

## Outer Planets Assessment Group (OPAG) Report 19-20 February 2015

NASA's Outer Planets Assessment Group (OPAG) met 19-20 February 2015 at the NASA Ames Research Center in San Jose, CA. OPAG assembles twice per year, engaging the widest community possible, to assess the current state of outer solar system exploration, goals for future exploration, and technology development needed to achieve those goals.

The community is ecstatic that there will be a new start for a Europa mission. A Europa mission was a very high priority in both the 2003 and 2013 Decadal Surveys. We continue to support the *Europa Clipper* mission as a scientifically compelling, technologically feasible and fiscally responsible approach to exploration of Europa. The *Europa Clipper* mission meets the requirements of the 2013-2022 Decadal Survey: it will accomplish flagship-worthy science by investigating Europa and its subsurface ocean, a potential habitable zone.

The new start for a mission to Europa will bookend what had been an open-ended gap in US-led missions to the outer solar system after the end of the *Cassini*, *Juno*, and *New Horizons* missions in 2017, 2018, and 2019, resp. With the selection of instruments for the Europa mission payload coming soon the community can still access the experience of many of the instrument builders and scientists that built and now operate the payloads of Cassini and Juno in their unique outer solar system environments.

There are other bright spots for outer solar system exploration, discussed at the February OPAG meeting: the removal of Phase E cost from Discovery mission funding caps helps level the playing field for outer solar system destinations. The Pu238 domestic production restart will enable future missions to the far reaches of the outer solar system. The Nuclear Power Assessment Study represents a major step in the evaluation of future technology development needs.

OPAG also heard a report on the implementation of the re-structured Research and Analysis (R&A) program. Considerable time was spent discussing the impact of the low selection rates on scientists' careers. Very few actual metrics were provided, and those that were did not clarify whether or not the outer solar system community fared as well in the new architecture as they would have in OPR, although it was noted that the SSW selection rate of 18% was comparable to the OPR selection rate of 20%. The actual comparison will not be available until the final 2014 selections have been made across the entire program. The early career scientist panel discussion at the end of the second day echoed the concerns of the assembled group as a whole.

The remainder of the meeting was focused on the new OPAG science goals document. Five “luminaries” in our field discussed big picture science questions that will be important themes in the new report.

***Most of OPAG’s findings address what is needed for a healthy program of outer solar system exploration:***

- A. Maintain current mission support, and make sure the experience is not lost over the looming gap in missions to the outer solar system
- B. Get the development of a Decadal-Survey-responsive Europa mission going as quickly as possible to minimize the duration of the gap
- C. Make sure that outer solar system missions have a home in Discovery and New Frontiers
- D. Invest in power sources appropriate for the outer solar system missions
- E. Support our human capital – essential to the success of NASA’s missions.

**OPAG FINDINGS**

**1. Europa Mission.** OPAG lauds in no uncertain terms the inclusion of funding for a new start for a Europa mission in the President’s FY2016 budget. A tremendous opportunity presents itself to NASA and the nation. A properly designed and instrumented mission to Europa will markedly advance our understanding of the Outer Solar System, and may very well revolutionize our understanding of life in the Universe.

In this regard, OPAG continues to offer its firm support for the *Europa Clipper* mission. This mission is the ultimate result of more than a decade of ever more detailed study and down-selects, and offers paradigm-shifting, flagship-level science at Jupiter’s ocean moon. *Europa Clipper* is very highly responsive to the most recent Planetary Science Decadal Survey recommendation that the cost of the then-proposed Jupiter Europa Orbiter (JEO), which was ranked scientifically on par with a Mars sample-caching mission, be substantially reduced. It retains most of the scientific return of JEO, while the costs have been more than halved. As OPAG has previously stated, the breakthrough concept of a *multiple-flyby mission* derives in part from the highly successful multiple-Titan-flyby experience of *Cassini*, and for many of the Europa remote sensing instruments the multiple-flyby architecture actually offers a superior platform for operations and radiation reduction. *Europa Clipper, or a similar multiple-flyby mission, could enter phase-A today, and should be started in accordance with the President’s FY2016 budget.*

***OPAG strongly encourages NASA to move forward with the Europa Clipper. OPAG wishes to be informed at the earliest opportunity of NASA’s plans for***

***Europa mission formulation during phase A, including but not limited to the selection of instruments. Modest expansion of instrumentation to do important plume science, should that opportunity exist at Europa, is encouraged, but only if the budget allows, and not at the expense of the core payload or at the price of a significant delay to the launch.***

**2. Europa Plumes and Life.** A workshop on possible strategies for detecting life in a Europa plume was held immediately prior to OPAG meeting. Several OPAG Steering Committee members were in attendance. As exciting as this concept is, OPAG urges caution on the part of NASA. As presented at the workshop, and at the Europa Clipper Science Definition Team Meeting Invited Advisory Session on Potential Plume Measurements, held at the Applied Physics Laboratory in June 2014, new *HST* observations of Europa have yet to confirm the existence of any plumes on Europa. Plumes may exist but be below the detection threshold of present-day observations, or they may be intermittent. But the lack of definitive observations hinders our attempts at plume characterization, much less instrument design for potential “bio-signature” experiments at Europa.

