



Mercury  
Venus  
Earth  
Mars

Jupiter

Uranus

Neptune

Eris

Pluto

Saturn

# Planetary Science Division Update

Jim Green  
Director, Planetary Science  
December 19, 2012

# Planetary Science Mission Recent Events



• Completed

## 2010

- \* September 16 – Lunar Reconnaissance Orbiter in PSD
- \* November 4 - EPOXI encounters Comet Hartley 2
- \* November 19 - Launch of O/OREOS - astrobiology small sat

## 2011

- \* February 14 - Stardust NExT encounters comet Tempel 1
- \* March 7 – Planetary Science Decadal Survey released
- \* March 17 - MESSENGER orbit insertion at Mercury
- \* May 5 – Selection of 3 Discovery-class missions for study
- \* May – Selection of the next New Frontier mission for flight - *OSIRIS-REx*
- \* July 16 - Dawn orbit insertion at asteroid Vesta
- \* August 5 - Juno launch to Jupiter
- \* August 9 - Mars Opportunity Rover arrives at Endeavour Crater
- \* September 10 - GRAIL (A and B) launch to the Earth's Moon
- \* November 26 – Mars Science Laboratory (MSL) launch to Mars
- \* December 31 – GRAIL A (Ebb) orbit insertion at Earth's Moon

## 2012

- \* January 1 – GRAIL B (Flow) orbit insertion at Earth's Moon
- \* June 6 – Venus transits the Sun (last time this Century)
- \* August 5 – MSL/Curiosity successfully lands on Mars
- \* August 20 – Selection of Discovery 12 Mission - *InSight*
- \* September 5 - Dawn leaves Vesta and starts on its journey to Ceres
- \* December 17 – Ebb and Flow impacts the Moon

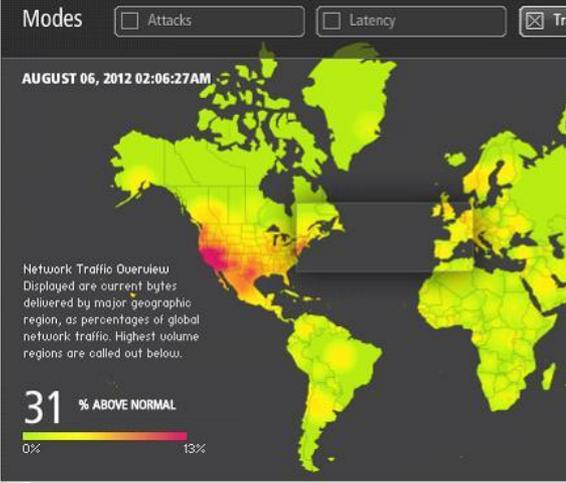


# TOSHIBA



**We're NASA and We Know It (Mars Curiosity)**

Satire  Subscribe  1 video



# Lunar Atmosphere and Dust Environment Explorer

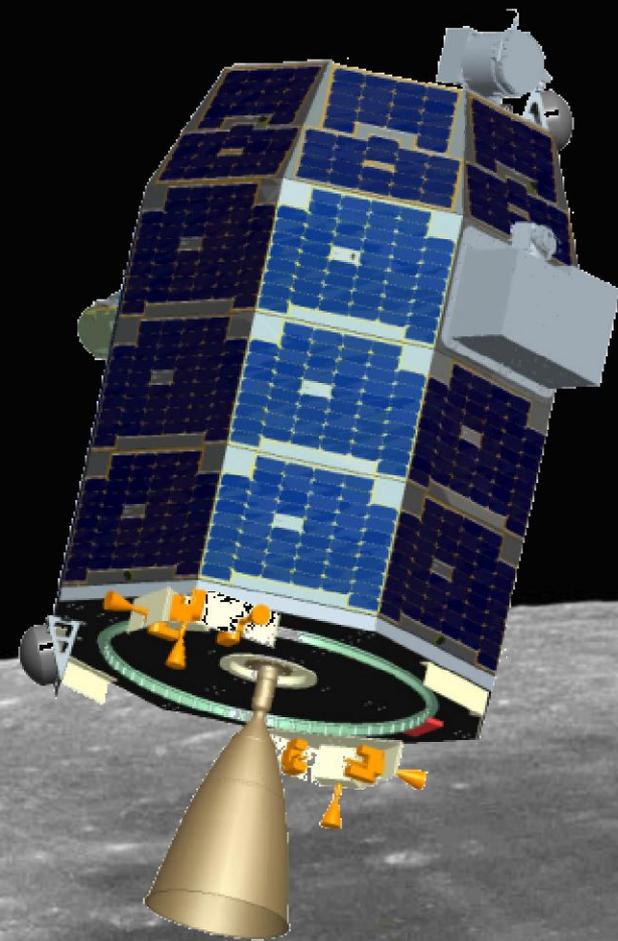
## Objective:

