

Planetary Science Division Status Report

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September 3, 2014

Committee on Astrobiology and Planetary Science

Outline

- Planetary upcoming mission events
- Recent accomplishments
- NASA participation in ESA's Rosetta mission
- PSD role in the ARM mission
- Planetary Technologies
- Use of Astrophysics Telescopes

Planetary Science Missions Events *as of July 24, 2014*

2014

July – *Mars2020* Rover instrument selection announcement

August 6 – 2nd Year Anniversary of *Curiosity* Landing on Mars

* Completed

September 21 - *MAVEN* inserted in Mars orbit

October 19 – Comet Siding Spring encounters Mars

Fall - *Curiosity* arrives at Mt. Sharp

November 11 – ESA's *Rosetta* mission lands on Comet Churyumov–Gerasimenko

Nov/Dec – Launch of Hayabusa-2 to asteroid 1999 JU₃

2015

March - *MESSENGER* spacecraft impacts Mercury

Late March – *Dawn* inserted into orbit at dwarf planet Ceres

April - Europa instrument Step 1 selection

May - Discovery 2014 Step 1 selection

July 14 – *New Horizons* flies through the Pluto system

2016

March – Launch of Mars missions *InSight* and ESA's *ExoMars Trace Gas Orbiter*

March - Europa instrument step 2 selection

July - *Juno* inserted in Jupiter orbit

July – ESA's Bepi Columbo launch to Mercury

August - Discovery 2014 Step 2 selection

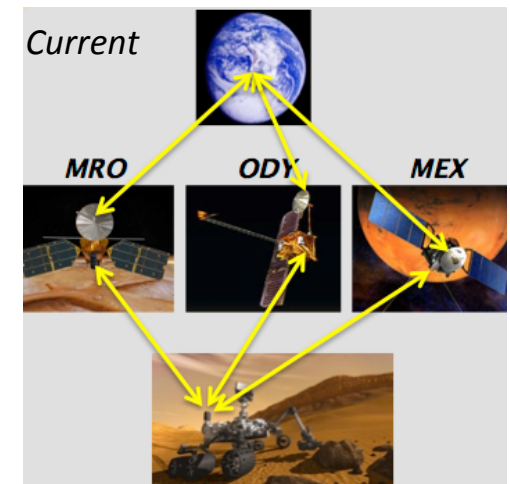
September - *InSight* Mars landing

September – Launch of Asteroid mission *OSIRIS – REx* to asteroid Bennu

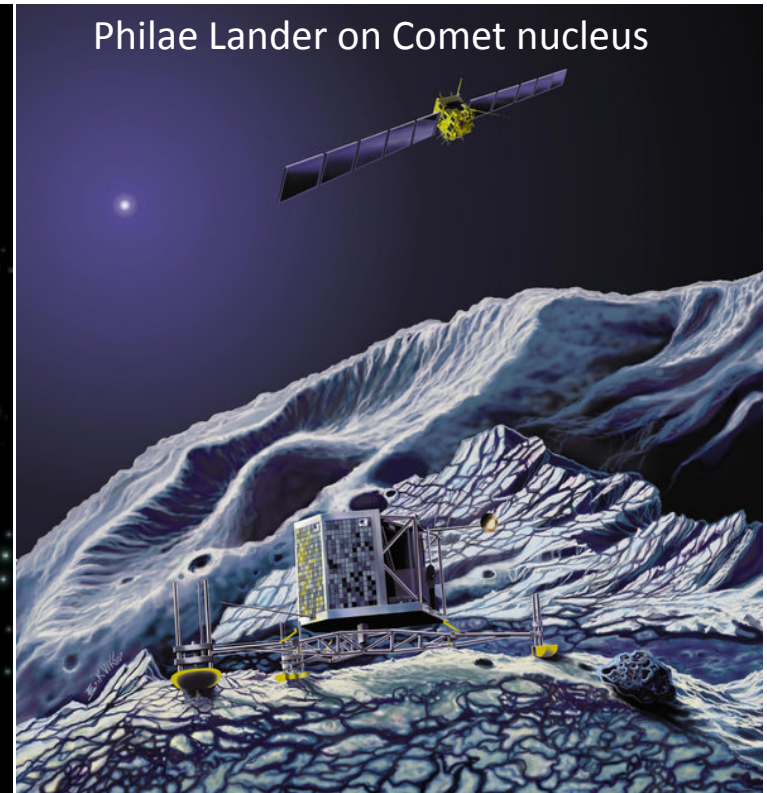
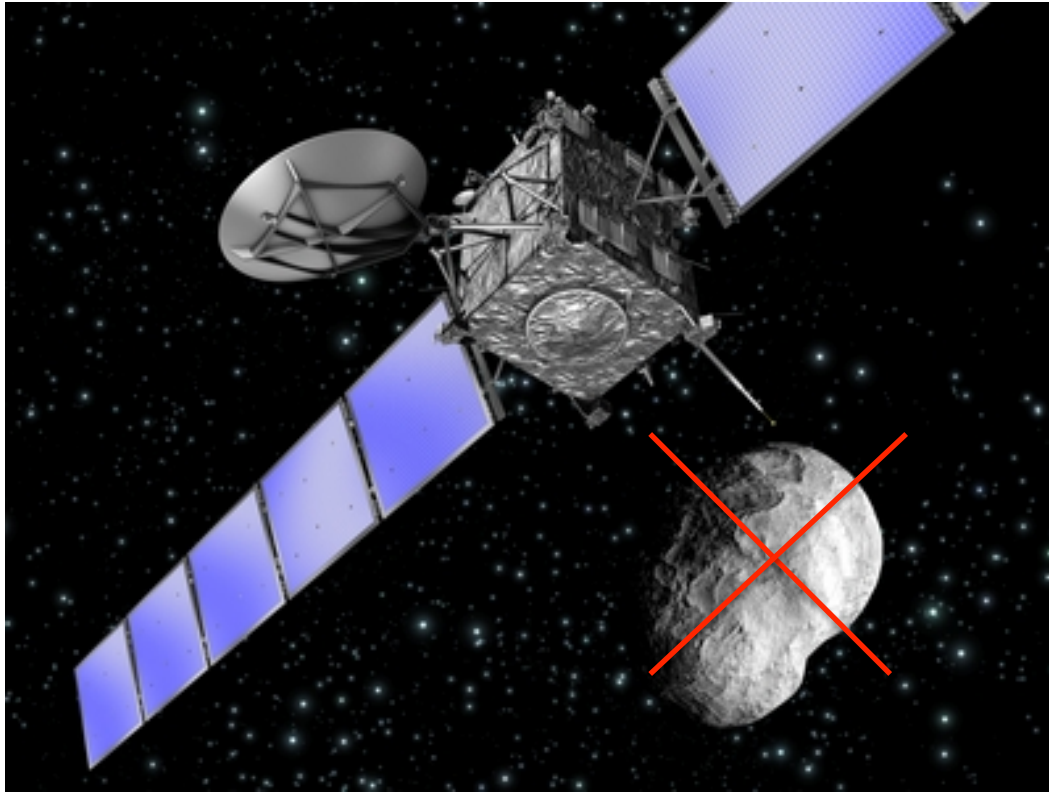
September - *Cassini* begins to orbit between Saturn's rings & planet

