

PLANETARY SCIENCE ADVISORY COMMITTEE

June 21–23, 2023

MEETING REPORT

Dr. Serina Diniega, Chair
Jet Propulsion Laboratory

Dr. Stephen Rinehart, Executive Secretary
NASA Headquarters

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Tom & Jerry, Inc.*

June 21, 2023

Welcome & Introductions

Planetary Science Advisory Committee (PAC) Executive Secretary, Dr. Stephen Rinehart, opened the meeting. Dr. Rinehart completed roll call and noted that quorum was met for the meeting.

Dr. Serina Diniega, Chair of the PAC, welcomed all members of the PAC and those attending the meeting. She gave brief instructions regarding communication, questions, and notes. She informed the community of the public comment periods to be found in the agenda.

Dr. Lori Glaze, Director of the Planetary Science Division (PSD), welcomed all those attending the PAC meeting.

Planetary Science Division Update

Dr. Glaze reviewed a quick view of the fleet chart that reveals 39 Planetary missions associated with the Moon, Mars, or elsewhere in the solar system. These missions are either in development or in current operations. Green missions are operating, blue missions are extended missions, yellow missions are in formulation and orange missions are in the implementation stages. BepiColombo just had its third flyby of six of Mercury.

Before Dr. Glaze handed the meeting over to Ms. Joan Salute to present the PSD update, she discussed Ms. Salute's retirement in the upcoming months.

Ms. Salute discussed highlights since the last PAC meeting, including the launch of Jupiter Icy moons Explorer (JUICE), Psyche, Europa Clipper, Near-Earth Object (NEO) Surveyor, Juno, Moon Missions, Mars2020, Venus Science Coordination Group (VeSCoor), the Planetary Data Ecosystem (PDE), Early Career Award Winners, and the Here to Observe (H2O) program.

In April of 2023, JUICE launched from French Guiana a day later than scheduled. The radar antennas did not open correctly but after approximately a week, the team was able to get the antenna to open. It is operating well and commissioning activities are taking place through June. In July, JUICE will have its post-launch assessment reviews and the a near-Earth commissioning phase will be completed. It is expected to reach Jupiter in 2031.

The Psyche launch period is currently set for October 5 to 25, 2023, with an arrival at Psyche in August of 2029. The Spacecraft Assembly, Test, and Launch Operations (ATLO) 2.0 began in June of 2023. The Jet Propulsion Laboratory (JPL) is working closely with the project to maintain the level of experienced staff to complete the remaining work prior to the launch. The Phase-E cost profile was approved by the Directorate Program Management Council (DPMC) during their February 2023 meeting. The Internal Review Board (IRB) out brief was held May 20, 2023, with the final report media briefing held on June 5, 2023. A Key Decision Point E (KDP-E) is scheduled for September 14, 2023.

The ATLO for Europa Clipper is continuing. The "Message in a Bottle" campaign was launched and includes a new poem from United States (US) Poet Laureate, Ada Limón, that will be

inscribed on the spacecraft. This campaign allows anyone to send in their name to be included, through the “Message in a Bottle” website¹. Nine of ten instruments have been delivered. Clipper’s Mapping Imaging Spectrometer for Europa (MISE) is on track for a July delivery. The Clipper’s Rader for Europa Assessment and Sounding (REASON) antenna and the Europa Clipper Magnetometer (ECM) boom have not yet been delivered, but the electronics have been received. Most of the instruments are installed in the spacecraft. It was stacked into final flight configuration during the week of June 12. The target launch window is 21-days-long in October 2024, and the mission will have a Jupiter orbit insertion date in April 2030.

NEO Surveyor passed its KDP-C in November of 2022. The instrument subsystem’s Critical Design Reviews (CDR) started in 2023 and it is on track to launch no later than June 2028.

Dr. Glaze discussed the Juno extended mission. The 50th Jupiter orbit was completed in April 2023. The most recent flyby of Io was in May 2023 at an approximate altitude of 22,000 miles. Upcoming Io flybys will bring the spacecraft to within 1,500 kilometers (km) of the surface and is expected in July, October, and December of 2023 followed by one in February of 2024.

Dr. Glaze spent some time reflecting on the progress made on lunar activities. Five years ago, NASA had the Lunar Reconnaissance Orbiter (LRO) and Apollo Next Generation Sample Analysis 1. Now there are many more activities: the Korean Pathfinder Lunar Orbiter (KPLO) is operating at the Moon, with the ShadowCam instrument from Arizona State University (ASU); the Volatiles Investigating Polar Exploration Rover (VIPER) just had its KDP-D prior to integration and testing and delivery in 2024; the Commercial Lunar Payload Services (CLPS) program has been spectacular—the goal is to have two calls per year and two launches per year. In addition, Dr. Glaze stated she was impressed with the magnitude of things that are being prepared for Artemis: the Artemis II Astronaut training is being conducted; the geology team proposals for Artemis III have been received; Artemis III payloads solicitations have been released and one for Artemis IV should follow soon; the Lunar Terrain Vehicle (LTV) instruments draft solicitation is also coming soon; a landing site science community workshop was conducted; and a Joint Extravehicular Activity (EVA) Test Team (JETT)-5 for Artemis III analog science team will be selected through the Analog Activities solicitation; Artemis III and IV project scientists have been named (Kelsey Young was named as the Lead for Artemis II) Lastly, the Apollo Next Generation Sample Analysis (ANGSA) 2.0 and the Solar System Exploration Research Virtual Institute (SSERVI) Cooperative Agreement Notice (CAN)-4 selections have been made and a joint PSD and Exploration Science Strategy and Integration Office (ESSIO) team is developing new lunar science strategy.

Dr. Glaze touched on Mars2020. Perseverance Rover has traveled approximately 19 km. She also discussed the samples collected and the Upper Fan Campaign.

The VeSCoor membership selections have been made for the newly established joint NASA and European Space Agency (ESA) committee for identification of synergistic scientific approaches and outcomes for the Venus mission. NASA selections include Dr. David Grinspoon as co-chair, Dr. Tatiana Bocanegra-Bahamon, Dr. Larry Esposito, Dr. Patrick McGovern, Dr. Joseph

¹ <https://europa.nasa.gov/message-in-a-bottle/sign-on/>

O'Rourke, and Dr. Jason Rabinovitch. ESA selections include Dr. Lucia Marinangelia as co-chair, Dr. Giulia Alemanno, Dr. Yoshifumi Futaana, Dr. James Holmes, Dr. Arianna Piccialli, and Dr. Iván López Ruiz-Labranderas.

Continuing work to address the PDE IRB recommendations include welcoming Dr. Robin Ferguson as the new NASA Planetary Data Officer. Additional PDE updates will be provided at the fall PAC meeting. The PSD Early Career Award (ECA) winners for 2022 were announced by Dr. Glaze. Michael Sori from Purdue University won with their submission of "Enabling the Future of Planetary Geodesy," Xinting Yu from the University of Texas, San Antonio won with their submission of "The Next-Generation Laboratory Experiments on Planetary Materials," Jamie Molaro from the Planetary Science Institute (PSI) won with their submission of "Efficacy of Thermally Driven Regolith Creep on Lunar, Martian, and Asteroid Surfaces," David Welch from Columbia University won with their submission of "Development of an Inexpensive Ultraviolet (UV) Spectrometer for Science Education," and Lynnae Quick from Goddard Space Flight Center (GSFC) won with their submission of "[A] Historically Black Colleges and Universities (HBCU) Pilot Program to Diversify the Planetary Science Pipeline."

Dr. Glaze touched on the H2O program. It is the second year of the program with two Minority Serving Institutions (MSI) and mission pairings: the University of Puerto Rico and Europa Clipper, and Virginia State University and Dragonfly. The H2O Program solicitation was released in Research Opportunities in Space and Earth Science (ROSES)-2023 as a no-due date program. The expectation is that the program will expand with a possible six pairings at a time.

Dr. Glaze discussed issues and challenges being faced by PSD, including the current budget forecast, concerns with the Mars Sample Return (MSR), Dragonfly, Venus Emissivity, Radio Science, Interferometric synthetic aperture radar (InSAR), Topography, and Spectroscopy (VERITAS), New Frontiers, Discovery, Small Innovative Missions for Planetary Exploration (SIMPLEx), and New Horizons.

Following the bill passed by Congress to suspend the debt ceiling until January of 2025, PSD will find itself capped at the 2023 budget level, leading to a \$183 million deficit relative to what the President requested for planetary in 2024. The budget that PSD had been planning to currently is \$3.383 billion for 2024 and the budget for 2023 is \$3.2 billion. Dr. Glaze presented pictographs of the PSD budget for 2015–2028 that showed the budget impact of current and planned missions. She discussed the impact of COVID, the supply chain, and inflation on the budget. She stated that they were prioritizing the missions that were already in development that had made it to KDP-C as that point meant that they are committed to the cost and schedule of the missions. She also discussed trying to minimize interruptions of international missions.

MSR has additional upper funds proposed for fiscal year (FY) 2024, but not yet for FY25 and beyond. The project is working to make it to the KDP-C for the commitment of the cost and schedule. They are reviewing the backwards planetary protection process. The Sample Receiving Project will need facilities and capabilities at the back end prior to samples being researched.

For Dragonfly, preliminary design and technology maturation are complete and the mission successfully passed all technical requirements for mission Preliminary Design Review (PDR) in

March 2023. Detailed design activities are ongoing along with preparation for their NASA confirmation review which occurs later in 2023. VERITAS is working through the 2025 budget process to incorporate the mission delay, of no less than three years.

The New Frontiers Announcement of Opportunity (AO), which had been originally scheduled for November 2023, will most likely not meet that timetable. In part owing to the uncertainty around the impacts of the Debt Ceiling deal. A Community Announcement will be released this summer that will provide more details. A delay to the next Discovery and SIMPLEx AOs is likely.

The PSD, Heliophysics Division (HPD), and Astrophysics Division (APD) are coordinating on the future of New Horizons. HPC received sufficient input from Request For Information (RFI) responses to inform the budget planning process for FY25 and beyond. HPD will determine the timeline and future steps for the possibility of spacecraft operations through HPD. If HPD is unable to support New Horizons in FY25, the spacecraft may be placed in hibernation mode. PSD continues to support observations of the Kuiper Belt that could influence activities, through the Solar System Observations Research and Analysis (R&A) program.

Dr. Glaze commented on looking forward to programs and missions including CLPS and Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx). As part of CLPS, the Astrobotic Peregrine Mission 1 launch is awaiting the United Launch Alliance (ULA) and Vulcan-Centaur vehicle; this lander will carry NASA payloads from five Centers. The Intuitive Machines (IM) Nova-C will be launching in the third quarter of 2023 with five NASA payloads from three Centers and six non-NASA payloads. The Intuitive Machines Polar Resources Ice Mining Experiment (PRIME) 1 will be launching in November 2023 with the Lunar Trailblazer. OSIRIS-REx has the sample capsule landing at 10:55 am Eastern Daylight Time (EDT) on September 24, 2023, at the Utah Test and Training Range (UTTR) with approximately 250 grams (+/-) of material. The capsule will be retrieved by helicopter and taken to a UTTR pop-up clean room for a preliminary checkout. The capsule and contents will be flown to JSC on September 25, 2023. Once samples are delivered, the OSIRIS-Apophis Explorer (APEX) mission will begin, while OSIRIS-REx sample analysis campaign begins. A new US Postal Service (USPS) stamp will be released to honor OSIRIS-REx.

Dr. Glaze then discussed the response of the PSD that the PAC had recommended based on previous findings.

Finding 1: VERITAS Delay

Finding: The PAC re-affirms their support for the VERITAS mission (see December 2022 PAC Finding 2) and efforts that aim to enable a VERITAS engineering development restart in 2025 and launch in 2031 (or sooner, should the situation allow). The PAC acknowledges that PSD leadership described, at the February 2023 and the December 2022 PAC meetings, specific requirements for the approval of new mission starts managed by JPL. The PAC acknowledges and shares community concern and confusion about how these metrics will be evaluated and applied to the approval and selection of new mission starts managed by JPL, and to the restart of VERITAS.

Recommendation: To maintain community confidence and transparency, the PAC recommends that PSD leadership continue to publicly share the specific metrics required for the approval of new mission efforts managed by JPL, and for the restart of VERITAS. Additionally, the PAC recommends that any requirements and circumstances that may lead to changes to these metrics also be shared clearly and promptly in a public forum. As a means of clarifying circumstances that may impact JPL readiness evaluations, the PAC also recommends that PSD publicly document if there is any relationship between requests for budget updates and the metrics that must be met by JPL for them to be approved to manage a new mission effort. In particular, the PAC requests updates on the PSD plan at (1) the Summer 2023 PAC meeting, following the interim Psyche IRB assessment, and (2) at the Spring 2024 PAC meeting, following the full Psyche IRB assessment and NASA budget updates.

Response: As shared during the previous PAC meeting, are three criteria that must be met before the VERITAS mission will be restarted: (1) JPL must successfully address matters arising from the Psyche IRB report; (2) PSD must secure funding in the appropriate years; and (3) NASA-Indian Space Research Organization (ISRO) Synthetic Aperture Radar (NISAR) and Europa Clipper missions must stay on schedule for their respective launches. An update on the mission status was provided earlier in this presentation and NASA will continue to update the PAC on the progress towards restarting. The VERITAS Mission. The current budget planning cycle for FY25 and beyond provides the opportunity to lay in a restart plan for Veritas. SMD. Is requesting a budget profile for VERITAS that targets a launch no earlier than 2031.

In addition, SMD's response to the Psyche IRB's final Implementation Assessment was published on June 5, 2023². That assessment indicates, and NASA concurs, that the response to all JPL Institution findings and recommendations are appropriate and exceed the Board's expectations. JPL director, Dr. Laurie Leshin, will provide a summary of JPL's response to the IRB findings on day three of this PAC meeting. Further, NASA acknowledges that one finding received an "inadequate" rating in the final IRB assessment, relating to Standing Review Board (SRB) Changes. The NASA response to this finding is ongoing, and it is known that it relates to the agency, rather than just SMD or PSD.

Finding 2: NASA Center Workforce Health

Finding: The PAC recognizes that the success and future health of the planetary science community hinges upon the health of the workforce. The Psyche IRB report pointed out insufficiencies in staffing, necessary expertise, communication, and psychological safety related to one Federally Funded Research and Development (R&D) Center (FFRDC) likely relevant to other major institutions involved in planetary missions. Such issues have been demonstrated to have far reaching negative ramifications for NASA goals and missions. The PAC has heard about ongoing assessments of planetary missions and involved major institutions, and that there are plans for future assessments of additional major institutions involved in PSD missions.

Recommendation: The PAC requests to hear the results of the ongoing and future assessments of workforce health at major institutions involved in PSD missions. At a future PAC meeting, the

² https://www.nasa.gov/sites/default/files/atoms/files/psyche_irb_assessment_report_with_nasa_response_may_2023_508.pdf

PAC recommends the involvement of the SMD-operated Inclusivity, Diversity, Equity, and Accessibility (IDEA) group in these assessments to ensure that IDEA concerns are part of that conversation, and the assessors have access to the expertise provided by that group, including their outside contractors.

Response: NASA concurs that the success of PSD depends on the health of the planetary science community and would value additional conversation with the PAC on the intent of this finding and recommendation. For now, NASA notes an external facing SMD website³ that provides information on a study commissioned by SMD in 2020 to develop workforce strategies targeted towards the broad science community. The final report from February 2021 is available, along with details on several workforce initiatives that resulted from the study. This study focused on science workforce and thus did not include other integral members of the planetary exploration communities (e.g., engineers, program and project managers, administrative support personnel, etc.). Laurie Leshin, JPL Director, will provide a summary of the JPL IRB response on day three of this PAC meeting, which will include topics related to the JPL workforce.

Finding 3: Large Mission Progress and Risks

Finding: As PSD and JPL work to support ongoing missions before new mission starts, the PAC is concerned about the potential of programs at the scale of MSR to affect the delay of VERITAS and other new mission selections. While the PAC is encouraged with the recent reports on MSR development and upcoming reviews, a general concern remains about potential MSR development delays and their impact on PSD planning.

Recommendation: The PAC requests to hear about potential risks identified at key reviews for ongoing NASA directed and flagship missions if those risks appear likely to lead to cost and/or schedule overruns that would impact PSD and SMD decisions about other ongoing missions or future opportunities. In particular, the PAC requests continued reports on the MSR development, including any major risks identified at the upcoming KDP-C if those risks may impact other missions' development.

Response: The MSR program is developing the cost and schedule estimates based on flight element preliminary design activities during phase B prior to an agency confirmation decision, which is expected to occur later this fall. In addition to NASA's internal formulation process that provides for multiple independent life cycle reviews of project designs and performance, SMD has commissioned a second IRB to review program risks, cost, and schedule prior to the system-level PDR and Confirmation, at which point program cost and schedule commitments are established. Additional information related to program status and risk posture will continue to be included in the MSR program updates to the PAC.

Finding 4: Astrobiology Research Coordination Networks (RCNs)

Finding: The PAC commends and appreciates the positive work done by the Astrobiology RCNs towards community engagement, early career involvement, and diversity, equity, and inclusion (DEI). The inclusive group formats highlighted by the RCNs (e.g., as reported by the Network for Life Detection (NfoLD) and the Prebiotic Chemistry and Early Earth Environments

³ <https://science.nasa.gov/about-us/science-workforce-initiatives>

Consortium (PCE3): the think tank, social hour, and early career seminar series) are capturing the attention of the community and target audiences very successfully. Clear topical connections were recognized by the PAC between the work by these RCNs, community Assessment/Analysis Groups (AGs), and NASA groups working on planetary samples.

Recommendation: As many clear similarities and overlap in research interests exist between RCNs, AGs, and NASA groups working on samples, particularly with relevance to ongoing and upcoming astrobiology-focused missions, it would be beneficial for PSD to more fully explore formal, intentional, and strategic avenues to share information to leverage advantages and avoid duplicating efforts. The PAC recommends that relevant programs in PSD explore options to leverage the clear organizational and community-driven advantages that the RCNs provide, and that PSD clearly delineate the roles, responsibilities, and activities of the RCNs. It's possible that some of these connections and definitions are already in place, and the PAC would be interested in hearing about specific examples in future presentations.

Response: This is a timely recommendation, as the PSD has recently completed the review of the Nexus for Exoplanet System Science (NExSS) RCN. PSD concurs that the RCNs have been an effective tool for the development of the astrobiology community, and that there are potential benefits from exploring a similar model for other segments of the planetary science community. As the NExSS report is digested, they will also explore how they might implement RCNs more broadly. The roles, responsibilities, and activities of the RCNs have been described on several occasions and will be discussed as part of the astrobiology presentation at this PAC meeting.

Finding 5: IDEA Cross-AG Working Group Communication

Finding: The PAC recognizes the importance of the work done by the IDEA Cross-AG Working Group, facilitated by the science community existing across the AGs and the greater planetary community. Thus, as stated in prior Findings, the PAC would like to receive regular updates from the IDEA Cross-AG Working Group about community concerns and their work to address such concerns.

Recommendation: The PAC recommends that PSD leadership converse with the AGs and the IDEA Cross-AG Working Group to (1) determine the types of inputs PSD thinks would be useful additions to PAC meetings and (2) for PSD to hear from the AGs and the IDEA Cross-AG Working Group on the IDEA Cross-AG Working Group's scope and goals. From this conversation, PSD should create a clear pathway for the IDEA Cross-AG Working Group to share relevant information with the PAC, clarifying if such updates/communications would generally come through the AG reports and/or via direct reports (e.g., when covering a broad-reaching topic). In either case, adequate presentation and discussion time for the community's IDEA topics/concerns should be included in each PAC meeting agenda.

Response: PSD thanks the PAC for this recommendation and recognizes the importance of the work done by the IDEA Cross-AG Working Group (CAWG). PSD is committed to IDEA and, with one exception (November 2020), has included an IDEA-related topic on the agenda of each PAC meeting since August 2020. To ensure the IDEA CAWG has a direct line of communication to PSD leadership, PSD has provided the IDEA CAWG with two NASA

Headquarters liaisons. PSD welcomes a presentation from the IDEA CAWG at one PAC meeting per year (i.e., the second PAC meeting of each year) to share relevant information with the PAC. In addition, given the limited time availability on the PAC agendas, and the underlying principle that the IDEA CAWG is representative of the greater planetary science community, the IDEA CAWG has also been encouraged to share their findings and recommendations with the AGs they represent throughout the year—for the AGs to bring forward to the PAC. Furthermore, given the importance of the work done by the IDEA CAWG, the PSD encourages the AGs to develop open communication mechanisms between their AG and the IDEA CAWG, and to have at least one member of their steering committee represent their AG as a member of the IDEA CAWG steering committee, and dedicate time in their AG meetings for IDEA-related discussions.

Finding 6: Planetary Radar Data

Finding: The Arecibo Observatory is currently scheduled to end science operations in April 2023 with discontinued access for the scientific staff after mid-August 2023. To ensure continued usability of the Arecibo radar data, processing software and systems need to be preserved along with the data. It is presently unclear to the community if the end-of-operations plan includes retaining Arecibo planetary radar data processing software and systems in addition to the radar data archive, and which agency, either the National Science Foundation (NSF) or NASA, is responsible for such work.

Recommendation: The PAC requests to hear, at the Summer 2023 PAC meeting, the end-of-operations plan for retaining Arecibo planetary radar data processing software and systems, including identification of the appropriate organization for hosting them and the agency responsible for supporting the endeavor.

Response: NASA’s Planetary Data System Small Bodies Node (SBN) is in the process of capturing the Arecibo radar data and software copy hosted by Arecibo radar team members at the University of Arizona. The SBN will deliver those data and software as a pre-archive backup to the NASA Space Science Data Coordinated Archive for preservation. The Arecibo radar team continues formal PDS archiving of the radar data products with the SBN and the software on a publicly accessible software archive. NSF has communicated to NASA that the Arecibo radar data and software copy at the Texas Advancing Computing Center will be kept for the foreseeable future, while NASA completes its preservation and formal archiving process.

Dr. Glaze concluded the presentation and was available for clarification questions.

