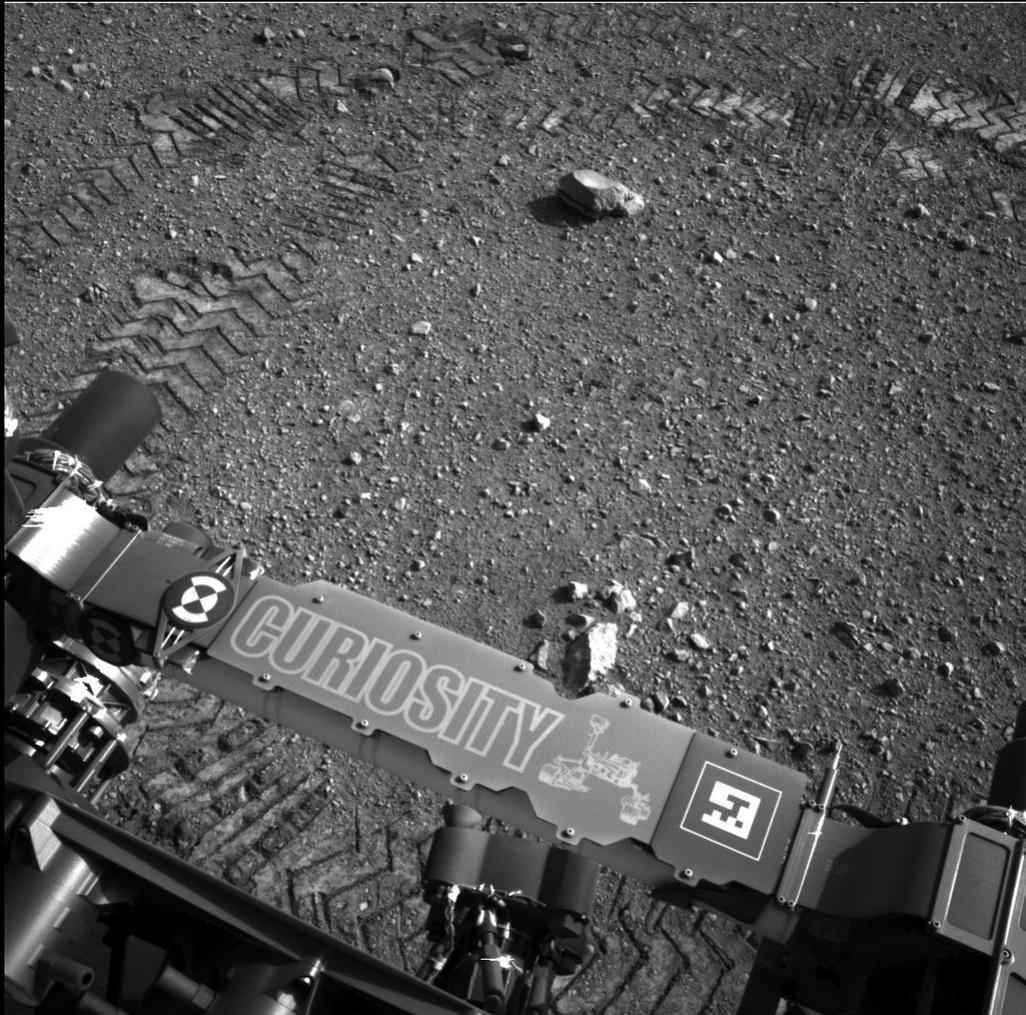




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Pasadena, California



Commercial Space Activities at the Jet Propulsion Laboratory

Lt. Gen. Eugene Tattini (USAF, Ret.)
Deputy Director

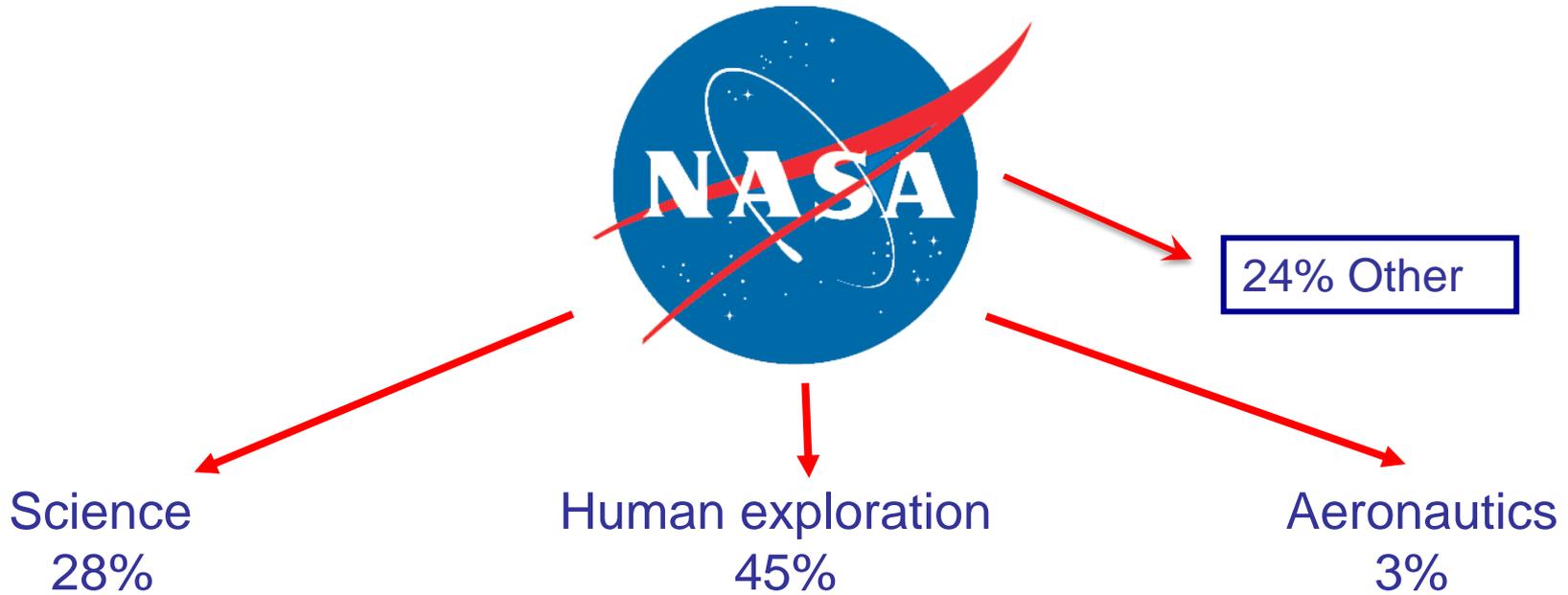
Jet Propulsion Laboratory
California Institute of Technology

September 18, 2012



National Aeronautics and
Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Space Exploration Supported by U.S. Government

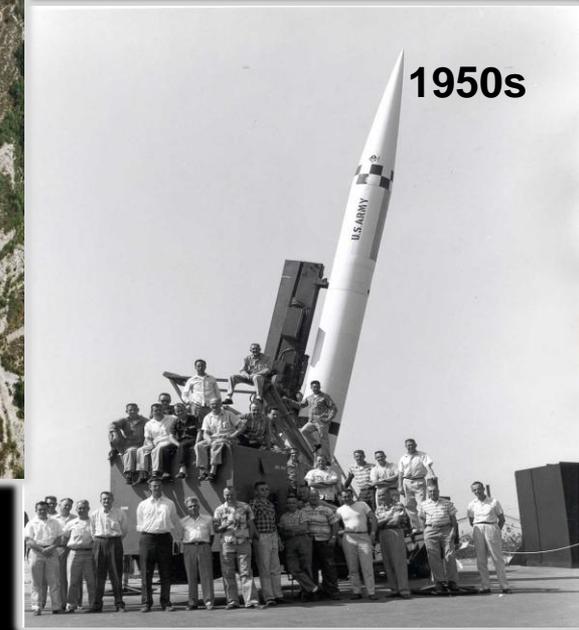
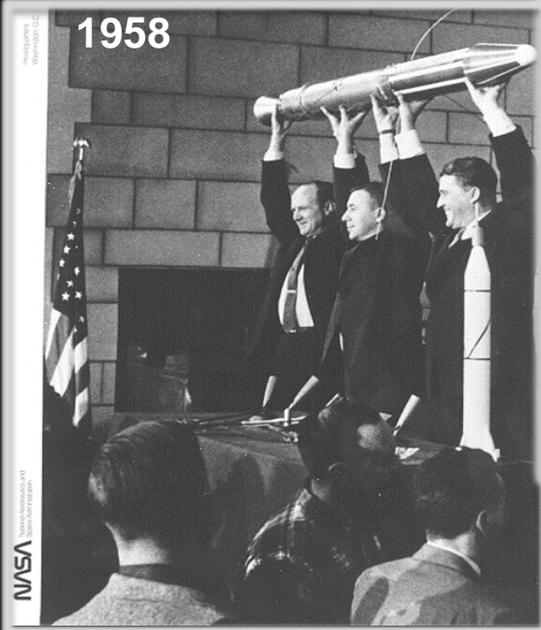




