



Decadal Survey Process and Mars Program Introduction

**Mars Decadal Survey Panel Kick-off
September 9, 2009**

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Agenda

- Decadal Process
- Mars Program Overview
 - Program Construct
 - Budget Status and Considerations
 - Technology Opportunities



Decadal Perspective for the Panel

Decadal Survey final report must be a *fully integrated view* of the solar system

- Moon, Mars, and the rest of the solar system
- It's all about setting *priorities* not *expectations*

Must address planetary science within human exploration as it evolves

Must address all aspects of the program

- R&A
- Key technologies
- International cooperation and coordination
- Integrated strategic program
 - Unique within Planetary Science Division
 - Facilitates discovery and greater scientific progress

Budget and Technical reality

- Program must fit within the known planetary budget
- Use the FY11 Presidents budget after it is announced in February 2010



Assessment of NASA's Mars Architecture 2007-2016





The Decadal Process A Mars Program View



MEP External Advice and Community Input

Community Input

The Mars Exploration Program Analysis Group (MEPAG)

- Self-identified scientific community interested in Mars exploration
- Executive Committee for planning MEPAG meetings and commissioning Science Analysis Groups
- Chair is member of the Planetary Science Subcommittee

NASA Advisory Council

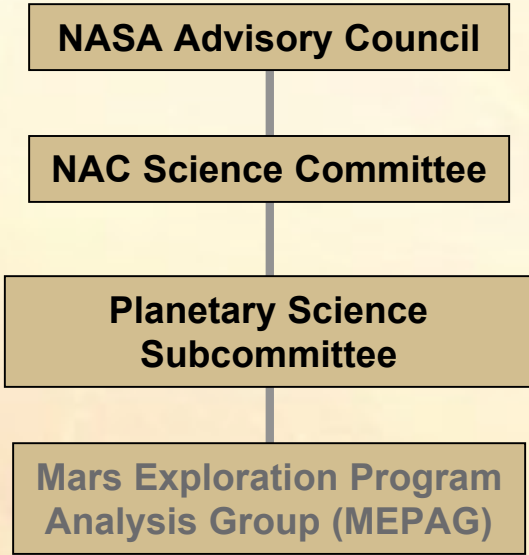
Planetary Science Subcommittee

- Advise on scientific and programmatic priorities for Planetary Science

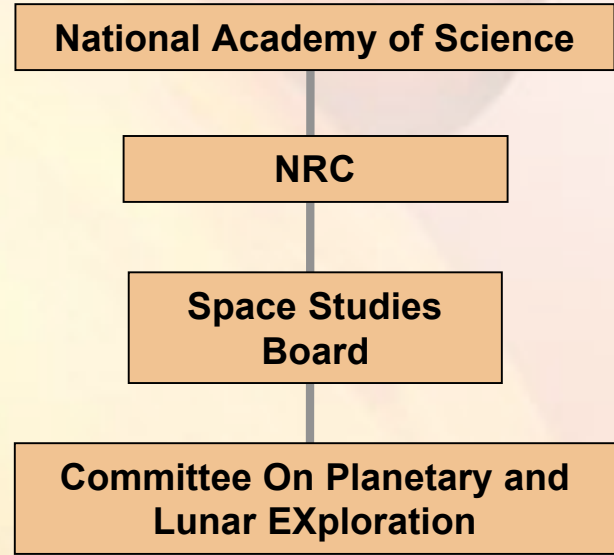
Planetary Protection Subcommittee

- Advise on planetary protection requirements for missions

NASA Advisory Structure



Federal Science Advisory System



National Research Council

- Committee on Review of Solar System exploration including Mars
 - Decadal Survey
 - Special assessments on request
 - Planetary Exploration (COMPLEX)
 - Committee on Origin and Evolution of Life (COEL)
- Astrobiology Strategy for Mars Exploration (recent Publication)



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
- Main “entry point” into NASA & responsible for ensuring timely responses to panel requests
- Facilitate the mission concept process that NASA has set up
- Periodically report back to Mars and PSD management to ensure consistency, and that the panels are getting what they need



Mission Concepts

Key Centers will analyze decadal missions

- NASA will assign the centers for studies requested by the Steering Panel
 - POC will be the main conduit for information between the Center and the Panel
- Provide specific analysis & supporting documentation to the Decadal Steering Panel and to the NRC contract cost reviewer
- Develop mission architectures that “close”, resulting in a “realistic” cost

Design Study Guidelines

- Input Standard:
 - Guidelines and standard input templates are in work at HQ and will be delivered to the Steering Group after iteration with design centers
 - A "science champion" is needed to provide input and define science requirements (this is not the HQ-POC)
 - Expect 1-2 week dedicated time when study kicks-off—in residence at design center preferable; on-call afterwards
- Output Standard:
 - Mission Concept addresses an agreed upon set of information necessary for the NRC cost review
- Mission concepts that have been studied at length may not require a new study; previous study constraints need to be validated, however.



