

National Aeronautics and
Space Administration



EXPLORE SOLAR SYSTEM & BEYOND

Lori S. Glaze, Ph.D.
NASA Planetary Science Division Director

PAC Meeting
March 1, 2021



Budget

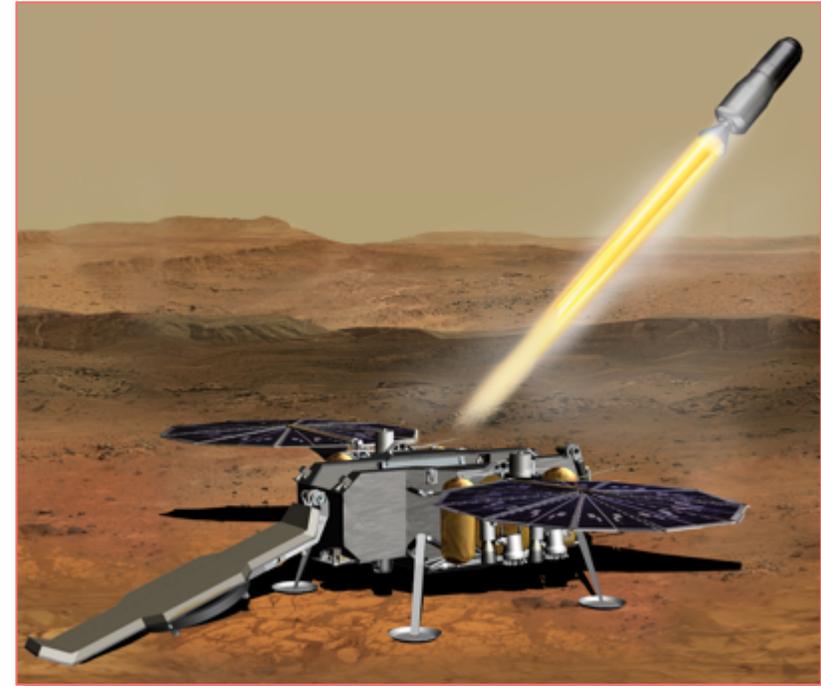


FY21 Appropriations Highlights

- FY 2021 Consolidated Appropriations Act signed into law December 27, 2020
- Continued strong support for Science with a \$7.3B budget
 - \$994M above the FY21 President's Budget request
 - \$162M above the FY20 enacted level

Planetary Science

- \$40M above the FY21 request
- Funding to support decadal priorities such a Mars Sample Return mission, Europa Clipper
- Additional funds for Planetary Defense, supporting DART and Near-Earth Object Surveillance Mission
- Additional funding for New Frontiers/Dragonfly
- Strong support for Lunar Discovery and Exploration, as well as Commercial Lunar Payload Services
- Europa Clipper given permission to use CLV in the event SLS is not available or incompatible



(\$M)	FY14	FY15	FY16	FY17	FY18	FY19	FY20	FY21 Omnibus Bill
PSD	1,342.3	1,446.7	1,628.0	1,827.5	2,217.9	2,746.7	2,712.6	2,700.0



Mission Updates



NEW HORIZONS

JANUS

OSIRIS-REx

MOON

LUNAR TRAILBLAZER

LUNA H-MAP

LUNAR RECONNAISSANCE ORBITER

VIPER

CLPS (X5)

MARS

MARS ODYSSEY

MARS EXPRESS (ESA)

MRO

MAVEN

TRACE GAS ORBITER (ESA)

MMX (JAXA)

INSIGHT

PERSEVERANCE

ROSALIND FRANKLIN (ESA)

CURIOSITY

DART

Q-PACE

BEPICOLOMBO (ESA)

NEOWISE

LUCY

PSYCHE

EUROPA CLIPPER

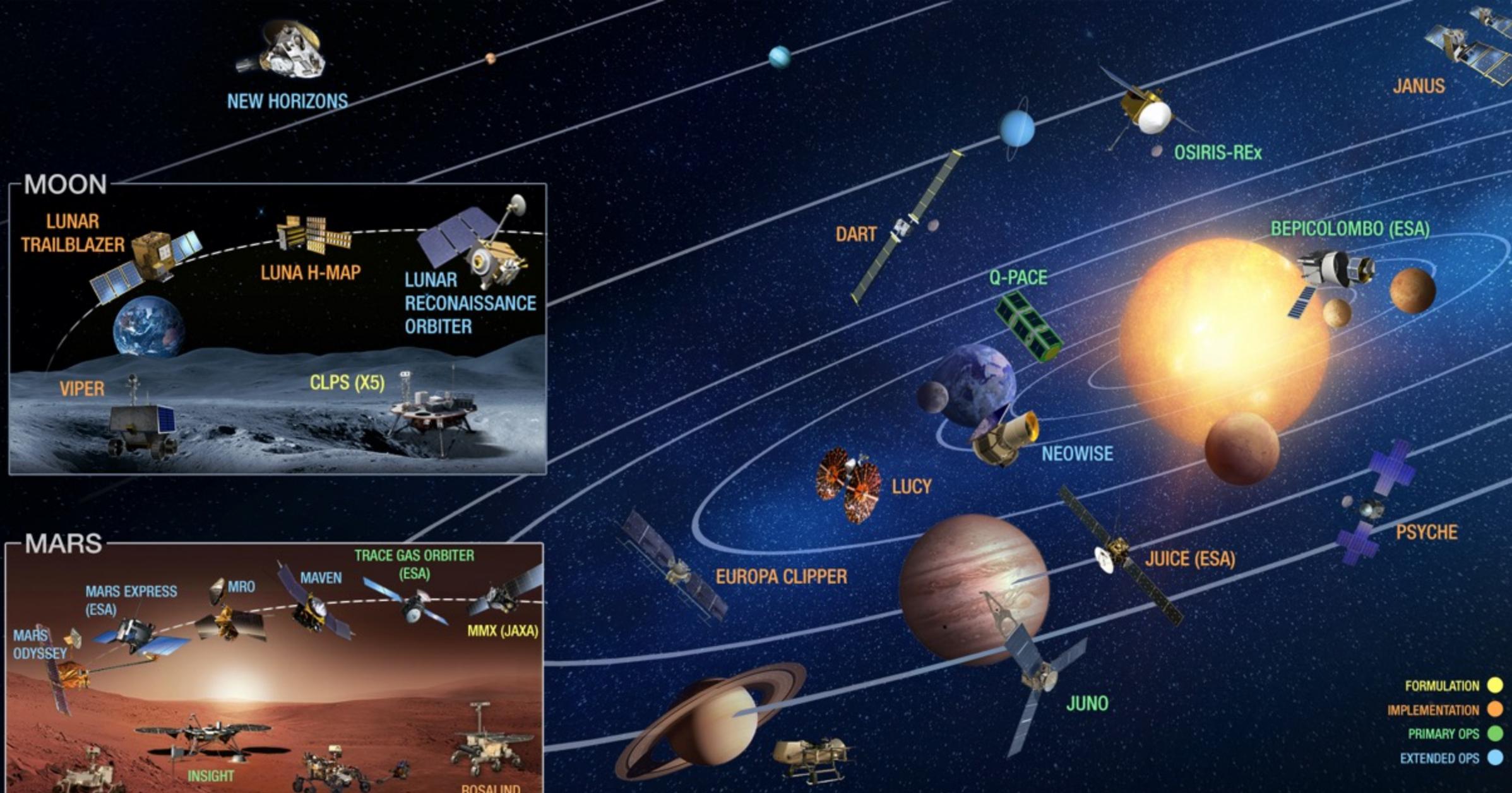
JUICE (ESA)

