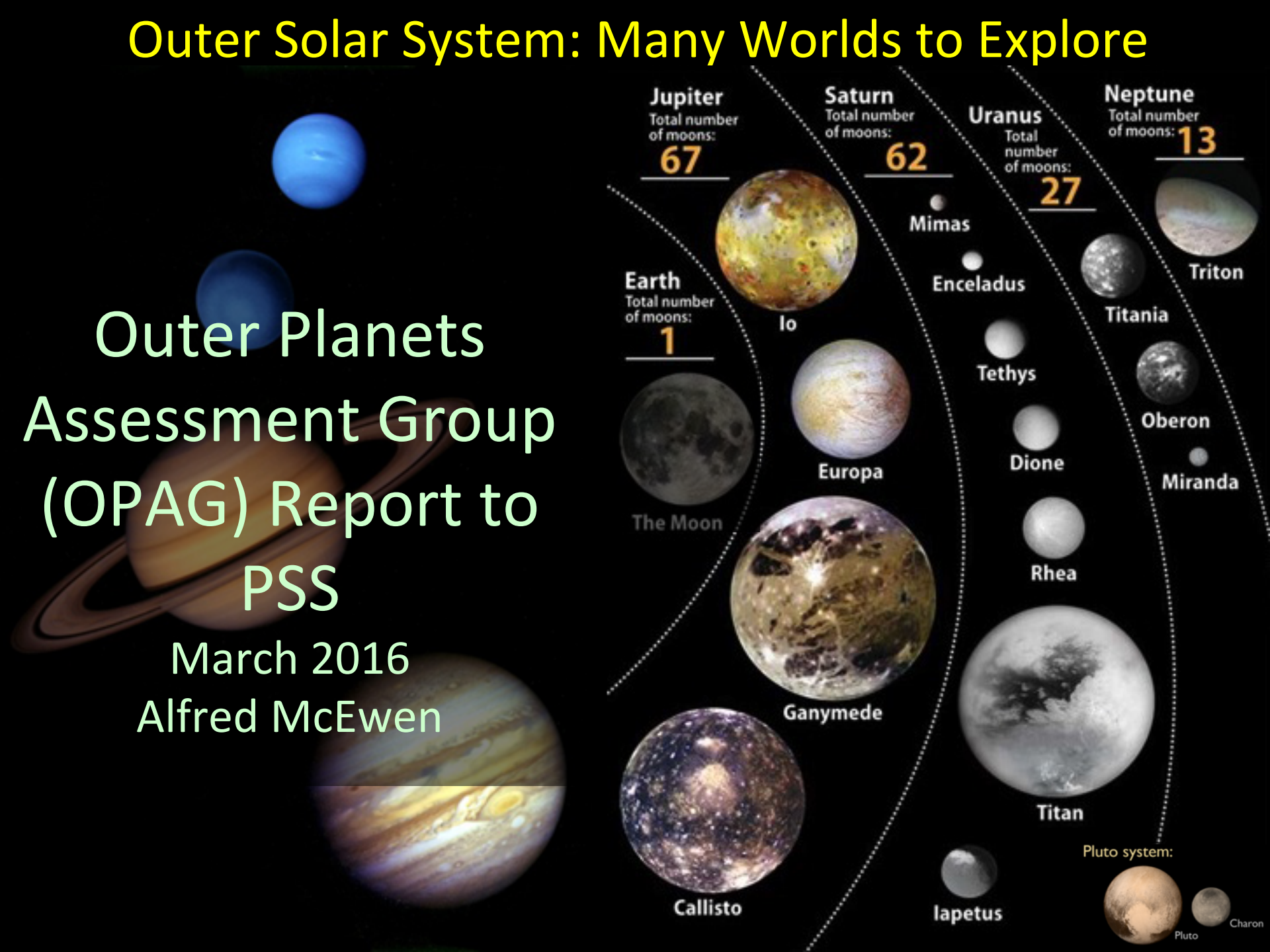
Outer Solar System: Many Worlds to Explore



