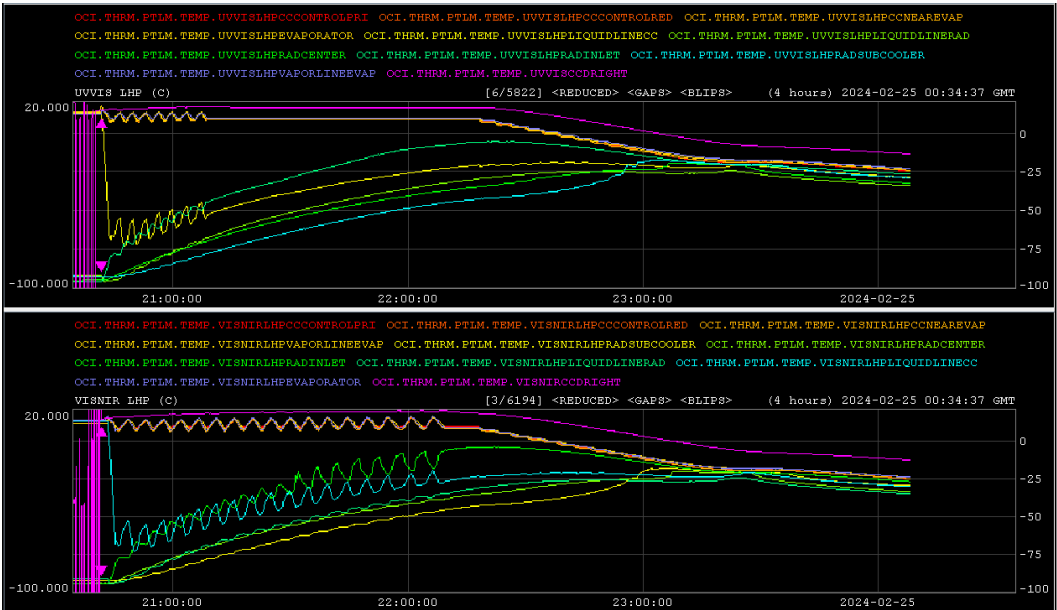


	OCI	SPEXone	HARP2
Spectral range (bandwidth)	342.5 - 887.5 @ 5 nm steps (5 nm)	385 - 770 nm @ 2-4 nm steps	440, 500, 670 (10 nm) & 870 nm (40 nm)
Shortwave infrared (OCI) / Polarized bands (SPEXone, HARP2)	Seven bands centered on 940, 1038, 1250, 1378, 1615, 2130 & 2260 nm	Same range in 15 to 45 nm steps	All
Number of viewing angles (tilt/azimuth)	Fore-aft tilt +/- 20° to avoid sun glint	Five [-57°, -20°, 0°, 20°, 57°]	10 for 440, 500, 670 nm & 60 for 870 nm (pointed over 114°)
Coverage (swath width)	+/- 56.5° (2063 km at 20° tilt)	+/- 4° (100 km)	+/- 47° (1508 km at nadir)
Days for global coverage	1-2	About 30	2
Ground sample distance	1 km at nadir	2.5 km	3 km
Institution(s)	Goddard Space Flight Center	SRON Netherlands Institute for Space Research, Airbus Defence and Space Netherlands, TNO	University of Maryland - Earth and Space Institute

5

5

First On-Orbit Startup of the PACE OCI LHPs



6

6

Lessons Learned from PACE OCI LHPs

- High power control heater
 - 9W control heater was used for PACE OCI LHPs.
 - Less than 3W is needed for all steady-state conditions.
 - The 9W control heater was employed to accomplish smooth startups from a large initial temperature difference between evaporator and condenser.
 - Initial conditions: $T_{\text{evap}} = +15^{\circ}\text{C}$, $T_{\text{cond}} = -95^{\circ}\text{C}$. The temperature difference is over 100°C .
- An autonomous startup scheme has been developed to eliminate human factor and keep FPA temperature rate of change below $2^{\circ}\text{C}/\text{min}$.
- Enlarged radiators compensated for higher than expected thermal strap ΔT .

7

7

James Webb Space Telescope (JWST) – Lessons Learned

Modeling

- Attention to detail was paramount. Everything needed to be evaluated as a significant path. "Chasing milli-watts."
- System-level model for all final cases.
- Need good data for temperature dependent materials. Property changes (k , C_p , e) are dramatic in JWST temperature range.

Verification

- Push Electrical teams for measurement/estimation of actual power use (dissipation) of each electronic element during TVAC testing.
- For TVAC analyses, treat Ground Support Equipment (GSE) with same level of detail as the payload. Underestimating the role of GSE on the thermal environment can make it difficult to achieve goals.
- After set-up in Chamber, test as many sensors as available (e.g. touch test, heat pad, etc). Check response is assigned to the proper mnemonic in the telemetry stream. This includes GSE sensors.

Operations

- Identify early if standard monitoring tools are sufficient to provide adequate protection.
- Forecast Time-to-Yellow/Red was extremely useful given 1000 sensors.
- Identify any non-time-critical tools which might be routinely needed for post-processing, and construct/test long before launch. Ex: JWST used MATLAB scripts to calculate heater duty-cycles.

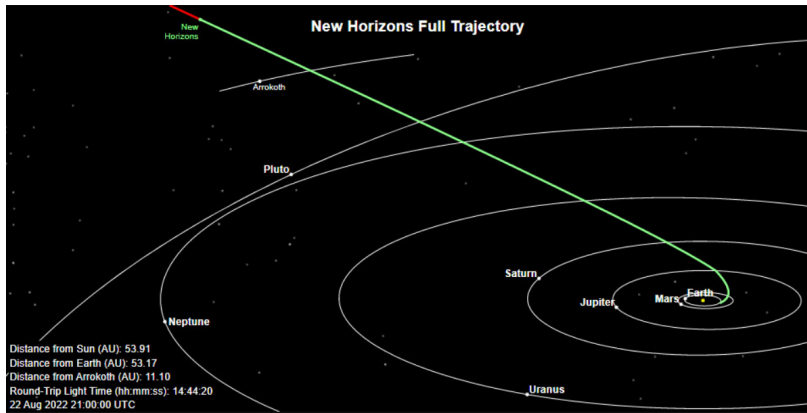
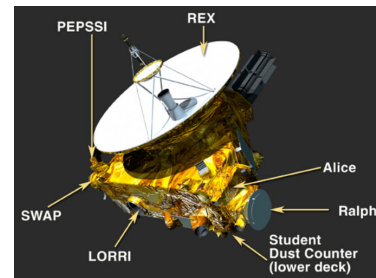


8

8

New Horizon

- New Horizons remains healthy while continuing its exploration of the Kuiper Belt and outer heliosphere.
- In April 2022 its mission was extended a second time to potentially conduct multi-disciplinary observations of relevance to the solar system and NASA's Heliophysics and Astrophysics Divisions.
- The New Horizons science payload consists of seven instruments – three optical instruments, two plasma instruments, a dust sensor and a radio science receiver/radiometer.



