EXPLORE
SOLAR SYSTEM & BEYOND

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PAC

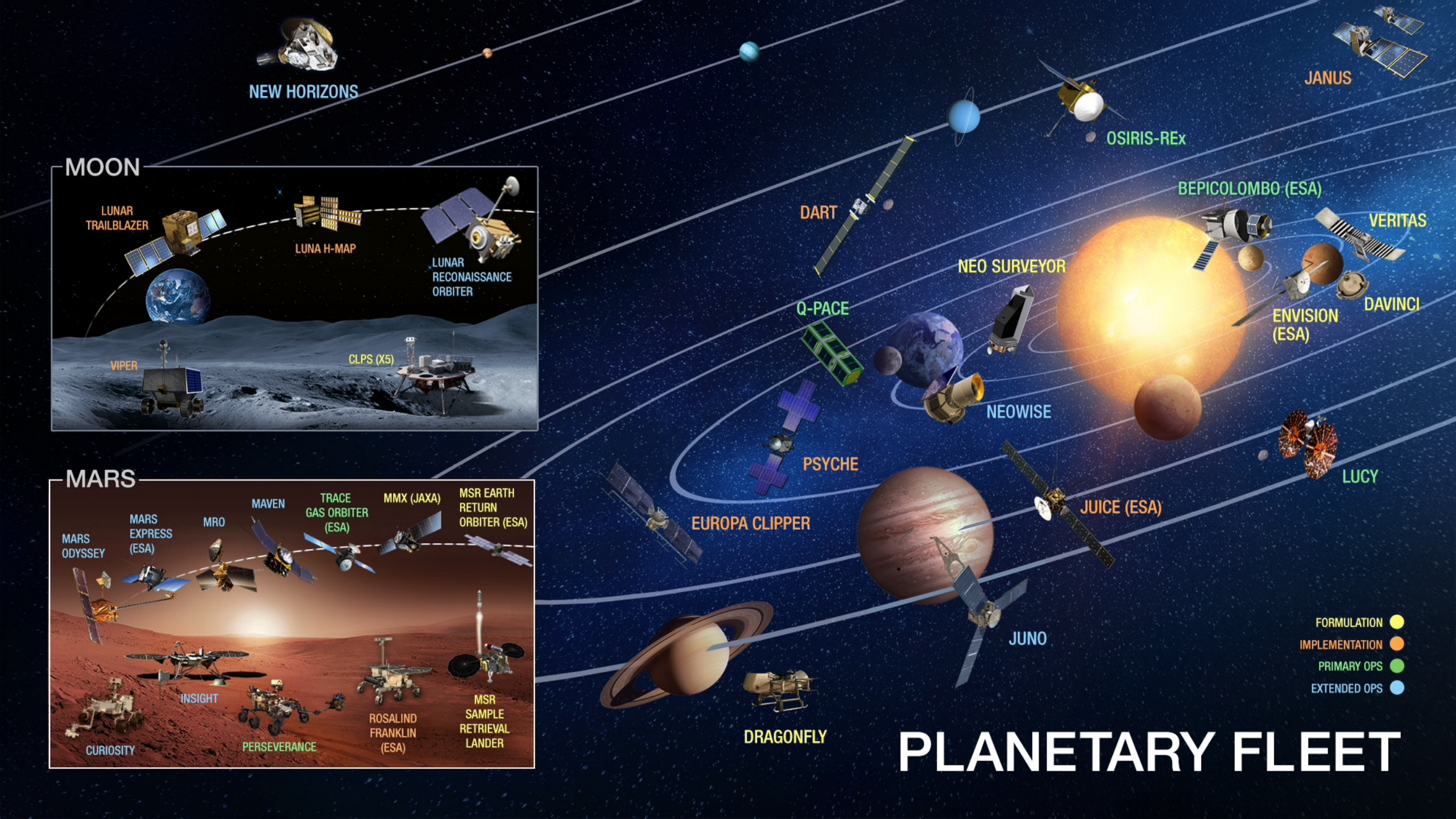
November 15, 2021

Welcome (back) to the PAC!

Brief PAC overview:

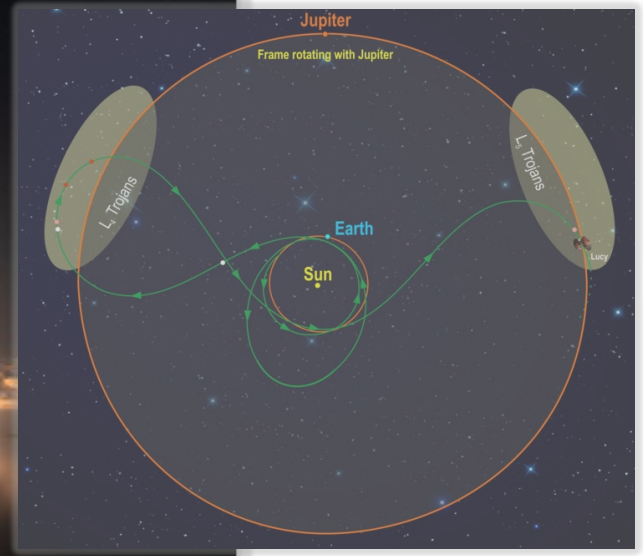
- Authority: Federal Advisory Committee Act (FACA)
- Objectives/scope: Provide advice and make recommendations to PSD Director on planetary science programs, policies, plans, and priorities.
  - Recommendations and analysis can be used to inform decisions on programmatic scope and priorities, and implementation of planetary science programs
  - A regular forum for broad discussion of planetary science and the role of planetary science within and outside of NASA
- PAC Charter is available on the PAC webpage: https://science.nasa.gov/researchers/nac/science-advisory-committees/pac

