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Planetary Science Advisory Committee

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Virtual Meeting

NASA Headquarters
Washington, D.C.

Amy Mainzer

Amy Mainzer, Chair

Rinehart, Stephen A. (GSFC-6650)

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Stephen Rinehart, Executive Secretary

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November 15, 2021

Welcome/Around the Table

Planetary Science Advisory Committee (PAC) Executive Secretary, Dr. Stephen Rinehart, opened the meeting. He noted that the last PAC meeting was not an official Federal Advisory Committee Act (FACA) meeting due to the PAC's expired charter, but that the PAC did receive a findings-style expert commentary, to be detailed and summarized during the course of the meeting. Dr. Rinehart thanked departing PAC members Drs. Britney Schmidt and Lynn Carter for their service, called roll, and announced that the PAC is back up to 13 members, with the recent addition of five new members. The full complement of members was recorded as being present for the meeting.

Planetary Science Division (PSD) Update

Dr. Lori Glaze, Director of the Planetary Science Division (PSD), presented a status of the division. She reported that she was pleased that the PAC had been re-chartered, and all its newest members fully approved. Dr. Glaze briefly recounted FACA rules for new members, and provided a brief overview of PAC objectives and scope, and its importance to the PSD.

A quick view of the fleet chart reveals 38 Planetary missions, including the initiation of Mars Sample Return (MSR) as the Perseverance rover operates on the surface of Mars, collecting samples to cache. A number of Commercial Lander Provider Service (CLPS) landers are being developed in the Exploration Science Strategy and Integration Office (ESSIO) program, and many other good things are going on. The newest addition to the Planetary fleet is the EnVision mission to Venus, a selection from the European Space Agency (ESA) medium-class (M5) call; NASA will provide a significant contribution to this mission. The Trojan asteroid probe, Lucy, has also just successfully launched.

Dr. Glaze introduced Dr. Joan Salute, Assistant Director for all Flight programs within PSD, excluding the Mars Exploration Program (MEP). Dr. Salute provided an update on the Flight program, beginning with the Lucy mission, which launched without a hitch, and has begun its 12-year mission to the Trojan asteroids. The spacecraft will fly by Earth for a gravity assist in another year, as it follows a "pretzel" trajectory. Lucy has two large circular solar arrays, one of which did not fully open upon checkout; the electrical power of the affected array is at about 90%, and the mission team is analyzing scenarios on how to deal with the problem: use the array as is, or re-deploy it. The Double Asteroid Redirection Test (DART) mission will launch the week of 23 November (the mission has since launched successfully, on November 23, 2021). DART is a technology demonstration that will test the technique of impacting an asteroid and deflecting it. DART will reach the binary asteroid system, Didymos/Dimorphos, in September 2022. Ground-based observatories will be used to measure how much the orbital period of the impacted body changes, post-impact.

The Europa Clipper mission is on track for launch in October 2024, and is now assigned to a SpaceX Falcon Heavy on a MEGA trajectory; this assignment is now locked in, along with an integrated technical and cost/schedule baseline. The Europa Clipper has experienced a $100M financial impact from the COVID pandemic. The solar array has been a source of concern for some time, and is still under analysis. However, the solar arrays and the MISE instrument remain on schedule. Juno is now in an extended mission (EM) for a few years, and will be observing Ganymede, Io, and Europa. Psyche is on track to launch in August 2022. The lunar mission, Volatiles Investigating Polar Exploration Rover (VIPER), has adopted a science study area near the Nobile crater, and recently passed its Critical Design Review (CDR) milestone. The Dragonfly probe to the Saturnian moon, Titan, is scheduled for launch in 2027, and is on track for its subsystem Preliminary Design Review (PDR).

Contact with the SIMPLEx-1 satellite, Q-PACE, has still not been made, but the mission hasn't yet given up on trying to reach it. The LunaH-Map instrument has been integrated into Artemis I, which is

scheduled for launch no earlier than February 2023. Janus is still scheduled for a launch, along with Psyche as a rideshare, but is still beset with some schedule uncertainty. Lunar Trailblazer passed its CDR in July 2021, and the Mars mission, Escape and Plasma Acceleration and Dynamics Explorers (ESCAPADE), passed its Key Decision Point C (KDP-C) milestone.

Dr. Glaze provided updates on OSIRIS-REx, which is scheduled to return to Earth in 2023 with sample material collected from the asteroid Bennu; Johnson Space Center (JSC) is preparing for receipt and curation of the samples, and recently conducted a successful rehearsal. NASA will be receiving samples from the Hayabusa-2 asteroid sample return mission in December. COVID has posed challenges to the sample-sharing program, but NASA and JAXA believe they have a good path forward (and, indeed, the samples have since been received at JSC). The catalog of the US sample share is about 10% of the total sample. Sample availability from JAXA itself will be announced this winter. PSD will be holding a Senior Review this year for the Mars Reconnaissance Orbiter (MRO), the InSight (seismic) Mars probe, Mars Aeronomy and Volatiles Experiment (MAVEN), the Lunar Reconnaissance Orbiter (LRO), Mars Odyssey (MO), Mars Science Laboratory (MSL; Curiosity), New Horizons, and OSIRIS-REx missions. Juno is not on this list, as the mission has been selected to go to end of life. All missions will be reviewed for a three-year extension except for OSIRIS-REx, which will be proposing a visit to Apophis in 2029, after its close Earth encounter. Each mission in the Senior Review will be evaluated independently (by a separate panel for each mission) and the missions are not compared with each other. Decisions on extended missions are expected to be finalized by April 2022.

Ms. Salute described the impacts of COVID on Planetary Flight missions. In response to the pandemic, the Science Mission Directorate (SMD) had created impact assumptions for budget-planning purposes, which are in the process of being examined for possible updates. Initially, SMD had been feeling the greatest impacts in missions that were in phases C and D. Now, however, NASA is getting hit with four brand new missions in phase B, which are experiencing big impacts on the time needed to place procurements. Phasing plans are looking problematic for launch dates, costs are going up, and the Agency is starting to see the effects of losing some staff in the contractor population, due to vaccine mandate issues. There are also economy-wide supply chain delays to contend with. NASA is trying to look ahead, bearing in mind that the challenges to planning include attempting to separate normal workmanship issues from COVID stressors. There are different ways of measuring this. To date, no PSD missions have slipped launch readiness dates (LRDs) due to COVID, which is a tremendous accomplishment. However, there will be continuing impacts to Clipper, Psyche, Lucy, and Dragonfly. Notable cost increases to date: Clipper ($108M); Psyche ($46M); and Lucy ($19M). COVID is still a big challenge; PSD is coping, but is not quite there yet.

Dr. Glaze highlighted the most recent Early Career Award (ECA) winners from the 2020 call. The next ECA call is coming up; the deadline is 8 December. PSD conducted a Senior Review on the Solar System Exploration Research Virtual Institute (SSERVI), the findings of which will be incorporated into the next SSERVI Cooperative Agreement Notice (CAN-4). There was much internal discussion as to what the next call should include. This next CAN will be focused on the Moon, excluding near-Earth objects (NEOs) and the Mars moons, Phobos and Deimos. The Planetary Data Ecosystem (PDE) is making progress; there will be a full presentation on PDE at a future meeting. One of the main recommendations of the PDE Independent Review Board (IRB) was to establish a community-based group, thus PSD is addressing this recommendation through a series of workshops to help establish definitions. PDE will be actively supporting radar data and archive activities; Astromat has been chosen to be used as the laboratory analysis archive for OSIRIS-REx, and a PDE Chief Scientist is to be selected by the end of November.

Selections are now being made on a no-due-date (NoDD) basis in Emerging Worlds (EW), Solar System Workings (SSW); Planetary Data Archiving, Restoration, and Tools (PDART); Exobiology (Exobio); Solar System Observations (SSO); Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO); and Laboratory Analysis of Returned Samples (LARS). The VenSAR Science Team solicitation is now out on the street, a NASA contribution to the ESA EnVision mission. The Facilities call, normally under ROSES-21 C.17, has been changed to PSEF as a new way to support Planetary facilities. In addition, a new Research Catalyst Fund (RCF) has been initiated, which is a small SMD-level funding line designed to act as a focal point and catalyst for programmatic activities that cut across the directorate's science disciplines. The RCF will be used to co-fund research fitting priority criteria, e.g., high-risk/high-impact research, interdisciplinary research, and research from underrepresented institutions; the projects will come in through regular ROSES programs. There has been a lot of activity in the SMD Inclusion, Diversity, Equity and Accessibility (IDEA) Working Group, as well as in PSD. The SMD IDEA WG, which reports to the IDEA Leadership Council, has been formed and has a number of different groups that preside over a variety of activities, some inward-focused, some outward.

Mentoring365, a joint effort among NASA, and multiple other organizations including the American Geophysical Union (AGU), the American Association for the Advancement of Science (AAAS), and the Government Services Administration (GSA), is now part of an SMD-wide effort to expand the program. Dr. Glaze encouraged people to sign up [[https://mentoring365.chronus.com/p/p1/]. Another new initiative is the SMD Bridge Program, included as part of the Fiscal Year 2022 (FY22) Presidential Budget Request (PBR), which is focusing on paid research and engineering studentships at participating institutions to transition science and engineering students from undergraduate studies into graduate schools, and to employment by NASA; Dr. Glaze recommended that the community stay tuned as this effort grows. The SMD Bridge program will also seek to increase inclusion, diversity, equity, and accessibility within the NASA workforce and within the U.S. science and engineering community. The Here to Observe (H_2O) pilot program is also growing, and is working this year with Lucy, Dragonfly, and Europa Clipper, partnering with three MSI universities. Thirty students have been enrolled so far. Each student is paired with a mentor. The kickoff social event for H_2O was a virtual Lucy launch party, which saw great participation. The Planetary Decadal Survey is expected to be released in Spring 2022. A huge effort is in force to stay on schedule; the document itself is slated to go to reviewers in November. It will take some time for the Agency to read it, absorb it, and respond to it. NASA plans to have an initial response within 90 days of the release, followed later by a more comprehensive response.

Dr. Glaze provided feedback to PAC comments on the Planetary Data Ecosystem IRB, with regard to the observation that funding must be provided. PSD recognizes this; there are costs involved with all aspects of PDE, and PSD is leveraging funds wherever possible, and is also working through the budgetary process. Regarding PAC comments on Research and Analysis (R&A) funding, PSD responds that it is encouraged by PBR22, and will continue to commit to future increases, pending Congressional disposition. In response to a related comment, Dr. Glaze reiterated that PSD cannot directly charge community service to grants.

Responding to comments on the international Mars Ice Mapper (I-MIM) mission and concerns about community involvement, Dr. Glaze noted that NASA, the Canadian Space Agency (CSA), JAXA, and the Italian space agency developed a call for an international Reconnaissance/Science Measurement Definition Team (MDT), which precipitated a fantastic response of community members in terms of number, reputation, and diversity. Responding to comments on Mars Sample Return Science Management, Dr. Glaze said that NASA has been taking measures to address the potential of a gap in science management between the four elements of returning samples from Mars, via the Mars Sample Return Science Planning Group. NASA has also completed a year-long international study addressing sample handling requirements, associated technical issues, a science management framework, and a

timeline of science milestones (to be published in *Astrobiology* in December 2021). The NASA and ESA MSR Operational Scenarios Definition Team, created to address workflows in the Sample Receiving Facility, will conclude their study this month. Personnel have been appointed to the MSR program to pay attention to the science (e.g., Drs. Michael Meyer and Meenakshi Wadhwa). NASA is also working with ESA through a memorandum of understanding (MOU), which should be signed early in 2022. A Science Management Plan is also expected to be completed and signed early in 2022. Johnson Space Center (JSC) has released a Request for Information (RFI) for trade studies for a Sample Receiving Facility (SRF). In response to PAC concerns on the cost of MSR, Dr. Glaze noted that MSR is a flagship mission with high priority in the Decadal Survey, and that NASA will not commit to cost until 2023, at the end of phase B. In other matters, Dr. Glaze pointed out that PSD is making plans to maximize the science return on the close approach of Apophis, in addition to OSIRIS-REx opportunity previously mentioned. PSD will also continue to ensure that closed captioning (CC) is available during public meetings.

Dr. Serina Diniega asked if there was a website available for IDEA, or H_2O. Dr. Glaze said that the next day's presentation on IDEA would yield more information, but that she didn't think H_2O had its own website yet, as it is a nascent project. Dr. Diniega asked for a reminder on sample-sharing strategies. Dr. Glaze explained that with regard to Hayabusa-2, NASA will curate and make available the 10% of the allotment that the Agency is responsible for. Participating Scientists already have samples in hand and are working actively. Capabilities at JSC have been developed over the past few years to improve and increase capabilities for sample reception and curation. PSD is also working with JSC on how to accommodate future lunar samples. MSR is a special case that will need its own capabilities (i.e., a Sample Receiving Facility). Dr. Hope Ishii asked if there would be any coordination of sample releases for Hayabusa-2. Dr. Glaze directed the question to Dr. Jeff Grossman, who said that while NASA had hoped to coordinate with JAXA, there simply had not been enough time to produce a catalog. That said, anyone who wants immediate sample access will have to coordinate with JAXA. The second Announcement of Opportunity (AO), however, will be coordinated between NASA and JAXA. Dr. Mainzer brought up the fact that the Astrophysics Decadal Survey had just been released, and asked whether any results were worthy of mention. Dr. Glaze felt the next big exoplanet mission was very exciting, and that there had also been explicit recommendations on community health and IDEA; it will be interesting to see how the Planetary Decadal Survey treats these same subjects. Dr. Rinehart commented that the AP Decadal Survey is quite ambitious, and had reflected many of the white papers that had informed it.