Thermal Control

- The spacecraft is covered with MLI.
- Heat from the electronics has kept the spacecraft operating between 10 °C and 30°C.
- Active control with electrical heaters and louvers.

9

9

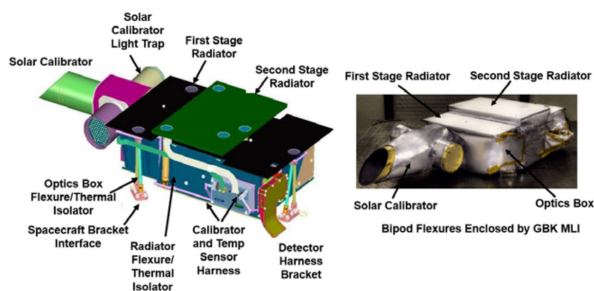
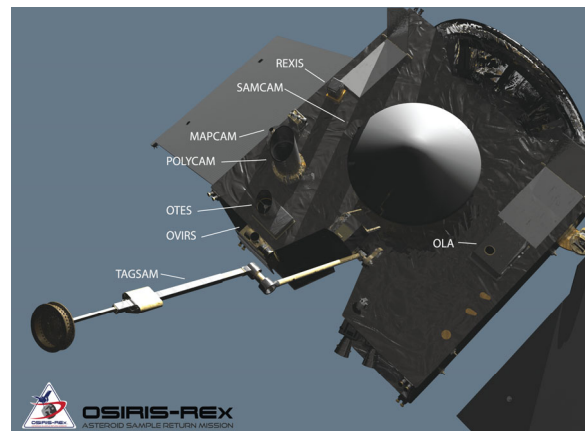
OSIRIS-REx

- NASA's OSIRIS-REx, the first U.S. mission to collect a sample from an asteroid, will return to Earth on Sept. 24, 2023, with material from asteroid Benu.
- The Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer (OSIRIS-REx) Visible and Infrared Spectrometer (OVIRS) is a cryogenic instrument.

Updates:

- The OSIRIS-REx mission was officially completed on 9/24/2023 after the Benu asteroid sample was successfully returned to Earth. OSIRIS-APEX, an extended mission, began on 9/24/2023 to encounter Asteroid Apophi in 2029. The trajectory takes the spacecraft within 0.506 AU of the sun (warmer thermal environment than OSIRIS-REx).

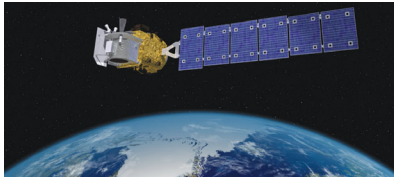
OVIRS with a Two-Stage Radiator, Flexures and MLI Blankets



Credits: NASA/University of Arizona

10

10

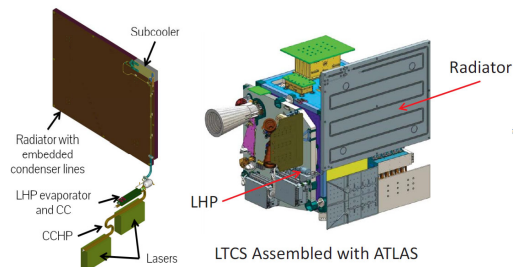
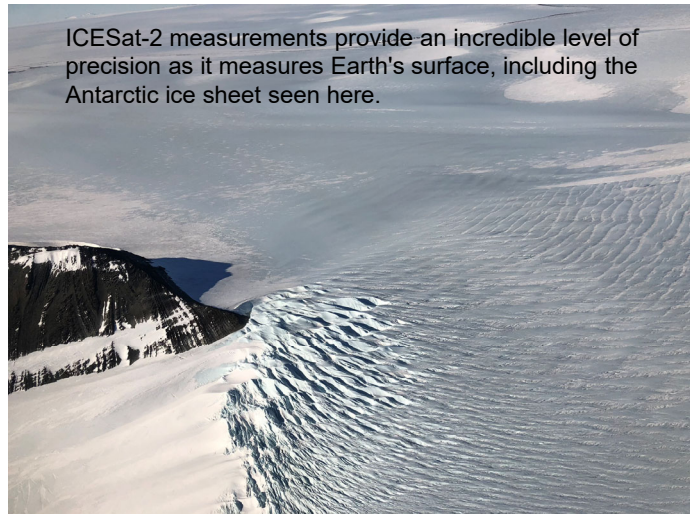


ICESAT-2 / ATLAS



- ICESat-2 carries a single instrument – the Advanced Topographic Laser Altimeter System, or ATLAS. Like the altimeter on the first ICESat mission, ATLAS measures the travel times of laser pulses to calculate the distance between the spacecraft and Earth's surface.
- Last summer NASA Approves Continuation of ICESat-2 After 4+ Years of successful operation.

Redundant lasers are cooled via a single Laser Thermal Control System

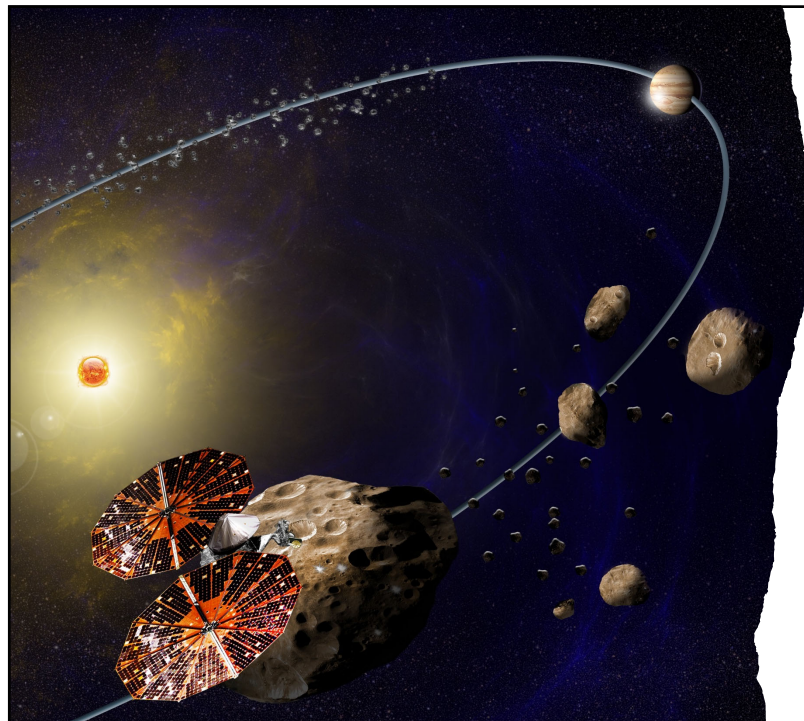


ICESat-2 measurements provide an incredible level of precision as it measures Earth's surface, including the Antarctic ice sheet seen here.