Outer Planets Assessment Group (OPAG) Report to PSS

March 2016

Alfred McEwen

OPAG Charter and Meetings

Explore Outer Planets and Ocean Worlds

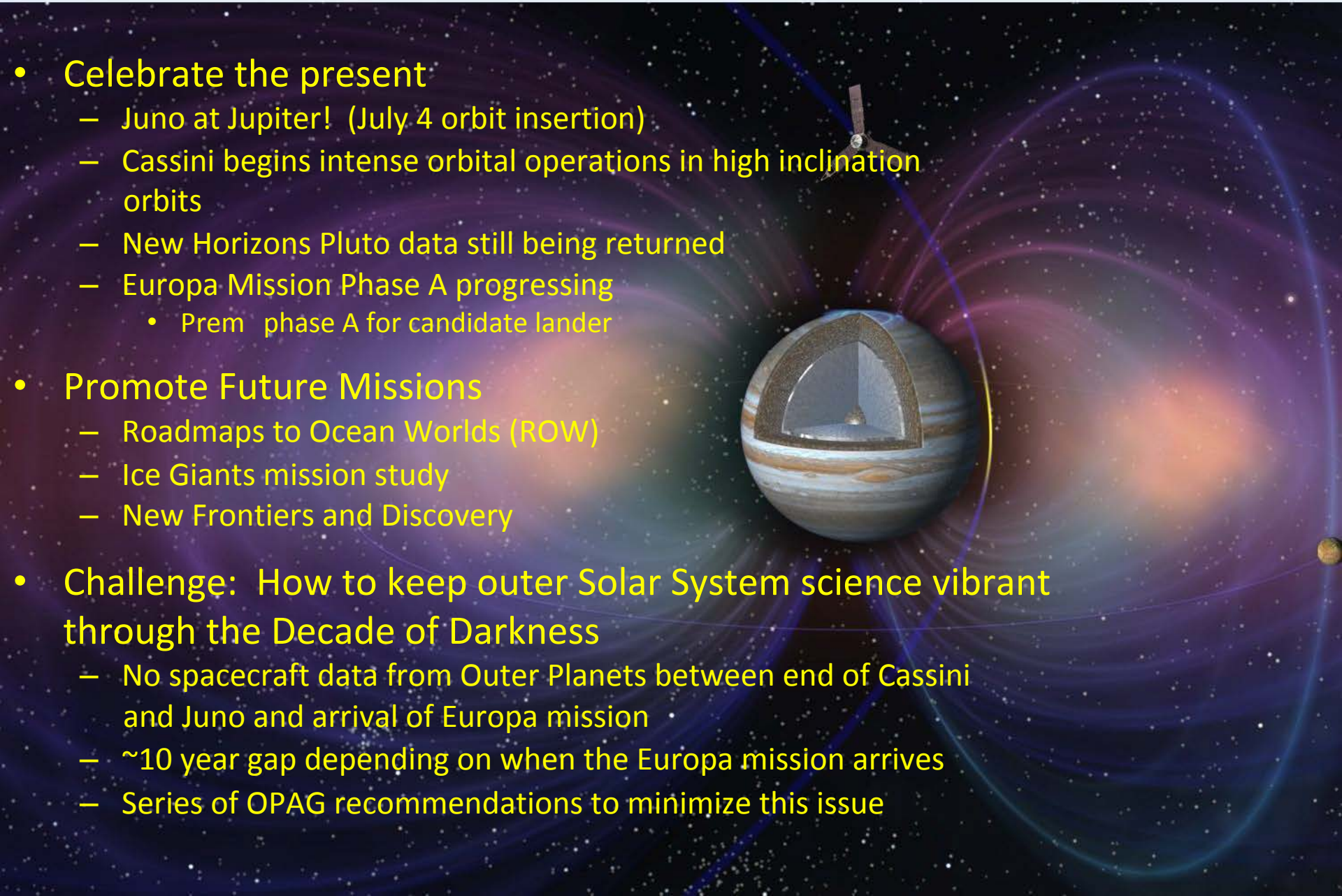
Charter:

- **OPAG regularly evaluates outer Solar System exploration goals, objectives, investigations and required measurements on the basis of the widest possible community outreach. The group assembles twice per year to assess the current state of outer solar system exploration, goals for future exploration, and technology development needed to achieve those goals.**

Meetings:

- The most recent OPAG meeting was Feb 1-2 hosted by SWRI in San Antonio, TX
- OPAG Town Hall at LPSC Thursday March 24 at noon
- Roadmaps to Ocean Worlds (ROW) workshop likely in May
- The next full OPAG meeting will be August 11-12 in Flagstaff AZ
  - ROW workshop on August 10
- Ocean Worlds Meeting Aug 25-26, Woods Hole MA
  - http://www.whoi.edu/oceanworlds2/
- In 2017 we will have winter meetings in Washington DC in late Feb, after president's budget is released.

