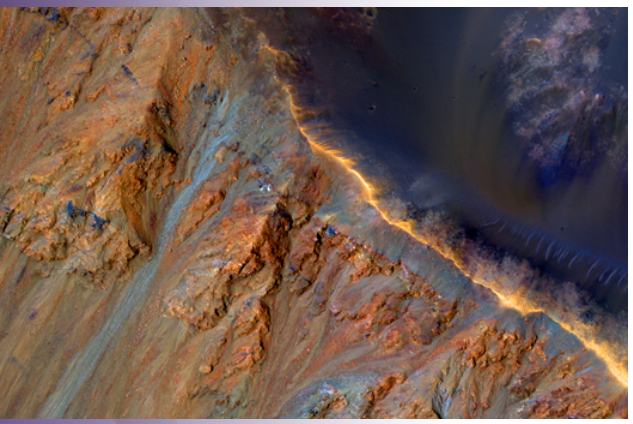
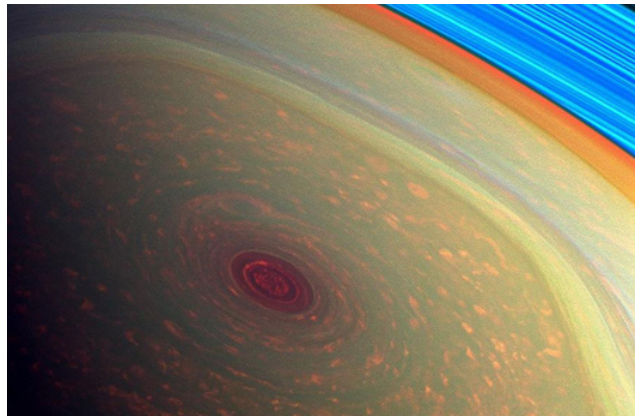
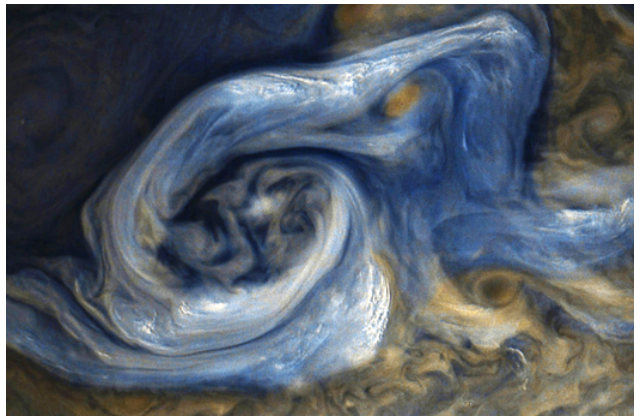
SCIENCE

National Aeronautics and Space Administration


Committee on Astrobiology and Planetary Sciences (CAPS)

PLANETARY SCIENCE DIVISION

Curt Niebur

for Lori S. Glaze

Planetary Science Division Director (acting)
Science Mission Directorate, NASA

September 11, 2018

Planetary Science Missions: Events

2017

*Completed

January 4 – Discovery Mission selection announced

February 9-20 – OSIRIS-REx conducted Earth-Trojan search

April 22 – Cassini began plane change maneuver for the “Grand Finale”

August 21 – Solar Eclipse across America

September 15 – Cassini end of mission at Saturn

September 22 – OSIRIS-REx Earth flyby

October 28 – International Observe the Moon night (1st quarter)

2018

May 5 – Launch of InSight mission to Mars

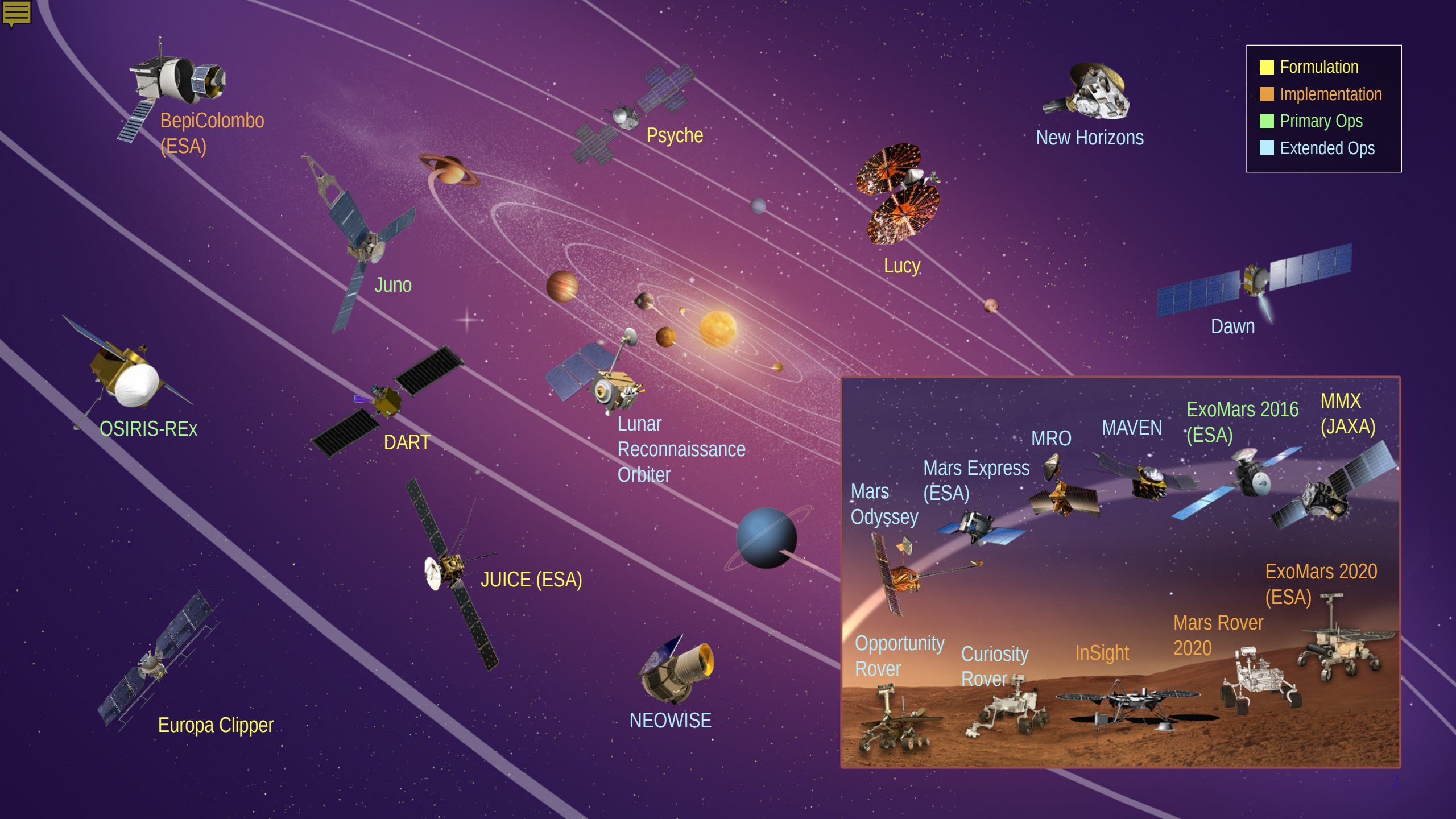
August – OSIRIS-REx begins observing Bennu

October – Launch of ESA’s BepiColombo to Mercury

November 26 – InSight landing on Mars

2019

January 1 – New Horizons flyby of Kuiper Belt object Ultima Thule


Formulation
Implementation
Primary Ops
Extended Ops
BepiColombo (ESA)
Psyche
New Horizons
Juno
Lucy
Dawn
OSIRIS-REx
DART
Lunar Reconnaissance Orbiter
JUICE (ESA)
Europa Clipper
NEOWISE
Mars Odyssey
Mars Express (ESA)
MRO
MAVEN
ExoMars 2016 (ESA)
MMX (JAXA)
ExoMars 2020 (ESA)
Opportunity Rover
Curiosity Rover
InSight
Mars Rover 2020

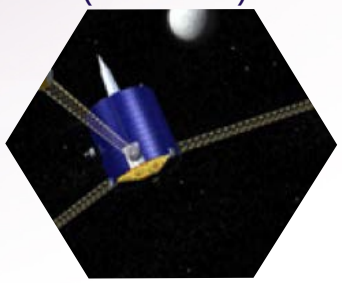
Discovery Program

Discovery Program

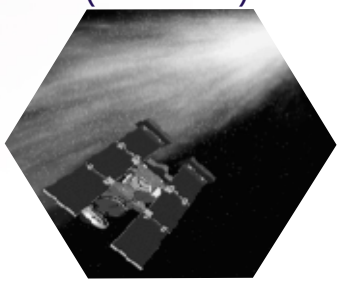
NEO characteristics
NEAR
(1996-1999)

Mars evolution
Mars Pathfinder
(1996-1997)

Lunar formation
Lunar Prospector
(1998-1999)