Credits: NASA's Goddard Space Flight Center/Kate Ramsayer

11

11



Lucy

The first space mission to explore a population of small bodies known as the Trojan asteroids, which orbit the Sun "in front of" and "behind" the gas giant Jupiter. The Trojan Asteroids are leftovers from the early days of our solar system, effectively the fossils of planet formation.

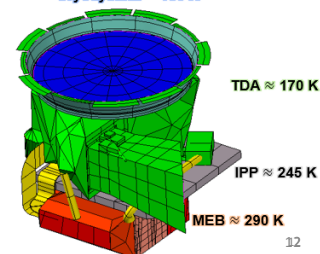
Launched October 16th, 2021

L'Ralph

The L'Ralph IR detector is running colder than expected.

GSFC in-house instrument on Lucy with two detectors: The visible wavelength multicolor imager (MVIC) and the infrared Linear Etalon Imaging Spectral Array (LEISA), which is passively cooled to 100K. Image below shows temperature zones.

Cryosystem ≈ 100 K



12

12

Landsat 9 (Earth from Space)



- Science Instruments: OLI-2; TIRS-2
 - OLI-2 build: Ball Aerospace & Technology Corp.
 - TIRS-2 build: NASA Goddard Space Flight Center
- Design Life: 5 years
- Spacecraft Provider: Northrop Grumman Innovative Systems (NGIS)
- Image Data: > 700 scenes per day
- Launch Date: Sept. 27, 2021
- Launch Vehicle: United Launch Alliance Atlas V 401
- Orbit: near-polar, sun-synchronous at an altitude of 438 miles (705 km)
- Orbital Inclination: 98.2°
- Spacecraft Speed: 16,760 mi/hr (26,972 km/hr)
- **All instruments and spacecraft operating normally.**

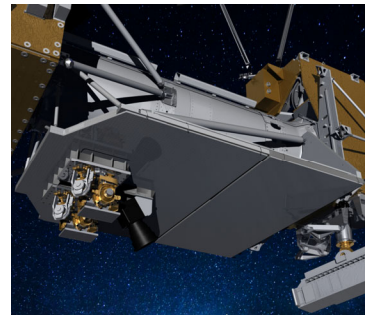
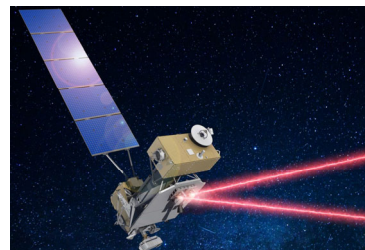


13

13

Laser Communications Relay Demonstration (LCRD)

- The LCRD payload is hosted aboard the U.S. Department of Defense's Space Test Program Satellite 6 (STPSat-6). After launch Dec. 7, 2021, engineers at LCRD's mission operations center in Las Cruces, New Mexico, turned the payload on and prepared it to start transmitting data over infrared lasers.
- With LCRD relaying data for ILLUMA-T, this is the first operational optical communications system for human spaceflight. ILLUMA-T sends data to LCRD at rates of 1.2 gigabits per second over optical links, allowing for more high-resolution experiment data to be transmitted back to Earth.
- **LCRD is working normally.**

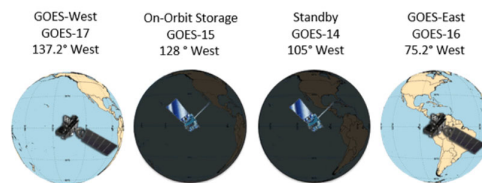


14

14

GOES-R Series LHPs

- GOES-R (GOES 16/GOES East)
 - ABI and GLM instruments fully operational since launch in 2016
 - ABI LHP1 and GLM LHP1 have operated since 2016
 - GOES East expected to be replaced by GOES 19
- GOES-S (GOES 17/Storage mode)
 - SC and instrument provided weather data but did not meet all requirements
 - ABI LHP1 & LHP2 transport was <10% of requirement
 - Replaced by GOES-T
- GOES-T (GOES 18/GOES West)
 - Launched and operational since 2022.
 - ABI LHPs were redesigned
 - Titanium wick and ammonia working fluid rather than nickel wick and propylene
 - Serpentine condenser instead parallel leg condenser
 - LHPs operating nominally
- GOES-U/19 (Awaiting Launch 6/25/24)
 - Duplicate ABI LHP design as GOES-T



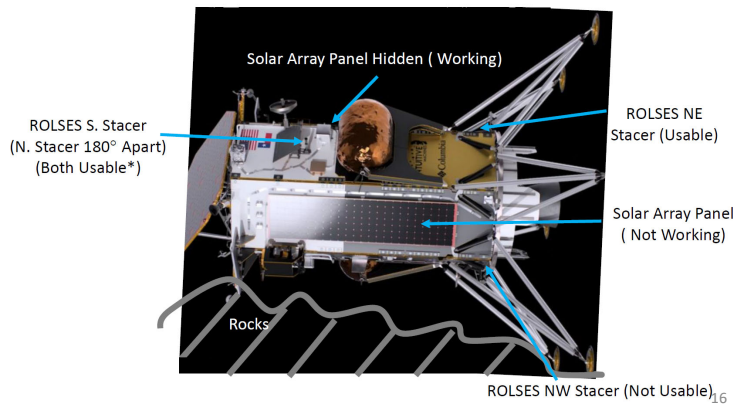
15

15

Lunar Lander



- A lunar lander or Moon lander is a spacecraft designed to land on the surface of the Moon.
- The second Commercial Lunar Payload Services (CLPS) probe Odysseus landed on 22 February 2024 on the Moon, marking the United States' first unmanned lunar soft-landing in over 50 years. This mission is the first private-NASA partnership to land on the Moon and the first landing using cryogenic propellants.
- However, the mission experienced some anomalies, including tipping-over on one side on the lunar surface; an off-nominal initial lunar orbit, a non-functioning landing LIDAR instrument, and apparently low communication bandwidth.