OPAG notes that, at present, there is no clear scientific consensus on how to best detect living organisms elsewhere in the solar system, short of bringing back samples to terrestrial laboratories. How to return enough sample to be able to address these questions is also not clear since the volume of sample required to be able to make such detections is immense. In contrast, assessing the prerequisites for habitability (e.g., water, energy, biogenic elements) is feasible with planetary spacecraft, as is searching for the signatures of life as we know it (specific organic chemical attributes, isotopic ratios, i.e., “biomarkers”). Methods for determining compelling biomarkers and instruments and technology to improve biomarker detection are worthy of further study by NASA and highlight how the Astrobiology and OPAG communities would benefit from collaboration.

***OPAG finding: The PICASSO and MatISSE programs are ideally suited for the technology development required for instruments for the payload of a future “biosignature” investigation, anywhere in the Solar System. Because it takes a decade or more to develop and test potential flight instruments, NASA should consider increased funding and annual calls for proposals to these programs.***

**3. The Legacy of Cassini.** Cassini's data return from the Saturn system continues to inspire, challenge and enchant us. Cassini has passed the senior review milestone, and funding is secure for the Grand Finale phase of the mission.

We thank NASA HQ for selecting nine additional Cassini Participating scientists in the most recent Cassini Data Analysis and Participating Scientist (CDAPS) cycle. To date, the very successful Cassini Participating scientist program has incorporated over 30 new participating scientists into the Cassini teams. In some cases these young scientists have made significant, new contributions to the growing list of Cassini discoveries.

Looking ahead, we urge NASA to consider continuing this program well past Cassini's end-of-mission in September 2017. The unique end-of-mission science will take time to analyze and understand, promising new results on the origin and evolution of Saturn, its rings and moons. Once the Cassini mission ends and project funding stops the CDAP program remains the best place to fund continued research on these data. The end of project funding for Cassini PI's, Co-Is, and other science associates will push the entire group into the R&A program to continue their research.

We also note that there is considerable pressure to keep science teams small during the mission development phase (e.g. no funding for US JUICE Co-I's on European instrument teams), which also increases pressure on the R&A program to sustain outer solar system scientists between missions' operational phases.

***OPAG finding: The CDAPS program has been incredibly successful in funding analysis and modeling of the wealth of data collected by Cassini. Continuation of CDAP (or possibly OP-DAP [Outer-Planets-DAP]) until the Europa mission is on its way will help to bridge the large gap before the next outer solar system mission and ensure that a knowledgeable cadre of outer planet scientists will be ready to operate and analyze data from the Europa mission instruments.***

**4. New Frontiers.** OPAG welcomes and strongly supports the news of \$5 million for a New Frontiers mission start. Beginning a New Frontiers mission at this time is directly in line with recommendations in the Decadal Survey that NASA select two New Frontiers missions in the decade 2013-2022. These medium-class directed missions, at a complete cost of close to \$1 billion, allow the NASA planetary science community to target regions of great importance in the solar system with capable missions of moderate breadth. These missions especially enable outer solar system science, as four of the seven proposed New Frontiers destinations could be outer solar system targets. Insertion of a New Frontiers mission amid a Discovery selection and the new start of a Europa flagship mission enables us to achieve major Decadal Survey goals, engage the planetary science community and maximize science return per dollar.

***OPAG finding: OPAG recognizes the funding challenges PSD has faced for the past few years. Thus, we are especially appreciative of, and register our support for, the New Frontiers program, and are pleased that the administration has requested funds to restore this critical program.***

**5. Discovery Program.** OPAG supports a robust and continued Discovery Program that welcomes a diverse set of missions, including those to outer solar system targets. We applaud recent changes to the Discovery Program (removal of Phase E costs from the cap) that remove a significant competitive cost disadvantage for proposed missions to the outer planets, which require longer duration transits. OPAG recognizes that some outer planets missions are only possible with radioactive power sources and recommends that NASA HQ include RPS as GFE within the Discovery Program.