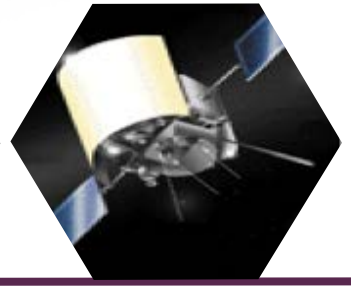
Nature of dust/coma
Stardust
(1999-2011)



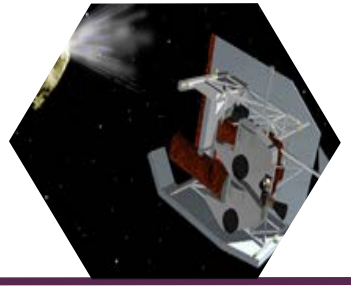
Solar wind sampling
Genesis
(2001-2004)

Comet Diversity
CONTOUR
(2002)

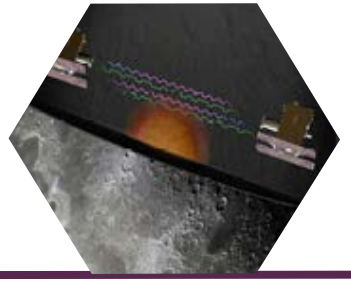
Mercury Environment
MESSENGER
(2004-2015)



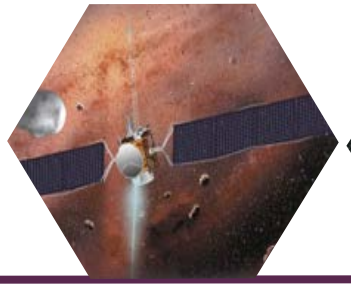
Comet Internal Structure
Deep Impact
(2005-2012)



Lunar Internal Structure
GRAIL
(2011-2012)

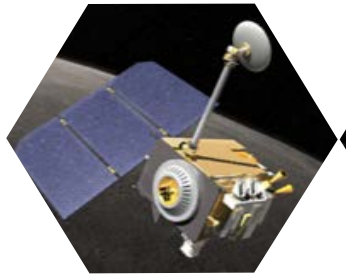


Main-belt Asteroids
Dawn
(2007-TBD)

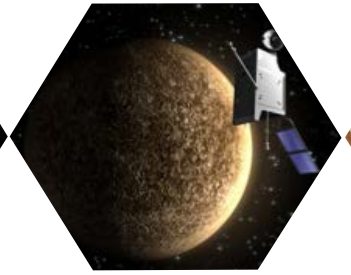


Exoplanets
Kepler
(2009-TBD)

Lunar Surface
LRO
(2009-TBD)



ESA/Mercury
Surface
Strofio



Mars Interior
InSight
(2018)

Trojan Asteroids
Lucy
(2021)

Metal Asteroid
Psyche
(2022)

Martian Moons
MMX/MEGANE
(2024)

Discovery Long-Range Planning

- Cost Cap $500M Phase A-D (FY19) excluding LV
- ~~May not propose the use of radio-isotope power systems (RPS)~~ – UPDATED
- May include radioisotope heater units (RHUs)

Release of draft AO ..... September 2018 (target)

Release of final AO ..... February 2019 (target)

Pre-proposal conference ..... ~3 weeks after final AO release

Proposals due ..... 90 days after AO release

Selection for competitive Phase A studies ..... December 2019 (target)

Concept study reports due ..... November 2020 (target)

Down-selection ..... June 2021 (target)

Launch readiness date ..... NLT December 31, 2026

New Frontiers Program

New Frontiers Program

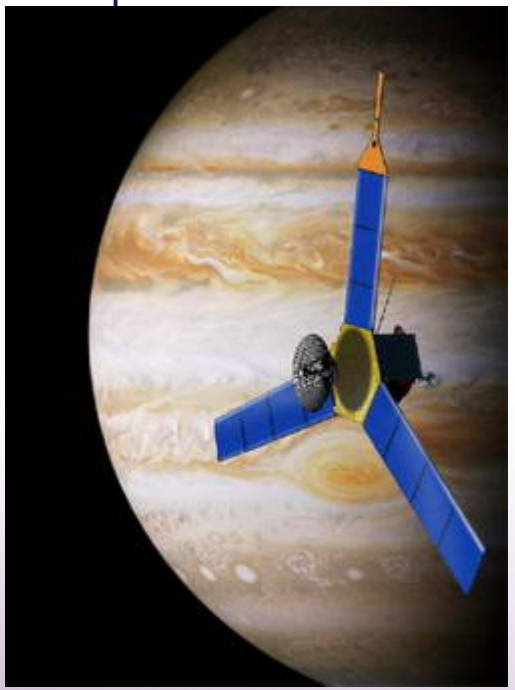
1st NF mission
New Horizons

Pluto-Kuiper Belt

Launched January 2006
Flyby July 14, 2015
PI: Alan Stern (SwRI-CO)

2nd NF mission
Juno

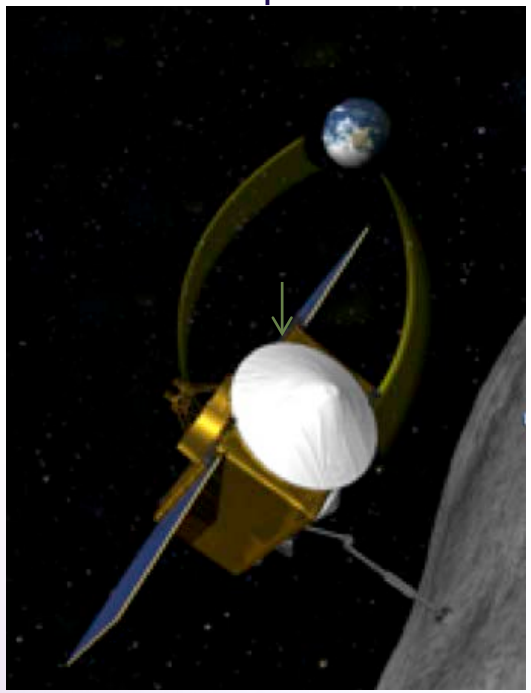
Jupiter Polar Orbiter



Launched August 2011
Arrived July 4, 2016
PI: Scott Bolton (SwRI-TX)

3rd NF mission
OSIRIS-REx

Asteroid Sample Return



Launched September 2016
PI: Dante Lauretta (UA)

New Frontiers 4 AO

Investigations (listed without priority)

- Comet Surface Sample Return
- Lunar South Pole-Aitken Basin Sample Return
- Ocean Worlds (Titan, Enceladus)
- Saturn Probe
- Trojan Tour and Rendezvous
- Venus In Situ Explorer

12 Proposals received on ..... April 28, 2017

Step-1 Selections Announced ..... December 2017

Phase A Concept Study Reports due..... December 2018

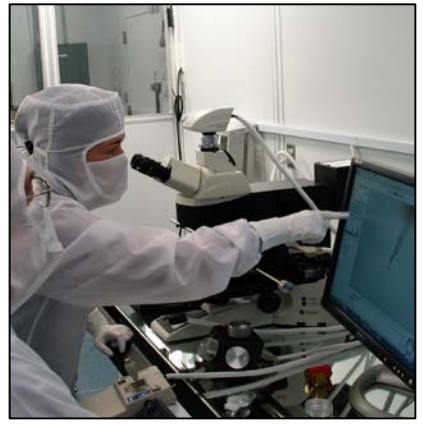
Down selection for Flight (target)..... July 2019

Launch Readiness Date..... NLT December 31, 2025

Comet Astrobiology Exploration Sample Return

- Comets record presolar history, the initial stages of planet formation, and the sources of prebiotic organics and volatiles available for the origin of life.
- Target comet is 67P/Churyumov-Gerasimenko.
- Mission and Sample Acquisition System (SAS) have been designed for the known properties of 67P.
- SAS collects at least 80 g of comet nucleus sample.
- As volatiles evolve from the sample they are transferred to a separate reservoir, preventing sample alteration. Both non-volatile and volatile materials are returned to Earth for analysis.
- Sample stored at -80° to -40° C through return cruise, and below 0° C through entry, descent, landing, and recovery.

PI: Steve Sqyres, Cornell University. CAESAR would return the first sample from the nucleus of a comet. Sample analysis in worldwide laboratories will address questions about Solar System starting materials, and how they came together to form planets and give rise to life.