- Measure the lofted Lunar dust
- Composition of the thin Lunar atmosphere

## Instruments:

- Science: NMS, UVS, and LDEX
- Technology: Laser Communications

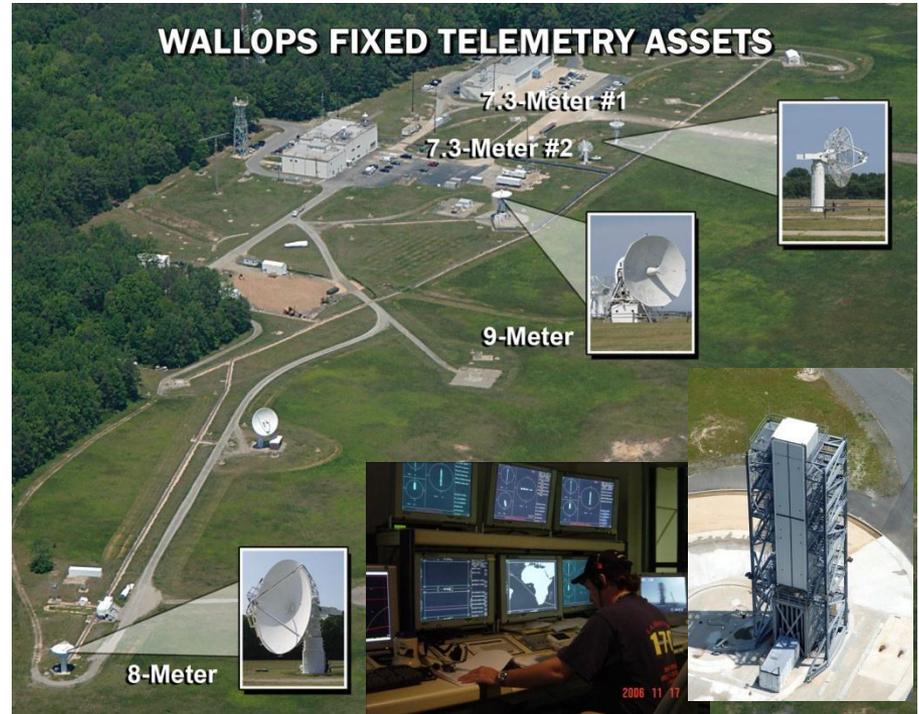
Launch August 2013, Wallops Flight Facility



**WFF preparing to launch** ● 1<sup>st</sup> Deep Space/Lunar mission from WFF ● Ames' 1<sup>st</sup> in-house built spacecraft ● 1<sup>st</sup> Minotaur IV/V (Peace Keeper family) launch from WFF ● 1<sup>st</sup> Minotaur V anywhere ● 1<sup>st</sup> for WFF to provide the Launch Vehicle service- coordinator role ● Guest Ops planning getting underway with kick off meeting Nov. 19 at WFF.



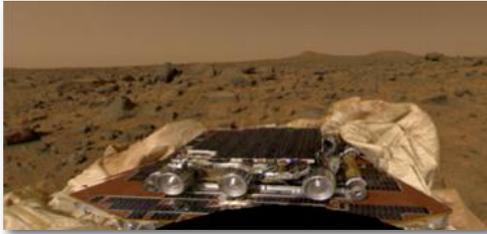
LADEE Pathfinder activities - View towards the south after gantry roll-away on newly enlarged Pad 0B w/ Min V mockup.