National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

JPL History

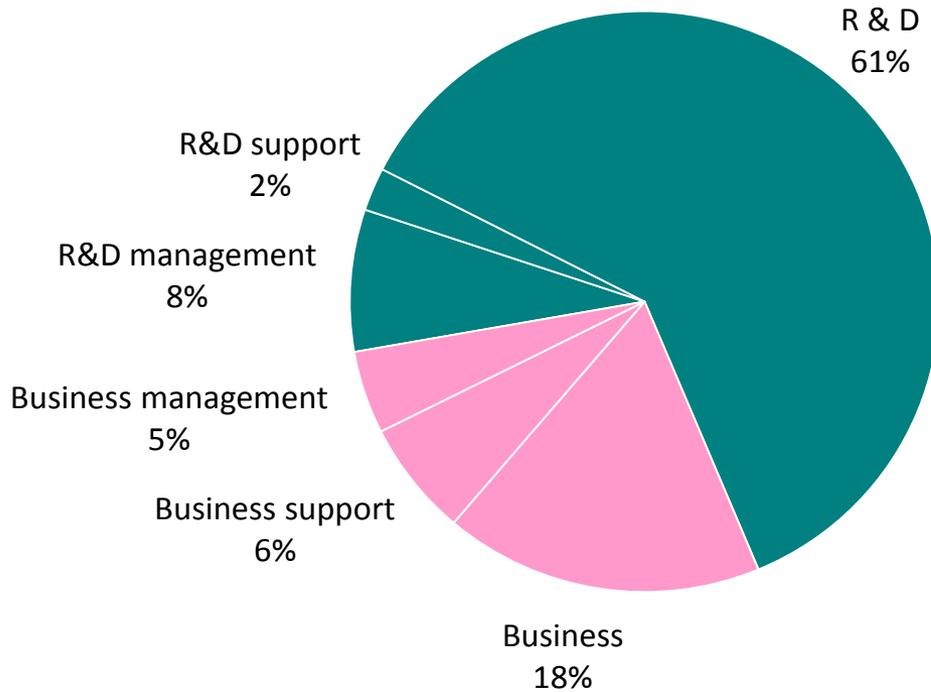




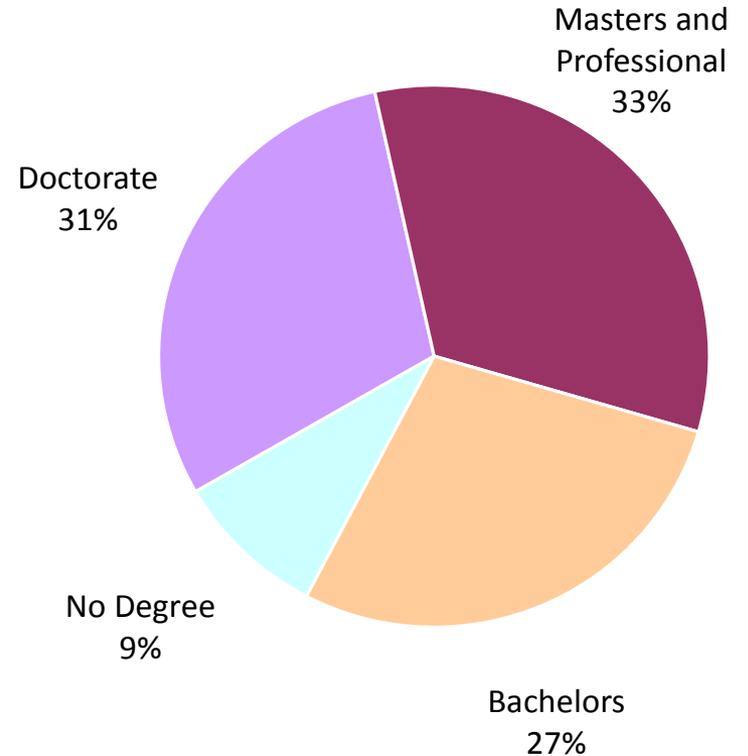
FY 12 JPL Population

Staff Composition by Job Classification and Academic Degree

- Staff composition by job classification for 4823 employees (4743 FTEs)



- R&D staff distribution by academic degree for 3453 employees

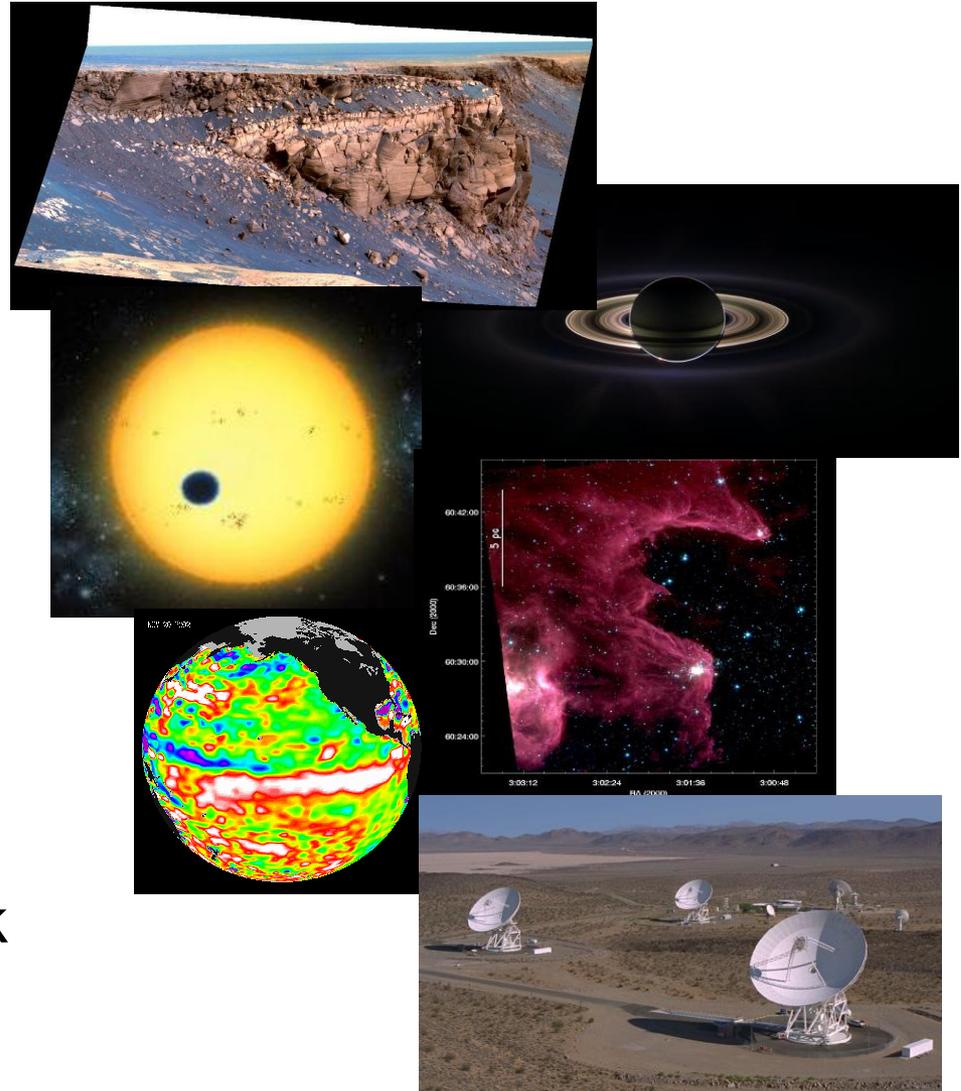




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JPL's mission for NASA is robotic space exploration

- Mars
- Solar System
- Exoplanets
- Astrophysics
- Earth Science
- Interplanetary Network

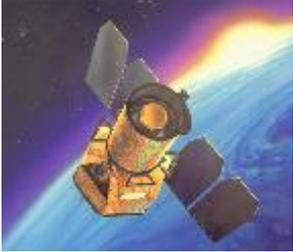




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Pasadena, California

24 Spacecraft and 10 Instruments Across the Solar System and Beyond



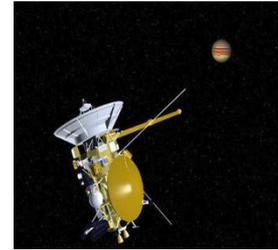
GALEX



ACRIMSAT



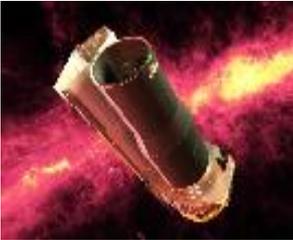
Mars Odyssey



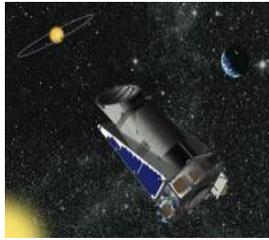
Cassini



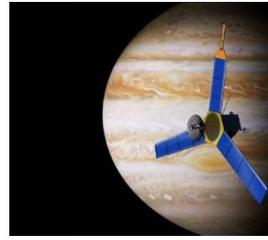
CloudSat



Spitzer



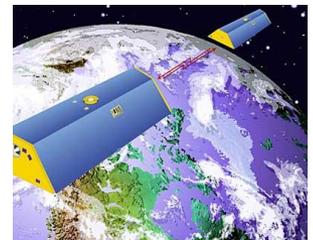
Kepler



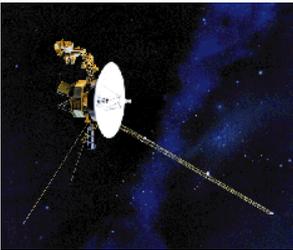
Juno



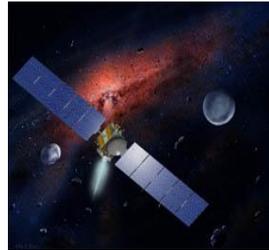
Aquarius



GRACE



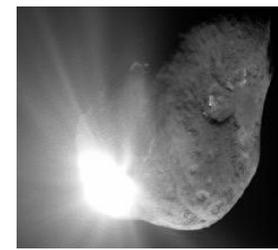
Two Voyagers



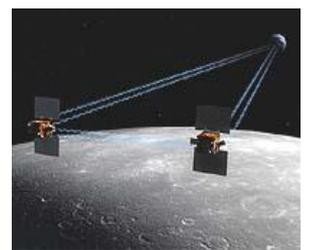
Dawn



Opportunity



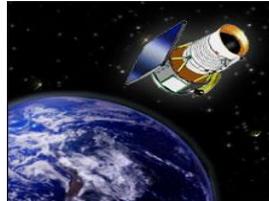
EPOXI-Deep Impact



GRAIL



Mars Science Laboratory



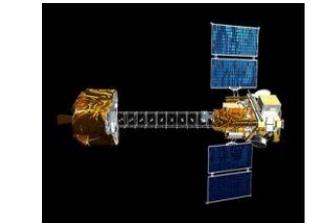
Wide-field Infrared Survey Explorer (WISE)