A question inquired about the balance of missions based on the Decadal. Dr. Glaze stated that while they are going through belt tightening, she felt that it is important to understand that the Decadal is not lost. They have been in a similar situation before and came out well. It is important to be patient. She is trying to be an optimist and admitted that she is still concerned about MSR. They are working to protect what they already have.

A question was raised regarding the potential for MSR cost growth increases, how does it impact other programs? Does it impact VERITAS start date, operating missions, Uranus new start, or the SRF? Dr. Glaze stated that the SRF is tied together with MSR. She stated that she is not sure

she can answer the question. She stated it depends on the timing of the impact. Where is the pressure point? How big is the impact point? She stated that the ones who are already past confirmation would be the safest. She mentioned Psyche and Europa Clipper and their potential impacts. Dr. Glaze apologized and stated that she wished she could give a straight answer. Despite such a large trade space, they are doing the best they can.

A question was asked if New Horizons is being treated the same or different than Voyager? Dr. Glaze stated that Voyager's focus changed at one time, but the motivation is similar, in that there is very good Heliophysics science that can be conducted with the New Horizons spacecraft. The idea was to shift the operational assets over to Heliophysics. It was asked if it was more suited to be a Heliophysics versus Planetary. Dr. Glaze stated that both Voyagers fall within Heliophysics. She stated that the Senior Review rated the overall mission as Excellent/Very Good (E/VG). There was concern regarding observational time if New Horizons was placed over in Heliophysics. As in, it would be difficult to get observational time for non-planetary mission for planetary objects. Dr. Glaze stated that no one has approached her to ask that question. Dr. Diniega asked who specifically she might be hearing that question from? It was stated that someone from the team should do so. Dr. Glaze did discuss the telescope programs.

Exploration Science Strategy and Integration Office (ESSIO) & Lunar Updates

Dr. Joel Kearns, Deputy Associate Administrator for Exploration of the SMD, was introduced to present the Lunar Discovery and Exploration Program Update.

As of June 13, 2023, the Lunar Discovery and Exploration Program Status planning and strategies included: the NASA Integrated Lunar Science Strategy; the Moon2Mars (M2M) Objectives and the Decadal Surveys Trace; a Community Science Definition Team: objectives for Endurance A Mission (South Pole-Aitken Basin sample return); and National Academies of Sciences, Engineering, and Medicine (NASEM) studies e.g., Science from Humans on Mars.

The Competitive Solicitations include PRISM3 selections in June 2023 of the proposer selecting a landing site, a higher instrument suite cost cap, a "Mobility as Service" offered by CLPS, and "Survive the Night" offered by CLPS; Artemis III Geology Team (A3GT) call step 2 proposals were received April 25, 2023; Artemis III Deployed Instruments (A3DI) call was released May 30, 2023; planning of the LTV Instruments, Artemis IV Deployed Instruments (A4DI), and PRISM4.

PRISM1 instrument suites are in development: the Lunar Vertex will be exploring the Intersection of Geoscience and Space Plasma; the Farside Seismic Suite (FSS); and Lunar Interior Temperature and Material Suite (LITMS). PRISM2 instrument suites in development: Lunar Vulkan Imaging and Spectroscopy Explorer (LunarVISE) and the Lunar Explorer Instrument for Space Biology Applications (LEIA). CLPS delivery competitions were included.

Masten XL-1 will not take place and their instruments are to be re-manifested. VIPER has progressed through System Integration Review (SIR) with an expected landing of November 2024. Lunar Trailblazer is in thermal vacuum (TVAC) testing and will be launched with IM-2.

The Astrobiotic Technologies Peregrine Lander Mission (PM-1) is on hold because the ULA Vulcan-Centaur had an issue. They have not given a new date for the shipment of the lander to Florida. For now, the lander is completed but the launch date is to be determined. IM Nova-C Lander will be launching soon, within the third quarter of 2023.

Dr. Kearns concluded his presentation and was available for clarification questions.

Dr. Sarah Noble, PSD Lunar Science Lead, was introduced to present the Lunar Science Update. The PSD/ESSIO are continuing to build the integrated lunar science strategy. Near-term activities include developing statement of task for a NASEM study on potential non-polar human destinations; JPL is conducting a study to better define Endurance concept and has a community workshop August 9 to 11, 2023; planning for Endurance Science Definition Team (SDT); GSFC is conducting pre-phase A study on Lunar Exploration Science Orbiter (LExSO) using the Lunar Exploration Analysis Group (LEAG) Continuous Lunar Orbital Capabilities – Specific Action Team (SAT) (CLOC-SAT) report as a guide; the Permanently Shadowed Regions (PSR) Cryo Extraction Roadmapping study is being conducted by the Exploration Systems Development Mission Directorate (ESDMD) to better understand the knowledge and capabilities gaps for cryogenic sample return; and instigating a joint LEAG/Extraterrestrial Materials Assessment Group (ExMAG) study on Artemis Samples. They are working on a white paper “snapshot,” which they expect to provide to the community for comment later in 2023.

The Artemis II Crew was named and have been provided “Lunar Fundamentals” classroom training. Artemis III and IV project scientists were named, Dr. Noah Petro and Dr. Barbara Cohen, respectively. There is an expectation of a NASA-internal call for deputies for both missions for fall of 2023. The Artemis Contamination Control Scientist was hired at GSFC (Dr. Andrew Needham) and the Artemis Curation Lead should be announced soon.

The A3GT proposals were received and are in review. An announcement is expected in fall of 2023. There was a successful JETT-3 (Joint EVA Test Team) analog test in fall 2022, and they are currently gearing up for the JETT-5 analog test in September or October. The science team was selected through the Analog Activities call and is deep in planning. The LEAG Analog Objectives for Artemis (AOA) SAT is being updated. Space has been identified in Johnson Space Center (JSC) Building 30 (i.e., Mission Control) for the Science Evaluation Room (SER) and a design is being worked now based on the input from JETT-3 and is expected to be built next year.

ANGSA (Apollo Next Generation Sample Analysis) 1.0 Teams are finishing up with a lot of new science results. There are lessons learned for Preliminary Examination (PE) and curation being collected and incorporated into Artemis planning. The ANGSA 2.0 Selections have been made, including the Spectroscopies for Assessing Redox Conditions (SPARC); The Enigma of Evolved Lunar Granites: A consortium approach to solving their petrogenesis; and Evaluating geochronologic complexity and impactor diversity of highland impactites.

As for the Hakuto-R, on April 25, 2023, ispace attempted landing on the lunar surface near the crater Atlas. During landing, an anomaly prevented the lander from successfully touching down. On April 26, twelve hours after the landing attempt, the Lunar Reconnaissance Orbiter (LRO)

Camera (LROC) acquired 10 images across the landing region. After approximately two weeks of searching, LROC identified multiple changes due to the impact, at least four prominent pieces of debris, several smaller low-contrast anomalies, and a few ambiguous smudges. The debris spread over at least 40 meters with a regolith disturbance over at least 60 meters.

The ShadowCam payload on KPLO was built by ASU and funded by the ESDMD. SMD/ESSIO will take over operations in its extended mission ops in CY24. Images provided by ShadowCam will aid future robotic and human operations in shadowed areas as it provides high resolution imagery of Lunar PSRs and deep shadowed terrain.

The Lunar Surface Science Workshop (LSSW) on Geologic Mapping for Artemis is August 16 to 17, 2023. There is a call for abstracts out now, due July 12, 2023. The goals of the workshop are to bring together science and technical professionals to jointly discuss cartographic needs related to geologic maps for Artemis exploration in the near- and long-term. The workshop aims to result in a recognition that geologic maps are applied science products that help ensure crew and asset safety and maximize science return. It is to help determine stakeholders and map users, the most relevant data layers to satisfy the broadest range of stakeholder needs, approaches to assessing and conveying map accuracy, and a plan to create Artemis geologic map products across a range of scale, similar to those maps produced for each of the Apollo candidate landing sites.

Dr. Noble concluded the presentation and was available for clarification questions.

Dr. Diniega requested clarification on the aforementioned White Paper and if it was primarily for the NASA community. Dr. Noble responded that NASA would write the white paper and release it to the community for comment. They did have a plan to incorporate community feedback as necessary.

A question was asked regarding the risk associated the high-risk CLPS missions. Dr. Kearns stated that they have shared with stakeholders the risks and that commercial involvement is necessary for movement forward. They also ensure that the PIs are aware of this fact. Dr. Glaze reinforced that they ensure that the stakeholders and the community know that the objectives of the program are slightly different, and this is about the long game, getting access to the moon for the long-term. They look at hard landings and soft landings, because no matter what happens, they are going to learn. A follow up question was posed regarding addressing the public concern on these issues. Dr. Kearns pointed out that when they speak with Congress, they tell them that not all the landings might be soft.

A question was asked regarding the resources being available as ESA joins the commercial economy. Dr. Kearns stated that they believe that American companies are going to aggressively compete for customers outside of the US. For example, ESA is directly paying a CLPS company to bring an ESA instrument to the Moon. There does appear to be quite a bit of work in the future.

Infrared Telescope Facility (IRTF) Independent Review

Dr. Lucas Paganini, IRTF Independent Review Lead from the APD, was introduced to present the Independent Review for NASA's InfraRed Telescope Facility (IRTF). He first thanked the Subject Matter Experts (SMEs) for serving on the IRTF Independent Review (IR) panel and others.

The objective of NASA's IRTF IR was to obtain an independent assessment of NASA's investment in the IRTF, determine if IRTF capabilities are unduplicated with other assets, and provide feedback to IRTF management regarding current strategy to achieve Planetary Defense, PSD, and APD Strategic Objectives. The logistics of the IRTF IR included six SMEs, two-day in-person review of IRTF report and presentations, and three core evaluation criteria. The IRTF IR is not a periodic review, and it is not a competition with other NASA missions, projects, or NASA-funded activities. However, PSD might perform these reviews every five years. The panel assessment is used by PSD, along with other inputs, to balance strategic value within the broader context of NASA priorities. Material resulting from the IRTF IR is available online⁴.

The SME Panel evaluated a comprehensive IRTF Report against the following metrics. Relevance and responsiveness to NASA strategic goals and objectives – they were to review the overall scientific strength and impact of the IRTF in achieving NASA's strategic goals, productivity using performance metrics such as papers, citations, etc., and quality of data archiving and management. Technical Capability and Cost Reasonableness – they were to perform an assessment of technical capabilities, including the current suite of instrumentation, to achieve Planetary and Astrophysics Decadal science; and an assessment of cost reasonableness, including general budget details and status, yearly operational costs, level of effort, travel costs, Maunakea support services, projected costs for future operation, etc. Management and operations – they were to perform an assessment of how IRTF management gets inputs from the community, responds to their feedback, and stays competitive; facility operations (e.g., instruments health, carbon footprint compared to other telescopic facilities and plans to be more energy-efficient); and planned new capabilities and future needs from 2023 to 2032.

Dr. Paganini concluded his presentation and introduced Dr. Nancy Chanover from New Mexico State University (NMSU), co-chair. Dr. Chanover reiterated the appreciation of all those involved in this process. Those at NASA's Headquarters (HQ), NASA Research and Education Support Services (NRESS), all panelists, and the IRTF staff.

Dr. Chanover discussed the relevance and responsiveness to NASA's strategic goals and objectives.

The NASA IRTF represents a unique asset in NASA's portfolio to support NASA's Strategic **Objective 1.2** and to provide mission support capabilities and NEO characterization. IRTF's unique strengths are derived from a combination of its site which is a high altitude, low-humidity, stable atmosphere, and geographic location; its instrumentation as the only facility in the northern hemisphere with mid-infrared capabilities; and its operations as the only major

⁴ https://www.lpi.usra.edu/NASA-academies-resources/resources/IRTF_Independent_Panel_Review_public.pdf

facility to perform daylight observations and provides a very rapid non-sidereal tracking capability.

Relating to NASA's **Strategic Objective 1.2** of "*Understand[ing] the Sun, solar system, and universe...*" IRTF's infrared observations of objects from small bodies to extragalactic transients directly address **Objective 1.2**. It has time domain capabilities covering the range of milliseconds (occultations) to decades and has nearly year-round monitoring capabilities for the solar system due to daytime observing abilities.

Scientific productivity in both planetary science and general astrophysics is significant given the aperture size. There are approximately 100 refereed publications per year and the publication rate and impact for solar system studies is substantially higher than that of telescopes of its class and is higher than all other ground-based telescopes.

IRTF is uniquely capable for planetary defense as it has efficient visible and near-infrared spectroscopy, visible photometry, and mid-infrared photometry. These capabilities combined can provide the determination of bulk density, mass, albedo, and size of NEOs. No current or planned facility, including NEO Surveyor, combines these capabilities. Additionally, IRTF has extremely fast non-sidereal tracking, enabling studies of very close passage, fast-moving objects.

Data from two main facility instruments, Spectropolarimeter for Planetary Exploration (SpeX) and Immersion Grating Echelle Spectrograph (iSHELL), are being archived and curated at the Infrared Processing and Analysis Center (IPAC) Infrared Science Archive (IRSA), with Mid-Infrared Spectrometer and Imager (MIRSI) to follow once commissioning is complete. Python-based data reduction pipeline for SpeX is in development and, once complete, all legacy SpeX data will be reduced and made publicly available. The IRTF's current, and planned, data management activities are consistent with NASA requirements and expectations.

Dr. Chanover discussed the technical capability and cost reasonableness of IRTF.

The conversion of several guest instruments to facility instruments has been a cost-effective way to offer state-of-the-art IR instrumentation at relatively low cost. A graph was presented that described the capability, Astro2020 applications, and planetary applications of SpeX, iSHELL, MIRSI, daytime observing, and high speed imaging. IRTF has identified a new integral field spectrograph covering 0.4-4.2 microns. This instrument has the endorsement of the NASA IRTF-Keck Users Group (NIKUG) and the IRTF community. The SPECTRE (Spectrograph Express) instrument would significantly increase IRTF's capabilities across the portfolio. However, the overall funding plan for the instrument is uncertain, given the challenges in opportunities at NSF, and the need for adequate margin to be incorporated in the cost.

Enhanced capabilities include remote observing, daytime observing, short instrument changes and creative scheduling approaches have enabled more versatile usage and high scientific impact. The Director's Discretionary Time and Target of Opportunity requests are powerful ways to meet the observational needs of time domain astronomers. Upgrades to image quality have been identified but have not yet been resourced.

The science return of the IRTF is high relative to its overall costs of approximately \$6 million per year, reported in 2019. Additional programmatic value to NASA is added by the significant mission support and planetary defense roles of the IRTF. IRTF is extremely well managed, providing unique astronomical capabilities at a fraction of the cost of other facilities. Its staff is diverse, specialized, and highly trained.

Dr. Chanover discussed the IRTF management and operations.

The IRTF Director and staff actively and regularly solicit feedback from the user community through exhibitor booth at conferences, the NIKUG, and a “Future Directions Workshop.”

Regarding facilities operations, the IRTF has implemented an established approach for identifying, characterizing, and mitigating risks. The IRTF has reduced its carbon footprint, largely through remote observing and reducing personnel travel. Multiple programs can (and usually are) executed per night, providing flexibility and efficiency gains.

The IRTF identified the completion of SPECTRE as the highest priority for enhancing its role in planetary defense and ability for NEO characterization. Additional telescope and scheduling improvements (active guiding and better DDT usage, respectively) are also being evaluated. With the recent completion of Astro2020 and Planetary/Astrobiology Decadal Surveys, this is an appropriate time for IRTF to reignite its strategic planning efforts.

IRTF has no budget for outreach, and no requirements to participate in Maunakea Observatory (MKO) efforts. Nevertheless, IRTF participates in Kindergarten through 12th grade Science, Technology, Engineering, and Math (STEM) outreach, Maunakea Scholars program, University of Hawaii (UH) undergraduate training, and the NSF Research Experiences for Undergraduates (REU) program.

Dr. Chanover discussed areas for improvement as far as the IRTF is concerned.

SPECTRE funding: The budget to construct SPECTRE is currently uncertain, with estimates in the range of \$3-4 million, without margin. Proposals at this scale for NSF funding have difficulty succeeding in the current environment. Moreover, instrumentation like SPECTRE may need on the order of 30% margin in cost estimate.

Optical improvements: Several optical improvements, including adaptive optics, have been identified by the community, but cannot be realized within the current budget.

Target of Opportunity (ToO): At present, the community is using Director’s Discretionary Target (DDT) requests to fulfill the role of ToO more often than the existing ToO Time Allocation Committee (TAC)-approved process. Policy clarity on ToO vs DDT is warranted.

Data management: Automatic data reduction to Level 1 data products is not yet in place. Progress is currently limited to external efforts. A timeline to establish a full archive of IRTF data is not yet developed.

Strategic planning: IRTF does not have a focused strategic planning document covering the next decade, with the last major strategic exercise in 2018. Long-term alignment with Decadal future priorities is not sufficiently explored.

Staff: Key staff retirements soon may need additional effort and focus.

Community engagement beyond STEM: The nature of community engagement in Hawaii is evolving beyond a purely STEM focus. Robust community engagement will be needed in the coming years, but outreach efforts at IRTF are not in the budget.

Maunakea Stewardship Oversight Authority (MKSOA): Management of Maunakea transitions to the MKSOA in 2028, with sublease expiration for UH/IRTF in 2033. Engagement should begin early and robustly if IRTF is to continue operations after 2033. Co-Chair Dr. John O'Meara will brief SMD leadership on Maunakea issues separately, as this is not in the charge of the review.

Dr. Chanover concluded the presentation and was available for clarification questions.

A question was asked if there is any merit in including something like IRTF in a senior review with other missions or activities. Dr. Glaze stated that they had discussed treating this like a senior review. They wanted to treat this review as a baseline as the telescope had never been reviewed before. She discussed the authority at Maunakea and the lease that is up in ten years. They wanted a baseline to be able to decide when they need to be thinking about the lease. They do need to do that kind of assessment, but as of now they needed just a baseline. IRTF is completely unique to NASA. Clarification was garnered regarding the fact that NASA owns the facility and NSF funds the instrumentation. Dr. Paganini stated that historically NSF has funded the instrumentation while NASA owned the property.

Dr. Diniega questioned about the bias or selection equity between the approaches especially as they discussed DDT. She asked if they had thought about those concerns or included them in the review. Dr. Chanover stated that they had not but that they recognized that the ToO process is more involved whereas the DDT is less so. A list of the DDT and ToO awards were listed in the IRTF report. Dr. Chanover stated that she felt very few people were declined when they presented a compelling argument to the Director. Dr. Diniega asked if IRTF had anything in place to look at this issue. Dr. Chanover replied that they did not, but stated a recommendation could be brought in to include that.

A question was asked regarding if there was time set aside for UH. Dr. Kelly Fast, Program Scientist, stated that there was some time set aside for them as part of the lease agreement as has been standard practice with any of the observatories on Maunakea. The remaining time is then publicly competed entirely. DDT is for quick turnaround items such as a supernova or a newly discovered asteroid making a close approach to Earth. Otherwise, they would need to go through the TAC process. Someone asked for clarification between the difference of ToO and DDT. Dr. Fast stated that they are similar. ToO is when someone anticipates transients and puts in a proposal to observe relevant transients during a certain period.

Dr. Diniega asked if there were any outreach programs that allowed citizens of Hawaii access to IRTF and/or later career opportunities. Dr. Chanover stated that there is a program, with multiple observatories across Maunakea, that allows University students to view/work with the telescope. There is another program, she mentioned, that is unique to the IRTF is the creation of a position, the Assistant to the Telescope Operator, that is open to the Hawaiian community. This position does not require the normal technical degree.

A question was asked about the proposal pressure of IRTF. Dr. Fast stated that with their efficient scheduling they can accommodate more programs and requests. Dr. Chanover stated that there is some increased proposal pressure when there is new instrumentation.

Research and Analysis Program Update

Dr. Rinehart presented the PSD R&A Program Update.

He presented a pictograph of the PSD ROSES-22 Programs along with their step due dates, panels being held, selections and proposals, the selection dates, and the days from step-2 to selection. A graph of the percentage change in proposal pressure from ROSES-20 for Due Date Programs across programs was discussed along with a graph of the proposal pressure across SMD as it had been normalized to ROSES-20. He reported No Due Date (NoDD) program statistics for the past year. A graph of the proposal pressure under NoDD was presented. 81% of proposers were notified in less than 180 days. Selections in NoDD include a higher fraction of very good (VG) rated proposals. He stated that he would not read into the differences between NoDD and not NoDD because the error bars are kind of large. NoDD is picking most of the VG and above. They are considered fundable.

Planetary Protection Research (PPR) is set for an annual cadence. The past decade, 2012–2021, has experienced large variability in whether PPR was solicited. Such variability creates challenges for researchers that cannot rely on the potential funding. Since ROSES-21, PPR has been solicited on a yearly cadence. This regularity should assist in growing the community of proponents to this portfolio. Funding is available to provide this consistent support.

As a reminder for ROSES-23, NoDD program proposals are now open⁵. It is important to remember the rules on duplicate proposals. They are checking and strictly enforcing compliance rules. Non-compliant proposals may be returned without review or be declined on this basis regardless of intrinsic merit score from the panel. Compliance rules exist, in part, to ensure readability and accessibility. Compliance checking scripts are provided online⁶, but are not guaranteed to catch every compliance issue. New in ROSES-23 is that all critical team members must be registered in the NASA Solicitation and Proposal Integrated Review and Evaluation System (NSPIRES) and confirm commitment there.

A Dual-Anonymous Peer Review (DAPR) town hall is being held June 29, 2023, from 3 to 4 PM EDT. On March 29, 2023, Grants Policy and Compliance, the Office of STEM Engagement (OSTEM), the Office of Diversity and Equal Opportunity (ODEO, and the NASA Shared

⁵ <https://science.nasa.gov/researchers/NoDD>

⁶ <https://github.com/nasa/ROSES-Compliance-Checking-Tools/blob/main/README.md>

Services Center (NSSC) recorded an outreach session – Ask NASA: What to Know Before Applying for NASA Grants and Cooperative Agreement. The event focused on outreach to underserved communities and organizations that have not yet received NASA funding. The recording of the event is now available on the NASA YouTube Channel⁷. NASA has published a help document on Uniform Guidance for grants⁸. The pilot Astrobiology Mission Ideation Factory will take place the week of August 21, 2023⁹. There is an astrobiology town hall planned for July 26, 2023. A town hall for NASA RFI on Increasing Access to the Results of NASA-Supported Research is scheduled for July 14, 2023.