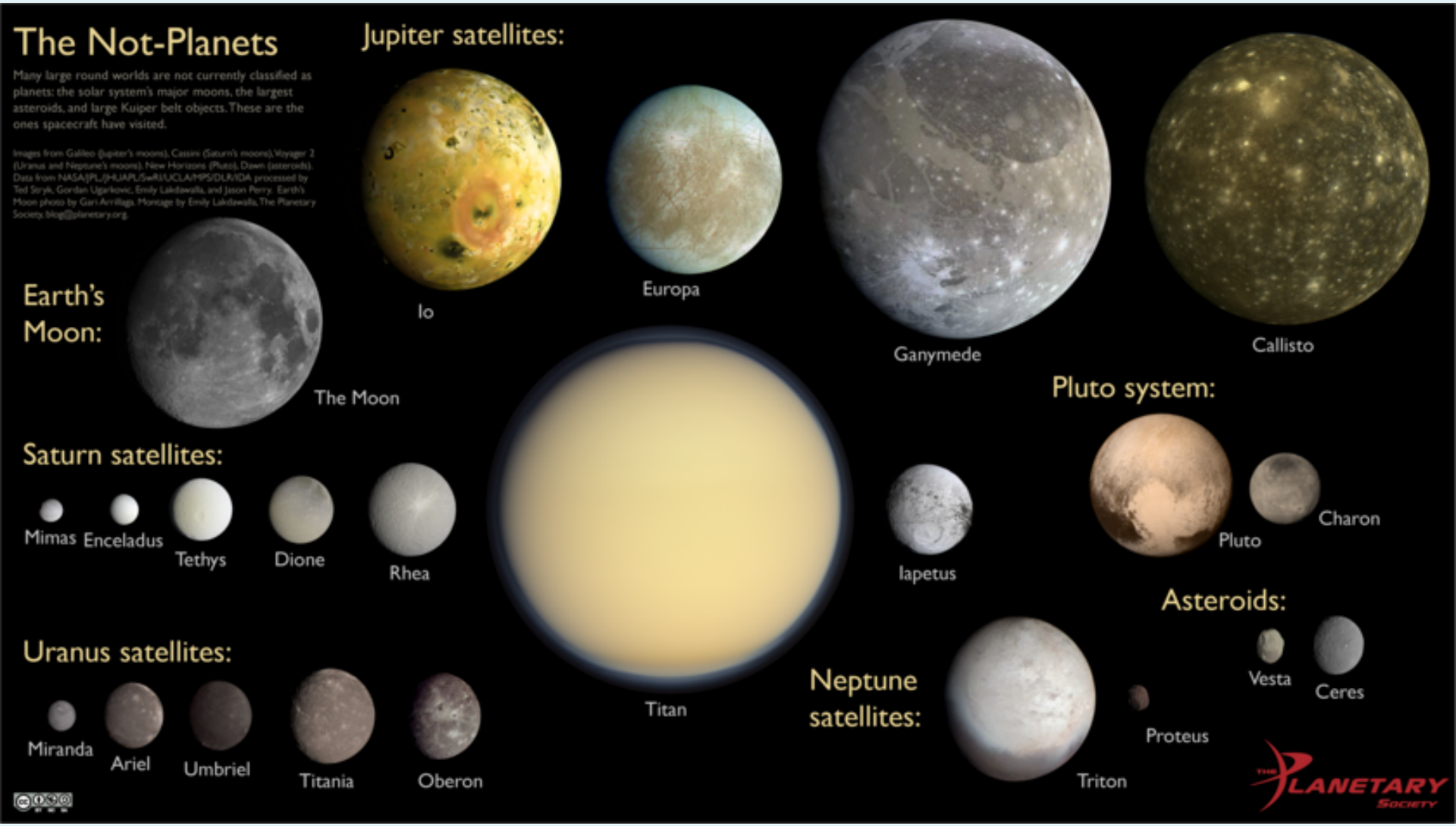
Major objectives for the August meeting



- Celebrate the present
  - Juno at Jupiter! (July 4 orbit insertion)
  - Cassini begins intense orbital operations in high inclination orbits
  - New Horizons Pluto data still being returned
  - Europa Mission Phase A progressing
    - Prem phase A for candidate lander
- Promote Future Missions
  - Roadmaps to Ocean Worlds (ROW)
  - Ice Giants mission study
  - New Frontiers and Discovery
- Challenge: How to keep outer Solar System science vibrant through the Decade of Darkness
  - No spacecraft data from Outer Planets between end of Cassini and Juno and arrival of Europa mission
  - ~10 year gap depending on when the Europa mission arrives
  - Series of OPAG recommendations to minimize this issue

OPAG FINDINGS FROM THE FEB 2016 OPAG MEETING;

FULL REPORT:
HTTP://WWW.LPI.USRA.EDU/OPAG/MEETINGS/FEB2016/FINDINGS.PDF
OR HTTP://WWW.LPI.USRA.EDU/OPAG/MEETINGS/ARCHIVE/



1. Ocean Worlds Program

- **Finding**: *OPAG enthusiastically supports the Ocean Worlds program initiative and the roadmapping effort, and requests logistical support from NASA for Roadmaps to Ocean Worlds (ROW).*
- ROW team is a strategic planning group drawn from the broad outer solar system community to define goals and strategies for exploration of Ocean Worlds.
- ROW co-chairs selected: Amanda Hendrix (PSI) and Terry Hurford (GSFC)

2. FY16 Budget

- **Finding:** *OPAG is pleased by the FY16 budget and the expectation of increased funding for R&A.*
- We were especially pleased to hear Jim Green affirm that the R&A budgets will rise along with the overall PSD budget.

3. Deep Space Network

OPAG is extremely concerned about the DSN organization budget cuts and noticeable loss of data to multiple missions.