Mars Reconnaissance Orbiter



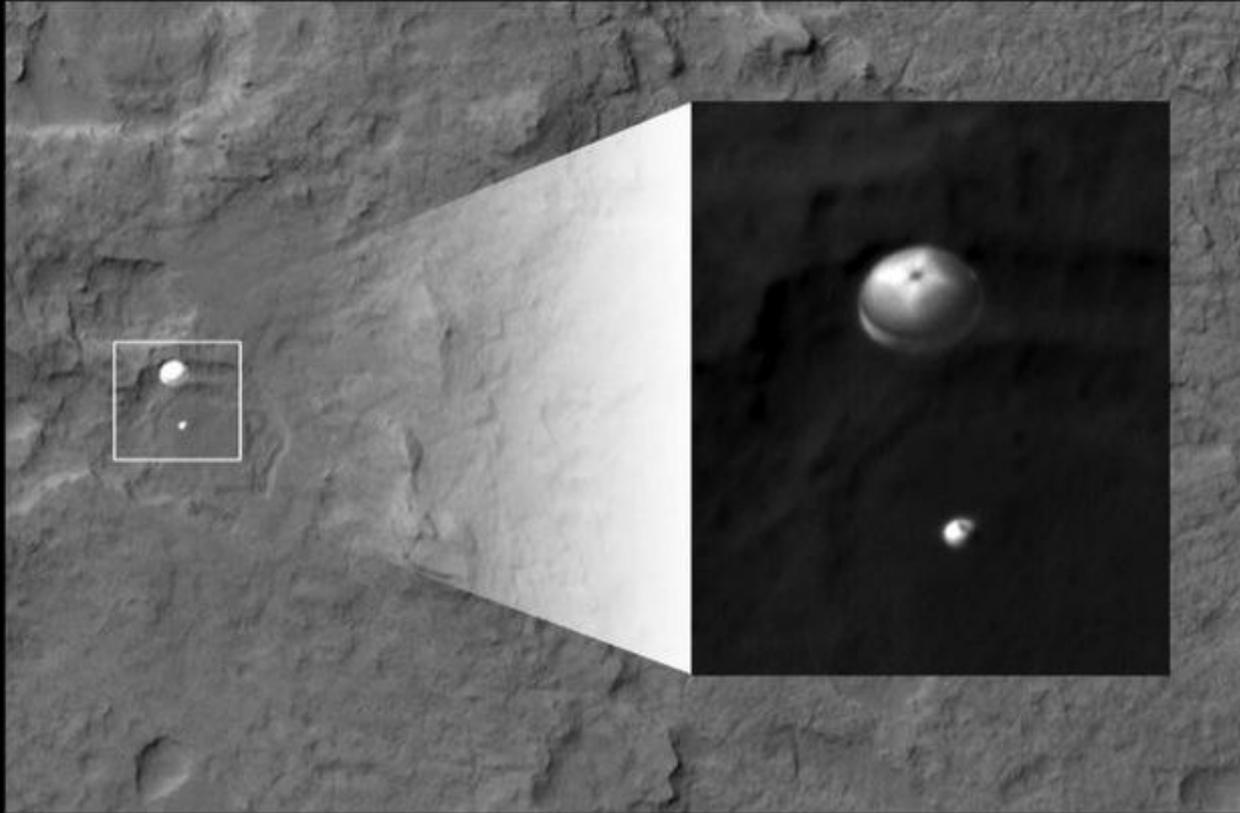
Jason 1 and Jason 2



Nuclear Spectroscopic Telescope Array (NuSTAR)