Dr. Rinehart made a job announcement. NASA HQ is hiring Civil Servant Program Scientists. The ad opens for applications June 22, 2023, closing June 28, 2023. The listing number is HQ-23-DE-11986063-DS. He stated that it is a wide-open advertisement and encouraged applications. PSD anticipates hiring one or more Computer Science (CS) program scientist through this call.

Regarding the NExSS assessment, the positives include that NExSS has demonstrably catalyzed interdisciplinary, community interactions in ways that have benefited the community, including observing campaigns, modeling, and input to Decadals. It is of high value for early career researchers involved in the NExSS program. There are some areas of improvement including the fact that NASA Division representation is not uniform; the mission statement is not well-defined or conveyed; the leadership structure and selection process lacks clarity; and all volunteer leadership models have not scaled with the growth of NExSS.

SMD Policy Document (SPD)-41A¹⁰ is the NASA policy that sets the requirements for how SMD-funded scientific information must be shared. Scientific information equates publications, data, software, etc. Starting in ROSES-23, proposals must not include an Open Science & Data Management Plan (OSDMP). The SMD Open Science Guidelines¹¹ is available and provides details on acceptable approaches to implementation. Each SMD Division has provided a Division-level supplement to SPD-41A. The PSD supplement to SPD-41A¹² is now available on the NASA Planetary Data website¹³. Key additions include guidance on Physical Materials and Derived Science Data which can be found in section 7. PSD considers this supplemental policy as a living document and seeks feedback which is discussed in section 11.

As a reminder of definitions, the Planetary R&A portfolio includes all activities funded under the R&A budget line. The Planetary Research Program (PRP) includes all research activities including activities funded under R&A, those funded through mission lines, and openly-competed and closed-competition research.

Dr. Rinehart presented the R&A portfolio budget breakdown. It showed the R&A portfolio growth from FY22 to FY29, including numbers from the FY24 President’s Budget Request

⁷ <https://www.youtube.com/watch?v=pdJx7T0AdQ>

⁸ https://www.nasa.gov/sites/default/files/atoms/files/navigating_the_cfr.pdf

⁹ <https://astrobiology.nasa.gov/events/astrobiology-mission-ideation-factory-the-search-f/>

¹⁰ <https://science.nasa.gov/science-red/s3fs-public/atoms/files/SMD-information-policy-SPD-41a.pdf>

¹¹ https://github.com/nasa/smd-open-science-guidelines/tree/main/OSS_Guidance

¹² <https://science.nasa.gov/science-red/s3fs-public/atoms/files/PSD%20Information%20&%20Data%20Management%20Policy.pdf>

¹³ <https://science.nasa.gov/solar-system/planetary-data-overview>

(PBR). It did not include all competed research. A pie chart of the FY24 funding distribution of the R&A portfolio was shared. IDEA funding is being used to kick off the H2O program, but once it is established those programs will be funded out of other portfolios. The reserves end up covering research. Support is very lean.

A graph was presented on the outlook for all competed research from the research program. The numbers come from the FY24 PBR. A second graph was presented that showed the competed research as a percentage of the PSD budget based on the Decadal recommendation. Competed research hits 10.1% in FY28. If the Internal Scientist Funding Model (ISFM) is included, then it will be 10.2% in FY26. It is not completely known how the debt ceiling deal will affect FY24/25 budget numbers. There is a new PBR every year and there is no guarantee that numbers will be consistent. Ultimately, funding levels are set by Congress. Dr. Glaze stated that protecting the R&A plans is her number one priority—to meet the Decadal 10% of the PSD top line recommendation. Dr. Rinehart stated that there is some concern that there might be too much money in R&A, or that someone will think that there is too much money.

The growth in R&A is an opportunity to broaden participation and create a more diverse and inclusive community. This is the core philosophy of why they have requested the budget they requested. It is part of growing capacity and being able to do things with the community.

Dr. Rinehart read a selection from the Decadal Survey, State of the Profession chapter: “Consider evidence-based bias education for itself and associate institutions. Honest discussions of policies and practices that no longer serve the functioning of modern scientific enterprises should be sought with enthusiasm that mirrors the enthusiasm NASA PSD brings to its scientific innovation.” A goal of R&A is to create conditions necessary for effecting cultural change and developing the vibrant, equitable, inclusive community as they seek to facilitate co-creation of solutions between the existing community of practice and historically underserved communities; inreach and training of the community on the undertaking of education of individuals about the cost of bias, the limitations of homogeneity, the benefits of diversity, and the lived experiences of those “othered” by the system; and outreach to communities of potential by building bridges with communities that have been largely left out of the conversation.

Dr. Rinehart addressed where the additional R&A money would be allocated: building capacity and additional funding for support of the growing R&A programs, along with new programs such as Mission Concept Studies, a Postdoctoral Fellowship Program, Mission: IDEA, and the Cross-Cutting Research Program.

Because there was a crush and a rush to get studies done for the Decadal, there was a lack of opportunities to allow new concepts to mature earlier, and there was a need to maintain momentum for existing concepts, the new Mission Studies program from FY25 is suggested. The tentative plan would be to fund two-year studies at a higher funding level (than the pre-decadal studies); studies would feed into technology development programs; studies would be an opportunity to broaden participation; and there would be no more than one study per mission concept.

Because there was a recommendation in the Astrophysics Decadal to have fellowship opportunities at “career boundaries” and a need to learn from the success of APD’s Fellowship program(s) the Fellowships program is suggested. The tentative plan is to have high-prestige fellowships going to the postdoctoral level; engaging with APD to copy as much as makes sense; merging Astrobiology NASA Postdoctoral Program (NPP) fellows into the program; and coming up with a name for the program.

Because the Decadal white papers showed that there are ideas that need to mature including implementation plans and metrics to be successful; and to encourage collaboration across disciplinary boundaries and diverse communities; and to provide funding for people doing the heavy lifting the Mission: IDEA program is suggested. The tentative plan is to have proposals led by social scientists with participation from the planetary science community; provide significant funding for concept studies that will explore approaches to improving participation in planetary science; focusing on IDEA activities that can be embedded, not siloed; and down selecting some studies to become actual pilot programs.

Dr. Rinehart concluded the presentation and was available for clarification question.

Dr. Diniega asked if the fellowships can be from Centers? Dr. Rinehart said it would be like the Hubble fellowship.

A question was asked if there were a lot of engagement in the bridge effort. Dr. Rinehart stated that they want to be engaged with it to assist and to help the R&A program to learn. There is a lot of value there.

Dr. Diniega asked if someone could propose to do a workforce survey under the Mission: IDEA? Dr. Rinehart replied that he would have to check but then clarified that it could not.

Dr. Joseph Westlake inquired if it may help to understand the demographics of proposers and the people included on the proposals whether low submission rates are affecting graduate students, the postdocs, and the pipeline into planetary science. Dr. Rinehart stated that they receive many proposals per year. Someone else voiced that there is an ability to track student versus non-student proposals. Someone asked about the number of resubmitted proposals. Dr. Rinehart stated that the number is decreased as compared with previous years because proposals are being selected. Dr. Glaze stated that this is an argument for not a taking from one and giving to another.

A question was asked regarding the Mission Concept Studies and whether that included Uranus. Dr. Rinehart stated that it was too early to be able to say what would be included or excluded.

Mars Sample Return Update

Mr. Jeff Gramling was introduced to present the MSR update.

Per the *Origins, Worlds, and Life – A Decadal Strategy for Planetary Science and Astrobiology 2023-2032*¹⁴, “The highest scientific priority of NASA’s robotic exploration efforts this decade

¹⁴ <https://nap.nationalacademies.org/read/26522/chapter/1>

should be completion of Mars Sample Return as soon as is practicably possible with no increase or decrease in its current scope.” MSR is the best near-term opportunity to answer the question “Is Earth alone in the universe?” Mars may have the best record of the first billion years of planetary evolution and life’s beginning in the Solar System. The returned samples will be analyzed in laboratories at universities/research institutes across the world, for decades to come. The capabilities demonstrated and science returned by the first sample return from another planet will ensure American leadership and pave the way for eventual human exploration of Mars. What is learned from the samples can significantly retire planetary protection concerns and reduce the costs of future Mars missions.

Currently, the Perseverance rover has selected and created a surface cache of scientifically-selected samples. The MSR Project PDRs are in progress. In December 2022, the Capture, Containment, & Return System (CCRS) PDR Part 1 was completed. In April 2023, the Mars Ascent Vehicle (MAV) PDR was held. In May 2023, the Sample Retrieval Lander (SRL) PDR was held. The CCRS PDR Part 2 is still TBD. The MAV first and second stage solid rocket Development Motor-1 hot fire test was completed in April. Preliminary test results indicate that the thrust vector control supersonic splitline (SSSL) achieved Technology Readiness Level (TRL) 6, the only technology readiness item for the Program. The final TRL-6 test report is to be released by early August 2023. Sample tubes contained in a test article are undergoing Earth impact drop testing via the tower at JPL. This tests how the tubes respond to insults received within the containment vessels beyond the levels already tested during Mars 2020. The Program will proceed into Implementation Phase following System-level PDR. Given the complexity and cost of a mission such as MSR, a second Independent Review Board has been commissioned prior to Confirmation with kick-off briefings held May 23–25, 2023.

Mr. Gramling introduced Dr. Michael Meyer, the Mars Lead Scientist.

Dr. Meyer stated that the NASA/ESA MSR Campaign Science Group (MCSG) addresses Campaign science, including sample integrity planning, developing ground-based infrastructure, and science community engagement. They led a Science Community Workshop in assessing the initial depot as return worthy. All seven of the objectives can be addressed by the samples in this depot. The Sample Return Facility (SRF) Contamination Panel has been established to define terrestrial biological, organic and inorganic contamination limits for the samples from Mars during residence of the samples inside the SRF. Rock and gas teams have assessed procedures to open the returned sample tubes to maximize the head gas extraction and minimize rock/regolith disruption. These reports conclude this summer. There is an open call for membership on the Measurement Definition Team (MDT) that will develop a strawman set of instruments that would be needed within the high-containment facility to accomplish sample safety assessment, curation, and science. The MDT Terms of Reference was signed on June 14, 2023. Over 850 people have registered to receive the announcement of the MDT membership call. Letters of applications are due July 17, 2023. After the selection, the MDT will be commissioned for approximately six months.

A picture was presented of the Three Forks Cache Status that highlighted the tubes cached at Three Forks. A second picture was presented of the Upper Fan Campaign. The sampling attempt

at Ouzel Falls conglomerate was not successful as the rock was very unconsolidated. They are proceeding to investigate surrounding areas for potential next sampling attempts. A critical event review will be conducted prior to leaving the Jezero crater, which should occur in approximately six months.

The MSR is the first mission to address the challenging “break-the-chain” Backward Planetary Protection (BPP) requirements. It is expected that redundancy will be employed for breaking the chain of contact with Mars. The system is tolerant to the failure of any one of three protective elements: a primary container, sterilization of the container exterior, and a secondary containment vessel. The samples, approximately 500 grams, collected by Perseverance would be further protected within hermetically sealed sample tubes, in addition to the primary and secondary containment vessels. The MSR approach to BPP is to manage less than 40 milligrams (mg) of uncontained aeolian dust exterior to the Orbiting Sample (OS) container that recognizes the very low potential hazard of subcellular entities to Earth’s biosphere; Uses an alternative sterilization process, UV, for cellular entities that reduces risk to sample integrity versus heat; and less complex implementation should enhance reliability. The BPP approach is consistent with NASA and international BPP policies to achieve a very low risk of harm to Earth’s biosphere from sample return. The independent review of this approach will be accomplished through an independent panel review of MSR’s approach to subcellular entities and UV sterilization that will be commissioned by NASA’s Office of Chief Scientist (OCS). The OCS study group is expected to release a report in the summer of 2023. It will also be accomplished through the testing of UV sterilization efficacy in the CCRS environment. The University of Florida’s independent testing of UV sterilization efficacy began June 2023.

The current MSR activities include building of the scientific consensus for assessing the safety of Martian dust on the Earth’s biosphere; defining in-situ encapsulation and sterilization techniques; and helping shape Governmental policy and process for future Mars returns. The returned samples of rock, regolith, dust, and atmosphere will be analyzed and evaluated for human safety.

Dr. Meyer introduced Mr. Richard Cook, the MSR Program Manager.

Mr. Cook presented a pictograph of the SRL Evolution and another of the CCRS Evolution. The Sample Recovery Helicopter (SRH) was incorporated into the MSR campaign in mid-2022 replacing the ESA Sample Fetch Rover. It is meant as a backup for delivery of samples to the Lander. SRH is derived from the successful Ingenuity technology demonstration on the M2020 mission. Low-pressure chamber testing of an engineering model was completed at the end of February, to demonstrate the SRH capability to retrieve samples cached on the surface by Perseverance. They tested a range of parameters from within the design envelope with a combination of changes from Ingenuity heritage. Design changes from Ingenuity include an extension of the rotor to 1.4-m diameter, increased rotor speed, and higher angle of attack to support the 2.5-kg mass requirement. A picture of the Ingenuity-like rotorcraft with ground mobility, tube manipulator, stereo vision, with inflight, absolute localization was included.

The MAV first and second stage solid rocket Development Motor-1 hot fire tests were completed in April. Preliminary test results indicate that the thrust vector control SSSL achieve TRL-6. The

SSSL nozzle assembly provided expected thrust vectoring for the full duration of the motor burn. Post-test inspection and disassembly started on April 17, 2023. The final TRL-6 test report is to be released by early August.

Mr. Gramling reviewed the National Environmental Policy Act (NEPA) status and key milestones for the MSR Campaign Programmatic Environmental Impact Statement (PEIS). A Notice of Availability (NOA) for Final Tier I PEIS was published in the Federal Register on June 2, 2023, and was signed by the Office of Strategic Infrastructure. This initiated a mandatory 30-day waiting period before the Record of Decision (ROD). The ROD will acknowledge coordination with the Department of Air Force (DAF) regarding “post-ROD” actions such as preparation activities between now and Earth Entry System (EES) landing and recovery at UTTR. Tier II effort for the Mars Exploration Program’s (MEP) Sample Receiving Project is to follow later to cover transportation from UTTR and the SRF.

To maintain progress on the FY24 PRB towards the earliest possible launch date, the FY24 budget request is \$949.3 million. The SRL launch may be as early as 2028, the Earth Return Orbiter (ERO) and CCRS may launch as early as 2027, with sample return as early as 2033. This may include descope options with potentially one helicopter. Supply chain issues and inflation are affecting all aspects of the campaign. On June 3, 2023, President Biden signed the *Fiscal Responsibility Act of 2023*. This Act holds all non-defense discretionary spending for FY24 to no more than FY23 levels and holds all non-defense discretionary spending for FY25 to no more than FY24 levels plus 1%. Congress has not passed a budget for FY24.

The MSR IRB-2 will provide an independent review of the program’s readiness for Confirmation. SMD commissioned a second program IRB, which was chaired by Orlando Figueroa, to review the Program to ensure that the program has completed Formulation with an executable technical baseline and has developed realistic cost and schedule estimates to take forward to Agency Confirmation. The schedule was designed to perform IRB activities between the Program Element PDRs and the Program PDR, with completion targeted by the end of August 2023. The IRB’s objectives and scope are derived from the MSR Pre-Phase A IRB convening memo and updated to address focused questions bearing on Confirmation for a complex and distributed program such as MSR. The MSR will be the most reviewed early mission concept, with the intent of ensuring the design has been thoroughly reviewed, increasing confidence in the associated cost and schedule estimates to inform the agency’s Confirmation decision.

In summary, MSR progress is in Formulation. The Mars Ascent Vehicle’s first and second stage solid rocket motors testing is complete. The SRH is on-track for PDR in September. The System-level PDR will be conducted following an on-going IRB activity and is planned for completion in August 2023. The FY24 is likely to be challenging. MSR samples of ancient Martian rocks will be the first scientifically-selected samples made available to the world’s laboratories to answer fundamental questions about early evolution of a habitable world, and the origin of life in our solar system.

Mr. Gramling concluded the presentation and was available for clarification questions.

Dr. Diniega inquired if all the reports being worked on would be released publicly. Mr. Gramling stated that the intention is to make all findings public.

There was a clarification request on the statement regarding the quoted FY23 versus FY24 budget. The PAC requested an update on the budget for their November meeting if the President's budget has been released by then. A comment was made regarding how the MSR would operate if the budget was restricted. Mr. Gramling stated that they would have to live within the provided budget. If there is cost growth, what options does the PSD have in the upcoming years? Dr. Glaze stated that they would need to try to meet the near term schedule, or they could relieve pressure in the near years. She then went through the budget request process.

Solar System Exploration Research Virtual Institute Update

Mr. Greg Schmidt, the SSERVI Director, was introduced to present the SSERVI update. He introduced Deputy Director, Ms. Kristina Gibbs and Lead for Solar System Treks, Mr. Brian Day.

Mr. Schmidt described that SSERVI has been jointly funded by NASA's Science and Human Exploration Directorates (now SMD and ESDMD) since its inception in 2008 as the NASA Lunar Science Institute (NLSI) for targeted lunar science and support of human exploration. SSERVI bridges the two directorates with a focus on exploration science: science enabling human exploration or science enabled by human exploration. NASA HQ can leverage active partnerships between Institute and foreign agencies/institutions for Mission development support and research opportunities. Cooperative Agreement Notices (CANs) set the science/exploration guidelines to which the teams propose. NASA HQ provides input on both CAN focus and team selections. CANs issued every 2.5 to 3 years allow overlap between Teams and provides continuity of the Institute's core research to NASA's changing strategic goals. In 2013, NASA HQ broadened research topics to include Near-Earth Asteroid (NEAs), Martian moons in response to Administration direction. The SSERVI Senior Review was held in 2022 and received strong support for SSERVI structure and activities. SSERVI responded to Artemis with increased focus on lunar exploration research in CAN-4.

The institute structure consists of, currently, thirteen US teams, funded in 2019 and 2023, each with 5-year cooperative agreements. There have been 1200+ publications since the institute became SSERVI in 2013 with 250+ funded researchers and students. It also includes 11 international partners with major focus on lunar science and missions with more in development. The Solar System Treks Project (SSTP) is a visualization tool originally created during Constellation program, enabling science, missions, and outreach. SSERVI assumed management at the request of NASA HQ in 2013. There is leadership and overall institute direction with planning and management of domestic teams and international partnerships. Community development and support through a wide variety of activities. SSERVI is committed to mentoring the next generation of space enthusiasts and leaders in innovation through partnerships with schools, educators, and students. Key institute goals include Equity, Diversity, Inclusion, and Accessibility (EDIA) and training the next generation.

The SSERVI Mission Statement is to conduct groundbreaking cross-disciplinary research between the science and exploration communities; integrate enabling scientific and technical analyses into NASA's human exploration and science enterprises; connect the research community using innovative technological approaches for collaboration and information dissemination across geographic boundaries; train and develop a diverse next generation of explorers; and win the hearts and minds of the public through global outreach and engagement.

The CAN-3 Teams, funded in October of 2019, include the following: Center for Lunar and Asteroid Surface Science (CLASS), Prof. Daniel Britt, University of Central Florida, Orlando, Florida; Interdisciplinary Consortium for Evaluating Volatile Origins (ICE FIVE-O), Dr. Jeffrey Gillis Davis, Washington University, St. Louis, Missouri; Remote, In Situ, and Synchrotron Studies for Science and Exploration 2 (RISE2), Prof. Timothy Glotch, Stony Brook University, Stony Brook, New York; Resource Exploration and Science of OUR Cosmic Environment (RESOURCE), Dr. Jennifer L. Heldmann, NASA Ames Research Center, Moffett Field, California; Institute for Modeling Plasma, Atmospheres and Cosmic Dust (IMPACT), Prof. Mihaly Horanyi, University of Colorado, Boulder, Colorado; Lunar Environment And Dynamics for Exploration Research (LEADER), Dr. Rosemary Killen, NASA Goddard Space Flight Center, Greenbelt, Maryland; Center for Lunar Science and Exploration (CLSE), Dr. David A. Kring, Lunar and Planetary Institute, Houston, Texas; and Geophysical Exploration Of Dynamics and Evolution of Solar System (GEODES), Dr. Nicholas Schmerr, University of Maryland, College Park, Maryland.

The CAN-4 Teams, to be onboarded the Summer of 2023; include the following: Lunar Structure, Composition, and Processes for Exploration (LunaSCOPE), led by Alexander Evans at Brown University in Providence, Rhode Island. The team will investigate the evolution, fate, and consequences of the lunar magma ocean, as well as the origin, abundance, distribution, and isotopic composition of volatiles; Center for Lunar Origin and Evolution (CLOE), led by Bill Bottke of Southwest Research Institute's Solar System Science and Exploration Division, which is in Boulder, Colorado. The team will investigate important questions related to the understanding of solar system origin and the conditions of Earth-Moon formation; Research Activities Supporting Science and Lunar Exploration (RASSLE), led by Dana Hurley at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland. The team will lay the science foundation for the future of lunar exploration in the fields of the evolution of volatiles in lunar polar regions, solar system chronology, and cryogenic sample handling; Center for Lunar Environment and Volatile Exploration Research (CLEVER), led by Thomas Orlando at the Georgia Institute of Technology in Atlanta. The team will characterize the lunar environment and volatile inventories required for near-term sustained human exploration of the Moon; and Center for Advanced Sample Analysis of Astromaterials from the Moon and Beyond (CASA Moon), led by Charles (Chip) Shearer at the University of New Mexico in Albuquerque. The team will decipher the origin, evolution, and chronology of the ancient lunar crust through lunar sample analysis.