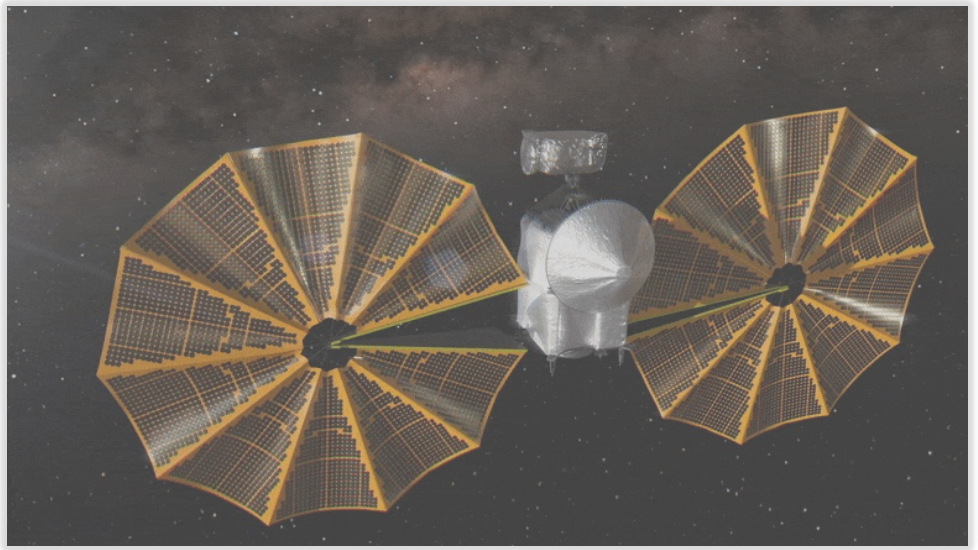
Mission Updates

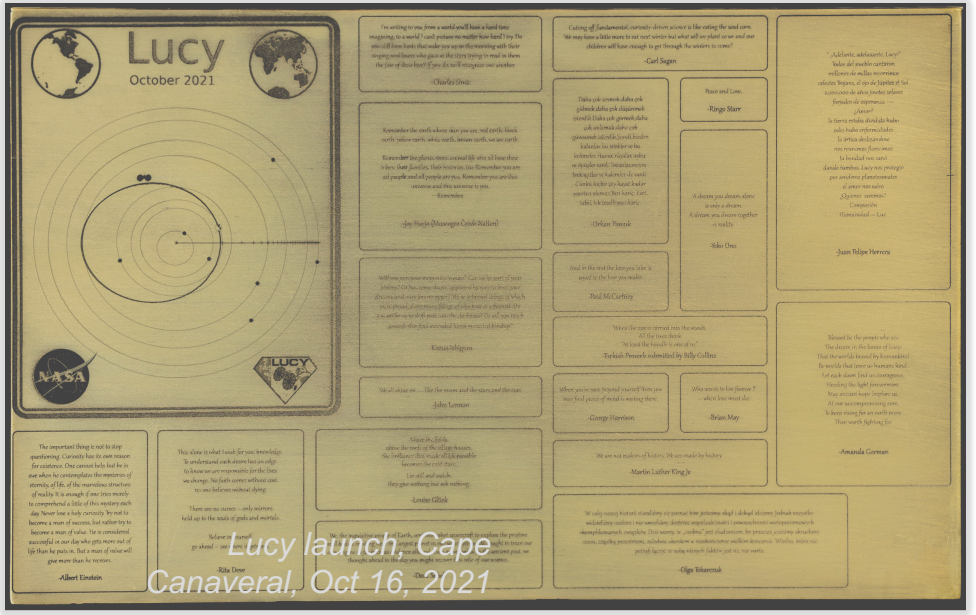

NEW HORIZONS
MOON
LUNAR TRAILBLAZER
LUNA H-MAP
LUNAR RECONAISSANCE ORBITER
VIPER
CLPS (X5)
MARS
MARS ODYSSEY
MARS EXPRESS (ESA)
MRO
MAVEN
TRACE GAS ORBITER (ESA)
MMX (JAXA)
MSR EARTH RETURN ORBITER (ESA)
INSIGHT
CURIOSITY
PERSEVERANCE
ROSALIND FRANKLIN (ESA)
MSR SAMPLE RETRIEVAL LANDER
JANUS
OSIRIS-REx
DART
BEPICOLOMBO (ESA)
VERITAS
NEO SURVEYOR
Q-PACE
ENVISION (ESA)
DAVINCI
NEOWISE
PSYCHE
LUCY
EUROPA CLIPPER
JUICE (ESA)
JUNO
DRAGONFLY
FORMULATION
IMPLEMENTATION
PRIMARY OPS
EXTENDED OPS
PLANETARY FLEET

Lucy Launched!

Lucy launch, Cape Canaveral, Oct 16, 2021



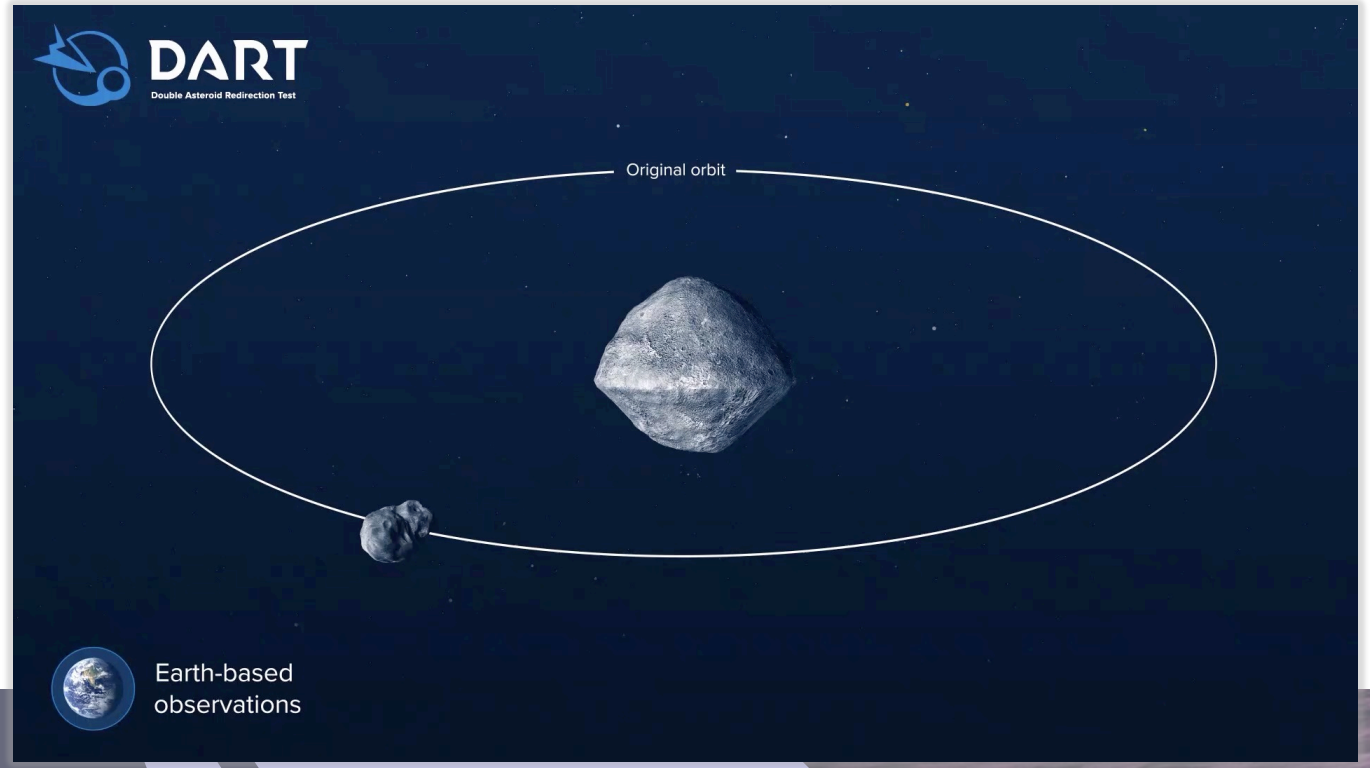




Lucy launch, Cape Canaveral, Oct 16, 2021

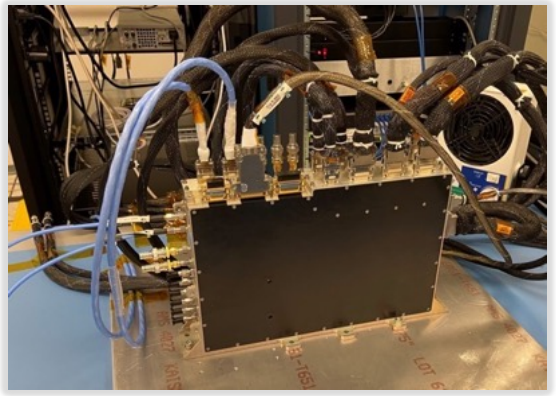
Double Asteroid Redirection Test

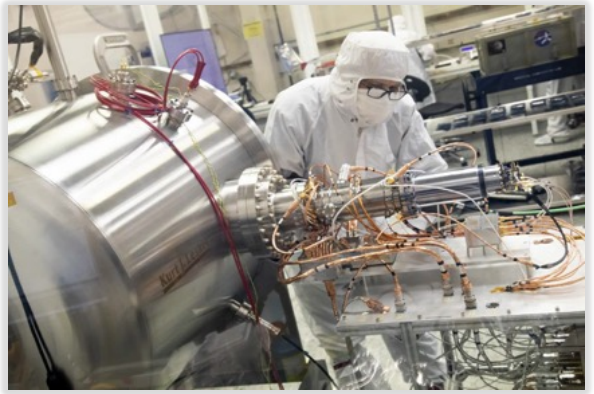
- Spacecraft arrived at Vandenberg Space Force Base (VSFB) on October 3
- Flight Readiness Review will be November 17
- Launch window opens November 24 (November 23 local time, VSFB)
- DART will arrive at Didymos binary asteroid system September 2022