A rotorcraft to explore prebiotic chemistry and habitability on the ocean world Titan

- Flight is highly efficient on Titan, enabling Dragonfly to sample materials in a variety of settings with its <u>science payload:</u>
  - Mass spectrometer
  - Gamma-ray and neutron spectrometer
  - Meteorology and seismic sensors
  - Camera suite

<u>Science Objectives:</u>

- Analyze chemical components and processes at work that produce biologically relevant compounds
- Measure atmospheric conditions, identify methane reservoirs, and determine transport rates
- Constrain processes that mix organics with past surface liquid water reservoirs and subsurface ocean
- Search for chemical evidence of water-based or hydrocarbon-based life

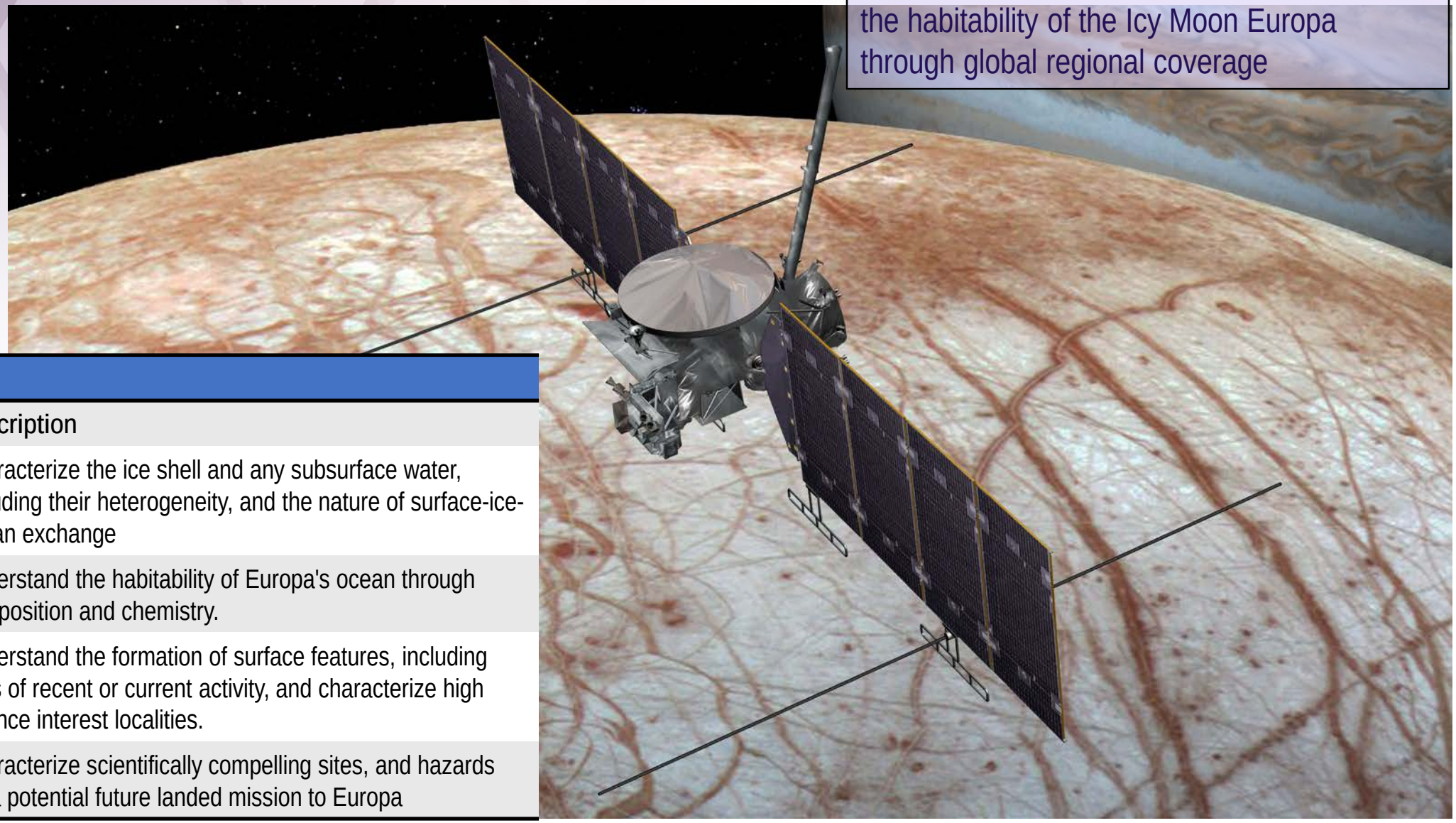
Aerial mobility provides access to Titan's diverse materials at a wide range of geologic settings at <u>dozens</u> of sites,
<u>10s to 100s of kilometers apart</u>

PI: Dr. Elizabeth Turtle at APL
Dragonfly would arrive at Titan in 2034 and explore for over 2 years, performing detailed chemical analyses, measuring the atmosphere and seismic activity, and imaging the surface.

Ocean Worlds

Europa Clipper Overview

Will conduct approximately 45 low altitude flybys (25 – 100 km altitude) to characterize the habitability of the Icy Moon Europa through global regional coverage



Science	
Objective	**Description**
Ice Shell & Ocean	Characterize the ice shell and any subsurface water, including their heterogeneity, and the nature of surface-ice-ocean exchange
Composition	Understand the habitability of Europa's ocean through composition and chemistry.
Geology	Understand the formation of surface features, including sites of recent or current activity, and characterize high science interest localities.
Recon	Characterize scientifically compelling sites, and hazards for a potential future landed mission to Europa

Small Innovative Missions For Planetary Exploration (SIMPLEx)

SIMPLEx Selection Schedule

- July 24, 2018
  - Proposal due date for first round of evaluation/selections
  - Final Proposal due date for Lucy and Psyche
  - 12 Proposals Received
- Proposal due date for CYCLE-2 round of evaluations/selections will be announced well in advance of that deadline. This due date is likely to be no earlier than July, 2019.
- August - September 2018
  - Science Review Panels
- August 2018 – December 2018
  - Technical Management Cost Review Panels
- ~February 2019 – Selection Announcements
- ~May – ~August 2019 – Contract Awards
  - Contract award time based on dollar value of contract

PSD R&A Update

General R&A Updates

- ROSES 2018 released on Feb 14, 2018
- ECF – Still developing framework but plan to amend new program into ROSES 2018
- Facilities Update – New CAN for Facilities on hold:
  - NASA has requested a National Academies study; *ad hoc* committee is working: Sample Analysis Future Investment Strategy
- National Academies Study on R&A Restructuring
  - Report completed https://www.nap.edu/catalog/24759/review-of-the-restructured-research-and-analysis-programs-of-nasas-planetary-science-division
- Archiving manuscripts – new policy for all NASA funded work to be put into PubSpace (part of PubMed)

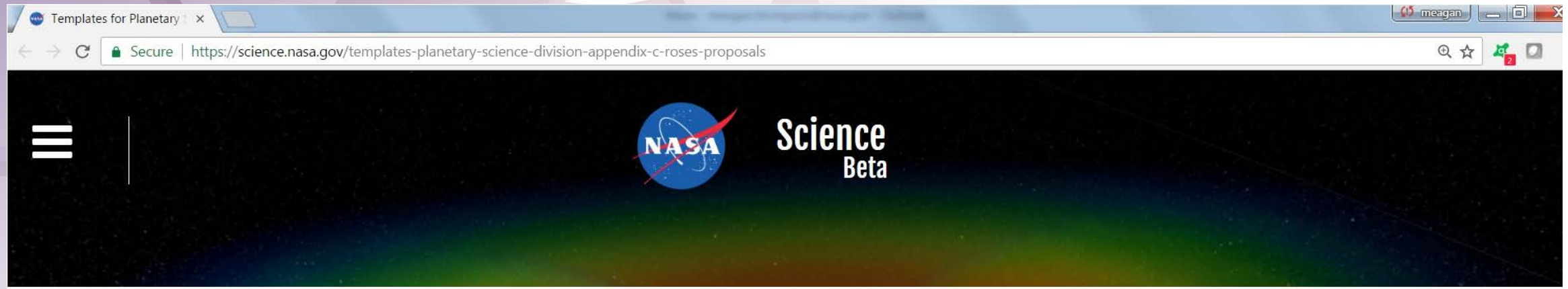
  https://www.nasa.gov/open/researchaccess/pubspace

General R&A Update

- Language added to many ROSES 2018 calls to emphasize the Moon
  - Expecting a significant increase in proposal pressure across all programs
- New Scientific Exploration Subsurface Access Mechanism for Europa (SESAME) technology development program element released in ROSES 2018
- NASA encourages experts in all fields to commit to supporting our peer-review process either as panelists or external reviewers
  - Volunteer at: https://science.nasa.gov/researchers/volunteer-review-panels
  - Or, when contacted by a program officer, consider joining the Team

C.17 Planetary Major Equipment and Facilities (PMEF)

- Replaces the former Planetary Major Equipment (PME) program element
- PMEF requests may still be APPENDED to full research proposals in the same program elements as before
  - But, only for Investigator Instruments, not Facility Instruments
- STAND-ALONE proposals may still be made for both Investigator and (all) Facility Instruments
  - But, there is now a **single deadline** for all such proposals (Step 1: July 17; Step 2: Sept. 17)
  - Step 1s will either be invited to submit Step 2 or declined
  - PI does **not** have to be current PI
  - Open to same programs as before, plus ISFM and XRP
- Minimum budget raised from $40k to $50k



Templates for Planetary Science Division (Appendix C) ROSES proposals

Updated Templates for both Data Management Plan and Table of Work Effort.