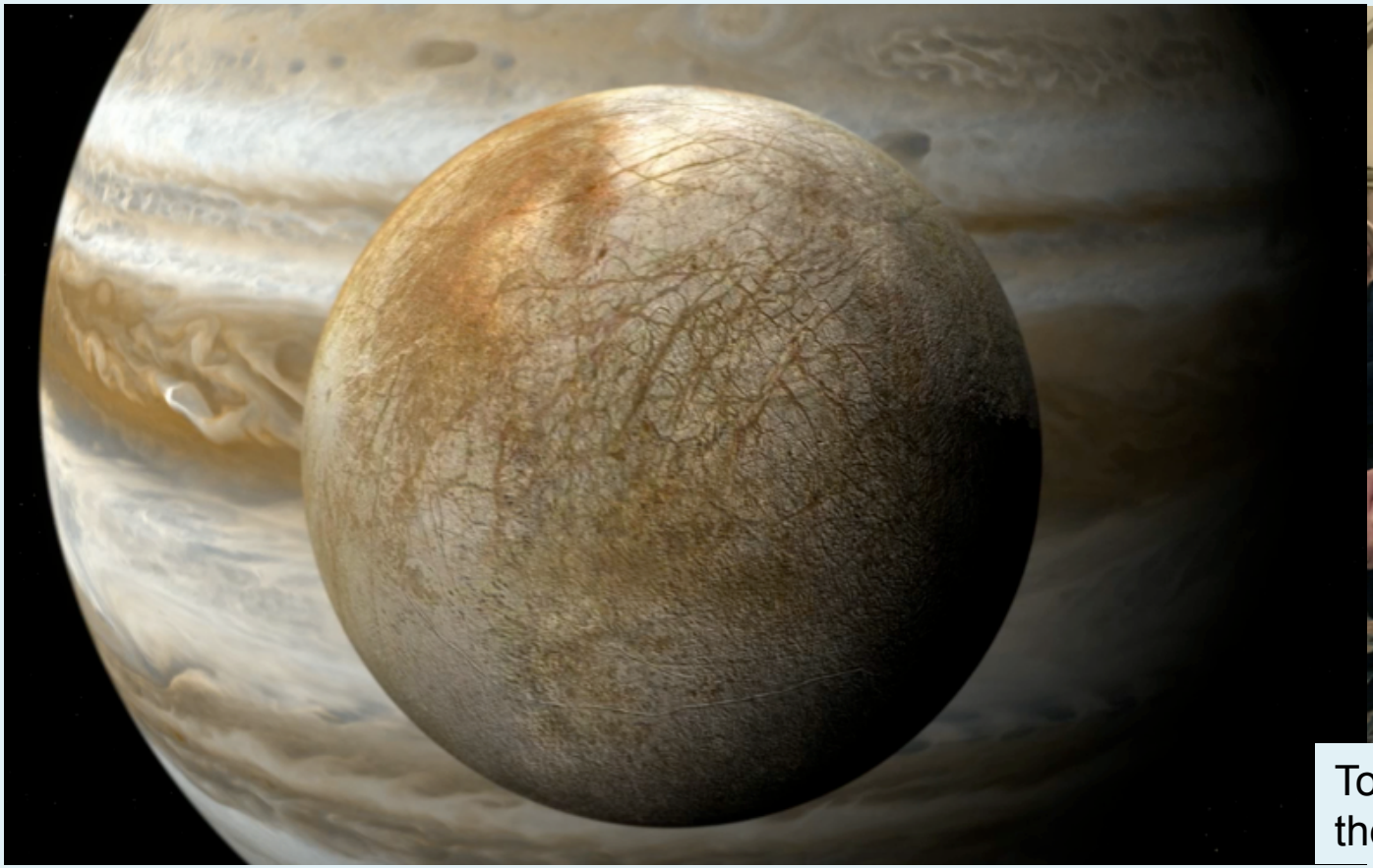
- ***Finding:*** *It is imperative that current DSN capabilities be maintained and OPAG requests an update on this situation by the next PSS meeting.*

From Vision and Voyages:

The Deep Space Network (DSN) is a critical element of NASA's solar system exploration program. It is the only asset available for communications with missions to the outer solar system, and it is heavily subscribed by inner solar system missions as well. As instruments advance and larger data streams are expected over the coming decade, this capability must keep pace with the needs of the mission portfolio. Future demands on the DSN will be substantial. Missions to the distant outer solar system require access to either 70-meter antennas or equivalent arrays of smaller antennas. The DSN must also be able to receive data from more than one mission at one station simultaneously. If new arrays can only mimic the ability of one 70-meter station and nothing more, missions will still be downlink-constrained and will have to compete against one another for limited downlink resources.

4. Europa Mission

- **Finding**: *OPAG strongly supports the Europa multiple flyby mission and urges NASA to remain committed to its earliest possible arrival date at Jupiter.*