Europa Clipper

- Clipper launch vehicle acquisition completed
  - SpaceX Falcon Heavy selected to launch Clipper on MEGA trajectory in October 2024
- Replanning integrated technical/cost/schedule baseline for MEGA 2024 on Expendable Launch Vehicle (ELV)
  - Full replan to be presented at System Integration Review (SIR) in November 2021
- ATLO Readiness Review as very successful – on track for ATLO start in March 2022
- Areas of concern:
  - COVID impacts currently estimated at ~$103M – stretching out hardware delivery schedules
  - Solar array schedule improving, but being watched closely (planned delivery is to JPL, but with a fallback option for KSC delivery, post environmental testing)
  - Projected MISE instrument delivery is just in time for environmental testing





Top right: *Flight high-gain antenna assembly*
Top Left: *REASON FM DPU SN03*
Center: *Dual-String Avionics testing*
Bottom: *MASPEX FM A1*

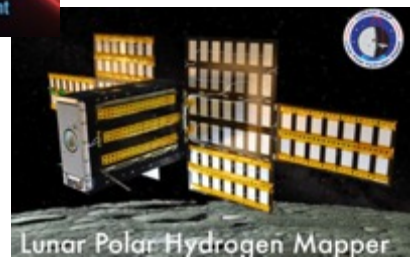
Some Other Mission Highlights

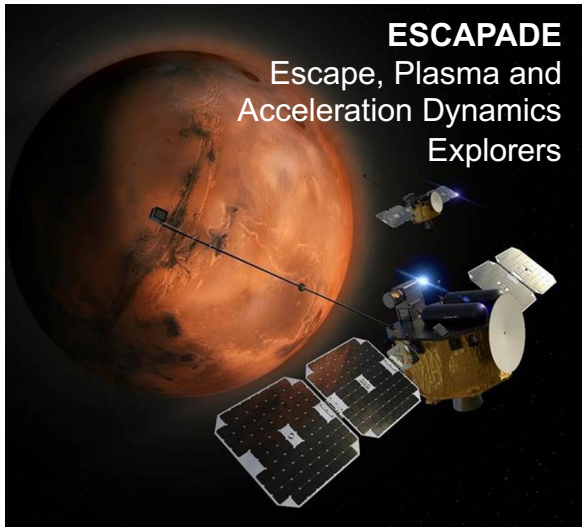
- **Mars 2020:** Perseverance: first two core samples obtained from “Rochette” at “Citadelle” location (September 6 and 8); Ingenuity now in operational demo phase
- **Juno:** Now in extended mission; several flybys of Ganymede, Io, Europa planned
- **Psyche:** Psyche ATLO is progressing, scheduled for launch August 2022
- **VIPER:** Science Study Area near Nobile crater has been selected; specific landing site within the Area TBD
- **Mars Sample Return:** Science Plan being developed jointly with ESA; moving towards Mission Design Review in early 2022
- **Dragonfly:** On track for subsystem PDRs and mission PDR in 2022; successful testbed flights at Imperial Dunes (Yuma, AZ) demonstrated several autonomous operational scenarios and optical navigation over terrestrial analogs for Titan’s dunes

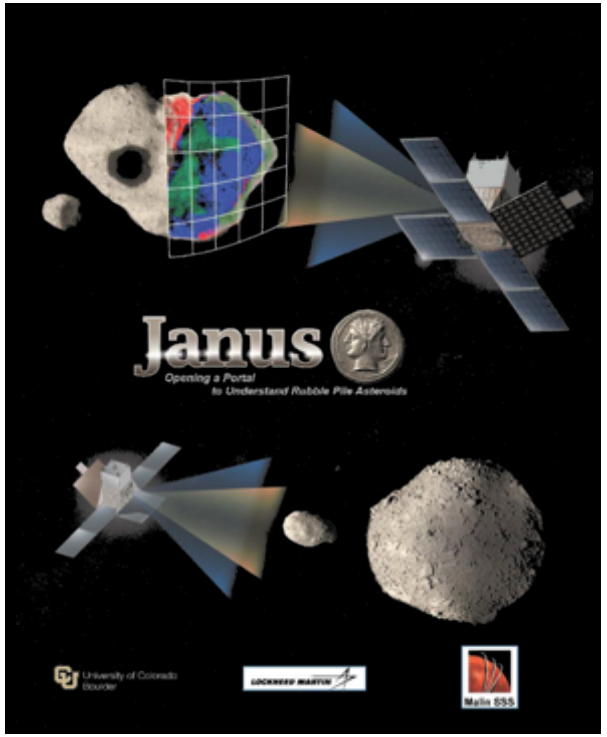

“Rochette” sampled

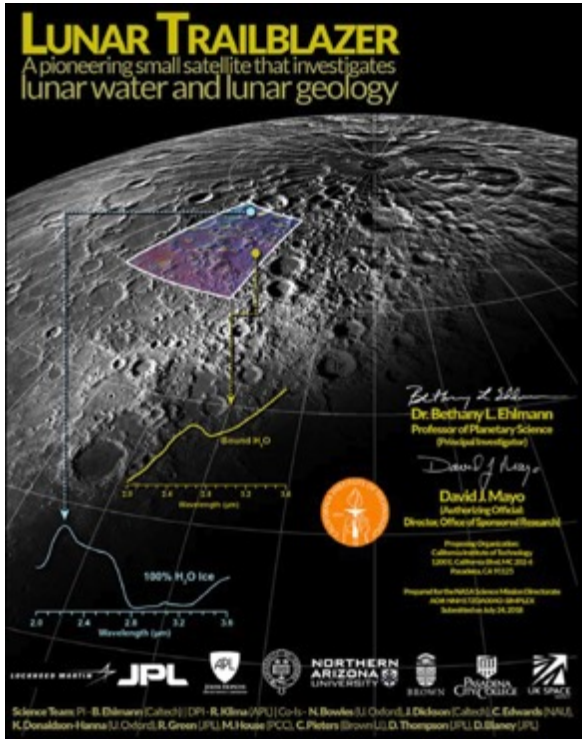

VIPER test model at GRC


Dragonfly half-scale testbed in flight, Sep 2021









SIMPLEx

SIMPLEx-1

Q-PACE:

- Launched on Virgin Orbit's LauncherOne January 17
- The spacecraft's beacon has not been detected despite multiple attempts

LunaH-Map:

