

Planetary Science Division Status Report



Jim Green

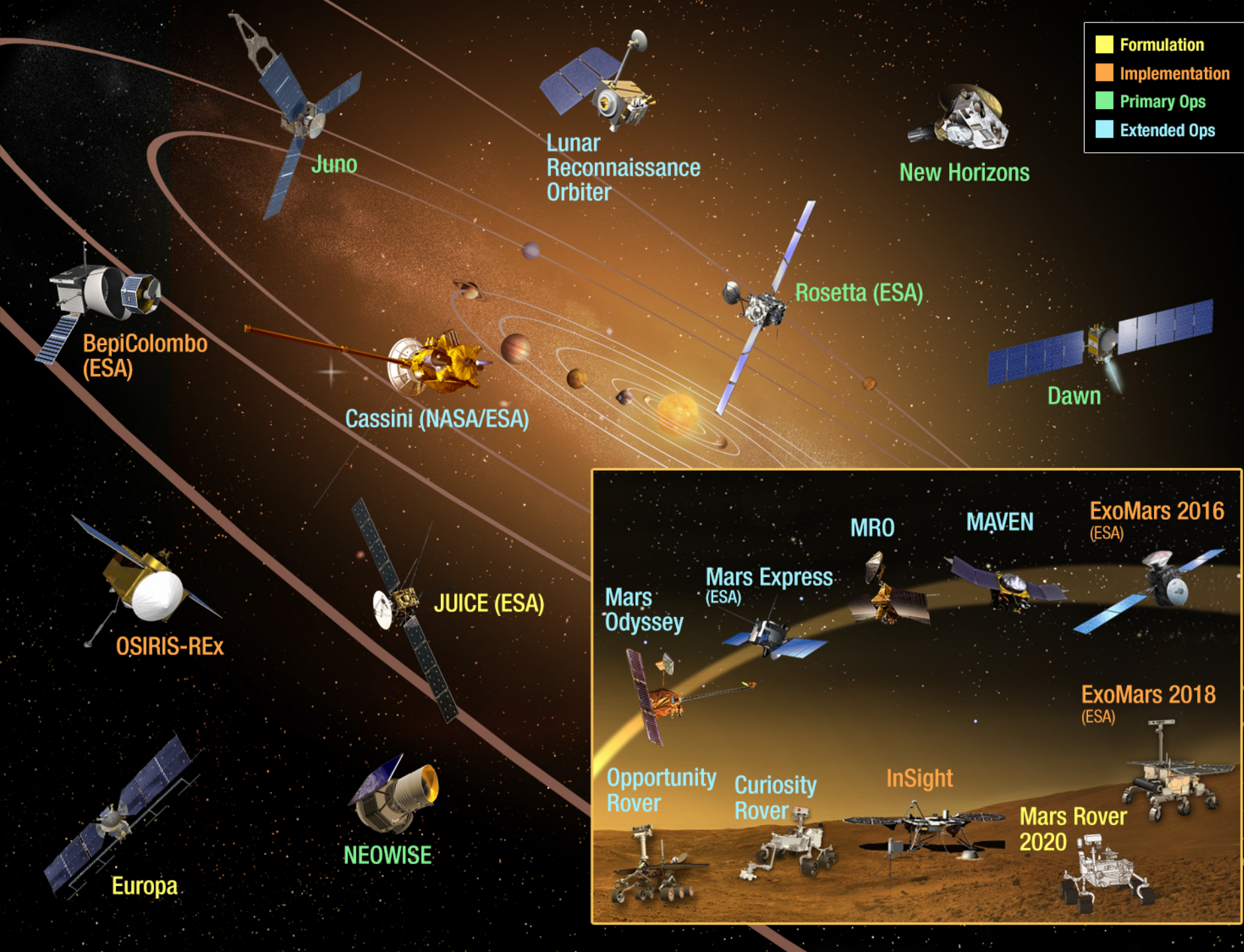
NASA, Planetary Science Division

February 2, 2016

Presentation at OPAG

Outline

- Mission Overview
- FY 2016 Appropriation
- Discovery & New Frontiers and Mars Exploration Programs
- Europa mission
- New Cubesat Selections
- Initiate New Activities





Planetary Science Missions Events

2014

- July – *Mars 2020* Rover instrument selection announcement * **Completed**
- August 6 – 2nd Year Anniversary of *Curiosity* Landing on Mars
- September 21 – *MAVEN* inserted in Mars orbit
- October 19 – Comet Siding Spring encountered Mars
- September – *Curiosity* arrives at Mt. Sharp
- November 12 – ESA's *Rosetta* mission lands on Comet Churyumov–Gerasimenko
- December 2/3 – Launch of *Hayabusa-2* to asteroid 1999 JU₃

2015

- March 6 – *Dawn* inserted into orbit around dwarf planet Ceres
- April 30 – *MESSENGER* spacecraft impacted Mercury
- May 26 – Europa instrument Step 1 selection
- July 14 – *New Horizons* flies through the Pluto system
- September – Discovery 2014 Step 1 selection
- December 6 – *Akatsuki* inserted into orbit around Venus