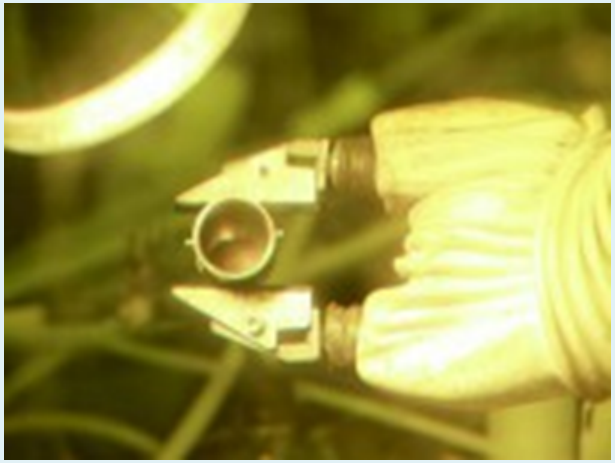


Torrence Johnson receives the 1st monolith award

5. Radioisotope Power Systems (RPS)

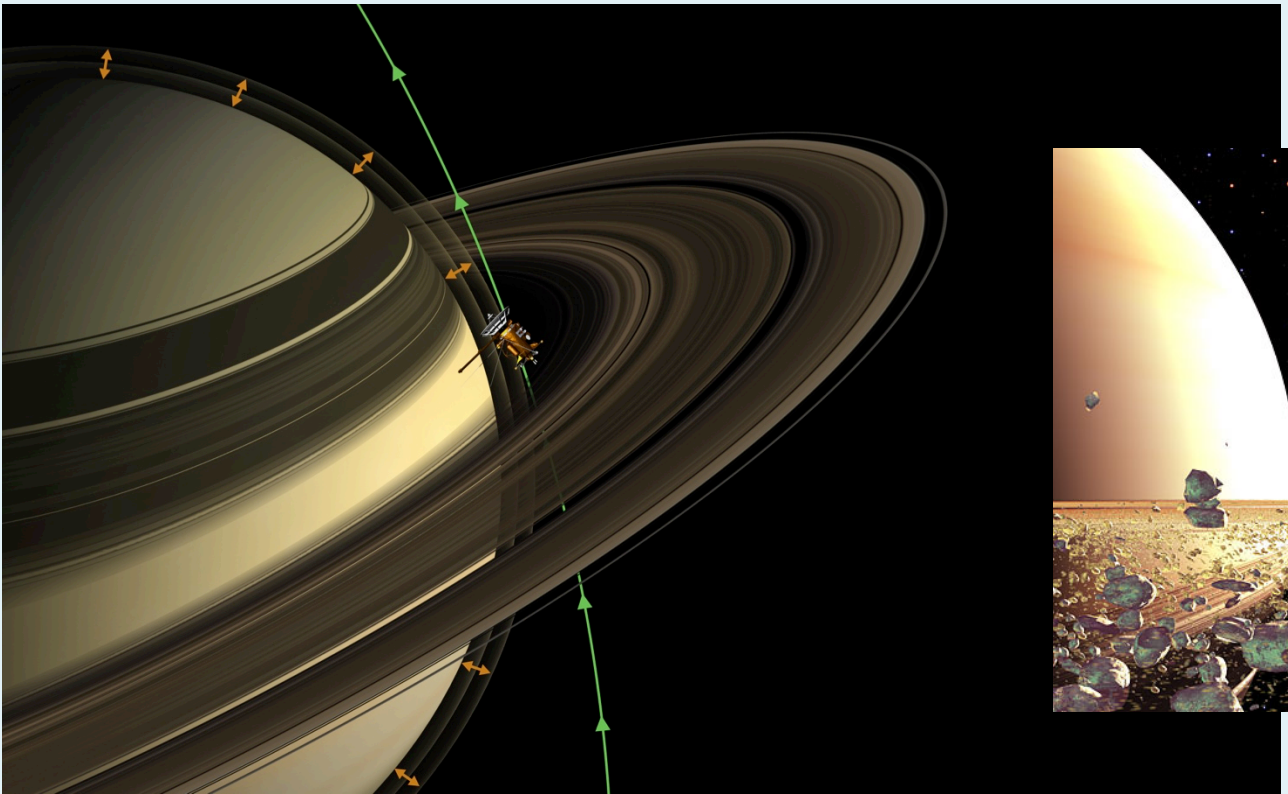
DOE recently produced Pum-238 for the first time in 30 years: a 50-gram demonstration batch using new production processes and equipment.

Finding: *OPAG notes the significant progress being made in the area of RPS. OPAG urges PSD to rapidly advance RPS systems to enable the end-of-mission power levels required for outer planet science missions*



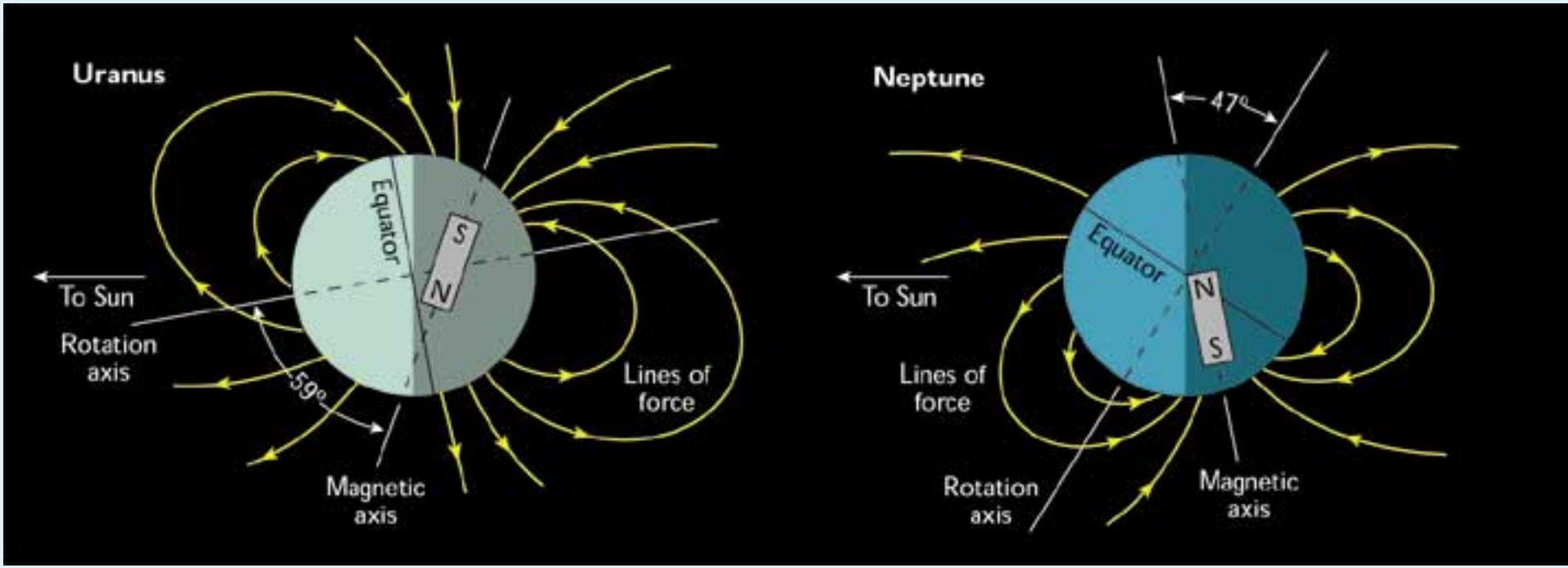
6. The Legacy of Cassini and Cassini Data Analysis Program (CDAP)