Mars Exploration Program A Short Primer



Today's Mars Exploration Program Science Goals & Drivers

Decadal Solar System Themes

The First Billion Years of Solar System History

Volatiles and Organics: The Stuff of Life

The Origin and Evolution of Habitable Worlds

Processes: How Planetary Systems Work

Themes for Mars

Mars as a Potential Abode of Life

Water, Atmosphere & Climate on Mars

Structure and Evolution of Mars

Mars Exploration Program

LIFE

CLIMATE

GEOLOGY

Prepare for Human Exploration

Follow the Water

MEP Missions for 2001+

Reconnaissance

- ODY, MRO, MAVEN

Ground Truth

- MER, PHX, MSL/Curiosity

Future

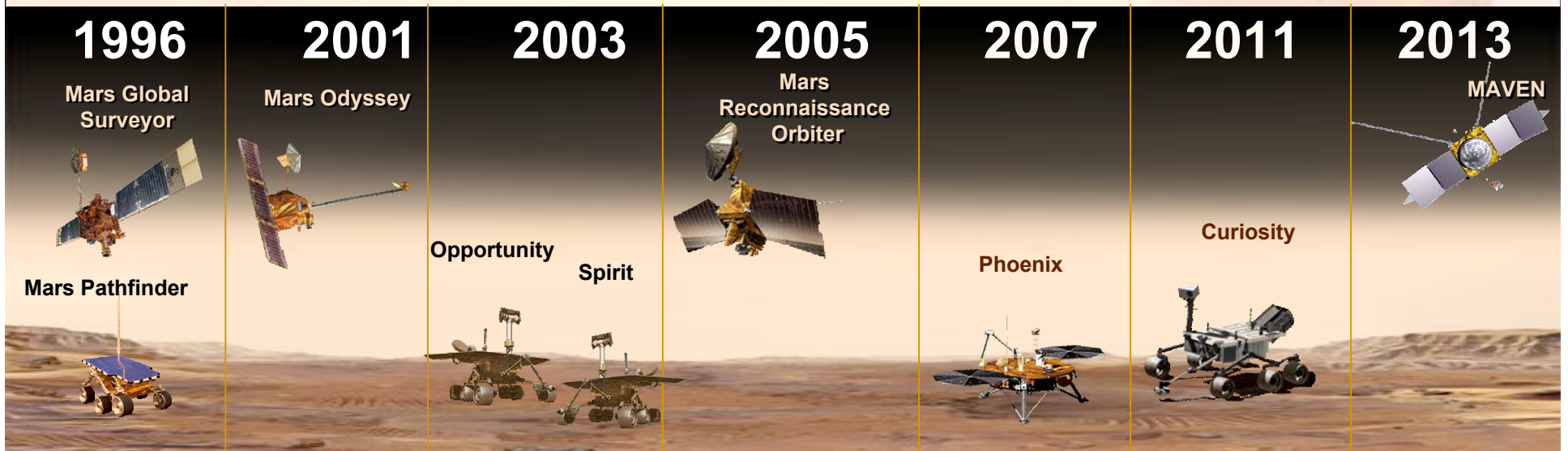
- Aeronomy (MAVEN), Trace Gases/methane, Sample Return

MEPAG: Goals, Objectives & Investigations



MEP—An Integrated Set of Activities Creating a True Program Structure

Year of Launch



Strategic, Core Missions

Competitive PI-Led Missions

Advanced Planning & Community Input

Research and E/PO Programs

Base Technology

MER Focused Technology

MRO Focused Technology

MSL Focused Technology



Progress on Current Decadal Survey Science Goals

MEP has made progress despite significant implementation challenges.

Mars Sample Return -- *Major Progress*

- ✓ Returned data have reinforced the need to return samples to Earth for detailed and repeated geological, climatological and biological analyses
- ✓ Identified several kinds of water-related environments on Mars
- ✓ Identified potentially habitable environments, some possibly able to preserve biosignatures
- ✓ Developed the MSL (“Skycrane”) delivery system which will be the basis during the next decade (or more) for landing sample caching and sample return flight systems
- Plans to follow with a system to prepare retrievable cache; further technology work being planned into follow-on missions; possible by the 2018 mission—NASA/ESA and MEPAG studies