- Microsoft Word
- LaTeX

https://science.nasa.gov/templates-planetary-science-division-appendix-c-roses-proposals

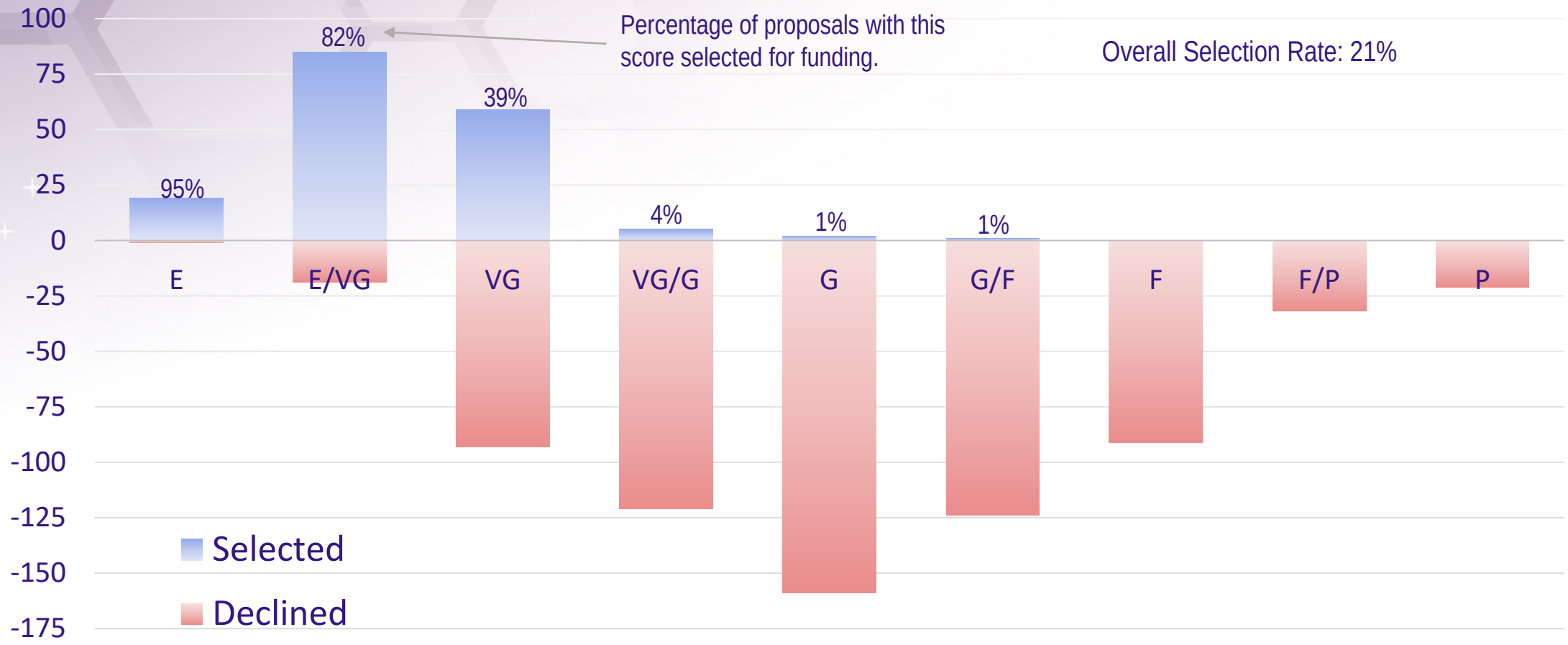
ROSES 18 Due Dates

Program Name	Step-1 Due Date	Step-2 Due Date
Juno PSP	***03/01/2018***	***04/26/2018***
Exobiology (EXOB)	***04/16/2018****	***05/24/2018***
Exoplanets (XRP)	***03/29/2018***	***05/30/2018***
Emerging Worlds (EW)	***04/12/2018***	***06/01/2018***
Development & Advance of Lunar Instruments (DALI)	***04/03/2018***	***06/05/2018***
Solar System Obs. (SSO)	***04/05/2018***	***06/07/2018***
MatISSE	***04/18/2018***	***06/20/2018***
Laboratory Analysis of Returned Sample (LARS)	***04/26/2018***	***06/28/2018***
Planetary Data Archiving, Restoration, Tools (PDART)	***05/10/2018***	***07/12/2018***
Cassini Data Analysis (CDAP)	***06/01/2018***	***08/01/2018***
New Frontiers Data Analysis Program (NFDAP)	***06/12/2018***	***08/23/2018***
Planetary Major Equipment/Facilities (PMEF)	***07/17/2018***	09/17/2018
Planetary Sci./Tech. Through Analog Research (PSTAR)	***07/25/2018***	10/10/2018
Mars Data Analysis (MDAP)	***08/23/2018***	10/25/2018
Discovery Data Analysis (DDAP)	***08/30/2018***	11/01/2018
Rosetta Data Analysis Program (RDAP)	***08/30/2018***	11/01/2018
PICASSO	09/20/2018	11/20/2018
Habitable Worlds (HW)	11/15/2018	01/17/2019
Solar System Workings (SSW)	11/15/2018*	01/31/2019
Lunar Data Analysis (LDAP)	11/29/2018	02/28/2019

NESSF Changes

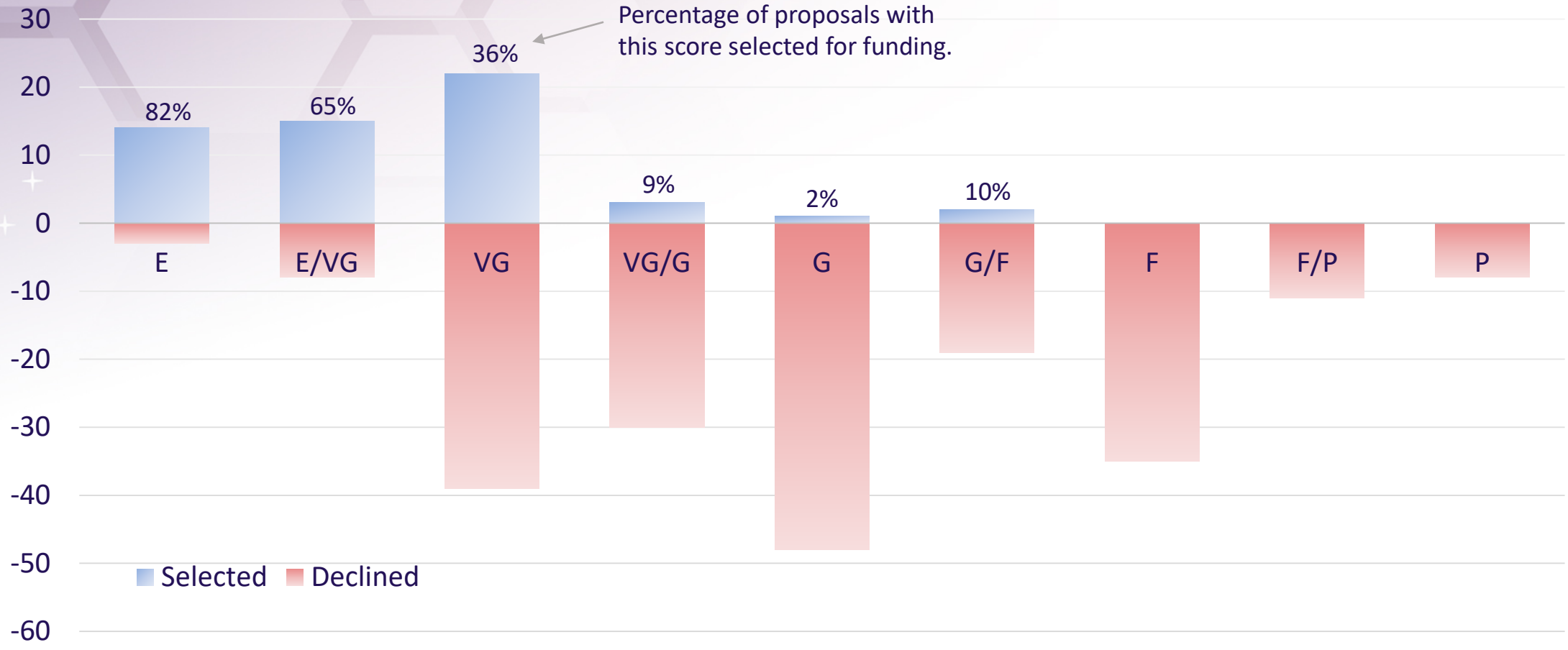
- Award amount increased to $45K. ($35K stipend + $10K for travel to conferences and seminars, health insurance policy, books, tuition and fees, etc.)
- New award amount more in line with other graduate research fellowships, NASA will be able to compete for the best students
- Change went into effect for ROSES17, and impacts existing renewal NESSF awards
- Overall budgets did not change