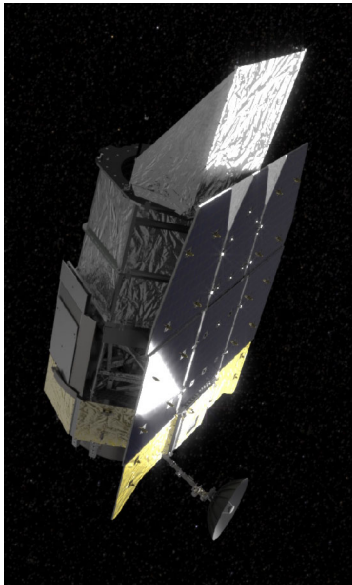
16

NASA GSFC Future Missions

17

17

Roman Space Telescope (RST)



- The Roman Space Telescope is a NASA observatory designed to unravel the secrets of dark energy and dark matter, search for and image exoplanets, and explore many topics in infrared astrophysics.
- The Roman Space Telescope will have two instruments, the Wide Field Instrument, and the Coronagraph Instrument.
 - The Primary Wide Field Instrument will have a field of view that is 100 times greater than the Hubble infrared instrument, capturing more of the sky with less observing time
 - The Coronagraph Instrument will perform high contrast imaging and spectroscopy of individual nearby exoplanets.
- The Roman Space Telescope has a 2.4m telescope. the same size as Hubble's, but with a view 100 times greater than Hubble's.

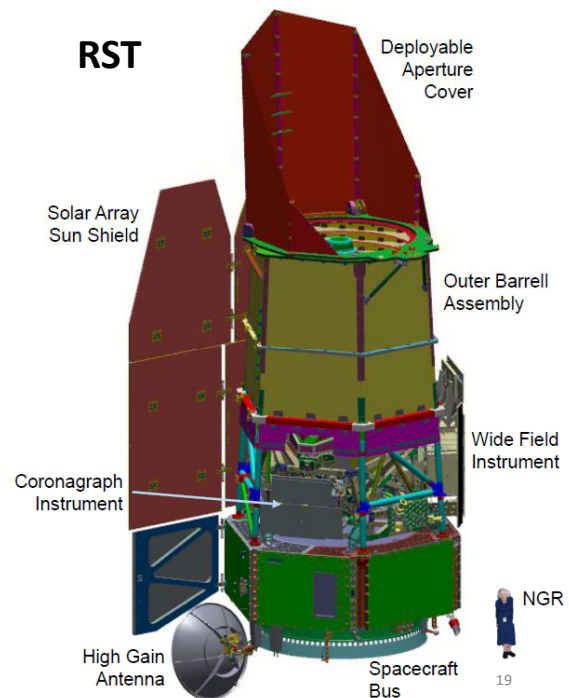
18

18

OBSERVATORY

- 12-m height, 10,500 kg, 4500W
- 3-axis stabilized, mono-prop hydrazine propulsion
- 1.7-m High Gain Antenna
- Vibration isolation between Payload and Spacecraft
- Tight thermal control

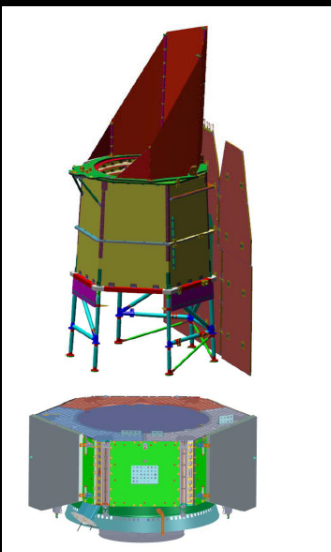
RST



19

OBSERVATORY

RST

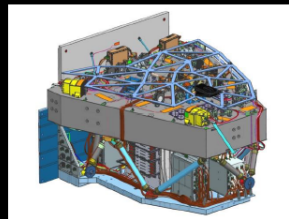


Spacecraft
(NASA/GSFC)

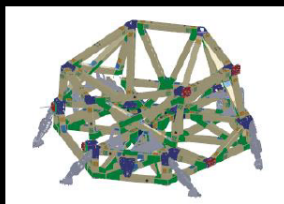
Optical
Telescope
Assembly
(L3Harris)



Electronics
not shown

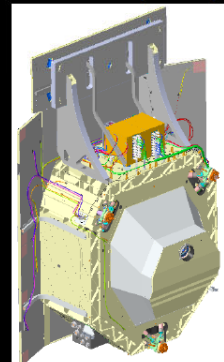


Coronagraph
Instrument
(JPL)



Instrument Carrier
(NASA/GSFC +
Northrop Grumman)

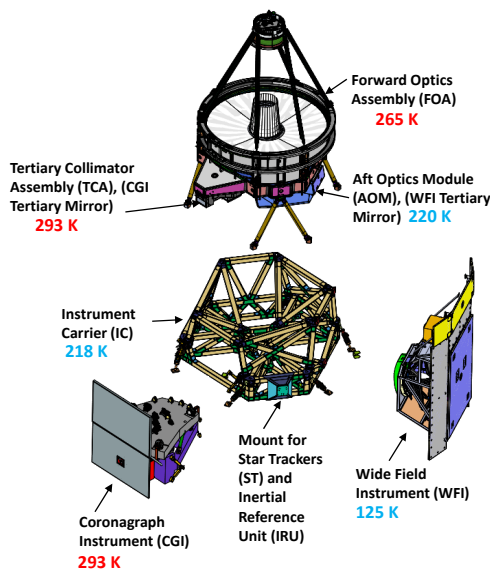
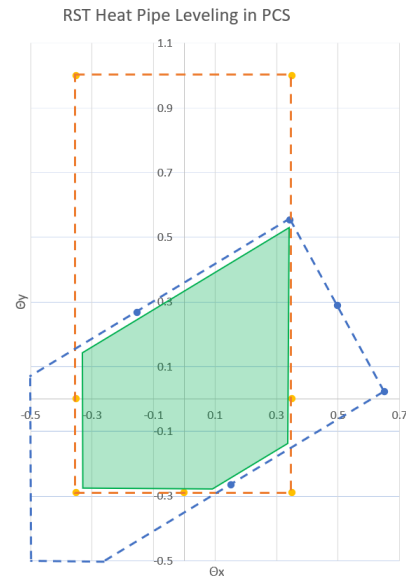
Wide Field
Instrument
(NASA/GSFC +
Ball Aerospace)