Mars Aeronomy -- *Major Progress*

- ✓ MAVEN (Mars Scout)-- Will characterize upper atmosphere response to solar inputs and characterize mechanisms for atmospheric loss to space
- Trace Gas Orbiter -- Inventory and mapping of lower atmosphere trace gases; in study for 2016

Habitability (Mars as an abode of life) -- *Major Progress*

- ✓ Identified several kinds of water-related environments on Mars; placed in global context
- ✓ Identified potentially habitable environments from orbital data; placed in regional context
- *MSL/Curiosity* will investigate the habitability of one of these environments in detail.
- Planning to follow with Mid-sized rover to new site
- ESA’s ExoMars will provide related science

Mars Network -- *Little Progress*

- Still in planning stage



Tomorrow's Mars Exploration Program: Overcoming Implementation Challenges through Partnership

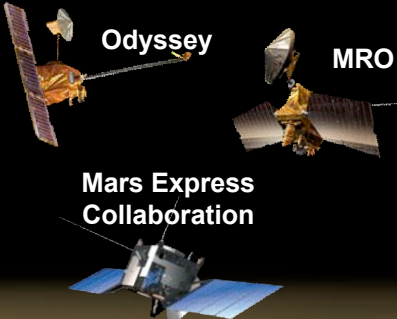






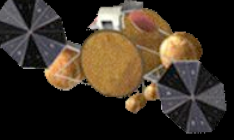


- Efforts are underway to merge the NASA and ESA Mars Exploration Programs into a single initiative
 - Joint studies began the first week of January, 2009
 - Joint NASA-ESA Engineering Working Group (JEWG)
 - Joint Instrument Definition Team (JIDT)
 - Joint Mars Executive Board (JMEB)
- Initial studies determined ESA's desired approach of carrying unmodified ExoMars was unachievable (technical and cost risk unacceptable)
- July '09 Bi-Lateral agreement to distribute ESA's ExoMars architecture over multiple opportunities (2016/2018)
 - Joint studies re-started in late July
 - Conceptual architecture developed and being studied
 - Viability of this concept will be better understood later in CY09
- **The Decadal Study results will inform the science goals/objectives, and NASA's priorities, in the intended partnership**
 - **Consider a Joint Program as an implementation method**



Joint NASA-ESA Mars Initiative

Conceptual Architecture Currently Under Study

← NASA-ESA Joint Mars Initiative (in planning) →

Operational 2001-2009	2011	2013	2016	2018	2020	2022 & Beyond The Era of Mars Sample Return
 						  
		<ul style="list-style-type: none"> • Decadal Science • Proximity link (limited) 	<ul style="list-style-type: none"> • ESA Lead • NASA's trace gas science/mission concept • 110kg payload & ~1m imaging • Long-lived comm. @ Mars • ESA EDL tech demo lander (targeting ~200kg) 	<ul style="list-style-type: none"> • NASA Lead • Astrobiology & sample caching • Rover sizes limited—based on EDL and ELV constraints • US science needs based on community input & Decadal Study 	<ul style="list-style-type: none"> • Leadership TBD • Network Science likely mission concept • 2016 ESA Tech demo lander feed-forward 	<ul style="list-style-type: none"> • NASA lead with ESA co-lead • Goal of returning samples in the mid-2020's • Tech development and landing site selection threaded through preceding opportunities • Significant interest in participation by other nations expected (a la iMARS 2007-08)



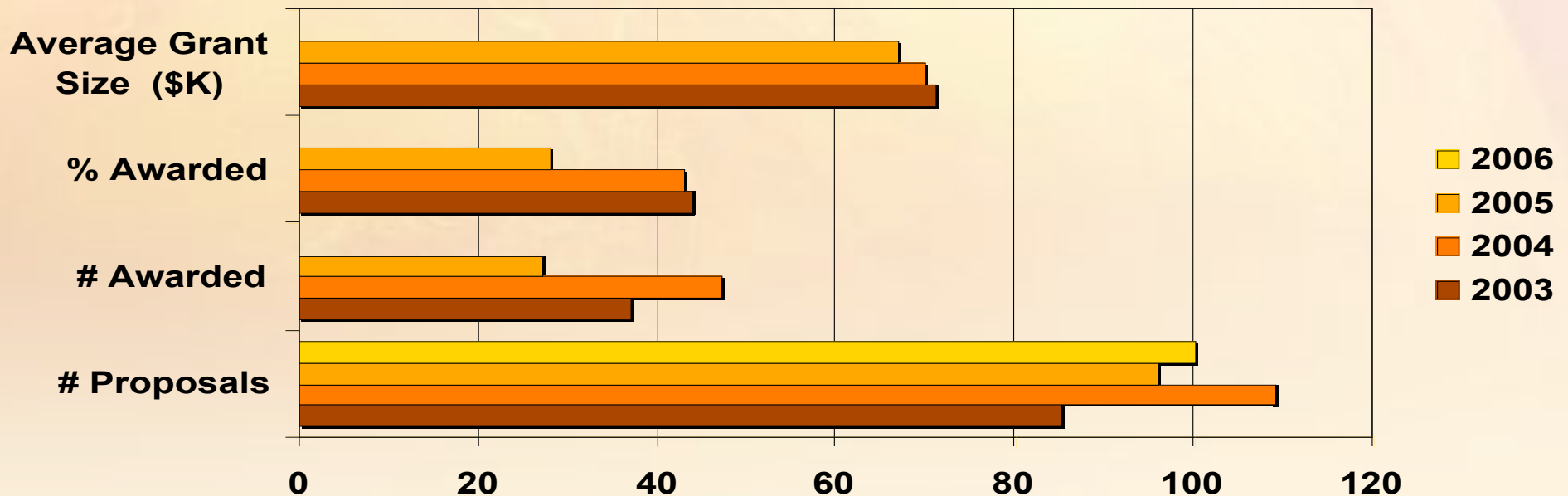
Research and Analysis— Mars Data Analysis Program (MDAP)

