

Charge to the Decadal Survey

Presentation to Planetary Science Decadal Panels

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Director, Planetary Science Division

August 26, 2009



Outline

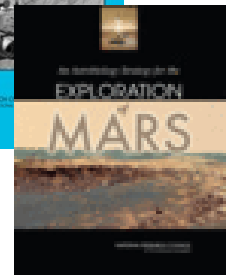
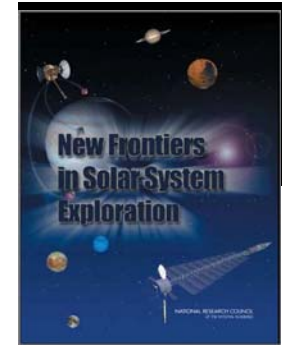


- Decadal Charge and Process
- FY10 Planetary Budget Overview
- Planetary Missions Overview
- New Frontiers & Discovery
- Outer Planets
- Supporting Research & Technologies
- Mission Enabling Technologies
- International agreements



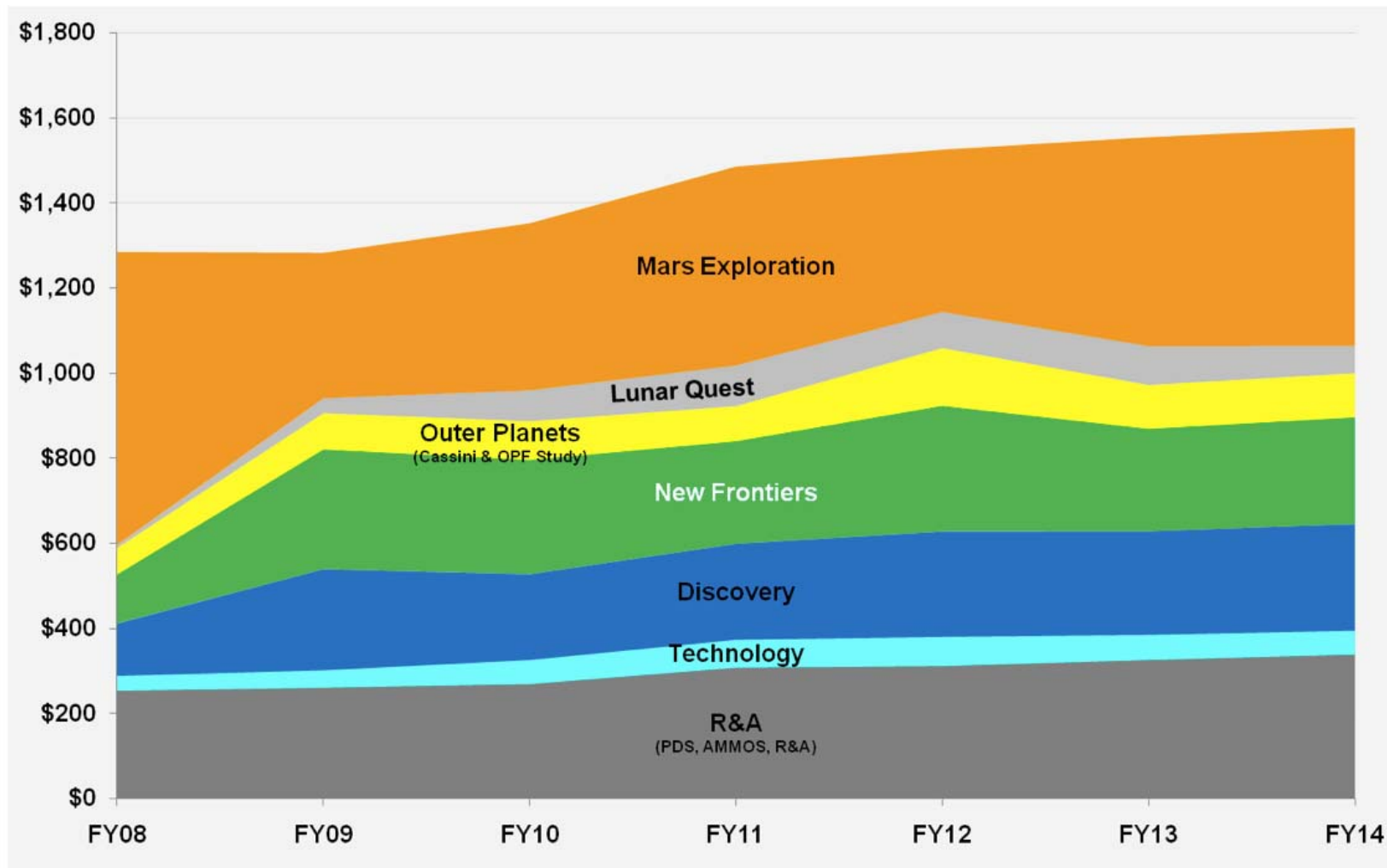
PSD Decadal Perspective

- Decadal results are shared between NASA & NSF with clear roles and responsibilities
 - NASA has space-based planetary science
 - NSF has ground-based planetary science
- Must be a *fully integrated view* of the entire solar system
 - Moon, Mars, and the rest of the solar system
 - Its is all about setting *priorities* not *expectations*
- Must also address planetary science within human exploration as it evolves (late in the next decade)
- Must address all aspects of the program
 - Sections on R&A and key technologies are important
- Budget and Technical reality
 - Program must fit within the known planetary budget
 - Use the FY11 Presidents budget after it is announced in February 2010





Planetary FY10 Budget



- Use the President's FY11 budget when issued in Feb '10
- 1st budget with goals from the new administration



POC & Main Duties



- PSD has assigned a HQ CS to be a point of contact for each panel
 - Steering Panel – Jim Green
 - Inner Planets Panel – George Tahu
 - Giant Planets Panel – Len Dudzinski
 - Mars Panel – Lisa May
 - Primitive Bodies Panel – Lindley Johnson
 - Satellites Panel – Curt Niebur
- Main Duties:
 - Be at every panel meeting
 - Responsible for satisfying panel requests for information
 - Facilitate the mission concept (MC) process that NASA has set up
 - Periodically report back to PSD management to ensure consistency and that the panels are getting what they need



Mission Concepts



- Key Centers have been selected to participate in the analysis of decadal missions by using their capabilities to develop a mission architecture that “closes” and results in a “realistic” cost
 - Provide specific analysis & supporting documentation to the Decadal Steering panel and to the NRC contract cost reviewer