JUNO

DRAGONFLY

- FORMULATION ●
- IMPLEMENTATION ●
- PRIMARY OPS ●
- EXTENDED OPS ●

PLANETARY FLEET

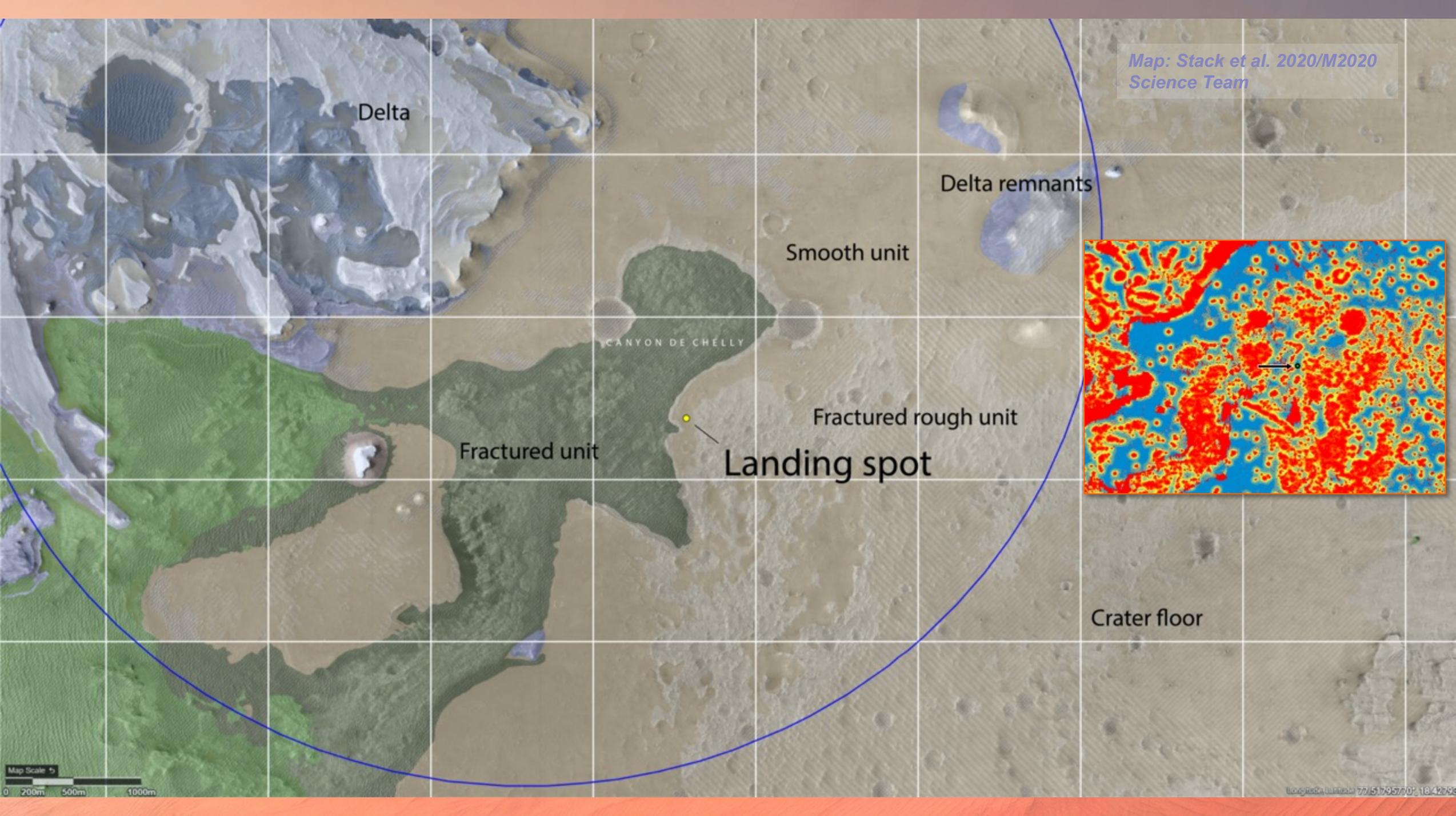


A wide-angle photograph of the Mission Management Team (M&M) control room for the Mars 2020 mission. The room is filled with rows of operators seated at long desks equipped with multiple computer monitors. The operators are wearing face masks. In the background, the NASA logo and the JPL logo are visible on the wall, along with a large American flag. The text "MARS 2020" is also visible on the wall. The overall atmosphere is professional and focused.