PSD R&A Selections – ROSES 2016



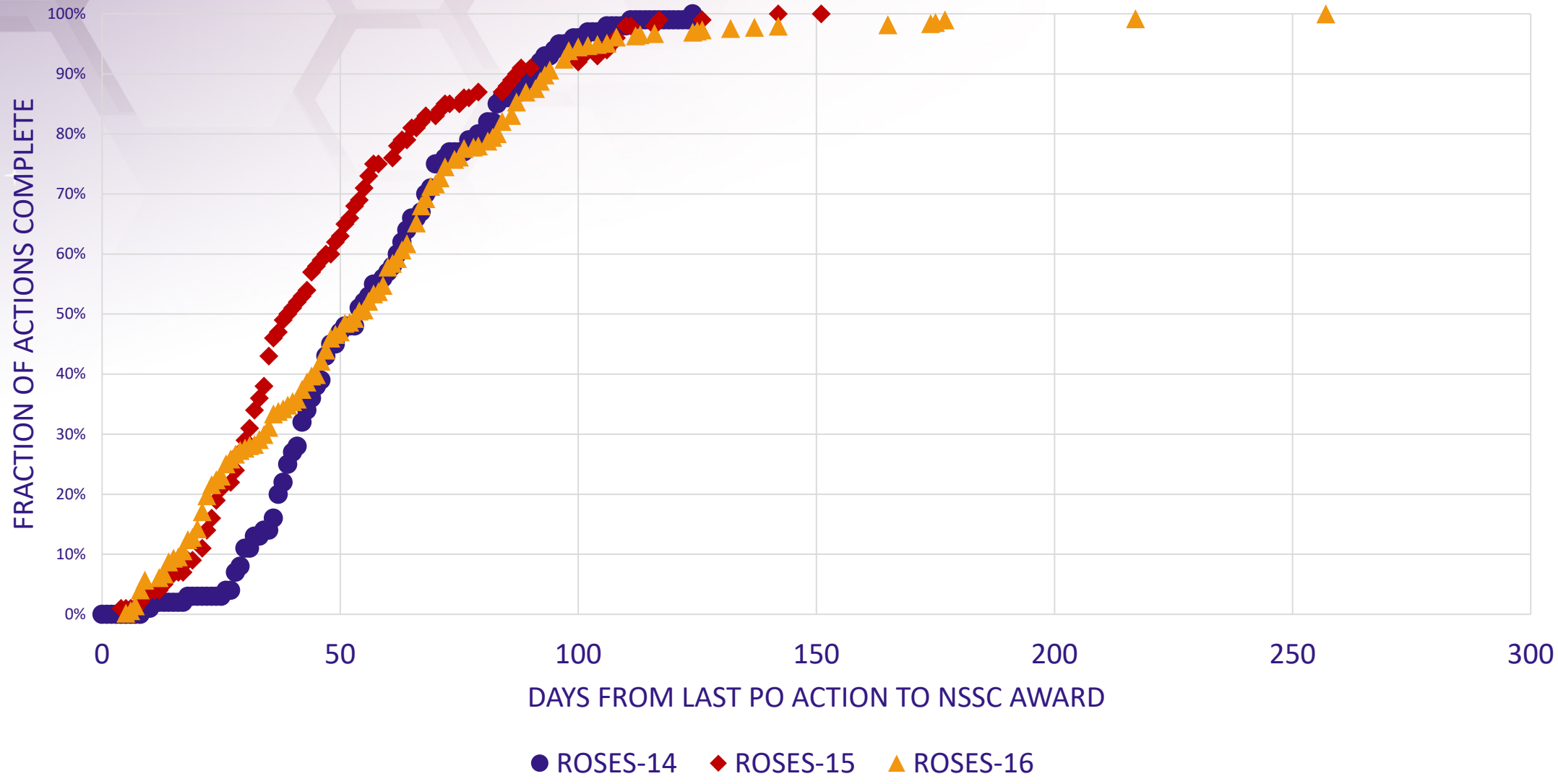
For proposals submitted to ROSES 2016, including all core programs (EW, SSW, HW, SSO, EXO) and all DAPs (MDAP, DDAP, LDAP, CDAPS).

PSD R&A Technology Selections – ROSES 2016



For technology proposals submitted to ROSES 2016, including MatISSE, PICASSO, COLDTech, HOTTech. The awards below VG/G reflect descopes/proof of concept studies that were not re-voted, hence scores remain low