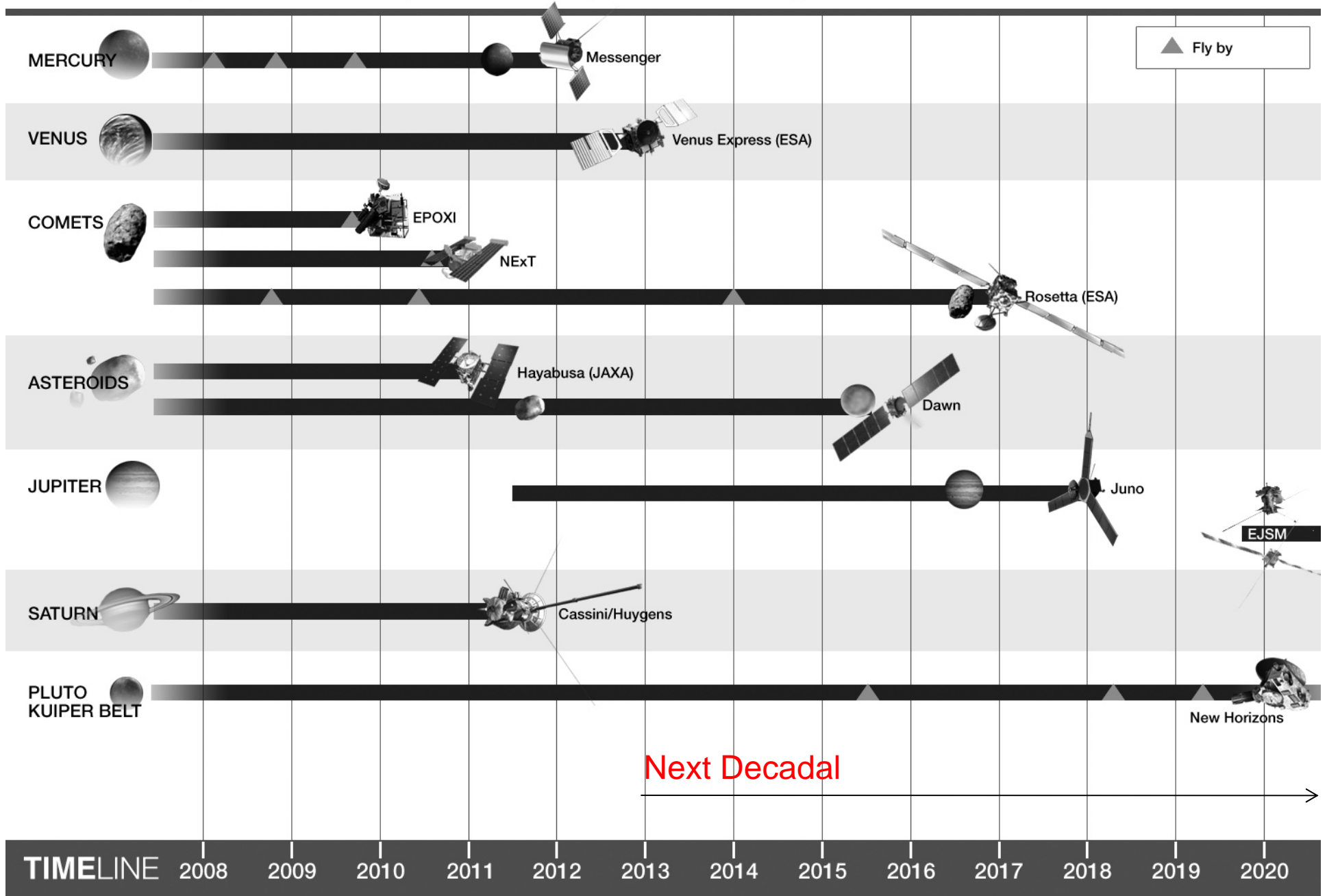
Next Steps:

- Study Guidelines (ie.: launch vehicles..)
- Input Standard:
 - Request for a Study should come from the Steering Group with a certain set of sufficient information to start the process
 - A "science champion" to keep the studies on course (this is not the HQ-POC)
- Output Standard:
 - MC addresses an agreed upon set of information necessary for the NRC cost review