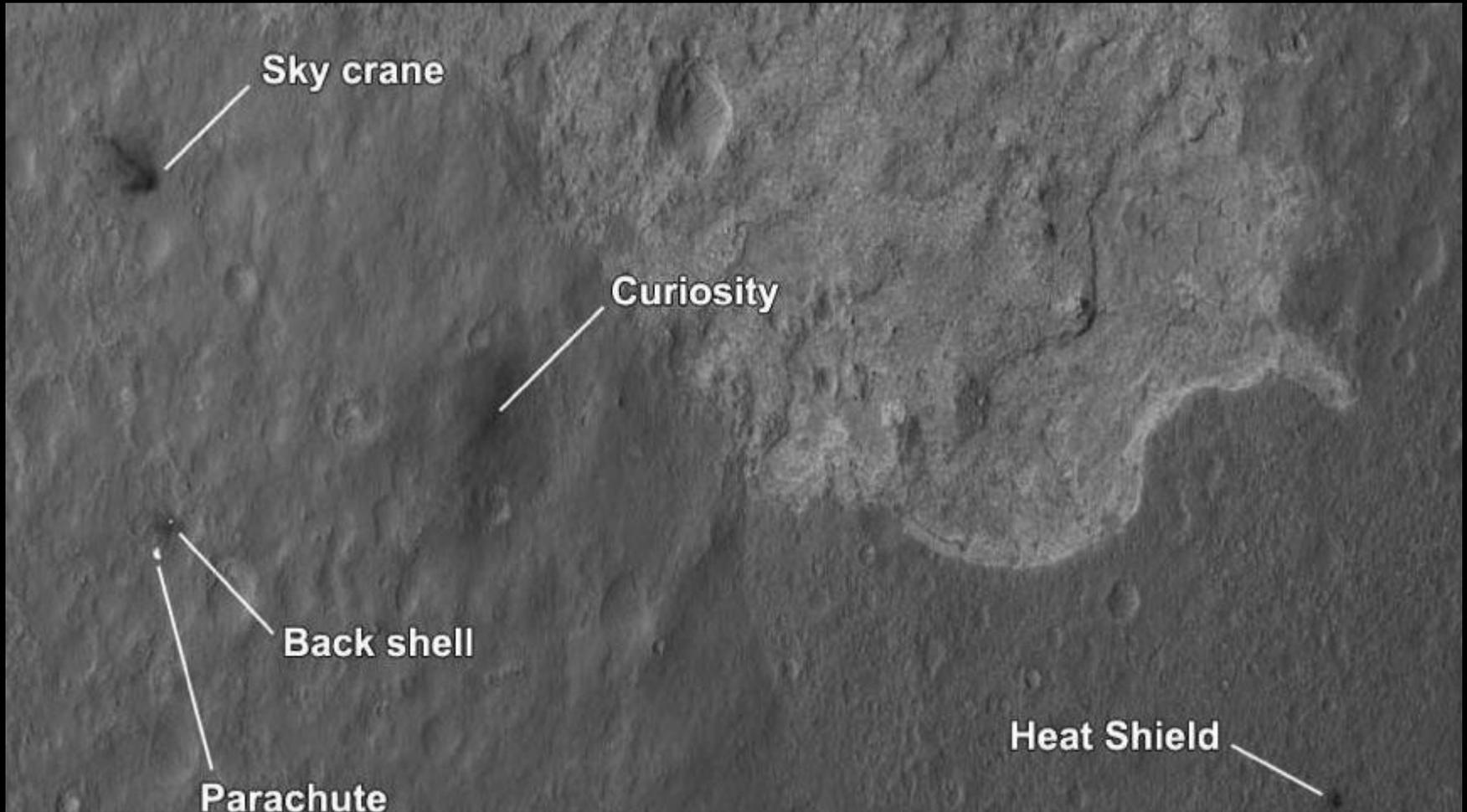
Three Generations of Rovers



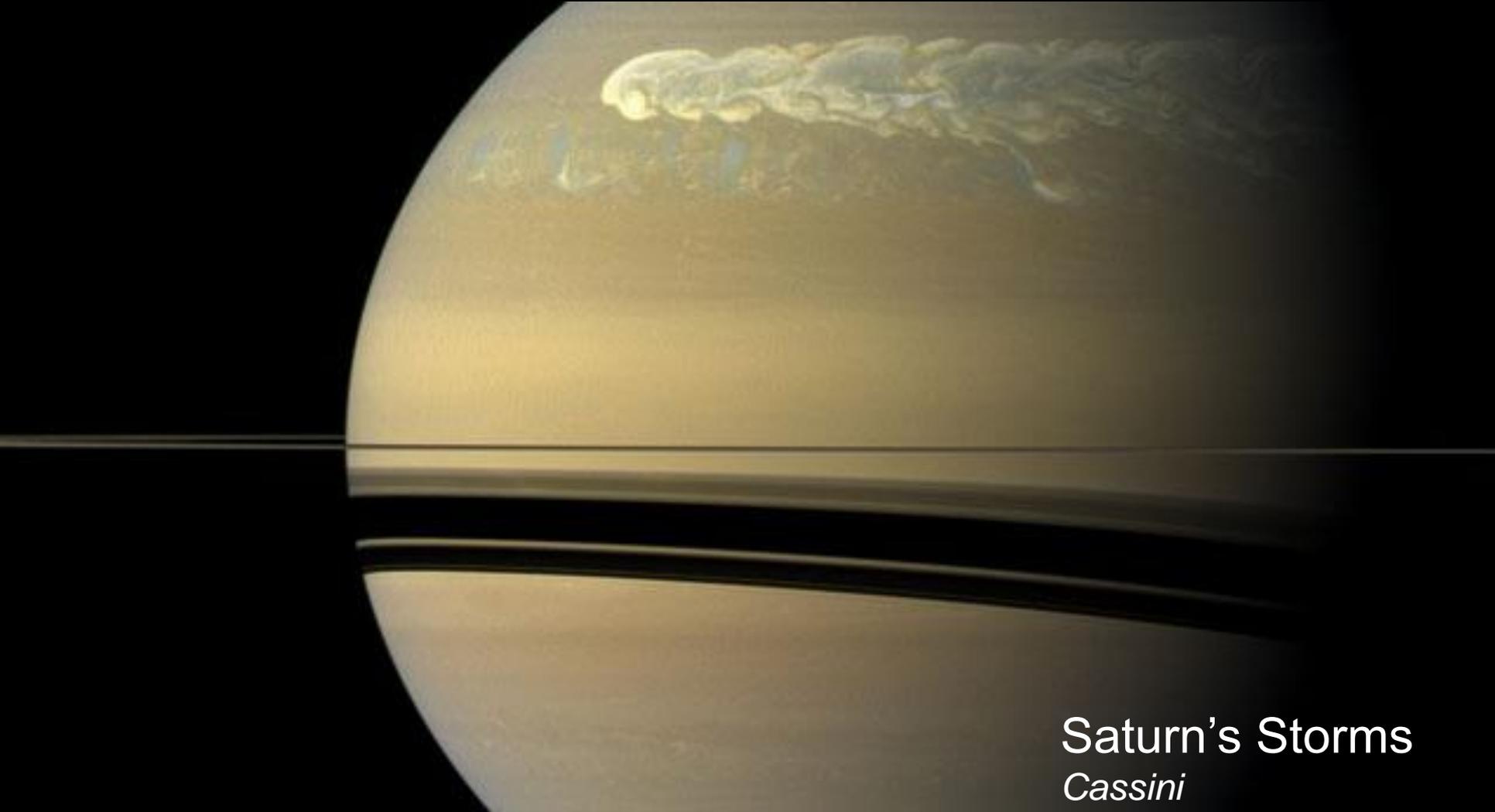
Parachute Deployed
MRO HiRISE camera



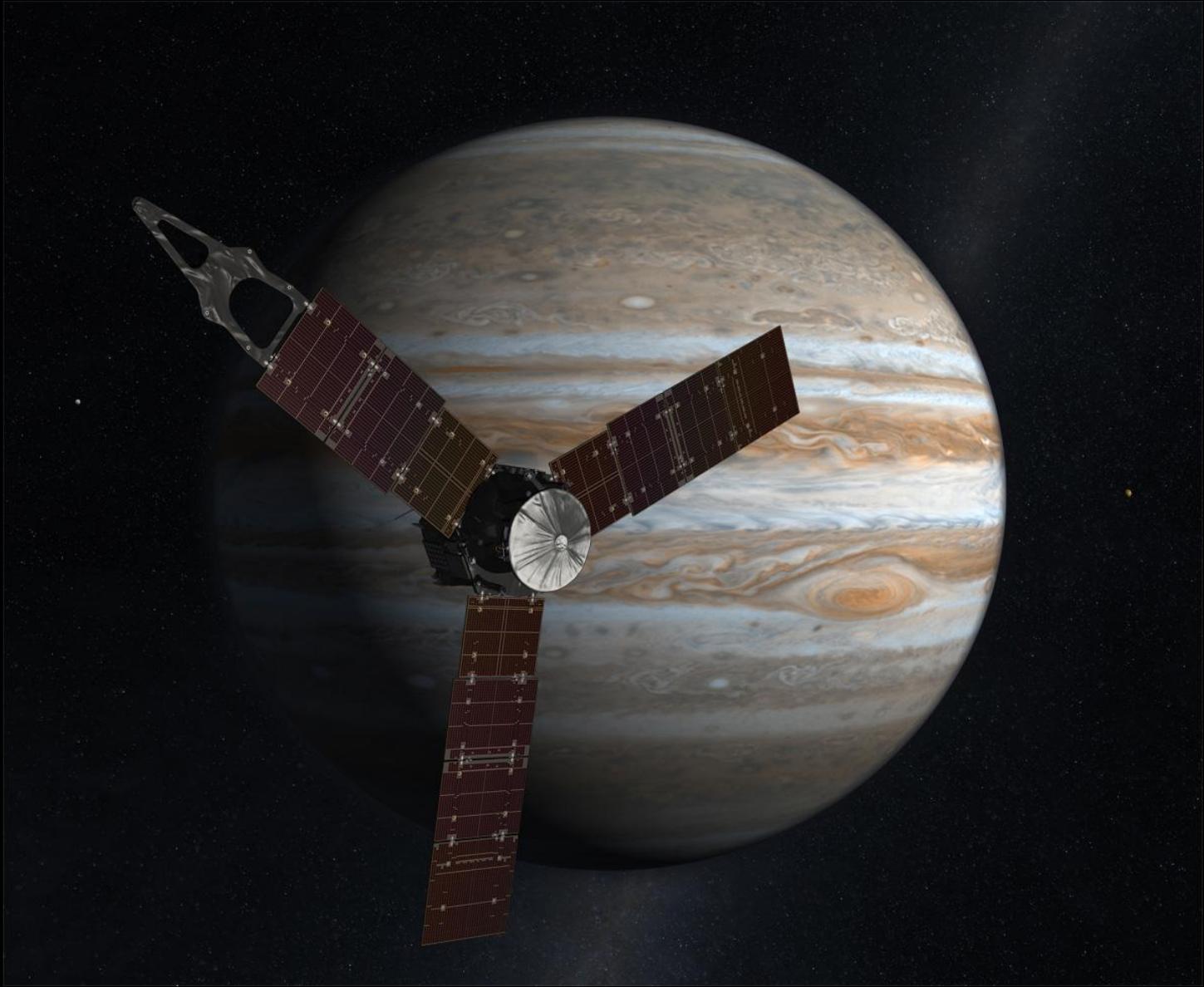
Heatshield Jettisoned
MSL MARDI camera



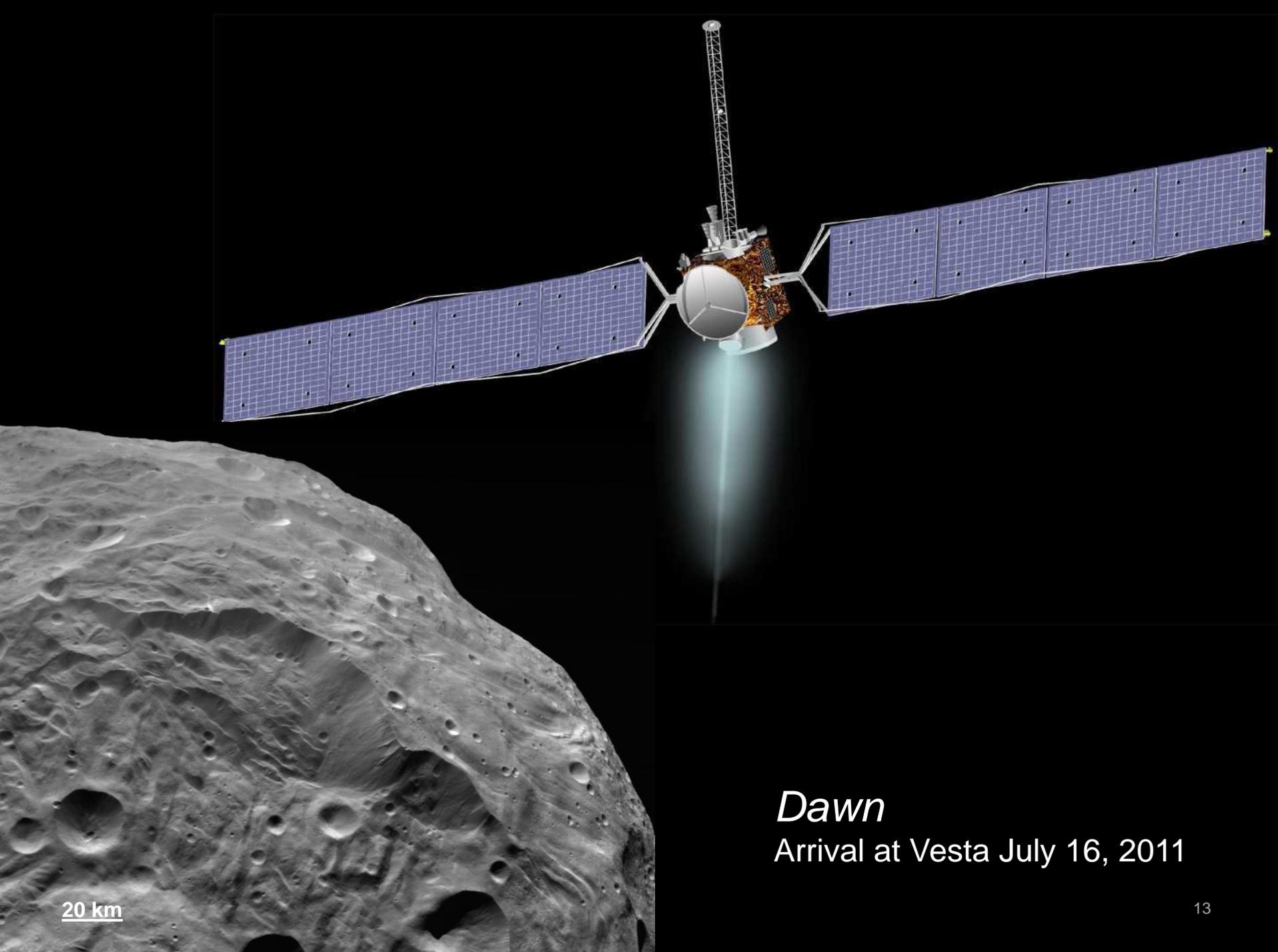
CSI: Mars



Saturn's Storms
Cassini



Juno
Arrival at Jupiter: July 2016



Dawn
Arrival at Vesta July 16, 2011

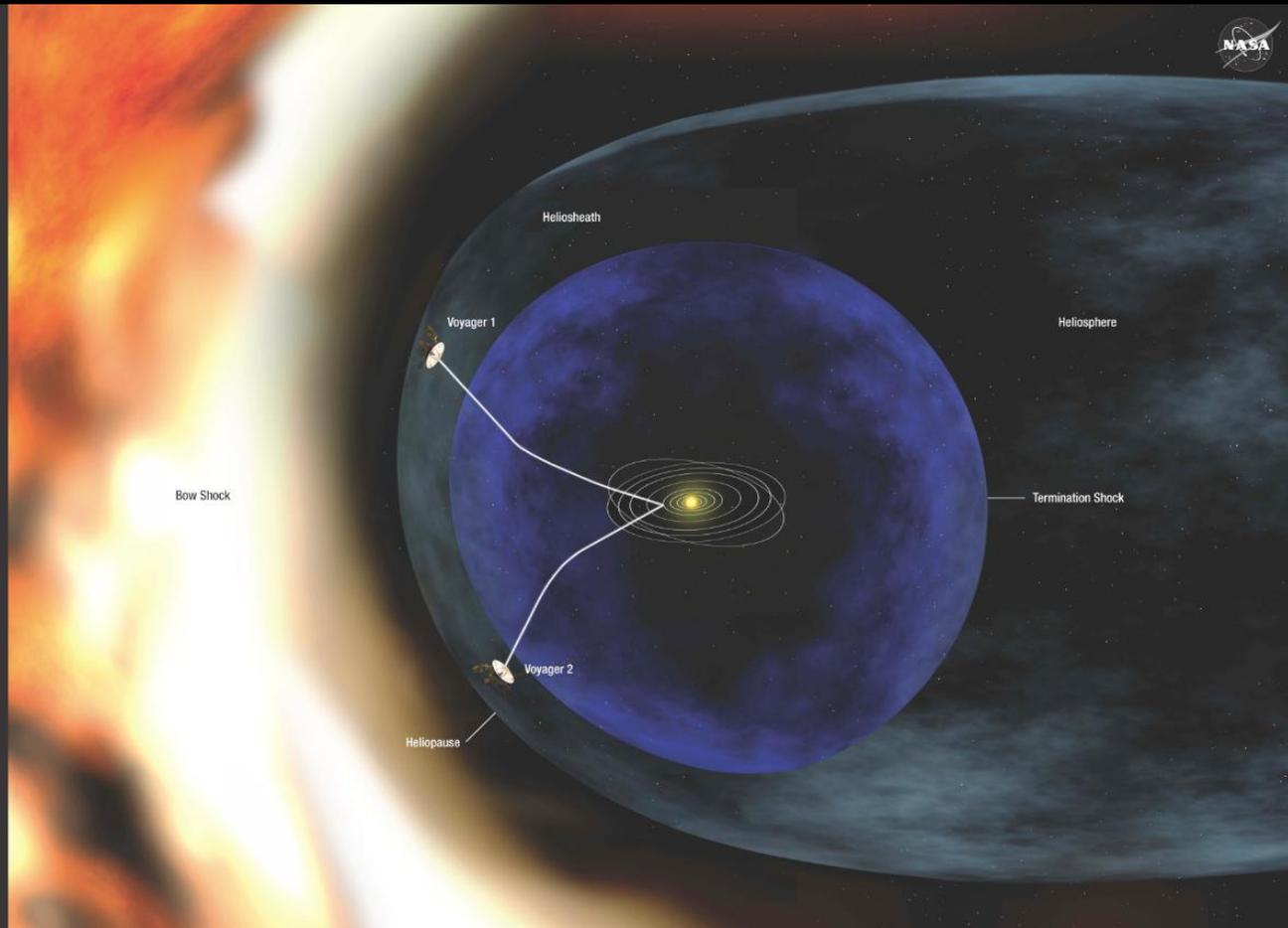
20 km

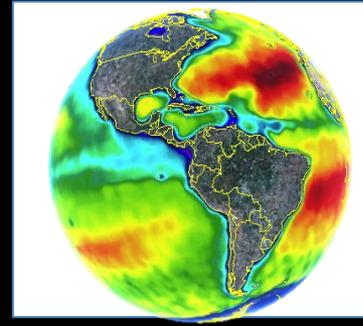
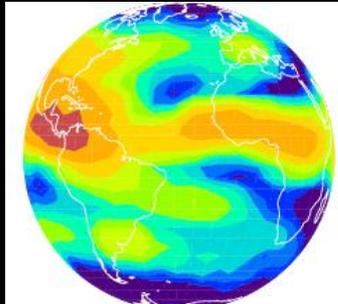
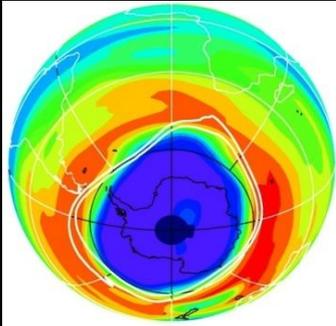
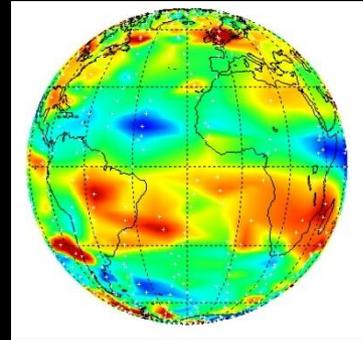
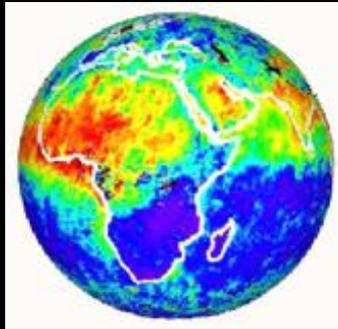
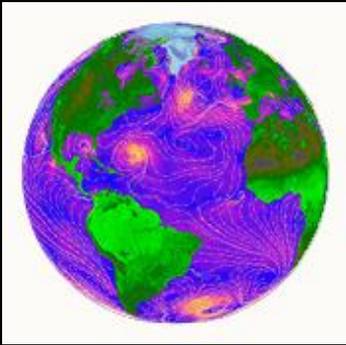
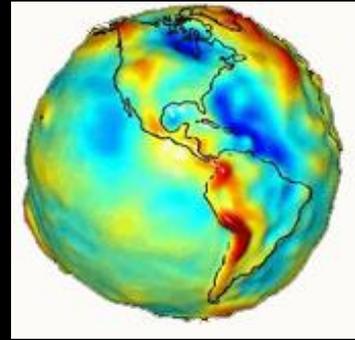
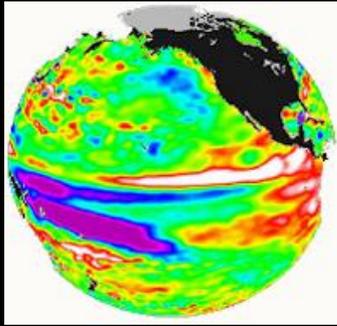
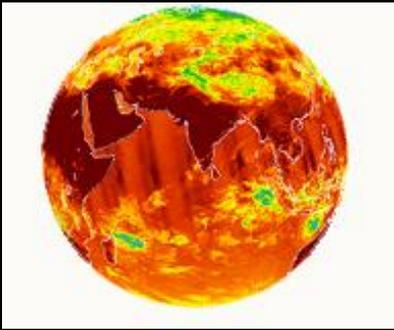
