

**Findings**

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

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

**Finding 3. Radioisotope Power Systems (RPS).** RP systems are critical enabling technology for Uranus Orbiter and Probe (UOP) and other outer planet missions. The Decadal Survey identified that three units of Next Generation Radioisotope Thermal Generators (NextGen RTGs), each producing about 300 W upon launch, are required for the UOP mission. At the OPAG 2023 Spring Meeting, Len Dudzinski provided a summary on the current state of the RPS technology development as well as Pu238 production. In addition, we reviewed key recommendations by the recent NASA Inspector General's Report ("IG Report") on RPS technology.

OPAG is concerned about two aspects of preparing RTGs for UOP:

- a. **Pu238 & clads:** OPAG is concerned about the availability of Pu238 to fuel the three units of NextGen RTGs for UOP to launch in time to arrive at the Uranus System before the 2049 Equinox. First, the IG report noted that the current Pu238 production plan, which aims to produce up to 15 fuel clads per year, is not sufficient to support UOP in a timely manner. Even if the production rate of 15 clads per year is achieved immediately, more than a decade is needed to produce the 192 clads to fuel three NextGen units. At this OPAG Spring Meeting Len Dudzinski confirmed that, at the current Pu238 production rate, UOP launch cannot be supported before the mid- to late-2030s. Based on these, OPAG agrees with the IG Report's concern that the Pu238 production capability is insufficient to support missions recommended by the Decadal Survey including UOP. In particular, OPAG is concerned that the Pu238 production issues may delay the mission

and thus prevent observations of Uranus at a scientifically critical time period before the 2049 equinox.

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

**Finding: OPAG encourages NASA to work with DOE to increase the production rate of Pu238 material and fuel clads to ensure supply such that UOP can arrive at the Uranus System before the 2049 Equinox, in addition to sufficient supply for other missions requiring RPSs over the next decade. OPAG also encourages the RPS Program to implement a stringent external review analogous to flight program reviews, as recommended by the IG Report, to monitor the developments of NextGen RTG Mod0 and Mod1.**

**Finding 4. Planetary Mission Concept Studies (PMCS).** The OPAG meeting included a panel discussion that reviewed lessons learned from the Planetary Mission Concept Studies (PMCS) conducted as a ROSES element in preparation for the OWL Decadal Survey.

- Overall, the community responses to the PMCS program were positive. The community is excited about the PMCS program's potential to make the mission concept development more open and broaden community participation in the mission formulation process. In particular, the program offered early and mid-career researchers the opportunity to lead mission concept proposals.
- Repeating PMCS calls in the inter-decadal period would enable refining existing concepts and examining new ideas in response to new scientific discoveries so that more high-fidelity concepts can be ready in time for the next decadal survey, and more time is available for more feasibility and costing studies (e.g., CATE in V&V and TRACE in OWL) during the decadal survey process.
- The PMCS program could further broaden participation and allow for the study of more innovative concepts if the mission design centers were not limited to JPL, GSFC and APL. We suggest that future rounds of PMCS programs could solicit two categories of mission concepts; (1) concepts mature enough to merit from high-fidelity point design and cost model only available at JPL, GSFC and APL, and (2) early concepts that examine innovative designs that can be studied at other centers. To broaden participation, future PMCS calls could include Points of Contacts at various participating design

centers as was done in the C.23 Planetary Science Deep-Space SmallSats (PSDS3) program in 2016.

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

**Finding: The OPAG community thanks NASA for empowering the community to take part in formulating future mission concepts through the PMCS program in preparation of the OWL decadal survey. Given the significant value offered by the PMCS program, OPAG encourages NASA to:**

- a. Make PMCS a recurring ROSES element (more than once per decade).**
- b. Structure the program so that more mission design centers can participate (beyond JPL, GSFC and APL), in order to broaden participation of community members and allow more innovative concepts to be studied.**
- c. Consider options to allow for design modifications during the decadal process by PMCS teams.**

**Furthermore, OPAG encourages NASA (in coordination with the Academies) to make more time available during the decadal process so that more mission concepts can be costed.**

### **Statements of support and concern**

**R&A statement of concern.** As noted in the statements of concern from the OPAG 2022 Fall meeting, the OPAG community continues to be concerned about the drop in NASA PSD ROSES proposal submissions in the last few years. We thank Stephen Rinehart for taking steps to understand the problem and collecting feedback, but OPAG would like see a survey conducted, which would allow for anonymous inputs, and will work with the American Astronomical Society's Division for Planetary Sciences (DPS) to conduct such a survey to reach the whole community along these lines.