Electronics not shown

20

Defining the Allowable Tilt Space for the RST Heat Pipes



21

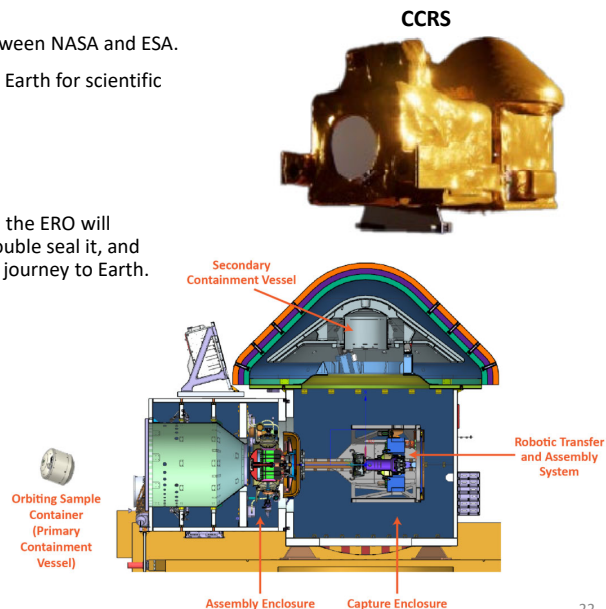
21

Mars Sample Return Program and Capture, Containment and Return System

- The Mars Sample Return (MSR) Program is a partnership between NASA and ESA.
- Program objective is to return Martian geological samples to Earth for scientific study.
- The MSR Program consists of two major flight projects:
 - The Earth Return Orbiter (ERO)
 - Sample Retrieval Lander (SRL).
- The Capture, Containment and Return System (CCRS) aboard the ERO will capture the Orbiting Sample container in orbit, orient and double seal it, and transfer it into the Earth Entry System—a clean zone—for its journey to Earth.

Updates:

- CCRS is delayed due to MSR funding restrictions.
- New launch dated TBD.
- Updated method of sterilizing the Sample Container requires heat transport:
 - ☐ Requires spatially uniform temperature of source.
 - ☐ Variable dissipation from source.
 - ☐ Local removal of heat with transport to external radiator via heat pipes.



22

22

COSI – the Compton Spectrometer and Imager



The Compton Spectrometer and Imager (COSI) is a soft gamma-ray survey telescope.

Science goals:

- Uncover the origin of galactic positrons
- Reveal galactic element formation
- Gain insight into extreme environments with polarization
- Probe the physics of multi-messenger events

Operation:

- 2 year prime mission
- all-sky maps
- spectroscopic survey

Instrument:

- compact and powerful (0.2-5 MeV) Compton telescope
- active shielding

Status:

- COSI has been confirmed and is proceeding to Phase C.
- The Key Decision Point review occurred on April 16, 2024.
- This marks the end of the mission formulation phase and the start of implementation.



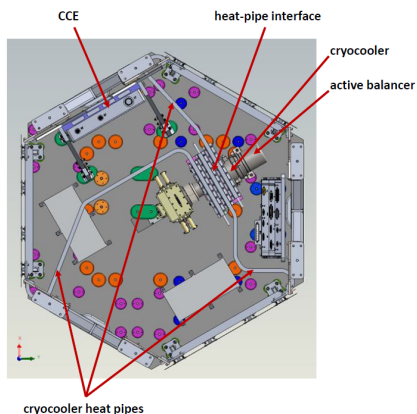
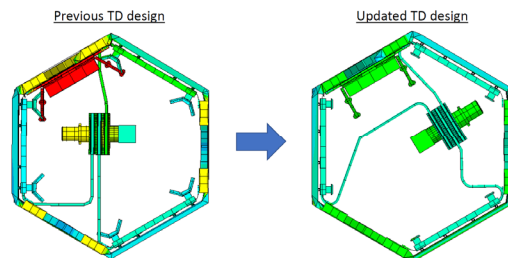
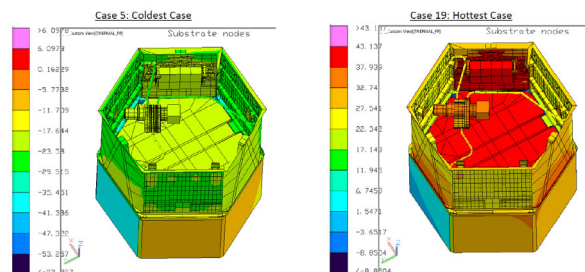
23

23

COSI – Cryostat Heat Removal Subsystem (CHRS)



- Cryocooler was relocated due to payload constraints.
- Cryocooler heat pipes were redesigned.
- Updated thermal models.
- Completed PDR and selected heat pipe vendor.



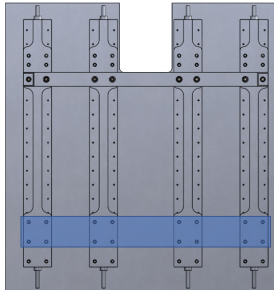
24

24

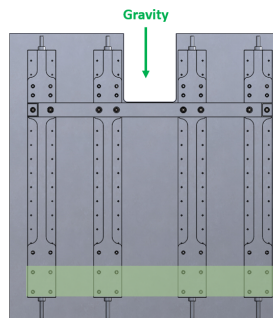
COSI CHRS Challenges



- TVAC testing at Goddard.
- Two mounting bolt patterns for cryocooler heat pipes:
 - One for the flight (shown in blue)
 - One for the CHRS TVAC (shown in green)

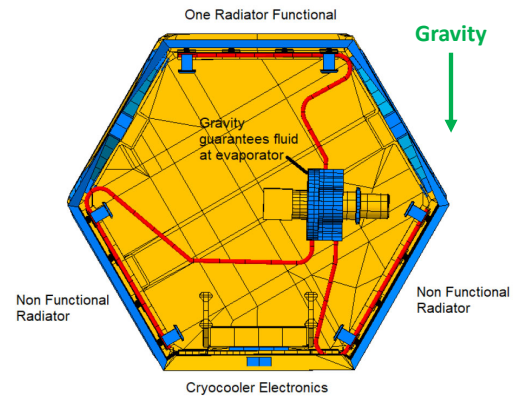


Cryocooler heat pipe attachment
Flight Configuration



Cryocooler heat pipe attachment
during the TVAC of the CHRS

- Observatory level TVAC at bus Vendor.
- Two out of three cryo heat pipes will not be operational.
- GSE chiller clamped onto the cryo heat pipe interface to remove heat.