- Spacecraft (built at ASU) successfully integrated into Artemis-1 adaptor ring; will launch on Artemis-1, NET February 2022

SIMPLEx-2

Janus (Psyche rideshare):

- CDR held in February with delta propulsion review in April and independent propulsion review in August; ATLO began in August 2021

Lunar Trailblazer (IMAP rideshare):

- Passed CDR in July 2021; Systems Integration Review will be May 2022

ESCAPADE (TBD rideshare) – Funded by HPD:

- KDP-C passed August 2021

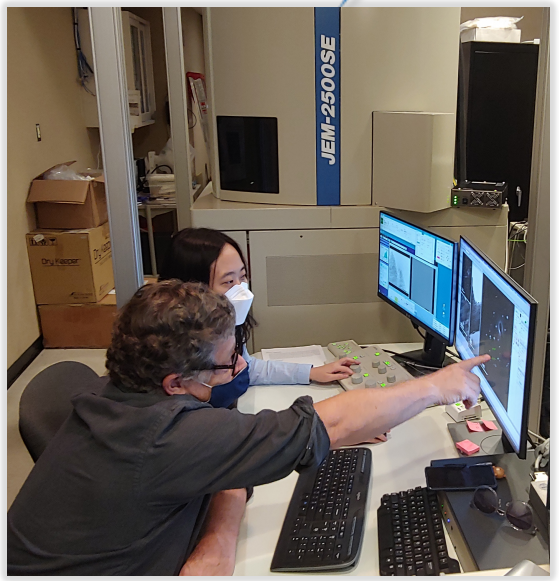
OSIRIS-REx and Hayabusa-2

OSIRIS-REx:

- Arrives back at Earth September 2023
- Curation rehearsal held successfully at NASA JSC in early November

Hayabusa-2:

- In final stages of arranging for delivery of Hayabusa-2 samples to NASA in early December
  - COVID protocols have posed challenges to this
- Catalog of U.S. sample share (10% / 0.5 g) will be posted by late spring 2022 and opened to loan requests
- Expect JAXA sample availability to be announced this winter, for allocation in early summer 2022



Left: Hayabusa-2 NASA Participating Scientists analyzing a Ryugu grain in the laboratory

Bottom: Hayabusa-2 sample container

Senior Review

- Senior Reviews for missions are held on a three-year cadence
- PMSR22 will be in February 2022
- Missions to be reviewed:

MRO	Mars Odyssey
InSight	MSL
MAVEN	New Horizons
LRO	OSIRIS-REx

- Except for OSIRIS-REx, all missions will be reviewed for three-year extensions
- OSIRIS-REx will propose a visit to Apophis, with an encounter starting in 2029 (after Earth close approach)
- Each mission is reviewed independently (by a separate panel for each mission) and they are not compared with each other
- Decision on extending missions expected by April 2022

COVID

COVID impacts on Planetary Flight Missions

- SMD-wide COVID Impact Assumptions were created for budget planning consistency
  - Initial release July 2020, updated April 2021; currently being re-evaluated for updates
  - Impacts vary widely by:
    - project organization and return to work status;
    - setbacks based on safety protocols (e.g., facility occupancy and social distancing);
    - vaccine acceptance and efficacy;
    - development phase;
    - procurement cost increases; and
    - supply chain delays
  - Assumptions:
    - For April 1, 2021 to September 30, 2021: assume efficiency status and trends remain fairly consistent
    - For October 1, 2021 to March 31, 2022: assume efficiency ramps up to prior ‘normal’ or a ‘new’ normal, targeting ≥90% efficiency

COVID impacts on Planetary Flight Missions

- Challenges include:
  - In some cases, distinguishing COVID impacts from other cost/schedule hits (e.g., workmanship issues), i.e., are impacts ‘normal’, caused by COVID stress, or COVID-related changes in personnel?
  - Variable methods of measuring/estimating COVID impact, as method is not proscribed
- No PSD missions have slipped LRD due to COVID
- Most notable cost increases to date:
  - Clipper: $108M
  - Psyche $46M
  - Lucy $19M

Community

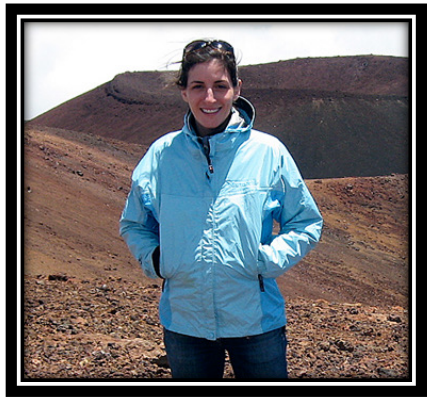
PSD Early Career Award 2020 Winners!

Kristen Bennett
(USGS Flagstaff)

Developing an Effective and Inclusive Mentoring Program

Alicia Rutledge
(Northern Arizona University)

Ice, Ice, Rock: Analog Studies in Cold Environments to Understand Past Climate



Sharon Purdy
(Smithsonian Institution)

Insight into the Late-Stage Climate Record of Mars Through Analog Studies of Alluvial Fans in the Atacama Desert

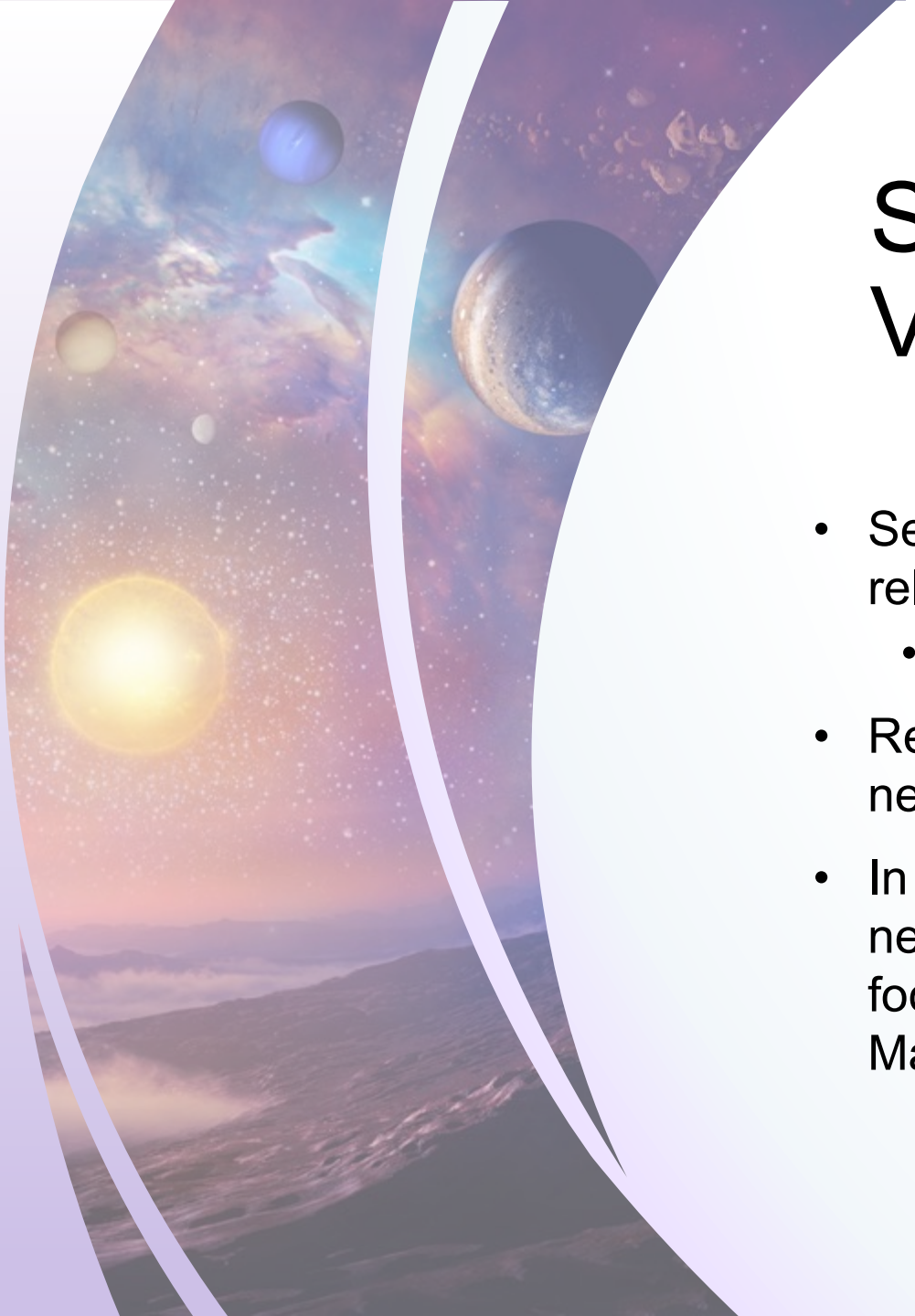
Abigail Fraeman
(JPL)