Recent Accomplishments

- Released *draft* Discovery AO – July 2, 2014
 - Comments were due July 16, 2014 (received more than 100)
 - AO release planned by the first week in October
 - Step-1 proposals will be due late in CY2014.
- Released Europa Instrument AO – July 15, 2014
 - Proposals due October 17, 2014
- 2014 Senior Review completed
 - Report and response posted (see B. Knopf's talk)
 - All missions will continue
- RFI for Commercial buy of Mars Communications
 - Surface to Orbiter and to Earth also Orbiter to Orbiter
 - Deadline August 25th
 - Obtained more than a dozen responses
- R&A first cadre of reviews after the restructure are ongoing. Community is active and reviewers pleased with process (see J. Rall's talk)

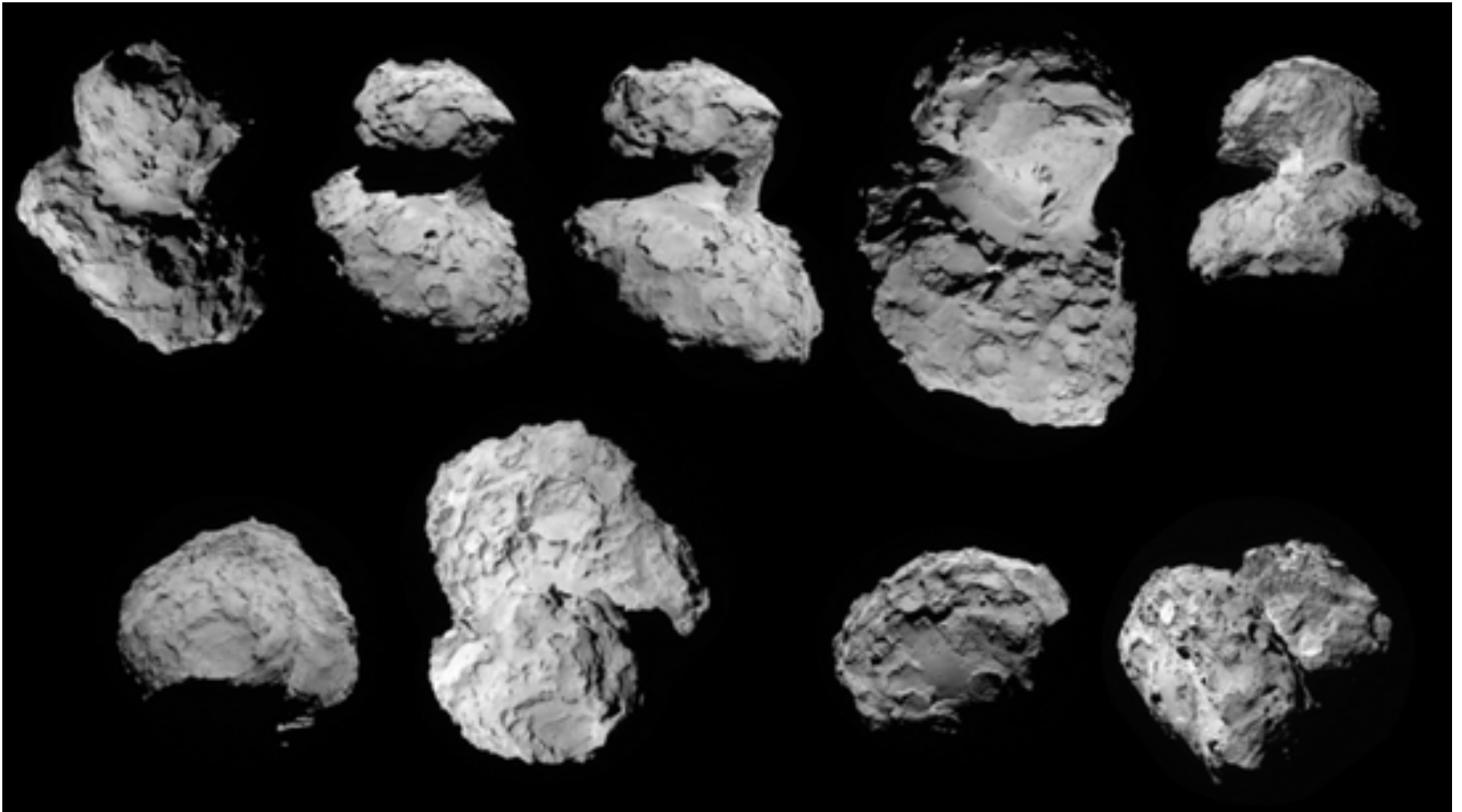


ESA's Rosetta Mission



- Rosetta has arrived at Comet Churyumov–Gerasimenko
- In November 2014 Rosetta will drop off the Philae lander and follow the comet into perihelion
- It has produced some stunning images of the comet!

Comet Churyumov–Gerasimenko



NASA Contribution to ESA's Rosetta Mission

1. 3 instruments plus a significant portion of the electronics package for another (MIRO, ALICE, IES, and ROSINA DFMS Electronics)
2. 3 Principal Investigators, Interdisciplinary Scientist
3. 40 Co-Investigators and researchers
4. Deep Space Network 70 meter and 34 meter support
5. Scheduling software for science observations
6. Multi-mission Ephemeris Support tool
7. Comet modeling
8. Shadow navigation for flight dynamics verification
9. Outreach and media products
10. Support for ESA's Amateur Ground Observing Campaign

NASA Hardware Contribution

ALICE (an ultraviolet imaging spectrometer) will map the comet's nucleus for pockets of both dust and ice – Alan Stern, SWRI