25

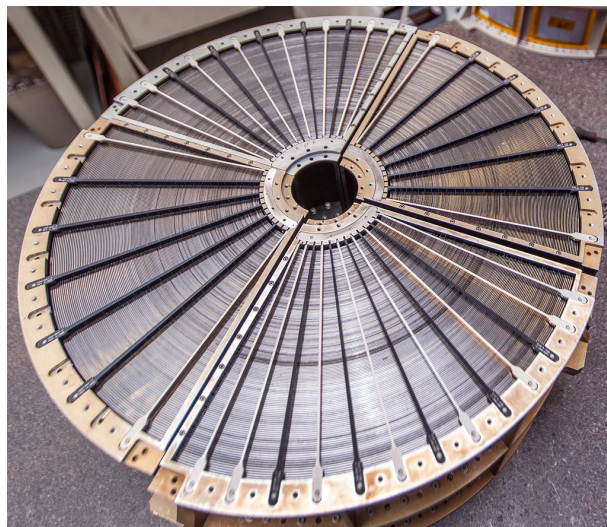
25

XRISM

XRISM Spacecraft at JAXA
The Mirror Assembly is under MLI



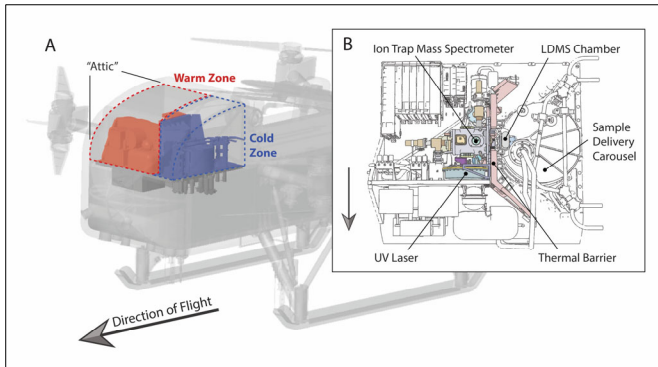
XMA mirror



26

26

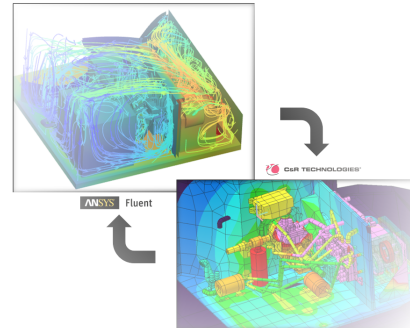
DraMS (Dragonfly Mass Spectrometer)



Updates:

- ANSYS FLUENT and TD Co-Solver is utilized on DraMS program.
- It allows to analyze complex convection/radiation/conduction thermal problems.

- Dragonfly will fly around Titan looking for origins and signs of life.
- Titan's atmosphere is 94K and 1.5 bars pressure.

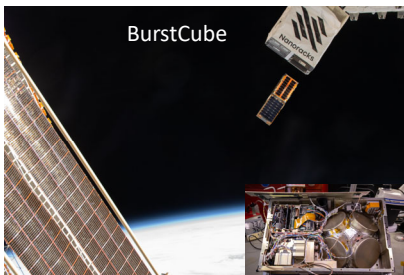


27

27

CubeSats

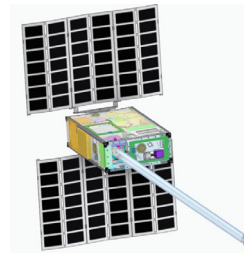
- BurstCube and SNOOPI launched to the ISS on March 21st of 2024.



- PolSIR completed SRR in January of 2024.
 - PolSIR will study high-altitude ice clouds
 - Two 12U CubeSats



- Dione is planned to be TVAC tested in August of 2024



28

28

DaVinci – Extreme Temperature Technologies (Venus environment)

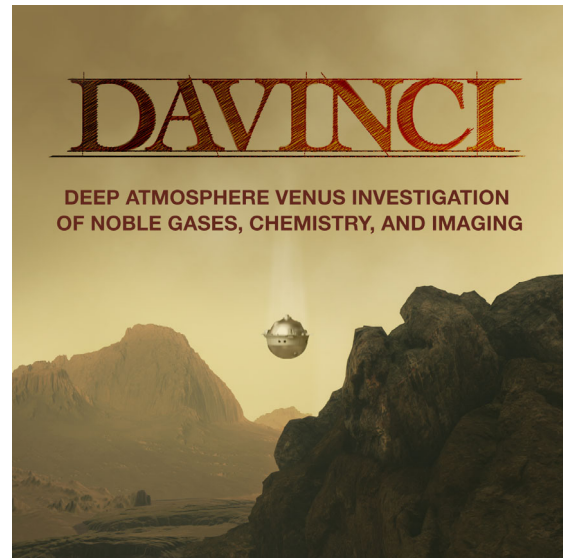
- NASA's DAVINCI mission will study the origin, evolution, and present state of Venus in unprecedented detail from near the top of the clouds to the planet's surface. The mission's goal is to help answer longstanding questions about our neighboring planet, especially whether Venus was ever wet and habitable like Earth.

Updates:

- Funding has been cut quite severely this fiscal year.
- Some tasks have been postponed until FY25.

Impact

- The descent sphere's baseline design of an internal vacuum environment may be reconsidered (1atm N₂), due to perceived outgassing which could increase pressures inside the sphere to unacceptably high levels.



29

29

On-orbit Servicing, Assembly, and Manufacturing 1 (OSAM-1)

- On Feb. 29, 2024 NASA held an Agency meeting to receive the recommendations from a Continuation Review conducted by an Independent Review Board related to NASA's OSAM-1 project. After the review, NASA canceled the project and notified Congress of the agency's decision. On March 9, NASA's Fiscal Year 2024 Appropriations was signed into law, directing NASA to continue with an adjusted OSAM-1 mission.
- At this time, NASA is working through the Appropriations Committee's direction related to OSAM-1 while it continues work on OSAM-1 and assesses whether the adjusted OSAM-1 mission outlined in FY24 Appropriations is viable.
- Additionally, NASA continues to explore potential partnerships.

30

30

GeoXO status

- The Geostationary Extended Observations (GeoXO) satellite system is the National Oceanic and Atmospheric Administration (NOAA)'s planned replacement for the existing Geostationary Operational Environmental Satellite (GOES) satellites.

GeoXO Imager (GXI)

- Back in March of 2023 NASA and NOAA awarded L3Harris a \$765.5 million contract to develop the first two GeoXO Imager (GXI) instruments.

GeoXO Sounder (GXS)

- On September 11, 2023, NASA and NOAA awarded Ball Aerospace (later sold to BAE Systems Inc.) a \$486.9 million contract to develop the GeoXO Sounder (GXS) instrument.