Overview:

- Funds the analysis of data returned from NASA and other missions to Mars.

Purpose:

- Enhance mission scientific return
- Broaden scientific participation in the analysis of mission datasets
- Fund high-priority areas of research that support planning for future missions





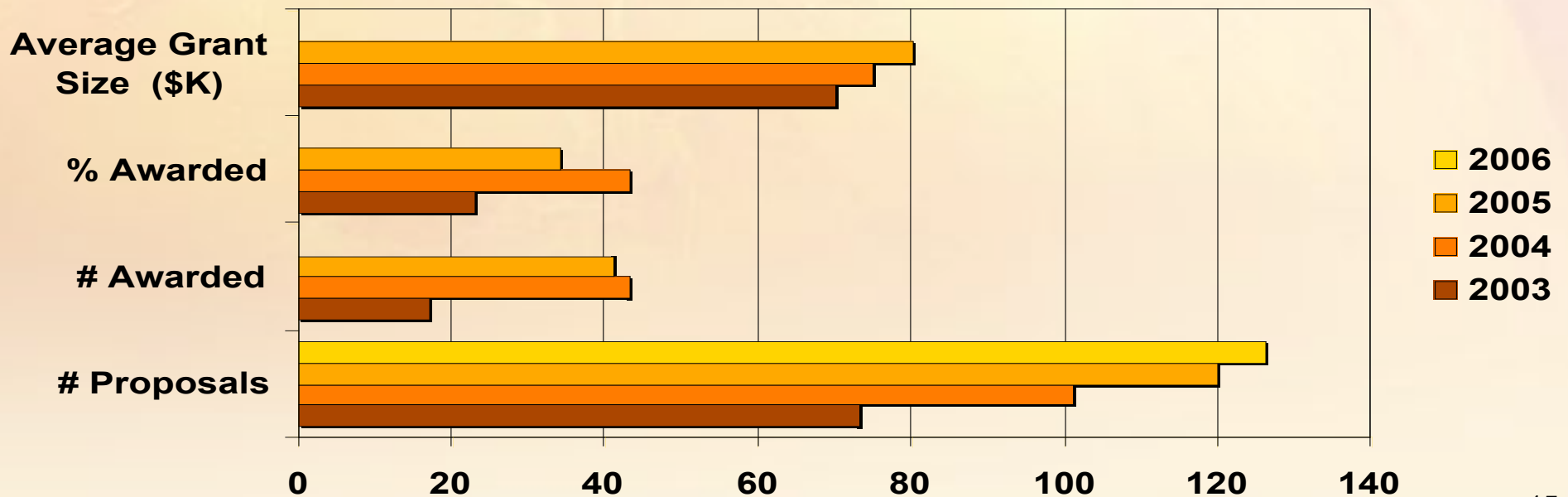
Research and Analysis— Mars Fundamental Research Program (MFRP)

Overview:

- Funds basic research relating to the origin, evolution and habitability of the Martian atmosphere, surface and interior

Types of studies:

- Theoretical modeling and experimental studies
- Laboratory and field studies
- Development of Mars-like datasets to aid in the interpretation of flight data