MIRO (Microwave Instrument for the Rosetta Orbiter) will remotely examine the vicinity for signs of water coming off the nucleus and will construct temperature maps – Sam Gulkis, JPL

IES (Ion and Electron Sensor) will look for examples of direct interaction between the solar wind and the nucleus – James Burch, SWRI

ROSINA (Rosetta Orbiter Spectrometer for Ion and Neutral Analysis) will identify gases sublimating from the comet. NASA is providing ROSINA's DFMS (Double Focusing Mass Spectrometer) Electronics – Stephen Fuselier, SWRI

NASA Participation in the Rosetta Payload

Orbiter Teams

1. ALICE - UV spectrometer
2. **CONCERT – tomography/radio sounding**
3. COSIMA – chemistry
4. **GIADA – dust analysis**
5. IES - ion and electron sensor
6. ICA – plasma analyzer
7. **MAG – magnetometer**
8. MIDAS – atomic force microscope (dust particles)
9. MIP – magnetic impedance probe
10. MIRO - microwave spectrometer / radiometer
11. LAP – Langmuir probe
12. **OSIRIS – camera**
13. ROSINA – mass spectrometer
14. **RSI – radio science**
15. **VIRTIS – IR spectrometer**

Lander Teams

16. **APXS – X-ray spectrometer**
17. CIVA -lander visible - IR camera (omnidirectional)
18. COSAC – lander mass spectrometer
19. MODULUS – gas analyzer
20. MUPUS – probe
21. ROLIS – lander descent camera
22. **ROMAP – lander magnetometer/material magnetism**
23. SESAME – seismic data
24. **CONCERT (2) – tomography/radio sounding**
25. SD2 – drill
26. PTOLEMY – gas analyzer

Legend:

NASA hardware contribution

NASA investigator participation

ARM Mission

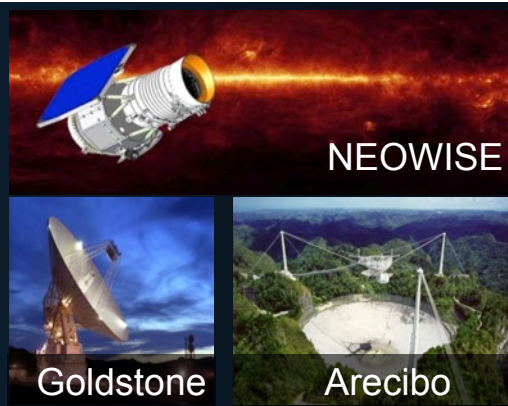
Asteroid Redirect Mission: Three Main Segments