2016

- March – Launch of ESA's *ExoMars Trace Gas Orbiter* (Launch of NASA's *InSight* postponed)
- July 4 – *Juno* inserted in Jupiter orbit
- September – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu
- September – *Cassini* begins plane change maneuver for the “Grand Finale”
- Late 2016 – Discovery 2014 Step 2 selection

FY16 Appropriation supports a robust Planetary Science program

Planetary Science \$270M above the request, at \$1.63B

- \$277M for Planetary Science Research
- \$189M for Discovery (+\$33M), including full funding for LRO
- \$259M for New Frontiers
- \$448M for Mars (+\$36M), including full funding for Opportunity
- \$197M for Technology (+\$55M)
 - Includes \$25M for icy satellites surface technology
- \$261M for Outer Planets (+\$145M) with direction
 - Directs that the Europa mission be launched on an SLS in 2022 and that a lander be included (\$175M)
- Direction to continue to fund AIDA/DART joint study with ESA
- Direction to establish a new Ocean Worlds program *with a primary goal to discover extant life on another world* using a mix of Discovery, New Frontiers, and flagship class missions.

Ocean Worlds (OW)

- Working with Astrobiology on life detection instruments for OW
- Developing the “ladder of life”
 - Type of life measurement versus instruments
- Discovery is open to OW mission proposals
- Titan and Enceladus added as targets in New Frontiers
- Request OPAG to develop an OW Roadmap consistent with the Planetary Decadal

Discovery and New Frontiers

- ◆ Address high-priority science objectives in solar system exploration
- ◆ Opportunities for the science community to propose full investigations
- ◆ Fixed-price cost cap full and open competition missions
- ◆ Principal Investigator-led project



- ◆ Established in 1992
- ◆ **\$450M cap** per mission excluding launch vehicle and operations phase (FY15\$)
- ◆ Open science competition for all solar system objects, except for the Earth and Sun



- ◆ Established in 2003
- ◆ **\$850M cap** per mission excluding launch vehicle and operations phase (FY15\$)
- ◆ Addresses high-priority investigations identified by the National Academy of Sciences

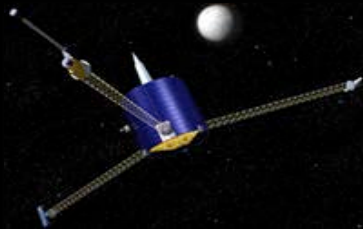
Discovery Program

Completed

**Mars evolution:
Mars Pathfinder (1996-1997)**



**Lunar formation:
Lunar Prospector (1998-1999)**



**NEO characteristics:
NEAR (1996-1999)**



**Solar wind sampling:
Genesis (2001-2004)**



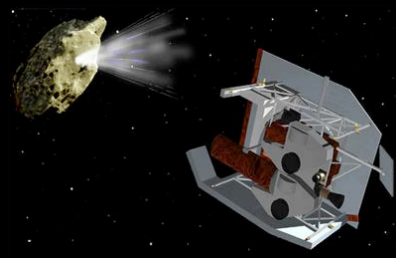
**Comet diversity:
CONTOUR (2002)**



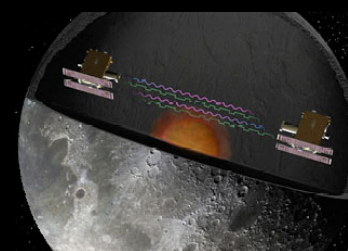
**Nature of dust/coma:
Stardust (1999-2011)**



**Comet internal structure:
Deep Impact (2005-2012)**

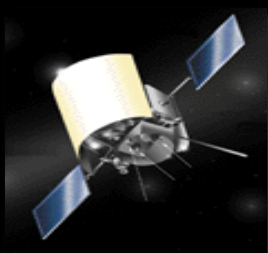


**Lunar Internal Structure
GRAIL (2011-2012)**

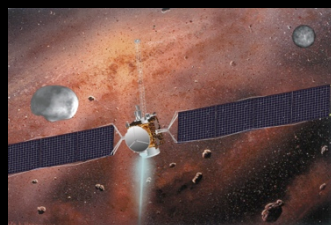


Completed

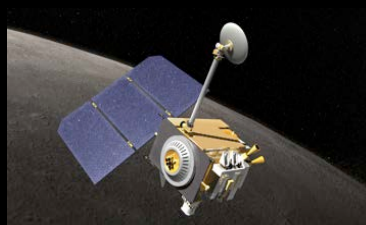
**Mercury environment:
MESSENGER (2004-2015)**