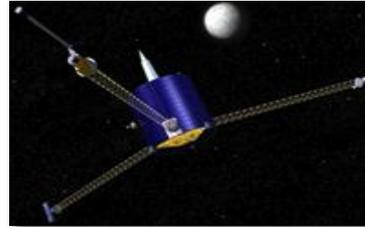
# Discovery Program

Completed

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



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

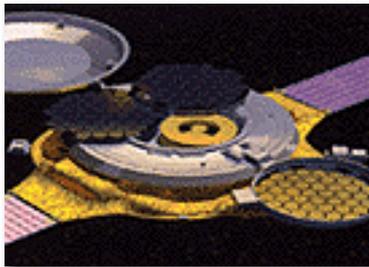


**NEO characteristics:  
NEAR (1996-1999)**

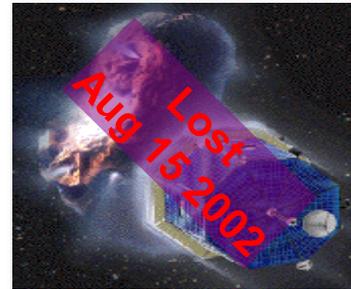


Completed

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



**Comet diversity:  
CONTOUR**

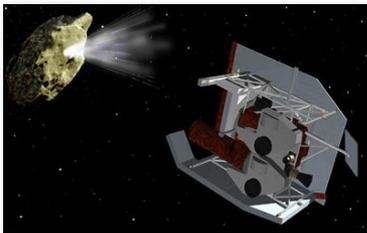


**Nature of dust/coma:  
Stardust (1999-2011)**

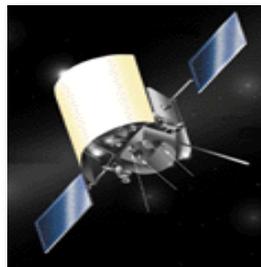


In Flight

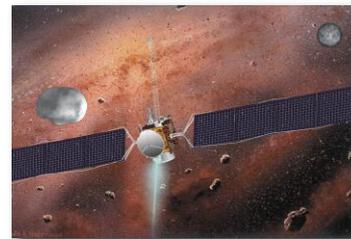
**Comet internal structure:  
Deep Impact (2005-2012)**



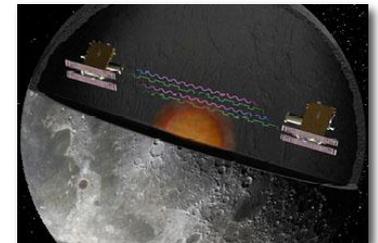
**Mercury environment:  
MESSENGER (2004-2013)**



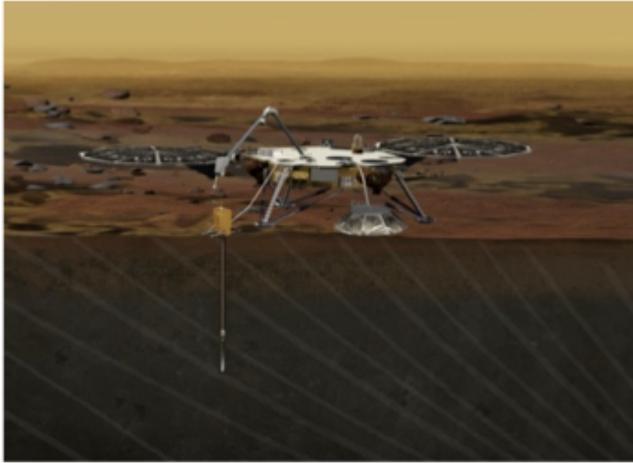
**Main-belt asteroids:  
Dawn (2007-2015)**



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



# InSight: Interior Structure from Seismic Investigations, Geodesy and Heat Transport



## Mission & Science Team:

PI: Bruce Banerdt, JPL

PM: Tom Hoffman, JPL

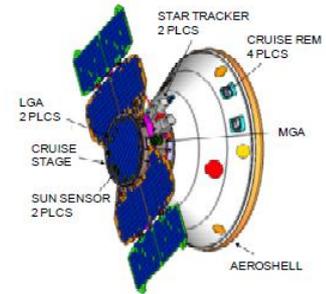
Deputy PI: Sue Smrekar, JPL

Management: JPL

Spacecraft: Lockheed-Martin

Operations: JPL/LM

Payload: CNES (France), DLR (Ger.), JPL



## Mission:

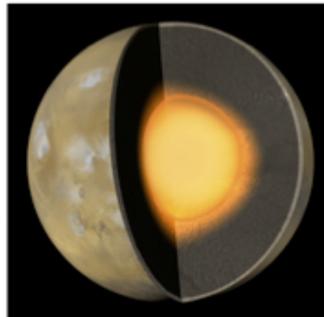
- Geophysical lander mission on Mars using Phoenix heritage spacecraft

## Goals:

- Understand formation/evolution of terrestrial planets via interior structure/processes of Mars
- Determine present tectonic activity and meteorite impact rate

## Payload:

- Seismic Experiment for Interior Structure (SEIS)
- Rotation & Interior Structure Experiment (RISE)
- Heat Flow & Physical Properties Probe (HP<sup>3</sup>)
- Instrument Deployment System