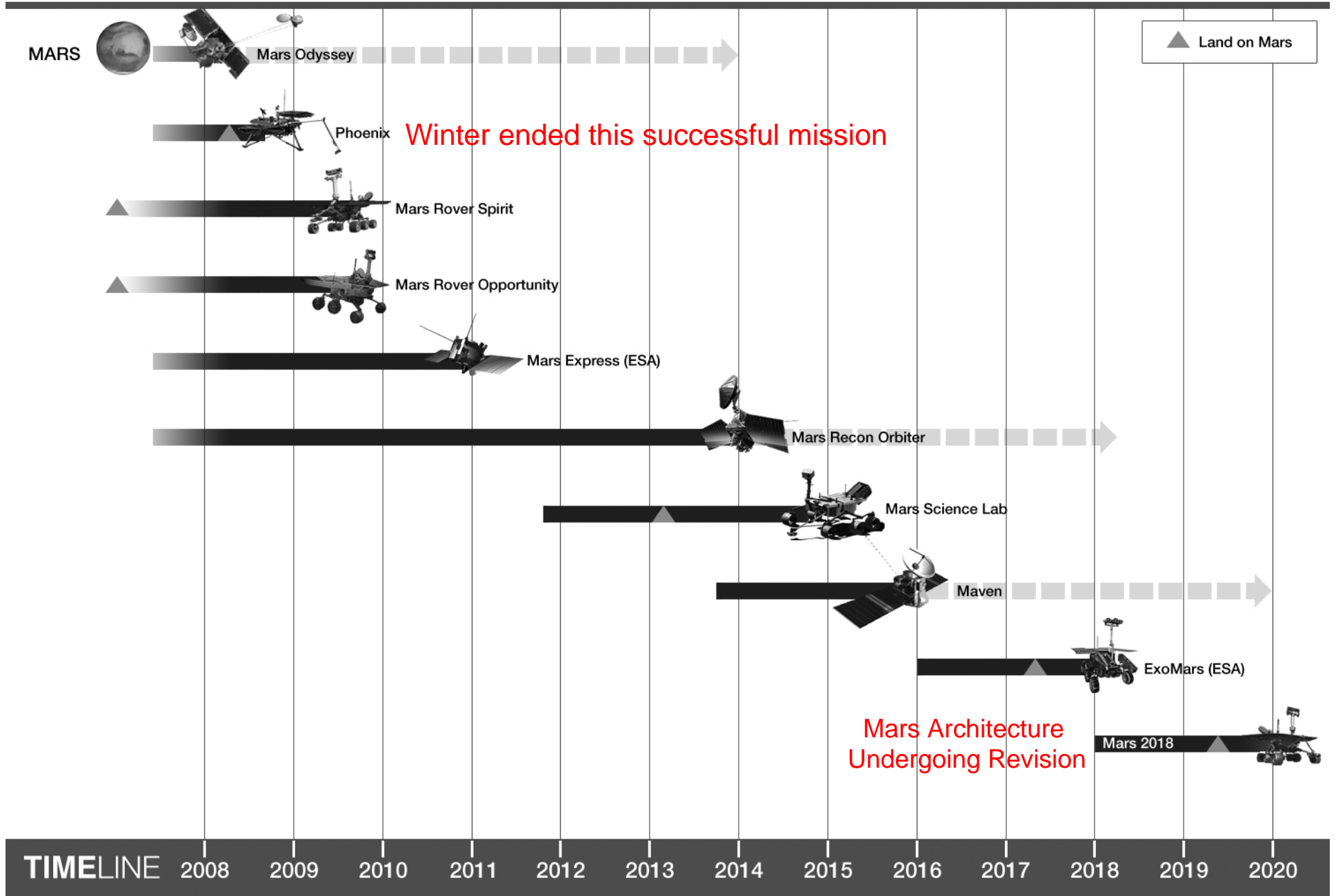
Planetary Missions Overview

Planetary Missions (Non-Mars, Non-Lunar) timeline



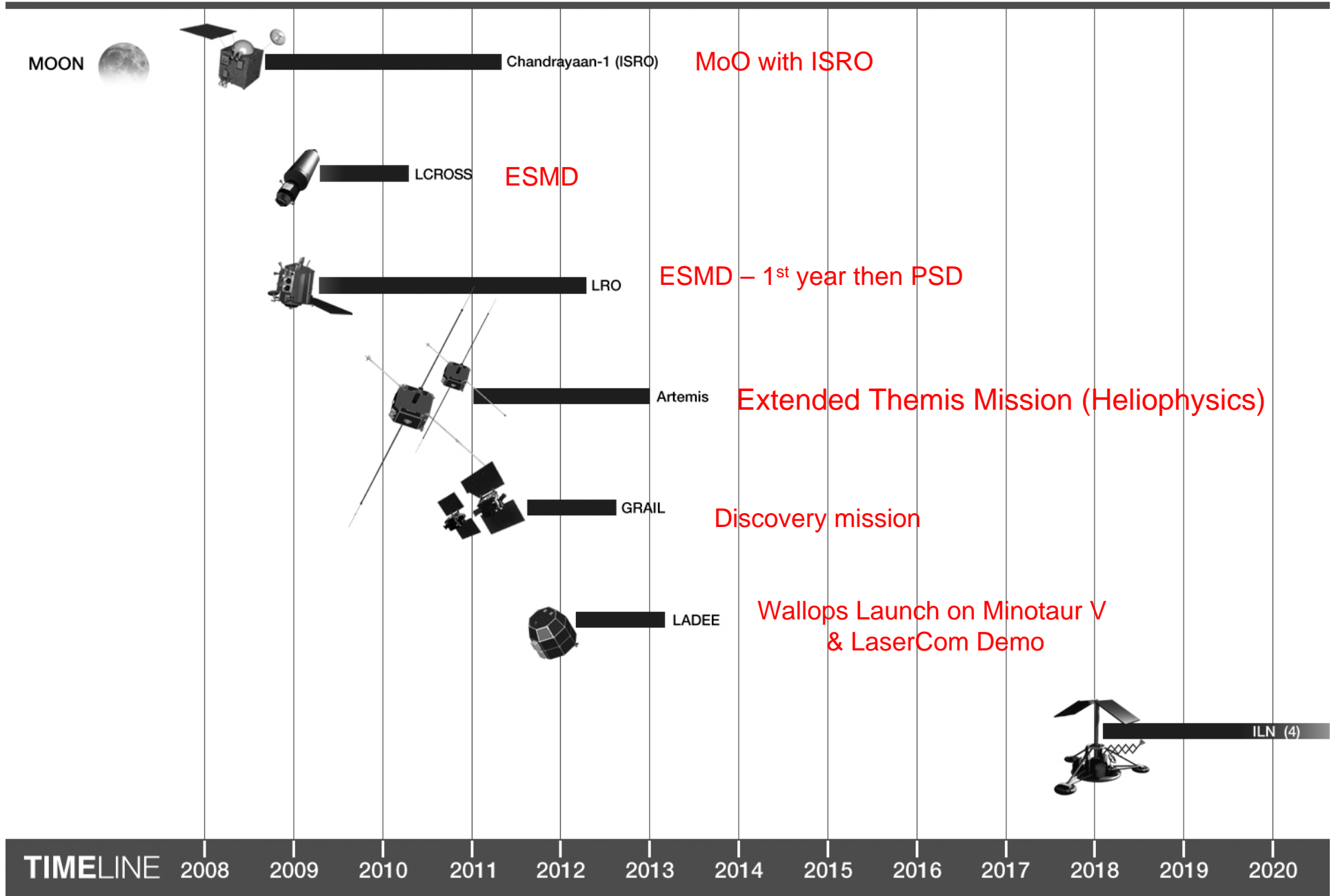
Mars Mission timeline

Next Decadal



Lunar Mission timeline

Next Decadal





New Frontiers & Discovery

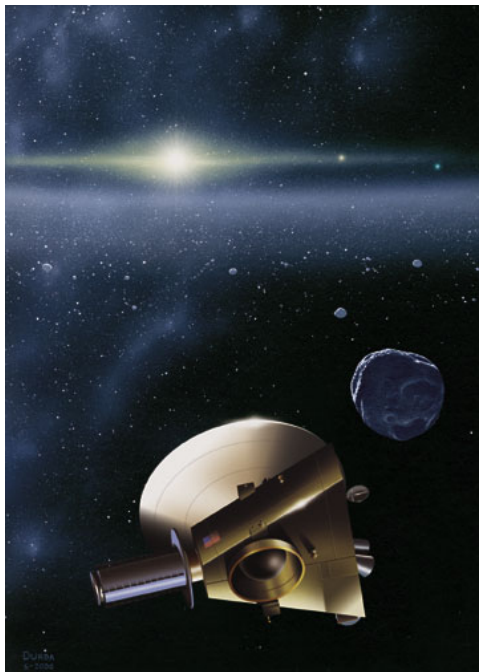
PI Mission Opportunities



New Frontiers Program

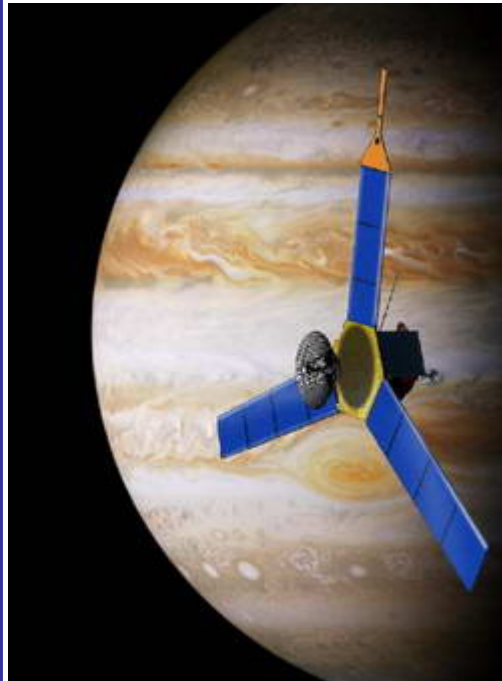


1st NF mission
New Horizons:
Pluto-Kuiper Belt Mission



Launched January 2006
Arrives July 2015

2nd NF mission
JUNO:
Jupiter Polar Orbiter Mission



August 2011 launch

3rd NF mission **AO**

South Pole -
Aitken Basin Sample
Return

Comet Surface
Sample Return

Venus In Situ
Explorer

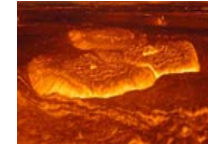
Network Science

Trojan/Centaur

Asteroid Sample Return

Io Observer

Ganymede Observer





New Frontier-3

- Open competition for PI class missions of strategic importance to Planetary Science in the < \$1B class
 - Select up to 3 for a 10 mo. Phase-A then a downselect to 1
 - Launch window beginning late CY 2016 ending NLT the end of CY 2018, according to target
 - Technology infusion:
 - NEXT ion propulsion system & Advanced Materials Bi-propellant rocket
- Proposals received and are in evaluation
 - Step 1 selection announcements on schedule (January 2010)