- **Finding:** *Continuation of CDAP will help to bridge the large gap before the next outer Solar System mission and ensure that a knowledgeable cohort of outer planet scientists will be ready to analyze data from the Europa mission, as well as other future outer planet missions. We encourage PSD to monitor the selection levels and be prepared to augment CDAP if needed in the future.*



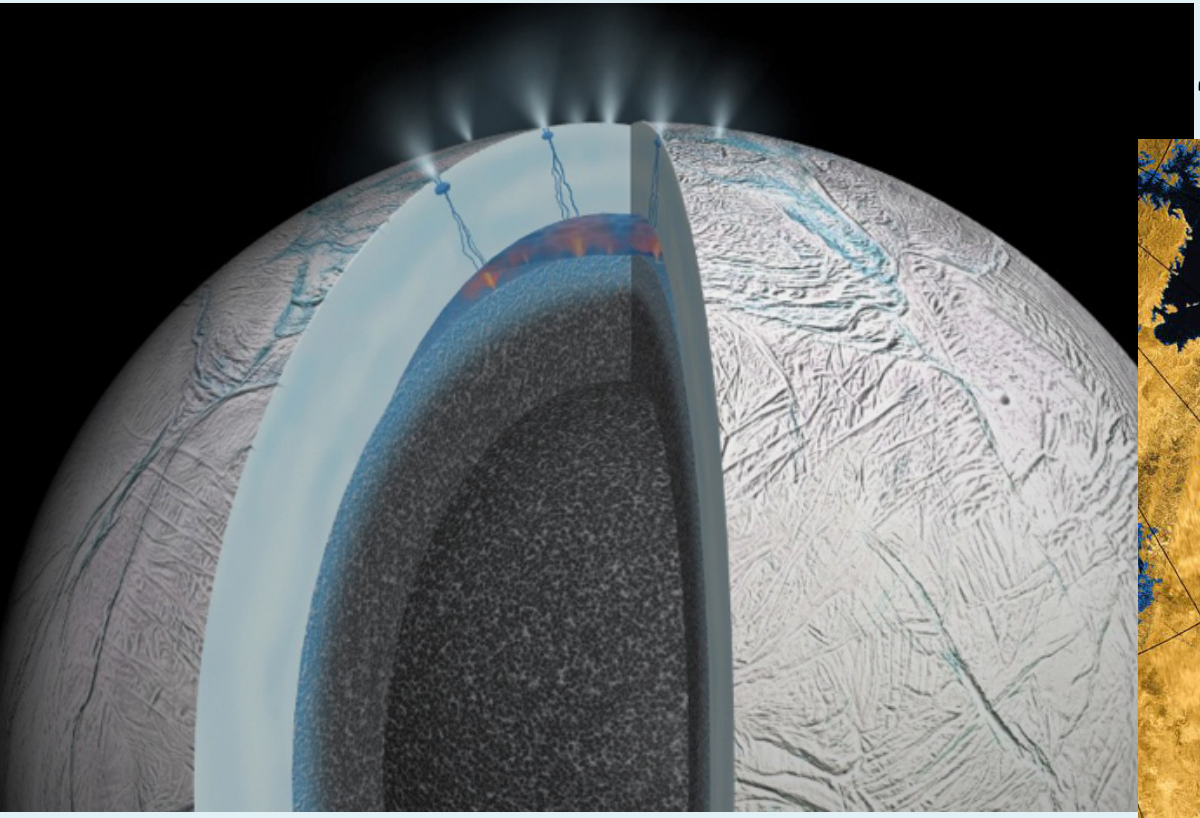
7. Ice Giant mission study for the next Decadal Survey