## Mission Details:

- Flight: 3/2016 launch w/ELV, 4m fairing; 9/2016 landing; ~6.5 mo cruise, 1 Mars yr surface ops
- System Features (Phoenix-based design): Phoenix EDL architecture, solar power, UHF relay comm with X-band backup, updated RAD 750-based avionics
- Mass: 597.6kg dry launch, margin  $\geq 31\%$  (depending on ELV)
- Schedule: 43.5 mo B/C/D, 105 days sched. reserve
- Threshold Mission: Descope: HP<sup>3</sup>, SEIS SP sensors

# New Frontiers Program

1<sup>st</sup> NF mission  
New Horizons:

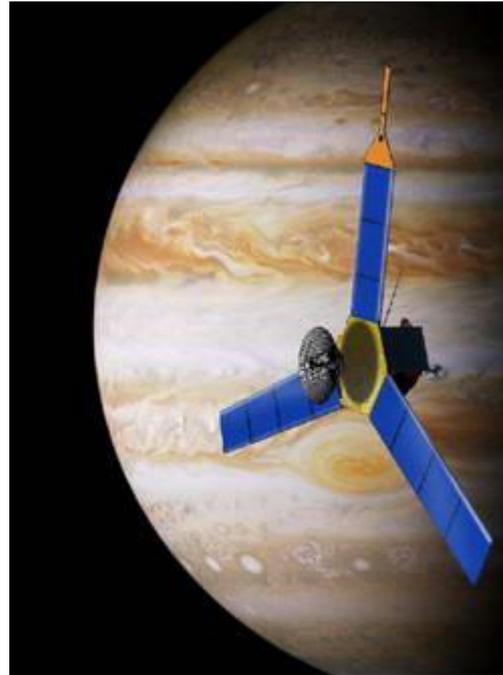
Pluto-Kuiper Belt



Launched January 2006  
Arrives July 2015  
PI: Alan Stern (SwRI-CO)

2<sup>nd</sup> NF mission  
JUNO:

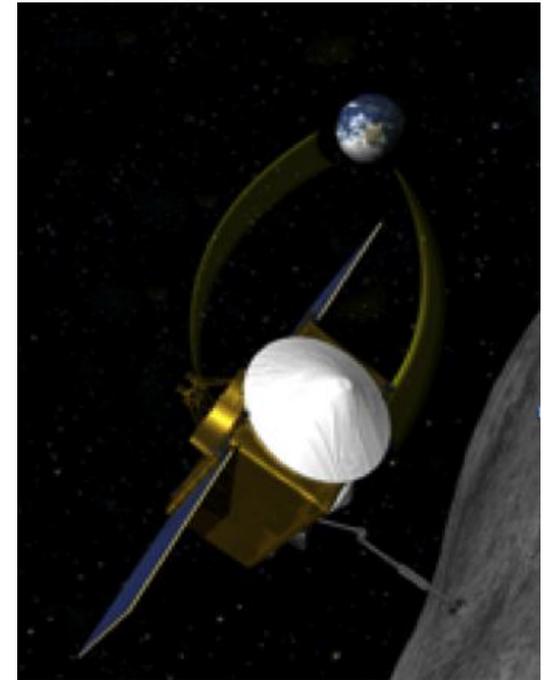
Jupiter Polar Orbiter



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

3<sup>rd</sup> NF mission  
OSIRIS-REx

Asteroid Sample Return



Sept. 2016 LRD  
PI: Dante Lauretta (UA)