ESSIO Update

Dr. Brad Bailey, substituting for ESSIO Deputy Associate Administrator (DAAX), Dr. Joel Kearns, presented, beginning with a quick statement of the ESSIO vision, which is to define and lead the science strategy for the Artemis missions through to Mars, and integrate science between the science, exploration, and technology directorates. ESSIO also seeks to promote a lunar economy, largely through the CLPS program. The ESSIO organization currently has an Associate DAAX position still open. The division hosts a number of Program Executives, Program Scientists, and some Program Managers (PMs) that are joint with PSD (e.g., Dr. Sarah Noble). The Lunar Surface Science Workshop (LSSW) series is ongoing, virtually, having begun in May 2020. These workshops are approximately monthly sessions, all of which have been archived online. Upcoming topics include Future CLPS Landing Sites (18 November); Inclusive Lunar Exploration (26–27 January 2022); and Heliophysics in (February 2022 date, TBD).

CLPS deliveries from 2022–25 are numerous, with more than 40 instruments scheduled thus far. Initial deliveries, such as the NASA Provided Lunar Payload (NPLP) instruments, were largely schedule-driven to get high-TRL instruments to the lunar surface quickly. By contrast, the Payloads and Research Investigations on the Surface of the Moon (PRISM) program deliveries are focused on specific science suites that are being designed to get to the lunar surface from 2024 onwards. NASA is also looking to evolve the capabilities of the vendors, to promote advanced technology through activities such as

Surviving the Night studies. The Agency has also been looking at time horizons to take advantage of vendor capabilities as they come online. Ultimately, ESSIO wants to be able to develop sample return missions through vendors. PRISM-1 selections include Lunar Vertex (small rover, magnetometer, microscope); a Farside Seismic Suite (FSS); and a Lunar Interior Temperature and Materials Suite (LITMS). The PRISM-2 draft solicitation was released in May of this year, and Step-1 proposals have been received, focused on providing mobility for suites of instruments on vendor-provided rovers. PRISM-2 marks the first opportunity to ask for mobility as a service from vendor. Initial deliveries from PRISM-2 are planned for the first two quarters of 2025, through 2026, to target the Gruithuisen Volcanic Domes and the South Pole. ESSIO is encouraging Early Career proposers and first-time PIs to participate in these calls, as it is a wonderful opportunity to earn experience. PRISM is planned as an annual call, and ESSIO anticipates a 2022 PRISM-3 call for deliveries in 2026, while also considering a Stand Alone/Site Agnostic PRISM call for individual instruments (e.g., heat flow probes). The LSSW on landing sites will help guide selection of CLPS landing sites and associated PRISM calls.

Future Artemis Crewed Landing calls include an expected call for the first set of deployed instruments for Artemis III and V, and an Artemis Geology Team. ESSIO also expects to solicit science instruments for a teleoperated Lunar Terrain Vehicle designed to be ready for Artemis V; this call should come out in a year or so. There will be many opportunities to participate not only through CLPS, but also in the Artemis program itself. ESSIO is looking for science teams to propose to these opportunities. The Apollo Next Generation Sample Analysis Program (ANGSA) announced its first science results, on the 73002 Upper Drive tube; an ANGSA 2.0 call is expected in 2022. LRO continues to be a workhorse as it helps to buy down risk and inform the architecture for crewed missions on the Moon. LRO recently supported an international Observe the Moon night and is now being prepared to view a partial lunar eclipse. New craters have been named near the lunar South Pole: Henson, Marvis and Spudis.

Dr. Dana Hurley asked if there were a plan for science small sats, or cubesat ride-alongs, in the CLPS program. Dr. Bailey said that there are short-term plans for soliciting for orbital drop-offs through CLPS vendors, but was unsure if CLPS would have specific calls. There are plans for Artemis I and II small sat opportunities, and there was a potential there for CLPS deliveries, but those would likely be worked through the rideshare office. Asked if there were biological research plans for the South Pole, Dr. Bailey said that ESSIO was focusing on the priorities of BPS for Moon: there are a number of CLPS opportunities to look at bacterial growth, include microbiology experiments, etc., and that ESSIO is making sure the community is aware of them.

MEP and MSR Program

Mr. Eric Ianson presented highlights from the Mars Exploration Program (MEP). The Perseverance rover successfully collected and stored two sample cores from a rock named “Rochette” on 6 and 8 September: the samples are named “Montdenier” and “Montagnac.” In response to the unsuccessful first coring attempt, the mission team has adopted a ground-in-the-loop sequence of imaging during sampling. Perseverance is in the process of taking its next sample at “Brac.” MEP is hopeful to get confirmation soon. The Ingenuity helicopter has finished its test phase, and is now an operational demonstration, working in tandem with the rover to enhance reconnaissance and provide additional science to the mission. An international Measurement Definition Team (MDT) has been selected and announced for the I-MIM orbiter. Mars assets successfully exited solar conjunction, with all systems working well. MEP held a Program Implementation Review (similar to PDR for flight projects) in October; the next step will be presenting its findings to the SMD Program Management Council (PMC), and perhaps to the Agency PMC. The Perseverance Science Team published its first findings on Jezero Crater in the *Science*, in October. A workshop will be held in January 2022 to discuss low-cost mission concepts, in preparation for results of the Planetary Decadal Survey.

MEP has a new Deputy Program Director, Ms. Tiffany Morgan, and a new MSL Program Scientist, Dr. Becky McCauley-Rench. New MEP Principal Scientist, Dr. Michael Mischna, is replacing Dr. Rich Zurek. Dr. Shannon Curry is the new MAVEN PI. NASA's MOMA instrument is now fully integrated with ESA Rosalind Franklin rover, and NASA is providing drop test support to ESA for the rover mission. All operating missions are healthy and well-funded. MRO is now 10 years beyond its original design life. MAVEN set a new Solar System record for throughput for a single communications session. MAVEN detected a moderate to strong solar storm that hit Mars in October of this year. A neutron detector on board Mars Odyssey, now in its 20th year since launch, detected the same solar event. ESA's ExoMars/Trace Gas Orbiter continues to support 55% of UHF communications.

To date, Perseverance has traveled over 1.6 miles. The I-MIM orbiter is being planned to map shallow ice at the mid-latitudes to answer science questions and to search for landing sites containing resources for future human exploration needs. The I-MIM team is currently completing a point design and draft schedule. The international MDT has total of 53 members. SMD Associate Administrator Dr. Thomas Zurbuchen announced the creation of the MDT on Twitter.

Dr. Michael Meyer presented highlights from the InSight mission. Studies released in July, based on analyses of its seismic sensors, indicate the probe might have detected a "chirp" signal, possibly attributable to a meteor impact; InSight also detected some of longest marsquakes recorded to date. The MSL Curiosity rover continues to go strong and is heading up Mount Sharp, heading to the sulfate-containing Greenheugh Pediment, sampling every 25 meters of elevation, and collecting great data on topographic characteristics. In its traverse, Curiosity has also come across nodules of magnesium sulfate. MEP is moving forward on the MSR campaign, having just signed an MOA between MSR and MEP to delineate and define roles and responsibilities on the Sample Return Campaign. The MSR Science Planning Group-2 (MSPG2) report has been completed and submitted for publication. MSPG2 was comprised of a very diverse international group, with 31 members from 11 countries. Preliminary results from the report deal with the need for an overall science management plan that crosses over into SRF; flag some technical issues associated with Biohazard 4 facilities and life detection assays, as well as sample hydration states. SRF requirements will also be need to be developed to help inform early trade studies at JSC. MSPG2 developed a timeline for SRF development to determine which things need to be developed in the short term (coordinating science); and later (proper certification criteria for the SRF). The report also flags points on the timeline where the science community can get involved.

Mr. Jeff Gramling reported on the MSR campaign, which spans three launches and one ground element. The NASA MSR program will manage the Sample Retrieval Lander (SRL), the Mars Ascent Vehicle (MAV), and the Capture, Containment, and Return System (CCRS), while ESA will manage the Earth Return Orbiter (ERO), the Sample Transfer Arm (STA), and the Sample Fetch Rover (SFR). Mr. Gramling briefly described the MSR architecture and sequence of activities, starting with the collection of samples previously cached by Perseverance, to the eventual sample landing in Utah. Once the samples return to Earth and are safely contained at the landing site, the MEP resumes responsibility. Per recommendation of the IRB, MSR is still looking at whether one or two sample retriever landers will be necessary. There are multiple paths to deliver sealed samples on the Mars surface (sample fetch rover, or Perseverance itself, if it is still functioning at that time). Recent personnel additions to MSR include the appointment of Dr. Mini Wadhwa as the Principal Scientist for Sample Return, and a number of other scientists who have prior experience with Mars missions. Mr. Gramling said that some MSR trade studies on "breaking the chain" of contact for samples are looking at a brazing approach (TRL 4–5), as well as an aseptic transfer approach that involves a heat-shrink method. MSR is currently assessing the risk of overheating samples in this latter approach. Drop tests and leak tests have also been performed. Mr. Gramling displayed an animation of the Vertically Ejected Controlled Tip-Off Release (VECTOR) approach to launching the Mars Ascent Vehicle (MAV) from the Mars surface, showing the MAV being

deployed into launch attitude. MSR science questions are being addressed by a group of scientists, led by Dr. Meyer, while the program develops proposals for what a campaign science team will look like. MEP and MSR developed an agreement in March of this year that defines how the programs will work together to coordinate M2020/Perseverance Phase-E operations, the MSR program design and operations, and the SRF.

In response to a question, Mr. Gramling indicated that MSR will enter phase B in April 2022, a fairly firm date. Asked whether the MAV will be small enough to fit on the same platform as fetch rover, Mr. Gramling said that MSR was still considering a need for two fetch rovers. The cost delta for two rovers, instead of one, is preliminary and internal at this point, and will be further defined at the KDP-B. Dr. Mainzer asked about some international aspects of MSR. Mr. Gramling said that NASA has an MOU with ESA; they are building a significant portion of the hardware, and will be providing a launch vehicle for the ERO. NASA continues to look at possibilities for other collaborations to further reduce cost, and hopes to have those answers by KDP-C (the beginning of Phase C).

Discussion/Q&A

Dr. Glaze was asked to comment about the next Discovery and New Frontiers calls. Dr. Glaze explained that the next New Frontiers call would be no later than late 2024, representing a two-year delay. NASA is looking at opportunities to pull that date forward, which are dependent on the budget planning process. The next Discovery call will be in 2023, and there, as yet, has been no discussion to change that plan. NASA is listening to the community, and trying to be responsive. Furthermore, as the New Frontiers 5 (NF-5) call will come out after the Decadal Survey is released, the Survey's Steering Committee, in recognition of this fact, stated that because of the delay, targets and destinations for NF-5 will remain the same as the previous Decadal Survey. Any changes would be aimed at NF-6. Dr. Diniega requested data on institution types, gender, and POCs, if available. Some information was later relayed by Mr. Ianson through the WebEx chat.

Dr. Diniega commented that there had been much talk about programs increasing the pipeline, and reaching out to Early Career (EC) scientists. NASA also need to be changing opportunities. She asked if NASA had more to say about encouraging people to be mentors to the EC folks. Dr. Glaze noted that the need for EC mentorship drove part of the SMD decision to expand Mentoring 365, and felt this expansion would benefit a much larger swath. Asked more about the SMD-level efforts in IDEA, Dr. Glaze said there were many activities ongoing, and agreed that several dimensions would be necessary, including an internal look at the barriers in current Agency processes and programs. Dr. Bailey added that for the PRISM-2 call, ESSIO has implemented an inclusion plan, and also has similar plans for all calls going forward. CLPS is also a wonderful opportunity to get diverse communities involved, with such projects as small 1-kg payloads to the Moon, e.g. Dr. Jennifer Glass added that IDEA is also about what the leadership looks like; this is something else to emphasize. Dr. Bailey said that NASA has encouraged the CLPS calls to follow that path as well.

R&A Program Update

Dr. Rinehart presented a status of the Research and Analysis (R&A) program, which has brought on two new civil servants, Drs. Delia Santiago-Materese and Kathleen Vander Kaaden. ROSES20 received almost 1600 proposals with 307 selections, yielding a selection rate of 19%. The average notification time for ROSES 20 was 154 days. Two programs exceeded 180 days: PDART (due to COVID delays) and LARS (due to program budget questions). Some program notifications came in under 100 days. Overall, the R&A program has received very positive reviews of the SMD Dual Anonymous Proposal Review (DAPR) experiment. Dr. Rinehart issued a reminder on ROSES21, which will be performing a no-budget experiment with DDAP, (DAPR on all DAPs), and another caveat on rules against duplicate proposals, as well as the strict enforcement of compliance.