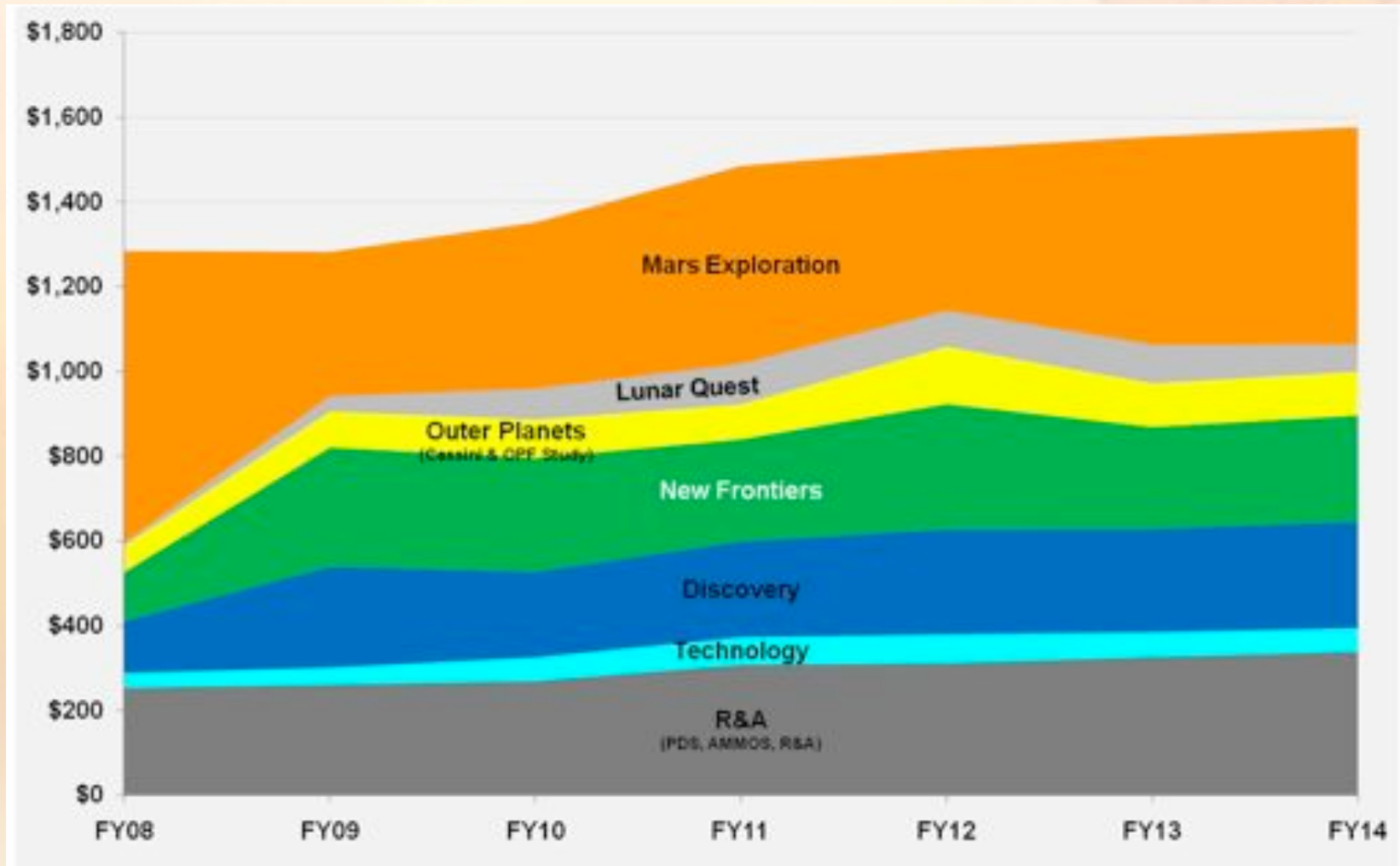
Mars Public Engagement

- MEP Public Engagement activities are thematic and programmatic
 - Conducted at the Program level in collaboration with missions (no Project-level EPO except Scout missions)
- Mars Public Engagement Plan covers over a decade of activities corresponding to the component missions, duration, and goals of the MEP
- The Plan is aligned with the NASA Strategic Plan and the NASA Education Framework
 - National reach through large networks, reaching >17,000 educators and >100,000 students
- Sustained Web presence: Over 350,00 unique web-visitors per month: enormous surge during critical Mars events
- MEP Public Engagement has been recognized as a “*model for the Agency*”
- Major Projects: Systemic Educator Professional Development Workshops, Mars Student Imaging and Analysis, Imagine Mars, Mars Museum Visualization Alliance, Mars National Parks Initiative