NF-4 AO in FY16

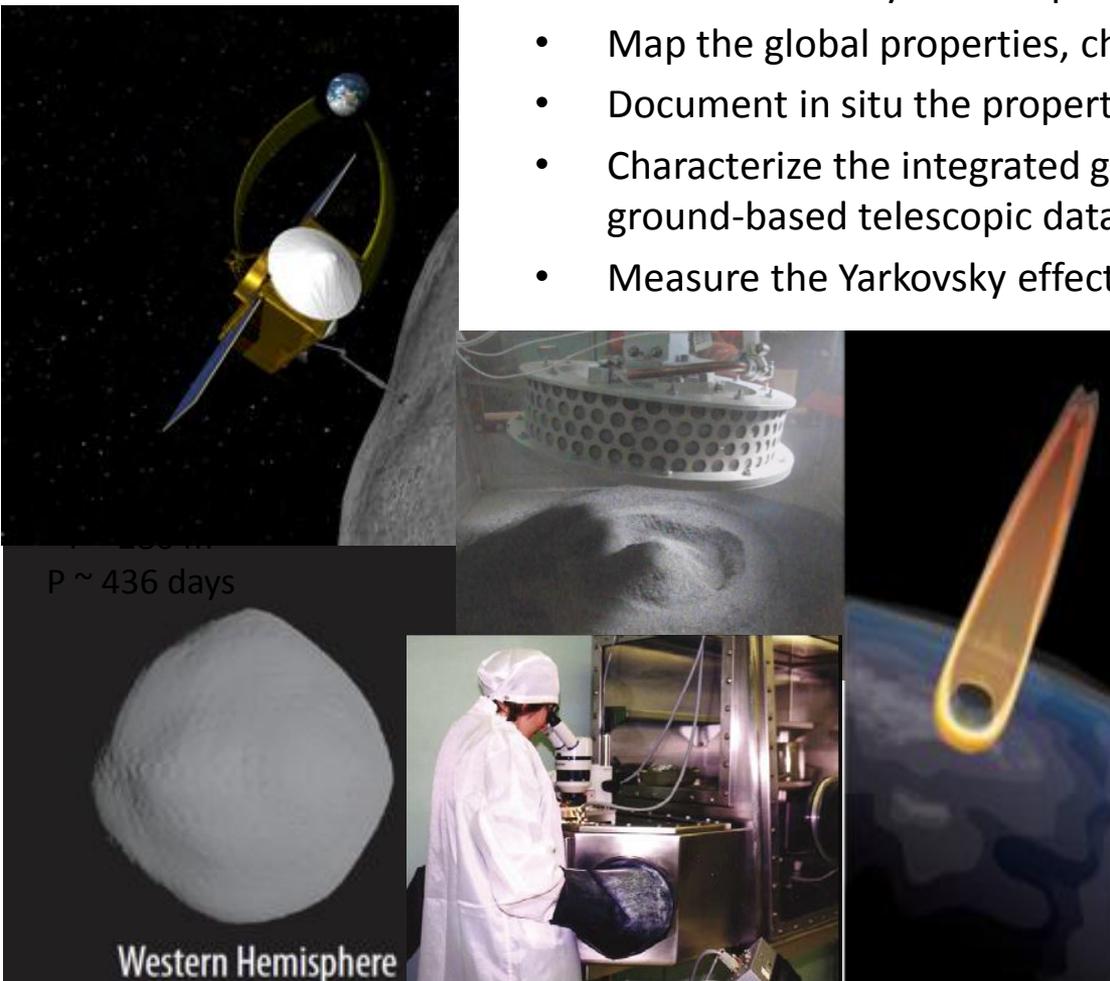
# Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx )

## Science Objectives:

- Return and analyze a sample of pristine carbonaceous asteroid
- Map the global properties, chemistry, and mineralogy
- Document in situ the properties of the regolith at the sampling site
- Characterize the integrated global properties to allow comparison with ground-based telescopic data of entire asteroid population
- Measure the Yarkovsky effect

## Mission Overview:

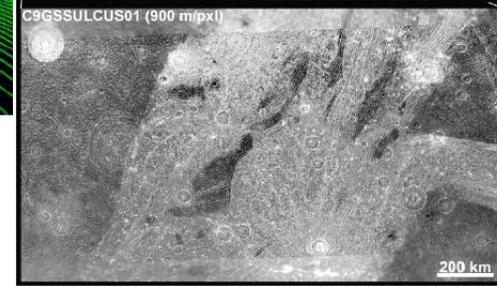
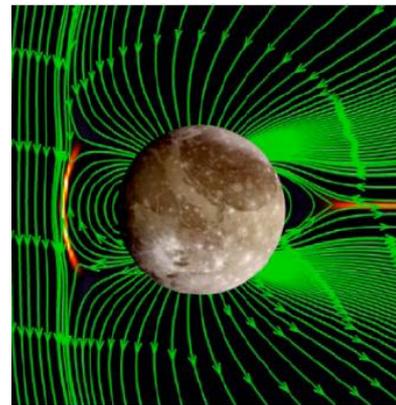
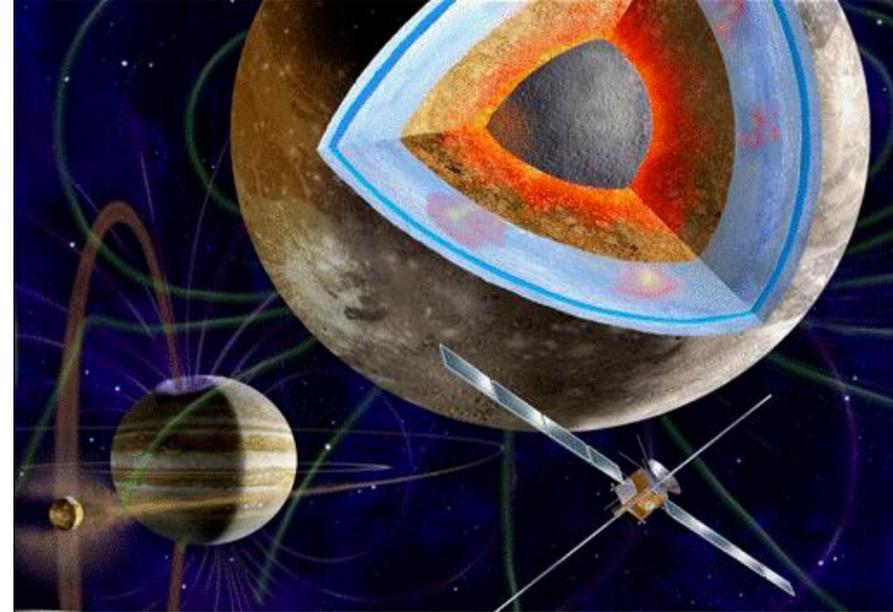
- Launch in September 2016
- Encounter asteroid (101955) 1999 RQ36 in October 2019
- Study RQ36 for up to 505 days, globally mapping the surface
- Obtain at least 60 g of pristine regolith/surface material
- Return sample to Earth in September 2023 in a Stardust-heritage capsule
- Deliver samples to JSC curation facility for world-wide distribution