Characterizing Solar System Materials with Novel Hyperspectral Imaging Techniques

Angela Stickle
(Johns Hopkins University Applied Physics Laboratory)

Planetary Defender: Making an Early Career Impact in the Community

ROSES-21 ECA Call (C.19)
proposal deadline:
December 8, 2021



Solar System Exploration Virtual Institute (SSERVI)

- Senior review has been completed, report will be released next month
  - Findings will be incorporated into SSERVI CAN-4
- Release of draft language for CAN-4 expected early next year (2022)
- In contrast to previous CANs, and in response to the needs and direction of NASA, CAN-4 will be lunar-focused and will not include NEOs and the moons of Mars

Planetary Data Ecosystem (PDE) Progress

Develop the Planetary Data Ecosystem

- PSD is identifying an appropriate path to bring together a **community-led group**, as identified by PDE Independent Review Board (IRB)
- PSD is developing a **PSD Data Website** on science.nasa.gov
  - A centralized location for information on planetary data, the definition of the PDE and identification of its elements, and updates on how PSD is addressing the PDE IRB recommendations
- PSD is planning a virtual **workshop** series addressing the PDE IRB recommendations that would be best served by a workshop format, including answering questions such as:
  - "What is the PDE?" and "What goes into a Data Management Plan"?

Address Data Preservation Needs

- PSD is actively supporting **radar** data analysis, publication, and archiving of Arecibo data at PDS Small Bodies Node (SBN)
  - PSD initiated meetings between SBN and Arecibo, JPL, and Goldstone radar groups to coordinate radar data archiving efforts
- PSD is working on preservation of mission-supported laboratory analyses of returned **sample materials** for the OSIRIS-REx mission
  - AstroMat will be the official laboratory analysis archive for OSIRIS-REx
  - PSD is using the OSIRIS-REx effort to identify and possibly address the broader needs of PSD laboratory sample data curation

Other Recommendations

- The Planetary Data System (PDS) Chief Scientist has been evolved into the **PDE Chief Scientist** (selection by end of November) to increase communication and interoperability of the PDS with the other PDE elements
- Specific **responses** from NASA addressing **ALL** of the PDE IRB recommendations (including current status, anticipated timeline to address, and potential future plans) will be provided on PDS Data Website

R&A Updates (1)

No Due Date Programs (NoDD)

- Emerging Worlds (EW); Solar System Workings (SSW); Planetary Data Archiving, Restoration, and Tools (PDART); Exobiology (Exobio); Solar System Observations (SSO); Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO); Laboratory Analysis of Returned Samples (LARS)
- More info: https://science.nasa.gov/researchers/NoDD

Dual Anonymous Peer Review (DAPR)

- All PSD data analysis programs (CDAP, DDAP, LDAP, MDAP, NFDAP) and cross-divisional Exoplanet's Research Program (XRP) are using DAPR in ROSES-2021
- Overview of DAPR results so far to be given during PAC meeting

VenSAR Science Team (VeST) Solicitation

- Will work with JPL VenSAR project and the broader EnVision mission to provide scientific feedback into VenSAR development
- Notices of Intent due November 19, 2021; 5-page proposals due January 20, 2022

R&A Updates (2)

Facilities Call

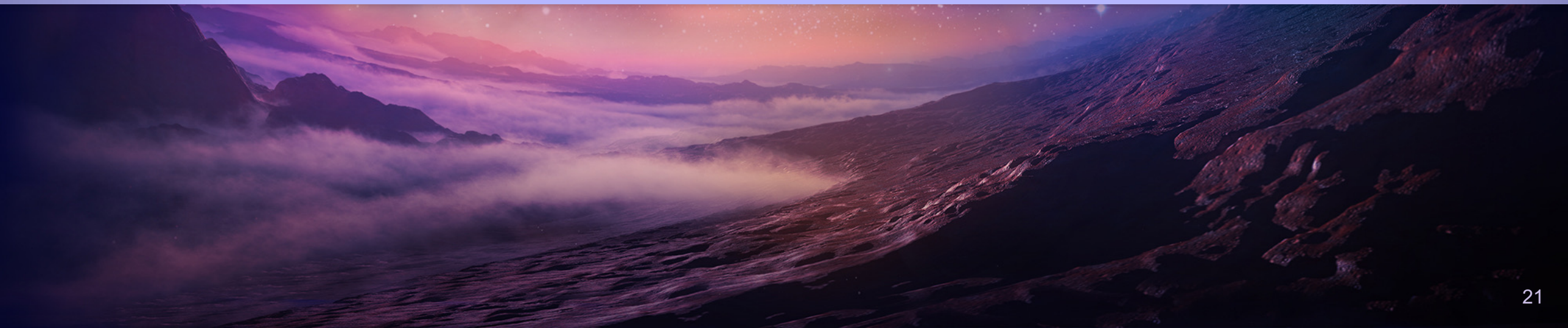
ROSES-21 C.17 has been amended and changed to **Planetary Science Enabling Facilities Program** (PSEF)

- Expect to solicit proposals in ROSES-21 for facilities and associated equipment that enable planetary science research
- Guidance on requesting non-facility instruments/equipment costing ≥$50,000 will be added to C.1 when PSEF is released