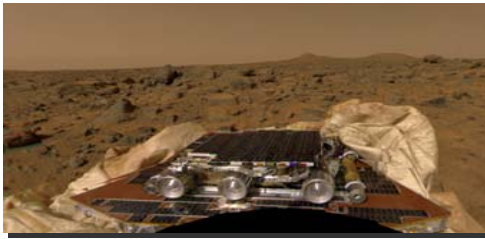


Discovery Program

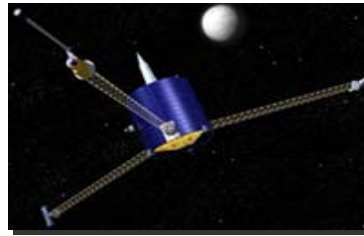


Completed

Mars evolution:
Mars Pathfinder (1996-1997)



Lunar formation:
Lunar Prospector (1998-1999)

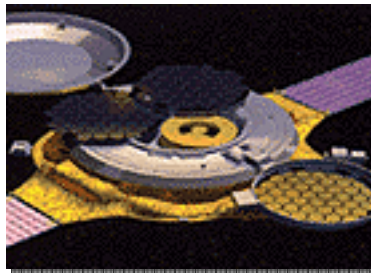


NEO characteristics:
NEAR (1996-1999)

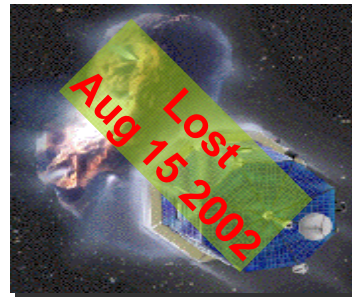


Completed / In Flight

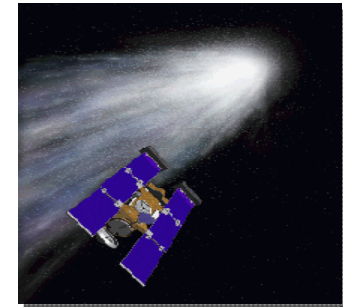
Solar wind sampling:
Genesis (2001-2004)



Comet diversity:
CONTOUR

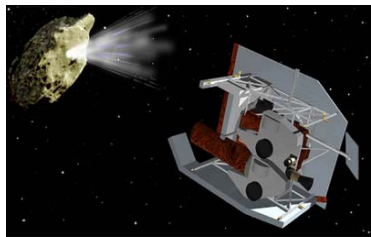


Nature of dust/coma:
Stardust(1999-2006)

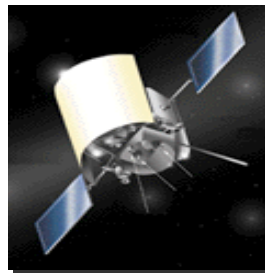


In Flight / In Development

Comet internal structure:
Deep Impact (2005-2006)



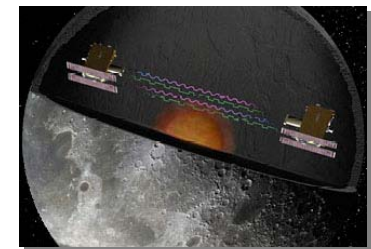
Mercury environment:
MESSENGER (2004-2012)



Main-belt asteroids:
Dawn (2007-2015)



Lunar Internal Structure
GRAIL (2011-2012)





Discovery-12



- Planetary Decadal science for PI missions
 - Across entire solar system (including Mars)
 - Cost Cap: \$425M FY10 (without LV)
 - Selection: 2 to 3 missions for a 9 mo. Phase-A then downselect to 1
 - Launch date NLT December 31, 2016
- ASRG is provided GFE as an option
 - Funded 9 feasibility studies
- Schedule:
 - Draft AO out before end of FY09
 - Final AO ~ near the end of CY2009
 - Proposals due 90 days after AO release



Outer Planets Flagships

Cassini

Europa & Ganymede missions

Cassini Mission Overview

Four-Year Prime Tour, Equinox Mission, and Solstice Mission (Proposed), July 2004 - July 2017

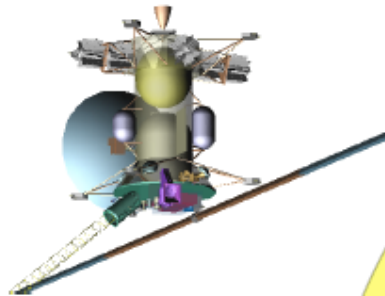


Proximal Orbits

EOM
Sep 15,
2017

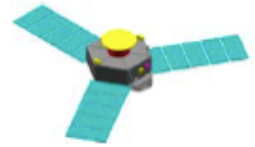
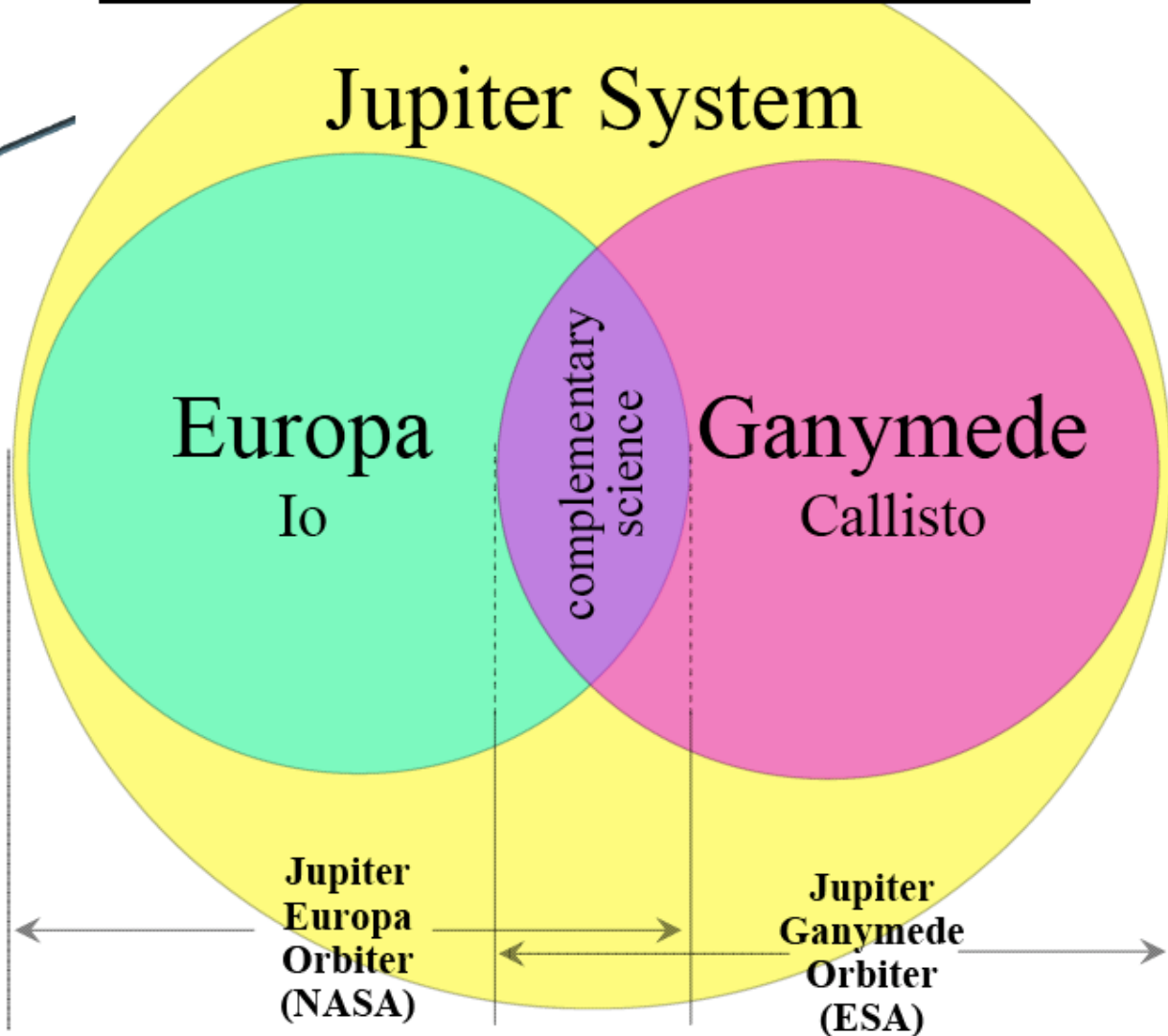