IDENTIFY

Ground and space based assets detect and characterize potential target asteroids



Pan-STARRS



NEOWISE

Goldstone



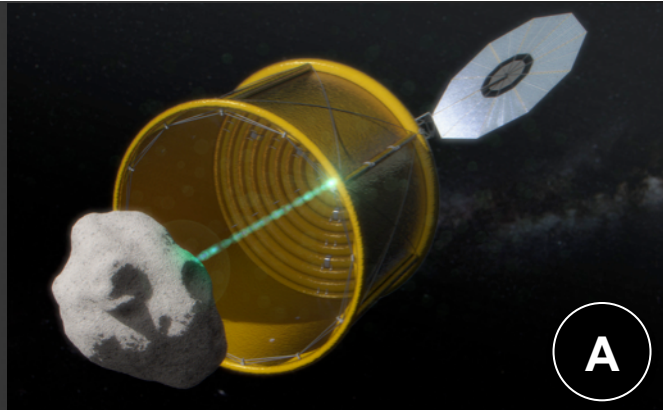
Arecibo



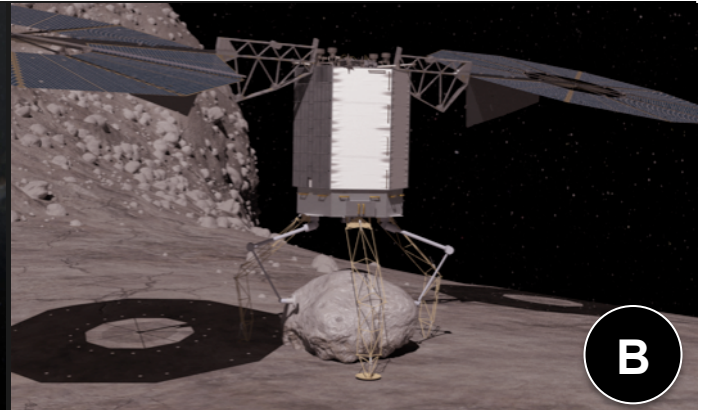
Infrared Telescope Facility

REDIRECT

Solar electric propulsion (SEP) based system redirects asteroid to cis-lunar space (two capture options)



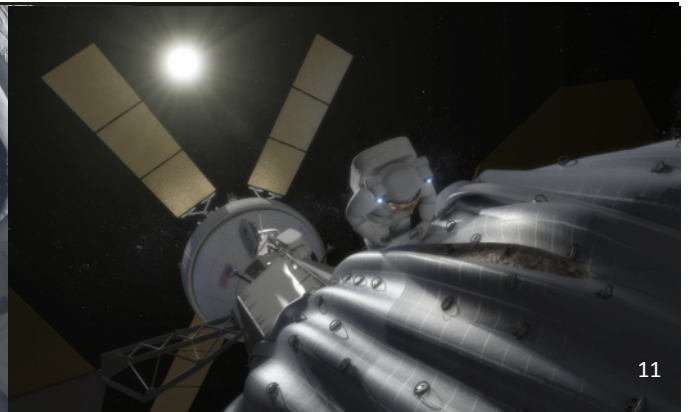
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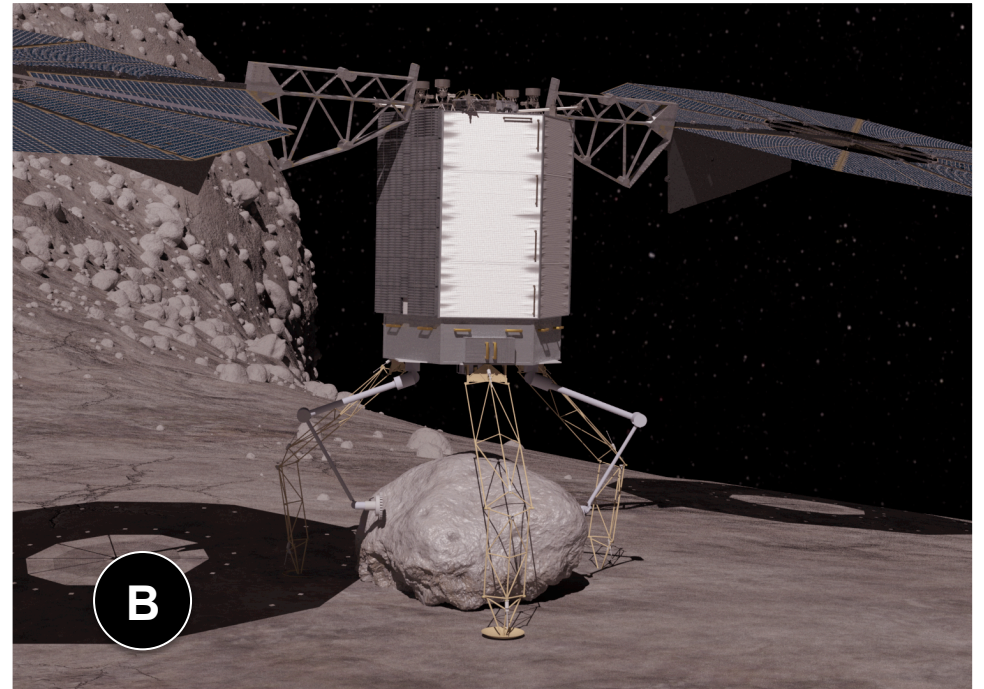
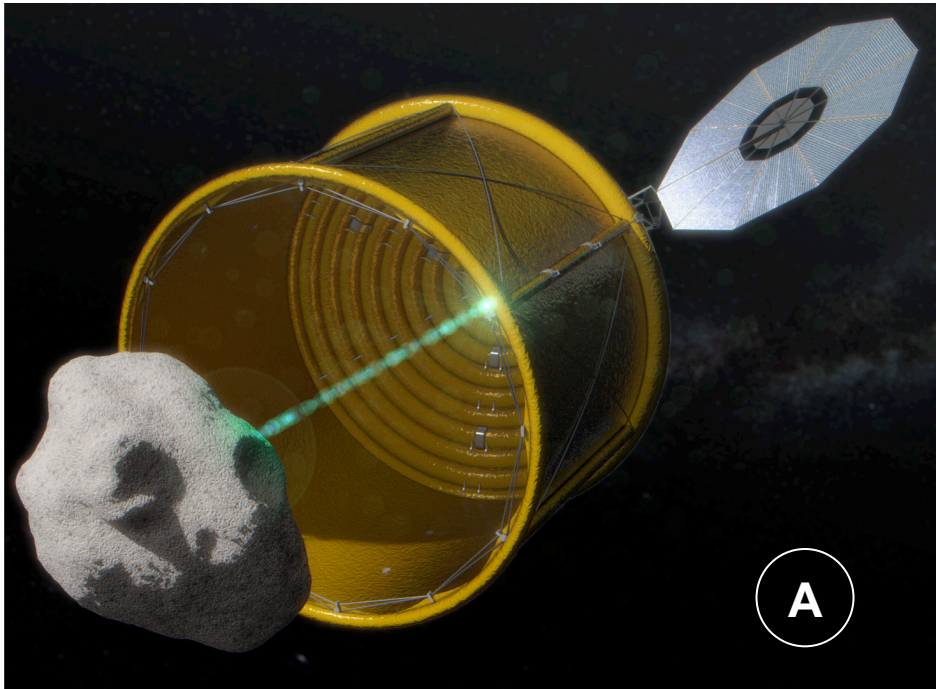
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EXPLORE