A major topic in the transition from ROSES21 to ROSES22 is that R&A is making a major change in the Planetary Major Equipment & Facilities (PMEF) call, replacing it with the Planetary Science Enabling Facilities (PSEF) call. In ROSES22, PMEF will exist as a funding line but not as an appendix. PSEF will still be there, but "appended" requests will be handled a bit differently. In ROSES21, to date, six programs have reported out, and the Hot Operating Temperature Technology (HOTTech) program is going out on 15 November, moving along. MatISSE, ICAR, and Habitable Worlds will not be solicited this year. Regarding No Due Date (NoDD) programs, sufficient time has not yet passed to report on them; several programs just passed their anniversary date, and one, Solar System Workings (SSW), will have an anniversary date in January. Forty-five percent of all proposals under NoDD have been reviewed as of 4 November, with an average notification under 120 days, across all programs. One proposal exceeded 245 days, which was the first one submitted in February 2021. PSD is expecting the selection rates to rise a bit, because it is holding back a little money in the case that more proposals come in at a faster rate. There have been no changes in the Fiscal Year 2021 (FY21) budget. Similarly, the FY22 budget slide is reflective of the current PBR, which has yet to be approved by Congress. PBR22 has an additional $11M slated for R&A; this value will depend on the ultimate disposition of Congress.

Some changes in ROSES22 include some new calls: ANGSA2, Desert Research and Technology Studies (D-RATS), Artemis Geology Team, and the OSIRIS-REx (OREx) Sample Analysis Participating Scientist Program (PSP). PDART will not accept any proposals for development and validation of tools. The reason for this that the PDE IRB made some observations about weaknesses in how tools are funded in PSD, leading to budgetary and other implications. Thus, R&A will be omitting tools from PDART until the program can figure out how to support tools after they are developed.

Addressing an observation that submitted proposal budgets have been increasing at rates well above inflation, Dr. Rinehart noted that in the past five years, program budgets been rising to the tune of about a 6% inflation rate. Possible reasons for this are that team sizes (FTEs) are growing, and that some particular element(s) are growing very fast. SSW, for instance, has experienced 40% cost growth in 6 years. It was noted that SSW is used as an example because it is the largest program with the best statistics, but that the same trends are observed for other programs as well. Takeaways from the known data are that selections are biased neither for nor against expensive proposals; so, where is the increase coming from? Salary and indirect costs appear to be the highest individual cost components; all components are growing at 6% per year, and sub-awards are growing a little bit faster. There is no obvious reason why everything is going up at the rate of 6%. Teams are getting bigger, by about 2% on average (i.e., number of people involved). It isn't clear whether teams are asking for more full-time equivalents (FTEs). The data also doesn't necessarily include all the students because they are often not reported in NSPIRES. Salaries in SSW are going up faster than inflation (3.6% per year). Combined with the 2% per year growth in team size, this appears to be roughly equivalent to the 6% inflation rate that has been observed.

In the course of doing this analysis, Dr. Rinehart pointed out that some proposals have excessive fringe rates. When that happens, the NASA Shared Services Center (NSSC) will notice this and flag them. As a result, NASA pulls the money and puts it back into the R&A program, resulting in big delays in getting awards out. Budgets are also reduced per NSSC findings of excessive fringe. What is excessive? Inflation rates of greater than 3%; "excessive" for fringe rates is less clear and depends upon an institution's negotiated rates. Addressing PAC questions about allowable costs for data archiving, Dr. Rinehart confirmed that data archiving costs can indeed be included in a proposal, but the request would be subject to peer review. As to the question of obtaining grant funding for community service, Dr. Rinehart noted that the short answer is "no," according to laws governing allowable costs in federal grants. Anything charged to the grant has to be "allocable." The costs incurred during the course of a grant must further the funded activity. Service on review panels is specifically called out as an "unallocable" cost. Service can

be covered, however, through institutional overheads on grants, but this must be explicitly stated as part of written institutional policy.

High-risk/High-impact update
After discussion within SMD, the special blue-ribbon panel on high-risk/high-impact (HR/HI) proposals will be discontinued for now. Data collected to date have indicated that HR/HI proposals are selected at the same or higher rates than proposals in general. SMD has also established the Research Catalyst Fund (RCF), a small SMD-funding line, which will address HR/HI proposals, as well as other criteria. RCF will co-fund disciplinary research awards based on four priorities, and is not a separate solicitation.

ISFM Update
NASA has renewed its Internal Science Funding Model (ISFM) programs, and they are moving forward. The next ISFM review will be in 2023, starting with the Ames Research Center ISFM. The ISFM budget is flat, unless the R&A budget changes. The overall PSD allocation is $20.9M per year. Quad charts from all the ISFMs have been provided to PAC members as an attempt to keep the PAC informed as to their status. Dr. Rinehart sought feedback from the PAC on whether the quad charts were sufficiently detailed.

Government Performance Reporting (GPRAMA) and Science Nuggets
It was observed this year that the demographic statistics of the science highlights presented in annual GPRAMA reporting exercises tend to skew toward more male, senior, Caucasian authors. The PSD R&A program recognizes this and wants to improve the diversity of these selections, and to improve communication to diverse members of the community. This topic will be the subject of a future meeting presentation.

Role of the Analysis Groups (AGs)
In response to feedback from the PAC on the role of the AGs in advising PSD, Dr. Rinehart explained that according to FACA rules, advice to NASA must come from committees that operate under FACA rules. AGs cannot directly provide advice or findings to NASA, but the AG point of contact can bring AG comments to the PAC, which is ultimately responsible for determining how it will treat these comments, e.g., to bring them forward as observations, findings, or recommendations. The PAC must discuss such comments in a public meeting to bring them forward as recommendations or findings.

Questions on Future of Data Analysis Programs
Dr. Rinehart brought up a point for discussion, first cautioning that the question reflected no intent to make any major changes. Over time, many DAPs acquire eligible missions, it might be useful to determine some sort of cut-off point for retiring a mission from DAP eligibility. What might this point be? *X* years after the end of a mission? When proposal pressure drops? Would having a single DAP make sense, much like the successful Astrophysics DAP in the Astrophysics Division of SMD?

Dr. Joseph Westlake commented that a single DAP may suffer logistical issues when it is review time, in terms of formulating a consolidated review panel with sufficient breadth of expertise. Dr. Rinehart said he thought of the question more in terms of whether a single DAP might be worthwhile from a science perspective, in the long term. Missions might be very different, but the science might be related across some of them. And the DAPs are small compared to the whole of the Solar Systems Working (SSW) program. Dr. Walter Kiefer noted that one issue is that some people write proposals to multiple DAPs; this could end up being an issue for proposers on soft money, who would then need to write multiple proposals.

Dual-Anonymous Peer Review (DAPR) Update

Dr. Delia Santiago-Materese, Planetary Lead for Dual-Anonymous Peer Review (DAPR), provided an update on the dual-anonymous review process, first relating the rationale for adapting the DAPR model, wherein reviewers do not know the identity of the proposers in the scientific portion of the review. Double-blinded, dual-anonymous reviews are a demonstrated way to mitigate implicit bias, and have been used in a number of disciplines. The Hubble Telescope time allocation study using the DAPR approach, which subsequently demonstrated equalization in male/female ratios, provided the motivation for some SMD-wide DAPR programs. Gender is only a part of the issue, however; the goal is to level the playing field for everyone by directing the discussion away from the individuals on the proposing teams, to focus on the science itself. There is detailed guidance on the process included in NSPIRES documentation, and on the DAPR web page: [[https://science.nasa.gov/researchers/dual-anonymous-peer-review]]. A Town Hall on the PSD DAPR kickoff, held in October 2020, also contributed to educating the community on the subject. The ROSES20 Habitable Worlds (HW), ROSES21 Exoplanet Research Program, and ROSES21 Cassini Data Analysis Program DAPR calls have been completed. Collected metrics have shown that these DAPR programs reported excellent compliance, a positive experience reported by reviewers, a focus on science, and a reduction of gender gap. Most PSD DAPR proposals were in compliance with DAPR requirements, and fewer than 2% of proposals were declined without review for egregious non-compliance. Common pitfalls seen in recent proposals: claiming ownership of past work, including metadata; providing names of investigators on contents pages; mentioning the institution name in the Budget Narrative; and failure to follow reference numbering scheme. Reviewer feedback indicated that the vast majority of participants agreed that the DAPR procedure improved the overall quality of the review, and a majority of reviewers felt that DAPR should be implemented in future. The statement, "The "Expertise and Resources - Not Anonymized Document reveal step was necessary for me to verify that the proposing team had the necessary capabilities to execute the proposed investigation," however, showed a roughly 50/50 split in agreement/disagreement. There was overwhelming agreement that the DAPR process focused on science rather than team members.

It is important to note that the pilot program, HW, and the successor DAPR programs, were chosen for programmatic reasons, and not because of demonstrated gender gaps. There are other areas where DAPR might be used to address implicit bias, such as with first-time PIs, and institutions, which will be examined in the future. Dr. Santiago-Materese briefly displayed recent DAPR results in the Astrophysics Division, and all PSD programs to date. All PSD DAPR programs to date are not hugely different, and will need to be looked at over several years.

Discussion

Dr. Kiefer said, particularly in trying to eliminate gender gap, that statistically, women and men had equivalent rates (in the presented material) and it might be hard to improve an already equivalent rate. Dr. Santiago-Materese said that APD's program did show some discrepancies in selections, which is why the "iceberg" metaphor is used. Dr. Mainzer asked how constructive feedback might be made to the PIs in DAPR. Dr. Santiago-Materese said that the current process doesn't address it, but that there has been discussion of making the "reveal" step visible to everyone.

Dr. Diniega said that gender is only one aspect, but certainly Early Career is an important one, which can also be tied to gender. Dr. Santiago-Materese noted that the Hubble DAPR study did report an increase in first proposers. Dr. Rinehart added that the same study showed also that smaller institutions fared better.

Dr. Mainzer noted that there had been much commentary in the meeting chat on compensation for community service, which is a tangled issue. Dr. Rinehart said that there are historical reasons for government-wide restrictions on grant usage, which are rooted in abuse. FACA is law, and could only be changed through Congressional action. Dr. Mainzer asked if there was an opportunity for flexibility on compensation through institutional overhead rules. Dr. Rinehart said that if serving on reviews is the

single most important thing, in terms of the compensation issue, then NASA could talk with the legal officers on the matter. Dr. Diniega suggested that there might be an opportunity to receive compensation for serving on Decadal Survey panels, writing white papers, or serving on AGs. Dr. Rinehart noted that the Decadal Survey is governed by the National Academies and beyond NASA's bounds, but that there might be room for discussion with the NASEM in the future. Dr. Mainzer asked if PIs could request, within a NASA grant, a sum to cover compensation for service on review panels. Dr. Rinehart said that NASA cannot give PIs money to do something under a grant. The Agency can't require anything under these auspices, other than an annual report. This could do be done in a contract situation, however. Dr. Diniega asked: are there other ways to support the community? Perhaps through a Flagship IDEA program at NASA, for example? Dr. Rinehart commented that there is likely a solution somewhere in "the weeds", but that it is difficult to figure out where it is. Would the community accept a 10% decrease in selection rate across the board in order to compensate service? NASA did recently increase the honorarium, in response to complaints that it is too small. If the community is willing to accept lower selection rates in R&A, PSD can do something about it.

Dr. Kiefer commented that the community wants inclusiveness, but a lot of science is not getting funded: how do we balance these needs? Dr. Mainzer asked if NASA would support a request to increase the R&A line to support this sort of thing. Dr. Glaze said that NASA is always trying to increase the R&A funding line, and has tried different approaches. She expected that the upcoming Decadal Survey will address the issue, too. The challenge is that even within SMD, the PBR has to fit in a certain box according to the Administration's agenda. Dr. Glaze said she liked the idea of the Flagship IDEA program, and it might be helpful as NASA thinks about the next budget request. The current administration has been supportive of IDEA, and inclusion has been made part of the facilities calls. Dr. Glaze welcomed suggestions for additional new initiatives. Dr. Mainzer said that selection pressure is just getting worse, while R&A is not keeping the pace with the rest of the budget. Is there a way the community can make a case to the Office of Management and Budget (OMB)? Dr. Glaze said that the argument that higher selection rates can support a healthier community is not proving effective. It will take a stronger or better argument. Dr. Rinehart added that the R&A program has in fact grown substantially over the last decade, but just not as fast as the total budget for PSD. Everyone also must recognize that IDEA is not free. Congress disposes these allocations. The only place NASA has discretion is in R&A. IDEA is not free, and the place it will be paid for is in R&A. Dr. Diniega observed that IDEA might affect selection rates, but it benefits the community in other ways.