- **Finding:** *OPAG is pleased with the selection of a Science Definition Team for the Ice Giant pre-decadal mission study, as well as the study's ground-rules. We encourage rapid progress on identifying candidate missions and supporting technologies.*



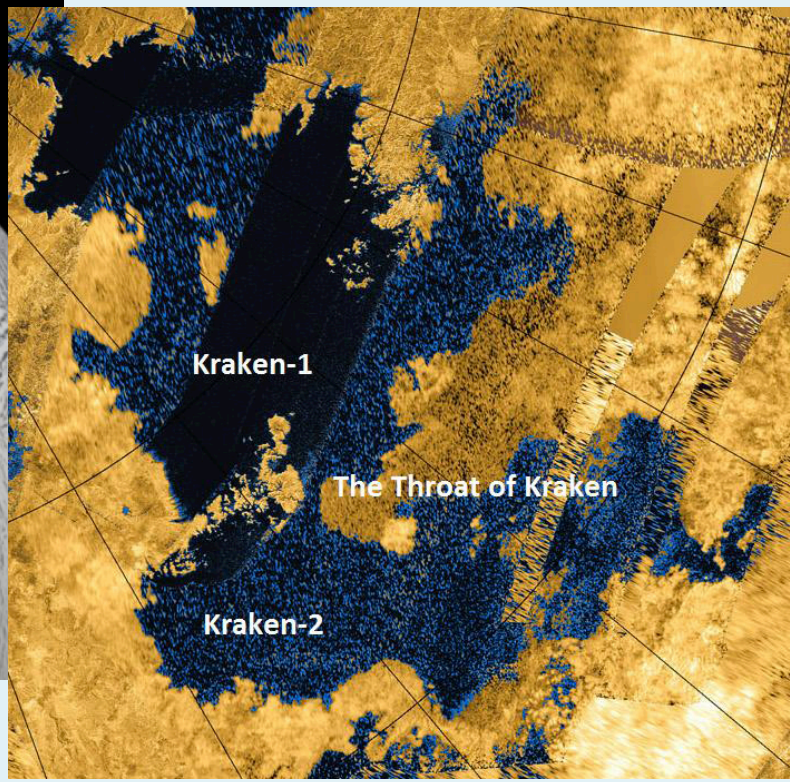
8. New Frontiers

- **Finding:** *Based on the newest results for Titan and Enceladus from Cassini, OPAG supports the inclusion of Ocean Worlds in New Frontiers, and urges NASA to strive to release the NF-5 AO before 2023.*



Enceladus plumes vent directly from ocean.

Whirlpools May Form in Titan's "Throat of Kraken" Strait



9. Discovery Program

- **Finding**: *OPAG recommends the cadence of five Discovery missions every decade and the inclusion of RPS as GFE within the Discovery Program.*

10. Participating Scientist Programs

- **Finding:** *We encourage NASA to consider broader use of participating scientist programs and early career mission support. At NASA's request OPAG (working with other AGs) will lead a white paper providing more detailed information to NASA about the importance and effectiveness of such programs.*

11. International Collaboration

- **Finding:** *NASA should facilitate cooperative activities with foreign-led missions whenever appropriate.*

12. CubeSats

- **Finding:** *OPAG encourages PSD to continue development of CubeSats and small instruments for planetary exploration.*

13. Astrophysics Assets for Outer Planets Research

- **Finding:** *We encourage the continued engagement of the planetary science community in the development and operation of these assets.*

14. New Frontiers Data Analysis Program

- **Finding:** *OPAG prefers that that the New Frontiers Data Analysis Program proposals be due after the second release of New Horizons data by the PDS.*

Roadmaps to Ocean Worlds

Telecons held 2/18/16 and 3/7/16

Amanda Hendrix (PSI), Terry Hurford (GSFC)
co-chairs

ROW Membership

Amend	Jan	USC
Aye	Michael	Univ. Colorado
Bannister	Michele	Univ. Victoria
Barge	Laurie	JPL
Beauchamp	Patricia	JPL
Bland	Michael	USGS
Bowman	Jeff	LDEO/Columbia U.
Byrne	Paul	N. Carolina State
Cabrol	Nathalie	NASA Ames/SETI
Castillo-Rogez	Julie	JPL
Collins	Geoffrey	Wheaton
Cooper	John	GSFC
Elder	Catherine	JPL
Furfaro	Roberto	U. Arizona
German	Chris	WHOI
Glein	Chris	SwRI
Hand	Kevin	JPL
Hayes	Alex	Cornell
Hibbard	Kenneth	JHU/APL
Hoehler	Tori	NASA Ames
Howett	Carly	SwRI
Kargel	Jeffrey	U. Arizona

Lindensmith	Chris	JPL
Lopes	Rosaly	JPL
MacKenzie	Shannon	U. Idaho
Malaska	Michael	JPL
McKay	Chris	NASA Ames
Neish	Catherine	U. Western Ontario
Neveu	Marc	ASU
Olkin	Cathy	SwRI
Pappalardo	Robert	JPL
Phillips	Cynthia	JPL
Portyankina	Ganna	U. Colorado
Quick	Lynnae	PSI
Rhoden	Alyssa	ASU
Schenk	Paul	LPI
Schmidt	Britney	Georgia Tech
Sherwood	Brent	JPL
Shock	Everett	ASU
Singer	Kelsi	SwRI
Soderblom	Jason	MIT
Sotin	Christophe	JPL
Turtle	Elizabeth	JHU/APL
Vance	Steve	JPL
Westlake	Joseph	JHU/APL
Wray	James	Georgia Tech