The Emergence of Habitable Worlds Around Gas Giants



NASA Jupiter Europa Orbiter (JEO)

ESA Jupiter Ganymede Orbiter (JGO)

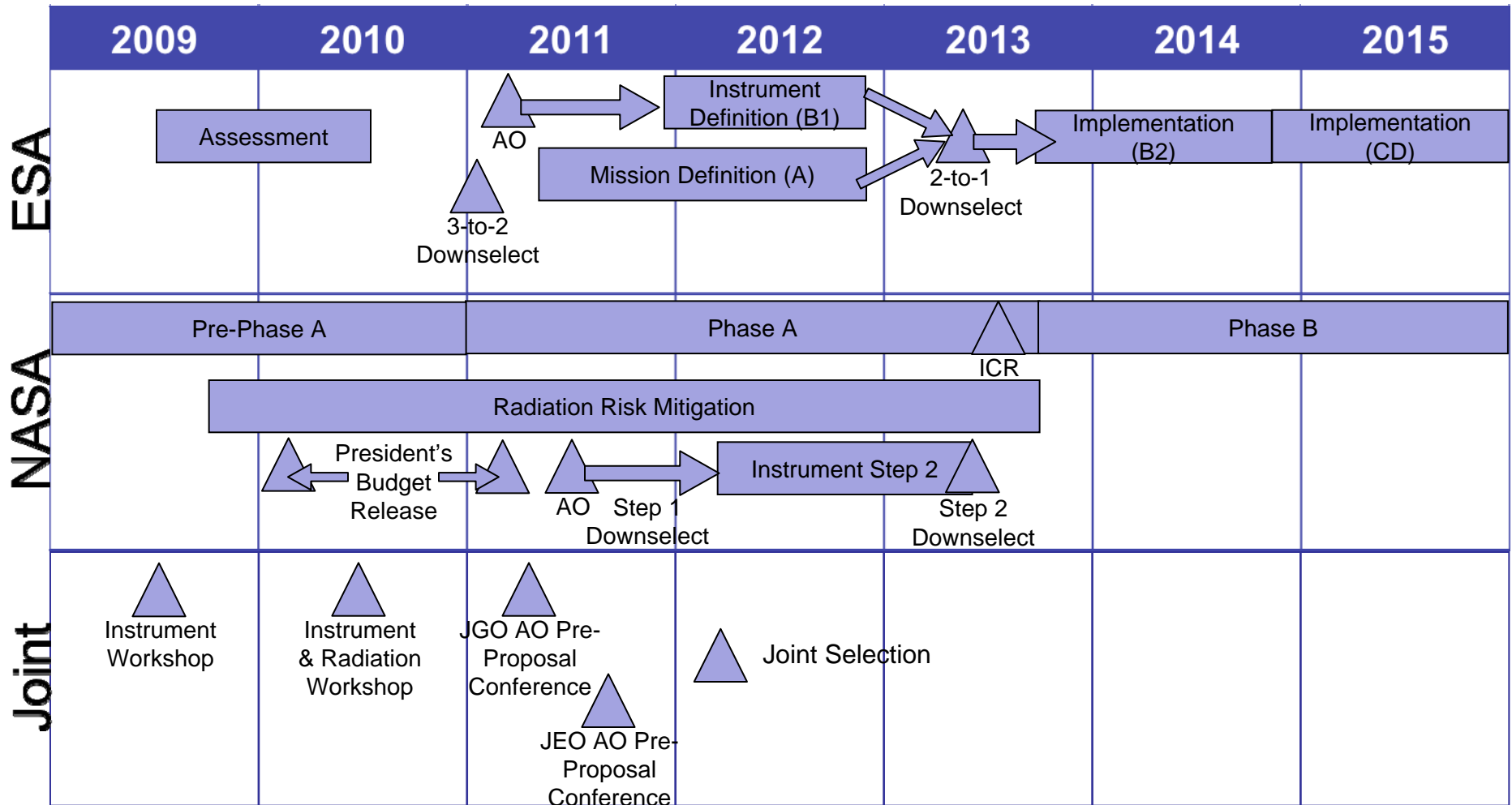


JAXA Jupiter Magnetospheric Orbiter (JMO)

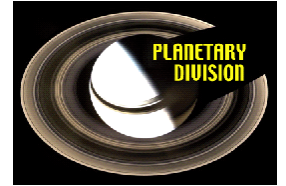
JEO is designed to stand alone or operate synergistically with ESA JGO



NASA and ESA Schedules



- Continued discussions on schedule & AO coordination



Supporting Research & Technology Program



SR&T Program Elements

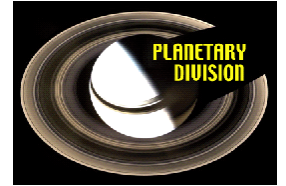
- Research & Analysis (ROSES)
- Astrobiology Institute
- Lunar Science Institute
- Near Earth Object Observations
- Planetary Data System (PDS)
- Astromaterials Curation Facility (JSC)