Planetary FY10 Budget

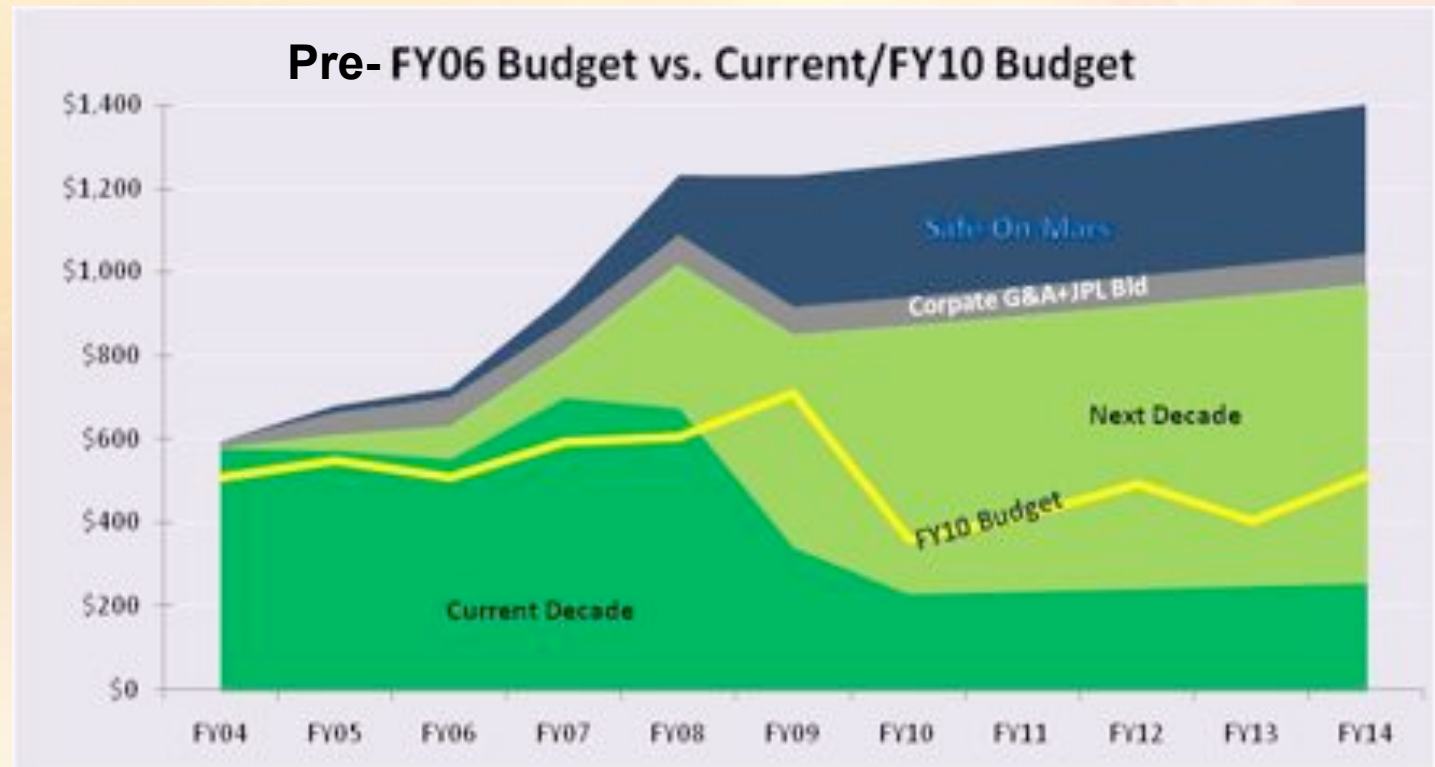
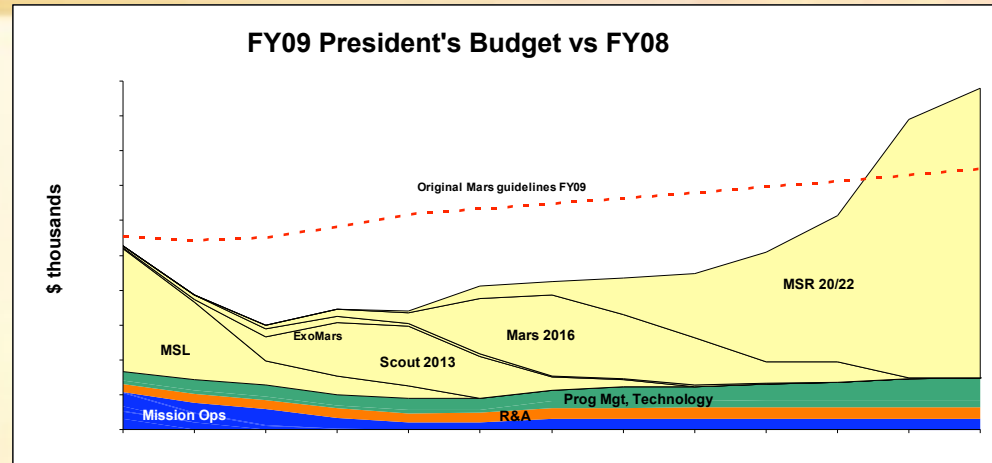