**Main-belt asteroids:
Dawn (2007-2016)**



**Lunar surface:
LRO (2009-TBD)**



**ESA/Mercury Surface:
Strofió (2017-TBD)**



**Mars Interior:
InSight (TBD)**





Status of Discovery Program

Discovery 2014 – Selections announced September 30

- About 3-year mission cadence for future opportunities

Missions in Development

- *InSight*: Missed March 2016 launch window
- Strofio: Delivered to SERENA Suite (ASI) for BepiColombo

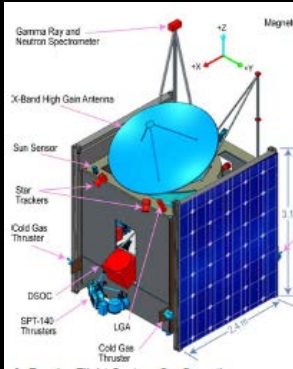
Missions in Operation

- *Dawn*: Science observation now in Low Altitude Mapping Orbit

Missions in Extended Operations

- *LRO*: In stable elliptical orbit, passing low over the lunar south pole

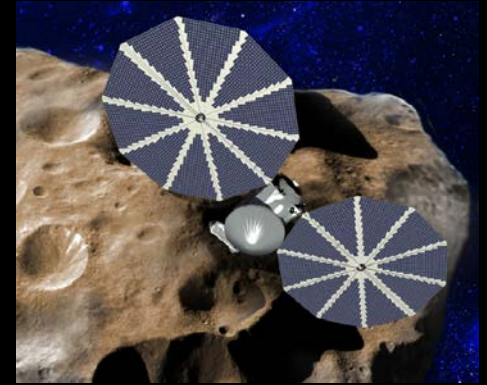
Discovery Selections 2014



Psyche: Journey to a Metal World
PI: Linda Elkins-Tanton, ASU
Deep-Space Optical Comm (DSOC)



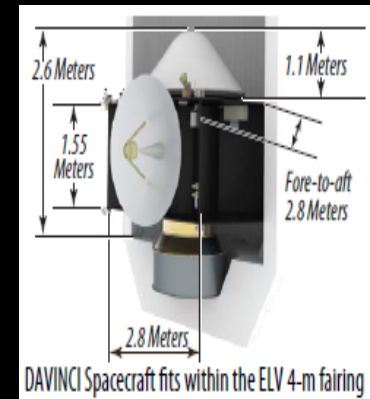
NEOCam:
Near-Earth Object Camera
PI: Amy Mainzer, JPL
Deep-Space Optical Comm (DSOC)



Lucy: Surveying the Diversity of Trojan Asteroids
PI: Harold Levison, Southwest Research Institute (SwRI)
Advanced Solar Arrays



VERITAS: Venus Emissivity, Radio Science, InSAR, Topography, And Spectroscopy
PI: Suzanne Smrekar, JPL
Deep-Space Optical Comm (DSOC)



DAVINCI: Deep Atmosphere Venus Investigations of Noble gases, Chemistry, and Imaging
PI: Lori Glaze, GSFC

New Frontiers Program

1st NF mission
New Horizons:

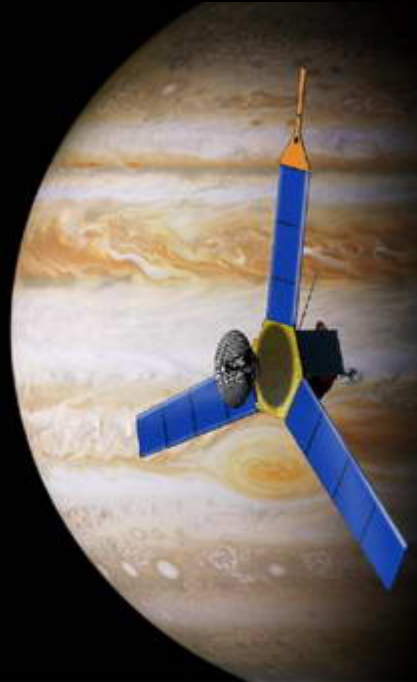
Pluto-Kuiper Belt



Launched January 2006
Flyby July 14, 2015
PI: Alan Stern (SwRI-CO)

2nd NF mission
Juno:

Jupiter Polar Orbiter



Launched August 2011
Arrives July 4, 2016
PI: Scott Bolton (SwRI-TX)

3rd NF mission
OSIRIS-REx:

Asteroid Sample Return



Launch window: Sept. 8,
2016
PI: Dante Lauretta (UA)

Status of New Frontiers Program

Missions in Development – OSIRIS-REx

- Launch in Sept 2016 & encounter asteroid Bennu in Oct 2018.
- Operate at Bennu for over 400 days.
- Returns a sample in 2023 that scientists will study for decades with ever more capable instruments and techniques.