# The JUper ICy moons Orbiter Mission

- ESA's first Large-class mission in Cosmic Vision Program
  - NASA will participate as a minor partner with ~\$100M for instruments
- The JUICE mission will investigate the emergence of habitable worlds around gas giants, characterizing Ganymede, Europa, and Callisto as planetary objects and potential habitats, and will also explore the Jupiter system as an archetype for gas giants.
- JUICE will first orbit Jupiter for ~2.5 years, providing 13 flybys of Callisto and 2 of Europa, and then will orbit Ganymede for 9 months
- Launch is scheduled for 2022 with Jupiter arrival in 2030 and Ganymede orbit insertion in 2032



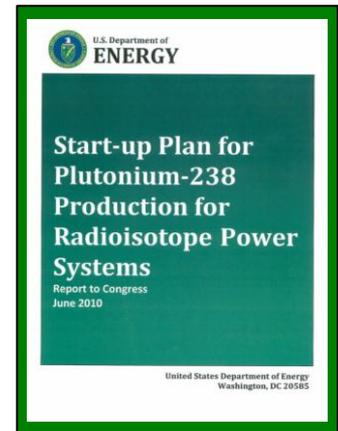
# ASRG and Pu-238 Production

## Advanced Stirling Radioisotope Generator (ASRG)

- After Discovery 12 selection, working to identify next ASRG mission
  - Expectation is that Discovery 13 will provide similar opportunities to test mission enabling technologies (ie: ASRG, NEXT...)
- Two ASRG flight units (F1 and F2) will be completed in 2016
  - The completed flight units will go into bonded storage, unfueled, pending a mission decision for flight use

## Plutonium-238

- Technology demonstration activities include:
  - A qualified Neptunium-237 target for irradiation in the High Flux Isotope Reactor (*First Np-237 targets irradiated*)
  - A qualified process for post-irradiation target processing
  - A qualified Pu-238 product
  - A project plan for scale-up to full-scale production at 1.5-2.0 kg/year
- Project baseline and confirmation by December 2013



# This Decade's Exploration of Mars

**Operational  
2001-2012**



**2013**



**2016**



**2018**

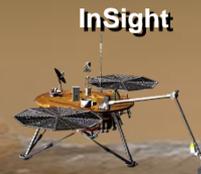
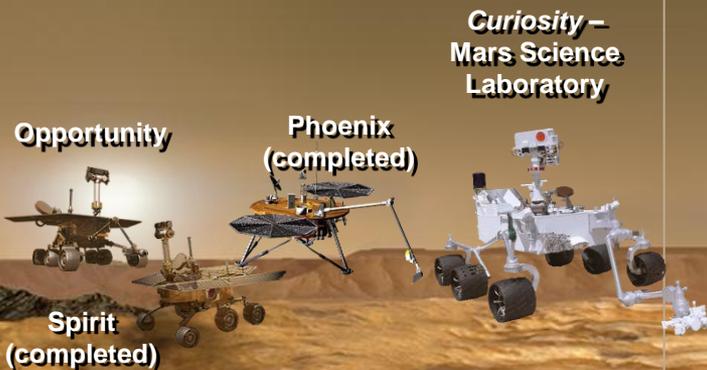
ESA ExoMars  
Rover (MOXA)