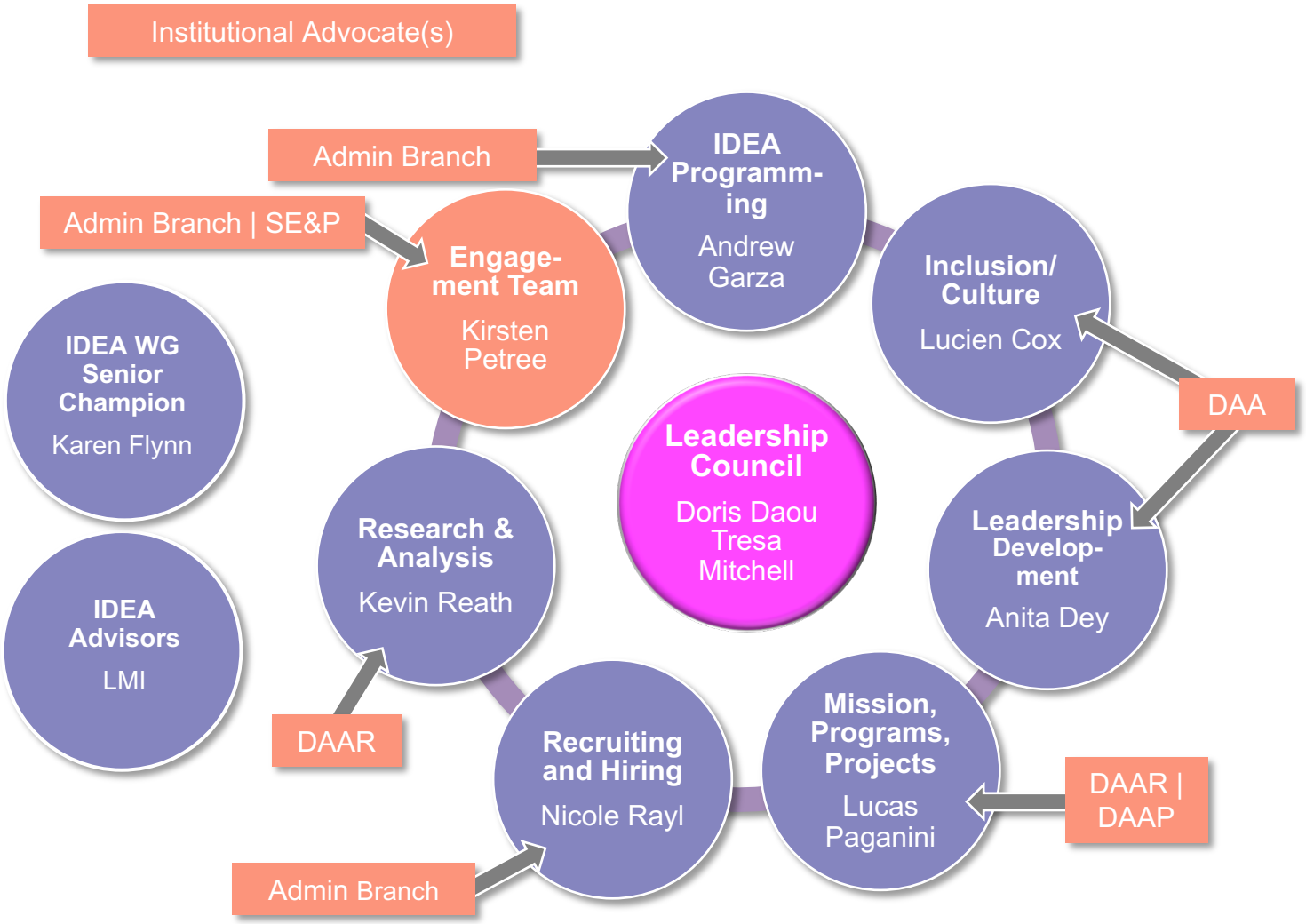
SMD Research Catalyst Fund (RCF)

- A small SMD-level funding line designed to act as a focal point and catalyst for programmatic activities that cut across the directorate's science disciplines
- Will be used to co-fund disciplinary research awards based on four priorities (not a separate solicitation):
  - High-risk/high-impact research
  - Interdivisional research
  - Research from underrepresented institutions
  - Participation in I-Corps Program—aimed at developing and nurturing a national innovation ecosystem (https://sbir.nasa.gov/content/I-Corps)

IDEA



SMD IDEA Working Group



Seven Subgroups

IDEA Programming: Identify programs to provide awareness, education

Inclusion/Culture: Identify best practices to foster a climate that promotes inclusion

Leadership Development: Develop leadership opportunities, development, and mentorship

Missions/Projects/Programs: Implement IDEA in the formation and operation of missions, projects, and programs

Recruitment and Hiring: Identify barriers to increasing diversity, develop processes, and initiatives to help SMD build and retain a diverse workforce

Research and Analysis: Increase diversity within selection panels; review processes and policies related to awarding grants, awards, and contracts

Engagement Team: Identify and implement a strategy that leads to relationships with new, diverse partners

IDEA Subgroup Activities In-Progress

IDEA WG Overall
- IDEA Central SharePoint Site
- SMD Climate Survey (coming soon)
- Monthly Conversation Series
- Overarching IDEA Strategy

Leadership Development
- Job Shadowing and Mentorship Program
- Term Leadership Opportunity

Research and Analysis
- Collected ROSES demographic data
- Developing standard code of conduct guidance
- Developing standard IDEA language for AOs

IDEA Programming
- Picture a Scientist event
- Future IDEA trainings
- Develop landscape of IDEA-related programs available to SMD workforce

Missions/Projects/Programs
- Monthly Speaker series
- Connecting with other Centers
- Assessing demographics of flight missions and related projects

Recruitment and Hiring
- Reviewing SMD Hiring Guide
- Webinars for understanding the hiring process (for community)

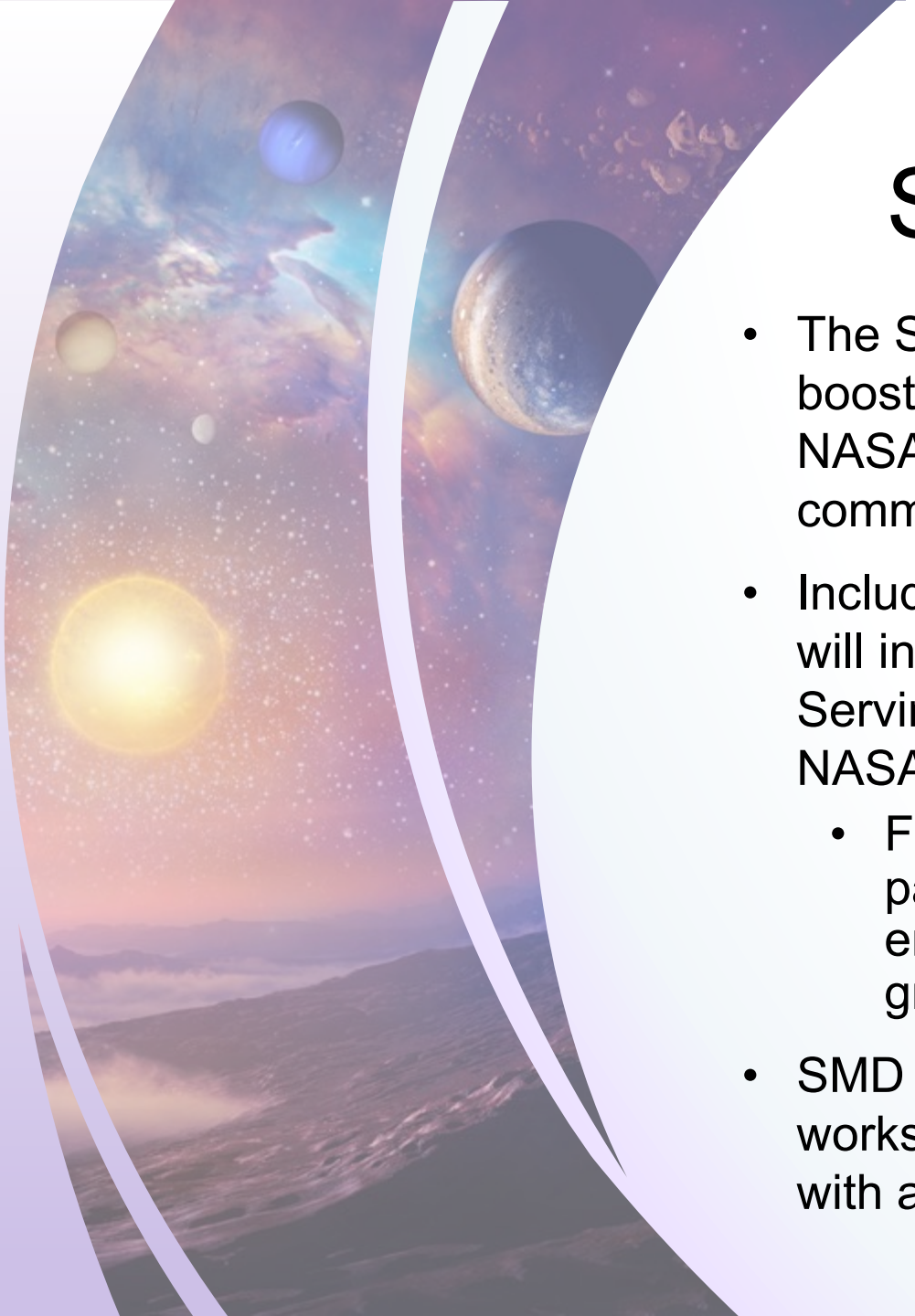
Inclusion and Culture
- Dialogue Sessions
- Anonymous Feedback Box for SMD workforce to provide input and share perspectives