31

31

Thermal Technology Development through SBIR

- Last year our topic (Thermal Control Systems – S16.05) was rotated out.
- It is back in this year!
- What is different this time?
 - Number of scopes was reduced from four to three.
 - Two scopes were updated:
 - **Compact** systems for Lunar applications.
 - Coatings for **structures** (not just for the radiators).
 - A new scope has been nominated for the 2024 SBIR solicitation:
 - **Artificial Intelligence** for TCS
- The solicitation is available online: https://www.nasa.gov/sbir_sttr/phase-i/

32

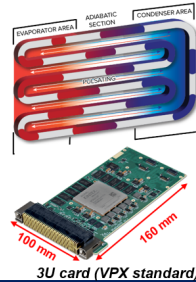
32

Advanced Cooling System for Modular Power Electronics (Z2.01-1280)

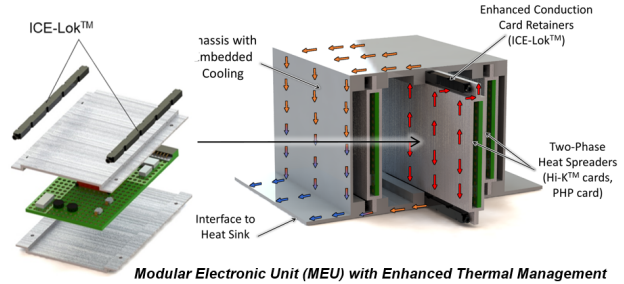
Contract (Center): 80NSSC22CA205 (GSFC); Subtopic: Z2.01 Spacecraft Thermal Management; Solicitation-Phase: SBIR 2021-II
PI: Kuan-Lin Lee, kuan-lin.lee@t-act.com; COR: Sergey Semenov

Innovation

- On-ground and space electronics cards can be easily accessible and interoperable through modularization
- High power dissipation from these cards requires effective and robust thermal management solution
- Pulsating Heat Pipe (PHP) heat spreader was proposed to handle high heat loads
 - Additive manufacturing allow PHP channels to extend into stepped edges
 - Improve card-to-chassis heat transfer
 - Thinner and lighter
 - No freezing issues



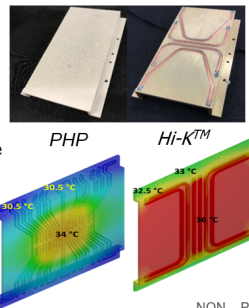
3U card (VPX standard)



Modular Electronic Unit (MEU) with Enhanced Thermal Management

Technical

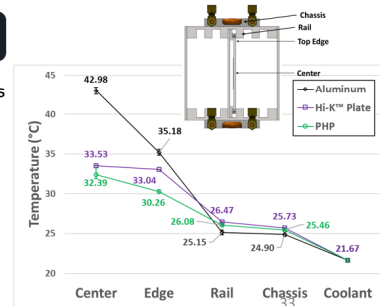
- Refine PHP design for modular electronics
- Mature PHP manufacturing
- Comparison between PHP and heat pipe embedded heat spreader (Hi-K™ plate)
- Develop embedded cooling chassis concept
- Space qualification testing



NON - PROPRIETARY DATA

Applications

- High heat flux electronics
- Aerospace heat spreading/rejection
- Defense systems
- Medical devices
- EV/battery cooling
- And more...



33



Robust Two-Phase Cooling Technology for Megawatt Space-Based Systems

FIRM: TTH RESEARCH, INC.
PI: Triem Hoang Proposal #:Z2.01-2742

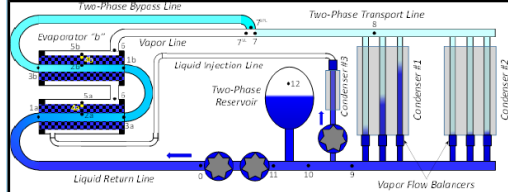


NON-PROPRIETARY DATA

Objectives

The Phase I tasks shall be dedicated to the completion of the two main objectives listed below at the end of the 6-month period of performance:

- To experimentally demonstrate the feasibility of a Hybrid Loop with Ammonia as the working fluid to increase heat transport capacity over that of a LHP of the same size by an order of magnitude.
- To design a high-fidelity LHP engineering demonstration unit (EDU) and prepare for hardware fabrication and testing in Phase II and/or other future opportunities.



ACCOMPLISHMENTS

Notable Deliverables Provided

The major delivery of the Phase I research is the design, construction, and 4-week performance testing of a Hybrid Mechanical/Capillary-Pumped Loop to demonstrate the viability of using a pair of mechanical pumps to augment the capillary pumping head. As a result, the maximum heat transport was enhanced an astounding one-order-of-magnitude over a Loop Heat Pipe of the same equivalent size. The maximum power achieved in the test was 775W compared to 50W for the LHP. But more important than that, every other aspects of operation that were proclaimed beforehand were all positively verified. All in all, the Phase I demonstration test unit was able to handle rapid transient dynamics (power step-ups/downs), deprime recovery, and variable pump speeds.

Key Milestones Met

The initial goal was extend the same design of a "bench test" hybrid loop with Freon as the working fluid to the much higher internal pressure of Ammonia system. Notwithstanding, the budget and schedule constraints of NASA Phase I, TTH Research Inc. and its hardware subcontractor, Boyd/Thermacore, has to salvage a multiple-evaporator miniature LHP and re-purposed it into the Phase I test unit. It was not a walk in the park, but everything was down properly, on time and on budget.

34



2023-1-124-S - Integration of Dust Resisting Secondary Emission Engineered Passive Thermal Control Material Systems (TCMS) Coating on - Flight & Test Hardware and Its Performance Validation Testing Per NASA-STD-1008

PI: Mukund Deshpande , Applied Material Systems Engineering, Inc. (AMSENG) - Schaumburg, IL



NON-PROPRIETARY DATA

IDENTIFICATION AND SIGNIFICANCE OF INNOVATION

AMSENG present a team with the capable candidates for further investment through a sequential Phase II Proposal invited for the white paper (2023-1-94-W) specifically for Technical Need Area 2023-1: Lunar Dust Mitigation Solutions. We plan to demonstrate Insertion of the developed Passive dust shedding TCMS coating Technology on to the Chosen Hardware: Engineering Design Unit (EDU), or Test Articles or Flight Hardware and Prepare the Material & Processing Protocols and SOPs for the Enhanced TRL for the further use. The Materials and Process Engineering Protocols and SOPs for the passive dense dust shedding Thermal Control coatings as applied to various aero-space surfaces and its validation for functioning over the full range of combined extreme lunar surface environmental conditions of UV-e⁺ radiation, and Moon's Charged Dusty environment on hardware witness coupons is anticipated. Our suggestions are based on the successes for the secondary emission engineering of Passive Dense Dust shedding TCMS per program: 80NSSC21C0514.