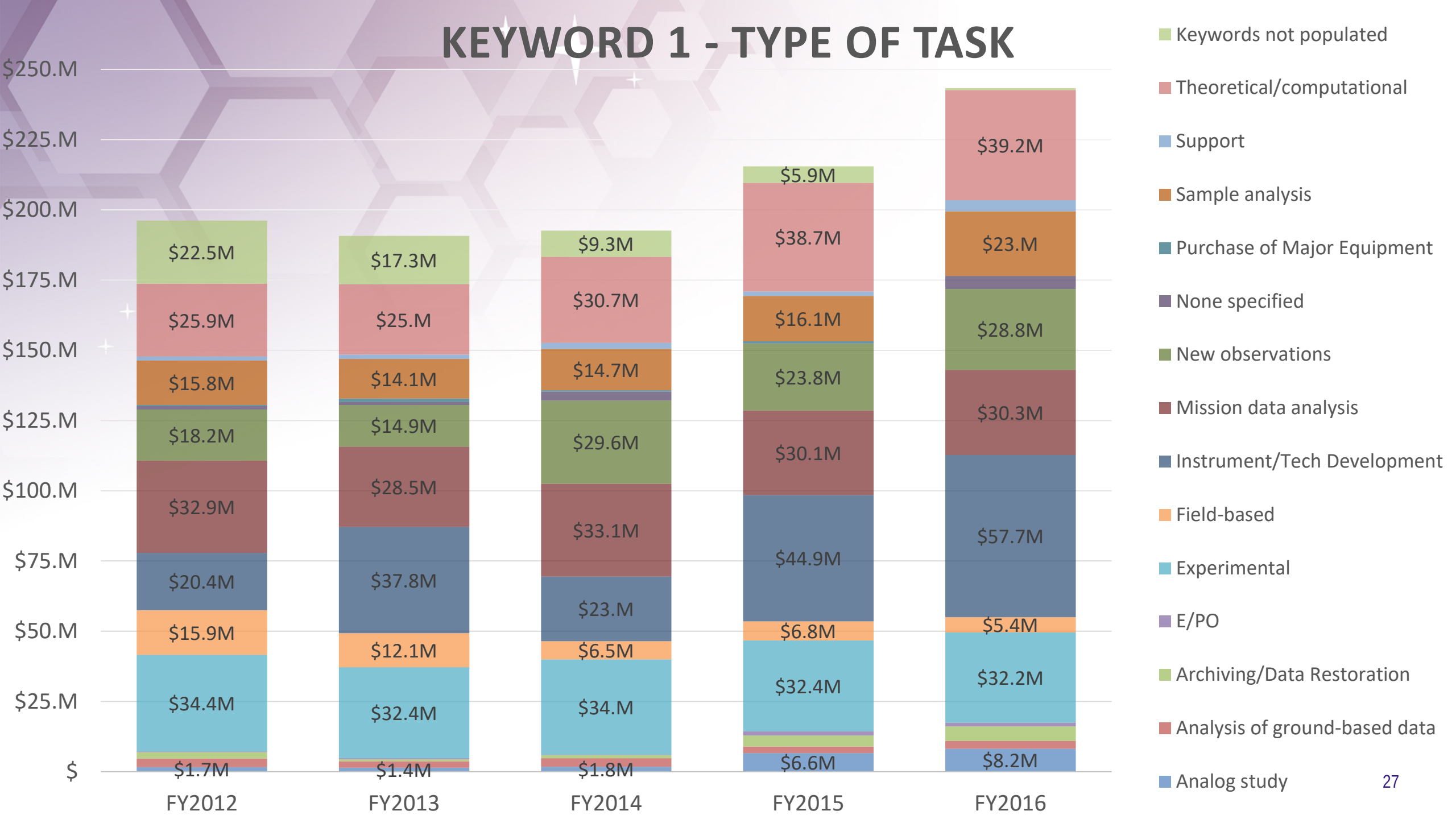
Speed of Money



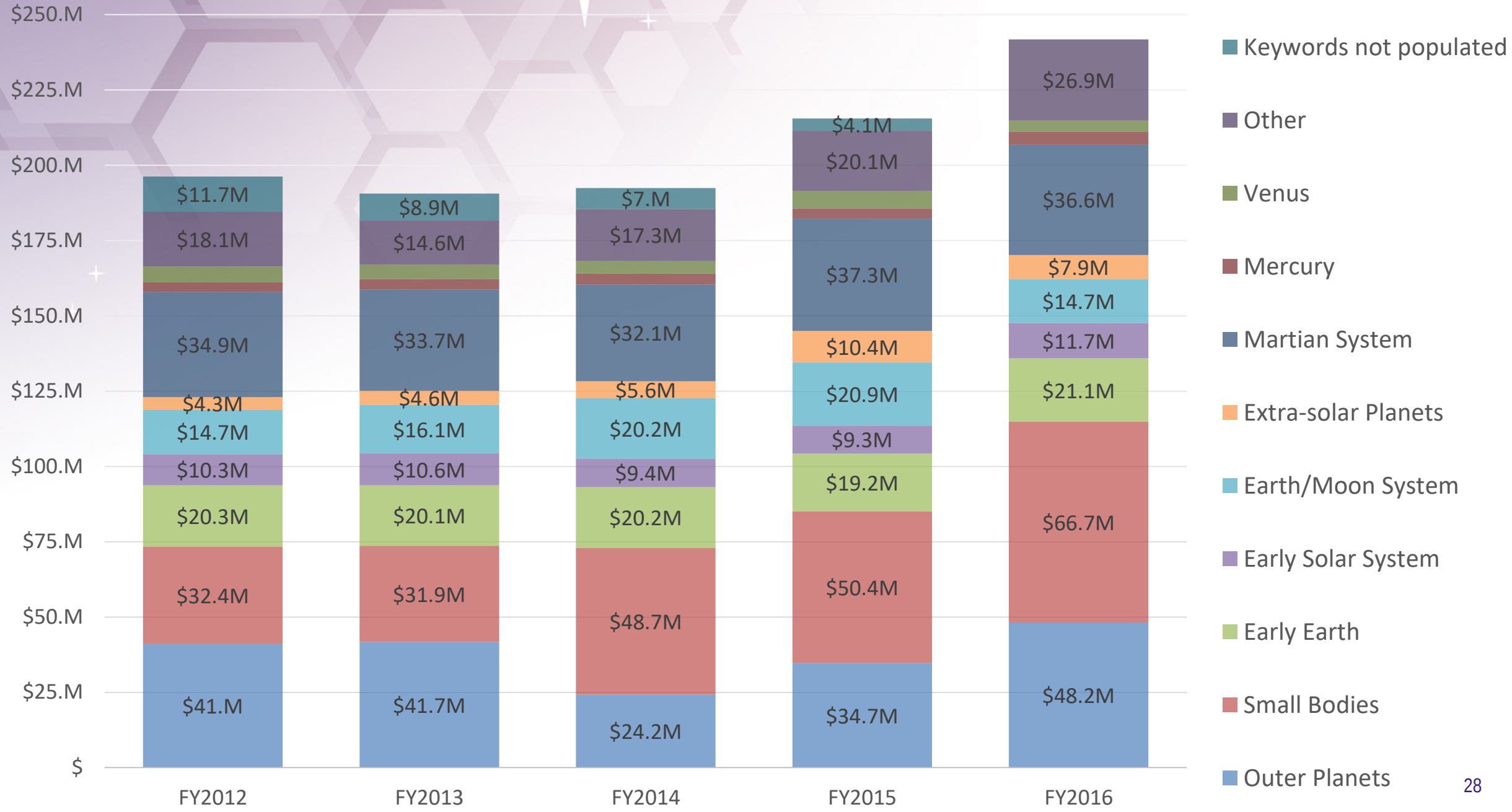
Keyword Analysis

- Analysis of keyword distribution, 2012-2016 for categories:
  - Type of Task (keyword category 1)
  - Object(s) of Study (keyword category 2)
  - Science Discipline (keyword category 3)
- Analysis includes:
  - R&A awards, including NAI CAN awards
  - Data Analysis Programs
  - Participating Scientist and Guest Investigator Programs
- Analysis excludes:
  - Support activities
  - Facilities (e.g. RPIFs, AVGR, GEER, PAL, RELAB, …)
- Caveats
  - If more than one keyword was used within any category, approved amount was equally divided between keywords
  - Return rate varied from year to year, portfolio to portfolio, and keyword category to keyword category
  - Keywords might have been used inconsistently between program officers