PERSEVERANCE ROVER'S DESCENT AND TOUCHDOWN ON MARS ONBOARD CAMERA VIEWS

EDL Activity

Map: Stack et al. 2020/M2020 Science Team



Delta

Delta remnants

Smooth unit

CANYON DE CHELLY

Fractured rough unit

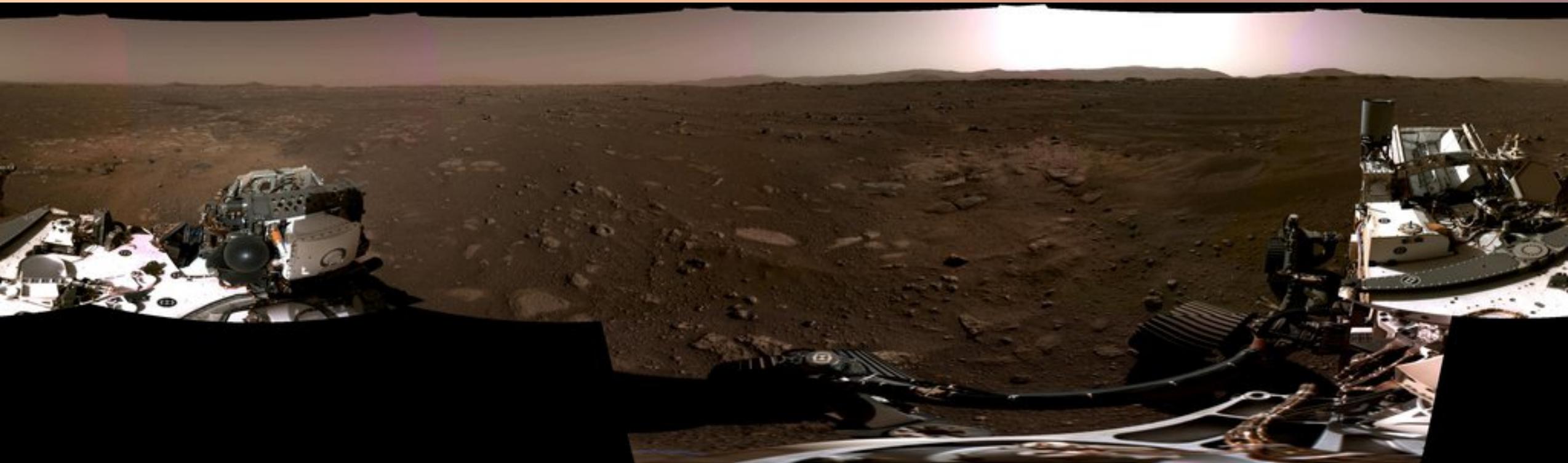
Fractured unit

Landing spot

Crater floor

Map Scale 5
0 200m 500m 1000m

Longitude, UTM: 77.51795770; 18.4279



Social and Traditional Media Coverage



Landing Broadcast:

- 4.2 million (at peak) live viewers watching the event broadcast of the Perseverance landing
- YouTube video of coverage: >20 million views (as of Feb. 24) and top viewed video of all time on the NASA YouTube channel

Landing video viewership:

- Landing YouTube video maintained #2 trending spot on YouTube
- >10 million video views (as of Feb 24)

Web Traffic: 26.9 million page views across all NASA sites on landing date (triple traffic from launch)

Hashtag Performance: >248k total social media mentions involving #CountdownToMars/Mars2020/Perseverance (Feb 18 to 19 across platforms)

Notable Mentions: From POTUS, VPOTUS, FLOTUS, Barack Obama, Ringo Starr

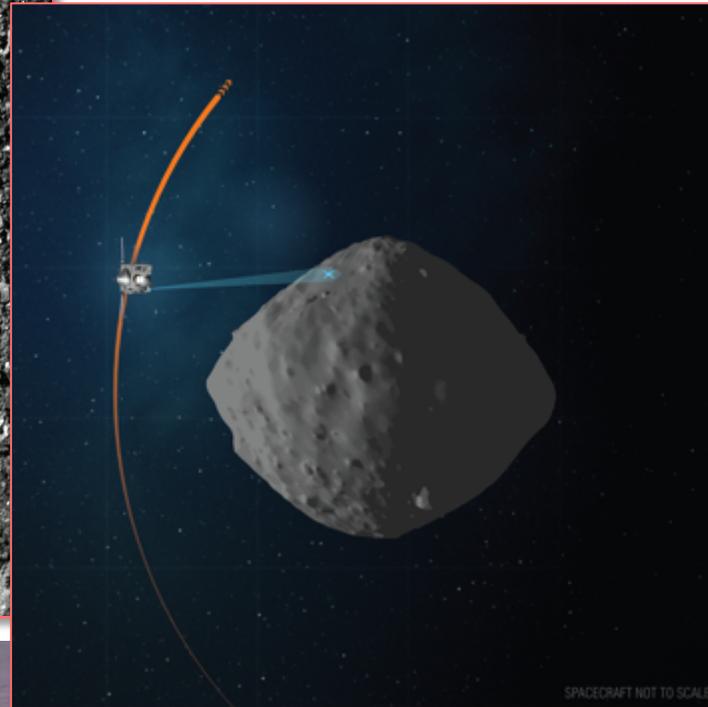
Traditional media:

- >8.7k media mentions between Feb 18 and 19 (e.g., The New York Times, CNN, NPR): estimated reach of 12 billion, with a \$12.7 million publicity value
- Front pages of 157 newspapers
- About 200 interviews with NASA experts; 25 in Spanish; 28 as radio/podcast format (most ever for both)