PSD R&A Program for ROSES 2009



- Cosmochemistry
- Laboratory Analysis of Returned Samples
- Planetary Geology And Geophysics
- Origins of Solar Systems (joint with Astrophysics)
- Planetary Astronomy
- Planetary Atmospheres
- Outer Planets Research
- Lunar Advanced Science and Exploration Research
- Near Earth Object Observations
- Cassini Data Analysis
- Planetary Missions Data Analysis
- Mars Data Analysis
- Mars Fundamental Research
- Mars Instrument Development
- Planetary Instrument Definition And Development
- Astrobiology: Exobiology And Evolutionary Biology
- Planetary Protection Research
- Astrobiology Science & Technology Instrument Development
- Astrobiology Science And Technology For Exploring Planets
- Dawn at Vesta Participating Scientists
- Early Career Fellowships
- Planetary Major Equipment
- Moon and Mars Analog Missions Activities



Mission Enabling Technologies



Technology Investment Overview



- Flight mission technologies
 - Radioisotope Power Systems
 - Laser Communications (with SOMD)
 - In-Space Propulsion Program
 - Propulsion: Electric & Advanced Chemical
 - Aerocapture
 - Advanced Multi-mission Operating Systems (AMMOS)
- Mars Technology Program
 - Mission specific technologies for strategic mission
 - Major cutbacks in this program due to MSL overruns
- Instrument Technologies from ROSES
 - Planetary Instrument Development & Definition Program (PIDDP)
 - Astrobiology Science & Tech. for Exploring Planets (ASTEP)
 - Astrobiology Science & Tech. Instrument Development (ASTID)
 - Mars Instrument Development Program (MIDP)

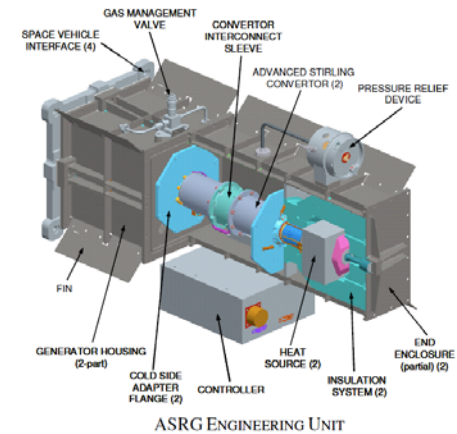


Advanced Stirling Radioisotope Generator Status



- Operation in space and surface of atmosphere-bearing planets & moons
- Characteristics:
 - ≥ 14 year lifetime
 - Nominal power : > 140 We
 - Mass: ~ 22 kg
 - Specific Power: > 6 W_e/kg
 - System efficiency: > 30 %
 - 2 GPHS (“Pu²³⁸ Bricks”) modules
 - Uses only 0.88 kg Pu ²³⁸
- ASRG Engineering Unit (EU) delivered by DOE/LM to NASA Glenn for extended (24/7) operation to provide long-life test
- ASRG EU has operated over 4000 hrs of operation to date (June 09) with no performance degradation identified.
- 2 Flight units to be delivered in 2014