Missions in Operation

- New Horizons:
 - Pluto system encounter July 14, 2015
 - NH targeted to a small Kuiper Belt object (2014 MU69)
 - Will be in the 2016 Senior Review
- Juno:
 - Spacecraft is ~54 million miles from Jupiter
 - Orbit insertion is July 4, 2016

Pluto News



- New Horizons Team selected as the 2016 winner of the Robert Goddard Memorial Trophy
- Twitter has named #PlutoFlyby one of the most influential moments of 2015
- The Pluto mission won the popular vote in Science Magazine's list of the biggest science breakthroughs of 2015
- The iconic image of Pluto revealed on the morning of July 14 was among TIME's list of the Top 100 Photos of 2015

Next New Frontiers Program AO

- Community Announcement Regarding New Frontiers Program January 2016
- Draft to be released by end of Fiscal Year 2016
- Investigations are limited to the following mission themes (listed without priority):
 - Comet Surface Sample Return
 - Lunar South Pole-Aitken Basin Sample Return
 - Ocean Worlds (Titan, Enceladus)
 - Saturn Probe
 - Trojan Tour and Rendezvous
 - Venus In Situ Explorer

Five themes are described in the Planetary Science Decadal Survey. The Ocean Worlds theme for this announcement is tentatively focused on the search for signs of extant life and/or characterizing the potential habitability of Titan or Enceladus. The draft AO will fully elucidate information on the mission themes.

Next New Frontiers AO Time Frame

Notional Schedule:

- Release of final AO..... January 2017 (target)
- Preproposal conference..... ~3 weeks after final AO release
- Proposals due ~90 days after AO release
- Selection for competitive Phase A November 2017 (target)
- Concept study reports due..... October 2018 (target)
- Down-selection May 2019 (target)
- KDP B August 2019 (target)
- Launch readiness date 2024

RPS Mission Planning

<div> <div> <div>Strategic</div> <div>New Frontiers</div> <div>Discovery</div> </div> <div> <div>Mars</div> <div>Lunar</div> <div>Other</div> </div> </div>		Projected Launch Year	Power Reqmnt (W_e)	RPS Type (Flight + Spare)	Pu-238 Availability
Mars Science Lab	Operational	2011	100	1 MMRTG	Yes
Mars 2020	In Development	2020	120	1 MMRTG + Spare	Yes
New Frontiers 4	In Planning	2025	300	3 MMRTG/ eMMRTG	Yes
New Frontiers 5	Notional	2030	300	TBD	Requires new

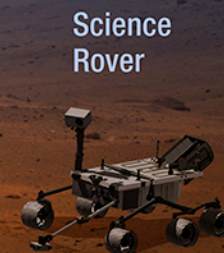
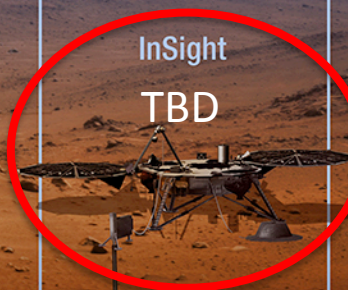
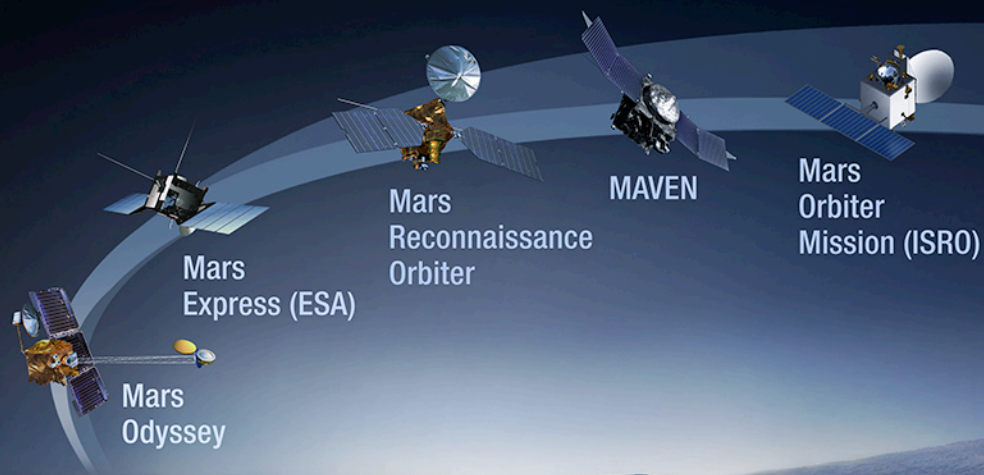
- Up to 3 MMRTGs can be used for NF4, with LRD of 2025
- Potential 5-6 year-cadence for New Frontier mission opportunities
 - RPS not required for all mission concepts
- Radioisotope heater units may be used on missions that do not require RPS
- Strategic missions often require RPS; highest priority strategic missions in current decadal (Mars 2020 and Europa) are already in work
 - Mars 2020 will use an MMRTG
 - Europa mission will be solar powered