OSIRIS-REx



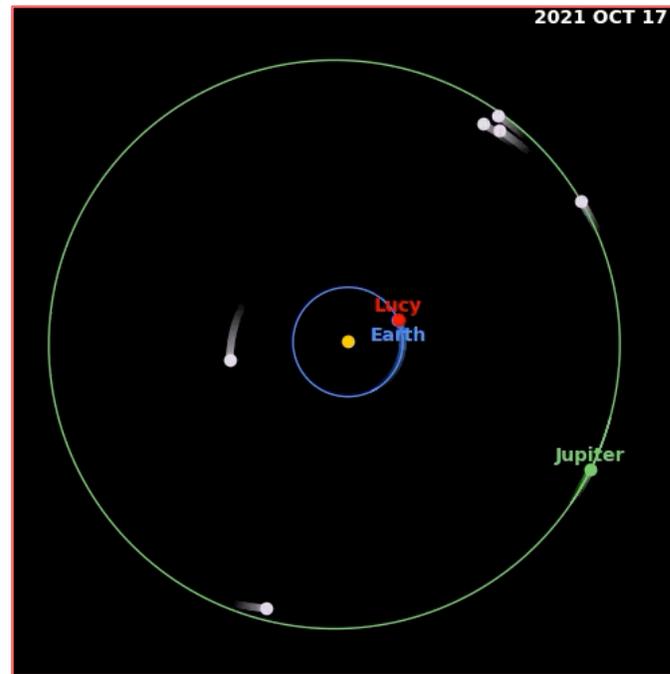
Touch-and-Go ("TAG")
at Nightingale Crater
Oct 20



- Final flyby of Bennu:
April 7, 2021
 - Will image sample collection site, *Nightingale*, to look for surface transformations (mimicking a 2019 observation sequence)
 - Will image Bennu for a full 4.3-hr rotation to obtain high-resolution images of the northern and southern hemisphere and its equatorial region
- Headed back to Earth:
May 10, 2021
- Arrives Earth: **September 2023**



Lucy



- First mission to the Trojan asteroids:
 - 12 years, 7 flybys, one spacecraft
- ATLO progressing well
 - All spacecraft components, except solar arrays, now integrated
 - Solar Array Wing 1 ready for delivery, Wing 2 has completed thermal vacuum cycling
 - Launch and Asteroid Encounter Systems Verification Tests performed successfully
- Pre-Environmental Review completed February 2021
- Launch window opens October 2021; first Trojan flyby August 2027

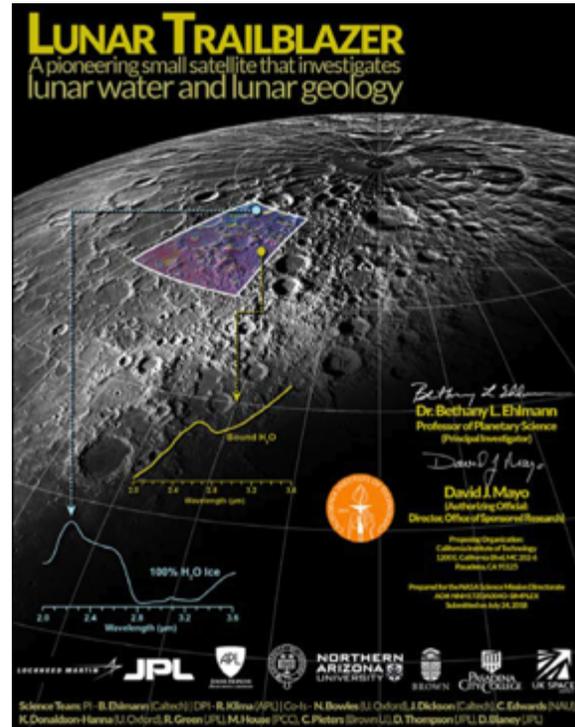
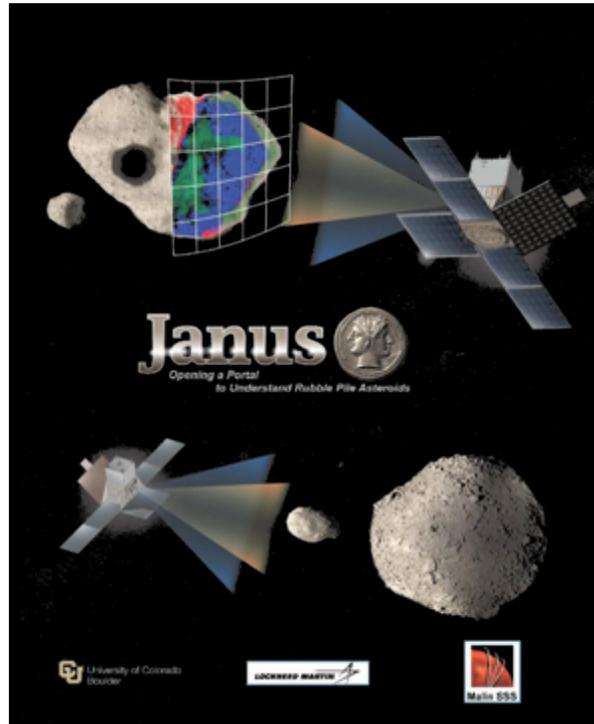
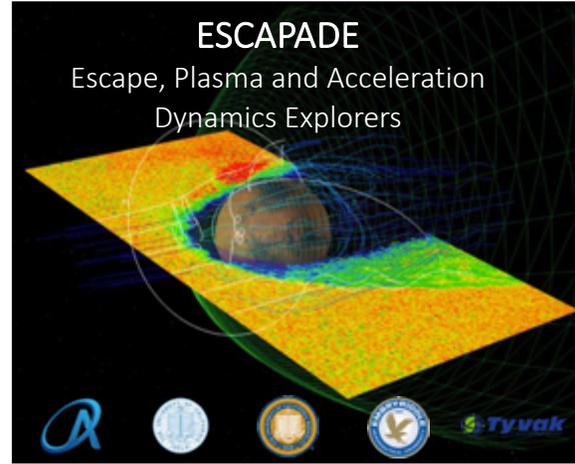
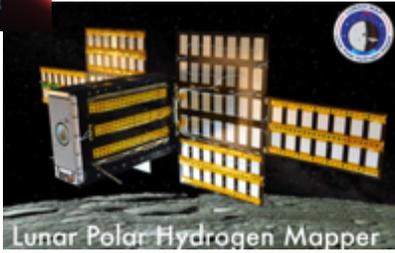
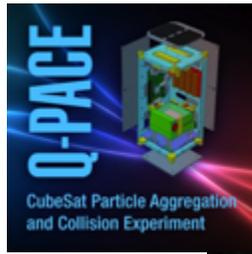