**2020**

2020  
Science Rover

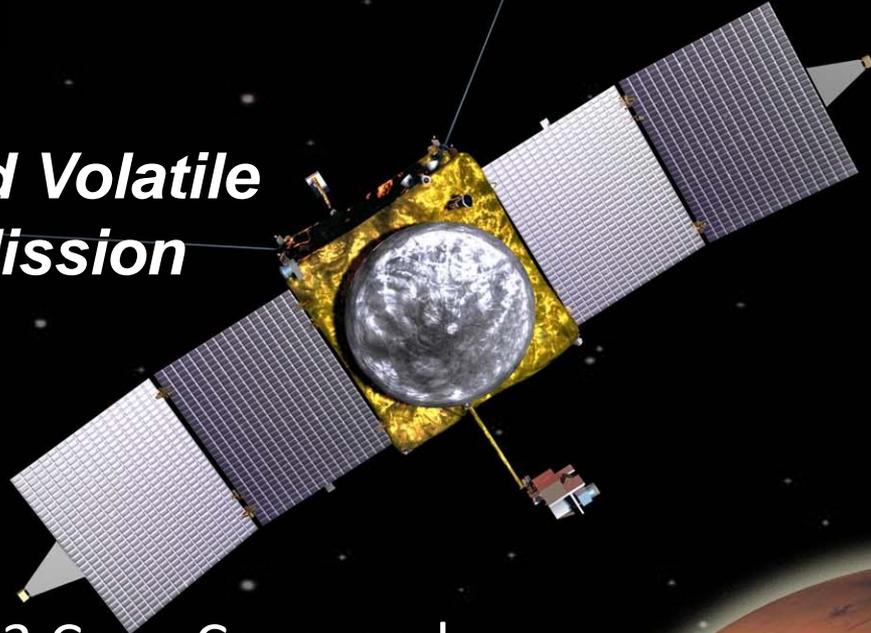
**2022**

Future  
Planning





## *Mars Atmosphere and Volatile Evolution (MAVEN) Mission*



Launch November, 2013 Cape Canaveral

- Mars orbit insertion in Sept. 2014

### Science:

- Determine the structure and composition of the Martian upper atmosphere today
- Determine rates of loss of gas to space today
- Measure properties and processes that will allow us to determine the integrated loss to space through time



# Mars Exploration Program

## Next Steps—NASA's In-Guide Plan

- Mars Program Planning Group (MPPG) September final report was integrated with other Agency factors to create a Mars Future Missions Plan
- Key Components of the Plan:
  1. Support 2013/MAVEN and Mars extended missions through 5-year budget horizon, including MSL/Curiosity
  2. Provide Electra telecom relay and engineering support for ESA's 2016 Trace Gas Orbiter and Entry, Descent and Landing (EDL) Demonstration Module
  3. Provide critical components to the Mars Organic Molecule Analyzer (MOMA) experiment plus engineering/telecom support for ESA's 2018 ExoMars rover mission
  4. Initiate Science Rover mission for 2020 launch - highest priority is surface science
    - Leverage MSL design, residual hardware, and experienced team—reduces cost/cost risk
    - Build on MSL/Curiosity results by investigating a new site for possible bio-signature preservation in full geologic context
    - Expand EDL capability and accuracy (improves access to compelling landing sites)
    - Provide OCT/STP and HEOMD opportunities
      - Anchors capability for larger landed masses & advanced surface operations for HEOMD and SMD
    - Provide opportunities for international collaboration

# Science Approach for the 2020 Rover

- Scientific intent of the 2020 rover mission - **Conduct mobile surface-based science at a site selected for its ability to preserve evidence of life, and prepare for the future return of samples per the latest NRC Planetary Decadal Survey**
- Payload acquisition through an open, competitive process
  - Community-based Science Definition Team (SDT)
    - Open letter to the community for membership in SDT to be released soon
    - Establish mission science objectives, in priority order
    - Draft strawman payload/instrument suite as proof of concept
    - Identify opportunities for contributed HEOMD payloads and technology infusion and/or demonstrations
    - Propose threshold objectives/measurements
  - Announcement of Opportunity (AO) derived from SDT findings
    - Release in early summer 2013
    - Open to international contributions
- Planetary Protection
  - Final objectives, including landing site and whether cache is included, will influence classification level
  - Pre-Project will study risk/cost of upgrading MSL system to meet Category IVc, which would permit exploration of a special region
  - MEP plans to engage Planetary Protection early in formulation process