Where are the Voyagers Today?

	<i>Distance from the Sun</i>	<i>Round-trip Light Time</i>
<i>Voyager 1</i>	17.55 billion km (117.35 AU)	32h 18m 16s
<i>Voyager 2</i>	14.30 billion km (95.60 AU)	26h 17m 46s

Where No Spacecraft Has Gone Before

Just as a comet's tail is swept behind it as the comet travels upstream in the solar wind, the ions streaming outward from the Sun are swept behind it as the solar system hurtles through the interstellar medium. This balloon-shaped region is known as the heliosphere. Deep within it lie the Sun, Earth, all the planets, and most of the Kuiper Belt objects.

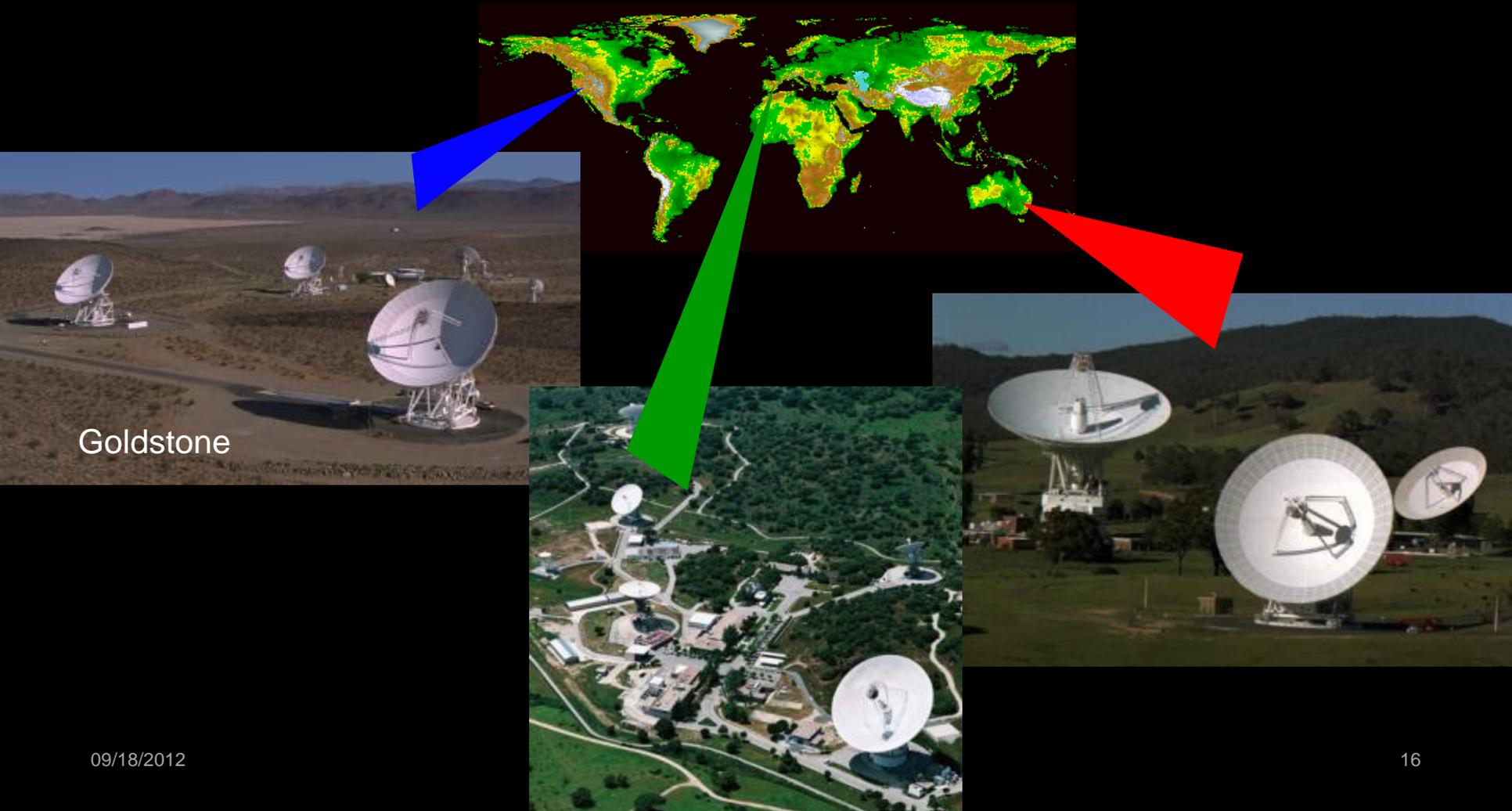




Aquarius - sea surface salinity

Multiple ways to look at a changing Earth

Deep space exploration enabled by NASA's Deep Space Network (DSN)