Double Asteroid Redirection Test



- Risk assessment was performed on DART project schedule to determine viability of primary and secondary launch periods
 - Technical challenges associated with DRACO imager and solar arrays
 - SMD has directed DART project to pursue secondary launch window (November 24, 2021 to February 15, 2022)
 - Project is working with SpaceX and NASA's Launch Services Program to identify earliest possible launch opportunity within this window
 - DART will arrive at Didymos binary asteroid system within a few days of the originally scheduled impact date (September 30, 2022)
- LICIA Cube manufacturing, integration, and test has started; on track for delivery May 2021





SIMPLEx

SIMPLEx-1

Q-PACE:

- Launched on Virgin Orbit's LauncherOne January 17
- As of February 26, the spacecraft's beacon has not been detected despite multiple attempts

LunaH-Map:

- Will launch on Artemis-1, NLT November 2021
- Delivery required March 2021

SIMPLEx-2

Janus (Psyche rideshare):

- Passed KDP-C in September; CDR held February

Lunar Trailblazer (IMAP rideshare):

- Passed KDP-C in November; CDR will be in June

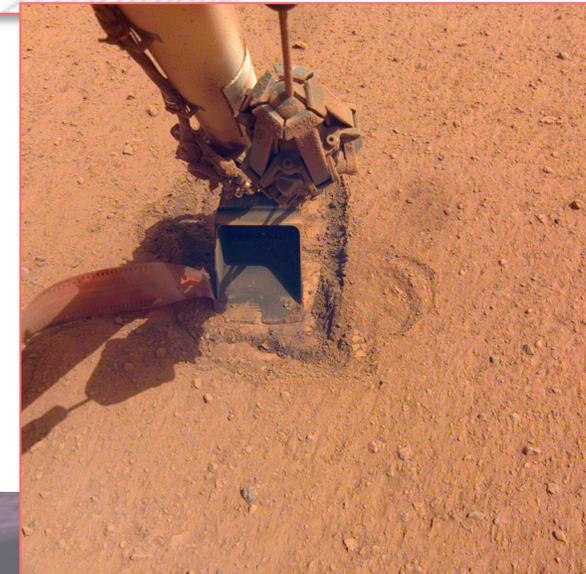
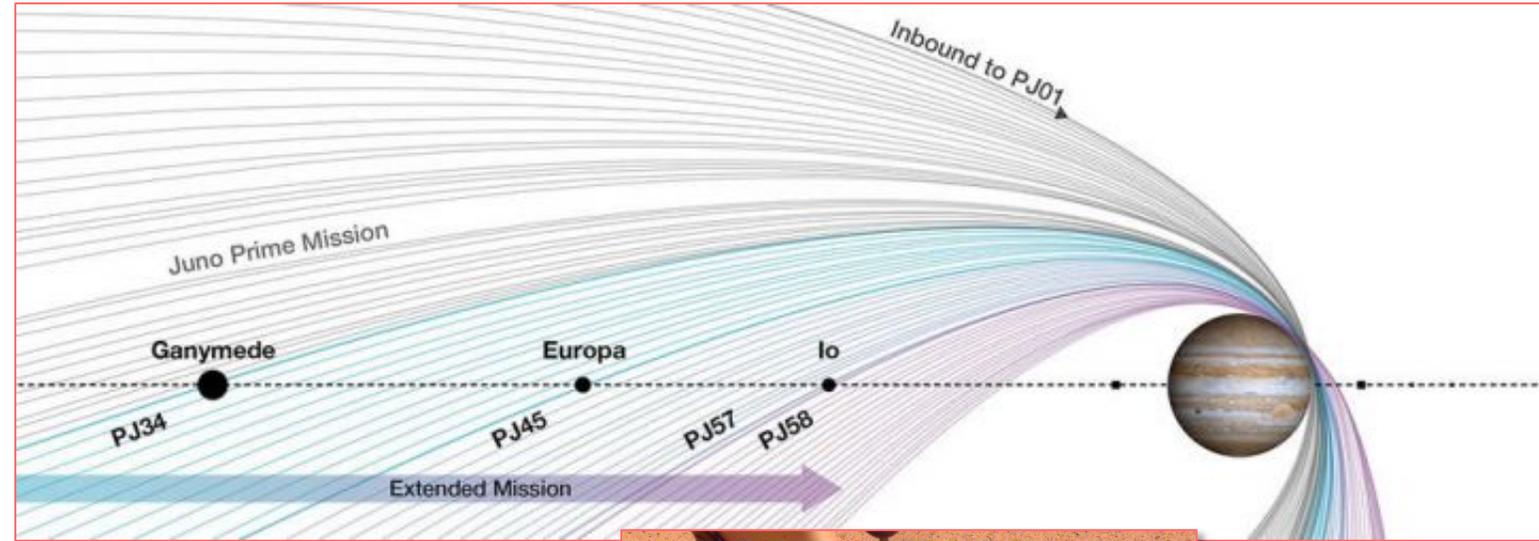
EscaPADE (TBD rideshare):