# Planetary Protection

## MSL Lessons Learned Status

- Planetary Protection LL activity is being added to the existing MSL project-level lessons learned study, organized by OCE and SMD in response to APMC direction
  - Project-level lessons learned study objective: examine contributors leading to launch 2009 → 2011 delay
  - Include planetary protection lessons to consolidate efforts, minimize duplication
  - Finalization of membership under way
    - Mark Saunders, Scott Hubbard, Noel Hinners, Gentry Lee, Dolly Perkins, Denis McCarthy(alt)
    - PP representative under discussion
  - Final report to be delivered by June, 2013
- Planetary Protection component of LL study
  - Focus on Curiosity wheels, drill bit handling, sample handling system as representations of PP-affected systems, and project/PP communications and coordination
  - Relevant project documentation retrieved by project and provided to PPO Nov 29.
- MSL independently-implemented activities may provide inputs for PP-LL study
  - MSL internal PP knowledge capture activity, initiated during launch campaign and continued through landing
  - Small internal task to capture data, images, and other information regarding the use of ATP assay during MSL ATLO

# Program Yearly Budgets and Distribution

# President's FY13 Budget

	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17
<u>Planetary Science</u>	<u>\$1,450.8</u>	<u>\$1,501.4</u>	<u>\$1,192.3</u>	<u>\$1,133.7</u>	<u>\$1,102.0</u>	<u>\$1,119.4</u>	<u>\$1,198.8</u>
Planetary Science Research	\$158.8	\$174.1	\$188.5	\$222.5	\$233.4	\$231.7	\$230.3
Lunar Quest Program	\$130.2	\$139.9	\$61.5	\$6.2			
Discovery	\$192.0	\$172.6	\$189.6	\$242.2	\$235.6	\$193.8	\$134.3
New Frontiers	\$213.2	\$160.7	\$175.0	\$269.8	\$279.6	\$259.9	\$155.1
Mars Exploration	\$547.4	\$587.0	\$360.8	\$227.7	\$188.7	\$266.9	\$503.1
Outer Planets	\$91.9	\$122.1	\$84.0	\$80.8	\$78.8	\$76.2	\$76.3
Technology	\$117.3	\$144.9	\$132.9	\$84.6	\$85.9	\$90.9	\$99.6

- Grey region is a “notional” budget – top line remains the same but details within may change

# Current Status of R&A Program

- Between FY12 &13 planetary reduced by 21%
  - Greatest reductions occurring in Flight program with much reduced participation in ESA's Mars 2016 & 2018 missions delay of Discovery and New Frontiers Programs
  - An overall decrease in the R&A program is ~10%
- Recent R&A funding profile:
  - FY10: \$206M, FY11: \$221M, FY12: \$245M, **FY13: \$228M (planned)**
  - Planetary Protection R&A FY12: \$2.54M, FY13: \$2.4M (~6%)
- An additional reduction in the Planetary Science in FY13 of 8% may also occur due to Sequestration Legislation kicking in early CY2013
- Current funding is under a Continuing Resolution

# PSD R&A Management Principles

- The PSD is following closely previous recommendations and findings of the Planetary Science Subcommittee (PSS)
- The following are the PSD R&A management principles:
  - 1. FY13 funding targets have been provided to all program officers (PO) for each of the PSD ROSES program elements.
  - 2. PO will meet current ongoing grants commitments before new selections can be made.
  - 3. Awards will be made and announced within one month after the review panel has met.
  - 4. Award announcements will be either: selected, not selected, or selectable.
  - 5. Proposals in the selectable category maybe selected as funding becomes available throughout the year.



<http://solarsystem.nasa.gov/yss>

**Questions?**

## FUTURE OF NLSI AND COOPERATIVE AGREEMENT NOTICE

- NLSI is Evolving into a New Solar System Science and Exploration Institute
  - Focus on the **science** and **exploration** of NASA's human exploration targets
  - Jointly sponsored by SMD and HEOMD and announced by both Directorate's AA's at this past summer's Lunar Forum
  - New name selection will be open to the science community for suggestions
  - Current team's Cooperative Agreements will end April 30, 2013
- New - Cooperative Agreement Notice (CAN)
  - Focuses on: The Moon, Near Earth Asteroids, Phobos and Deimos
  - CAN will include **Planetary, Heliophysics, Astrophysics, and Exploration**
  - Salient high-level portions of CAN released to community for comment via NSIPRES Community Announcement.
    - ~ 70 comments received and dispositioned
  - Final CAN is in the signature cycle – to be released soon!