A pictograph was shown of the SSERVI Teams Research Focus. New in CAN-4 is that the Moon is the primary focus; sample science has been added as a focus area; there are 6 provided

focused ESDMD research areas; it included biological and physical sciences objectives; and includes IDEA requirements. A second pictograph was shared of the SSERVI PI Geographic Distribution.

SSERVI science highlights were described, which included the Ancient Lunar Atmosphere; the Lunar Polar Wander; identifying and accessing Volatiles; dust toxicity research; E-beam dust mitigation technology; Exolith lab Regolith development; and New Space materials: neutron shielding, electrostatic charge dissipation, and dust mitigation.

Ancient Lunar Atmosphere: Analyses of Apollo samples indicated that magmas that breached the lunar surface and flowed for hundreds of kilometers, carried gas components, such as carbon monoxide, the ingredients for water, sulfur, and other volatile species. New calculations show those gases accumulated around the Moon to form a transient atmosphere. The atmosphere was thickest during the peak in volcanic activity about 3.5 billion years ago and, when created, would have persisted for about 70 million years before being lost. A portion of the volatiles may have been trapped from the atmosphere into cold, permanently shadowed regions near the lunar poles and, thus, may provide a source of air and fuel for astronauts conducting lunar surface operations and missions beyond the Moon.

Lunar Polar Wander: SSERVI researchers studied maps of lunar polar hydrogen from NASA satellite data to discover the Moon tilted away from its original axis by about five degrees roughly three billion years ago. Water ice can exist in areas of permanent shadow, but when exposed to direct sunlight it evaporates into space. A shift of the lunar spin axis enabled sunlight to creep into areas that were once shadowed. Ice that survived this shift effectively “paints” a path along which the axis moved. This is the first physical evidence that the Moon underwent a dramatic change in orientation and implies that much of the polar ice on the Moon is billions of years old. This research can inform them as to where the volatiles currently exist on the poles of the Moon and may open the door to further discoveries on the interior evolution of the Moon, as well as the origin of water on the Moon and early Earth.

Identifying and Accessing Volatiles: SSERVI research is enabling NASA’s ability to identify, locate, and access volatiles, as well as how to collect, preserve and process volatile samples. Researchers have produced new geologic resource prospecting maps for a portion of the Schrödinger basin peak ring and adjacent basin floor.

Dust Toxicity Research: RISE2 Team is studying lunar dust samples brought back by astronauts to investigate reactive species in lunar regolith, including silicon dioxide, iron oxide and calcium oxide, and other oxides. Researchers discovered certain minerals that are known to quickly react with human cells and generate toxic hydroxyl radicals that have previously been linked to lung cancers. Results revealed that inhaled particles may generate toxic hydroxyl radicals for up to 5-6 days in lung fluid. Models indicate that olivine in the human lungs can induce detrimental health effects like asbestos exposure. The work indicates that the lunar surface may be even worse for human health than they thought, as inhaled lunar dust can settle in the human lungs for years and could induce long-term potential health effects like that of silicosis.

E-beam Dust Mitigation Technology: SSERVI IMPACT team is developing an electron beam technology to remove lunar dust from sensitive surfaces such as spacesuits. Charged dust is ejected from the surface because of strong electric repulsive forces. Varying the e-beam incident angle optimized cleaning efficiency by 10-20%. The multiple e-beam demonstration resulted in most of the insulating samples showing 80-90% cleanliness after only 2-3 minutes.

Exolith Lab Regolith Development: SSERVI's CLASS team is developing new regolith simulants and agglutinates using Lunar simulants. Over 11 types of Lunars, Martian, and asteroid simulants are available for agency or community procurement, including Lunar Highland (LHS-1) and Mare (LHM-1) simulants. For more information, the exolith simulant website¹⁵.

New Space Materials: Neutron shielding, electrostatic charge dissipation, and dust mitigation: REVEALS Team is designing optimized shielding for Lunar neutrons by distributing boron in polyethylene (HDPE) composites. Developed spray-on coatings for static charge dissipation and dust mitigation for space suits, and other EVA applications. Results show a significant decrease in effective radiation dose, improving shielding technology by 4x to 30x over Al and 1.5x to 2x over HDPE.

Mr. Day discussed the NASA Solar System Treks Project (SSTP), an integrated suite of data visualization and analysis tools supporting mission planning, lunar/planetary science, and public engagement using advanced analysis tools, high resolution geospatial data, and digital elevation models. It was initially developed to support Constellation Program site selection and analysis in 2008. The Moon Trek was released in 2017 and replaced the Lunar Mapping and Modeling Project (LMMP). HQ and various missions have commissioned a variety of new portals for a growing number of planetary bodies that have been added to the Treks suite, facilitating comparative planetology. 2D and 3D interactive visualizations such as overlays, sharing, flyovers, 3D printing, and custom virtual reality (VR) experiences exist within the project. There is a wide range of analysis tools to take advantage of Machine Learning (ML) and Artificial Intelligence (AI). All Solar System Treks are available as resources for NASA Science Activation partners and to the greater outreach and education community. The online web portal¹⁶ requires no downloads and is available to anyone with internet access to view images and other digital products.

SSTP portals have been commissioned by missions to facilitate dissemination and visualization of mission data as well as for outreach and planning in advance of the return of mission data including the following: Dawn utilizing Vestra Trek and Ceres Trek; Cassini utilizing Titan Trek and Icy Moon Treks; OSIRIS-Rex utilizing Bennu Trek; Hyabusa2 utilizing Ryugu Trek; BepiColombo utilizing Mercury Trek; Europa Clipper utilizing Europa Trek; Mars Moon eXploration (MMX) utilizing the developing Phobos Trek; COLMENA utilizing the Moon Trek lunar surface analyses; Artemis, VIPER, and Endurance using the traverse planning, data dissemination, and ballistic dust hazard analysis; Lunar Trailblazer utilizing data dissemination

¹⁵ <https://exolithsimulants.com/>

¹⁶ <https://trek.nasa.gov/>

and visualization; Curiosity and Perseverance utilizing line of sight communications analysis and planning; and CLPS utilizing landing site analysis.

Ms. Gibbs discussed the network of 11 International teams that leverages government, academia, and industry to advance science and engineering technologies on a no-exchange-of-funds basis. Additionally, researchers from the following countries have contacted SSERVI to start new proposals for partnership from Taiwan, India, Norway, Namibia, and Mexico. Numerous achievements since inception of international program including establishment of pan-European lunar science consortium and annual European Lunar Symposium (ELS). The 11th ELS will be held under the umbrella of the European nodes of SSERVI on June 27-29, 2023, at the Palazzo della Salute in Padua, Italy. This conference brings together the European scientific community involved in lunar science and exploration and the international experts engaged in lunar missions. The conference will consist of both oral presentations and posters with particular emphasis on lunar science and technology for future exploration missions, lunar in-situ resource utilization (ISRU), and results from mission studies preparing for future human exploration on the lunar surface. The 2022 European Lunar Symposium produced 73 recorded presentations with nearly 5,000 live views and over 800 on-demand playback views.

Mr. Schmidt stated that the 2023 NASA Exploration Science Forum (NESF) will be held, in-person and virtually, at The Hotel, University of Maryland in College Park Maryland, from July 18–20, 2023. NESF is SSERVI's biggest annual event, held since 2008. They are excited to welcome audiences and presenters in-person and virtually for a hybrid meeting experience enabling rich science discovery, discussions, and networking opportunities. People are at the heart of SSERVI and the Forum, so they are making sure that all attendees have opportunities to network with each other. Come to hear about the latest science discoveries, share ideas, and help accelerate the mission. Students present their work to peers and distinguished scientists, connect with possible mentors for career advancement, or compete in student poster competitions.

There are SSERVI facilities that are open to the community. Lunar Lab and Regolith testbed is a SSERVI-managed testbed at NASA Ames contains 8 tons of JSC-1A lunar regolith and 22 tons of Anorthosite simulant available to SSERVI teams and other NASA partners. The Dust Accelerator Lab at the University of Colorado is currently the only setup in the world capable of generating hypervelocity dust particles (> 100 km/s). The 3 MV linear electrostatic dust accelerator is used for impact studies and instrument calibration for space applications. The Exolith Regolith Simulant Manufacturing Lab at the University of Central Florida provides simulant for important exploration and science tests and is the largest supplier in the world. The PLANETAS Lab at NASA Ames has field portable instrumentation that is available to the community. The Ultra High Vacuum Ice and Gas Target chambers at the University of Colorado is available for use along with the Radiation facility at GSFC, the UV Spectrometry Laboratory Facility at PSI, the Microgravity Drop Tower at the University of Central Florida, the Vibrational Spectroscopy Lab in Stonybrook, New York, and the Physical Properties Lab at the University of Central Florida.

The SSERVI Senior Review was an outcome of a recommendation of the previous decadal midterm review—to review virtual institutes. The SSERVI independent review committee was

chartered by PSD to comprehensively review SSERVI. The committee report is available online. Key recommendations stated that SSERVI should continue, with support from both science and exploration and that there should be a lunar focus for CAN-4. Additional input from the recently released planetary decadal report was in line with senior review recommendations. SSERVI continues working with key stakeholders—including NASA’s Mission Directorates, research teams, and international partners—to advance the goals of Artemis and enable a new era of human exploration of the Moon.

Key points from the SSERVI Senior Review included the following, “The SSERVI Senior Review Panel (SSRP) recommends that SSERVI should continue to be supported in a predictable manner by both SMD and HEOMD(ESDMD)”; “Research at the junction of [science and human exploration research] is critical for enabling a successful human exploration campaign to the Moon. The SSRP concluded that SSERVI brings high value to the planetary science and exploration communities as a large, cross-disciplinary institute”; “The SSERVI style of research complements the more targeted ROSES Research and Analysis (R&A) program in the planetary sciences. The review panel found that SSERVI is well positioned to both bridge and amplify NASA science and human exploration research, and funding from both NASA directorates should continue”; “SSERVI focus should be directed on the Earth’s Moon for the next cycle of node selections, and the current SSERVI nodes should align their work to include a focus on the Moon”; and “... rebuild and replenish the sample science community over the coming decade. Consider sample training, collection, documentation, preservation, curation, measurements, and science with integration among nodes in future focus themes and CANs.”

SSERVI has a strong track record and continued interest in supporting new commercial lunar efforts. Major history back to NLSI days including strong support of the Google Lunar X Prize (GLXP) and potential associated commercial lunar science program. Lunar Science for Landed Missions had major commercial participation. Commercial partnerships have been instrumental in the development the Lunar Regolith Testbed and production of SSERVI’s Books for the Blind. Provided Interface for CLPS leadership at SSERVI Executive Council Meetings.

SSERVI is deeply committed to taking steps to enable positive change in EDIA. While EDIA projects have been a part of SSERVI for a long time, it has been a major focus of the Institute since 2020. CAN 4 included EDIA requirements for the first time. Other Institute Objectives (OIO) included a Team Inclusion Plan, Community EDIA Plan, and Code-of-Conduct. SSERVI EDIA Focus Group was established in mid-2020 and has become one of the most active Focus Groups in the institute, with many members from the SSERVI PIs and non-SSERVI community. SSERVI researchers’ active writers/cosigners of EDIA white papers for Planetary Science Decadal Survey. Commitment to accessibility has permeated SSERVI practices e.g., tactile books for the blind have made extraordinary progress in explaining eclipses, lunar morphology, and other topics to the visually impaired.

Support of students since beginning through LunGradCon, Next Generation Lunar Scientists and Engineers (NGLSE), and many others. SSERVI provides student travel support to major scientific meetings. SSERVI internships provide hands-on research and professional development opportunities. NASA Postdoctoral Program (NPP) with postdocs shared between

teams to facilitate inter-team collaborations. SSERVI provides Laboratory and Field Research training opportunities. A wide range of supported activities ranging from “Books for the Blind,” to eclipses, K-12 engagement, and beyond.

Community support includes years of support to community organizations; broad virtual support of science and exploration communities; NASA Exploration Science Forum; International partnerships; Four annual awards widely recognized in community; and focus groups open to the entire community.

Mr. Schmidt concluded the presentation and was available for clarification questions.

A question regarded the mission budget for the use of the Treks. Mr. Schmidt stated that there are several organizations that fund Treks. They do not complete these by missions. Mr. Day stated that there are varying degrees of variation when it comes to budgeting. A follow up inquiry regarding the budget of the facilities available for use. Discussion has occurred with others, but no resolution has been met.

Dr. Diniega asked Dr. Noble if ESSIO was incorporating SSERVI into their work and if so, how? Dr. Noble stated that SSERVI, as an important part of the overall lunar R&A portfolio, was being incorporated into the strategy.

Public Comment Period

Dr. Rinehart opened the public comment period.

John Whitehead asked how was it determined that the special rocket nozzle is the only new technology for MSR? The whole MAV fits the definition of "new technology," and so does backward planetary protection (NASA Technology Readiness Assessment Guide, Figure 3.1.1-1)¹⁷. John Whitehead stated that it really was a question, appropriate to ask Jeff, and not just a comment. The answer was that they followed the standard processes to determine what is considered new technology. As a groundbreaking mission, they are doing new things but based on the processes they were not considered new.

John Whitehead asked if descoping options are needed for MSR, might that include a reduced payload mass for Mars ascent (fewer sample tubes)? John Whitehead stated that the main point of his descopel question is that the MAV components might be heavier than expected, thus reducing its capability for MAV payload mass. Nothing to do with the amount of mass on the lander, this is about launching off Mars, not about the helicopters. The answer was that the amount of sample tubes could be reduced but to do so, it would need to be done quickly. There was science evidence for the number of tubes chosen based on the science requirements. They are not certain on how to decrease the amount currently.

Vicky Hamilton asked if the PSD have plans to move away from the decadal Mission Concept Studies having a PI and science teams as there is a concern with teams developing a sense of ownership on those concepts rather than as performing a service for the information of the Decadal committee. Dr. Glaze stated that this was something to think about. That they try to

¹⁷ <https://ntrs.nasa.gov/api/citations/20205003605/downloads/%20SP-20205003605%20TRA%20BP%20Guide%20FINAL.pdf>

offer opportunities to the community to come up with ideas. The current thought was to open it up competitively as they have always done. However, she is correct in that it could lead to the concern of teams developing that sense of ownership.

Marcia Smith asked Dr. Glaze about the mentioned three international missions (MSR, Envision, MMX) that she wanted to avoid disrupting if there are budget cuts. What about Exobiology on Mars (ExoMars)? Where does that stand? Dr. Glaze stated that she forgot Rosalind Franklin and that it is an important new edition. It is in response to the War in Ukraine and the last minute necessity for ESA to back away from the launch of the rover. They are happy they got Presidential and Administrative support. That is added to the list.

Noam Izenberg asked if the R&A 'sort of surplus' exceed the available VG-VG/E-E pool of proposals in the various programs? If yes, is there reluctance this perhaps open the window for 'higher risk' G/VG or G proposals, or whatever level is generally considered above the 'selectable' floor but often lose out because of funding limitations? Dr. Rinehart stated that it depends on the program. He stated that they are not exceeding the funding. They could pick a few more proposals but they want to make sure that they are getting the best good out of everything instead of just spending money. When triage is implemented at least three reviews are obtained. All three of the reviews must get a below VG to be dropped. It is extremely unlikely that one is missed because it did not get a VG. Dr. Rinehart stated that he is not worried about proposals being triaged out.

Alfred McEwen asked Dr. Glaze how many new New Frontiers (NF) and Discovery missions do you anticipate in the OWL decade compared to recommendation for 3 NF and 5 Discovery? Dr. Glaze stated that she was not trying to be coy, but she is going to sidestep the question a bit. Referring to what she said earlier, based on the constraints of the budget she must review the decision rules of the Decadal and make decisions. She stated that she does not want to lose sight and that politics change. It is important to keep sight of the fact that there will be opportunities in the future to shift what that looks like. She stated that she is frustrated with the budget currently but is determined to do what needs to be done.

Dr. Diniega closed the public comment period at this time, but reminded attendees that there are two other public comment periods over the next two days.

June 22, 2023

Mars Exploration Program (MEP) Update & Mars Future Plan

Mr. Eric Ianson, Director of the Mars Exploration Program (MEP), was introduced. He described some MEP highlights including the release of the Draft Mars Future Plan; the collected Melyn sample at Tenby by Perseverance; Ingenuity completed its 50th flight on Mars; Perseverance Lego was released in Europe and is expected in the US later this summer; and 15 of 55 Mars Data Analysis Program (MDAP) proposals selected and those results are posted in NSPIRES.

The Sample Receiving Project (SRP) had a Sample Safety Assessment. A project tiger team was established to recommend test protocol, statistical analysis, and subsampling strategy and is expected to be completed in December of 2023. The Sample Receiving Facility Study is in Phase 2. They are studying the concept designs for modular containment suit-lab and cabinet-line facilities that are expected to be completed in late spring of 2024. The Measurement Definition Team (MDT) Terms of Reference was signed by NASA and ESA.

Progress continues on the potential collaboration on ESA's Rosalind Franklin Mission, with NASA participation subject to the availability of US funding. The team is proceeding with long-lead item contracts to acquire descent engines and restarting productions of Radioisotope Heater Units (RHU). The Mars Organic Molecule Analyzer (MOMA) reintegration reviews for a 2028 launch are underway.

Perseverance explored the 'Onahu' outcrop for over the past three weeks after abrading 'Ouzel Falls' indicated interesting conglomerates but worth a sampling attempt. Conglomerate core from Emerald Lake was acquired and they are working on sample processing now. Ingenuity connectivity to Perseverance is limited at its current location. Flight 52 data from April 25, 2023, will not be relayed to the rover until Perseverance moves closer to the Ingenuity landing site. After completing the Upper Fan science campaign, Perseverance will move toward the 'margin unit', the carbonate-bearing rocks located along the inner rim of Jezero.

The Mars Science Laboratory (MSL)'s Curiosity is headed toward the upper Gediz Vallis ridge, a landform that may record the most recent episode of liquid water on Mount Sharp. It has been driven over 30 kilometers and gained over 700 vertical meters on Mount Sharp. All ten instruments continue to return high value scientific measurements. It completed its 38th successful drill-based sampling campaign in May at Ubajara, marking 44 sampling campaigns overall. Years in the making, a major software update installed in April enables Curiosity to drive faster and reduce wear and tear on its wheels. This is just two of about 180 software changes implemented.

A map of Perseverance's quadrants themes was shown to describe the various quadrant themes in the vicinity of NASA's Perseverance Mars rover, which is currently in the Rocky Mountain quadrant within the much broader Jezero Crater. Each quadrant is 0.7 miles (1.2 kilometers) on each side. The Perseverance team chose quadrant themes related to various national parks across Earth, from Shenandoah National Park in Virginia to Jotunheimen National Park in Norway. The themes help organize the unofficial nicknames that are given by rover team members to different

surface features they want to study, such as hills, craters, boulders, and even specific rock surfaces.

Mr. Ianson then shifted to describe the Draft Mars Future Plan. Over the past two decades NASA and the MEP have been making progressive steps to better understand the planet and to search for past and present life at Mars through a series of orbiters, landers, and rovers. This critical chapter in Mars exploration would culminate in the return of samples to Earth through the planned MSR campaign. The MEP is now at an inflection point at which it must adapt to the changing space business environment (i.e., broadening international participation and expanding commercial interest/capability), address critical/aging infrastructure, and prepare for a human presence at Mars. A pictograph was shared of Mars fleet chart.

The highlights of accomplishments at Mars include that Odyssey revealed large subsurface water ice at the poles; the Phoenix lander sampled water directly, as ice and snow, and identified surface chemistry that can permit liquid water brine at modern-day Mars temperatures; the Spirit and Opportunity rovers demonstrated that Mars once had a warmer, watery past and used air bags for rover landing; Curiosity has demonstrated that Mars was once a habitable environment, with liquid water, organic materials, and a chemical environment necessary to sustain life as we know it. They used a sky crane for rover landing; MRO has detected active gullies, ice-revealing impacts, and other key geologic features and has significantly enabled subsequent rover landing-site characterizations (e.g., Gale Crater, an ancient crater lake, and Jezero Crater, site of an ancient delta); MAVEN has provided clues to the loss of water from the Martian atmosphere to space, important to understanding the history of climate and the planet's habitability through time; InSight has shown us that Mars continues to be a planet that is dynamic, including Marsquakes; and Perseverance is collecting samples from a location that was once water rich for Mars Sample Return, greatly improving the analysis that will be possible to perform on the samples.

MSR represents the culmination of the community's highest Mars Exploration priority over the last two decades, as cited in the past three Decadal Surveys. MEP has responsibilities on both ends of the MSR campaign including collecting samples with Mars rover Perseverance and curating them at the future SRF. While MSR would achieve decadal-class science enabled by the past two decades of MEP exploration, MEP is planning for the next two decades of equally profound scientific investigations with a new strategic paradigm designed to send lower-cost, high-science-value missions, and payloads to Mars at a higher frequency.

Mr. Ianson shared a couple of quotes regarding the MEP, "NASA should maintain the Mars Exploration Program, managed within the PSD, that is focused on the scientific exploration of Mars. The program should develop and execute a comprehensive architecture of missions, partnerships, and technology development to enable continued scientific discovery at Mars." – 2022 Planetary Science & Astrobiology Decadal Survey.

"A Program strategy should be developed before the end of 2022 following the release of the Decadal Survey. The strategy should provide a clear plan of action that includes the overarching science goal for the decade, mission cadence, opportunities for a mix of small, medium, and

large missions that increase opportunities for competition and broad community participation including the commercial sector, and that includes a strategy to replenish the communication infrastructure.” – MEP Program Implementation Review, Standing Review Board Recommendation.

Mr. Ianson reiterated that the following presentation provides a draft plan for the future of the MEP. The MEP is seeking input to this plan from key stakeholders before finalizing it. While this is a plan for an SMD program, it requires close coordination with many organizations, including ESDMD, SOMD, and STMD. The Mars Sample Return program remains the top priority for SMD Mars exploration. MSR is a foundational science mission that would inform future Mars activities. It is important to note that implementation of this plan is NOT included in the current MEP budget. Any budget and schedule information presented herein should be considered notional.