DOE/Lockheed
Martin ASRG EU

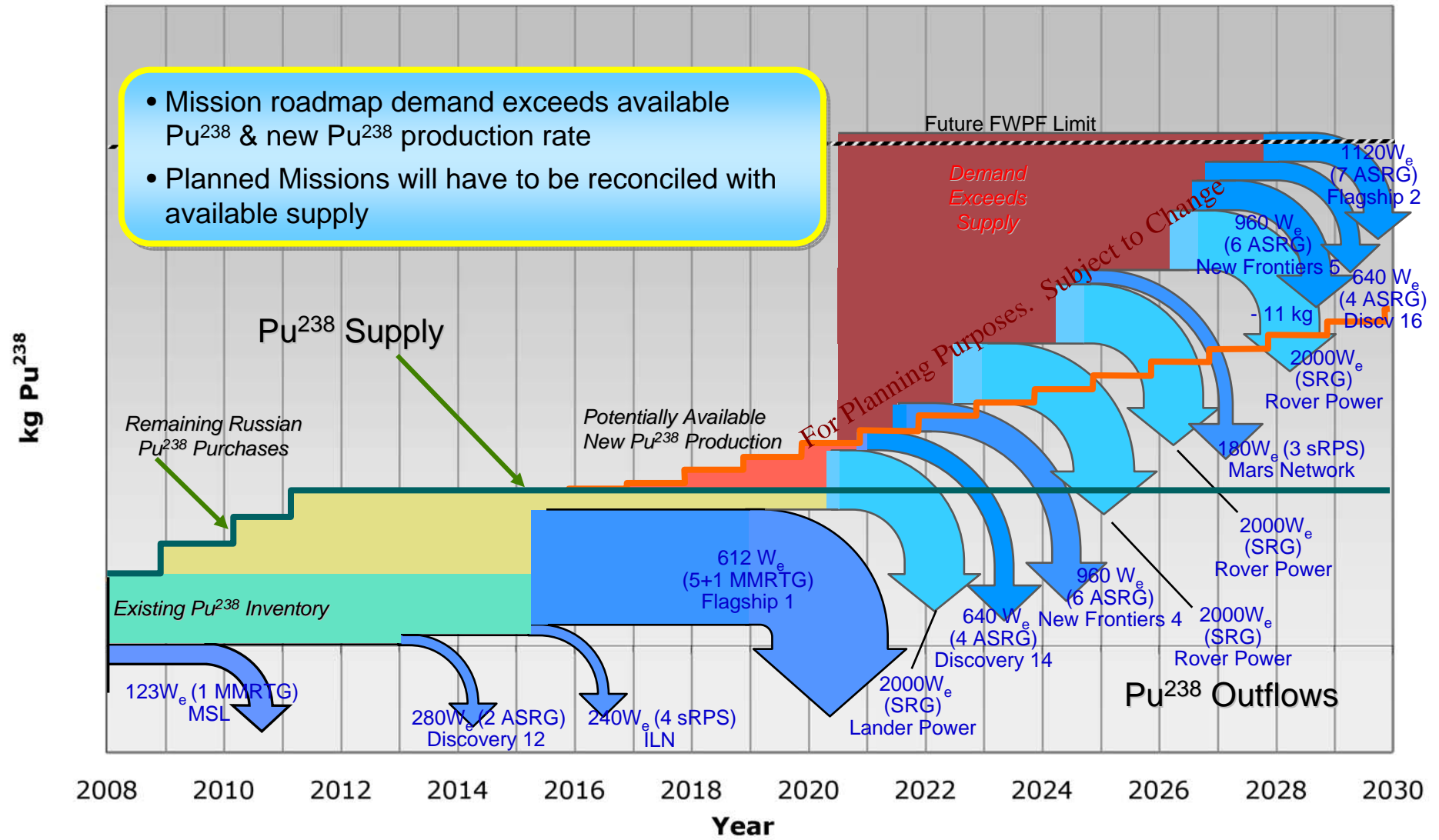


ASRG EU on test
at NASA Glenn



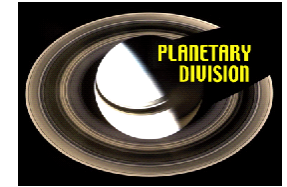


Plutonium Supply vs Potential NASA Demand Magnitude of the Potential Shortage



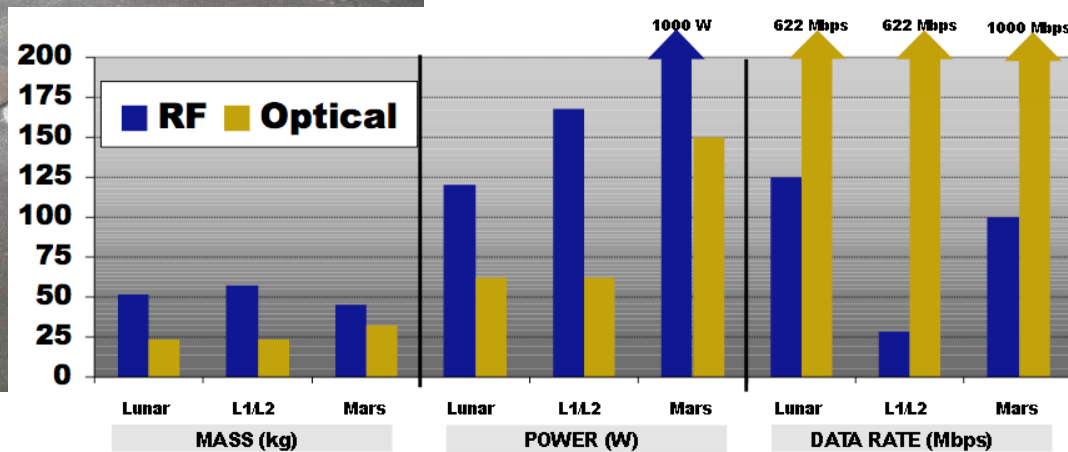
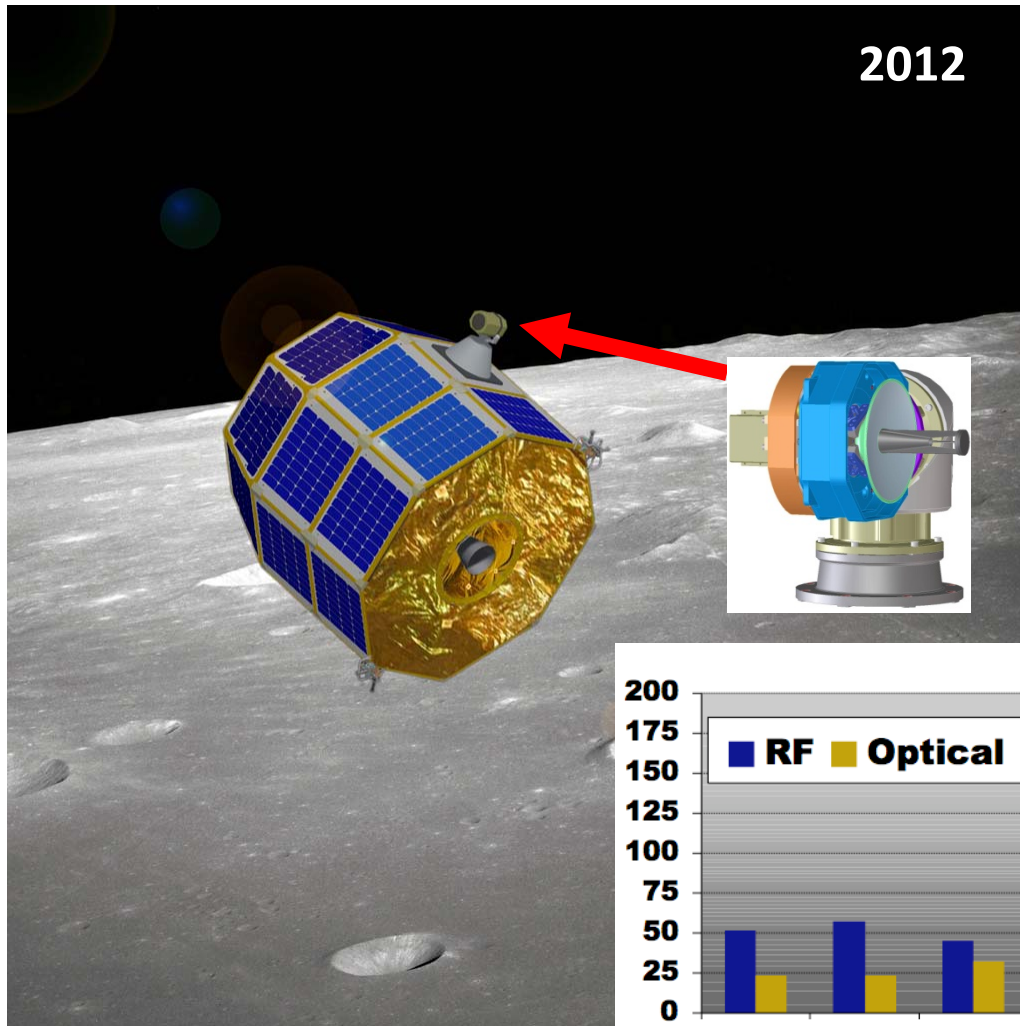


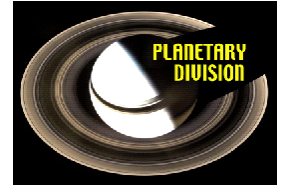
Deep Space Optical Comm Initiative



In Partnership with SOMD, LADEE will fly the 1st DS Optical Comm Demo

- Optical Terminal for LADEE on track
- Earth-based photon-counting technology
- Will provide 600 Mbps from moon
 - ✧ 10 cm terminal
 - ✧ Earth-based Beacon-aided acquisition & tracking
- LADEE will provide V&V flight time, and post science optical demonstration time
- Science NOT dependent on demo.





International Agreements



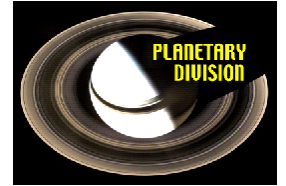
International Collaborations



- Many planetary PI missions have foreign instruments (ie: Dawn, Juno...)
- Agreements on foreign missions:
 - ESA: Venus Express, Mars Express, ExoMars, Rosetta
 - ASI: BepiColombo (recently selected instrument)
 - JAXA: Hayabusa
 - ISRO: Chandrayaan-1
 - Statement of Intent – 9 countries for ILN
- Developing Agreements:
 - ESA: OPF, Mars 16, 18, 20 ...
 - JAXA: Venus Climate Orbiter



SALMON: Types of Missions of Opportunity



- Traditional MoOs
 - Investigations involving participation in non-NASA space missions (ie: science instrument, technology demonstrations, hardware components ...)
- U.S. Participating Investigator
 - Co-Investigator (non-hardware) for a science or technology experiment to be built and flown by an agency other than NASA
- New Science Missions using Existing Spacecraft
 - Investigations that propose a new scientific use of existing NASA spacecraft (ie: NExT, EPOXI ...)
- Small Complete Missions
 - Science investigations that can be realized within the specified cost cap (includes all phases from access to space through data publication)
- Focused Opportunities
 - Investigations that address a specific, NASA-identified flight opportunity