Crews launches aboard SLS rocket, travels to redirected asteroid in Orion spacecraft to rendezvous with redirected asteroid, studies and returns samples to Earth



Asteroid Redirect Robotic Mission: Two Capture Options



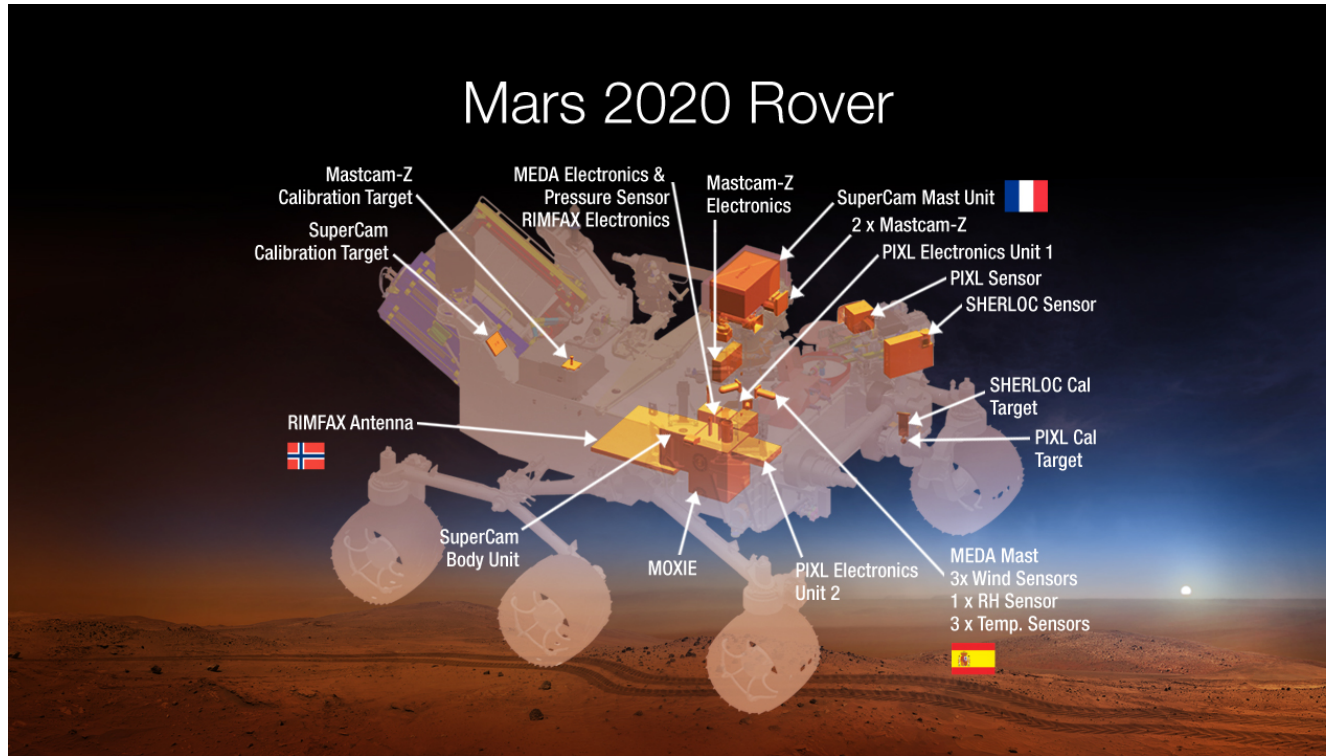
ARM Milestones to Mission Concept Review, Feb. 2015