Mars continues to pose key questions that call for a coordinated program of scientific exploration and three community-responsive science themes for 2023-2043 will guide MEP activities: explore the Potential for Martian Life; Support Human Exploration of Mars; and Discover Dynamic Mars. Emerging capabilities enable a new era of competitive missions, strengthened infrastructure, transportation opportunities, advanced technologies, and inclusive exploration. MEP will expand opportunities through frequent, small, low-cost missions to produce impactful science; build, strengthen, and maintain critical infrastructure; reduce the cost of access to Mars through partnerships, low-cost launch vehicle providers, and new delivery systems; develop technologies to enable new capabilities for exploring Mars; and make exploration more accessible and inclusive to the broader community.

This Plan incorporates inputs from several sources across the planetary science community, Mars science community, and engineering and technology communities. It includes input from the 2023-2032 Decadal Survey, the Mars Architecture Strategy Working Group (MASWG) & Mars Concurrent Exploration Science Analysis Group (MCE-SAG), the Keck Institute for Space Studies (KISS) Workshop: Revolutionizing Access to the Martian Surface, the Low-Cost Science Mission Concepts for Mars Exploration Workshop, Industry Day, the industry partnering opportunities through site visits, the International Mars Ice Mapper Measurement Definition Team (I-MIM MDT), Human Exploration, and the Moon-to-Mars Objectives/Recurring Tenets.

The High-Level Co-Equal Program Science Themes are driven by science. MEP will focus its systemic approach on the following science themes, which draw upon the Mars Exploration Analysis Group (MEPAG) goals of life, climate, geology, and preparation for human exploration. Exploring the potential for Martian life: Advance the search for past and present microbial life and habitable environments through time, while developing approaches that protect both Mars and Earth. Discover Dynamic Mars: Understand the dynamic geological and climatological processes on Mars to illuminate the evolution of the Martian system, our home planet Earth, our solar system, and distant planets around other stars. Support Human Exploration of Mars: Make observations that are synergistic with the objectives for human exploration of Mars and prepare for the science that humans will do once there.

Science Theme 1: Explore the Potential for Martian Life – Search for evidence of past or present life on Mars in potentially habitable environments and establish how the Martian environment and habitability co-evolved over time. **1.1** - Search for Biosignatures, Past & Present: Determine whether the Martian geologic record has biosignatures and identify areas most likely to capture preserved biosignatures based on what is known about past and current habitability at Mars. **1.2** Understand Temporal and Geographic Patterns of Habitability: Leverage Mars’ unique ancient geologic record to understand the extent of habitability and its temporal evolution, the existence of any present-day, subsurface habitable environments (including ice), and how habitable environments on Mars and Earth may have diverged. **1.2.1** Physical Access to the Subsurface: Advance investigations related to subsurface and ice science and access to the ice-rich subsurface as a major programmatic focus, building on water- and habitability-related scientific discoveries of the previous two decades. **1.3** Examine Samples from MSR to Understand Martian Geological & Biological Processes: Study returned samples to understand organic chemistry processes on Mars, what the samples reveal on global, regional, and temporal scales, the nature of any biosignatures, and the relationship between Mars’ geological and potential biological history. Planetary protection principles are key across our presence at Mars and upon return to Earth with samples and astronauts, especially as it relates to our search for life. A focus on potential “special regions” (natural or spacecraft-induced) and the environmental characterization of candidate landing/exploration sites is important to mitigate risks for future human explorers and/or to their astrobiological research.

Science Theme 2: Support Human Exploration of Mars – Make observations that are synergistic with objectives for the human exploration of Mars and prepare for the science that humans will do once there. **2.1** Define Priority Human-Led Science at Mars: Define, with multidisciplinary community input (science, human mission planning), the highest value scientific objectives humans could uniquely advance while traveling to and from Mars and on the surface. **2.2** Characterize Potential Ice-rich Sites for Human Exploration: Scientifically study the environment of candidate ice-rich sites to determine optimal locations for high-priority human led science, resource potential, and operational feasibility/safety. **2.3** Study Atmospheric Science and Weather for Human Needs: Target investigations of the Martian atmosphere/exosphere sufficient to support prediction of extreme events (e.g., dust storms), human-class landing/launch operations, and a better understanding of how terrestrial microbes released during human operations could propagate in the Martian atmosphere. **2.4** Understand Potential Health and Safety Hazards for Humans (Supporting): Coordinate with ESDMD to understand mechanical properties (e.g., abrasiveness for suit and hatch seal designs) and breathing hazards to humans (e.g., particle size and potential biological exposures). Supporting biological and physical science objectives in the Moon-to-Mars initiative, develop remote-sensing technologies and obtain data on the Martian environment relevant to human-mission planners in assessing ways to protect and strengthen human health and performance. **2.5** Construct Analogue Missions to Prepare for Expeditions on Mars (Collaborative): Coordinate with ESDMD to simulate science-driven, robot-assisted expeditions to prepare astronauts and the wide Mars science community on Earth for future interplanetary collaboration in making discoveries “in the Martian field” and in transit. Draw on human lunar activities to feed forward into Mars operational strategies where relevant.

Science Theme 3: Discover Dynamic Mars – *Reveal geological and climatological changes through Martian history to understand the evolution of Mars and its potential support of life; conduct interdisciplinary systems-science investigations of Mars and its moons in relation to other planets in our solar system and around other stars.* **3.1** Investigate Ancient and Modern Drivers of Change on an Active Planet. **3.1.1** Characterize Geologic Planetary Evolution from Early Mars through the Present. **3.1.2** Understand Early Environmental Change through the Stratigraphic Record. **3.1.3** Determine Recent Climate Evolution through the Study of Volatile Cycles. **3.1.4** Study Dynamic Modern Environments and their Processes. **3.1.5** Characterize Modern Habitability. **3.2** Understand Mars as a System through Investigations of the Global Environment: Conduct investigations through orbital, aerial, and landed spacecraft to illuminate the ways in which individual components of the Martian global environment – the atmosphere, hydrosphere, cryosphere, and geosphere – are integrated to make up the Martian system. **3.3** Study the Uniquely Available Geological Conditions on Mars to Conduct Comparative Planetology and Understand “Goldilocks Worlds”: Provide research opportunities that link the uniquely available geological conditions on Mars to fundamental understanding of comparative planetology.

Initiative 1: Expand Opportunities to Explore Mars through Competed, Lower Cost, and More Frequent Flight Opportunities – *Establish a regular cadence of science-driven, lower-cost mission opportunities as a new element of the MEP portfolio to provide rapid and flexible response to discoveries, to address the breadth of outstanding Mars questions, and to enable increased participation by the diverse Mars science community.* **1.1** Low-Cost Missions with targeted or discovery-responsive science. Completed small missions at the \$100, \$200, or \$300 million levels. The intent is to select missions for every Mars launch opportunity while considering one-step or two-step processes. May select multiple smaller missions per launch opportunities. Draws on experience from CLPS programs. **1.2** Medium-Class Missions with broad science. Strategic Decadal-class science with more complex instrument suites. New technologies in sample acquisition, mobility, and autonomy. Considering competing either at the mission or instrument level. Scalable to significant discoveries. **1.3** Competed Payloads by leveraging commercial and international opportunities. These are missions of opportunity and can potentially be competed or directed. Could be science or infrastructure focused. Flown on international or commercial missions.

Initiative 2: Strengthen and Broaden Infrastructure at Mars to Enable a Diverse Set of Missions and Opportunities for Partnerships – *Enable infrastructure advancements that no one mission could likely achieve alone and that lower the costs and risks of, and increase benefits for, all Mars missions.* Actively consider opportunities to buy commercial services to address infrastructure. **2.1** Mars Telecom Network. **2.2** High-Resolution Imaging. **2.3** Global Meteorological Monitoring. **2.4** Sample Handling and Receiving. **2.5** Ground Receiving Networks. **2.6** Data, Infrastructure, Visualization, and Analysis. **2.7** Spacecraft Delivery including Rideshares. **2.8** Payload Hosting Opportunities.

Initiative 3: Invest in Key Technologies to Enable Expanded Access to, and Scientific Understanding of, Mars – *Provide continuing improvement in the capabilities of robotic*

science- and human-enabling missions that collectively enhance US leadership in Mars exploration, lower the costs of all Mars missions, and build upon the developments and experience of Earth and the Moon-to-Mars initiative. 3.1 Entry/Deorbit, Descent, & Landing Systems and Surface Access. 3.2 Aerial Mobility, In Situ Surface Mobility, & Autonomy. 3.3 Revolutionary Subsurface Access up to Hundreds of Meters. 3.4 In Situ Sample Handling, Pre-Processing, and Analysis & Returned Sample Handling. 3.5 In Situ Remote Sensing and Search for Evidence of Life Measurements. 3.6 Direct to Orbit, Direct to Earth, and Proximity Link Telecommunications.

Initiative 4: Enable Participation in Mars Exploration for All Communities – Develop MEP initiatives that support NASA’s goals to train, sustain, and retain a qualified and diverse workforce, to develop scientific and technical literacy, and to foster a more inspired and informed society. 4.0 Establish Inclusive DEIA Leadership by Ensuring Involvement of Under-Represented Communities in Development of Data Driven Methods to Measure Progress. 4.1 Ensure Inclusivity in MEP by Involving and Supporting Under-Represented Communities in MEP Internships, Mission Teams, & Leadership Training Opportunities. 4.2 Enhance the State of the Profession by assessing MEP Demographics, Provide Career Opportunities, and Build a Culture of Inclusivity. 4.3 Create Opportunities for Public Participation in Mars Exploration by Enabling Direct Participation in Exploration through Immersive Technologies. 4.4 Create New Models for Community Collaboration by Building upon Emerging Synergistic Capabilities with New Public/Private Partnerships. 4.5 Respect Role in the Stewardship of Mars for Humanity by Being Mindful of Responsibilities in Exploring Mars “For All Humanity.”

As implementation of this plan is not funded, the program may begin precursor activities within existing program resources such as exploring opportunities for commercial services to address infrastructure needs; awarding study contracts to industry to better define potential public-private partnerships; engaging the international community on potential partnerships and hosting opportunities; commissioning a National Academies study to identify science objectives for human campaigns to Mars; investing in technologies to expand access to Mars and improve scientific understanding of the planet; developing a draft Announcement of Opportunity for the first Low-Cost Mission opportunity; and initiating work to enable broader participation in the Mars community.

An aspirational MEP Timeline was presented. The timeline should be considered hypothetical. There is flexibility to adjust the phasing of activities, if and when, funding becomes available to begin implementation and to respond to discovery. A sustainable budget chart was shared.

In summary, the priorities prior to the launch of MSR include achieving the objectives of the MEP Program of Record, including development of the Sample Receiving Project; collaborating with ESA on the ExoMars Rosalind Franklin Mission; seeking low-cost opportunities to address critical infrastructure needs (particularly communications relay and high-resolution imaging); continuing investments in key mission-enabling technologies, especially those enabling the search for life and subsurface access; and developing public/private partnership arrangements, reinforce existing international partnerships, and explore new opportunities with established and emerging space organizations. The priorities following the launch of MSR include implementing

a sustainable portfolio of low-cost competed missions, medium-class missions, infrastructure and technology investments, and missions of opportunity as content and schedule are variables to be managed against a sustained budget level and maximizing science return with a focus on smaller, lower-cost missions, partnerships, and missions of opportunity allows the program to be more agile and responsive to discoveries; and implementing science that is supportive of, and synergistic with, humans at Mars.

Mr. Ianson concluded the presentation and was available for clarification questions.

Dr. Diniega inquired about how the strategy may play out with a possible decreased budget. Would the plan be to stretch out the activities or would descoping occur? Mr. Ianson stated that the key thing about the budget is “when” everything happens. If budget challenges are happening, he feels that delaying the start of things would be best. A follow up regarded how infrastructure fits or if it attaches to something else? Mr. Ianson stated they would have a sustainable budget. It is hard to tell when they will have it, but they should have one. Infrastructure is a key component because it enables so many other parts of what they do. He did say that they also wanted to make sure that they do science missions as well.

A question was asked regarding the competed small missions and their relatively low cost. Mr. Ianson stated that they did not get a detailed study, but they did a low-cost workshop. He stated that it was best not to focus on those numbers specifically.

Astrobiology Update

Dr. Mary Voytek, Senior Scientist with Astrobiology (AB), was introduced.

The Astrobiology Program’s primary goals include enabling world-class interdisciplinary research in AB; catalyzing and coordinating AB research across science disciplines and organizations; providing scientific and technical input on the AB aspects of NASA missions; recruiting and supporting astrobiologists to be involved in mission planning, development, and implementation; participating in training students at the college and graduate levels; providing information to the general public; developing content for education; and organizing community input for research direction, facility and technology needs, communication, and workforce recruitment.

They had the AB Grad Con in 2023 this past May.

Fieldwork Ethics in the PSD programs include supporting field research in areas that have value to other users such as sensitive ecosystems or historic properties of religious, cultural, or scientific significance. There are already policies and practices in place to address and protect some of these valued sites (e.g., environmentally sensitive, desert varnish).

Ms. Daniella Scalice was introduced to present on *Beyond Permits and Codes of Conduct... Toward Relationships: Expanding Geoethics and Approaches For Field Research*. She described the process of the new language that is in ROSES – A long standing problem of geovandalism and abuse of sites. She provided multiple examples including the unauthorized drilling of core samples by a California Institute of Technology (CalTech) professor left dozens of 1-inch-diameter holes at the petroglyph site in the Volcanic Tablelands even after having their

permit denied. American Geophysical Union (AGU) and the Geological Society of America (GSA) had a late-breaking Town Hall at the 2021 AGU Fall Meeting. The formation of a working group and three main actions to be led in 2022 was the publication of an article summarizing the ideas presented in the Town Hall; surveying the community broadly to understand the current culture and ethics of geological sampling; and producing a workshop on ethics in fieldwork and sample collection at the 2022 AGU Fall Meeting.

The article summarizing the Town Hall, co-authored by Juliet Ryan-Davis and Daniella Scalice, was published in *AGU Advances*. The main area of focus was on broadening geoethics to center Indigenous perspectives, knowledges, and relationship to the lands, waters, and skies of would-be field sites by building relationships and collaborations between scientists and Tribes/Indigenous communities. Other foci included education for geoscientists to understand the ethics of sampling and their responsibilities; managing sample collections and finding new ways to share samples vs. re-sampling; and devising new systems for proposing and reviewing studies to evolve practice and increase accountability.

Many field research policies and protocols are already in place such as environmental protections for field sites along with anti-harassment codes of conduct to ensure race- and gender-based safety while in the field. Scientific field research is a privilege, not a right or an entitlement. In general, our community recognizes and respects this privilege and shares the desire to care for and protect the sites they work in with other entities, including Tribes and Indigenous communities. This is common ground to build on.

Even with the most thorough of permitting processes, there is a difference between legal permission to obtain samples in field research and ethical conduct with respect to the land. At an absolute bare minimum, the ethical conduct must ensure that Tribes and Indigenous communities are afforded free, prior, and informed consent to all that happens on their lands, waters, and skies. This is ethical, regardless of whether the Tribe has “legal” ownership of them, and regardless of what permitting processes to conduct field work entail.

This is not about stopping fieldwork. This is an evolution point – a broadening of geoethics toward a new consciousness, a new culture. Field research is conducted in a relational and reciprocal way that represents an authentic collaboration between scientists and the communities to whom the health of the lands, waters, and skies has been entrusted since time immemorial. The question was asked of how can they build relationships with Tribes and Indigenous communities and their places/spaces in which we desire to do our science?

There is an ethical space – “An ethical space is formed when two societies, with disparate worldviews, are poised to engage each other. It is the thought about diverse societies and the space in between them that contributes to the development of a framework for dialogue between human communities. Engagement at the ethical space triggers a dialogue that begins to set the parameter for an agreement to interact modeled on appropriate, ethical, and human principles. Dialogue is concerned with providing space for exploring fields of thought and attention is given to understanding how though functions in governing our behaviors.¹⁸” Guidelines from the

¹⁸ <https://tspace.library.utoronto.ca/bitstream/1807/17129/1/ILJ-6.1-Ermine.pdf>

Community: Supporting partnerships between science teams and Tribes and Indigenous communities is called Kūlana Noi‘i¹⁹. Ms. Scalice reviewed the document and its complexity as it applies to this concern along with maintaining a long-term focus, engaging with the community and co-reviewing, becoming knowledge stewardship, and holding oneself accountable.

International Policies: Vision MāTauranga Unlocking the Innovation Potential of Māori Knowledge, Resources and People. A policy framework that provides strategic direction for research of relevance to Māori, funded through Vote Research, Science and Technology. She reviewed lessons learned from the Māori Knowledge, Māori People, and Māori Resources.

As the new requirements were evolving, the Domestic Guidance: Federal Guidance for Departments and Agencies on Indigenous Knowledge (IK) was created. This is not an executive order. This is guidance for departments. The White House Office of Science and Technology Policy (OST) and the Council on Environmental Quality (CEQ) issue this guidance to assist Agencies in: (1) understanding IK, (2) growing and maintaining the mutually beneficial relationships with Tribal Nations and Indigenous Peoples needed to appropriately include IK, and (3) considering, including, and applying IK in Federal research, policies, and decision making. Overall, the Guidance: validates IK as a valid form of evidence for inclusion in federal policy; acknowledges multiple ways of knowing can improve research outcomes; encourages agencies to consider IK as an aspect of the best available science; acknowledges the racism and imperialism of Western science systems; encourages agencies to develop relationships with Tribes and Indigenous communities, especially outside of the formal consultation process, and provide resources for sustained engagements; encourages agencies to co-manage resources and co-produce knowledge with Tribes Encourages agencies to support Tribes to build capacity and fully participate in and lead research; and gives practical ideas for agencies to develop systemic approaches to applying IK within their missions.

NASA Policy was created to go into ROSES. Proposers conducting field research must include a description of their use of field site(s) that demonstrates: respect for the values of other users of the site by considering the impact that their work will have on the environment (e.g., sensitive ecosystems or historic properties of religious, cultural, or scientific significance); a research plan that reduces impact to the site (if any); the intention to obtain relevant permits and follow their guidelines. Moreover, to help create an environment that is free of harassment and discrimination, proposers must cite a specific policy, code of conduct, or ground rules provided to participants in advance of the fieldwork. This information will be provided by proposers in response to an NSPIRES cover page question.

Potential questions for proposers to consider as they address the proposal requirement: Do alternative sites exist where the impacts of your work would be lessened? Are there sample libraries in which comparable samples already exist? Does the site require a permit? Do you know the cultural provenance of the site? What Indigenous people or Tribal Nations hold history in that land? Does the site have history as a place of scientific research? Are there special

¹⁹ https://seagrant.soest.hawaii.edu/wp-content/uploads/2021/09/Kulana-Noii-2.0_LowRes.pdf

considerations needed to protect the long-term scientific value of the site)? Are you making efforts to protect the rights and interests of the people who value the site (for historical, cultural, scientific value, etc.)? Does the site have any considerations in terms of environmental fragility? Are you making efforts to protect the rights of research participants (workload, liability, anti-harassment, etc.)?

Questions reviewers should consider: Does the proposal discuss whether permits are required? Does the team have the permits or a process for acquiring permits? Does the proposal mention the provenance of the research site (for example: cultural heritage, scientific heritage, etc.)? Does the proposal discuss environmental impact/preservation (is there an environmental impact report (EIR)? Does the proposal present or discuss a Code of Conduct? Does the proposal present or discuss an Inclusion Plan? Does the proposal discuss alternative research sites or an argument for why the selected research site is the optimal choice?

Ms. Scalice concluded the presentation and was available for clarification questions.

A comment was made that some researchers appear to not have a care for the ethics. Are there any consequences? Dr. Rinehart stated they can be held accountable for what they are going to do. So, if they don't do what they proposed to do, then funding can be revoked. In theory, if they include how they are going to respect the site or the people, and then they don't do it then there is a right to terminate the grant. A follow up question was if that process did happen, would it impact their future work? Dr. Rinehart stated that, at this time, there was nothing in place for future consequences or carrying it forward. Dr. Voytek stated that the University that the grant is given to is ultimately responsible. If misconduct occurs, then they can take things back to the University that can affect them. Dr. Michael New chimed in that the selector can review items on different levels. If previous behavior demonstrates that they have not been ethical, and there is a recommendation or policy that supports it then the selector has solid ground to deny.

A comment was made that perhaps it is not that people are setting out to do these things but that they aren't thinking about the consequences of their actions. Having the language in the proposal has them thinking about it.

Dr. Diniega inquired if there were lessons learned from existing sample ethics and policies. Ms. Scalice stated that there are a lot of lessons to be learned. She stated that samples that are already sitting in collections, that systems should and could be created to access those. That more internal policies should be created to make decisions and assist with access.

RCN Update: Network for Ocean Worlds

Dr. Alison Murray was introduced to present the RNC update. The Network for Ocean Worlds (NOW) was established in 2019 with five co-leads and a coordinator. The goal of NOW is to accelerate ocean worlds research by facilitating communication among active research teams across NASA divisions and by expanding community-wide engagement.

There are five RCNs: PCE3, Life: Early Cells to Multicellularity (ECM), NfoLD, NOW, and NExSS. There is broad expertise across all the astrobiology that facilitates science communication. The NASA APD and the NASA Earth Science Division (ESD) are a part of this

program and process. They are all connected by AB's central tenet. It is a connected network of networks that supports the current NASA Mission Science.

Priority research themes of NOW include the physical and chemical properties of Ocean Worlds; searching for evidence of life on Ocean Worlds; analog studies on Earth to inform Ocean Worlds research; and development of technologies for future Ocean Worlds missions. Priority network activities of NOW include expanding NOW membership and provide mentoring; catalyzing communications across our NOW network; facilitating meetings, field-trips, and workshops; encouraging public outreach and education; and pursuing new synergies beyond the NOW network.

A diagram of the composition of the network was displayed that identified network affiliates, network team members, the steering committee, and the five co-leads. Those interested in joining an RCN can opt in if one is a PI of a program. There are many programs including Habitable Worlds, Solar System Workings, Exobiology, and more that support ocean worlds researchers that are involved in NOW.