***OPAG finding: OPAG strongly endorses removal of phase E costs from the Discovery cap, and recommends inclusion of RPS as GFE within the Discovery Program.***

**6. Radio-isotope Power Systems.** There are many potential planetary missions that require use of Radio-isotope Power Systems (RPS), including nearly all that would venture beyond Jupiter. OPAG has a keen interest in RPS because that is currently the only viable option for ice giant missions. To build on the demonstrated reliability of MMRTG technology, increase efficiency of Pu238 usage, and boost end-of-life mission power, the OPAG advocates the Planetary Science Division's continuous upgrade development path for radioisotope thermoelectric generators and Stirling generators.

***OPAG finding: The re-start of domestic production of Pu238 is a significant achievement and enables our continued exploration of the outer solar system. It is important to continue to invest in future technologies thus OPAG also endorses PSD's evaluation of other potential nuclear power system developments (the Nuclear Power Assessment Study) to meet future mission needs, and would like that study report to be released as soon as practical.***

**7. Research and Analysis (R&A) Program.** R&A is an essential part of maximizing science return from NASA's missions, and was recognized by the Decadal Survey as an essential part of a balanced program of planetary exploration. OPAG is naturally concerned about the low selection rate in recent years for the OPR and CDAPS programs especially. Because the looming decade-long gap in outer solar system missions means that many scientists with that expertise will have to be funded largely or even purely through R&A, we are concerned that we will lose vital skills

and knowledge as many outer solar system scientists may be forced to leave the field or seek alternative subjects of study.

The reductions in the PSD budget over the past few years have stressed all elements of NASA's planetary exploration effort. We may have turned a corner, however, with the new start for Mars 2020, a projected new start for the return to Europa, a restart of Pu-238 production, a new Discovery proposal round underway, and concrete plans for the next New Frontiers call. Overall R&A funding has been essentially flat the last few years. It is time to consider increasing this element of the planetary portfolio, to bring it in line with the rest, and maximize our nation's return on its investment.

In addition, the time dedicated to R&A discussion during OPAG meetings continues to grow. It is clear that our community has many questions about, for example, how SSW with two Step-2 deadlines is being implemented, programmatic balance within the new R&A programs, and the distribution of funding between programs. OPAG believes clarity regarding the new R&A organization would go a long way toward addressing community concerns. Although some data is currently available on the SARA site, R&A funding is distributed between multiple lines and remains difficult to track.

***OPAG finding: OPAG finds that increased funding to the R&A programs would improve selection rates and allow more excellent peer-reviewed planetary science and data analysis to proceed. In order not to lose vital expertise in outer solar system science in particular, we encourage NASA to implement a funding line specifically for the outer solar system, similar to MDAP, that would include analysis of data from recent and current missions and planning for future outer planets missions, including JUICE, Europa Clipper, and Cassini. Finally, better communication is key to building confidence in the restructured R&A program. We suggest that quarterly townhall meetings (some could be online) be held to enable productive communication between the science community and program managers.***

## **8. International Collaboration**

**8a. US Participation in ESA's M4 Cosmic Vision.** As numerous projects have demonstrated, strong, close international collaboration greatly increases mission capabilities and resources, enhancing scientific achievements. In many cases, international collaboration is an enabling factor for missions. OPAG lauds NASA's support of several responses to ESA's M4 Cosmic Vision call.

***OPAG finding: The collaborative international partnerships built by missions such as Cassini-Huygens represent decades of effort and investment, and benefit science immensely. In addition to support of the current M4 call, we encourage NASA to look ahead to identify opportunities and find mechanisms to enable***

*collaboration on projects of high priority to both NASA and ESA that would otherwise be out of reach for either agency alone.*

**8b. EXCEED Participating Scientists.** EXCEED is a UV telescope on board the JAXA mission Hisaki in orbit around Earth. Its primary objective is to observe the Io Plasma Torus and Jovian aurora.

*OPAG finding: OPAG recommends that NASA-SMD add a Participating scientist program call within a ROSES 2015 amendment to facilitate the further involvement of US scientists in the EXCEED investigation on the JAXA Hisaki mission. The results obtained will support ongoing Juno, MAVEN, and HST programs and will better inform the plans for future Europa Mission and JUICE investigations. NASA's support would also provide additional rationale for extending Hisaki's science mission beyond 2017.*

**9. Earth-based observations for mission support.** Earth-based, telescopic observations of planetary objects being studied by spacecraft enable greater science return than the mission itself can provide by giving context to the spacecraft data, and by observing the object for a longer time or with different instruments. The Galileo, Cassini, and New Horizons missions have already benefitted from earth-based observations that yielded contextual information on Io's volcanoes and Jupiter's clouds, for example. Future Juno-related science in particular can benefit from use of ground-based assets to find hotspots and to predict the location of major atmospheric features to facilitate targeting of Juno's JunoCam and JIRAM instruments.