Engagement Team
- MSI/HBCU Engagement Strategy
- Training, coaching, and advising for SMD Ambassadors at engagement events

IDEA Advocates
Great work is also being led by division advocates and champions. We are eager to connect with you to learn and share what you are doing!

Mentoring365

- Joint program from NASA, AGU, AAS, GSA, and others, to support early-career researchers and students
  - Goal: Fostering robust, diverse, equitable, and inclusive workforce in Earth and space sciences
- Will address several concerns: lack of community; lack of career advice; decreased job opportunities and access to financial support; unsafe virtual spaces
- Program is customizable: one-time/long-term mentoring; groups/one-on-one
- More information: https://mentoring365.chronus.com/p/p1/about

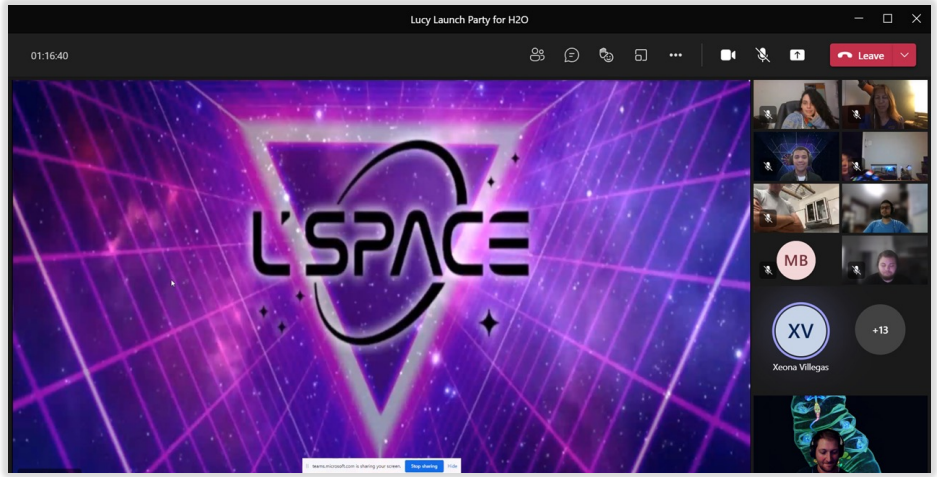


SMD Bridge Program

- The SMD Bridge Program is a new initiative designed to boost diversity, equity, inclusion, and accessibility within the NASA workforce and within the U.S. science and engineering community
- Included as part of the FY22 President's Budget, the Program will increase engagement and partnering between Minority-Serving Institutions, other PhD-granting universities, and NASA Centers:
  - Focus on paid research and engineering studentships at participating institutions to transition science and engineering students from undergraduate studies into graduate schools and employment by NASA
- SMD will be facilitating one or more community-planning workshops to collaboratively co-create the Bridge Program with all stakeholders

Here to Observe (H_2O) Pilot Program

- **Goal:** Spark and maintain an interest for underrepresented students considering STEM careers
- **Approach:** Commit PSD to sustained, cultivated partnerships with non-traditional institutions paired with our NASA missions through:
  1. Providing access for undergraduate student observers
  2. Supporting meaningful mentorship activities
  3. Encouraging peer cohort-building at the institution level
- **Scope:** 12-month pilot program, starting in summer 2021
  - Three mission/partner pairs: pairs: Europa Clipper and University of Puerto Rico; Dragonfly and Virginia State University; Lucy and Howard University
  - 30 students enrolled so far
- **Co-creation:** if successful, H_2O will be scaled up later (all PSD missions, more institutions) after refinement based on feedback from pilot
- **Core activities:** biannual mission science team meetings, AG meetings, and other mission meetings
- **Supplemental activities:** icebreakers, social events (launch parties), mission-led seminars, student-led seminars, career panels



Virtual Lucy launch party for H_2O participants

Decadal Survey

Decadal Survey – Current Timeline

November 2021	Draft report sent to reviewers
December 2021	Reviewer response
January 2022	Complete review/response package completed
February 2022	Report approved for release
March 1, 2022	Report delivered to NASA and NSF in prepublication format
March 2 – 8, 2022	Preliminary briefings to NASA, NSF, etc
March 7 – 11, 2022	Lunar Planetary Science Conference (LPSC)

- Timeline for a response to the Decadal will be set by SMD and PSD
- Initial PSD public response to the Decadal within 90 days
- Full written response provided later (timing to be shared publicly in advance of Decadal release)

EXPLORE

with us

Expert Comments from June 2021

(1) Planetary Data Ecosystem Independent Review Board

Comment: The PAC appreciates the efforts of the Planetary Data Ecosystem (PDE) Independent Review Board (IRB) and applauds PSD for its efforts to initiate and formalize a Planetary Data Ecosystem. The PAC recognizes that in order for a PDE to be fully implemented, supported, and maintained, additional resources and funding will be required. Specifically, the PAC acknowledges that funding will need to be provided to the planetary science community so that members of the community can properly participate in a fully realized PDE. The PAC understands that funding is limited and therefore encourages PSD to further engage other divisions to leverage as many financial and technical resources as possible to support the PDE now and into the future.