➤ FY14 Risk Reduction Plan for Boulder Capture Concept Option	Apr 3, 2014
➤ BAA Notice of Intent Due	Apr 4, 2014
➤ PPBE16 program submits due	Apr 28, 2014
➤ BAA Proposal Due Date	May 5, 2014
➤ STMD Solar Array Systems development Phase 1 complete	Jun 2014
➤ BAA Awards	NET Jul 14, 2014
➤ BAA Kickoff Meetings	Week of Jul 21
➤ STMD Integrated Thruster performance Test with 120V PPU	Sep 2014
➤ HEOMD MACES EVA end-to-end mission sim complete	Sep 2014
➤ STMD SEP Solar Array RFP release	Oct, 2014
➤ BAA Interim Reports	Oct 31, 2014
➤ STMD Electric Propulsion RFP release	Nov 2014
➤ Robotic mission concept Option A/B downselect	mid Dec 2014
➤ BAA Period of Performance Ends	Dec 31, 2014
➤ Mission Concept Review	Feb 2015

Technologies

PSD Instrument Development Success Stories

43% (3 out of 7) of the Instruments selected for M2020 have PSD instrument development heritage.



- **SuperCam**, an advanced version of Curiosity's ChemCam that will use three types of laser analysis to analyze rocks from a distance.
- **PIXL**, an X-ray fluorescence spectrometer, will provide capabilities that permit more detailed detection and analysis of chemical elements than ever before.
- **SHERLOC**, the first UV spectrometer to fly to the surface of Mars, will determine fine-scale mineralogy and detect organic compounds.

Instrument	PI	Institution	PIDDP	ASTEP	ASTID	SBIR/STTR
SuperCam	Roger Wiens	Los Alamos National Lab	X			
PIXL	Abigail Allwood	Jet Propulsion Lab	X			
SHERLOC	Luther Beagle	Jet Propulsion Lab	X	X	X	X

NASA-DOE RPS Production Status

- DOE continues its NASA-funded Pu-238 Supply Project
 - Goal of 1.5 kg/year of Plutonium Oxide production capacity by ~2021
 - Technology demonstration efforts continue on schedule
 - Target development, irradiation tests, and Pu-238 chemical recovery continue to be individually developed
 - The first of two integrated end-to-end demonstrations is planned to start in 2015
 - Assessment of Pu-238 product quality will occur at the end of each demonstration
 - The remainder of the project involves scaling up to the 1.5 kg/yr production rate
- NASA is now funding DOE Operations and Analysis (infrastructure)
 - Maintaining worker certifications and performing operational maintenance activities to support future RPS fueling and assembly capabilities at multiple DOE laboratories
 - Augmented funding to accelerate design and installation of a new Hot Press and furnace capability to reduce fuel clad production risk at Los Alamos National Laboratory (LANL)
 - Heat Source Manufacturing for potential Mars 2020 use will begin at LANL in 2015

RPS Status

- Fuel efficiency remains important even with restart of Pu-238 production
- Investments in thermoelectric technology to improve MMRTG capability
 - Enhanced thermoelectric couples could be on-ramped into future MMRTGs with minimal design change (improved couple life, and end-of-mission power)
 - Technology maturation evaluation in 2018 for an eMMRTG flight design
- Assembling Stirling hardware into Engineering Unit for testing
 - A 4x-efficiency improvement via Stirling still desired for certain missions
 - Study team assessing optimal Stirling sizes for Agency RPS and fission usage
- Mission pull continues
 - Heritage RPS on Voyager, Cassini, and New Horizons operating well
 - MMRTG operating well on Curiosity as it enters extended mission
 - MMRTG flight spares allocated for potential use by Mars 2020
 - Ready to support potential 2024 mission launch (possibly eMMRTGs)
 - Future potential for 2028-and-beyond mission launches

Use of Astrophysics Telescopes

Astrophysics Division telescopes

- HST surveys approved:
 - Looking for a NH KBO & Europa plumes
 - More planetary proposals to HST are encouraged!
- Spitzer operations extended for the next two yrs
 - Astrophysics and the Planetary Science Divisions have requested observing time commitments for FY15
- Spitzer & Keck solicit high priority investigations of solar system objects, including monitoring campaigns
 - Planetary science proposals reviewed, and selected in accordance with current Spitzer and Keck proposal practice
 - PSD strongly encourages you to submit Planetary proposals for time