Operational 2001–2015

2016

2018

2020



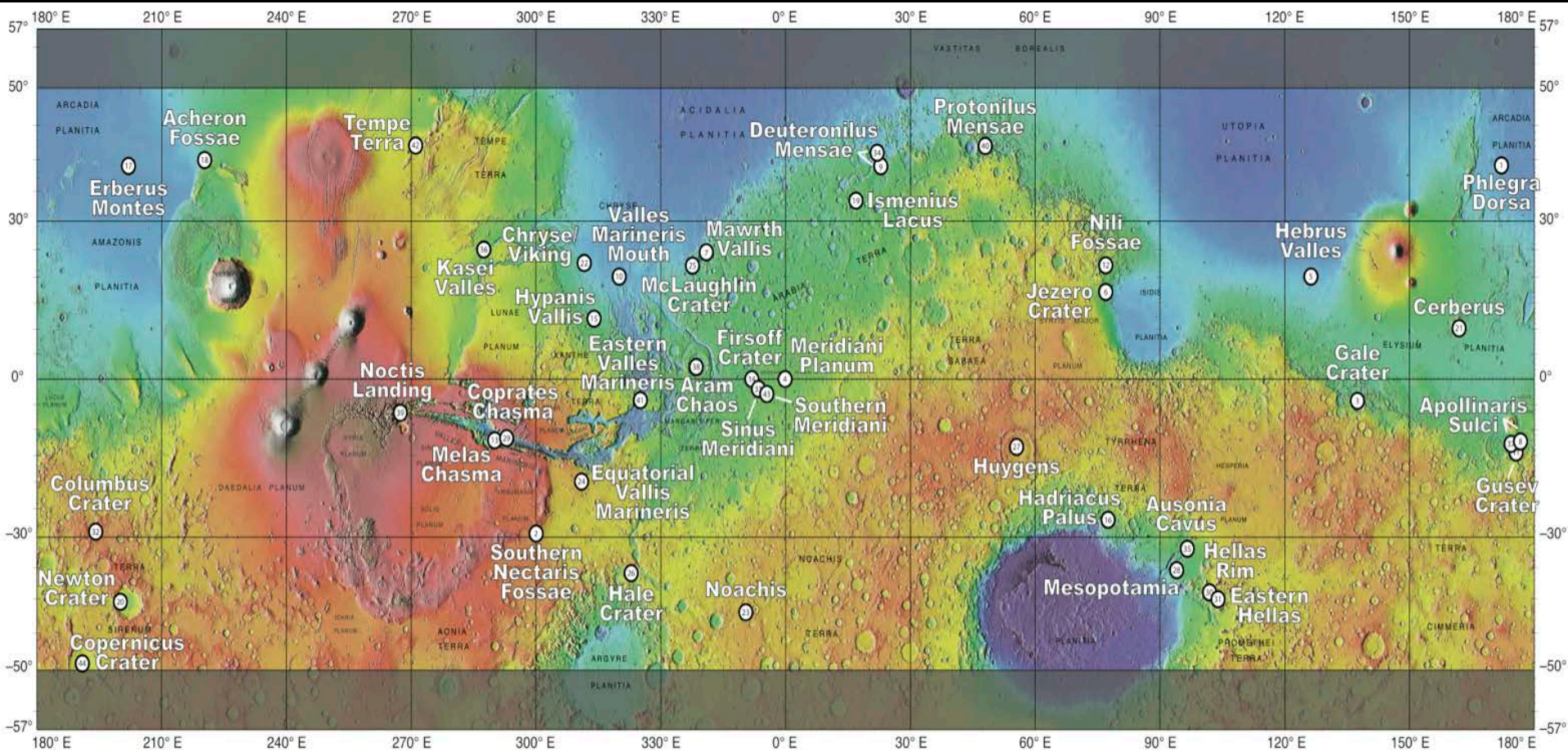
Follow the Water

Explore Habitability

Seek Signs of Life

Prepare for Future Human Explorers

Potential Exploration Zones

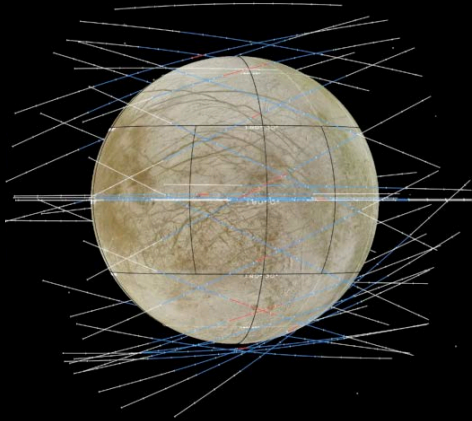


1st Human Landing Site Workshop
October 27-30 at LPI

#JOURNEYTOMARS

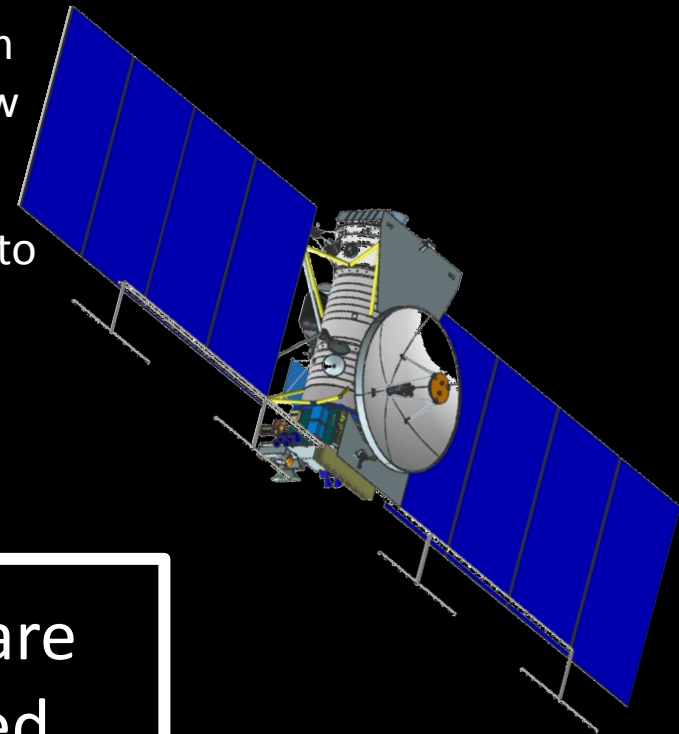


Europa Multi-Flyby Mission Concept Overview



Science	
Objective	Description
Ice Shell & Ocean	Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange
Composition	Understand the habitability of Europa's ocean through composition and chemistry.
Geology	Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.