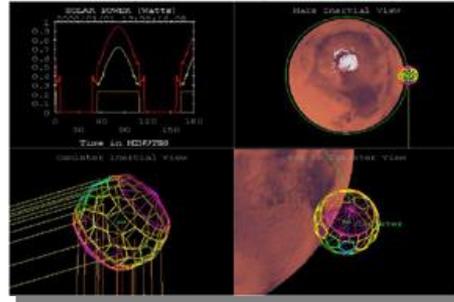




End-to-end capabilities needed to implement missions



Project Formulation - Team X



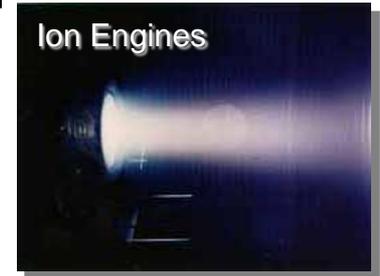
Mission Design



Mars Rovers



Large Structures - SRTM



Ion Engines



Integration and Test



Environmental Test



Real Time Operations

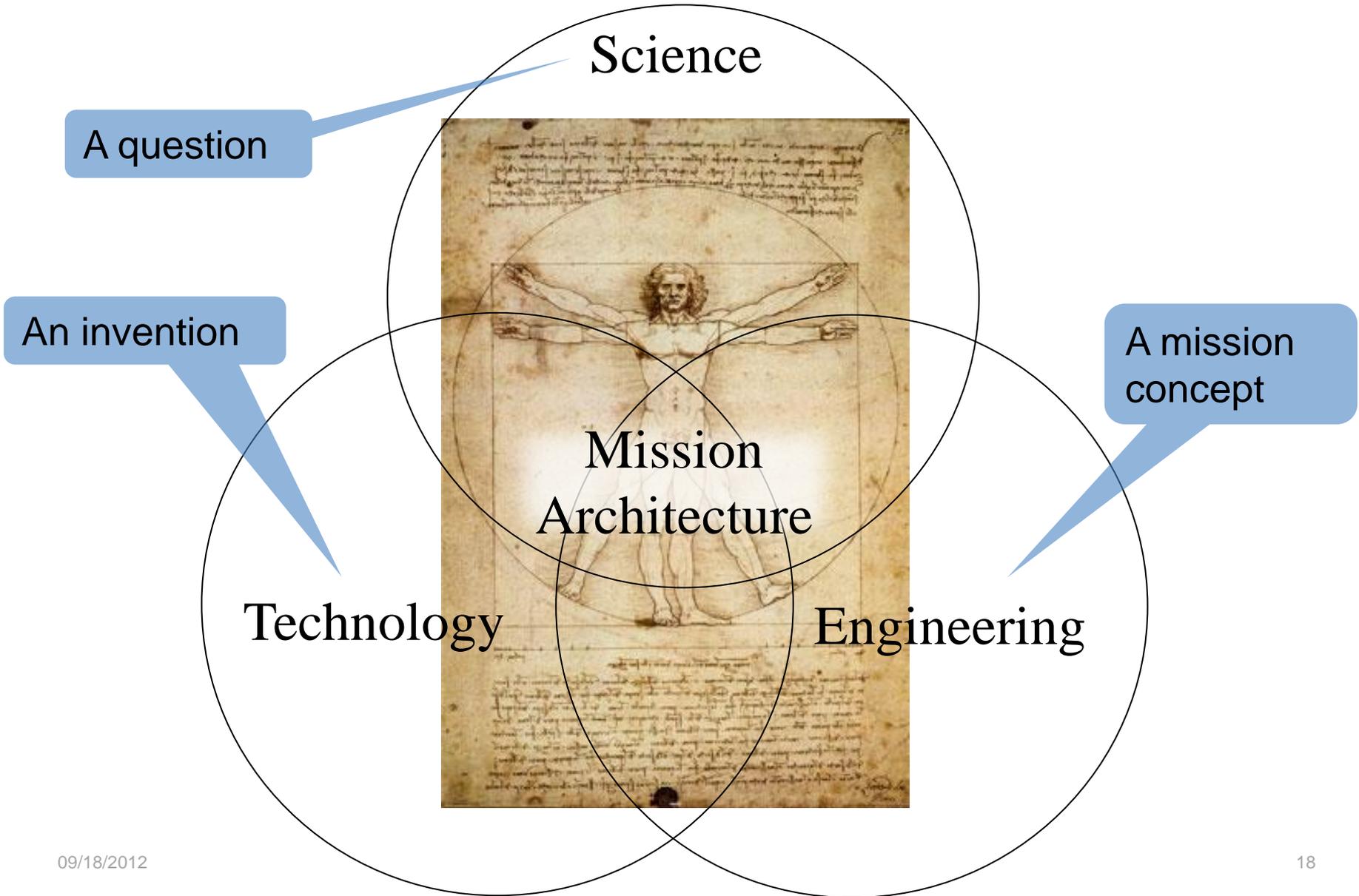


Scientific Research



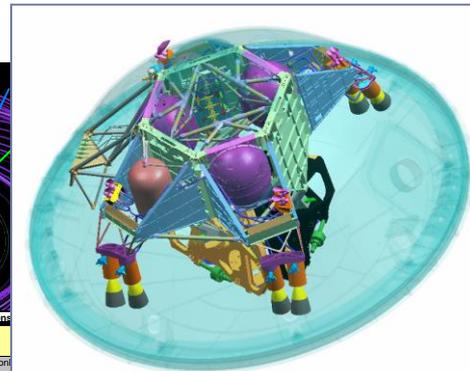
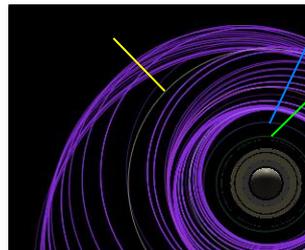
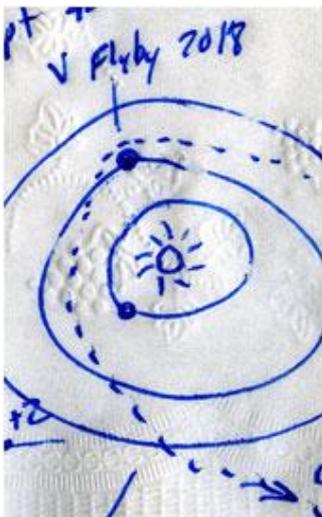


Every mission starts with a spark



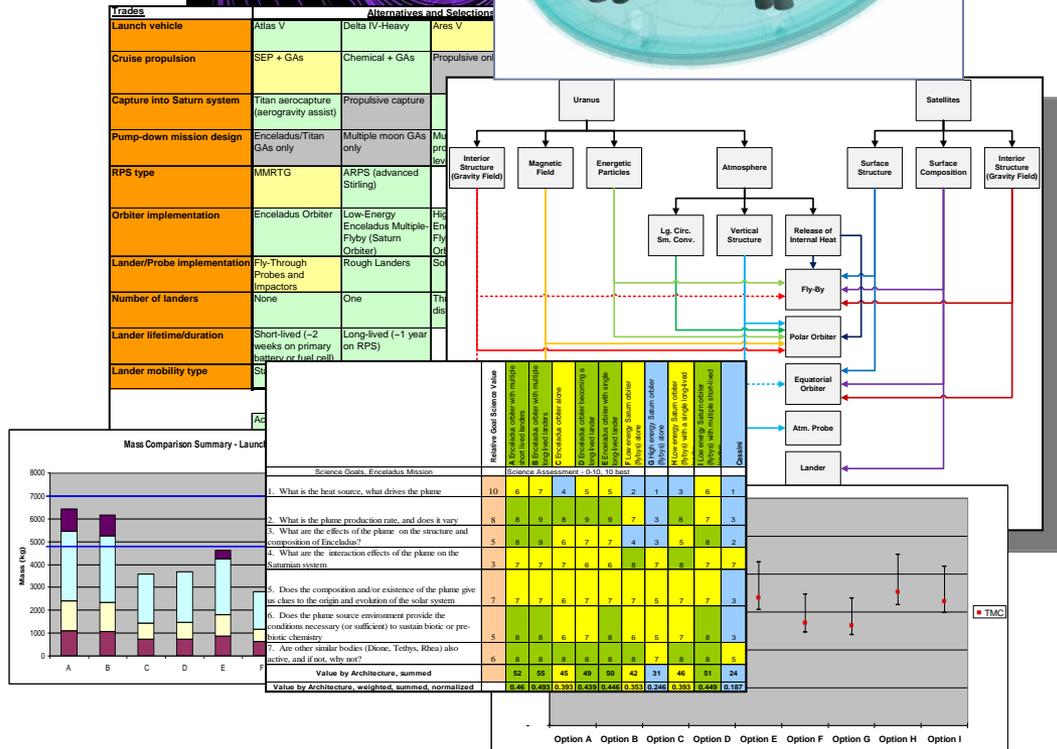


...then the concept is developed



or

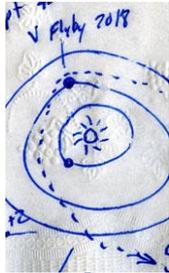
One man's concept is another's doodle...