Spitzer Warm Mission- Solar System Programs

Near Earth Objects – 600 hours

- The Warm Spitzer NEO Survey: Exploring the history of the inner Solar System and near Earth space (500 hours – an Exploration Science Program)
- 3552 Don Quixote (asteroid found to be a comet)
- Pilot program to use Spitzer to search for NEOs
- Eclipsing near earth asteroid 1996 FG3

Comets – 105 hours

- Tempel 1, Tempel 2, Encke, Gunn, Hartley 2, Wild 2, Wild 4, Schwassmann-Wachmann1, SW3, C/2009 KS McNaught, P2010 A1 LINEAR, C/2012 K5 LINEAR, C/2012 K1 PANSTARRS
- Sungrazing Comet C/2011 W3 Lovejoy
- C/2012 S1 (ISON)

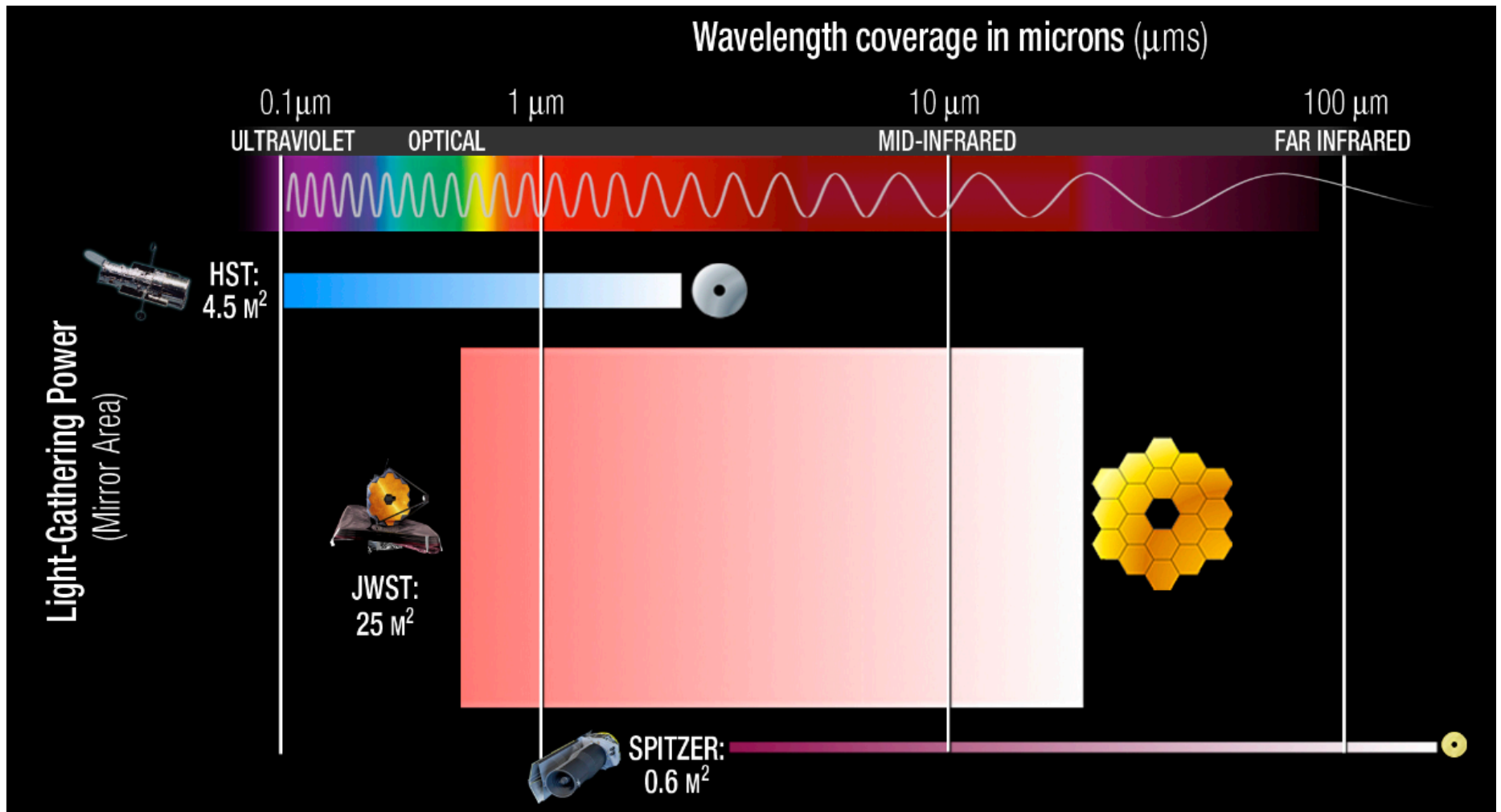
Asteroids and KBOs – 377 hours

- Many KBOs, KBO binaries, Centaurs
- Eclipsing binary asteroid 2000 DP107

Mission Support – 140 hours

- OSIRIS-REx targets, Hayabusa 2 (1999 JU3)
- The primary target (2009 BD) of the Asteroid Retrieval Mission (**Cycle 10**)
- Study Of Pluto In Support Of the NASA New Horizons Mission (**Cycle 10**)
- Siding Spring (C/2013 A1) (**Cycle 10**) – potential impact to orbiting spacecraft at Mars when the comet passes close to the planet in Oct 2014