Finding the Means to Address Challenging Goals

Current challenges in exploring Mars and the solar system

- Launch vehicle cost growth
- Reduction of Mars Program (and Planetary Division) by >50% since 2005





Funds Available for Future Mars Missions

President's FY10 Budget



- Studies to use the President's FY11 budget when issued in Feb '10
- 1st budget with goals from the new Administration



Planetary Division Mission Enabling Technologies



Technology Investment Overview

Mars Technology Program—MEP

- Mission specific technologies for strategic mission
- Mars Instrument Development Program (MIDP)
- Major cutbacks in this program due to MSL overruns

Flight mission technologies—PSD

- Radioisotope Power Systems
- Laser Communications (with SOMD)
- In-Space Propulsion Program
 - Propulsion: Electric & Advanced Chemical
 - Aerocapture
- Advanced Multi-mission Operating Systems (AMMOS)

Instrument Technologies from ROSES—PSD

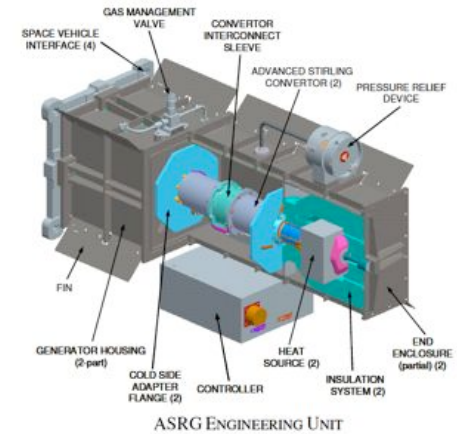
- Planetary Instrument Development & Definition Program (PIDDP)
- Astrobiology Science & Tech. for Exploring Planets (ASTEP)
- Astrobiology Science & Tech. Instrument Development (ASTID)



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 Pu²³⁸
- 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