Planetary Defense Coordination Office (PDCO)

Mr. Lindley Johnson gave an update on the Planetary Defense Coordination Office (PDCO). There are new signatories to the International Asteroid Warning Network, and many observations have been coming to the Minor Planet Center (MPC) from international partners. Near-Earth Asteroid (NEAs) discoveries to date stand at 27,487; the potentially hazardous asteroids (PHA) count stands at 2229, 160 of which are one kilometer or larger, and come within 5 million miles of Earth's orbit. Yearly discovery rates are flattening: 2959 in 2020, and 2752 so far in 2021, with 6 weeks to go until 2022. Over the last few years, the biggest contributor has been the Pan-STARRS-2 telescope. However, for 140m+ size asteroids, PDCO is still finding only about 500 per year. This year, 421 have been discovered. Discovery rates taper off as the number of observing facilities remain the same.

DART is one week away from launch. While there is no known asteroid that poses an actual impact risk to Earth at present, the impact hazard from asteroids is not known, as it is estimated that 60% of the asteroid population is yet to be discovered. The launch window for DART is from 24 November to 15 February 2022; the launch is scheduled to take place from Vandenberg SFB on a SpaceX Falcon 9 launch vehicle. DART will reach the Didymos/Dimorphos system in late September/early October 2022. DART will impact the Dimorphos moonlet at about 15,000 mph, as well as drop off an Italian space agency cubesat (LICIA) that will image the ejecta, and possibly the resultant crater. The asteroid system has been

under observation since 1996; its orbit is very well understood, and very well-characterized for testing. DART will impact the system when it is 6.5 million miles away, making it easily observable from ground-based systems on Earth. DART's Level 1 requirements are to impact Dimorphos; cause at least a greater than 73-second change in the orbital period of Dimorphos; measure from ground-based observatories the period change to within 10% (7.3 seconds); measure the beta factor (momentum enhancement factor) of the impact; and characterize the impact site and dynamics. Based on ground observations, Didymos is known to be roughly a half-mile in size, and Dimorphos is estimated to be about 163 meters. Dimorphos orbits about one kilometer above the surface of Didymos. Ground operations will assess changes in the light curve to assess any changes in period caused by the impact.

Observatories set to observe the impact include the Lowell Discovery Telescope in Arizona, Palomar (California), Keck (Hawaii), and the Galileo National Telescope (Spain). The DART spacecraft itself is about 670 kg, 2.6m by 2m, with a high-gain antenna and roll-out solar arrays (a version of which is currently operational on ISS). The arrays are designed to be very compact and lightweight for launch. The spacecraft is powered by NEXT-C, an ion thruster engine. Very little is known about the object the impactor will hit, although there is a radar-based approximation of the shape of Didymos. The secondary body, Dimorphos, is known only from light curves. The target will become observable at 24,000 kilometers' distance. The last four hours of approach will be autonomously controlled by the spacecraft. DART is meeting its milestones in the launch schedule, and is expected to launch on schedule.

Astrobiology Update

Dr. Mary Voytek gave an update on the Astrobiology Program, including four research coordination networks: NExSS, investigating the diversity of exoplanets and how their history, geology, and climate interact to create the conditions for life; Ocean Worlds (Habitable Worlds), investigating the diversity of other worlds in the solar system to learn how their history, geology, and climate interact to create the conditions for life; NfoLD, investigating life detection research, including biosignature creation and preservation, as well as related technology development; Prebiotic Chemistry and Early Earth Environments, investigating chemical processes under the conditions on the Early Earth and the formation of basic proto/biological molecules and pathways, leading to the emergence of systems harboring the potential for life. A new RCN, From Early Cells to Multicellularity, has just been set up to investigate the earliest biological processes and the evolution of life on Earth into more complex organisms up to the advent of multicellularity. This new RCN has selected co-leads and NASA Headquarters (HQ) liaisons, and is now writing up a charter to include goals and definitions. RCNs have an internal review after three years of operation, and an external review every five years. In 2022, PSD will review NExSS, in a Senior Review process, to determine measures of success such as demonstration of technology transfer between research areas and disciplines; production of a plan for utilization of current mission data and spawning ideas for new and exciting missions (if applicable); exhibiting influence on Decadal Surveys for all SMD Divisions; enhancement of international engagement; and supporting development of the early Astrobiology community.

Astrobiology currently has 14 active NASA Postdoctoral Program (NPP) Fellows, and two Postdoctoral Management (NPMP) Fellows. The last NPP call was suspended by COVID; next applications will begin to be accepted starting on 1 March 2022. The Astrobiology Graduate Conference (AbGradCon) 2021 was held virtually this year, and used Gather Town to support virtual presentations. Participants totaled 114, with much greater global (virtual) participation than in person. This year, NASA is going to hold the Astrobiology Science Conference (AbSciCon) in Atlanta, 15–20 May 2022: the theme will be Origins and Exploration from Stars to Cells.

Dr. Victoria Meadows reported on results of the July 2021 Biosignature Standards of Evidence Workshop. The need for biosignature standards of evidence is an urgent subject, given that there are sample return programs under way, from Mars and other bodies in the Solar System. Life detection is a

high-stakes scientific achievement that will attract high public interest. The community decided that there needed to be communication of the multi-step continuous process for detecting life, and sought to develop a generalized, progressive framework to accomplish this.

Dr. Heather Graham described the demographics of the workshop attendees: there were 125 discussion participants (95 from US/Canada/Mexico, 15 Asia/Pacific, 15 European). It was noted that many potential participants had indicated they could not commit to an entire week of discussion, thus the workshop included an asynchronous track that attracted 215 people. The workshop enjoyed great engagement, and did not experience an anticipated 20% drop-off. After the workshop, 60% of the attendees (74 people) elected to continue as the white paper writing team. Each section held weekly discussions and co-writing meetings for two months. The white paper was made available for public comment on 18 October; the comment period closes on 18 November.

Dr. Meadows detailed the Biosignature Assessment Framework:

Question 1: Have you detected an authentic signal?
Question 2: Have you adequately identified the signal?
Question 3: Are there abiotic sources for your detection?
Question 4: Is it likely that life would produce this expression in this environment?
Question 5: Are there independent lines of evidence to support a biological (or non-biological) explanation?

Dr. Graham described workshop examples used to develop a general biosignature assessment framework: using stromatolites as an authentic signal, the Early Earth Group considered field mapping as an approach, from initial discovery to adequately identifying the signal, while considering abiotic sources, environmental context, and independent lines of evidence. The other three groups examined *in-situ* detection of kerogens; detection of oxygen on an exoplanet; assemblage of organic chemicals (chirality, isotopes, etc.). Participants focused on actions the scientific community can adopt towards a biosignature reporting protocol, recognizing that a wider discussion will require input from stakeholders in the publication and communication fields.

Participants identified three high-priority areas of future research and community discussion:

- Develop more "worked examples" to generate a more detailed set of criteria that can serve as field-specific guidelines for biosignature assessment
- Hold collaborative discussions between biosignature scientists and data scientists to develop statistical methodologies that incorporate the step-wise error and uncertainty to build a more quantitative biosignature "confidence" scale and support hypothesis testing
- Carry out further work to incorporate the Framework with community data products and databases, including a Life Detection Knowledge Base, to inform users of the utility of specific life detection measurements in mission concept development

It will be important to pursue focused discussions on developing a reporting protocol that includes publishers, journalists, and science communicators to understand and address obstacles and incentives in those communities that relate to our scientific and communication goals.

Discussion
Dr. Diniega asked if there were any intention to document the workshop process, especially given the virtual format; it is important to understand new ways of doing meetings, and incorporating Lessons Learned. Dr. Meadows said the process had been documented and presented to the Committee on Astrobiology and Planetary Science (CAPS), and offered to send copies to the PAC.

Dr. Mainzer asked Mr. Johnson to describe what happens right after launch of DART. Mr. Johnson said that after the rollout of the solar arrays, the top cover comes off the engine, after which the cover of DRACO instrument is opened. These things happen fairly quickly after launch, followed by several tests and calibration. DART will be doing testing of the engine in the June timeframe, and the terminal approach to the asteroid system starts in September 2022.

Dr. Mainzer asked: What is a crisp, strong definition of life detection, and how do we infuse this into the rest of NASA, such as MSR? Dr. Meadows said the workshop includes a definition section in the applications section, and provides examples in the context of the framework. Dr. Graham added that one of the co-writers of that section had some *in situ* experience, and addressed ancillary data that can support evidence (context is everything); every piece of data is valuable in this instance, especially to understand abiotic sources of signal. Dr. Meadows said there was also discussion of embedding this crisp definition in the science traceability matrix, early on. Dr. Voytek commented that her biggest job at NASA was managing expectations; thus far Astrobiology has not been doing a very good job of making these life hunters feel acknowledged, and excited about using the framework to communicate what NASA has already accomplished in the path to life detection. Bringing along the taxpayers is important. Dr. Mainzer asked if these biosignature definitions would get folded into future missions. Dr. Meadows said that the exoplanet community is very aware of data surrounding false-positives, and is definitely seeing this as valuable.

Question to Dr. Voytek: how are the RCNs reviewed? Dr. Voytek explained that when the RCNs were established, the groups adopted their own charters, goals and metrics of success. The three-year review is a self-assessment, wherein the RCN is asked to put a report together reporting on their metrics, and discuss their future plans over the next two to three years. The external review brings two chairs into the process; in the case of NExSS, one will be from PSD and one from APD.

Dr. Diniega asked for an update on the I-MIM iMDT timeline, and whether a public release of the report is planned. Mr. Ianson said that meetings will be kicking off very soon, with reports expected in early 2022. The report deadline is 31 March, with an interim report about midway through. It is not expected that there will be any lengthy period of exclusivity. It might be a little tough to get to the March date, because it took a long time to get the selection done. Asked about timing for MSR, and implications of a reporting schedule slip, Dr. Glaze noted that the team is going through many trade studies right now, and the fact that phase B is shifting to the right does not mean everything else is shifting as well. The community will need to wait and see how the process plays out.

Dr. Mainzer raised a question regarding NASA's new open data policy, and whether publication of code will be a new requirement of the policy. Dr. Glaze reminded the PAC that the draft policy is out for comment. Dr. Rinehart added that the open data policy is a reflection of all the rules that are placed on NASA externally. All software funded by NASA is to be made publicly available, for instance. Dr. Rinehart took an action to provide the link to the comment section. (A NASA solicitation, number NNH22ZDA006L, was released on November 19, after this PAC meeting; the solicitation is a Request for Information regarding the data release policy and can be found on the NSPIRES website.)

Dr. Mainzer shared a concern, aired in the Science Committee, that the open data policy might become an unfunded mandate, resulting in responsibility for technical support infinitely. The concept of a "sharing economy" makes people nervous. Dr. Glaze said that NASA has discussed the issue internally at length, which is why it is still critical to get feedback from the community. The impetus behind open data and open science are based upon recommendations from the National Academies. NASA recognizes there will be costs, and needs to understand what they are. The train is moving forward, so the community

needs to prepare, and also needs to determine: What is defined as code? What kind of tech support will be needed?

Dr. Mainzer opened the discussion for potential findings. Dr. Diniega suggested findings on the DAP programs, and ISFM. Dr. Hope Ishii said that she was surprised that NASA doesn't seem to have a handle on how much FTE is being paid for. Dr. Rinehart said that the Table of Effort could be moved to NSPIRES, for visibility's sake, if the community feels it is important. He agreed that the DAP issue can definitely be targeted for longer-term discussion. Dr. Glass said she had been impressed with the movement toward diversity on the Mars organizational charts, and the lunar organizations would do well to follow suit. Dr. Hurley noted a lack of diversity in the EC awards, and asked what the applicant pool looked like. Dr. Rinehart said that NASA is not permitted to use diversity as selection factor; the EC awardees were all women this year because they scored really well. There is no information other than inferred gender; he thought the applicant pool was about 50-50 in terms of gender. Dr. Danielson commented on proposal compliance, and asked if it were possible to kick out continuously and egregiously non-compliant proposals that panel members have seen more than once, before they even get to the panel. Dr. Rinehart completely agreed with this sentiment, adding that Program Officers have scripts that look for the most common compliance problems; R&A attempts to catch these ahead of time. A few sneak through, but not many. If R&A starts telling people they will get rejected for non-compliance, they'll be more careful. Dr. Danielson asked if it were permissible to bring egregious compliance issues to the Program Officer (PO). Dr. Rinehart said yes, and that the Program Officer can make the decision to end review of such proposals before they go to panel; but once the proposal has gone to the panel, it is felt that the comments from reviewers should be sent on to the proposer.

Dr. Mainzer suggested a finding on the role of service work, accompanied by a list of all the different categories of service, and how each one can be addressed in terms of compensation solutions. The PAC agreed to formulate a finding.

Dr. Diniega commented that the while the PRISM call now has an inclusivity section, she was concerned that people don't know what it means and how to do it. Has there been any move at NASA to provide guidelines, or workshops, to explain how this is done? Dr. Rinehart said that APD had done this with the Theory program last year, and is still analyzing the results. Generally, scientists don't know how to write these or judge these proposals in terms of inclusivity. APD brought in SMEs to help the process along, and came to same conclusion. The PRISM folks are trying it. Once APD finishes their analysis, they will bring it forward and develop a plan to improve it. There should be more concrete guidance by Summer. Dr. Rinehart said he would plan to get the APD outcomes on the slate.