Astrophysics Telescopes

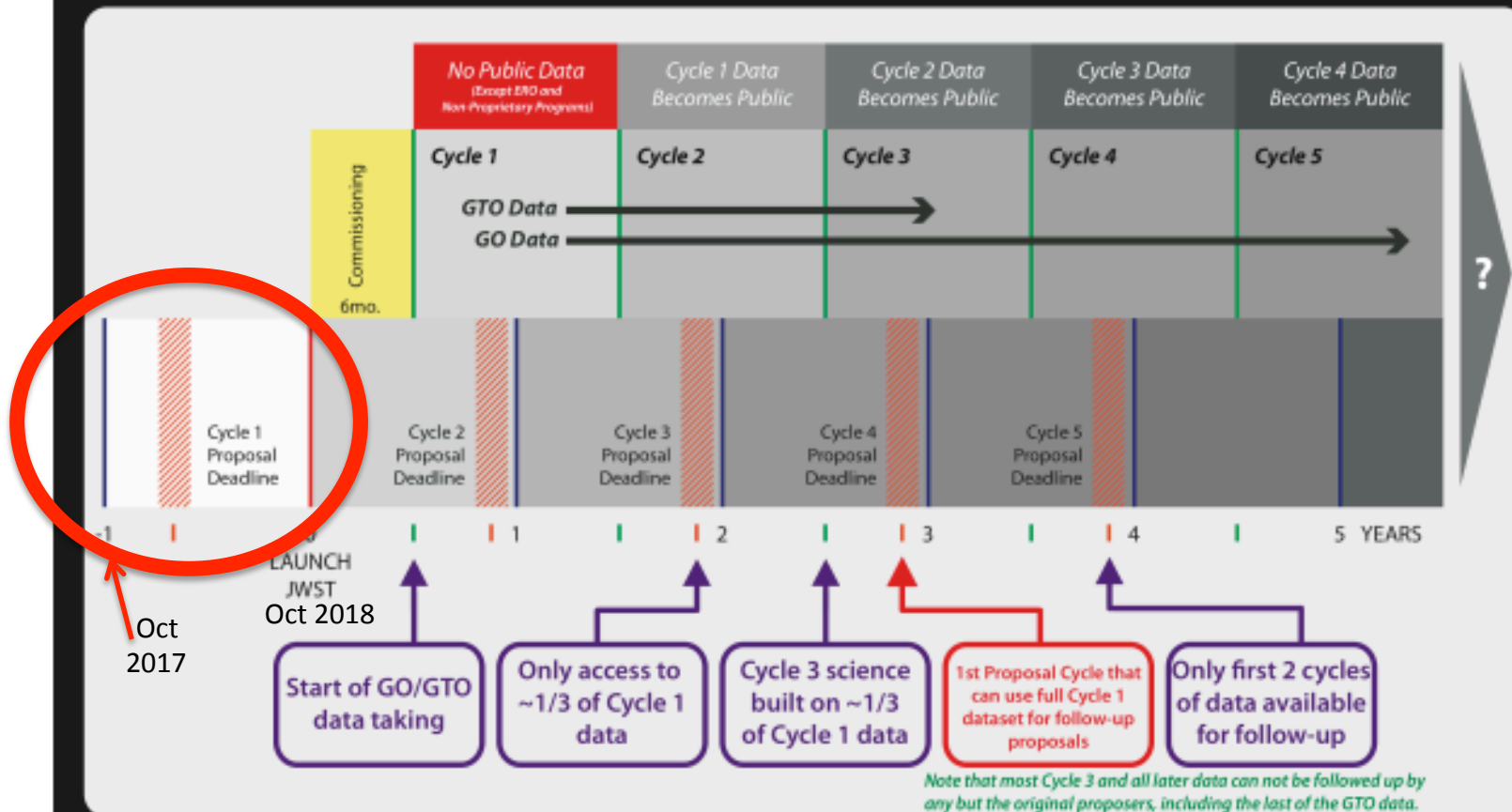


JWST: Solar System Science

- Many important molecules (e.g. H_2O , HDO , CO , CO_2 , S_2 , CH_4), ices, and minerals have strong features in the JWST wavelength range.
- JWST will have the sensitivity to obtain near-IR spectra and mid-IR photometry (albedos) of any Kuiper belt object (KBO) known today.
- Monitoring planetary (and satellite) weather for the duration of mission (minimum 5 years, probably > 10 years), 2 intervals of about 3 months each year.

JWST Science Data Availability Relative to Proposal Deadlines

(for required 5yr science mission)



GDI – 11/04/09 JSTAC
(with 7-8 months between proposal deadline and start of science observations)