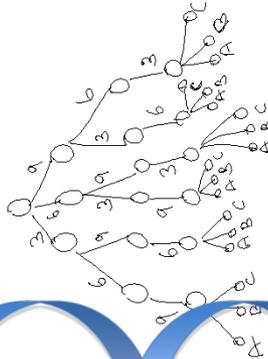


Concept Maturity Level Helps Benchmark *Before* MDR/PMSR

Cocktail Napkin



Trade Space



Baseline Concept



Preliminary Implementation Baseline



CML 1

CML 2

CML 3

CML 4

CML 5

CML 6

CML 7

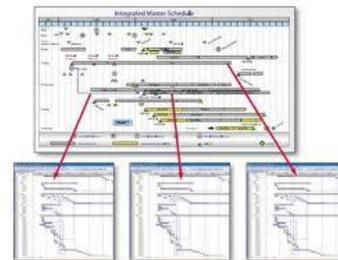
CML 8

$$F = ma$$

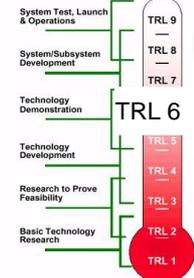
Initial Feasibility



Point Design



Integrated Concept

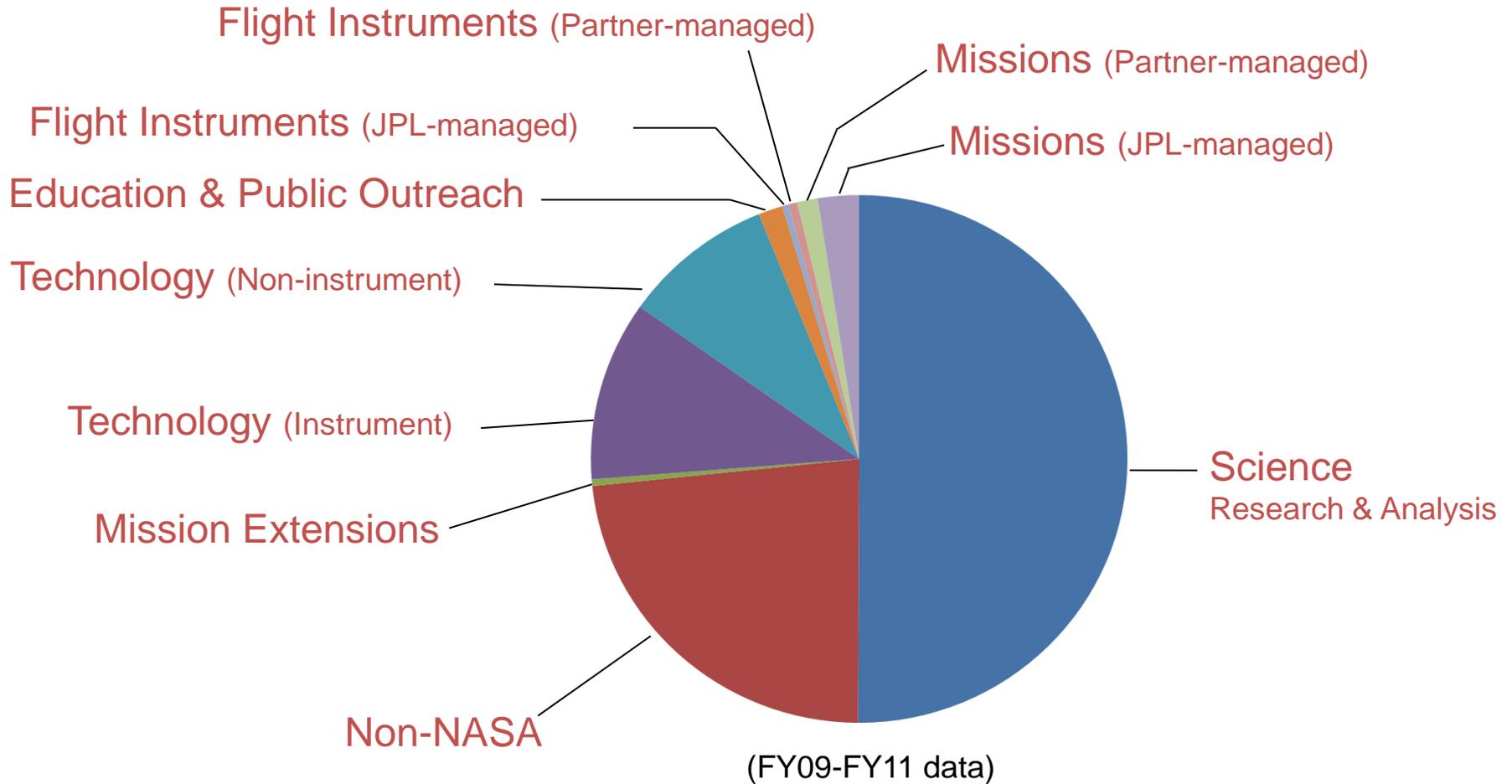


Integrated Baseline





JPL submits an average of 730 formal proposals, large and small, per year





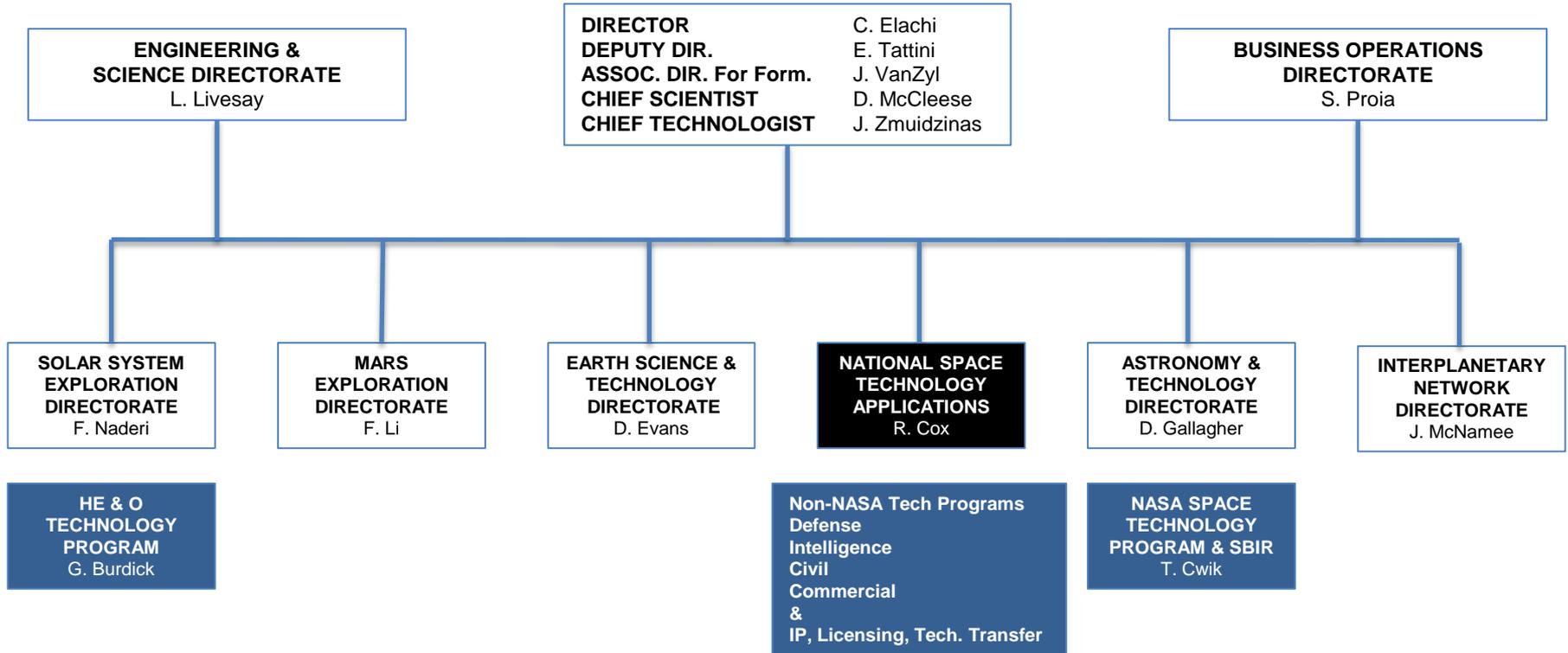
NAC Questions for the Centers

How is the Agency's commercial space strategy message being perceived at the Center?

- ✓ What is the Center doing to promote it?
- What are the Center's plans for transitioning from the Shuttle and Constellation programs to the new Agency direction that includes commercial space, and how are those plans progressing?
- How is the Center addressing excess capacity issues?
- ✓ Do you have any concerns or issues with transitioning to the Agency's commercial space strategy?



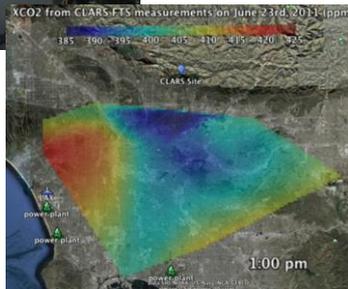
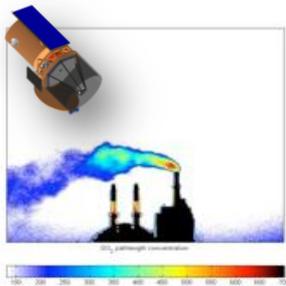
JPL Commercial Interfaces





Commercial Program Direction

Expand quality relationships to adapt investments in space technology for commercial uses that will lead larger national thrusts...



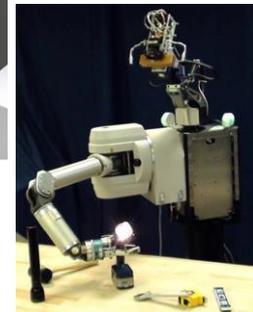
Space



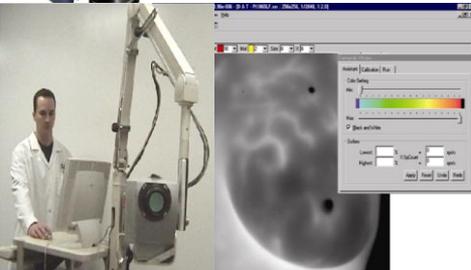
Climate



Robotics



Energy



Medical Research



Cyber Research



Commercial Space Strategy

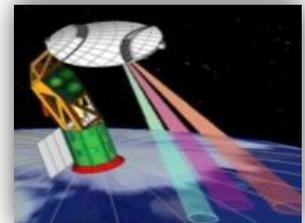
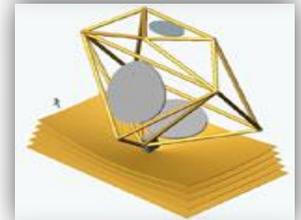
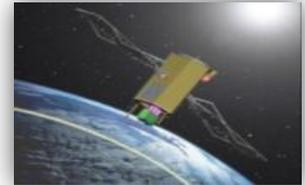
1. What is the JPL doing to promote it?
 - Active NASA and non-NASA engagement with commercial sponsors, providers and SBIR
 - Outsource 50% of robotic space mission funds to commercial space industry
 - Leads NASA with IP transfers and commercial licensing
 - Promote culture of entrepreneurial technology development & collaboration with industry
 - Encourage commercial robotic space exploration and commodity services
2. Does JPL have any concerns or issues with transitioning to the Agency's commercial space strategy?
 - Support the national initiative and NASA policy implementation
 - FFRDC's "non-competitive" overtones stimulates commercial space
 - Provide services and technical support to commercial entities
 - Limit use of facilities and infrastructure by commercial entities
 - HQs oversight and processes
 - Commercial market expansion will remain constrained with conflicting federal guidelines
 - Use of commercial data products and services are encouraged...
 - Weathersats and land remote sensing seen as inherently governmental function



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Primary JPL industry partners

- **Lockheed Martin Corporation**, Denver, CO
 - Spacecraft manufacturing
- **ITT/Exelis**, Monrovia, CA
 - Deep space network operations and maintenance
- **Lockheed Martin Integrated Systems**, Seabrook, MD
 - Desktop computing systems, software and services
- **Computer Science Corporation (CSC)**, Pasadena CA
 - Information technology infrastructure support
- **Orbital Sciences Corporation**, Germantown, MD
 - Spacecraft manufacturing



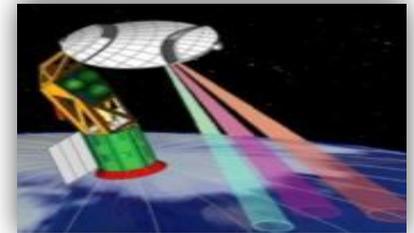
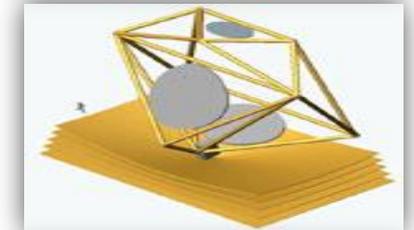
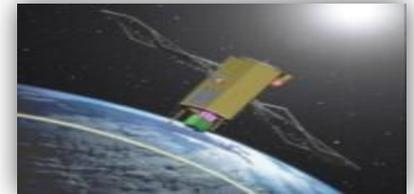


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Primary JPL industry partners (cont.)