Dr. Mainzer raised the issue of the DAPs, and referenced a Galileo paper. She asked if it might be worthwhile to expand the DAPs to accommodate more missions, given there might be fewer opportunities to propose. Dr. Rinehart reiterated that the goal of the DAPs is to help NASA maximize return on the missions, and that he was seeking feedback on whether the community felt that there comes a point to retire specific DAPs, for specific reasons. Dr. Glaze agreed that there is a point where the DAP data becomes part of the entire NASA archive, in the core programs. Dr. Kiefer supported employing a "*n*" number of years approach. Dr. Diniega suggested tying retirement to dropping proposal rates. Dr. Glaze suggested retiring a DAP as the number of publications starts to reach an asymptote. Dr. Ishii pointed out that sometimes a mission comes out that reinvigorates an old set of data. Dr. Rinehart said that, technically speaking, the latter case is already covered by the DAP guidelines. Connecting backwards is okay. Dr. Rinehart can have an internal discussion about the metrics and bring them back to PAC for discussion.

Dr. Mainzer proposed a finding on diversity in lunar leadership. Dr. Glass agreed that it was important to get the diversity to the upper levels in the lunar organizational chart. Dr. Glaze noted that there were few

opportunities to change ESSIO, as it is a very small office. Dr. Glass said she had been thinking more of the role models. Is there really no one who looks like them? Dr. Diniega suggested making a broader finding, beyond lunar, pipeline, etc., and added that the lunar program needed better advertising for the major calls.

November 16, 2021

Welcome
Dr. Rinehart re-opened the meeting.

Analysis Group Reports

Mars Exploration Analysis Group (MEPAG)
Dr. Aileen Yingst, MEPAG Chair, presented a status on the Mars Exploration Analysis Group (MEPAG), beginning with details of the AG's purpose and functions for the benefit of new members. MEPAG at present is actively seeking to fill an open position, and also has four goals committees. Dr. Yingst invited the community to get involved, and reminded everyone what a wonderful place space exploration is in, having just celebrated the 20th anniversary of Mars Odyssey this year. It is not just a matter of the sheer number of missions, but also the carefully considered long-term investment in the exploration of Mars. Overall the progressive arc is extraordinarily positive, thanks to the community at large, including scientists, administrators, and the public.

Active findings for the MEPAG:
MEPAG continues to request a more comprehensive rationale for I-MIM. There appears to be confusion about the rules of engagement, which has concerned the Mars science community. MEPAG recognizes that it makes sense that I-MIM is attractive to the Agency, and that radar does address some science questions re: ice, and is low-cost. There is a debate, however, as to whether the proposed radar can address science objectives for ice. If the mission is not scientifically adequate, the community does not stand a good chance of doing it again. It is also not clear whether I-MIM truly serves the purposes of human exploration. In addition, the domestic science community does not know how to plug into the international effort. Finally, SMD should not be held responsible for a failed mission. If the line item in the budget goes away, and I-MIM is too big to fail, who pays for it? MEPAG fully supports the newly formed Measurement Definition Team (MDT), and is waiting to see whether it can exercise its charter.

MEPAG also has a concern about the arc of future Mars missions, in that there are other ways to achieve compelling science, in addition to the science goals of MSR. MEPAG notes that there are other possible mission arcs in the Mars Architecture Systems Working Group (MASWG) report, and the Low-Cost Mars Science Mission Concepts Workshop. Overall, MEPAG is very grateful that NASA SMD has been openly engaged with the community in discussing these subjects.

Lastly, MEPAG continues to hold a finding on how to best assist the Mars program in preparing for human exploration, and proposes that MEPAG assist SMD/MEP in making the best use of the science mission data most likely to aid ESD. Mars Ice Mapper could be one of those missions, and MEPAG awaits the iMDT recommendations. MEPAG will continue to update its Goal IV (Preparations for Humans) developed with HEO. It is important for MEPAG community to take the longer view and to start to discuss the science that can be done on Mars.

Venus Exploration Analysis Group (VEXAG)

Dr. Darby Dyar, VEXAG Chair, presented an update, noting that Dr. Noam Izenberg would be taking over as Chair in May 2022. The Steering Committee has 17 members (plus one *ex officio*), including some Early Careers; two people rotate on and off every six months. VEXAG is seeking self-nominations for the Steering Committee, and is also selecting a new Deputy Chair, after which VEXAG will maintain a six-year succession plan for selecting new Chairs and Deputy Chairs, to maintain continuity and longevity.

Back in 2018, VEXAG had ambitious goals to build a Venus program by engaging the community, and improving communications, which have met with success. Keeping up proposal pressure eventually yielded the VERITAS mission (2029), DAVINCI, and ESA's EnVision selections. The community is excited about the science, and still hopes to send a surface lander to Venus through the New Frontiers program. The community has seen increased interest in Venus, therefore VEXAG is undertaking activities to anticipate this by developing a planning document. VEXAG uses its Science and Assessment Workgroups (SAWs) to provide a very fluid, nice structure to help VEXAG focus on its goals. SAW 1 produced the planning document, which is posted on the VEXAG website. SAW 2 undertook the planning for VEXAG's 2021 meeting, which had over 400 participants, and is now in the planning stages for VEXAG's November 2022 meeting. SAW 3 is overseeing planning and coordinating with the second biannual Exoplanets in Our Backyard meeting. SAW 4 is focused on Venus flyby opportunities and exploration targets, with NASA and other space agencies. SAW 5 is a mill that churns out science nuggets, and the AG now has a template for composing science nuggets, to ensure that they get to SMD Associate Administrator. SAW 6 produced a Venus Surface Platform Study, now complete and online. SAW 7 covers Exploration and Instrument Technology. SAW 8 supports a "Second planet, second Tuesday" event, a successful seminar series that is open to the general public. SAW 9 is trying to attract younger people to help VEXAG with its social media presence. SAW 10 focused on developing a VEXAG website, developed by Dr. Tommy Thompson, who passed away suddenly this Fall, leaving the website as his legacy. SAW 11 is focused on IDEA. VEXAG has also adopted codes of conduct on IDEA, largely from MEPAG, with an eye to having consistency among the AGs. SAW 12 is focused on aerial platforms. Dr. Dyar concluded by stating that it is a great time to be a Venus scientist.

Extraterrestrial Materials Analysis Group (ExMAG)

Dr. Barbara Cohen, ExMAG Chair, gave some background of how ExMAG had been evolved from the Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM), and how ExMAG is now building its own community and getting members involved in the AG process. Dr. Cohen reviewed the membership, and noted that the AG is going to put out a call for new members soon, as it better defines roles. Currently ExMAG is bringing on co-chairs and forming subcommittees (lunar samples, Mars samples, microparticles, asteroids, meteorites, Genesis). She noted that Dr. Ishii, formerly vice Chair of ExMAG, now sits on the PAC. ExMAG is still looking at best practices on how to incorporate Early Career scientists, beyond mere secretary roles. The Lunar Subcommittee is looking at best practices for dealing with additional Luna samples. The Meteorite Subcommittee met with the National Science Foundation (NSF) and Antarctic Search for Meteorites (ANSMET) to understand when activities will resume in Antarctica; the Mars Subcommittee is setting up joint activities with MEPAG related to MSR planning; the Facilities and Informatics Subcommittee is being reconstituted; and the Asteroid Subcommittee will be examining plans for OSIRIS-REx.

The ExMAG held two meetings in 2021, as well as a Town Hall meeting, and is continuing to plan for its Spring meeting, while trying not to hold it too close to the Lunar and Planetary Science Conference (LPSC). ExMAG held its Fall meeting in mid-October, focused on NASA Headquarters and mission updates, and acquisition and handling technologies. 150 to 170 participants were online at any given time; the meeting used an anonymous Q&A format to encourage questions. The ExMAG fall meeting produced no output that rose to the level of findings. Dr. Cohen reiterated a Spring ExMAG finding on Chang'e 5: ExMAG encourages NASA to explore a path to permit sample exchange, and reciprocal loans between

NASA and the Chinese Space Agency (CNSA) for Chang'e 5 and Apollo samples. The community has been getting mixed signals from NASA on what exactly will be possible in this arena.

Small Bodies Assessment Group (SBAG)
Dr. Bonnie Buratti, SBAG Chair, presented. She noted that the SBAG has had a lot of turnover during the last year, and now has a new Technology Lead, and a new Early Career secretary with a 2.5-year term. The Steering Committee selects the Chair, and has a number of other leads. SBAG holds two open meetings per year, with the next one scheduled for January 2022. SBAG holds a lot of Early Career talks, which are competitively selected; it also holds lightning talks, and "open mic" activities. The SBAG is also starting an Early Career mentoring program. In addition, the Committee on Planetary Protection (CoPP), a discipline committee of the Space Studies Board of the National Academy of Sciences, has requested SBAG's perspective on contamination of small bodies, for which it is now gathering information.

Dr. Buratti highlighted an SBAG finding emphasizing the science recovery from the Arecibo observatory, which is also important to Planetary Defense. Small body radar updates included report from Goldstone, currently under refurbishment, which observed 35 NEAs in 2021, and Canberra, which observed 6 NEAs in 2021. Goldstone is not at the level of Arecibo for new discoveries, but it is able to provide imagery, and a good estimate of diameter, such as in the case of asteroid 2016 AJ193. SBAG also issued a finding on the establishment of an SDT for studying the close encounter of Apophis in 2029, as it is important to both science and Planetary Defense, and will require access to ground-based facilities for observation. SBAG has stood up a 99942 Apophis Specific Action Team (SAT). The team is almost put together, and is expected to report out in August 2022. Dr. Buratti noted that her presentation included some backup slides on SBAG's suggested improvements to current radar capabilities.

Outer Planets Assessment Group (OPAG)
Dr. Linda Spilker, OPAG Co-chair, presented an update, and reviewed the membership of the Steering Committee (SC), which has three new members. The SC will be rotating off three to four members in the Spring. OPAG meets twice a year, and is planning a hybrid meeting in the Spring on the subject of Outer Planets and "joint custody" of Pluto. OPAG most recently met in August of this year, and is currently planning for two Town Halls, and its Spring meeting date. Dr. Spilker focused on three findings for PAC advocacy. First, the status of the Radioisotope Power System (RPS) development and production is really essential to the outer reaches of the Solar System. RPS enables exploration, thus OPAG is asking NASA to provide details on how many units are being prepared, and an associated timeline. OPAG further encourages that NASA commit to a timely development of higher power, next-generation radioisotope thermal generators to support missions beyond the 2030s; this will require planning. Secondly, OPAG, urges NASA to continue to exclude Launch Vehicle and phase E costs from AOs in Discovery and New Frontiers. Third, OPAG is concerned that the schedule for future Discovery and New Frontier AOs is too compressed, as the calls are less than one year apart. The finding requests that NASA incur no further delays, and to have an New Frontiers 5 draft as soon as possible, to help the community understand the cost cap and other details, to enable high-quality proposals.

Exoplanet Analysis Group (ExoPAG)
Dr. Michael Meyer, Chair of the ExoPAG Executive Committee, presented, first reviewing the composition of the Executive Committee, and noting that its membership spans the Astrophysics, Planetary, Heliophysics, and Earth Science Divisions. ExoPAG is also cognizant of diversity, which is an ongoing challenge, and which it seeks to improve in the future. ExoPAG activities since June 2021 include: reporting out to NExSS, and co-proposing a cross-PAG Study Assessment Group (SAG) to assess the barriers to representation in APD. Recently, ExoPAG participated in making APD more visible at the Society for Advancement of Chicanos/Hispanics & Native Americans in Science (SACNAS) and National Society for Black Physicists (NSBP), by planning sessions proposed at these meetings. ExoPAG

is also trying to study technology gaps and new developments in the NASA Open Science policy, as well as reviewing science gaps associated with technology gaps. ExoPAG has identified a list of 14 science gaps relevant to the strategic goals of the program, available at [[https://exoplanets.nasa.gov/exep/science-overview/]]. ExoPAG concerns include oversubscription to the James Webb Space Telescope (JWST) Cycle 1 funding, by a large factor, and the low selection rates in the Exoplanets Research Program (XRP). The community is planning to hold the ExoPAG25 meeting in Salt Lake City with AAS, where remote participation will also be supported. A number of Science Interest Groups (SIGs) and SAGs are in process, such as SIG2, on exoplanet demographics; and SIG3, on Exoplanet–Solar System Synergies. SAG proposals under consideration include a new exozodi SAG, based on the results from the LBTI HOSTS survey, new results from ALMA, recent high-contrast imaging of debris disks in reflected light, studies of dust in the Solar system (and beyond), and archival results from Spitzer/Herschel. A draft agenda for ExoPAG 25 includes discussion of the Astrophysics 2020 Decadal Survey Report, as well as JWST and Roman Space Telescope exoplanet science opportunities. There will be reporting out of SIG-2, as well as SAG22 on the properties of exoplanet host stars. ExoPAG25 will also feature presentations by junior scientists, as well as an update on Exoplanet Explorers (also involving junior scientists, paired with mentors).