Recon	Characterize scientifically compelling sites, and hazards for a potential future landed mission to Europa

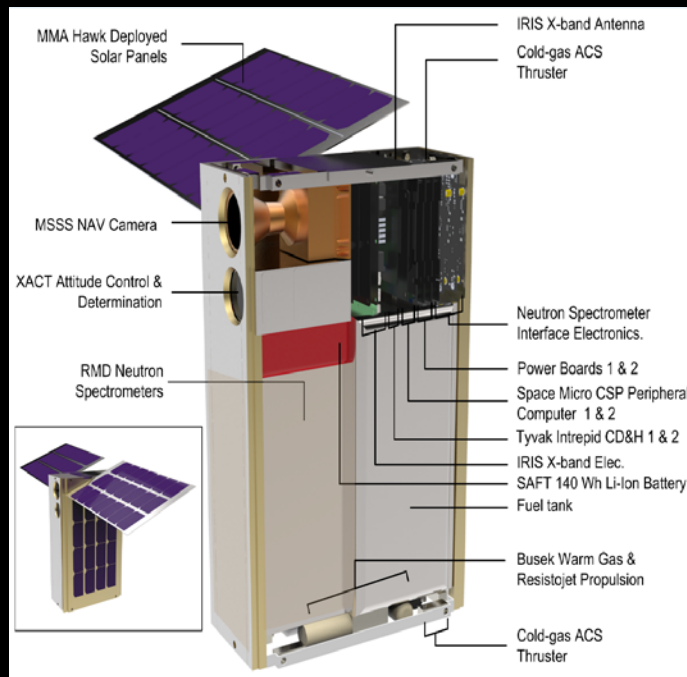
- Conduct 45 low altitude flybys with lowest 25 km (less than the ice crust) and a vast majority below 100 km to obtain global regional coverage
- Traded enormous amounts of fuel used to get into Europa orbit for shielding (lower total dose)
- Simpler operations strategy
- No need for real time down link



Lander Options are
being Considered

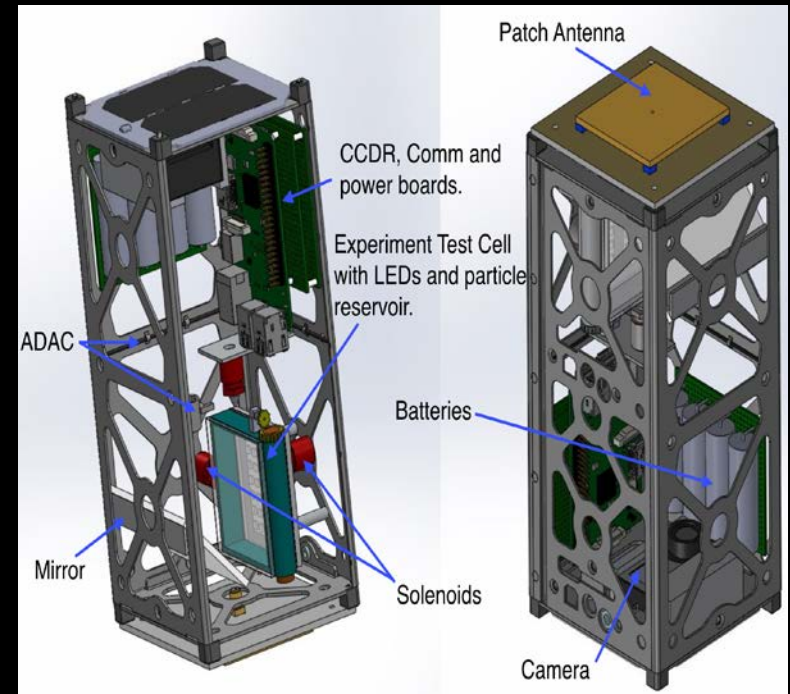
SIMPLEx Cubesats Selections
Full missions (2)
and
Approved for 1 year Tech Development (3)