Some of the key elements for such support are non-US assets. A previous example of such support was the use of the National Astronomical Observatory of Japan's Subaru Telescope for New Horizons. Such support could easily reflect the interests of their own space scientists and astronomers. For example, ground-based support by the Subaru Telescope would provide complementary information to the Juno campaign suggested by Astro H investigators that, in turn, supports Juno mission science. Ground-based support by ESO's Very Large Telescope would also provide direct support for European scientific interests on Juno, e.g. the Italian-led JIRAM investigation.

*OPAG finding: OPAG encourages NASA to support earth-based observations in general that leverage greater science return from active missions, including non-US assets. We urge NASA to contact key personnel in the appropriate agencies to arrange for such support as early as possible.*

**10. Early career researchers.** Early career researchers represent the next generation of planetary scientists. Early career scientists (ECS) face unique pressures with regards to establishing themselves, acquiring practical experience,

and funding their research. Even the most successful members of the ECS community are concerned about their ability to stay in science.

Mission teams have historically been comprised of established scientists with a few early career participants. Fewer active missions provide fewer opportunities for early career scientists to learn and gain experience from their more senior colleagues. Current trends in mission proposal announcements have brought downward pressure on Phase E budgets, shrinkage of science teams, and an emphasis on minimizing science team size and support throughout development. This is at odds with NASA's need to train early career scientists for the jobs that await in the decades to follow. With a gap in outer planets missions looming, and proposal pressure increasing, outer planets ECS are especially at risk of falling through the cracks, compromising NASA's ability to staff the next generation of planetary science missions with experienced leadership.

***OPAG finding: OPAG encourages NASA to continue funding Early Career Fellowships and to consider ways to increase participation of ECS in planetary missions, from Phase A-D through Phase E. OPAG encourages NASA to continue monitoring the involvement of ECS in planetary missions as well as the R&A program and to find ways to maintain the experienced ECS population needed to conduct future missions.***

## Meeting Outline

Presentations were heard as follows:

### ***Thursday, 19 February 2015***

Welcome, meeting objectives, logistics  
Candy Hansen, Planetary Science Institute

NASA Planetary Science Division Report  
Jim Green, NASA Headquarters

Science Talk 1: Musings on outer solar planet exploration  
Jeff Cuzzi, NASA Ames Research Center

Europa Clipper Update  
Barry Goldstein, Jet Propulsion Laboratory  
Bob Pappalardo, Jet Propulsion Laboratory

Europa Plume Workshop Highlights  
Britney Schmidt, Georgia Institute of Technology

Europa plumes search report  
Lorenz Roth, Royal Institute of Technology, Stockholm, Sweden

Science Talk 2: There is only one Rosetta stone in the solar system  
Toby Owen, IFA, Hawaii

New Horizons Mission Report  
Bill McKinnon, Washington University

Research & Analysis program, Solar System Workings implementation update  
Mary Vojtek, NASA Headquarters

Science Talk 3: From Powell to Pluto: Planetary exploration in perspective  
Torrence Johnson, Jet Propulsion Laboratory

Technology poster session overview  
Pat Beauchamp, Jet Propulsion Laboratory

*Technology Poster Session*  
The list of presenters and posters is on the OPAG website:  
[www.lpi.usra.edu/opag/feb2015/posters/](http://www.lpi.usra.edu/opag/feb2015/posters/)

### ***Friday, 20 February 2015***

JUICE Mission Update  
Olivier Witasse, European Space Agency

Juno Mission Status  
Scott Bolton, Southwest Research Institute

Science Talk 4: Organics and Life  
Chris McKay, NASA Ames Research Center

Nuclear Power Assessment Study results  
Ralph McNutt, JHU/Applied Physics Laboratory

Space and Defense Power Systems: Program information briefing  
Alice Caponiti, Department of Energy

EXCEED Participating Scientists  
Pontus Brandt, JHU/ Applied Physics Laboratory

Io Volcano Observer  
Alfred McEwen, University of Arizona

Low cost sample return from an icy world: Enceladus' plume  
Peter Tsou, Jet Propulsion Laboratory

Enceladus Life Finder: a Discovery mission to the outer solar system  
Jonathan Lunine, Cornell University

Kuiper: A Discovery-class Observatory  
Jim Bell, Arizona State University

Science Talk 5: Exploring Outer Exoplanetary Systems  
Scott Gaudi, Ohio State University

"Big Picture" science themes for outer solar system exploration  
Panel discussion