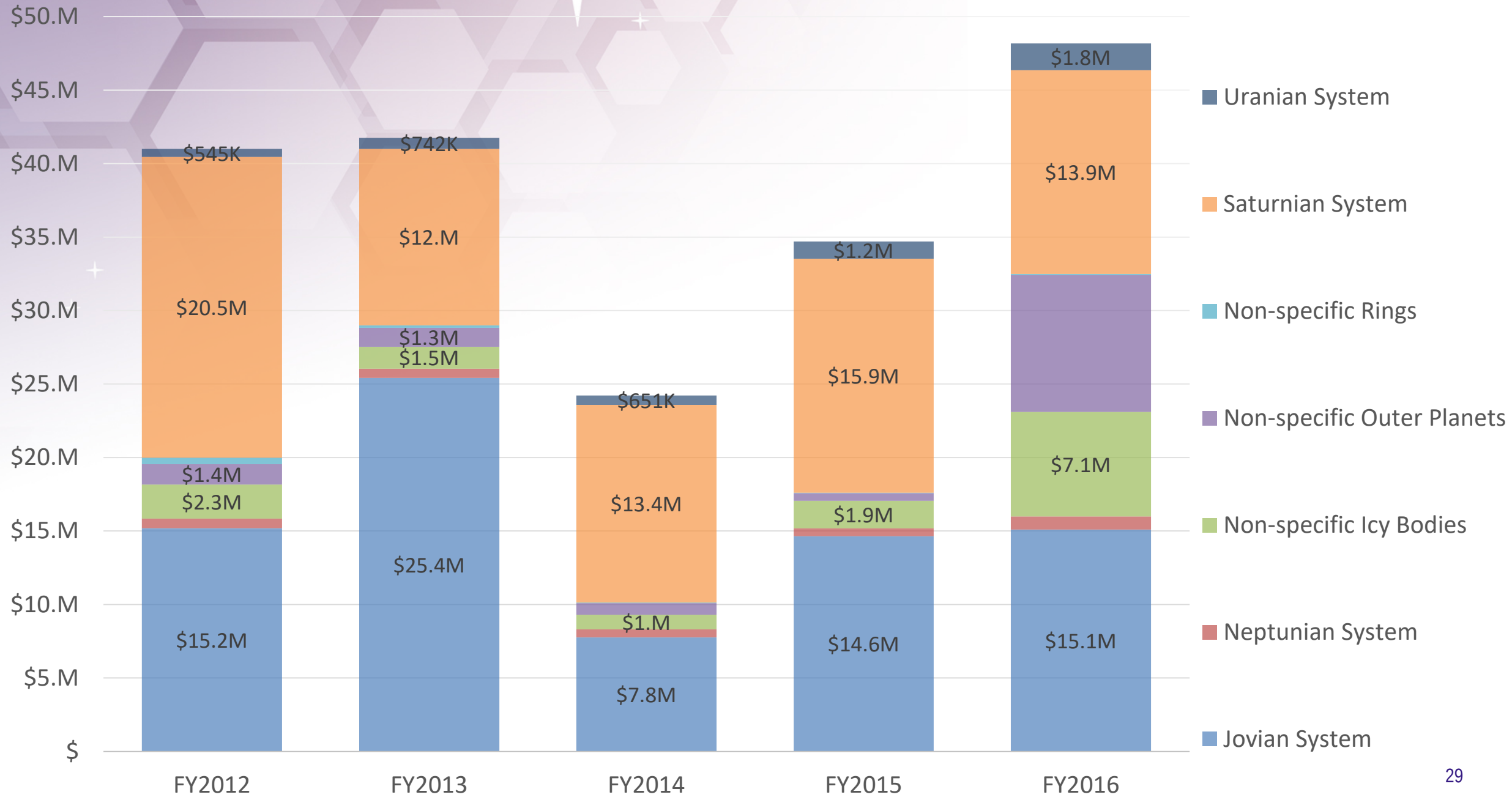
KEYWORD 1 - TYPE OF TASK



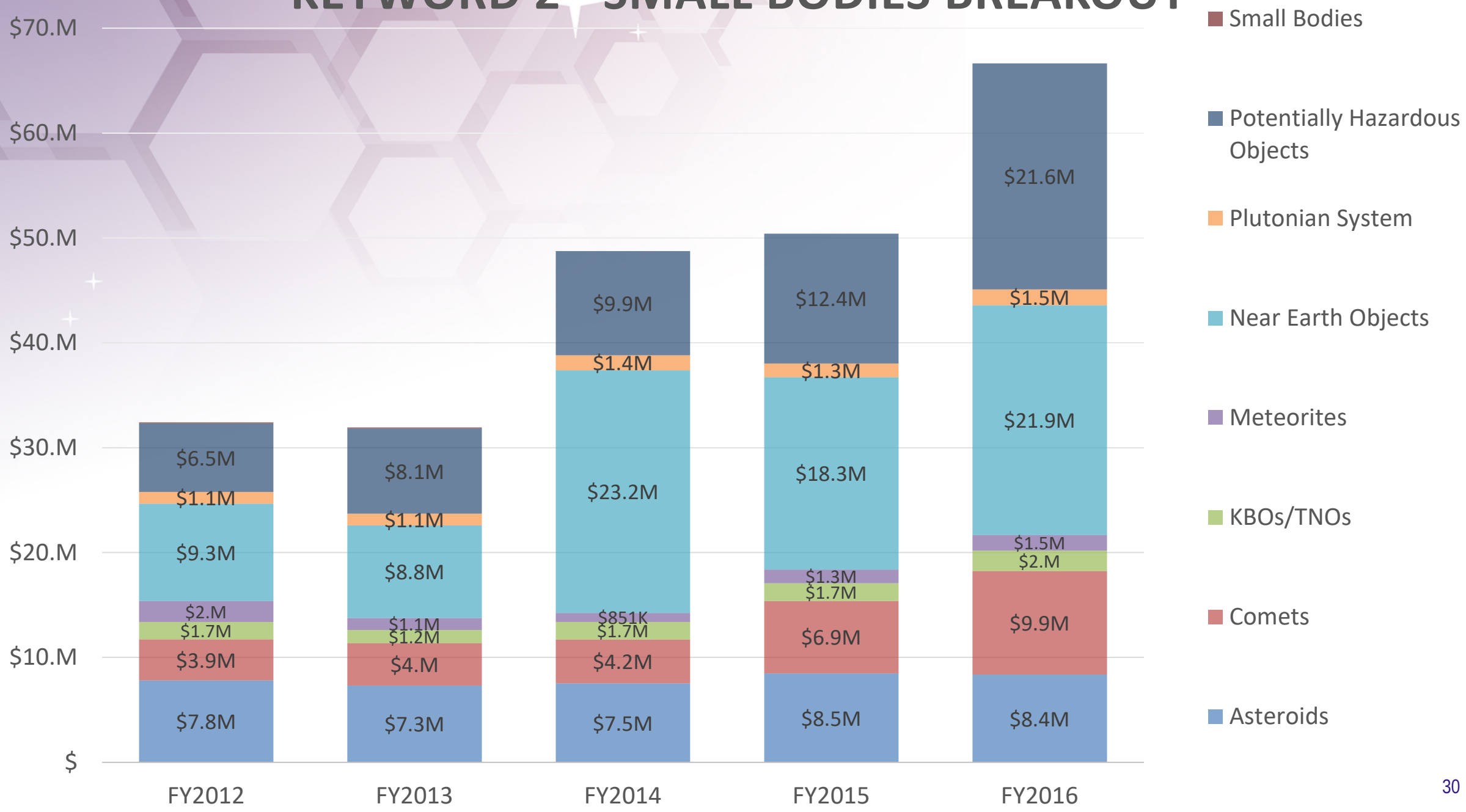
KEYWORD 2 - TARGET BODY OVERVIEW



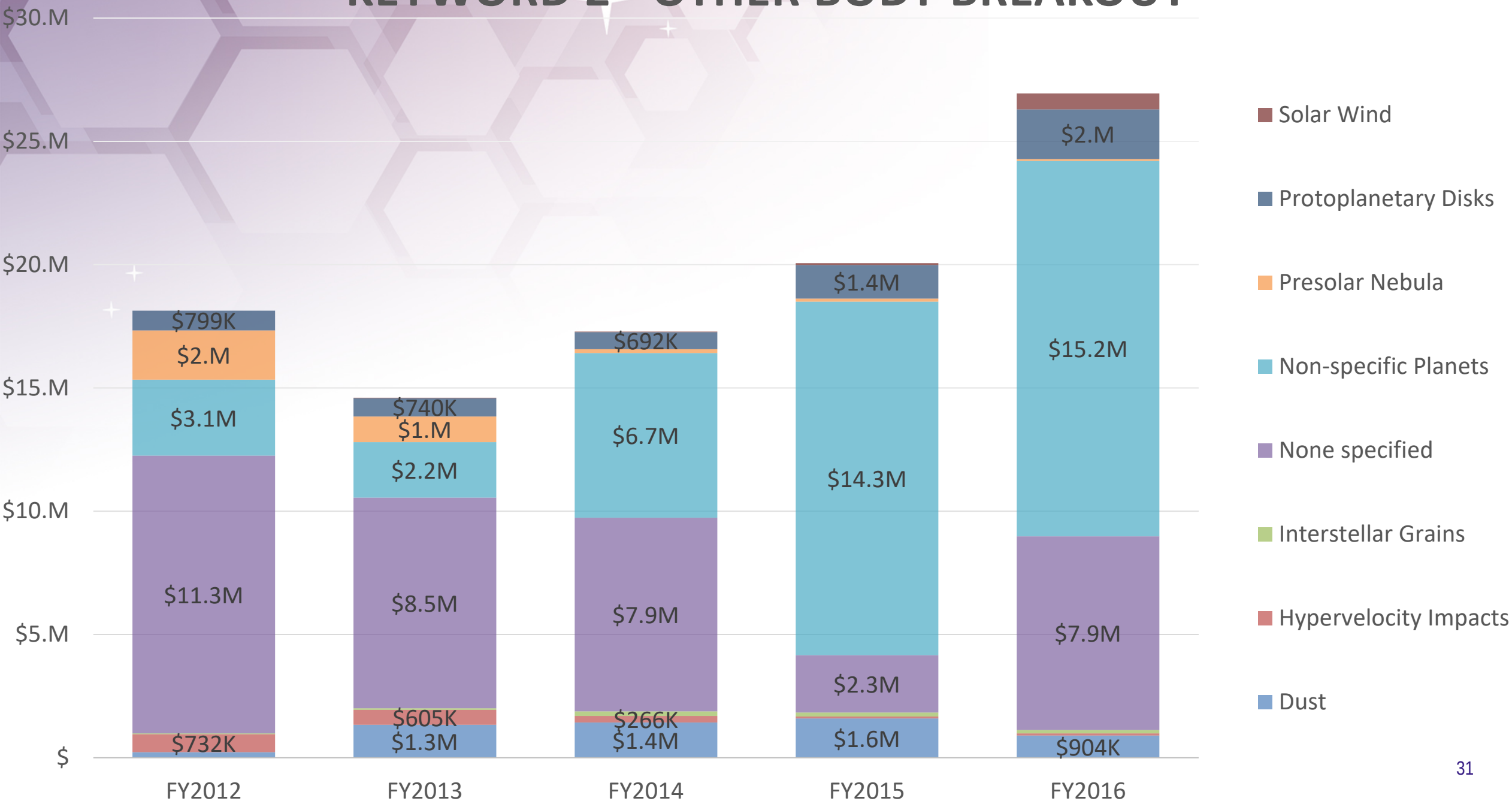
KEYWORD 2 - OUTER PLANETS BREAKOUT



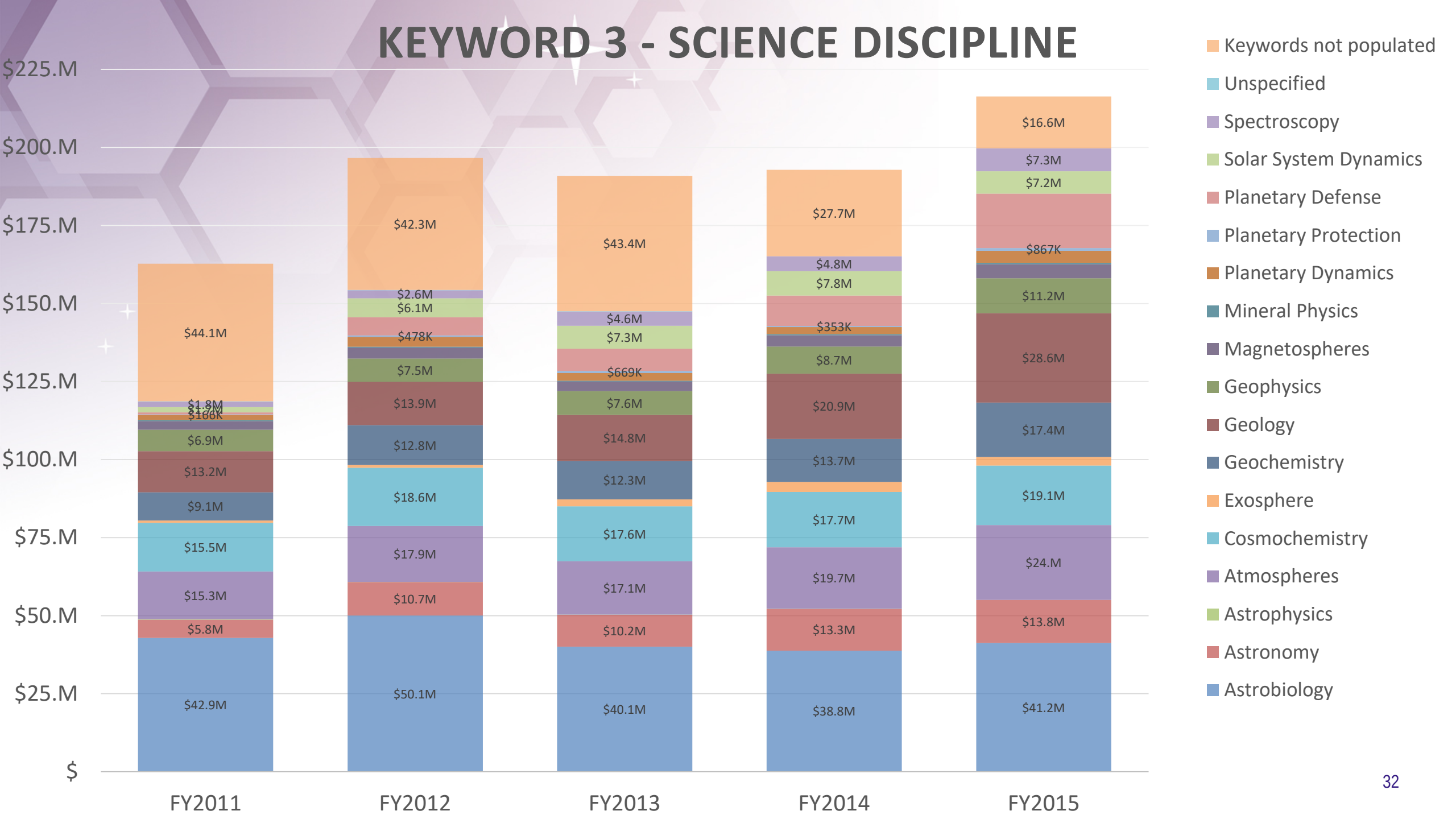
KEYWORD 2 - SMALL BODIES BREAKOUT



KEYWORD 2 - OTHER BODY BREAKOUT



KEYWORD 3 - SCIENCE DISCIPLINE



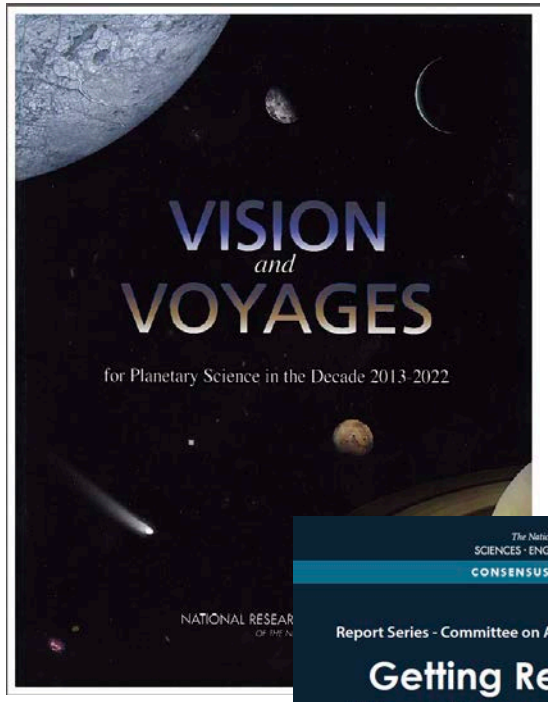
Missions Participating Scientist Programs

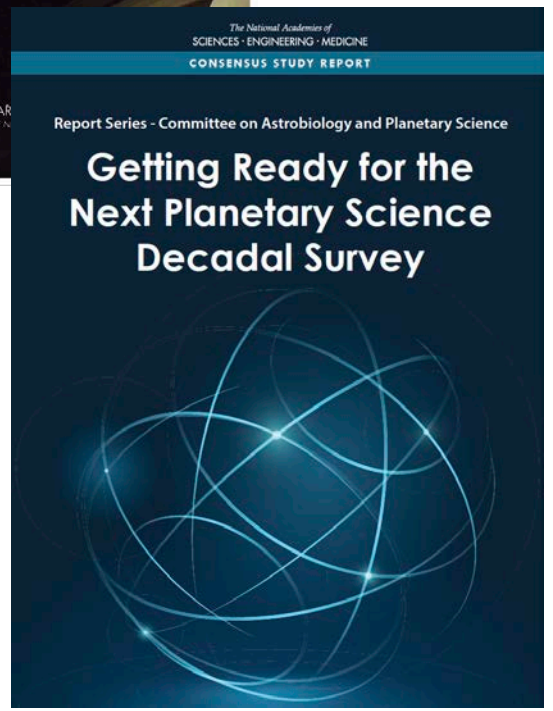
- The InSight PSP program is about to complete its review and is very close to making final decisions with regard to selecting Participating Scientists
- Korean Pathfinder Lunar Orbiter (KPLO) PSP Call waiting for HEO to provide reference documents. Otherwise, it is ready to be released
- BepiColombo will also have an opportunity for scientists to participate, most likely via a Guest Investigator Program or an InterDisciplinary Scientist program
- Juno Participating Scientists will be announced very soon

NASA Planetary Science Studies

Timeline of Studies

- 1st Planetary decadal: 2002-2012
- 2nd Planetary decadal: 2013-2022
- CubeSat Review: Completed June 2016
- Extended Missions Review: Completed Sept 2016
- R&A Restructuring Review: Completed June 2017
- Searching For Life : Completed Sept 2017
- Large Strategic Science Missions: Completed Aug 2017
- Midterm evaluation:
  - Tasked August 26, 2016
  - Above NAS studies will be input
  - Report recently released
- Sample Analysis Investment Strategy
  - Started November 2017
- 3rd Planetary Decadal: 2023-2032
  - To be tasked *before* October 2019
  - Expect report to NASA due 1st quarter 2022
- CAPS reviewed completed studies and recommended several more to be completed





Mission Studies Completed Thus Far

- Mars orbiter
  - 2015 MEPAG's Next Orbiter Science Analysis Group
- Uranus and Neptune (Ice Giants) system missions
  - 2017 NASA science definition team report
- Europa lander
  - 2017 NASA science definition team report
- Venus orbiter and lander (Venera-D)
  - 2017 joint U.S.-Russian science definition team report
- NEO Search and Characterization
  - 2017 NEO science definition team updated report

NASA Response to Mid Term DS

- NASA is currently working on a response to the recommendations in the Decadal Survey Mid-Term Report

Response to OPAG Findings from Feb. Meeting (1)

- Finding 1: OPAG supports the earliest possible arrival date for Europa Clipper, to maintain a healthy outer planets science community. OPAG further supports continued technology development towards follow-up ocean worlds missions such as Europa Lander
- NASA Response: The Project is currently working toward a 2022 launch date as funds allow. NASA recently issued two new NRAs for ocean world technology development (ICEE 2 and SESAME) and maintains language encouraging ocean worlds development in ongoing technology development programs.

Response to OPAG Findings from Feb. Meeting (2)