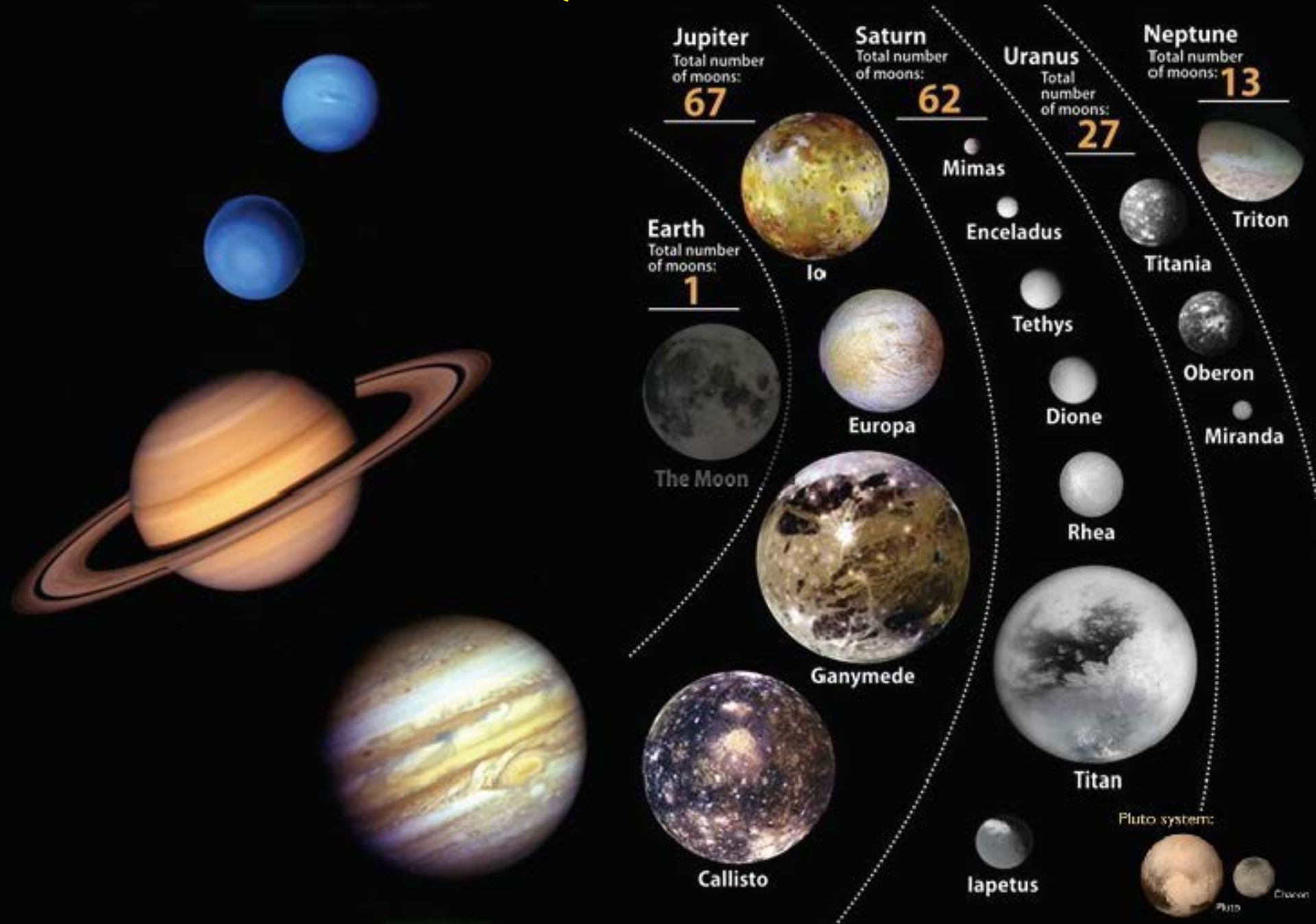
ROW

Draft Schedule & Milestones

Item	Date
Kickoff	February 2016
Define Science Questions?	April 2016?
ROW Team Face-to-Face Meeting	May 2016?
Define Overall Road Map?	June 2016?
Update to SBAG	June 2016
Progress Report to OPAG	August 2016
Assess how Ocean Worlds meet science goals?	September 2016?
Outline broad mission concepts?	October 2016?
Final Report	December 2016

We will aim for telecons every ~2 weeks.

Questions?


Jupiter
Total number of moons:
67
Saturn
Total number of moons:
62
Uranus
Total number of moons:
27
Neptune
Total number of moons:
13
Earth
Total number of moons:
1
Io
Mimas
Enceladus
Tethys
Dione
Rhea
Titan
Iapetus
Titania
Oberon
Miranda
Triton
Europa
The Moon
Ganymede
Callisto
Pluto system
Pluto
Charon