Response: PSD recognizes that there are costs associated with defining, creating, and sustaining a Planetary Data Ecosystem. PSD is continually leveraging SMD funds and resources, when available and appropriate. This is done, for example, through the NASA Open Source Science Initiative (OSSI), which realizes the benefits of shared data initiatives, cloud services and other data infrastructure, training workshops, policies, and lessons learned across the SMD Divisions. Although PSD will need to spend funds to realize the evolving and important data needs of the planetary science community, PSD anticipates those funds will have significant benefit to the planetary science community. For more information on OSSI: https://science.nasa.gov/open-science-overview

(2) Research & Analysis Funding

Comment: The additional funding available for R&A funding this year is excellent news. While not fixing the very low selection rates in most planetary R&A programs, it has prevented the cancellation of a number of calls. However, the PAC notes that this is a one-time increase in the budget. In order to improve selection rates, the PAC encourages NASA to request additional support for R&A in future budget requests. The PAC requests clarification on the use of NASA funds by principal investigators for community service, particularly for review panels.

Response: On budget: PSD is encouraged by the numbers in the President's Budget Request (PBR) and continues to request robust support for the R&A program through the annual budget cycle. We are watching the congressional budget process and look forward to having a final budget for this year.

On use of NASA funds for community service: The short answer is no, community service work for NASA (e.g., serving on review panels) is not allowable as a direct charge to a grant. Such service, however, can be covered through overheads on grants, but that is a matter of written institutional policy. Stephen Rinehart will present more information during the R&A presentation later at this PAC meeting.

(3) Mars missions' community involvement

Comment: The PAC was very happy to hear about the appointment of Dr. Meenakshi Wadhwa as the Mars Sample Return (MSR) Program Scientist. The PAC also appreciated the continued updating from PSD and MEP about the MSR campaign and Mars Ice Mapper (MIM) orbiter concepts. However, for both concepts many questions remain open about science community involvement, which is important to ensure the best science can be accomplished. The PAC refers back to the March 2021 meeting Findings and asks for a further update on those points. In particular, the PAC looks forward to hearing more about the formation of an International Recon/Science Measurement Definition Team for MIM and a Campaign Science Group for MSR - or other such groups that aim to increase community opportunity for input, and utilize the broad community expertise in definition of these concepts. The PAC recommends that the process for deciding which samples to return and assessing whether a particular sample meets Decadal science objectives should be open to the scientific community. The PAC also requests information on why an additional rover is needed in addition to Perseverance, as this will increase the cost and complexity of MSR.

(3a) Response: Mars Ice Mapper

NASA, CSA, JAXA, and ASI have formed an international Reconnaissance/Science Measurement Definition Team (MDT) to support refined definition of its pre-Phase A mission concept as a bridge to potential Phase A development. This process differs from traditional mission Science Definition Teams in that the Agency partners have pre-defined the high-level mission goals, objectives, and the anchor payload – an L-band, polarimetric Synthetic Aperture Radar (SAR)/SAR Sounder – along with other mission elements.

The MDT shall perform three tasks:

1. Define measurements for the anchor payload that are traceable to Reconnaissance Requirements (ice detection, overburden characterization, and candidate human-landing-site characterization) and ways to optimize the payload(s) for these purposes.
2. Provide findings on potential high-value, prioritized reconnaissance/science/engineering augmentations that are synergistic with the anchor payload and might maximize the mission's return on investment within established mission boundary conditions.
3. Prepare a model concept of operations based on findings for tasks 1 and 2.

The MDT is comprised of international experts from the partner Agencies and other nations who collectively have expertise in a variety of domains, including planetary science, synthetic aperture radar and radar sounding, in situ resource utilization (ISRU), human-class entry, descent and landing (EDL) and ascent, and civil engineering. Working together in a transdisciplinary manner, MDT members will ensure optimal use of the SAR's full capabilities to support measurements required in advance of future human missions.

The response to the MDT solicitation has exceeded expectations, with nearly 150 applicants. The quality of the applicants has been outstanding, making the selection process challenging (a very good problem to have). The MDT Selection Team has recently completed its review process and the MDT selection can be found at: https://science.nasa.gov/science-red/s3fs-public/atoms/files/MDT%20Selectees%20List.pdf

(3b) Response: MSR Science Management

NASA has been taking measures to address the potential of a gap in science management between the four elements of returning samples from Mars:

(1) Conducted studies:

- Completed the Mars Sample Return Science Planning Group – 2, a year-long international study addressing sample handling requirements, associated technical issues, a science management framework, and a timeline of science milestones. (To be published in Astrobiology in December 2021)
- The NASA and ESA MSR Operational Scenarios Definition Team, to address workflows in the SRF, will conclude their study this month.

(2) Personnel have been or will be appointed to pay attention to the science:

- MSR Lead Scientist is also the MEP Lead Scientist (NASA HQ)
- Deputy MSR Program Scientist (NASA HQ)
- MSR Principal Scientist (JPL)
- Deputy MSR Principal Scientists (JPL) – interviews in progress
- Lead Sample Integrity Scientist (JPL)
- CCRS Sample Integrity Scientist (JPL)
- A Sample Return Project Scientist (TBD) (JPL)
- Note: the Mars Exploration Program has the responsibility for the science of Mars Exploration, including MSR

(3b) Response: MSR Science Management (cont/d)

(3) Other activities:

- Science MOU between NASA and ESA is in development
- Science Management Plan in expected to be completed and signed early in 2022
- An international Mars Campaign Science Group has been recommended
  - An approach to satisfy the intent is being formulated between MEP and MSR
- JSC has released a RFI for trade studies for a Sample Receiving Facility
  - An assessment group is being assembled to feed into the forthcoming RFP, along with information from the MOSDT report

(4) Community involvement

- MSR has been, and intends to continue, briefing the scientific community, through official groups such as MEPAG and the PAC, and through science workshops and conferences, such as LPSC, AGU
- Furthermore, as demonstrated in the MSPG2 timeline, there are multiple opportunities for science community involvement in MSR, through workshops, assessment groups, and competitive AOs for team participation

(3c) Response: MSR Cost

MSR is a flagship planetary science endeavor that has been ranked among the most compelling objectives by the planetary science community in past Decadal Surveys. Through a partnership with ESA, NASA is planning to keep its investment in-family with other planetary science flagship mission like Europa Clipper. The program has made significant progress in Phase A, maturing its technical, cost, and schedule baseline and assessing a broad range of options. NASA will continue to assess options and refine its cost and schedule projections through summer of 2023 when a firm cost commitment will be made. Through a number of forums, including the ongoing Decadal Survey process, the science community has the opportunity to reflect upon and provide input to NASA on the science value, and cost and schedule, plans of MSR.

(4) Apophis

Comment: The asteroid 99942 Apophis will make a very close flyby of the Earth in 2029 – inside the orbit of geostationary satellites – making it a useful target for detailed study of a small body. Apophis poses no chance of impact in 2029 on its current trajectory. The PAC recommends that NASA set up a study team to investigate how to maximize the scientific return of this close approach without disturbing the object or perturbing its orbit.

Response: PSD is actively working with the Small Bodies Assessment Group (SBAG) to stand up a Specific Action Team (SAT) to study the scientific and planetary defense opportunities presented by the Apophis close approach. Staffing of the SAT is in progress and the expectation is that a report will be produced in the summer of 2022.

(5) Closed Captioning

Comment: The PAC greatly appreciates that closed captioning was made available at the June meeting as this increases the accessibility of the meeting. The PAC encourages NASA to make closed captioning available for all public, virtual NASA meetings, and to help standardize this practice within the science community.

Response: PSD will continue to ensure closed captioning is available during public meetings, and encourages members of the community to do the same during their own meetings. PSD also notes that all current and future AG meetings supported by the Lunar and Planetary Institute (LPI) will include closed captioning capabilities.