TECHNICAL OBJECTIVES AND PROPOSED DELIVERABLES

Passive Dust Shedding Dense Thermal Control Coatings Developed for Extreme Lunar Dusty Environment is planned for Integration on surfaces of the Engineering Design Units (EDUs) or Test or Flight Hardware for the Lunar Mission Hardware, Thermal Bus Hardware, Various Lunar Vehicles parts and Lunar Payload Hardware. The Demonstrated Enhancement of the TRL through Validation & Testing to illustrate success for the selected formulations and hardware.

Work Plan: (1) Leverage Secondary Emission Engineering Technology Achievements in NSSC21C0514 and process needed TCMS for the Dense - Dust Shedding Passive Thermal Control Coatings. (2) Formulate selected TCMS formulations and Quality - Validate through Space Environment Simulation: AFRL/SCEPTE and Lunar Dust Simulation: IITL-USA. (3) Carry out Needed Testing and Validate Coating Processing Protocols and SOPs per mission Needs.

Deliverable: (1) Quarterly Progress Reports, Final Report, Protocols and SOPs used for the Lunar Hardware Demonstration Units. Finalized Processing Protocols and SOPs for the Chosen Dense Dust Shedding Secondary Emission Engineered TCMS Coating Technology for the Enhanced TRL (2) Witness coupons for the Processed Hardware and Report on the generated Data from the GEO Space Simulation Testing and The Lunar Dust Simulation Testing

TRL

Estimated

1	2	3	4	5	6	7	8	9



80NSSC21C0514 Technologies & Facilities for Integration of Plasma Sprayed TCMS On Lunar Hardware

NASA APPLICATIONS

NASA Science Mission Directorate (SMD) missions can greatly benefit from this dust mitigation passive thermal coating technology: All Lunar-related projects - Power and Thermal Bus Sub Systems, and all projects involved with robotic science rovers and landers.

NON-NASA APPLICATIONS

The Technology Developed and Demonstrated through Sequential Program can be useful for:

(1) Survivable Thermal Control Material Systems and Coatings that are hardened for the upper atmospheric man made or natural Nuclear Event. (2) Solar Storms and GEO, MEO & LEO survivable Products and Technology that can employ electron on demand strategies in products like: Hardened Coating, Wiring harnesses

FIRM CONTACTS

Mukund Deshpande
Applied Material Systems Engineering, Inc. (AMSENG)
EMAIL: m.deshpande@amseng.net
PHONE: (312) 498-9673

35

35

Thermal Coatings Technology

Coatings Group Leader – Mark Hasegawa

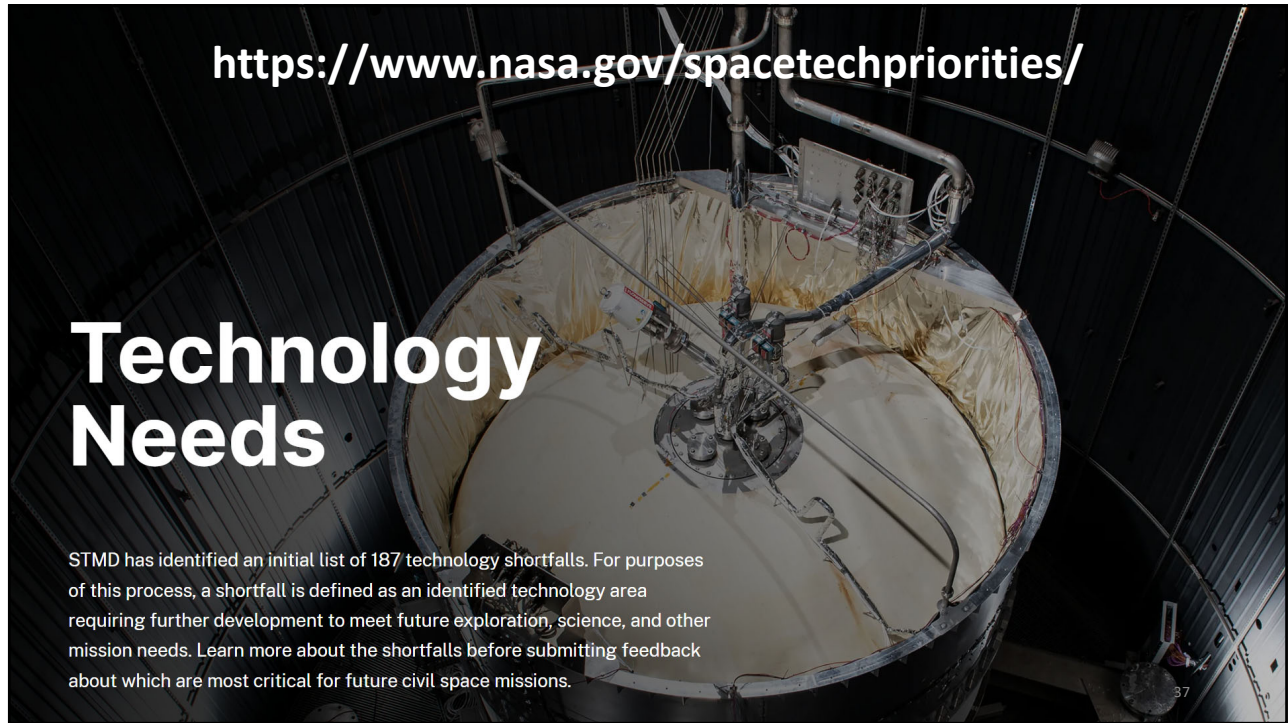
Mark.M.Hasegawa@nasa.gov



- Evaluation of new, white electrically dissipative inorganic silicate based coatings.
 - Incorporation into topcoats on existing silicate coated surfaces
 - Compatibility with human space flight projects
- Gold black UV absorptive vacuum deposited coating on complex surfaces.
- Improved space and terrestrial stability of second surface mirrored surfaces for MLI outer cover.

36

36



<https://www.nasa.gov/spacetechpriorities/>

Technology Needs

STMD has identified an initial list of 187 technology shortfalls. For purposes of this process, a shortfall is defined as an identified technology area requiring further development to meet future exploration, science, and other mission needs. Learn more about the shortfalls before submitting feedback about which are most critical for future civil space missions.