A central role of the network is being a central communications hub. There is a website²⁰, a newsletter, papers on Making Waves, a jobs board, monthly Steering Committee meetings, and meetings with program managers and internally on a weekly basis. They communicate to the scientific community. They participated in several White Papers, were involved in the Decadal Survey, had several articles in a special issue of *Oceanography*, and are frequently contacted by the press; most recently, the leads were interviewed for an article in *Scientific American*.

Recent activities include facilitating AB program development and research by creating a cohesive strategy for Ocean Worlds Exploration based on the Decadal Survey Recommendation. This involves supporting the new Ocean Worlds Working Group with members from the Outer Planets Assessment Group (OPAG) and Small Bodies Assessment Group (SBAG). They are delighted to welcome Michael Bland and Cynthia Phillips as new co-leads. They have been facilitating team building and proposal development for major ROSES calls. This includes the Preparatory Science Investigations for Europa (PSIE-PSD); Interdisciplinary Research in Earth Sciences (IRES-ESD); and Interdisciplinary Consortia for Astrobiology Research (ICAR-Astrobiology). They also participate in discussions with the Joint Research Coordination Network regarding the future directions of AB at the pan-SMD level.

The Future Leaders of Ocean Worlds (FLOW) Leadership has grown. They have three co-leads who have monthly check-ins with the NOW leads. FLOW Monthly Meetings to share opportunities for early career scientists. They have participated in collaborative Coffee Hour with the NOW Steering Committee. They are polling FLOW membership to stimulate engagement. Future activities planned by FLOW include taking lead on IDEA committees; playing a role in the NOW Retreat topical module design and leadership; participating in early career at the NOW retreat; and mentoring Best-Practices Discussion Fall 2023.

²⁰ <https://oceanworlds.space/>

The network members publish high impact research. The May 2023 Newsletter highlighted nine recent peer-reviewed articles. On geophysics: *Freezing impacts on ice composition; Interiors of large Uranian moons; Heat exchange and vapor flow in ice fractures on Enceladus; Cryogenic liquid rain on Titan; Icy satellite radar properties; and Atmospheric seismic-acoustic coupling to detect Venus quakes.* On habitability and geochemistry: *Biodiversity in serpentinization-hosted ecosystems; Phosphate availability on ocean worlds; and Hyperhydrated sodium chloride hydrates, stable at icy moon conditions.* Network members organize the Quarterly Lecture Series. The series is available for viewing on their website or on YouTube.

Network members identify high-priority needs of the community including that many distinct potentially habitable ocean world environments have signs of life may exist; that future missions will require robust ocean access technology (landed ops and drilling) and instrumentation; that testing facilities and infrastructure are needed to ensure ocean world science investigations are successful; and that currently NASA does not have a mechanism to provide routine access to any of these environments. These priorities were identified to mature concepts for both laboratory and field-based opportunities and discussed at the June 2022 and May 2023 NOW Steering committee meetings. One possibility is to use a resource, potentially at the NASA Glenn Research Center, for a NOW Cryo-Vac-Ice test facility. It would be able to simulate Ocean World surface ice conditions for test drilling technologies and to test new instruments, electronics, etc.

Forthcoming activities and news include establishing an Ocean Worlds Access Action Group and discovering National Testing Capability for Ocean Worlds Technology based on the highest priority community-wide need identified at a summer 2022 NOW meeting. A community workshop is to follow. They are hosting the 1st Annual NOW Retreat: *Exploring the science and technology of ocean worlds across the solar system* in August 2023 with the Steering Committee, FLOW, and members from the leadership of two other RCNs (PCE3 and NFoLD). They are hoping to build bridges among ocean & planetary science & technology; identify synergies in technology development that are mission-related. Future workshops include Uranus Orbiter Probe Workshop Participation, Pasadena, July 2023; Ocean Worlds Special Session at AGU Ocean Sciences Meeting (New Orleans LA, Feb. 2024); and Ocean Worlds Theme at Astrobiology Science Conference (Providence RI, May 2024).

The NOW directly feeds into current and future NASA Mission Science such as the Europa Clipper, Dragonfly, Uranus Orbiter and Probe, and Enceladus Orbit lander. Collectively, RCNs are assets that improve upon the programs. They would benefit from enhanced support because connecting and coordinating the RCNs could foster greater interoperability and help drive NASA missions.

Dr. Murray concluded the presentation and was available for clarification questions.

Dr. D'Arcy Meyer-Dombard inquired about membership. If one can only opt in once they are funded, how are they providing community and access to new members. Dr. Murray clarified that the Steering Committees of the RCNs are those who are funded, but anyone can join as an affiliate. As an affiliate, they can participate in the quarterly seminars, receive all NOW updates

and monthly newsletters, participate in NOW special sessions at conferences, etc. Dr. Dombard stated that there was some confusion regarding membership levels and what access each level includes. Dr. Alyssa Rhoden stated that they are not an open charter. The charter is to bring together those who are funded to strengthen that community, but they have made efforts to ensure that non-funded members can make connections and occasionally attend meetings or present at said meetings. It is true that they are not an open group, but they are taking the initiative to include as many people as they can to encourage membership. Dr. Dombard stated that the newsletter is highly appreciated by those who are signed up.

Dr. Diniega inquired about the creation of the Ocean Worlds Access Group and how their priorities would be documented. Dr. Murray stated that it is too early to answer because the action group is just now being formed and it will follow a fall workshop. She stated that she would think that white papers or research papers would be appropriate to provide to NASA.

Analysis Group (AG) Reports

Dr. Diniega gave instructions to the AG presenters prior to the start of this section.

Inclusion, Diversity, Equity, & Accessibility (IDEA) Cross-AG Working Group (CAWG)

Dr. Julie Rathbun, chair of the IDEA CAWG was introduced.

This working group was formed during the August 2019 OPAG meeting because IDEA affects the entire community, not just outer planets. The goal is to serve as an interface between the community and NASA SMD/PSG HQ representatives. The entire community is welcomed to join by sending an email²¹.

Accomplishments in 2023 include multiple presentations, organization and leading of a group comment on the New Frontiers Draft AO focusing on the requirement for a Diversity and Inclusion Plan, and formally recommending AGs to adopt best practices in their selection of new steering committee members and adoption of a Codes of Conduct (CoC).

The IDEA CAWG recommends that every AG adopt their own version of the selection best practice and CoC policies. They suggest modeling steering committee selection based on the exemplary process adopted by the Venus Exploration Analysis Group (VExAG) in 2021²². Any policy adopted should be transparent and follow best practices. View the Lunar and Planetary Science Conference (LPSC) best practices and lessons learned²³. They further recommend that each AG adopts a CoC for the AG that goes beyond the Lunar and Planetary Institute (LPI) meeting CoC. VExAG has outlined such a code²⁴. For another example of these policies, see ExMAG's Charter, list of committee roles, and their CoC²⁵.

Goals for the working group for 2023 and 2024 are collate recommendations on improving IDEA from various sources such as IDEACon; continue to facilitate discussions within the community and make recommendations from the community to the group that has the power to

²¹ planetarvedi+subscribe@psi.edu

²² <https://www.lpi.usra.edu/vexag/documents/organizational-docs/steering-committee/>

²³ <https://www.hou.usra.edu/meetings/lpsc2023/pdf/1284.pdf>

²⁴ <https://www.lpi.usra.edu/vexag/documents/organizational-docs/IDEA/>

²⁵ <https://www.lpi.usra.edu/exmag/>

implement changes such as the PAC; and write a Topical Workshops, Symposia, and Conferences (TWSC) proposal to fund an AG-like two-day meeting in 2024 to reach a larger portion of the community.

While they had no formal recommendations for the PAC, they had a couple of ideas. The top three IDEA Conference (IDEACon) recommendations for funding agencies was to create an outward facing position in SMD on IDEA; consider team diversity when selecting and extending mission teams; and that project teams must implement policies for creating inclusive environments. In December of 2022, they requested that NASA explore the legality of using diversity as a selection criterion and suggested that NASA work with the community to develop more resources for inclusion plans (IP). Suggested further action is that the PAC forward their previous recommendation to the NASA Advisory Council (NAC) as soon as possible. Dr. Rathbun requested a status report on the PAC finding and the PSD response on the status of an outward facing EDIA position within NASA and requested an update on the status of the template and implementation.

Regarding inclusion plans (Ips) in AOs, they had several recommendations and/or questions that they came up on the New Frontiers Draft AO. Why is NF5 asking for a Diversity and Inclusion Plan and not an Inclusion Plan? They suggested that the mission Inclusion Plan should have a maximum page limit of at least 3 pages, as the SSERVI call did. They recommended that AOs should be clear that IPs need resources such as the budget, personnel, etc. They suggest that progress reports should be required. They suggest including some suggested activities, as the SSERVI call did. They suggest that they require a code of conduct (CoC), as the SSERVI call did. Overall, the SSERVI call did a great job on how they solicited for IPs. However, the maximum budget allowed is insufficient for major DEIA tasks as it is currently, “a maximum of \$150K may be allocated from the total \$1.5M funding for public engagement and equity and diversity-focused activities combined.”

They appreciate the excellent resources shared on the SMD’s website for Inclusion Plan resources. However, it is missing some crucial information. The typical funding included in selected proposals for IPs. Resources developed by the Planetary Science Community such as: IDEA Con recommendations, DPS PCCS resources (reading list, DPS DEIA talks, recs to DPS), and the Workshop on DEIA for Leaders in Planetary Science. They would like to see improved communication avenues between NASA IDEA and Inclusion Plan experts and non-NASA Planetary Science community DEIA leaders. It has been reported to them by community members who have served on Inclusion Plan panels that they have not been contacted by NASA to get further input on improving IPs. They recommend that each PAC meeting include presentations by, and discussions between, at least one NASA-affiliated DEIA expert or group and at least one community DEIA expert or group that is not NASA-affiliated.

Dr. Rathbun posed a question to the PAC. What would they like to see in an AG-style meeting? Are any members of the PAC part of an organization that is doing work on EDIA? If so, they are invited to give a presentation at the AG-style or one of their monthly meetings. They are welcomed to join them in forming a group to work on the TWSC proposal and they welcome attendance to their meetings.

Dr. Rathbun concluded the presentation and was available for clarification questions.

Dr. Diniega responded to one of the asks from the presentation regarding the possible outward facing position. She stated that the question/recommendation has been raised to the NAC Science Committee at the last two meetings and is included in a report to the NAC. That meeting was held a few weeks ago. It should be making its way up to the next NAC meeting whenever that may be. Someone stated that they were working with the lawyers regarding the status of the CoCs.

A comment and question were raised about a maximum for IPs with SSERVI, but there not being a minimum. Is there an expected minimum? Dr. Diniega stated that with ROSES there is no min/max guidance given.

Dr. Diniega inquired about the CAWG structure. How is that structure working reaching across the AGs? Dr. Rathbun stated that they have a good way of sharing recommendations on how to run an AG. The Steering Committee meetings have been dominated by best practice discussions. That has been useful to the AGs to be more inclusive and accessible to members of the community. The issue is how to make recommendations/suggestions on things NASA should do. She gave an example regarding OPAG.

Mars Exploration Analysis Group

Dr. Vicky Hamilton, chair of the MEPAG, presented their abridged subset of findings from their April 2023 meeting that focus on programmatic issues. The Debt Ceiling deal had not yet been made so the findings do not reflect the new information. MEPAG supports the draft MEP Future Plan. NASA leadership should continue to engage with the MEPAG and PSD community on the known or anticipated impacts of MSR and SRP costs on other priorities. Talk should continue about Mars science objectives for Moon to Mars. Preserve the science budgets of extended Mars missions at levels consistent with the Academies' Extended Missions study recommendation. Provide specific details on an infrastructure plan as soon as possible.

MEPAG understands the significant effort that has gone into the MEP draft plan and the broad range of community inputs that were considered in its development. Even as NASA is realizing the nearly 50-year strategic goal of returning samples from Mars, it is looking ahead to continuing exploration of the Red Planet; the plan includes exciting opportunities for lower-cost, small-class missions, the Decadal Survey recommended medium-class mission, technology development, engagement with the commercial sector and international partners, expanded interactions with the human flight program, and plans to enable the participation of all communities in Mars exploration. MEPAG supports the overall goals of the draft plan and appreciates the opportunity to review and comment on the plan.

MEPAG understands that the budget available for additional activities during peak MSR spending currently is limited; unfortunately, this results in a significant gap in new launches that extends to 2028, whereas the 2023 Decadal Survey (OWL) envisioned an ongoing MEP that could support small, low-cost missions in the period leading up to the launch of NASA's MSR flight elements. It is crucial to MEP flight missions, and the Moon-to-Mars initiative, that scientific expertise is not lost during this timeframe. MEPAG encourages PSD/MEP, as part of

the regular budget planning cycle, to seek the budget augmentation required to enable the launch of small-class missions earlier than currently envisioned in the draft plan and as implied by the Decadal Survey. MEPAG strongly endorses the preparatory elements of the draft plan.

After nearly 50 years of study, and as reaffirmed by the latest Decadal Survey, Mars Sample Return remains the highest scientific priority of the PSD and the MEP as well as an Agency priority. The MEPAG community is pleased that the US contribution to this international mission appears to be on track to complete the KDP-C milestone this calendar year and supports the convening of a second Independent Review Board to assess the MSR Program's progress. Nonetheless, there is genuine concern in the MEPAG community about the possibility of increases in costs for MSR and SRP and the pressure that could place on the draft plan for the Mars Exploration Program and the broader Planetary Science Division budgets and priorities. MEPAG encourages NASA leadership to continue to openly engage with the MEPAG and PSD community on the known or anticipated impacts of MSR and SRP costs on other priorities and what mitigations are being pursued to minimize those impacts (e.g., following Decadal Survey recommendations). Providing information to these communities, as soon as possible, will permit them to proactively adapt to an evolving budgetary landscape and update exploration priorities for the next decade as needed.

As noted previously, the Moon to Mars effort will benefit from early, vigorous communication among the stakeholders with respect to the high-priority science that could be accomplished by crewed missions to Mars; MEPAG continues to have concerns as to how science community input will be integrated into planning efforts on an ongoing, iterative basis. MEPAG looks forward to a near-term demonstration by NASA of the formal pathway by which science planning will be integrated into Moon to Mars strategic planning and strongly supports the immediate inclusion of science discussion and input into the ongoing development of detailed, Moon to Mars objectives that will reduce risk and maximize science return.

The 2023 Decadal Survey and the Academies' study "Extending Science: NASA's Space Science Mission Extensions and the Senior Review Process (2016)" asserted the exceptional value of extended missions (EM). EM continue to return valuable science data heading into a period with no new missions on the near-term horizon. The cost of continuing to collect science data and perform data analysis via EM is incremental relative to the cost of new missions. Extended missions will provide ongoing support for developing and maintaining multigenerational community expertise through this gap period, ranging from students and early career researchers to mid-career and senior members whose expertise and mentoring efforts will ensure a strong, stable community. Although MEPAG understands the MEP budget is constrained at present, preserving the science budgets of extended Mars missions at levels consistent with the Academies' study recommendation (i.e., to account for inflation), in addition to current programmatic needs, is a very high priority. MEPAG considers this support crucial for workforce stability through the gap between launch opportunities.

Mars orbiters are conducting critical science and rover data relay but are operating long beyond their design lifetimes. The need for continued reconnaissance science and systematic monitoring has been identified by several studies, and the orbiters' relay burden will not decrease given the

anticipated lack of missions to be launched in the next 5 to 10 years; the loss of these critical assets would be damaging to future science. As acknowledged by Initiative 2 of the draft MEP plan, the Agency must address critical/aging infrastructure; approaching future communication relay, reconnaissance, and critical event coverage needs by design, rather than by happenstance, will maximize resources for the entire MEP, especially for small-class missions with potentially limited communications capabilities. MEPAG encourages the MEP to provide specific details on an infrastructure plan as soon as possible, including a target launch date and the feasibility of re-engagement with the International Mars Ice Mapper, to ensure adequate support of current assets and enable planning for future missions before there is a gap.

Dr. Hamilton concluded the presentation and was available for clarification questions.

A question was asked regarding a decision priority system around decisions regarding choosing between low-class or medium-class missions when the time comes. Dr. Hamilton stated that this is not something MEPAG has looked at yet. Dr. Glaze stated that the infrastructure is critical. Using commercial and private partnerships may assist with the choice as a decision needs to be made. The near term seems a difficult time to make these types of decisions.

Outer Planets Assessment Group

Dr. Amanda Hendrix, OPAG chair, presented the OPAG update. OPAG held a community meeting in May 2023. They came out with four findings and concerns, the final version of which will be reported soon.

Background & Finding 1. The OPAG community is concerned about the cost growth of Mars Sample Return and its effects on the outer planets mission portfolio, and requests more information from NASA on the current MSR budget situation. Specifically, OPAG would like NASA to comment on how close MSR currently is to the yearly OWL-recommended ceiling (35% of PSD yearly budget) and overall, OWL-recommended budget (no more than a 20% increase over a total cost of \$5.3 billion). OPAG encourages NASA to follow the decadal recommendation that the cost of MSR not be allowed to undermine the long-term programmatic balance of the planetary portfolio. What is NASA's plan if MSR goes over budget, beyond the threshold set by OWL, and Congress does not provide more funds? Furthermore, OPAG would like to understand the impacts of the 20% reduction to Dragonfly's FY24 budget (launch delay, etc.).

Background & Finding 2. As reported in the OPAG findings from the 2022 Fall Meeting, the community identified a strong scientific desire that the UOP tour in the Uranian system start before equinox (2049). OPAG is glad to see an FY25 budget for UOP in the President's FY24 budget request, and notes that UOP continues to appear in the budget projections through FY28. The OPAG community supports NASA's previously announced intention to start focused studies (e.g., study UOP's trajectory options including launch dates to arrive well ahead of equinox, and mission design), and encourages NASA to start these focused studies as soon as possible.

Background & Finding 3. Radioisotope Power Systems (RPS) are critical enabling technology for UOP and other outer planet missions. The Decadal Survey identified that three units of Next Generation Radioisotope Thermal Generators (NextGen RTGs), each producing about 300 W

upon launch, are required for the UOP mission. OPAG is concerned about two aspects of preparing RTGs for UOP and other missions.

OPAG is concerned about the availability of the availability of Plutonium 238 (Pu238) to fuel the three units of NextGen RTGs for UOP to launch in time to arrive at the Uranus System before the 2049 Equinox. The recent IG report noted that the current Pu238 production plan, which aims to produce up to 15 fuel clads per year, is not sufficient to support UOP in a timely manner; even if the production rate of 15 clads per year is achieved immediately, more than a decade is needed to produce the 192 clads to fuel three NextGen units. At the OPAG Spring Meeting Len Dudzinski confirmed that, at the current Pu238 production rate, UOP launch cannot be supported before the mid- to late-2030s. Thus, as noted in the IG Report, the Pu238 production capability is insufficient to support missions recommended by the Decadal Survey, including UOP. OPAG is concerned that the Pu238 production issues may delay the mission and thus prevent observations of Uranus at a scientifically critical period before the 2049 equinox.

The Department of Energy has identified availability of ~30 kg of Pu238 for NASA missions until that is used up the clad production rate is likely the limiter. There are two upcoming missions to be concerned about: NF5 (if RPS-enabled) and UOP. The potential NF5 mission could use up to 2 MMRTGs (32 clads per RTG), launch in first half of 2030s. The Uranus mission needs 3 NGRTGs (64 clads per RTG), to be launched also in the first half of the 2030s. What does HQ need to do now to be ready? The production rate of clads needs to be increased to ~30-40 clads/year compared to the current production rate of 10-15/year. Blend newly-produced Pu238 into the old stock as quickly as it is produced. After these two missions the Pu238 inventory will be used, and the clad production rate will be determined by Pu238 production. The NF4 Dragonfly mission will use the remaining MMRTG (supplies are allocated). In addition, there might be a Discovery mission, as well as a lunar rover (Endurance).

OPAG is concerned about the readiness of NextGen RTG technology for UOP. The IG Report found that the NextGen Mod1 RTG, which builds on the Galileo-heritage General Purpose Heat Source RTG (GPHS-RTG) heritage, is at high risk of not being ready for UOP in a timely manner and recommended that the RPS Program implement a rigorous external review to monitor its development. OPAG is similarly concerned about the development of the NextGen Mod0 RTG, which is being built using components of the last remaining flight spare of the Galileo-heritage GPHS-RTG. Len Dudzinski stated that the RPS program is not planning to implement an external review on the status of the Mod0 development. OPAG is concerned that, without formal external reviews, any delay in the Mod0 development may not be addressed. A Mod0 NextGen RTG might be key to power prior (i.e., pre-UOP) missions, offsetting the gap between RPS needs and availability, thus allowing Mod1 RTGs to be developed on time and in sufficient numbers for UOP.

OPAG encourages NASA to work with DOE to increase the production rate of Pu238 material and fuel clads to ensure supply such that UOP can arrive at the Uranus System before the 2049 Equinox, in addition to ensuring sufficient supply for other missions requiring RPSs over the next decade. OPAG also encourages the RPS Program to implement a stringent external review

analogous to flight program reviews, as recommended by the IG Report, to monitor the developments of NextGen RTG Mod0 and Mod1.

Background & Finding 4. The OPAG meeting included a panel discussion that reviewed lessons learned from the Planetary Mission Concept Studies (PMCS) conducted as a ROSES element in preparation for the OWL Decadal Survey. Overall, the community responses to the PMCS program were positive, particularly in terms of providing the opportunities to flesh out new ideas and determine how they fit into different mission classes, as well as to enable access to early career people to participate in studies. The community is excited about the PMCS program's potential to make the mission concept development more open and broaden community participation in the mission formulation process. In particular, the program offered early and mid-career researchers the opportunity to lead mission concept proposals.