- KDP-C will be summer 2021

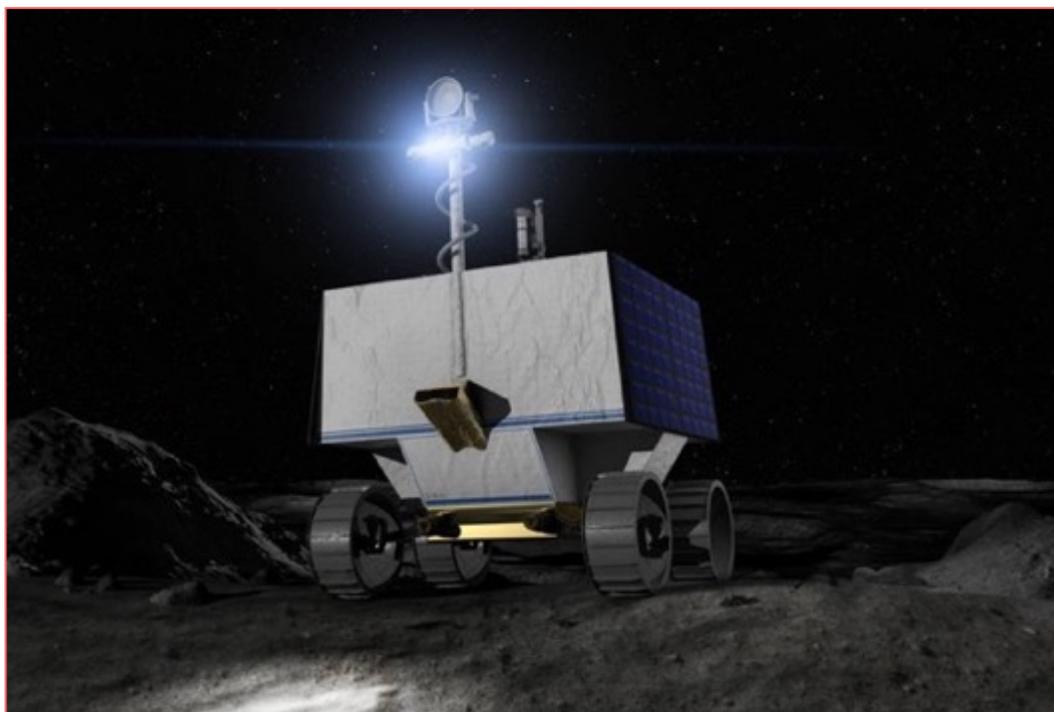
Juno and InSight



- Extended missions for both missions approved!
- **Juno:** approved through September 2025
 - Continued investigation of Jupiter
 - Flybys of Ganymede, Europa, Io
 - Investigation of Jupiter's rings
 - Planning to run a Participating Scientist Program in ROSES-2021
- **InSight:** extended for two years (through December 2022)
 - Focus on producing long-duration, high-quality seismic dataset
 - Continued operation of weather station and burial of seismic tether using Instrument Deployment Arm
 - 'Mole' recovery efforts have now ended
 - Energy challenges caused by dust covering the solar arrays

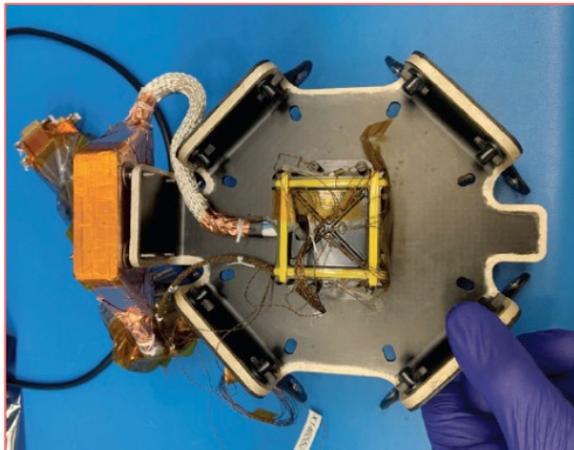
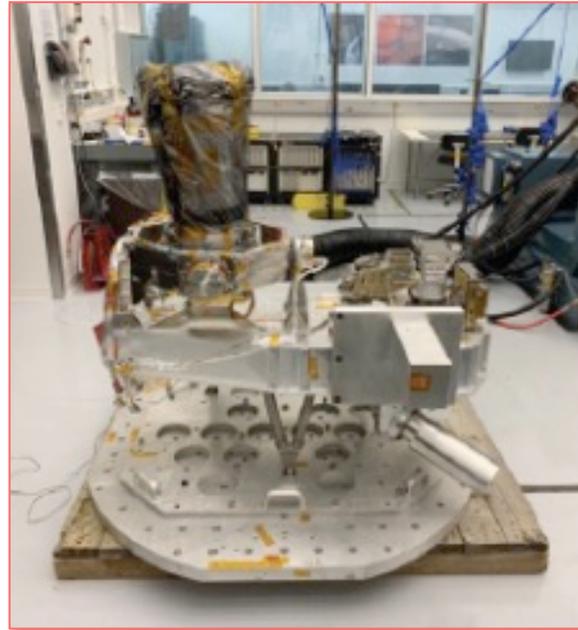
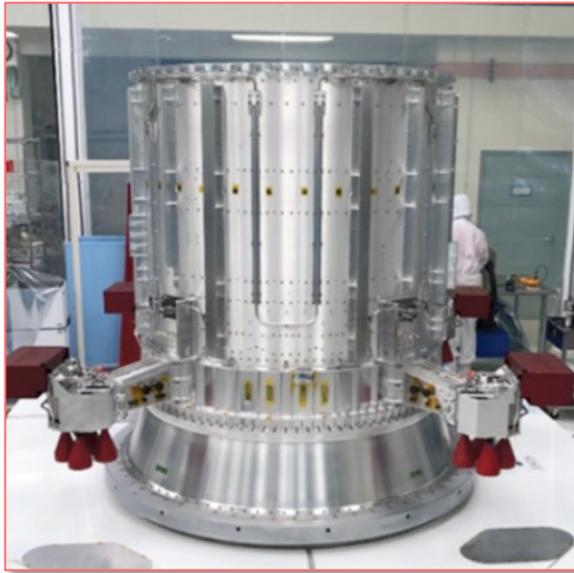


VIPER



- Golf-cart-sized rover – first ever resource mapping on another body
- Will be delivered by Astrobotic (CLPS) later 2023 for a 100-day mission
- Will explore the South Pole of the Moon in search of water ice and other potential resources
- Instruments: neutron, near-IR, and mass spectrometers; and a 1-m drill
- KDP-C held February 23, 2021

Europa Clipper



Project Schedule: Project & Flight System CDR was December 2020; in midst of reporting results to HQ

Launch: Team is working to launch readiness in 2024; in process of acquiring CLV via competitive selection

Instrument Cost Control: EIS and MASPEX are proceeding well under their cost caps

Instrument & Flight System Hardware: Instruments are delivered this year!