Small Innovative Missions for Planetary Exploration (SIMPLEx-2014) – New Awards in FY15



Lunar Polar Hydrogen Mapper (LunaH-Map)

PI: Craig Hardgrove
ASU School of Earth and Space Exploration

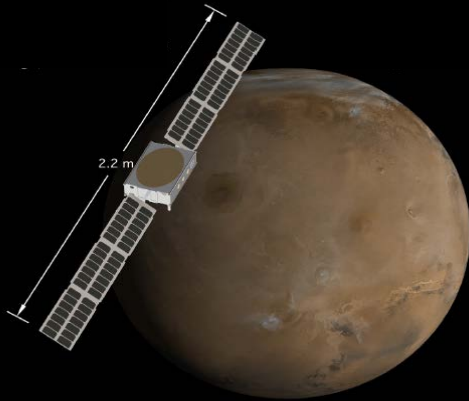


CubeSat Particle Aggregation and Collision Experiment (Q-PACE)

PI: Josh Colwel
University of Central Florida

Simplex Cubesats

Approved for Tech Development (1 year) Study ONLY



Mars Micro Orbiter

PI: Michael Malin

Malin Space Science Systems

Diminutive Asteroid Visitor using Ion Drive (DAVID)

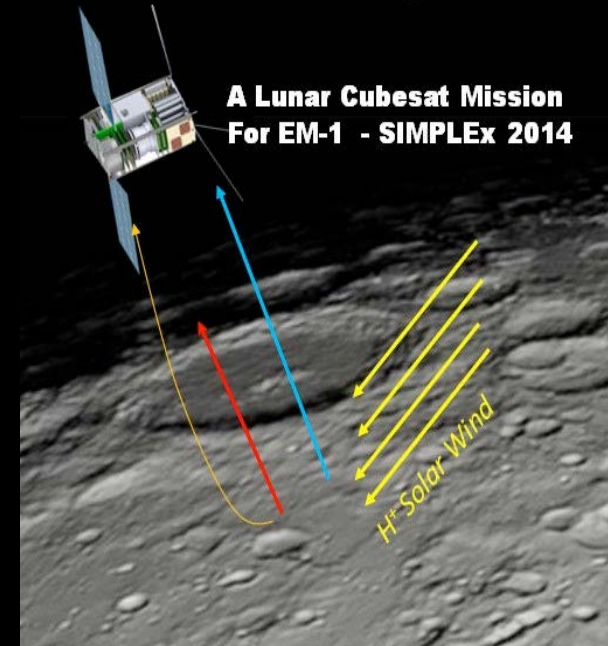
PI: Geoffrey Landis

NASA Glenn Research Center



Hydrogen Albedo Lunar Orbiter (HALO)

A Lunar Cubesat Mission
For EM-1 - SIMPLEx 2014



Hydrogen Albedo Lunar Orbiter (HALO)

PI: Michael Collier,
NASA GSFC

Planetary Defense Coordination Office (PDCO)

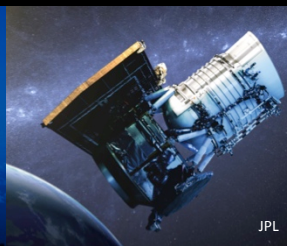
Hosted by the Planetary Science Division PDCO is responsible for:

- Oversight of potentially hazardous objects (PHOs):
 - Ensure early detection
 - Characterize PHOs of size large enough to affect Earth's surface
 - Provide warning of potential impact effects if not deflected or mitigated
 - Provide timely and accurate communications about PHOs and any potential impact
- Lead research into potential asteroid deflection and impact mitigation technologies and techniques
- Provide lead coordination role in U.S. Gov't planning for response to an actual impact threat (*e.g.*, planetary science and deep space mission expertise for Federal Emergency Response Team)



Planetary Defense Coordination Office (PDCO)

- Manages NASA's Near-Earth Object Observations (NEOO) Program to obtain best data available
- Coordinates NEO observation efforts conducted at ground-based observatories sponsored by the National Science Foundation and space situational awareness facilities of the U.S. Air Force
- Participates in Federal agency exercises to plan and develop appropriate potential impact response
- Conducts collaborative research on mitigation techniques with interagency and international partners