Repeating PMCS calls in the inter-decadal period would enable refining existing concepts and examining new ideas in response to new scientific discoveries so that more high fidelity concepts can be ready in time for the next decadal survey, and more time is available for more feasibility and costing studies during the decadal survey process. The PMCS program could further broaden participation and allow for the study of more innovative concepts if the mission design centers were not limited to JPL, GSFC and APL. OPAG suggest that future rounds of PMCS programs could solicit two categories of mission concepts; (1) concepts mature enough to merit from high-fidelity point design and cost model only available at JPL, GSFC and APL, and (2) early concepts that examine innovative designs that can be studied at other centers. To broaden participation, future PMCS calls could include Points of Contacts at various participating design centers as was done in the C.23 Planetary Science Deep-Space SmallSats (PSDS3) program in 2016.

Discussion of how PMCS reports were incorporated into the decadal survey process did emphasize a few challenges. PMCS studies of flagship concepts were conducted under varying assumptions regarding launch vehicle (e.g., availability of SLS), cost constraints, and allowable trajectories (i.e., launch dates). In some cases (e.g., Neptune Odyssey) the assumptions used by the PMCS team were not compatible with constraints known at the time the decadal survey was reviewing the concept. Given that the PMCS team had already been disbanded before the decadal survey started, it was difficult to modify the concept to accommodate known constraints prior to the TRACE process. When developing future PMCS calls, we encourage NASA to consider these issues (especially for flagship-level concepts). Potential mitigations could include a more stringent set of parameters to be described in the PMCS AO or additional funding specifically allocated for the PMCS team (and associated mission design center) to permit limited design modifications to be conducted during the next decadal survey to accommodate constraints emerge after the initial PMCS report is delivered.

The OPAG community thanks NASA for empowering the community to take part in formulating future mission concepts through the PMCS program in preparation of the OWL decadal survey. Given the significant value offered by the PMCS program, OPAG encourages NASA to: (A) Make PMCS a recurring ROSES element (more than once per decade). (B) Structure the program so that more mission design centers can participate (beyond JPL, GSFC and APL), to

broaden participation of community members and allow more innovative concepts to be studied. (C) Consider options to allow for design modifications during the decadal process by PMCS teams. Furthermore, OPAG encourages NASA (in coordination with the Academies) to make more time available during the decadal process so that more mission concepts can be costed.

OPAG statements of concern and support include a R&A statement of concern, New Frontiers-5 concern, support for Europa Clipper, Dragonfly, demographic survey, the Deep Space Network (DSN) support, New Horizons, Ocean Worlds Working Group (OWWG), Discovery, lessons learned, and education. Dr. Hendrix focused on the New Frontiers call and how it may be furthered delayed. The NF5 call is very important to the outer planets community, and OPAG is concerned about the cost caps. The cost caps need to be adjusted. They want the call to be released as soon as possible if the cost caps do not suffer for it.

Dr. Hendrix concluded the presentation and was available for clarification questions.

Dr. Diniega requested a future presentation on RPS. Dr. Glaze stated that this falls under the PSD/PAC. She stated that caution should be made that Plutonium is the only limiting factor. She discussed the budget restraints being more impactful than the Plutonium.

A comment was made about the DSN support being listed. Dr. Hendrix stated that the DSN gave a great presentation and that they wanted to support the DSN as a critical component of planetary missions.

Exoplanet Analysis Group

Dr. Natalie Hinkel, the new PSD representative, presented the Exoplanet Analysis Group (ExoPAG) update.

The new ExoPAG members include Ian Crossfield, Kate Follette, Samson Johnson, Lily Zhao, and Malena Rice. Two new study analysis groups (SAGs) are being launched. *Benefits of a Starshade + IROUV Chronograph* – To elucidate the unique/critical interdisciplinary science and identify key measurements needed to establish Earth-like habitable conditions, especially in prep for the Habitable Worlds Observatory (HWO). This SAG just met with the EC, and it will be presented to the APAC, then it will need approval from Mark Clampin. *Exoplanet Atmospheric Retrieval* – Still in preliminary stage, but already has involvement from planetary scientists. The EC will receive a presentation from them at the Aug '23 meeting, it will be presented at the Fall APAC meeting, then approvals will be needed.

The ExoPAG voted to hold the ExoPAG28 meeting just before the joint Division for Planetary Sciences (DPS) and Europlanet Science Congress (EPSC) 2023 meeting in San Antonio, Texas. One of the major focuses for the ExoPAG EC is to strengthen the connections between the astronomy (exoplanet) and planetary communities. All PAC members are welcome to attend.

Dr. Hinkel concluded the presentation and was available for clarification questions.

Mapping and Planetary Spatial Infrastructure Team

Dr. Brad Thomson, chair of the Mapping and Planetary Spatial Infrastructure Team (MAPSIT), presented the update. He included information regarding their steering committee.

Finding: NASA should support efforts to produce analysis-ready data in a platform-agnostic format. One example is US Geological Survey (USGS) effort to process and upload Mars data into Amazon's Open Data Registry, a cloud-based service. Analysis-ready data can be directly accessed via an Application Programming Interface (API), maximizing the diversity of software platforms that one could use for data access. One such platform or data interface is GeoStac²⁶.

Finding: NASA should continue to fund and support production of lunar maps (with an emphasis on geologic maps but also tactical maps, resource maps, hazard maps, etc.) at multiple scales. This follows the recommendations of the Lunar Critical Data Products LEAG/MAPSIT Special Action Team²⁷. Multiple map scales are necessary to bridge the gap between orbital resolution and the much higher spatial resolution of landed mission data. Global and regional scale products provide important context for high resolution mission maps MAPSIT is encouraged by the convening of a Lunar Surface Science Workshop, *Geological Mapping to Support Artemis Strategic Decisions* Aug 16–17, 2023 (Virtual). Could lunar map production be a highlighted element of a future Lunar Data Analysis Program (LDAP) call or is a Lunar Critical Data Product call necessary?

Finding: MAPSIT encourages continuing support for planetary Spatial Data Infrastructure (SDIs). The Lunar SDI has great traction in the community right now and it is pushing ahead with engagement and standards definition²⁸. The Europa SDI is about to release a defined horizontal datum²⁹ that will be of immense value to missions like Clipper and JUICE.

Finding: MAPSIT should be formally consulted as the US Government ponders aspects of implementing potential changes to the lunar reference system. There is currently a debate about whether and how to refine the current lunar reference system. Within the MAPSIT Steering Committee (and community at large), there is a lack of consensus on the best way to resolve the issue. They suggest establishing a SAT to develop a community consensus on this topic.

Upcoming activities include the 6th Planetary Data Workshop (PDW); the Lunar Surface Science Workshop, *Geological Mapping to Support Artemis Strategic Decisions*; and the Planetary Geology Mappers' Meeting.

Dr. Thomson concluded the presentation and was available for clarification questions.

A comment was made that MAPSIT's lunar findings were not something that LEAG expressed any concerns about. A suggestion was that perhaps the groups needed to communicate regarding overlap and concerns. Is LEAG and MAPSIT speaking regarding these concerns? Dr. Fagan stated that MAPSIT has initiated conversation regarding the topics. She stated the concerns were not a surprise and that they support MAPSIT. Dr. Diniega followed up to inquire if the LEAG shares the same concerns. Dr. Fagan deferred to Dr. Thomson. Dr. Thomson stated that they should engage more fully with LEAG regarding specific actions and that they would carry more weight if they were jointly endorsed. Dr. Noble reinforced that they are all in discussions.

²⁶ <https://stac.astrogeology.usgs.gov/geostac/>

²⁷ <https://zenodo.org/record/7236426>

²⁸ <https://psdi.astrogeology.usgs.gov/moon/about/>

²⁹ <https://psdi.astrogeology.usgs.gov/europa/about/>

Dr. Glaze discussed the reference frames and that she would like to understand this concern better. A follow up was a concern about the necessitated changes.

Extraterrestrial Materials Analysis Group

Dr. Barbara Cohen, chair of the ExMAG, presented the update.

ExMAG provided public comment to the “Support for Planetary Sample Science (SPSS)” CAN. ExMAG supports NASA facilitating community members' access to the NASA collections housed at JSC and the unique opportunities associated with the JSC curatorial facilities. However, the current SPSS CAN does not consider support for analysts to use advanced analytical capabilities and facilities available outside of JSC and as such, is not in line with other ongoing facilities support efforts by NASA such as the PSEF. ExMAG supports the CAN inclusion for training activities to make best use of the NASA collections. ExMAG further recommends that training in software skills for sample analysis be considered as well. ExMAG recommends that the SPSS CAN also include training for investigators on current, NASA-compliant data repositories available to archive planetary sample analysis data with the expectation that data generated from work done via the CAN be appropriately archived. ExMAG stands ready to work with NASA in the future to help understand how the community uses these CAN functions, how often they are needed, what unique access they provide, and how support for sample collection access, analysis facilities, and data archives might evolve to better support our community.

The ExMAG Mars Subcommittee met with Michael Meyer and Lindsay Hays regarding MSR plans to define returned sample science and analysis priorities and allocations. They have been invited to the ExMAG meeting on Aug 3 to discuss with the committee and community and will continue to engage. Participation in the upcoming Endurance Science Workshop for sample return from the SPA basin highlights the continuing issue of sample exchange with China. ExMAG understands NASA has been looking for avenues for cooperation. Is there any other way they can help the science community – multilateral agreements, guidance on participation, etc. Could the NASA Chief Scientist engage here?

Dr. Cohen concluded the presentation and was available for clarification questions.

Mercury Exploration Analysis Group

Dr. Steven Hauck, the outgoing Mercury Exploration Analysis Group (MExAG) chair, presented the update.

Regarding the ground-based observatories, they request to work with optical telescope facilities on which NASA acquires time (e.g., Keck Observatory) and their TACs to ease the scheduling of twilight-time observations for Mercury. Regarding Discovery, they note MExAG is the sole AG community for which Discovery is the only potential avenue for exploration in the next decade. This fact, compounded by the long cruise times for missions to Mercury, means that any delays or reductions in the Discovery AO cadence will disproportionately impact opportunities for exploration of the innermost planet and the health of the Mercury community.

They are on target to complete the first MExAG Science Goals Document in Q3 2023. A full draft is to be circulated to community this summer for feedback. They recruited four new members and selected a new Vice-Chair via open call. They are preparing to initiate the processes in the technology and community goals document within the next 12 months. As far as BepiColombo, it completed Mercury Flyby 3 on June 20.

Dr. Hauck concluded the presentation and was available for clarification questions.

Venus Exploration Analysis Group

Dr. Noam Izenberg, chair of VEXAG, presented the update. He stated that their next meeting is in November.

Regarding VERITAS, the status is a TBD launch in 2031 or later. VERITAS has supplied budget profiles for launches, they are waiting for HQ response. The SMD criteria for VERITAS restart included that JPL must address issues from the Psyche IRB to SMD's satisfaction which has been completed; SMD must secure funding the appropriate years which is still pending; and NISAR and Clipper must stay on schedule. The budget is still a concern. VEXAG states that a reality-based, soon-as-possible launch date for VERITAS would reduce technical and cost risk and increase stability across the portfolio. They have some questions: How will SMD fund VERITAS? How will SMD mitigate partner impacts and other risks? When will a launch date be specified?

He discussed activities that would benefit the Venus community, all upcoming Venus missions, and planetary science including the standing up of VeSCoor and the future of potential joint science activities; the organization of national and international lab capability and cooperation; wider community access to Magellan and data for deeper new analysis and re-analysis; and ensuring support for all three missions in all their stages.

Dr. Izenberg concluded the presentation and was available for clarification questions.

Dr. Glaze was asked to comment on the specific questions presented by VEXAG regarding VERITAS. She stated that when she has answers, they will be communicated.

Lunar Exploration Analysis Group

Dr. Amy Fagan, the LEAG chair, presented the LEAG response to the PAC queries regarding mechanisms for interacting with PSD/SMD and community thoughts on Inclusion Plan process. What is working is that communication is open, easy, positive with Dr. Noble, Dr. Glaze, and others. Growth could occur because sometimes it is challenging to get their biggest push-points into the PAC findings and perhaps they can improve their own communication. They also have thought about more formal mechanisms for receiving feedback on the annual meeting findings.

The lunar community continues to adapt to IPs and finds some positives among the growing pains. High-level feelings from the community consist of it still being early and many are waiting for reviews back on their first IPs and some are just beginning to digest theirs. LEAG will have more of an update in the fall. They are continuing to have a lot of frustration in developing plans and feel a sense of defeat with inadequate plans that appear to be requiring a professional level of understanding of another field. The good includes that reviews are

extremely detailed and constructive and can be used for improving in the future. Also, NASA's reiterating message that everyone is learning together. They have an appreciation for conversations and developing mechanisms to ensure that everyone is welcome. The frustrating points mostly fall upon the lack of resources such as an uncertainty and burden of time and space, a lack of a rubric, and no formal references and training. She discussed thoughts for improving the process including continuing to update the website, active workshops, and proper training.

Dr. Fagan concluded the presentation and was available for clarification questions.

Small Bodies Assessment Group

Dr. Lori Feaga, chair of the SBAG, was present to provide the update. SBAG has not had a meeting since the last PAC meeting, but they are elevating three of their findings.

Finding 5: SBAG recommends that the future planetary defense rapid response reconnaissance mission be selected by an open competitive process.

Finding 6: SBAG urges NASA to stress to all participants in the Inter-agency Radar Panel the urgency of their work, especially with respect to the future capabilities of planetary radar and planetary defense and asks that the details of its findings and actions to the community are publicly released at the Panel's conclusion.

Finding 7: SBAG eagerly awaits the public release of a SIMPLEX program lessons learned draft and recommends that there be a period of community engagement and stakeholder input before the document is finalized.

SBAG's next community meeting will be held July 11 to 13, 2023, in the Washington, DC area and in hybrid format. The Human Exploration Lead Steering Committee position is still open, but the applicant response has been nonexistent. At-large and Early Career Steering Committee selections will be announced later.

Dr. Feaga concluded the presentation and was available for clarification questions.

General AG Discussion

A discussion was had regarding a demographic survey, analyzing results of a survey, etc.

Dr. Diniega inquired if any of the AG groups had any questions or concerns regarding IPs prior to their conversation and update from SMD on the matter. No comments or added concerns were made.

Dr. Diniega stated that a lot of information is being presented at the PAC meeting and information moving formally forward is one use of the meeting, but the hope is that the AGs have other avenues of communicating with the SMDs including their liaisons. She asked if the AG groups had any comments or concerns regarding said communication routes. Dr. Hamilton commented that Michael Meyer is regularly at their meetings and active within the community. She stated that Dr. Glaze comes to at least one meeting a year. She stated that communication for their group is good and expressed no concerns. Dr. Hendrix stated that Henry is a great liaison and is present at most bi-weekly teleconferences and in-person meetings. OPAG still continues

to be concerned with the limited amount of time during the PAC meeting and how it does not allow for major discussion with the PSD. The sense of the community is that this is the time PSD can hear from the community and if the presentations are only a few minutes long, that gets challenging. Dr. Izenberg echoed that his liaison works well with them. Addressing findings/questions to specific people has helped them. Dr. Rathbun stated their liaisons have been fabulous. Dr. Cohen states that the ExMAG liaison is engaged. For communication with the PAC, the FACA rules were discussed. Dr. Glaze stated that this conversation has been the best open forum of conversation in a while. Someone else stated that in the past two years, they agree.

Inclusion Plans in Research Proposals

Dr. Amanda Nahm was introduced to present the IPs in Research Proposals from SMD. A brief history of the Inclusion Plan Pilot Program was discussed. Inclusion is a core NASA value and SMD is committed to fostering a more diverse and inclusive community. To support Agency values, the Inclusion Plan pilot program was started in 2021 in program element D.4 Astrophysics Therapy (ATP; ROSES 2021) which was led by Evan Scannapieco, the chair of the APD R&A IDEA Task Force at the time. The main goal of the Inclusion Plan Pilot Program was to determine if SMD could assess whether R&A proposals would further NASA's inclusion goals and whether such assessments could be factored into future selection decisions. SMD's Payloads and Research Investigations on the Surface of the Moon (PRISM, ROSES-2021; PRISM-21) was the second program element to require IPs. PRISM-21 took lessons learned from ATP and made changes to the solicitation and review process and gathered further input from proposers and panelists to further refine the requirements for PRISM-22. Approximately 13 ROSES-2022 program elements required IPs.

Reviewers from both the ATP-21 and PRISM-21 IPs provided suggestions on how to improve the solicitation language and review process. For example, extending page length and allowing for references and letters of support; IPs should be reviewed by a separate panel and should be comprised of approximately 50% members of the planetary science community and approximately 50% IDEA professionals from outside the community. This is the practice PRISM has adopted for both iterations of their IP review. NASA should develop resources and workshops to educate the community on inclusion best practices and how to write IPs. From both panels, there was unanimous support from the reviewers to continue IPs in future ROSES solicitations.

Originally, the language for the IP requirements was up to each program, based on language crafted from prior solicitations and finalized by the SMD IDEA R&A group. In 2022, an Inclusion Plan Community of Practice (CoP) was established by the Deputy Associate Administrator for Research, Michael New, and his team. The leads were Dr. Nahm and Dr. Ryan Watkins. Members are representatives from each division within SMD including science engagement and partnerships, as well as the ESSIO and a social scientist from the Logistics Management Institute (LMI) at NASA HQ. The goal is to centralize the goals and processes related to IPs. The tasks include drafting standardized language for all ROSES elements that require IPs; developing standard evaluation criteria and review processes; developing resources for crafting IPs.

All ROSES 2023 elements that require IPs will have the same language. The full standardized language can be found in the ROSES 2023 AO³⁰. Proposals must clearly state goals for creating and sustaining a positive and inclusive working environment and describe activities to achieve these goals. Proposals must also address ways in which the investigation team will work to attenuate or reduce these barriers. Barriers must be specific to the proposing team and not generic to the broader STEM community. Proposals must contain assessment mechanisms for evaluating progress towards the proposed Inclusion Plan activities or goals. They should describe roles, responsibilities, and work effort for all team members who will be participating in Inclusion Plan activities and the page length is dependent on individual programs but must not exceed more than three pages.

Proposers are encouraged to leverage institutional resources, if available; request time or funded work effort for team members to carry out proposed IP activities; hire IDEA experts as consultants to advise the team on the proposed IP activities; cite references to appropriate literature in a references section; and request funds to support IP activities, such as training for the proposal team.

IPs will again not be part of the adjectival rating for the proposal and will not inform the selection of proposals, but some programs may require an acceptable plan for the selected proposal(s) before funding may be released. Beginning in ROSES 2023, and beyond, IPs will be reviewed by individuals with practical and/or research expertise in IDEA topics, from both within and outside the science community.

Reviewers will be asked to consider whether the IP demonstrated an awareness of system barriers to creating and sustaining inclusive work environments; related identified barriers to the team; provided actionable steps to address the barriers; contained specificity around who will benefit from the actions in the plan; included plans for assessing the progress towards and effectiveness of the proposed activities; considered psychological mechanisms (belonging, team climate, etc.) rather than solely focusing on demographics when thinking about barriers; demonstrated an awareness of the literature surrounding inclusion and barriers team members may face including citations and references; described roles, responsibilities, and work effort for all team members who will be participating in IP activities; and provided a reasonable timeline and budget for accomplishing the proposed activities.

Currently, SMD does not intend to solicit feedback about the call language or evaluation from proposers, but welcome feedback via the CoP members and/or individual proposal debriefs.

Some common weaknesses include the tokenizing diverse team members; confusing inclusion with team building and/or outreach activities; confusing diversity numbers with inclusion (e.g., solely hiring more members of diverse backgrounds in an effort to “check the box” of being inclusive); use of IDEA language from the PI’s institute and claiming “this flows down to our team” (i.e., posting of institutional statements with no explanation of how it applies to the project team) and proposers are encouraged to leverage institutional resources rather than solely

³⁰ <https://nspires.nasaprs.com/external/solicitations/summary.do?solId=%7b274C8365-A038-339F-A3AE-8F5BFE178312%7d&path=&method=init>

outsourcing (and assuming adequate team support) from institutions;” insufficient, or lacking, descriptions of desired outcomes and evidence supporting the likelihood of success; explaining good workplace practices without, or by only weakly, tying these practices back to the team and proposed investigation; and uncertainty regarding how to utilize metrics of success.

Some common strengths include clearly discussing barriers specific to the proposal team; discussing specific, actionable items to mitigate identified barriers; connecting barriers to specific mitigating actions; containing well-defined goals; demonstrating understanding of inclusion vs. diversity; including metrics for assessing success of described plan; and identified/acknowledged intersecting axes of diversity of team members.

In response to community feedback, SMD has developed a website³¹ with resources to support writing, revision, and implementations of IPs. This website also contains the recordings from the first Inclusion Plan Best Practices Workshop, held in November 2022.

Dr. Nahm concluded the presentation and was available for clarification questions.

Public Comment Period

Dr. Rinehart opened the public comment period.

John Whitehead asked how do people feel about multiple future lower-cost MSRs? Jim Head from Brown University told the Decadal Mars Panel that the top priority should be samples from many locations. Multiple MSRs could be made affordable by technology development to make smaller MAVs, but such a future possibility was not mentioned in the OWL document, nor on Eric's technology slide today. Ironically, the underlying reason for cost growth of the present MSR Campaign is mass growth of the MAV, needing a huge lander to needing a huge lander to deliver the MAV. And to answer the person who asked if this came up before, the Decadal could have included a mention of my white papers about the need for creative engineering for a smaller MAV.

Julie Rathburn asked if a comment could be made on how they have involved experts from the Planetary Science Community (non-NASA) in developing or implementing IPs or resources? We are aware that members of this community have been used as reviewers of IPs. I need to point out that embers of our Working Group who have served as reviewers have reported that they were never contacted for feedback. I'm not sure where the disconnect is happening, but suggest it be investigated. Are there other ways members of this community have been consulted? As noted in the CAWG presentation - the IP resource webpage is lacking resources from the PS IDEA community. We suggest that we arrange for better communication between the NASA IP working group and the CAWG to help share information.

Flora Paganelli had a general comment on Moon reference frame ME/PSA - Gramling, Cheryl J. (GSFC-5900; cheryl.j.gramling@nasa.gov) is leading effort in current conversation on ME/PA between NASA/USGS and ESA international community and LunaNet interoperability. Brent Archinal, of USGS and IAU Cartographic Committee, WGCCRE, could be a good point of

³¹ <https://science.nasa.gov/researchers/inclusion>

contact for input in this conversation – conversation still ongoing and no decision have been made.