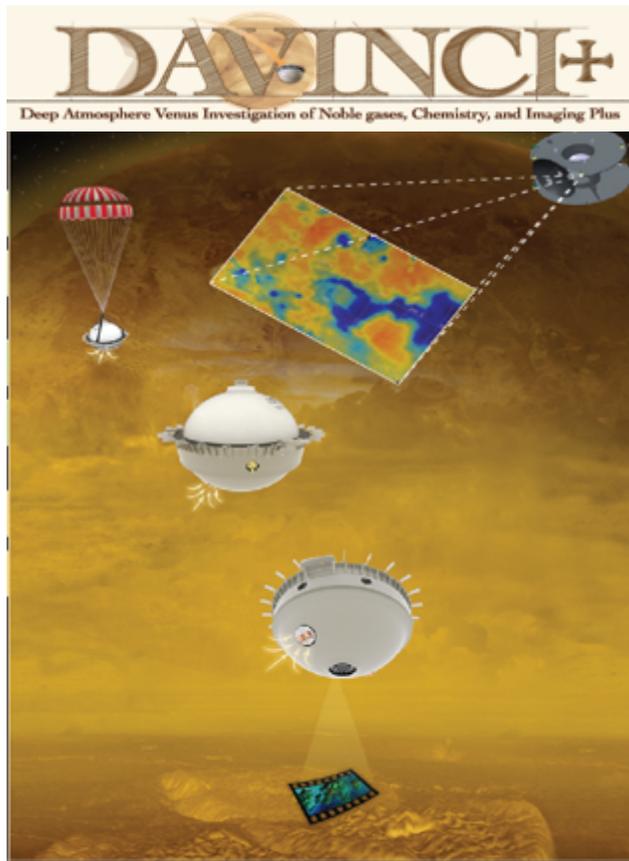
Concerns: COVID impacts are stretching resources, thermal pump, internal electrostatic discharge (IESD), EM interference/cleanliness, contamination control

Clockwise, starting top left: REM installation to lower cylinder of Propulsion Module; NADIR deck shock testing of NAC and WAC; FM oxidizer tank; EM flux gate sensor



Looking Forward





Discovery and New Frontiers

Discovery

- Discovery 2019 remains on schedule, despite COVID-19
- Step-2 selections expected mid-July 2021

New Frontiers

- Dragonfly progressing toward confirmation
- NF5 to be released Fall 2022 (current schedule)
- Community engagement began last fall and is ongoing
 - Community announcement with planning parameters released November 5
 - Community Town Hall will be held late March



Community





Community Initiatives – NASEM Studies

- Decadal Survey panel meetings are ongoing
 - Additional mission concept studies list received, and started
 - Targeting release March 2022
- NASEM study on [Increasing Diversity and Inclusion in the Leadership of Competed Space Missions:](#)
 - Jointly performed under Space Studies Board and Board on Science Education
 - Committee co-chaired by Fran Bagenal (LASP) and Wanda Ward (UIUC)
 - First public meeting was February 8
- NASA has requested a study from the NASEM Committee on Planetary Protection on the criteria for determining locations on Mars that are suitable for robotic missions of lower biological cleanliness than the current Category IV requirements – study will likely be complete by Fall 2021

Community Opportunities

- As part of a PSD pilot study Psyche, Europa Clipper, and Dragonfly provided the opportunity for early-career scientists to observe their science team meetings
 - Lessons learned being considered before continuing the program
- Next PI Launchpad: **June 14–25, 2021**
 - Virtual over two weeks: 1 week of asynchronous content, 1 week interactive (2 to 3 hours per day)
 - Application information posted to NSPIRES January 28; deadline for applications: March 22; notifications by May 3
- Content from 2019 workshop is online:
<https://science.nasa.gov/researchers/pi-launchpad>
- LPSC events:
 - NASA Headquarters Briefing: Thursday March 18, 1:30–2:30 pm Eastern
 - Meet with PSD R&A Program Officers during LPSC week
- Senior review of the Planetary Data System discipline nodes will begin with a call for proposals from the existing nodes in March 2021; will be influenced by the Planetary Data Ecosystem Independent Review Board findings and recommendations



SMD ROSES Gaps Request For Information (RFI)

RFI to identify gaps in opportunities for interdisciplinary/interdivisional research was issued late last year: 97 responses received

Major Findings:

1. Some research projects are specific short-term projects, or are second/third priority for divisions; others fall between discipline stovepipes
2. Technology development **across** multiple disciplines could be better coordinated
3. Data science technologies and algorithms could be better shared and coordinated across SMD
4. Community desire for NASA to make larger investments in ground-based items (telescopes, sensors/instruments, labs)
5. Community wants NASA to review and build more-holistic archives with appropriate policies for initiating, maintaining, and sunsetting archives

Various actions identified and underway. More information: https://science.nasa.gov/science-red/s3fs-public/atoms/files/Sheth_RFI%20Gaps_APAC_Oct2020.pdf



R&A Updates

- COVID-19 Augmentations and Funded Extensions
 - [Call for requests](#) released December 1; deadline March 5, 2021
- ROSES-2021 was released February 12
 - All PSD data analysis programs (CDAP, DDAP, LDAP, MDAP, NFDAP) and cross-divisional Exoplanet's Research Program (XRP) will use Dual-Anonymous Peer Review (DAPR)
 - No Due Date (NoDD)/Rolling Submissions in place for seven PSD programs:
 - Solar Systems Workings, Emerging Worlds, Exobiology, PICASSO, Laboratory Analysis of Returned Samples, Solar System Observations, PDART
 - More information:
<https://science.nasa.gov/researchers/NoDD>