Mercury Exploration Analysis Group (MExAG)

Dr. Steven Hauck, Chair of the MExAG, reported that the still-nascent AG is in the process of organizing itself and developing a Goals document. There are 11 members on the Steering Committee; one member will be rotating off soon to take on a role at NASA Headquarters, therefore the AG will be searching for new member. The MExAG kicked off its Goals document exercise at its first annual meeting in 2020; the first set of science goals has been drafted and is now being circulated. The next task will be developing Community and Technology goals. The MExAG process is focused at present on science, technology, and community, associated with interdisciplinary themes of below surface, at surface, and above the surface at Mercury. The document is high-level at present, and the next steps are to flesh them out before MExAG can tackle Technology goals. There are currently four draft science goals: Goal 1 is to understand the formation of Mercury, with 3 associated science objectives. Goal 2 is to characterize Mercury's evolution since formation, with 5 objectives. Goal 3 is to investigate processes currently ongoing at Mercury, with 3 objectives. Goal 4 is to establish Mercury's context in our solar system and others, with 3 objectives.

Additional MExAG activities include the release of a MExAG Quarterly Newsletter; responding to a request from NASA to gather community input on Mercury datasets in need of preservation and/or restoration; facilitating Mercury session at the American Geophysical Union (AGU); and planning the annual MExAG meeting in February 2022. MExAG's most recent findings are ongoing, and include requests to see more cross-divisional mission support, as well as more ground-based observation support. Dr. Hauck referred the PAC to the full text in the presentation slide package. Science highlights: BepiColombo made its first flyby at Mercury in October, and its PHEBUS instrument made initial measurements of calcium and hydrogen during the close approach; the community is looking forward to more data. The next BepiColombo flyby will be on 23 June 2022.

Mapping and Planetary Spatial Infrastructure Team (MAPSIT)

Dr. Julie Stopar, Vice Chair for MAPSIT, detailed how MAPSIT oversees the accumulation of Solar-System-wide planetary spatial data, which is not body-specific. MAPSIT encourages the creation of initiatives to ensure that planetary spatial data are correctly obtained and processed, and are discoverable and usable for a wide range of research and exploration purposes. The Team's main goals are to address accuracy, usability and access, and to maximize science output to spatial data. MAPSIT has had some additions and retirements on its Steering Committee, and is looking for a new IDEA member.

Dr. Stopar presented current findings:

- Live website version of knowledge inventory of foundational data products in planetary science (Laura and Beyer, 2021) at [[https://fdp.astrogeology.usgs.gov/ and https://github.com/USGSAstrogeology/FoundationalDataProducts]]. MAPSIT supports this community effort.
- Knowledge Inventory: PSD Call for community-identified datasets of priority for restoration or preservation. MAPSIT supports and encourages community efforts to identify critical data products and foundational products for each community.

Dr. Stopar encouraged thoughts from the PAC on the second finding.

Another recent MAPSIT activity was participation in the Lunar Critical Data Products (LCDP)-SAT report, where MAPSIT addressed six tasks. The final report documents are on MAPSIT's website. Commenting on the LCDP report, MAPSIT feels that some findings of this report can broadly apply to other programs, such as the importance of making data interoperable to maximize their utility, and having set standards and best practices documented early. MAPSIT issued a finding on 2020 PMSR issues with regard to data standards, i.e., current missions are required to deliver data in PDS4 format, and it has been estimated that it would take >$1M to convert the existing HIRISE PDS3 archive to PDS4. MAPSIT is requesting a little more feedback on how to handle overguide options, or requests for PDS funding. MAPSIT also made a finding on SPD-41, NASA's Data Policy document: this is in accordance with current best practices and aligns with FAIR data principals (i.e., to make data Findable, Accessible, Interoperate, and Reusable). MAPSIT's further comment on SPD-41 is that PMSR teams could use further clarification of PSD/SMD priorities for data and how to prioritize PDS3 to PDS4 conversion costs, particularly for lower-order data products that are not widely used.

Lunar Exploration Analysis Group (LEAG)

Dr. Amy Fagan, LEAG Chair, presented brief updates. LEAG had its annual meeting in late August and formulated 17 findings across three themes, all of which are posted on the LEAG website, and are also on backup slides. LEAG's three main themes are Artemis, the Strategic Lunar Exploration Plan, and supporting and utilizing the lunar science and exploration community. LEAG has a new at-large member, Dr. Hannah Sargeant, as well as a new SAT, Continuous Lunar Orbital Capabilities (CLOC)SAT, the purpose of which is to identify investigations and measurements to be completed by one or more lunar orbiters (before LRO reaches end-of-mission).

LEAG issued a finding on the need for a "big-picture" plan for the Moon, and requests that the PAC recommend the development of a broad lunar science and exploration with clear hierarchy and authority, including advocating for PSD to have authority to develop science requirements for Artemis. One specific concern is that there are potential conflicts with CLPS and science missions; there is no LDEP Director in PSD to push forward high science priorities to ESSIO). How will sample science be supported with Artemis? A recent Office of the Inspector General (OIG) report expresses similar concerns. LEAG also requests that PAC recommend the creation of a CLPS evolution plan (akin to a roadmap) to prevent potential delays in achieving some scientific objectives. In addition, LEAG would like the PAC to advocate for more integrated, continuous, and broader community participation with Artemis Science. LEAG feels that PRISM offers significant technology opportunities, and requests that PAC advocate for more integrated, continuous, and broader community participation with Artemis Science. Finally, LEAG issued a follow-up request for clarification on CAN vehicles for some Flight programs.

Discussion

Dr. Mainzer commented that ensuring Artemis science remain a part of the mission is a fundamental concern for PAC, and asked for thoughts. Dr. Hurley agreed, noting that LDEP is under ESSIO. Dr. Sarah Noble of PSD/ESSIO, commented that Dr. Kearns is director of the LDEP budget line. Dr. Hurley noted

that ESSIO, is a pretty flat organization, and it is not clear who is responsible for what. Is anyone coming up with a clearly defined hierarchy, such as that found in MEP? Dr. Noble said she could bring this concern back to Dr. Kearns, and pointed out that roles are evolving along with Artemis, and also noted that ESSIO is currently searching for a Deputy Director.

Dr. Diniega said she had been hearing similar concerns with regard to I-MIM: who is responsible? Responsibility only matters if it comes with funding. Where's the science, how is the community involved? Dr. Fagan said she was a little concerned that the message is that Artemis is getting us ready for Mars, with no mention of science. Is science on the back burner? Should science not be one of the driving components of Artemis? Dr. Westlake agreed, and wondered if there were opinions from the MEPAG on this issue, which might be a good finding. He also supported OPAG's finding on RPS development, SBAG's findings on Arecibo and NASA's radar capabilities, and ExMAG's finding on a NASA/China collaboration on lunar samples.

Dr. Mainzer said she had previously requested information on RTGs from NASA, and suggested the PAC defer a finding until the information was received. The sample finding from Chang'e 5 is absolutely important. Dr. Rinehart noted that collaboration with China revolves around a legal question that is outside the PAC's domain. Dr. Mainzer said the theme of ensuring firm scientific direction in all the missions under discussion made a good thread for a finding. Jennifer Glass agreed, and added that a finding on PDS4 might be connected to making science software deliverable. Dr. Westlake commented that in relation to R&A grants, it looks like it's being pushed on the mission side as well, what are the impacts of PDS4 conversions? How far back do we go? Are we going to archive New Horizons software? There is a potential for cost impacts here. Dr. Conor Nixon suggested a finding on Phase-E costs for leveling the field. Dr. Mainzer felt that the last two Discovery and New Frontiers calls addressed these concerns and was not sure the PAC needed to call it out. Dr. Hurley noted that the Decadal Survey might also make recommendations along these lines.

R&A Diversity Activities

Ms. LaJuan Moore updated the PAC on the progress of diversity initiatives in R&A and described her experience with the R&A IDEA group. She presented selected results of a survey that had been sent out to the team, which among other questions asked: why are you interested in this group? Answers included:

- To have more people of color walking the halls of NASA, SMD, PSD
- To focus on making changes and shaking up the norm
- To increase the diversity of people we fund and ensure that our selections represent the community and US as a whole
- To see PSD reflect NASA's new diversity goals, in concert with forward-looking science and exploration goals

According to survey answers, the focus for the next three months is to identify the starting point, by identifying the scope of what we in R&A can actually have an impact on, examine what we are doing well and what we can/need to improve; develop a pipeline of peer reviewers from MSIs; and check on finding out how the proposals are sent out and to whom; provide assistance with proposal writing; create videos on how to create proposals; learn from experts; create connections (working with the SMD IDEA groups, NSBP, e.g.); and figure out the current diversity landscape within PSD R&A in SMD. NASA is working to obtain that data now. The next questions and issues to be considered are: What solutions should this group be working toward? Understand the issues with education and training. Make sure the MSIs/HBCUs have information to submit proposals and review them, and help with applications to NASA positions. At present, the R&D IDEA group has started bystander intervention training to identify microaggressions, and is involved in the H_2O program, which is leveraging activities in the Europa Clipper, Dragonfly and Lucy missions, to ensure that NASA is focused on change.

Dr. Nicolle Zellner continued, addressing how results from the 2020 Planetary Science Workforce survey could be used to inform action items from the PSD survey. To reach members of the science community who are underrepresented in Planetary Science, PSD participated for the first time at the annual meeting of NSBP, where it presented information on how to become an IPA, and on volunteer opportunities. At present, efforts are focused on trying to figure out what other members of the IDEA community are doing, and the best way to disseminate information about the MSI Exchange, to the community, and to distribute information through such means as proposal-writing videos. PSD is now sponsoring workshops on Bystander Intervention Training and advertising other webinars and workshops to members of R&A. In the future, NASA plans to have presence at SACNAS and NSBP, and is working with the STEM Office on creating stronger collaborations and developing a pipeline of peer reviewers. PSD also wishes to cultivate contact with STEM educators

Dr. Diniega commented that she had been seeing a lot of issues with the pipeline and networking: are the efforts focused on those who are already in the community? Dr. Zellner said that figuring out how NASA can get information to all the PhDs who are already out there is still a challenge—the IDEA group is working on it. Dr. Mainzer asked if the H_2O program would be expanded. Ms. Moore recommended that the community stay tuned until July 2022, when the first year of the H_2O pilot ends.

Planetary Science Technology Development/Radioisotope Thermoelectric Generators (RTGs)
Dr. Carolyn Mercer updated the PAC on Planetary Science Technology Development. There are four ways to fund technology development in PSD: through the Planetary Exploration Science Technology Office (PESTO), Radioisotope Power Systems (RPS), mission-specific lines, and Space Technology Mission Directorate (STMD) collaborations. PESTO is now four years old; the Office manages PSD science instruments and spacecraft technologies until they're adopted by missions, and its recommendations are informed by the Decadal Survey. PESTO has made presentations to the Decadal Survey and recently presented to VEXAG. The four major instrument programs in PESTO are PICASSO, MatISSE, DALI, and ICEE. A recent study found that PESTO does well when addressing novel targets, and provides good opportunities to get instruments infused into missions. Recent Venus Surface and Atmosphere efforts in PESTO include LLISSE, HOTTech-2016 and 21 (7 selections for 2021). PESTO also leverages work in the STMD SBIR program, and EPScoR. PESTO now has a dedicated line item for Icy Satellites that includes COLDTech-2016; SESAME, a line designed to get instrumentation into deep sub-ice oceans; and COLDTech-2020. Communities of practice are forming around some gap areas in exploring icy satellites, such as instruments needed for drilling through ice, life detection, etc. PESTO also helps the HOTTech program along by giving them the ability to do integrated testing, under the guidance of flight personnel. PSD is funding pre-project efforts for the Europa Lander, and has done so as well as for Mars missions (e.g., Ingenuity helicopter, in collaboration with STMD and Aeronautics) Other core technologies supported by PSD include Entry Systems Modeling, SmallSat Electric Propulsion, as well as tech demos to be flown on DART, Psyche, and Veritas, all in collaboration with STMD. STMD continues to work on technology maturation in several areas: Lunar Surface Innovation Initiative (power systems, dust mitigation systems); Game Changing Technology Development Program (Entry Systems Modeling, High Performance Spaceflight Computing, Mars EDL); and Technology Demonstrations (Deep Space Optical Communications, Laser Communications Relay).

Dr. Leonard Dudzinski, Planetary Science Chief Technologist, presented an update on radioisotope power systems (RPS). At NASA, RPS units are fueled by Pu-238, though the Agency is aware of other isotope production efforts that are supported internationally. NASA RPS allows missions go to deep space, such as the Voyager probes, and is now being considered for powering systems on the lunar surface, to help instruments and spacecraft "survive the night." Perseverance is the 30th US mission to use RPS; in this case, the mission team provided an Multi-mission RTG (MMRTG) that came in under budget, ahead of

schedule, and over power, during the COVID pandemic. The Dragonfly probe to the Saturnian moon Titan, launching in 2026, will be powered by an RPS.