Dr. Diniega closed the public comment period at this time, but reminded attendees that there is one other public comment period tomorrow.

June 23, 2023

Planetary Defense Coordination Office Update

Dr. Kelly Fast, NEO Observation Program Manager, was introduced. The Planetary Defense Coordination Office (PDCO) was established in January 2016 at NASA HQ to manage planetary defense-related activities across NASA and coordinate with both U.S. interagency and international efforts to study and plan the response to the asteroid impact hazard. The mission statement of the PDCO is to lead national and international efforts to detect any potential for significant impact of Earth by natural objects; appraise the range of potential effects by any possible impact; and develop strategies to mitigate impact effects on human welfare.

The process of planetary defense is to search, detect, and track natural objects by finding the Near-Earth Objects—asteroids and comets—to track those whose orbits create an impact hazard to Earth; to characterize the physical characteristics of NEOs by their size, shape, composition, rotation, etc. to better understand their natural state; to plan and coordinate with the US interagency and international collaborations on effective actions for impact threat response; to mitigate with technologies and techniques to divert or disrupt asteroids in space or inform emergency response activities on the ground; and to assess by determining NEO population survey completeness and hazard from NEOs that pose the highest risk.

The 8th International Academy of Astronautics (IAA) Planetary Defense Conference was hosted by the United Nations Office of Outer Space Affairs in Vienna, Austria in April 2023. Conference highlights included an asteroid impact tabletop exercise that included representatives from the UN-endorsed International Asteroid Warning Network (IAWN) and the Space Mission Planning Advisory Group (SMPAG); remarks from Halilu Ahmad Shaba, Director General of the National Space Research and Development Agency of Nigeria, who brought critical Nigerian national and African continent perspective to the tabletop exercise panel of decision makers; remarks from Erik Hooks, FEMA Deputy Administrator, on how FEMA coordinates response to emergency events and what information would be needed from the Planetary Defense community; remarks from Matt Daniels, Assistant Director of the White House Office of Science and Technology Policy (OSTP) for Space Security & Special Projects on the release of the updated National Preparedness Strategy and Action Plan for Near-Earth Objects and Planetary Defense; and remarks by other distinguished participants.

NASA's DART mission pushed planetary defense into a new era, but despite this achievement, less than half of NEOs capable of catastrophic Earth damage have been found. To emphasize priorities, the White House OSTP released, in April 2023, its update to the 2018 National Preparedness Strategy and Action Plan for NEO Hazards and Planetary Defense³², outlining six key national goals to address the NEO hazard for the next 10 years. NASA released its complementary Planetary Defense Strategy and Action Plan³³ to further specify NASA's and the PDCO's role in achieving the national plan's objectives. The National Plan Strategic Goals are

³² <https://www.whitehouse.gov/wp-content/uploads/2023/04/2023-NSTC-National-Preparedness-Strategy-and-Action-Plan-for-Near-Earth-Object-Hazards-and-Planetary-Defense.pdf>

³³ https://www.nasa.gov/sites/default/files/thumbnails/image/nasa_planetary_defense_strategy_and_action_plan_cover.jpg

as follows: (1) Enhance NEO detection, tracking, and characterization capabilities (2) Improve NEO modeling, prediction, and information integration (3) Develop technologies for NEO reconnaissance, deflection, and disruption missions (4) Increase international cooperation on NEO preparedness (5) Strengthen and routinely exercise NEO impact emergency procedures and action protocols (6) Improve U.S. management of planetary defense through enhanced interagency collaboration (7) Improve organization of NASA's planetary defense activities and (8) Enhance strategic communications related to planetary defense. 1, 3, and 4 are of "critical focus" for the 10-year horizon.

On March 16, 2023, the Minor Planet Center announced the discovery of near-Earth asteroid 2023 DZ2 by the joint Romanian-Spanish team Para-SOL, initially estimated to be 40–100 m in size. The size, combined with future impact probability, resulted in a Torino Scale 1 hazard rating. Impact probability rose to 1 in 435 in 2026 before dropping out altogether with additional observations. It was to pass within half a lunar distance on March 25, 2023. This close approach represented an ideal opportunity for an IAWN rapid response characterization campaign to exercise the capability of the planetary defense community to collect observations and physically characterize the object on very short notice. During the short campaign, data was quickly analyzed, and results were shared by the photometry, spectroscopy, thermal modeling, and radar working group leads in the virtual campaign meetings.

NEO Surveyor is being developed—a space-based infra-red telescope to address the congressional taksing to NASA to find the 140-m-and-larger NEO population. The project was approved for Phase C at KDP-C in November of 2022. NASA IRTF is funded by the NEO Observations Program in PSD/PDCO as a primary NEO characterization asset and continues to be open-access for planetary science and astrophysics in support of NASA missions and Decadal science. The IRTF Independent Review was briefed to the PAC on Wednesday. Dr. Fast provided an example of NEO characterization involving IRTF, a coordinated target of opportunity response to the Earth close approach of asteroid 2023 BU.

The Interagency Deep Space Radar government study is a very preliminary look at potential overlapping needs and technical solutions for deep space/planetary radar across U.S. government agencies that could inform possible interagency partnerships and challenges in pursuing future capabilities. This government study is completing this month and the intention is to produce a publicly releasable report soon.

Dr. Fast concluded the presentation and was available for clarification questions.

Dr. Diniega asked about the IRTF review and if she had any questions/concerns/comments regarding the results. Dr. Fast stated that she would like to see the timing resources allocated for outreach.

A comment was expressed regarding a comment from SBAG on the need for competitively selective mission activities. Dr. Fast stated that there is not currently a line for competed mission activities. She stated that they would follow the guidance from the Decadal. A comment was made that even though the Decadal states what mission should go next doesn't mean it cannot be

competed. Mr. Johnson stated that they would like a competed mission but currently there isn't one.

Arecibo Update

Dr. Fast provided the update on the data preservation and archiving on the Arecibo Radar. She provided information in response to the PAC's finding. NASA's Planetary Data System Small Bodies Node (SBN) is in the process of capturing the Arecibo radar data and software copy hosted by Arecibo radar team members at the University of Arizona. The SBN will deliver those data and software as a pre-archive backup to the NASA Space Science Data Coordinated Archive for preservation. The Arecibo radar team continues formal PDS archiving of the radar data products with the SBN and the software on a publicly accessible software archive. NSF has communicated to NASA that the Arecibo radar data and software copy at the Texas Advancing Computing Center will be kept for the foreseeable future, while NASA completes its preservation and formal archiving process.

Dr. Fast concluded the presentation and was available for clarification questions.

Psyche Internal Review Board Response Summary

Dr. Laurie Leshin, Director of JPL, was introduced. JPL drives the forefront of scientific discovery and extraordinary benefit to humanity through innovative missions, technology, and research. They inspire people everywhere to think bigger and imagine what is possible. They leverage their unique capabilities to advance the broader space exploration and STEM ecosystems. They create a safe, inclusive, exciting workplace where all can thrive.

She reviewed the Psyche IRB's positive impact on JPL. The Psyche replan is being executed with an enhanced, fully staffed team, on track for October 2023 launch. There is a New Remote and Hybrid Work Policy resulting in mission and other teams being on lab together more frequently, and more structured/thoughtful interaction with fully remote colleagues. Europa Clipper is receiving significant senior management attention, undergoing Psyche-inspired re-org to center on work to-go, and making strong progress toward October 2024. There has been a fully revamped senior management oversight with new monthly senior management reviews to engage on issues and metrics more deeply and more frequently with senior leaders. They added full time Flight Projects Deputy and moved JPL Office of the Chief Engineer to the Director's Office reporting to the ADFPMS (Leslie) & intentional project and management engagement around use of ITA. The Weekly Director's Workforce Management Meeting driving rapid response on staffing key flight projects (Psyche, Clipper, NISAR, MSR). There is a strong focus on balance of work while looking to the future: Launched Future Work Board to make essential choices about future work strategy and scope and drive appropriate make-buy decisions. The departure rate is down to historical levels due to focused action on hiring and retention. Significant realignment of line organization roles/responsibilities/organization/collaboration is underway.

The judgement of the IRB is that the response to the IRB recommendations and work-to-go is outstanding and exceeded the board's high expectations. The PI, Psyche Project, JPL senior leadership, and JPL Line organization are to be commended for their exceptional contributions.

A credible plan has been developed for the remaining work to be accomplished to support an October 2023 launch. Initial operations planning is viewed by the IRB to be positive; however, this area has a significant amount of work yet to be accomplished. The IRB believes the October 2023 Launch Ready Date (LRD) is credible and the overall probability of mission success is high. It is the judgement of the IRB that the positive actions observed validate NASA's decision to continue the Psyche Project.

The IRB recognizes that the board's findings and recommendations were challenging, necessary, and would ultimately require considerable time to complete the corrective actions. The IRB's assessment includes the work accomplished to date and the plans to complete the remaining actions. The IRB assesses that the response to all the findings and recommendations are appropriate. The IRB is extraordinarily impressed by the accomplishments of the total JPL organization and Caltech. Engagement in and leadership of the overall response process by the JPL Director and senior leadership is deemed "world class." The amount of work-to-go is extensive and will require continued engagement, commitment, and leadership. The IRB is confident this will occur.

A fleet chart of missions was presented.

Dr. Leshin concluded the presentation and was available for clarification questions.

Dr. Hope Ishii inquired about line management and that JPL received notes for additional improvement. Dr. Leshin stated that Dr. Young said that "work to go" and "ready" are very high marks and that they are not concerns or indications of issues. Clarification was requested about the line management. Dr. Leshin said that it was good. Dr. Ishii asked about the flight software. Dr. Leshin stated that flight software is in really good shape and that she has no concerns. Dr. Glaze asked if Dr. Leshin had mentioned line management as it relates to Clipper. Dr. Leshin stated that they are focusing agency wide on the changes and not just the now.

Discussion occurred regarding the Green/Yellow/Red marking system. Dr. Glaze stated that policy changes are going to be required and changes are needed. More information on the SMD perspective could be given at a presentation or talk during a future PAC meeting. Dr. Leshin stated that it wasn't necessarily fair to expect the SRB to figure this all out when the leadership team hadn't even figured it out. This situation was exacerbated by COVID and the lack of in-person interactions. Dr. Leshin stated that they were working on sharpening the definitions of the colors and what actions are associated with the colors.

A question was asked about the Europa Clipper and the sustainability of the staff versus the schedule. Dr. Leshin stated that one of the major issues is the schedule and testing. They had always planned two shifts a day. Plans were made to increase staff. They just started Saturdays. Dr. Leshin stated that there is a concern regarding the schedule and ensuring that Clipper launches on time. That team is very focused on the human factors. They are doing things to try to make it easier on the team. She stated she wasn't very concerned about it right now because they are paying such close attention to it. There is a go-slow, go-fast period. They are ensuring that no corners are cut during this process.

An inquiry was made regarding the carry over of culture to Mars missions. Dr. Leshin stated that they are creating plans to ensure that these lessons are being applied as they move forward.

Dr. Ishii asked if she felt JPL had addressed issues that might affect VERITAS. Dr. Glaze stated that JPL has been addressing the issues. The second concern was regarding NISAR and Clipper and NISAR is out of JPL's hands. She stated the other half would be based on the future planning budget. Dr. Leshin stated that they want to ensure that the wrong kind of pressure is not applied to the team despite knowing that Clipper needs to fly.

Comments were made regarding the multitude of missions and the pressure. Is communication occurring regarding the challenges associated with all of them especially with staffing? Dr. Leshin stated that there is communication regarding staff and the needs of each mission. Staffing is never done. They spend a lot of time and energy on the people.

Remote SRBs and meetings were discussed. SRBs are very effective when they are in person, someone said. Dr. Leshin stated that she appreciated the acknowledgment of the hard work that has taken place.

Public Comment Period

Dr. Rinehart opened the public comment period. No comments were received.

Discussion

Dr. Diniega started the discussion over the PAC's findings that have been in development since the beginning of the meeting. Conversation occurred over multiple topics including protecting and growing R&A to at least 10% of the PSD budget as recommended by the Decadal, supporting of ongoing confirmed Phase C missions, supporting missions that are in Phase B including restarting VERITAS, protecting international missions, pushing to reach the 10% support by 2028 or earlier, protecting the balance of the planetary program following OWL guidance, and guardrails on MSR with possible need for further budgeting. UOP trade studies were debated regarding the timeline of them beginning. There was dialogue regarding MSR and low-cost versus medium-cost missions. The PAC discussed their findings and spent time constructing their recommendations.

Adjournment

Dates of the next PAC meeting were discussed (November 2023). Dr. Rinehart and Dr. Diniega then adjourned the meeting at 1:30 PM EDT.

Appendix A Attendees

PAC Members

Dr. Serina Diniega
Dr. Stephen Rinehart
Dr. Shannon Curry
Dr. Lisa Danielson
Dr. Jennifer Glass
Dr. John Grant
Dr. Hope Ishii

Dr. Kandi Jessup
Dr. Walter Kiefer
Dr. D'Arcy Meyer-Dombard
Dr. Conor Nixon
Dr. Tyler Robinson
Dr. Joseph Westlake

Attendees³⁴

Aaron Burton
Aaron Gronstal
Adam Cohen
Adrian Brown
Alana Johnson
Alexandra Witze
Alfred McEwen
Alfred Menendez
Alison Murray
Alyssa Rhoden
Amanda Hendrix
Amanda Nahm
Amy Fagan
Amy Reis
Anthea Chu
Ashlee Wilkins
Ashley Mae (Rivers)
Audrey
B Harvey
Barbara Cohen
Becky McCauley
Bethany Ehlmann
Bo Trieu
Brad Thomson
Brent Archinal
Brian Day
Caitlin Bordeaux
Caleb Fassett
Candy Hansen
Casey Dreier
Cathirame Lee
Cheryl Alexander
Chris Haberle
Chris House
Christinia Viviano
Curtis
Cynthia Dinwiddie

D Smith
Daniella Scalice
David G
David Millman
David Smith
Dawn Graninger
Debra Hernandez
Delia Santiago-Materese
DMG
Doug Isbell
Ed Rivera-Valentin
Elaine
Elaine Denning
Elena Adams
Emily Shteynberg
Erin Leonard
Erin Morton
Etienne Dauvergne
Flora Paganelli
Gabriela Himmele
Gene Mikulka
Greg Garner
Gregory Schmidt
Hanna
Heather D. Smith
Henry Throop
J Andy Spry
Jack R. Kiraly
James Lochner
James Roberts
James Tuttle Keane
Jason Callahan
Jason Kalirai
Jay
Jeff Foust
Jeff Gramling
Jeff Johnson

³⁴ The names and/or affiliations are as given by the attendees, and/or as recorded by the teleconference operator.

Jeffry Grossman
Jemma Davidson
Jennifer Glass
Joan Salute
Joel Kearns
John Andrews
John Rummel
John Whitehead
Jordan Garberding
Josh Handal
Julie Castillo
Julie Rathbun
Justin Filiberto
Karen Gelmis
Karl Mitchell
Kate Craft
Kathleen Vander Kaaden
Kathryn Pietro
Kathy Mandt
Kelly Fast
Kelsie Kرافton
Kenneth Hurst
Kim Selos
Kinsey Flanders
Krista Soderlund
Kristina Gibbs
Kunio Sayanagi
Kurt Retherford
Kyree Standifer
LaJuan Moore
Laurie Leshin
Leo Enright Irish
Lewis Groswald
Linda Billings
Linda Karanian
Lindley Johnson
Lisa
Lori Feaga
Lori Glaze
Louise P
Louise Prockter
Lucas Paganini
Luisa Fernanda Zambrano Marin
Marchel Holle
Marcia Smith
Mark Carreau
Mark Hofstadter
Mark Simons
Mary Voytek
Matt Berg
Matt H.
Max
Meagan Thompson
Megan Ansdell
Megan B Russell

Melissa Kirven-Brooks
Michael Meyer
Michael New
Mike Fanelli
Mike Kelly
Monty Di Biasi
Mtosciano
Nancy Chanover
Natalie Hinkel
Nicholas Pinder
Nick Lang
Nick Saab
Noam Izenberg
Noma
Ocean McIntyre
Original Gram
Patrick Taylor
Paul Byrne
Paul Voosen
Paula do Vale Pereira
Prajakta Mane
Rebecca McCauley Rench
Richard Cook
Richard Rogers
Robert Fogel
Robin Fergason
Ron Ballouz
Ruth Nichols
Ryan Park
Ryan Watkins
Sarah Noble
Sarah Valencia
Shane Byrne
Shoshana Weider
Shulte
Sierra Ferguson
Stacy Weinstein-Weiss
Stephanie Getty
Steve Hauck
Sue Smrekar
Tammy D
Theresa Carta
Thomas Statler
Tibor Balint
Tiffany Morgan
Tony Freeman
Tracy Becker
Trent Hare
Vicky Hamilton
Zibi Turtle
Zoe Wai

Appendix B

Planetary Science Advisory Committee Members

Dr. Serina Diniega, Chair
Jet Propulsion Laboratory

Dr. Stephen Rinehart
NASA Executive Secretary

Brent Barbee
NASA Goddard Space Flight Center

Dr. Shannon Curry
University of California, Berkeley

Dr. Lisa Danielson
Los Alamos National Laboratory

Dr. Jennifer Glass
Georgia Institute of Technology

Dr. Hope Ishii
University of Hawaii

Dr. Kandi Jessup
Southwest Research Institute

Dr. Walter Kiefer
Lunar and Planetary Institute

Dr. D'Arcy Meyer-Dombard
University of Illinois at Chicago

Dr. Conor Nixon
NASA Goddard Space Flight Center

Dr. Tyler Robinson
Northern Arizona University

Dr. Joseph Westlake
Johns Hopkins University Applied Physics Laboratory

Appendix C **Presentations**

1. Planetary Science Division (PSD) Update, *L. Glaze and J. Salute*
2. ESSIO/Lunar Science Update, *J. Kearns and S. Noble*
3. IRTF Independent Review, *L. Paganini and N. Chanover*
4. R&A Update, *S. Rinehart*
5. Mars Sample Return (MSR) Updates, *J. Gramling et al.*
6. SSERVI Update, *Greg Schmidt et al.*
7. Mars Exploration Program (MEP), *E. Ianson et. al*
8. Astrobiology Update, *M. Voytek, D. Scalice et al.*
9. RCN Update, *Network for Ocean Worlds (NOW)*
10. IDEA Cross-AG Working Group (CAWG), *M. McAdam and J. Rathbun*
11. Assessment/Analysis Group (AG) Q&A Period, *AG Representatives*
12. Inclusion Plans in Research Proposals, *A. Nahm and R. Watkins*
13. Planetary Defense Coordination Office Update, *L. Johnson and K. Fast*
14. Arecibo Update, *K Fast*
15. Psyche IRB Response Summary, *L. Leshin*

Appendix D
Agenda

Planetary Science Advisory Committee Meeting
Hybrid
June 21–23, 2023

Wednesday, June 21

| | | |
|---------|-----------------------------------|-------------------------------|
| 1000 AM | Welcome & Introductions | Stephen Rinehart |
| 1005 AM | Planetary Science Division Update | Lori Glaze |
| 1100 AM | PAC Q&A/Discussion | All |
| 1120 AM | ESSIO/Lunar Science Update | Joel Kearns, Sarah Noble |
| 1150 AM | PAC Q&A/Discussion | All |
| 1205 PM | IRTF Independent Review | Lucas Paganini Nancy Chanover |
| 1235 PM | PAC Q&A/Discussion | All |
| 1250 PM | Lunch | |
| 0150 PM | R&A Update | Stephen Rinehart |
| 0235 PM | PAC Q&A/Discussion | All |
| 0255 PM | Mars Sample Return Update | Jeff Gramling |
| 0325 PM | PAC Q&A/Discussion | All |
| 0345 PM | Break | |
| 0415 PM | SSERVI Update | Greg Schmidt |
| 0445 PM | PAC Q&A/Discussion | All |
| 0445 PM | Public Comment Period | All |
| 0500 PM | PAC Q&A/Discussion | |
| 0600 PM | Adjourn | |

Agenda

Planetary Science Advisory Committee Meeting Hybrid June 21–23, 2023

Thursday, June 22

| | | |
|---------|--|-------------------------------|
| 1000 AM | Welcome & Introductions | Stephen Rinehart |
| 1005 AM | MEP Update & Mars Future Plan | Eric Ianson |
| 1100 AM | PAC Q&A/Discussion | All |
| 1125 AM | Astrobiology Update | Mary Voytek, Daniella Scalice |
| 1155 AM | RCN Update | Network for Ocean Worlds |
| 1215 PM | PAC Q&A/Discussion | All |
| 1230 PM | Lunch | |
| 0130 PM | IDEA Cross-AG Working Group (CAWG) | Maggie McAdam, Julie Rathbun |
| 0150 PM | Assessment/Analysis Group (AG) Updates | AG Representatives |
| 0231 PM | PAC Q&A/Discussion | All |
| 0330 PM | Break | |
| 0400 PM | Inclusion Plans in Research Proposals | Amanda Nahm, Ryan Watkins |
| 0415 PM | PAC Q&A/Discussion | All |
| 0430 PM | Public Comment Period | |
| 0445 PM | PAC Q&A/Discussion | All |
| 0600 PM | Adjourn | |

Agenda

Planetary Science Advisory Committee Meeting Hybrid June 21–23, 2023

Friday, June 23

| | | |
|---------|-----------------------------|-----------------------------|
| 1000 AM | Welcome & Introductions | Stephen Rinehart |
| 1005 AM | PDCO Update | Lindley Johnson, Kelly Fast |
| 1025 AM | Arecibo | Kelly Fast |
| 1045 AM | PAC Q&A/Discussion | All |
| 1100 AM | Psyche IRB Response Summary | Laurie Leshin |
| 1130 PM | PAC Q&A/Discussion | All |
| 1130 PM | Public Comment Period | |
| 1200 PM | Break | |
| 1215 PM | PAC Q&A/Discussion | All |
| 0145 PM | Adjourn | |