Response to November 2020 Findings



Finding 1: Arecibo Observatory

Finding: The collapse of the main instrument structure of the Arecibo Observatory represents a significant loss to the planetary science community but fortunately did not incur loss of life. We are saddened by this turn of events for the world-famous facility, which has enabled groundbreaking planetary science over many decades. In addition to contributions towards important science research, Arecibo has played a key role in broadening access to STEM fields, inspiring generations of scientists and engineers across a wide array of backgrounds to pursue careers in STEM. The PAC encourages PSD to assess the impacts to planetary science and the planetary science community from the loss of the facility, and to put together a plan for alternative approaches to mitigate such impacts.

NASA Response: The collapse of the Arecibo 305-m telescope was a tragic end for a facility that adeptly served and enabled breakthroughs in multiple areas of atmospheric science, planetary science, and astrophysics for many decades. NASA will continue to utilize the 70-meter Goldstone Solar System Radar facility in California to characterize known NEOs and other targets. The Goldstone facility has greater pointing capability but less range than had been possible with Arecibo's planetary radar, and some scientific research on planets and distant asteroids will be impacted. The Goldstone facility returned to full operations in November 2020 after successful delivery and testing of a new klystron tube for its high-power transmitter. In the short term, NASA is considering ways to enhance resilience at Goldstone. However, this opens the opportunity to think more broadly about what is required for a future planetary radar capability, and NASA welcomes the Decadal Survey process and other avenues for discussions with other key government stakeholders in looking ahead to possible next generation planetary radars.

Finding 2: Research & Analysis (R&A) Funding

Finding: The PAC continues to be concerned at the R&A low selection rates across the PSD portfolio and, in some cases, deferred opportunities for certain programs, since a robust research community is essential to the success of PSD's missions and ultimately the long-term health of PSD's portfolio. The PAC thanks PSD for delivering an improved and comprehensive dataset illustrating how R&A fits into the overall PSD portfolio, including ISFM, and encourages continued presentation of these data going forward. The PAC encourages continued dialog with PSD to consider potential mitigations, including discussion of the "no due date" program implementation and of the criteria used when deciding to convert a call for proposals from an annual cycle to biennial.

NASA Response: PSD shares the PAC's concerns and will continue our efforts to provide transparency into developments within the R&A program. Further, we would like to engage the PAC on specific topics where advice would be particularly valuable. We do note one correction, however; the "no due date" programs were not conceived or implemented as a mitigation for low selection rates, but to provide additional flexibility for all persons involved in the proposal process.

Finding 3: Mars Ice Mapper

Finding: The PAC continues to be concerned about the process by which the Mars Ice Mapper mission appeared in the Mars mission portfolio, as its scope and the plans for its funding remain unclear and evolve with each presentation. The PAC encourages increased communication with the community in the formulation of this concept and recommends that PSD/MEP form a Mission Design Team (MDT), including scientists from the participating international partners and specialists from HEO, early enough in mission definition for science community recommendations to be incorporated. The PAC recommends that any additional instruments beyond the SAR should be competed to maximize science return.

NASA Response: PSD accepts the PAC finding. In March 2021, NASA will be conducting a “Pre-Acquisition Strategy Meeting” (Pre-ASM). Following that Pre-ASM, PSD will establish a Mars Ice Mapper project office at a NASA center. In addition, the recently signed Statement of Intent among the four potential partners (ASI, CSA, JAXA, and NASA) sets the stage for a more formal Memorandum of Understanding later this year, which will more specifically define the roles and responsibilities of the partners. The key point here is that we are very early in the pre-formulation process of the project and things will continue to evolve. We recognize the desire for the science community to play a more integral role in the formulation of Mars Ice Mapper. As we solidify the structural elements of the project, it is our intent to address this specific desire. How this is accomplished will be a point of discussion among the partners.

Finding 4: Diversity in Mission Leadership

Finding: The importance of diversity, across multiple axes, in all aspects of mission leadership (including principal investigators, project scientists, project managers, systems engineers, and business managers) and at all levels, is recognized by PSD and SMD to be key to mission success. The PAC looks forward to hearing results of the newly chartered NASEM study, and encourages NASA to ensure such works build from past efforts, such as the 2018 NASA SMD PI Diversity Workshop. Notably, the leadership of both the proposed Mars Sample Return (MSR) mission and the Mars Exploration Program (MEP) appear lacking in diversity (gender and otherwise) relative to other areas within SMD. Given the large scope in time and science investment involved in Mars exploration, the PAC encourages PSD to look for ways to broaden diversity and inclusivity of the MSR and MEP leadership teams.

NASA Response: We thank the PAC for this finding and this observation regarding the lack of diversity in our leadership teams. We concur that it is necessary to find ways to broaden the diversity, in particular, of the MEP and MSR teams, and we continue to investigate ways to achieve this.

Finding 5: Mars Exploration Program and Mars Sample Return Organization

Finding: The PAC appreciated hearing about the recent organizational changes within MEP, and in particular about how the Mars Sample Return (MSR) campaign will be managed in a parallel structure. While the presented reasons for this management separation were clear, this structure presents challenges in coordinating and prioritizing objectives between these two tracks (including areas of overlap). The PAC emphasizes the importance of keeping Mars exploration and science objectives and MSR objectives aligned and balanced, and encourages NASA to carefully consider the communication structures and methods of prioritization as both of these programs move forward. Additionally, NASA should continue to communicate about these program structures and plans to the Mars community, such as via MEPAG.

NASA Response: We concur with this finding. In response to this finding, as well as to the findings of the MSR Standing Review and Independent Review Boards, a Memorandum Of Understanding (MOU) has been drafted. This MOU explicitly describes the coordination between the MSR and MEP.

EXPLORE

with us