One core objective of the RPS program is to ensure that the actions required by the National Environmental Policy Act (NEPA), and launch authorities, are efficiently and cost-effectively carried out. As a result of a decade-long effort with the Department of Energy (DOE), NASA now has sufficient material and capability to support RPS into the foreseeable future, and is working to increase thermoelectric efficiencies as compared to those that were available in 2009. Right now, NASA has small, canister-sized Light Weight Radioisotope Heater Units (LWRHUs; 1 Watt thermal), MMRTG (Curiosity and Perseverance, planned for Dragonfly), and is developing Dynamic Radioisotope Power Systems (DRPS) and the next-generation RTG unit. The MMRTG and DPRS are multi-mission rated, and can keep atmosphere out, while the NEXT Gen RTG is vacuum-only. NASA is also working with the Applied Physics Laboratory (APL) on the Dragonfly mission, which plans to fly an F4 MMRTG unit, which is now under contract to be manufactured. The F3 unit will remain at Idaho for future missions. NASA is planning to make a number of LWRHUs for use on lunar missions. NASA is also developing NextGen Mod 1, resurrecting the design of the heritage General Purpose Heat Source (GPHS)-RTGs that flew on missions such as Galileo, Cassini, and New Horizons. A contract award for developing DRPS is imminent; these RPS technology investments can improve power, and DRPS technology can triple the amount of power output for the same quantity of Pu-238. DOE remains a critical partner in stewardship; Dr. Dudzinski credited the successes of the Perseverance mission to the concerted efforts undertaken between NASA and DOE. Plutonium availability is no longer a challenge, so if the Decadal Survey provides the vision, NASA will work with DOE to support those missions.

Facilities Programs

Dr. Aaron Burton presented a number of changes that PSD wants to make in the PMEF program to meet PSD R&A needs. PMEF currently accept three kinds of proposals: appended PME requests (capped at $200k), Standalone Investigator Instruments, and Facility Investigator Instruments. To address a number of issues, PSD is proposing the following changes:

- Appended PME requests >$50K will follow specific instructions outlined in C.1.

Programs excluded: Technology Development (e.g., PICASSO, cMATISSE); programs under mission lines (PSP; Co-I; DAPs other than LDAP).

- Standalone Investigator Instrument (SII) requests will be handled like other augmentation requests to existing awards.

  PIs need to contact PO for requirements of request, and POs will solicit external reviews as appropriate.

- Facility Instruments will be requested through Planetary Science Enabling Facilities call (PSEF).

  Targeting February 2022 Step-1 due date, March 2022 Step-2 due date; this change allows instrument acquisition to be directly tied to plans for community access, and will include language on partnering with MSIs.

The intent of these changes is to make SII requests more rare, and to replace lost capabilities (e.g., instrument failure). Dr. Burton displayed PSD-relevant programs eligible and ineligible for PME program listed (available in slide package), and reviewed a sample flow process for a new proposal involving equipment over $50k.

The impetus for these changes arose from a recent Facilities Senior Review, which concluded that shared Planetary Science facilities can provide significant value to both the PSD R&A community and NASA; existing facilities are uncommon or unique, and re-creating them elsewhere would be costly; external interfaces for existing facilities generally could be improved; capabilities, availability and mechanisms for access not always well-explained. Shared facilities often represent a barrier for external users, as facility use tends to be dominated by internal users, and many existing facilities require users to have funded R&A proposals, which further limits the user-base of facilities.

Guiding principles for the new PSEF call:

- The PSEF program should provide funding stability coupled with regular review to ensure community needs are being addressed
- Different types of facilities have different staffing and funding needs, and proposers should have flexibility to propose what they need
- Facilities should be encouraged to maintain or grow user base
- A significant fraction of funded time for analyses/experiments should be made available to the community

New guidelines for baseline NASA Science-Enabling Facility:
Facilities program provides minimum level of support for:

- Maintenance
- Minor improvements
- Technical expertise to keep instrument/facility operational
- Evaluation and disposition of requests
- Users secure additional funding for the experiments/analyses through proposals to R&A programs
- User fees directly if funds are available
- Usage related to work in PSD R&A awards should be top priority
- 4-year expected length of awards, with review after 2 years
- Pending outcome of mid-term review, award can be extended, continue as proposed, or be reduced in scope

The Enhanced NASA Science Enabling Facility concept is characterized by the following:

- A pro-rated share of the full labor, supplies, and maintenance costs are paid for through PSEF program
- Users propose for time/sample analysis, get reviewed by some process, and time/analyses are awarded
- Users can include analyses in R&A proposals; if proposal is selected, then those analyses are in highest priority category
- Separate process for PSD-relevant analyses not proposed through ROSES. These are lower priority than those in R&A awards
- Share of time to be funded by HQ is identified by proposers at time of submission, and actual usage will be evaluated at mid-term review.

Dr. Burton closed by briefly touching on facility review outcomes, and submissions for facility instrument upgrade appendices.

<u>Discussion</u>
Dr. Mainzer opened the discussion with a question on sample science as it pertains to particular missions: how are those sample analysis costs bookkept? Are they a part of the mission? Dr. Grossman answered

that the mission has to demonstrate that they can accomplish their goals, and yes, there can be a mismatch, especially when there is a long lead time. Sample analysis needs must be tackled in the proposal. PMEF is not intended to be a mission support activity; it's for R&A.

Dr. Ishii asked some questions about PMEF changes: Can a facility request a cost estimate in the proposal or request? Where is the funding for this new model going to come from? Dr. Rinehart said that some of the PBR22's extra allocation for R&A was specifically meant to start up and support a new Facilities program. PSD had been trying to do more with the funding; it will require more money, and it will require more money forever. Dr. Ishii commented that the new program carried the risk that it is a one-off and it will fade away. Dr. Rinehart said that if no money appears in the future, it will be no different than the present PMEF, except for having spent money on facilities for one year. Dr. Glaze added that everything NASA does costs something, and the new facilities funding represented a good opportunity to take this step. Once established, PSD facilities will have a good foundation going forward. Dr. Danielson asked about PMEF/PSEF review criteria. Dr. Burton said that investigator instruments will still be about science, and facilities proposals will ask for different things, not the science, but really more about community capabilities to do certain types of analyses. Dr. Ishii asked if ISFM-funded instruments were open for community access, and how they might relate to the new facilities program. Dr. Rinehart said that ISFMs do not have facilities; they do have equipment. The ISFMs are not required to make their equipment accessible, however a lot of ISFMs do share equipment, or make measurements for those who requests them, as a part of what they view to be their fundamental commitment to the community. He did not foresee this being a big issue for the first round of the facilities call. ISFM do not have facilities, period, and NASA does not fund the facilities through ISFM. Dr. Glaze reiterated that the ISFM is about funding science research that would normally have been funded through an R&A grant, and that a big part of ISFM is the community service aspect: each ISFM must demonstrate service to the community, and making laboratories available is one way to do it. With the new PSEF program, will there be training, such as training sample scientists in the field. Dr. Rinehart noted that LPI, in collaboration with JSC, is already running training in sample science, as part of a Cooperative Agreement. Any proposer for a facility that needs to have training for its users must explicitly call out this need in their proposal.

Dr. Diniega commented that there doesn't seem to be a website for H_2O, and that there is a concern about who is able to participate. It seemed that there was a limited number of participants in H_2O, and they had to be selected by faculty. Are there any plans to make H_2O more accessible? Dr. David Smith said that the H_2O effort was intended to be small, as it was a pilot, and NASA will work with both faculty and students to expand it if it proves successful. If so, NASA will come up with a way to advertise it and reach out to more institutions. In order to reach out, NASA will be leaning heavily on higher-education faculty to advise on how to build these programs, and what makes sense for their institutions. It's about reaching students at their institutions. Dr. Rinehart added that because H_2O is a pilot, NASA is also trying to co-create programs with the students and the institutions, and wants to avoid prescribing solutions. Instead, NASA wants to know where to best expend the Agency's efforts. Dr. Diniega asked if the faculty mentors would be interacting with the mission mentors. Dr. Smith said that once the effort gets under way, faculty will help analyze the participant survey data. H_2O is doing a lot of interaction with student leaders, with oversight by faculty. Dr. Mainzer commented that there is a lot of interest in this program, and that the PAC hoped to hear more about it. Dr. Smith said he would happy to provide updates along the way, and get some student leaders to present at PAC meetings.

Dr. Mainzer raised the issue of RTGs, noting that in general, the situation is a lot better than it used to be. The question remains of the timeline for planned missions: are the number of units matched up with the mission schedule? Dr. Westlake said that it seemed like some of the smaller-class missions were on the same competitive playing field, perhaps prompting a finding. Dr. Dudzinski said that NASA has been paying close attention to planetary exploration missions that require radioisotopic power; and does recognize that the more capable and costly missions will require RTGs. As long as NASA has the vision,

the Agency will support radioisotopic power, and work with Congress to keep it that way. Dr. Spilker thanked Dr. Dudzinski for his presentation, and asked if there is a detailed timeline on the NASA website. Dr. Dudzinski said there was no detailed schedule on line, but said that a modified GPHS by was expected by 2023, and a new one by 2028. The RPS program is continuing to work toward making some other capabilities available by the late 2020s. Dr. Dudzinski took an action to put a more detailed schedule on the website. Asked how the concept for the small LWHUs came about, Dr. Dudzinski said they were really meant to keep things warm on Galileo and other missions, and they have now been seen as useful for the lunar program. RPS plans to make many more for future missions into deep space.

Findings and Recommendation Discussion Period

Dr. Mainzer deferred a discussion and finding on RTGs until June 2022, post-Decadal Survey.

Dr. Mainzer opened the discussion on an I-MIM finding: The mission is not completely driven by science community. Is that a fair statement? Dr. Justin Filiberto said that it was bigger than that: if -MIM flies as is, is this going to fall back on the Mars/planetary community? Dr. Mainzer said I-MIM seemed to have more of an application focus. Dr. Kiefer noted that the iMDT seems to narrow the scope even further. Dr. Ianson said he would welcome any input about any additional payloads, which would be useful to the iMDT, reminding the PAC that this is an opportunity to leverage a radar mission at Mars. But the points are well taken about science community concerns. He didn't think the iMDT would be the last step in this process. Dr. Mainzer asked: how do we connect science to the measurements? Dr. Glaze said that this was a good point, and an opportunity to tailor and shape the mission. Dr. Ianson said that I-MIM was still early in the process, and not even at KDP-A. Dr. Mainzer suggested letting the iMDT take a crack at it, and to defer a finding until then. Dr. Diniega recommended a broader finding on Artemis and I-MIM, to avoid shoehorning science into a pre-existing concept. Dr. Mainzer asked if there was a way the PAC could help define science requirements in Artemis. Dr. Kiefer felt it was that the science community had a say in landing site selections. The community should be asking for clarification of what we will learn at the Moon, and for coordination of science and exploration strategies. Dr. Glaze said that she shared PAC concerns about the science, and that PSD is having active conversations about the science driving Artemis; she offered to get a briefing from Dr. Noble on details and potential gaps. Dr. Ishii suggested reiterating LEAG's call for an Artemis roadmap.

Dr. Filiberto thought I-MIM was going in the right direction. Dr. Hurley suggested an overarching finding, as so much science is going on cross-directorate, it would be good to know if science is being treated appropriately. The PAC agreed to draft a broad finding, based on the LEAG finding. Dr. Kiefer asked if there was a broad science strategy guiding CLPS; it's not clear that the way it's being done is optimized for science return. Dr. Mainzer suggested requesting a briefing on how science influences CLPS selections. Dr. Glaze said she was not sure ESSIO had a science roadmap, but that the PAC should keep in mind that these are missions that SMD is not driving—the whole point of CLPS is to build a commercial capability to deliver payloads to the Moon. Dr. Hurley thought it would be important to know when NASA wants a (lunar) sample analysis capability. Dr. Kiefer said he also wanted to understand the Artemis and CLPS side and how selections are made, and what the schedule and timeline looked like.

There was a request for Dr. Rinehart to re-present his briefing on the byzantine budget process.

Dr. Mainzer suggested it would be useful to encourage NASA to publish the Discovery and New Frontiers schedules when possible. Dr. Glaze noted that the schedule is online, but that it will change as things evolve. Cadences are another matter. Excluding the launch vehicle (LV) and Phase-E costs has effectively doubled the cost of Discovery, which has affected the program cadence. PSD has discussed these cost changes and the need for program balance, at length, with the Decadal Survey. Dr. Glaze said she was not arguing that it was wrong to remove LV and Phase-E costs, but that the decision had impacts.

Dr. Kiefer thought it was the right thing to do. Dr. Diniega suggested a finding, with a caveat that the Decadal Survey will have a say in the ultimate outcome. Dr. Mainzer agreed to a general finding.

Dr. Mainzer requested an itemized list of services performed by committee members, so that the PAC could go through each of the categories and their legal requirements. Are there alternative ways to alleviate the compensation issue? Dr. Rinehart noted that one option is to get each affiliated institution to make it a written policy; it is the simplest solution. Dr. Danielson suggested having an institutional related column (in proposals?), detailing what an individual's institution can do; some are good at supporting service, and some are not. Dr. Rinehart said he would be happy to draft a matrix, but would need help from the PAC. Dr. Mainzer suggested putting more money into honoraria for review panels. Dr. Diniega offered to share a white paper on the subject.