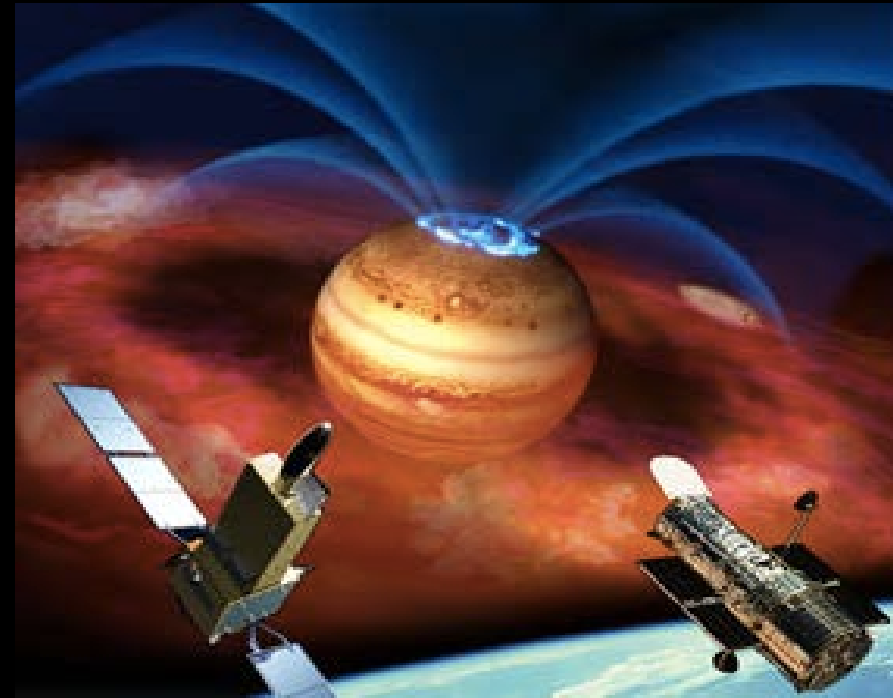


Astrophysics Missions - Planetary Science Community

- New Website: <http://www.lpi.usra.edu/astrophysicsassets/>
- Mission Updates, Links and Presentations:
 - Kepler/K2
 - SOFIA
 - Spitzer
 - HST/JWST
 - IRSA and NEOWISE
 - IRTF
 - PDS
- Important Deadlines for Astrophysics Assets
 - Hubble Cycle 23 mid-cycle call: due by Jan. 31, 2016 (rolling deadline)
 - Hubble Cycle 24 Phase I due: Apr 8, 2016 & Phase II due Jul 21, 2016
 - Kepler K2, Campaigns 11-12-13: due Feb 5, 2016 (submitted through NSPIRES)

HISAKI- Guest Investigator

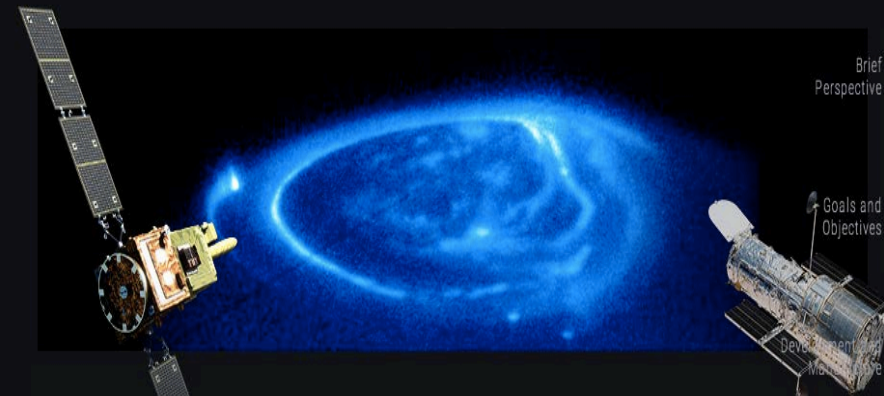
- Hisaki was launch Sept. 2013
- Main science instrument: EXCEED (EUV spectrometer)
- Primary science: Jupiter–Io interaction, auroras, Jovian magnetospheric system
- NASA Hisaki-GI Program announced
 - NOI due: Feb 8, 2016
 - Proposal due: Feb 29, 2016
 - Final Selections Announced in late March/April 2016



Explosion of Jupiter's auroral caused by rapid rotation

-Discovery by the Hubble Space Telescope and Hisaki satellite-

Top



Brief
Perspective

Goals and
Objectives

Development
Mission

Questions?



Image by john doe

Planetary Defense Coordination Office



Public Communications

Lead Program Executive
Planetary Defense Officer

Policy Development

NEO Observation Program

Program Manager
Program Scientist

- Minor Planet Center/IAWN
- Center for NEO Studies @ JPL
- Catalina Sky Survey
- Pan-STARRS
- LINEAR/SST
- IRTF
- GSSR
- NEOWISE
-

Interagency and
Emergency Response Projects
Program Officer(s)

- Interagency coordination
- Emergency Response planning
- Interagency exercises

Mitigation Research Projects
Program Officer(s)

- SMPAG
- ARM Gravity Tractor Demo
- AIDA
- Short Warning Mitigation
-