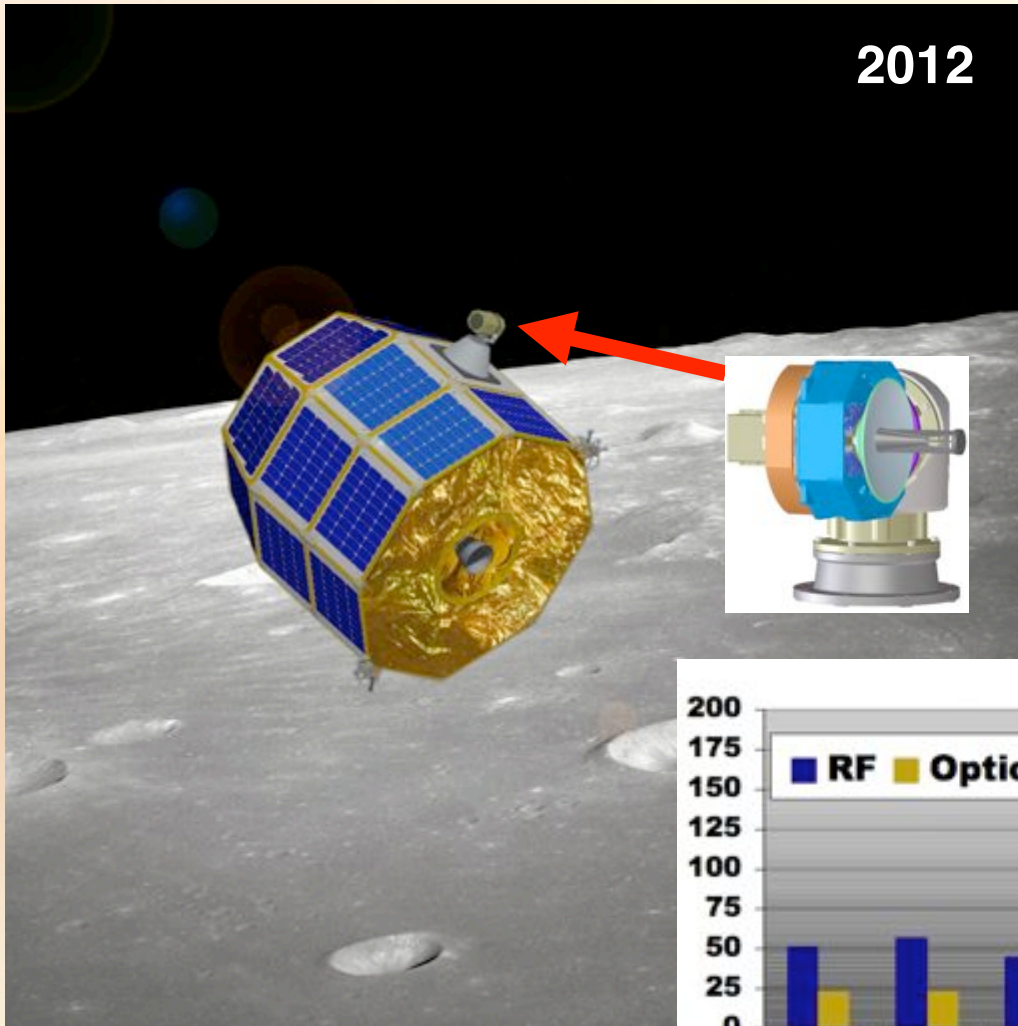
ASRG EU on test
at NASA Glenn



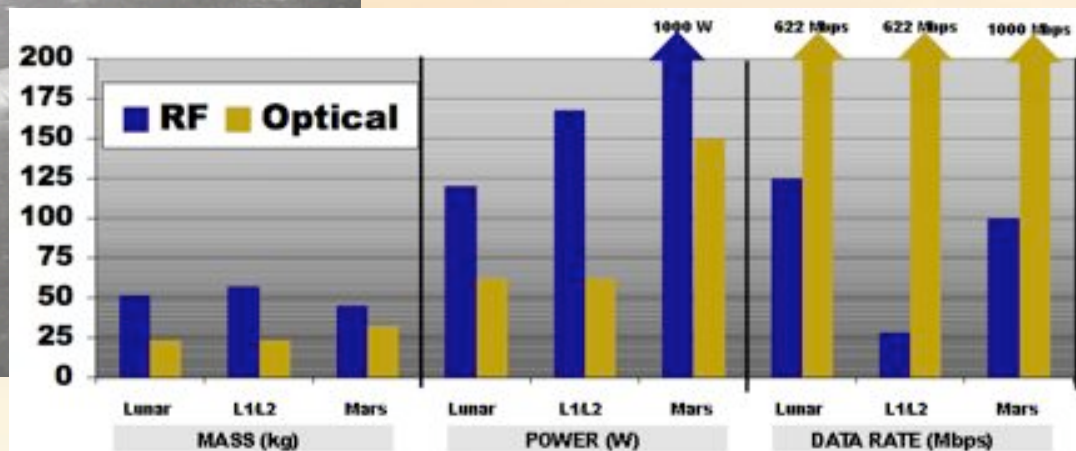


Deep Space Optical Comm. Initiative

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
- Enabling technology for Mars





Backup



Mars Program and Planetary Science Division Budget History (\$M)

Combined budgets of Mars Exploration Program and Solar System Exploration Division



	FY08	FY09	FY10	FY11	FY12	FY13	FY14
FY05 PFP (w/ DSN, O/H, & Lunar Robotics)	\$2,855	\$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	\$1,409	
FY10 PFP	\$1,313	\$1,288	\$1,346	\$1,501	\$1,578	\$1,400	\$1,633



MEP Mission Traceability Matrix

Scientific Objectives for Mars (from MEPAG)	MGS	ODY	MER	MRO	PHX	MSL
Goal I. Life						
Assess past and present <u>habitability potential</u> of Mars	X	X	XX	X	XX	XX
Characterize <u>carbon cycling</u> in its geochemical context (including its origin and distribution)	X			X	X	XX
<u>Test for life</u> (identify and determine the spatial distribution of biosignatures)						
Goal II. Atmosphere						
Characterize the atmosphere and <u>present</u> climate and processes	XX	X	x	XX	XX	X
Characterize Mars' <u>ancient</u> climate and climate processes.	X	x	X		X	X
Atmospheric state and processes of critical importance for the <u>safe operation of spacecraft</u>	XX	XX	X	XX	X	X
Goal III. Geology						
Determine the nature and evolution of the geologic processes that have created and modified the <u>martian crust and surface</u>	XX	XX	XX	XX	XX	XX
Characterize the structure, composition, dynamics, and evolution of the <u>martian interior</u>	XX			x		
Goal IV. Preparation						
Obtain <u>knowledge of Mars</u> sufficient to design and implement a human mission with acceptable cost, risk and performance		X			XX	X
Conduct risk and/or cost reduction <u>technology and infrastructure demonstrations</u> in transit to, at, or on the surface of Mars.					X	XX

Note: An XX rating means the mission is particularly significant for that goal.