With regard to a DAP retirement finding, Dr. Danielson said he liked the idea of establishing a specific time, while recognizing the value of old data. One concern about a "Monster DAP" is that it would result in a net decrease in funding for DAPs. Dr. Glaze noted that the economy of a single DAP would be in the overhead associated with it. The funding lines from programs are all rooted in individual programs; there would be no net impact on funding. Dr. Rinehart commented that R&A had been doing "micropanels" with NoDD, yielding interesting but not conclusive data. It is not yet clear what the answer is in terms of one DAP vs. multiple DAPs. Dr. Kiefer thought missions should be retired from DAPs at some timepoint. Some Mars data are 25 years old: when does that data go to the core program? Dr. Rinehart said that the DAPs all use different criteria for such decisions. It would be nice to have a general policy. Dr. Kiefer observed that the DAPs fill a role, as do the core programs; it would be unwise to hurt one at the expense of the other. He suggested that PAC ask NASA to come forward for some ideas on the DAPs. Dr. Shoshana Weider asked about the cases for using much older, but relevant (e.g, Apollo) data. Dr. Robinson suggested establishing retirement criteria and revival criteria. Dr. Rinehart said there may be more options by the summer meeting, and an opportunity for further discussion.

Dr. Mainzer suggested a finding on NASA COVID relief, and asked if NASA planned to continue to offer COVID augmentations. Dr. Westlake commented that there will be a lot of mission impact, which could eat other missions. Dr. Danielson said that from her perspective, she had been seeing more impact on time, access to labs, and mission-related schedules. Dr. Rinehart commented that the missions have been doing extraordinarily well at adapting to COVID challenges, and getting the work done, and questioned how NASA could further compensate for unpredictable problems. PAC members had varied opinions on where the impacts were worst. Dr. Rinehart said that during the course of planning COVID augmentations, he saw just how heterogeneous the community is; the augmentations ended up being very uneven. It is not clear that the COVID augmentations were 100% successful. Dr. Glaze said she had gotten a lot of feedback from late Early Careers, who were really concerned that money would be taken out of R&A for the augmentations. Dr. Rinehart cautioned that COVID relief comes out of the R&A program. Dr. Mainzer deferred a finding on the subject.

Public comment period commenced at 5:00
No comments noted.

Findings and Recommendation Discussion Period, continued
On the subject of PDS4 archiving and open software, Dr. Diniega thought that the issue of the unfunded mandate was the important part. Dr. Mainzer took an action to spread the word on the Public Comment period for Software Policy. Dr. Rinehart felt that as software is not defined in the law, there might be room to argue about what is and isn't data, and what is and isn't software. Dr. Mainzer encouraged everyone to read the policy, and to take it up next time. Questions and comments on SPD-41 to HQ-SMD-SPD41@mail.nasa.gov.

Dr. Mainzer recommended a finding on samples from Chang'e 5. Dr. Glaze commented that it couldn't hurt, and that she knew that Dr. Zurbuchen supported the idea, as well.

Dr. Mainzer suggested a finding on ISFM. Dr. Rinehart noted that NASA gives a status on them annually, and that they are more heavily reviewed than any other grant. Dr. Mainzer felt that there are differing opinions on ISFM, and that the question was how science and service return could be maximized from ISFM. Dr. Danielson said more information was needed on achievement of goals. Can NASA share portions of the ISFM reviews? Dr. Rinehart said he could share some review summaries. He said the Office of the Chief Scientist (OCS) had done the programmatic review, which found that eight metrics were being met, with one metric judged as slightly under successful. The ISFMs have been meeting programmatic requirements regularly and laudably. Dr. Mainzer suggested a finding on having regular standing updates from ISFM, including number of FTEs, topics, science highlights. Dr. Rinehart said he would think more about how to report ISFM results out succinctly, and added that the ISFMs are here to stay. Dr. Mainzer deferred the finding, pending requested presentations.

Dr. Kiefer suggested a finding on a replacement for the Arecibo radar facility.

Dr. Diniega commented that there are a whole lot of white papers that are not being used for NASA IDEA activities, and explicitly requested that NASA figure out how to get the MSI Exchange out there, perhaps by adding a box in NSPIRES that states HBCU/MSI, similar to a high-risk/high-impact box. Dr. Rinehart agreed that it might be helpful, but what matters more, NASA wants the roles to be substantial and meaningful.

Dr. Rinehart announced that the next meeting PAC meeting was scheduled for 15–16 February, 2022, and initial plans were under way for holding a second meeting in June. Dr. Rinehart closed the meeting at 6:13pm.

Appendix A
Attendees

Planetary Science Advisory Committee
Amy Mainzer, **Chair**, University of Arizona
Lisa Danielson, Los Alamos National Laboratory
Serina Diniega, Jet Propulsion Laboratory
Justin Filiberto, NASA Johnson Space Center
Jennifer Glass, Georgia Institute of Technology
Justin Hagerty, United States Geological Survey
Dana Hurley, Johns Hopkins University Applied Physics Laboratory
Walter Kiefer, Lunar and Planetary Institute
Hope Ishii, University of Hawaii
D'Arcy Meyer-Dombard, University of Illinois at Chicago
Conor Nixon, NASA Goddard Space Flight Center
Tyler Robinson, Northern Arizona University
Joseph Westlake, Johns Hopkins University Applied Physics Laboratory
Stephen Rinehart, Executive Secretary, NASA Headquarters

Attendees

Michael Meyer	Eileen Stansbery	Jess Barnes
Nicolle Zellner	Aaron Burton	Julie Castillo
Ryan Watkins	Conor Nixon	James Dottin
Michael Lienhard	Shoshana Weider	Tammy Dickinson
Megan Ansdell	Robert Fogel	Arya Udry
Lucas Paganini	Joan Salute	James Farquhar
Mary Voytek	Eric Ianson	Romy Hanna
Jeffery Hollingsworth	Melissa Morris	Rhiannon Mayne
Robert Collom	Jeffrey Grossman	Brian Dempsey
Sarah Noble	Meagan Thompson	Insoo Jun
Elizabeth Esther	Delia Santiago-Materese	Douglas Isbell
Eboni Whitfield-Miles	George Tahu	Pedro Mescali
David Smith	Mitchell Schulte	Leonard Dudzinski
Henry Throop	LaJuan Moore	Teresa Jensen
Barbara Cohen	Lori Glaze	James Lochner
Lindsay Hays	Richard Davis	Patricia Beauchamp
Melissa Kirven-Brooks	Doris Daou	Cynthia Dinwiddie
Rebecca McCauley-Rench	Carolyn Mercer	Linda Karanian
Kristin Spear	Diane Hammons	Ed Rivera-Valentín
Michael Kelley	Pierre Haenecour	Lindley Johnson

Tyler Robinson

Adrian Brown

K Beisser

Linda Spilker

Gregory Garner

Jemma Davidson

Devin Schrader

Kerri Beisser

Gene Mikulka

David Millman

Richard Zurek

Stefanie Hempel

Noam Izenberg

Walter Kiefer

Julie Rathbun

Cathirame Lee

Steven Hauck

Bonnie Buratti

Amy Fagan

Julie Stopar

Brett Denevi

Michael Mischna

R. Aileen Yingst

Darby Dyar

Joan Zimmermann

Amanda Nahm

Jeffrey Gramling

Shawn Domagal-Goldman

Heather Graham

Alana Johnson

Brad Bailey

Gregory Schmidt

Christy Layton

Richard Ryan

Kristina Gibbs

David Long

Thomas Wagner

Renee Leck

Joseph Gasbarre

Andrew Rowe

Mamta Nagaraja

Daniel Evans

Mike Gauss

Lorraine Fesq

Benita Bell

Ed Rivera-Valentin

Victoria Meadows

Flaviane

Alan Thurgood

Patrick Taylor

Appendix B
Agenda

NASA Planetary Science Advisory Committee (PAC) Meeting
November 15–16, 2021
VIRTUAL MEETING

Day 1: November 15, 2021

Public Connection Information

Webex URL:
https://nasaenterprise.webex.com/nasaenterprise/onstage/g.php?MTID=e3c5b67d79794f2efcc35cc9481250of8

Event meeting number: 199 427 6706
Password: sEwJ5wMM@28

For audio, provide your phone number when you join the event, or call US Toll: +1-415-527-5035 (Access code: 199 427 6706).

Agenda

Item & Speaker	Nov 15 (EDT)
Welcome/Around the table Stephen Rinehart	10.00–10.05
Planetary Science Division (PSD) Update Lori Glaze & Joan Salute	10.05–11.00
Exploration Science Strategy and Integration Office (ESSIO) Update Brad Bailey	11.00–11.30
Mars Exploration Program (MEP) & Mars Sample Return (MSR) Update Jeff Gramling, Eric Ianson, Michael Meyer	11.30–12.20
Additional Discussion/Q&A	12.20–12.30

BREAK	12.30–13.30
Research & Analysis (R&A) Program Update Stephen Rinehart	13.30–14.15
Dual Anonymous Peer Review (DAPR) Update Delia Santiago-Materese	14.15–14.35
Additional Discussion/Q&A	14.35–15.00
BREAK	15.00 – 16.00
Planetary Defense Update Lindley Johnson, Kelly Fast	16.00–16.20
Astrobiology Update & Standards of Evidence Workshop report Mary Voytek, Victoria Meadows, Heather Graham	16.20–16.50
Additional Discussion/Q&A	16.50 – 17.50
End Day 1	

Day 2: November 16, 2021

Public Connection Information

Webex URL:
https://nasaenterprise.webex.com/nasaenterprise/onstage/g.php?MTID=ecfa6e20c22be22391df3038d08a8c781

Event meeting number: 2761 489 8042
Password: JJzwJ44Aq*2

For audio, provide your phone number when you join the event, or call US Toll: +1-415-527-5035 (Access code: 2761 489 8042).

Agenda

Item & Speaker	**Nov 16 (EDT)**
Analysis/Assessment Group Updates	**10.00–12.15**

MEPAG VEXAG ExMAG SBAG ExoPAG OPAG MExAG MAPSIT LEAG	10.00–10.15 10.15–10.30 10.30–10.45 10.45–11.00 11.00–11.15 11.15–11.30 11.30–11.45 11.45–12.00 12.00–12.15
Additional Discussion/Q&A	12.15–12.30
BREAK	12.30–13.30
PSD/R&A IDEA Update LaJuan Moore, Nicolle Zellner	13.30–13.45
RTG/Technology Update Carolyn Mercer, Len Dudzinski	13.45–14.15
Facilities/Planetary Major Equipment Update Aaron Burton	14.15–14.30
Additional Discussion/Q&A	14.30–15.15
BREAK	15.15–16.15
Additional Discussion (as needed)	16.15–18.00
End Day 2	

Appendix C
PAC Membership

Amy Mainzer, **Chair**
University of Arizona

Lisa Danielson
Los Alamos National Laboratory

Serina Diniega
Jet Propulsion Laboratory

Justin Filiberto
NASA Johnson Space Center

Jennifer Glass
Georgia Institute of Technology

Justin Hagerty
United States Geological Survey

Dana Hurley
Johns Hopkins University
Applied Physics Laboratory

Walter Kiefer
Lunar and Planetary Institute

Hope Ishii
University of Hawaii

D'Arcy Meyer-Dombard
University of Illinois at Chicago

Conor Nixon
NASA Goddard Space Flight Center

Tyler Robinson
Northern Arizona University

Joseph Westlake
Johns Hopkins University
Applied Physics Laboratory

Stephen Rinehart
Executive Secretary, NASA Headquarters

Appendix D

Presentations

1. Planetary Science Division Status Report; Lori Glaze, Joan Salute
2. Exploration Science Strategy and Integration Office (ESSIO); Brad Bailey, Joel Kearns
3. Mars Exploration Status Highlights/Mars Sample Return Status; Eric Ianson, Michael Meyer, Jeffrey Gramling
4. Planetary Science Division R&A Status Report; Stephen Rinehart
5. Dual-Anonymous Peer Review (DAPR) Update; Delia Santiago-Materese
6. Planetary Defense Coordination Office; Lindley Johnson
7. Astrobiology Update/Standards of Evidence Workshop Report; Mary Voytek, Heather Graham, Victoria Meadows
8. Mars Exploration Program Analysis (MEPAG) Update; R. Aileen Yingst
9. Venus Exploration Analysis Group (VEXAG) Update; Darby Dyar
10. Extraterrestrial Materials Analysis Group (ExMAG); Barbara Cohen
11. Small Bodies Assessment Group (SBAG); Bonnie Buratti
12. Exoplanet Program Analysis Group (ExoPAG) Report; Michael Meyer
13. Outer Planet Assessment Group (OPAG) Update; Linda Spilker
14. Mercury Exploration Analysis Group (MExAG); Steve Hauck
15. Mapping and Planetary Spatial Infrastructure Team (MAPSIT); Julie Stopar
16. Lunar Exploration Analysis Group (LEAG) Update; Amy Fagan
17. IDEA; LaJuan Moore, Nicolle Zellner
18. Planetary Science Technology Update; Carolyn Mercer, Len Dudzinski
19. Planetary Major Equipment and Facilities; Aaron Burton