- **Northrop-Grumman**, Redondo Beach, CA
 - Flight Instrument and subsystem tasks
- **Raytheon**, Pasadena, CA
 - Scientific data systems operations and analysis
- **EMCOR**, CA
 - Facility maintenance and operations
- **Swales Aerospace**, Beltsville, MD
 - Mechanical and thermal engineering
- **Wackenhut Services Inc.**, Palm Beach, FL
 - Security and fire protection services





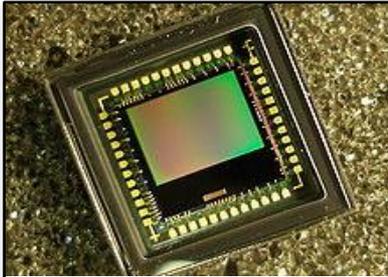
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 Jet Propulsion Laboratory
 California Institute of Technology
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JPL Commercial Collaboration

	Life Sciences	IT, Software, Internet	Electronics, Computers, Telecomm	Aerospace, Defense, Security	Automotive, Industrial Equipment	Energy, Utilities	Advanced Materials, Chemicals	Natural Resources, Agriculture
Detectors & Instruments	★		★	★	★	★		★
Power & Propulsion				★	★	★		
Exploration & Robotics				★	★	★		★
Modeling & Simulation	★ ★		★ ★	★ ★	★ ★	★ ★	★ ★	
Navigation, GPS, Comm			★	★	★	★		
Other (FF., LAS., S/W Avionics)				★		★	★	



Commercial applications from JPL-derived technology



Digital Cameras



Database Software



Sunglasses



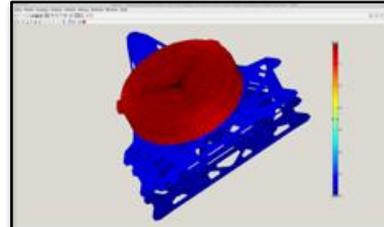
Cardiac Health



IR Thermometer



Fire Detection



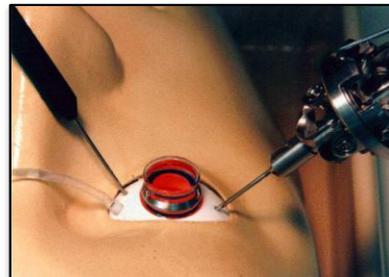
Engineering Design Software



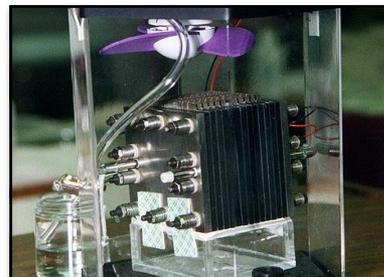
Global Positioning Systems



Precision Clocks



Robotic Surgery



Clean Energy

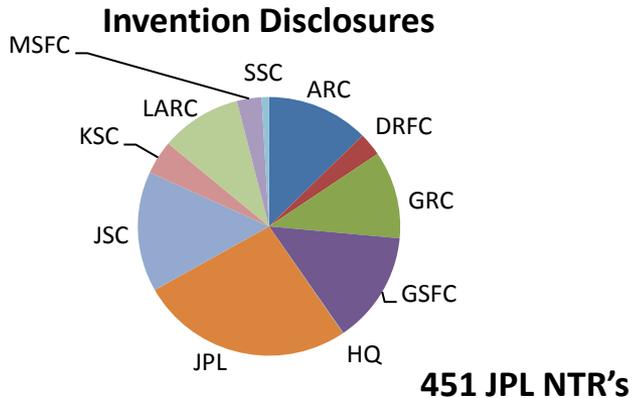


Mobile Robotics



Intellectual Property FY 2012

Capturing IP



Protecting IP

Patents Filed:

- 151 Provisional Patents
- 39 US Patents
- 16 Foreign Patents

Patents Issued:

- 39 US Patents
- 1 Foreign Patent

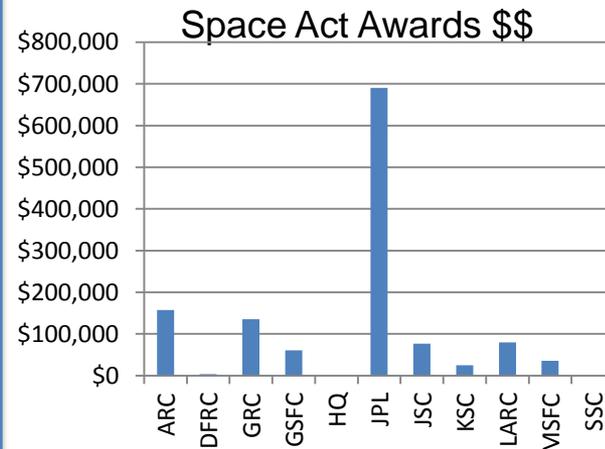
Technology Transfer

Key Partnerships/Licenses:

- Chevron Alliance
- Broad Reach Engineering
- LADWP
- Raytheon

Commercial License/Option Agreements – 7/6
Commercial License to Startup Firms -2
Open Channel Software Licenses - 283

Rewarding Innovation



NASA Software of the Year Co-Winner – QuakeSim



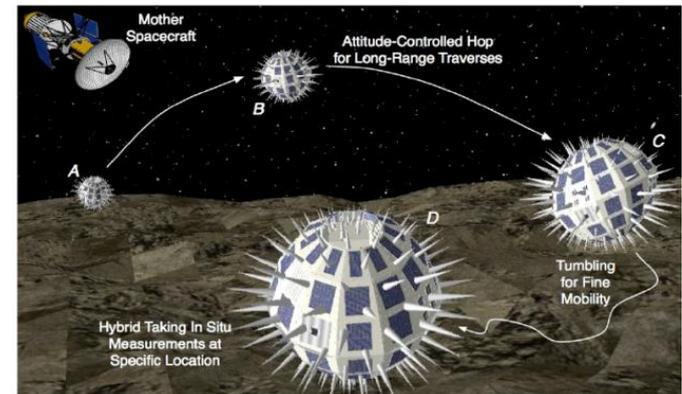
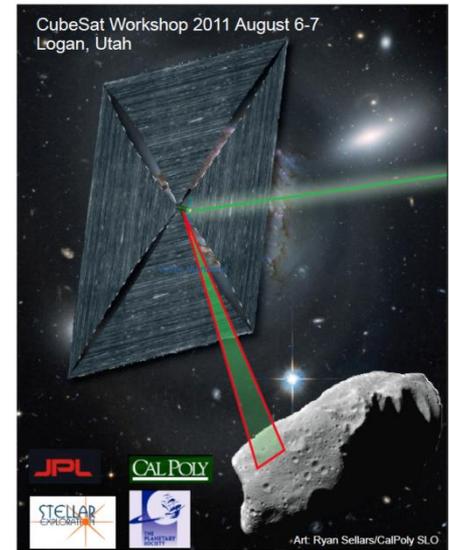
Early Stage Innovation

JPL has been awarded four NIAC grants

- Ghost Imaging of Space Objects
- Interplanetary CubeSats
- Printable Spacecraft
- Spacecraft/Rover Hybrids for the Exploration of Small Solar System Bodies

NASA OCT Selected 80 graduate Fellowships

- 15 Graduate students have been placed at JPL
 - Funding to JPL'ers for mentoring 10 weeks each year over the 2 or 4 year grant





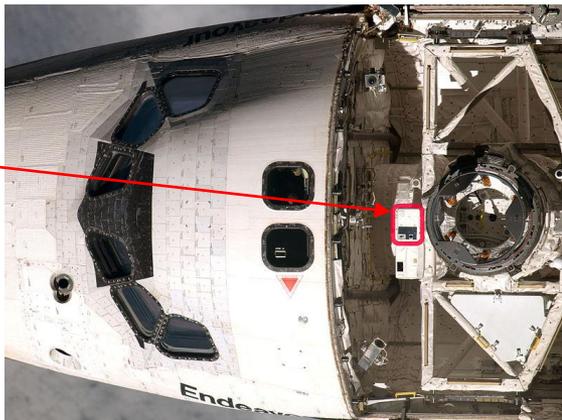
SBIR/STTR and Partnerships

Programatic (at JPL)

- 29 SBIR Phase II, 60 Phase I contracts
 - Over \$23 million in new R&D funding
- 3 STTR Phase II, 2 Phase I contracts
 - \$2 million in new R&D funding
- 2011 Solicitation release
 - JPL leads 15 Subtopics, participates in 40



DragonEye sensor as seen from space station on previous STS-127 mission



Infusion

- Improved Advanced Scientific Concepts 3D Flash Lidar (DragonEye) flown on STS-133, Discovery's final mission
- Qualification for SpaceX Dragon
- Promising autonomous guidance technology for future planetary or asteroid lander



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Other questions for the Centers

- What are [JPL's] plans for transitioning from the Shuttle and Constellation programs to the new Agency direction that includes commercial space, and how are those plans progressing?
 - JSC on robotic/human interfaces
 - Space X for ISS re-supply
 - Masten Space for vertical horizontal flight controls
- How is the Center addressing excess capacity issues?
 - JPL not challenged by excess capacity, but would like to make testing facilities available to commercial funders



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Summary

- JPL's commercial activities advance National Space Policy and NASA's missions
- JPL's robotic space missions engage many industrial segments
- JPL's non-NASA activities spur commercial growth and enrich space technology and mission capabilities