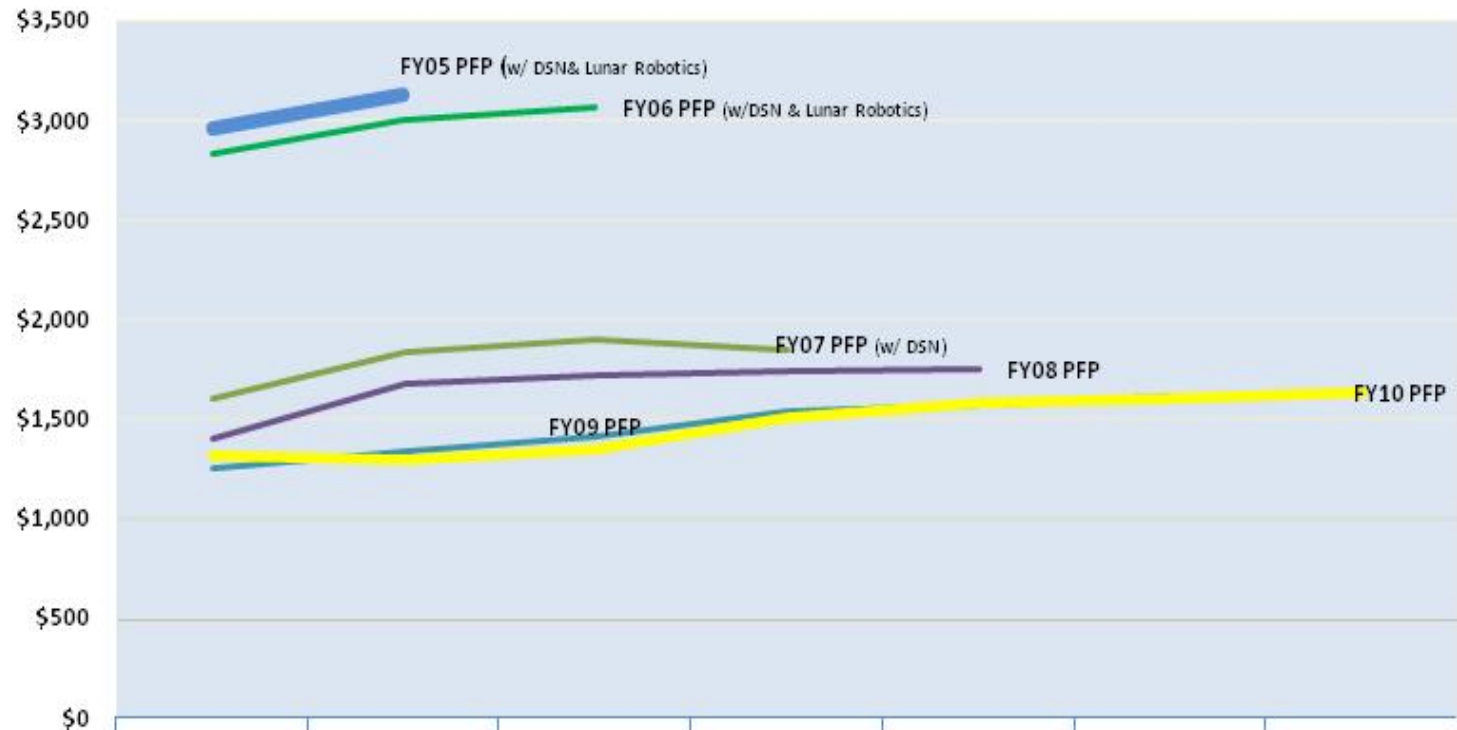
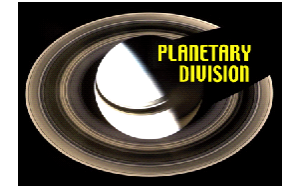
NASA's Planetary Science

Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space

“Flyby, Orbit, Land, Rove, and Return Samples”



Planetary Science Division Budget History (\$M)



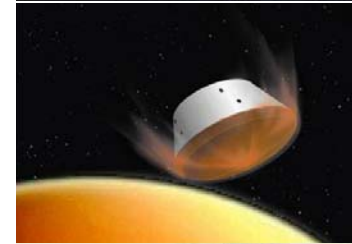
	FY08	FY09	FY10	FY11	FY12	FY13	FY14
FY05 PFP (w/ DSN, O/H, & Lunar Robotics)	\$2,955	\$3,126					
FY06 PFP (w/DSN, O/H, & Lunar Robotics)	\$2,832	\$2,999	\$3,066				
FY07 PFP (w/ DSN & O/H)	\$1,599	\$1,840	\$1,900	\$1,847			
FY08 PFP (include O/H)	\$1,396	\$1,677	\$1,720	\$1,738	\$1,748		
FY09 PFP	\$1,247	\$1,334	\$1,410	\$1,537	\$1,570	\$1,609	
FY10 PFP	\$1,313	\$1,288	\$1,346	\$1,501	\$1,578	\$1,600	\$1,633



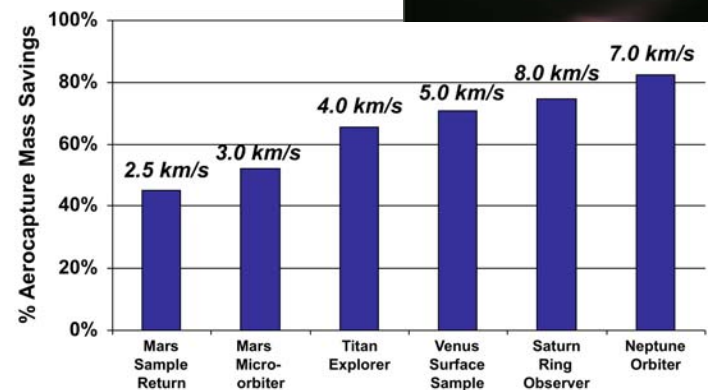
In-Space Propulsion Development



- **Electric Propulsion** – Significantly reduced propulsion/payload mass ratio, reducing planetary trip times, and expanding launch windows
 - NSTAR flying on DAWN
 - NEXT (3x increase in power over NSTAR) undergoing life testing
 - HiVHAC prototype thruster demos completed
- **Aerocapture** - Shorter trip times to outer planets with less propellant; autonomous aerodynamic control technology also enables precision landing.
 - Mission design studies of Mars, Titan, Venus, and Neptune completed
 - Research on materials and sensors on-going, HEAT sensor used on MSL, Lightweight aeroshells
 - Crossover applicability to Orion development



NEXT Thruster





In-Space Propulsion (con't)



Advanced Chemical Propulsion –

Increased thruster performance to reduce propellant needs and increase payload fraction

- AMBR engine – improving performance from 327 sec to 335 sec Isp w/200 lbf thrust at <70% cost
- Active mixture ratio control and balanced flow meter technology to reduce system inert mass, minimize required residual propellant
- Tank Liquid Volume Instrument enables unique measurement of tank contents in any configuration or gravity environment; enables precise knowledge of state of tank contents during operations and long cruises
- Lightweight tank development



AMBR engine