**NF-5 concerns.** OPAG awaits the response from NASA HQ on our concerns about the NF-5 cost cap and fixed Phase E cost reported in response to the draft AO in March 2023, as well as

clarifications on questions submitted to HQ by the community. We reiterate that the New Frontiers Program is particularly important for the outer planets community as the cost cap for Discovery missions is typically not sufficient to enable outer planets missions, and Flagship missions occur at a low cadence. We hope that outer planet destinations will continue to be accessible via NF-5 and future New Frontiers solicitations. While OPAG understands the need to control costs, the New Frontiers program is critical for outer planets missions and we urge PSD to strike a balance to allow for outer planet science in the New Frontiers program.

**Support for Europa Clipper.** OPAG continues to strongly endorse Europa Clipper and commends the team (and NASA HQ support) on tremendous progress as it moves to launch in Oct 2024. OPAG also supports the activities of JUICE-Clipper Steering Committee (JCSC) and its consideration on addressing Jupiter System Science Objectives by the two missions.

**Dragonfly.** OPAG strongly supports the Dragonfly mission and commends the team on a great job passing PDR, as they push on to Confirmation Review. The Dragonfly Guest Investigator Program is terrific, in its increasing access to students from universities that do not have planetary science programs, and OPAG looks forward to seeing this program extended to include postdocs and also seeing similar programs on other upcoming missions across the PSD portfolio.

**Demographic survey.** OPAG recognizes the critical importance of maintaining a diverse and inclusive workforce and of having a holistic view of participation in our field in order to identify where specific barriers to participation may lie. Understanding the current state of our community, and how both internal and external factors (i.e., DEIA efforts, COVID, etc.) have affected participation in our field is therefore of significant importance. As such, we will work with the cross-AG DEIA working group to determine the specific analyses required for existing demographic data (such as the 2020 Planetary Science Workforce Survey\*\*) and evaluate what new data should be collected.

\*\* [https://dps.aas.org/sites/dps.aas.org/files/reports/2020/Results\\_from\\_the\\_2020\\_Survey\\_of\\_the\\_Planetary\\_Science\\_Workforce.pdf](https://dps.aas.org/sites/dps.aas.org/files/reports/2020/Results_from_the_2020_Survey_of_the_Planetary_Science_Workforce.pdf)

**Deep Space Network (DSN) Support.** OPAG acknowledges that the DSN is a critical asset to enable current and future missions. OPAG appreciates the presentation on the DSN, and the effort to improve the capabilities to address critical needs. It has been pointed out that DSN utilization could benefit from increased use of Ka-band, as the communication rate is more efficient, and requires less resources than other lower bands (e.g., X-band). We agree with encouraging the proposer and user communities to take these DSN recommendations into consideration, in order to reduce the load and resource stress on the DSN.

**New Horizons.** New Horizons has been a groundbreaking mission and has provided numerous important results in the Kuiper Belt. OPAG supports the use of the New Horizons spacecraft and instruments for accomplishing science in the planetary, astrophysics and heliophysics areas, and supports the continued search for a new close flyby KB target for the New Horizons spacecraft.

**Ocean Worlds Working Group (OWWG).** Ocean Worlds are compelling targets for geology/geochemistry, habitability and astrobiology investigations, and given that most Ocean

Worlds discovered thus far orbit around the outer planets, the Ocean Worlds community is considered an integral part of the OPAG community. OPAG is happy to endorse the newly formed Ocean Worlds Working Group and looks forward to engaging this part of our community through its new co-chairs, Cynthia Phillips and Michael Bland.

**Discovery.** OPAG is glad to see Discovery in the FY25 budget and encourages a call to go out for a new mission as early as programmatically viable, without impacting parameters for NF5, UOP, and Dragonfly.

**Lessons learned.** OPAG recognizes the importance of understanding lessons learned, both from PMCS Leads (as noted in the panel presentations of the OPAG Spring 2023 meeting) as well as from the panel chairs of the OWL Decadal Survey. OPAG encourages NASA HQ to make these lessons learned public, so that future PMCS calls (if implemented) and the next Decadal Survey can benefit from, and improve upon, what occurred last time.

**Education.** During a presentation on and subsequent discussion of Team Psychological Safety by Dr. Kim Barnette, the importance of K-12 education was emphasized. OPAG recognizes the importance of K-12 education in stimulating participation in STEM career paths. For long duration outer planets missions, current K-12 students will be the future leaders of the mission operational phases. OPAG encourages NASA to provide a funding opportunity for outreach that is not tied to specific mission teams and is at the scale of individual centers and/or personnel, as opposed to large-scale conglomerates like the Science Activation Teams.