- Finding 2: OPAG is concerned about the sustainability of CDAP and NFDAP programs. In particular, we encourage NASA to ensure that these programs are funded at or above their current levels now and in the future and thereby optimize the science outputs from these successful missions and maintain the vibrant research community needed to support future exploration. After funding for these missions ceases, if proposal selection rates drop below the current percentages then a CDAP and/or NFDAP funding augmentation should be implemented to bring the proposal selection percentages back to their current values.
- NASA Response: NASA plans to continue CDAP and NFDAP for the foreseeable future. NFDAP funding needs are being monitored as more data is deposited into the PDS by operational missions. Dr. K.C. Hansen has recently started at NASA HQ as the new discipline scientist for CDAP.

Response to OPAG Findings from Feb. Meeting (3)

- Finding 3: OPAG encourages NASA to continue investment in the technologies and groundbased science that enhance an Ice Giants mission. We also encourage NASA and ESA to refine estimates of the programmatic factors related to such a mission (e.g. cost, partnerships, launch time-frames) and undertake a follow-up mission study focused on optimizing the science return within the current best estimate of available resources.
- NASA Response: ESA is moving forward with a study to explore possible collaborations. NASA is considering the path forward for Ice Giants in light of this study as well as OPAG feedback and the Decadal Survey Mid-Term report.

Response to OPAG Findings from Feb. Meeting (4)

- Finding 4: OPAG supports the inclusion of workforce issues in the next planetary decadal survey. Specifically, OPAG asks that a survey of workforce issues be included in the Statement of Tasks.
- NASA Response: PSD is considering the proper timing for a planetary science work force survey. Data from this survey could feed into Decadal Survey deliberations.

Response to OPAG Findings from Feb. Meeting (5)

- Finding 5: OPAG supports NASA's reconsideration of allowing RPS in future Discovery mission AOs, even if the number of MMRTGs is limited to only one or two units, as nuclear power is necessary to open up the solar system beyond Jupiter or Saturn to new exploration.
- NASA Response: After assessing MMRTG and plutonium needs for NF4 NASA announced that RPS would be available for the next Discovery AO.

Response to OPAG Findings from Feb. Meeting (6)

- Finding 6: The OPAG committee finds that NASA should initiate a formal National Academies study to explore how NASA can create an exploration strategy addressing Ocean Worlds.
- NASA Response: NASA would like OPAG's opinion on the pros and cons of a standalone National Academies study on this topic vs. relying on the Decadal Survey to address Ocean Worlds science and priorities.

Response to OPAG Findings from Feb. Meeting (7)

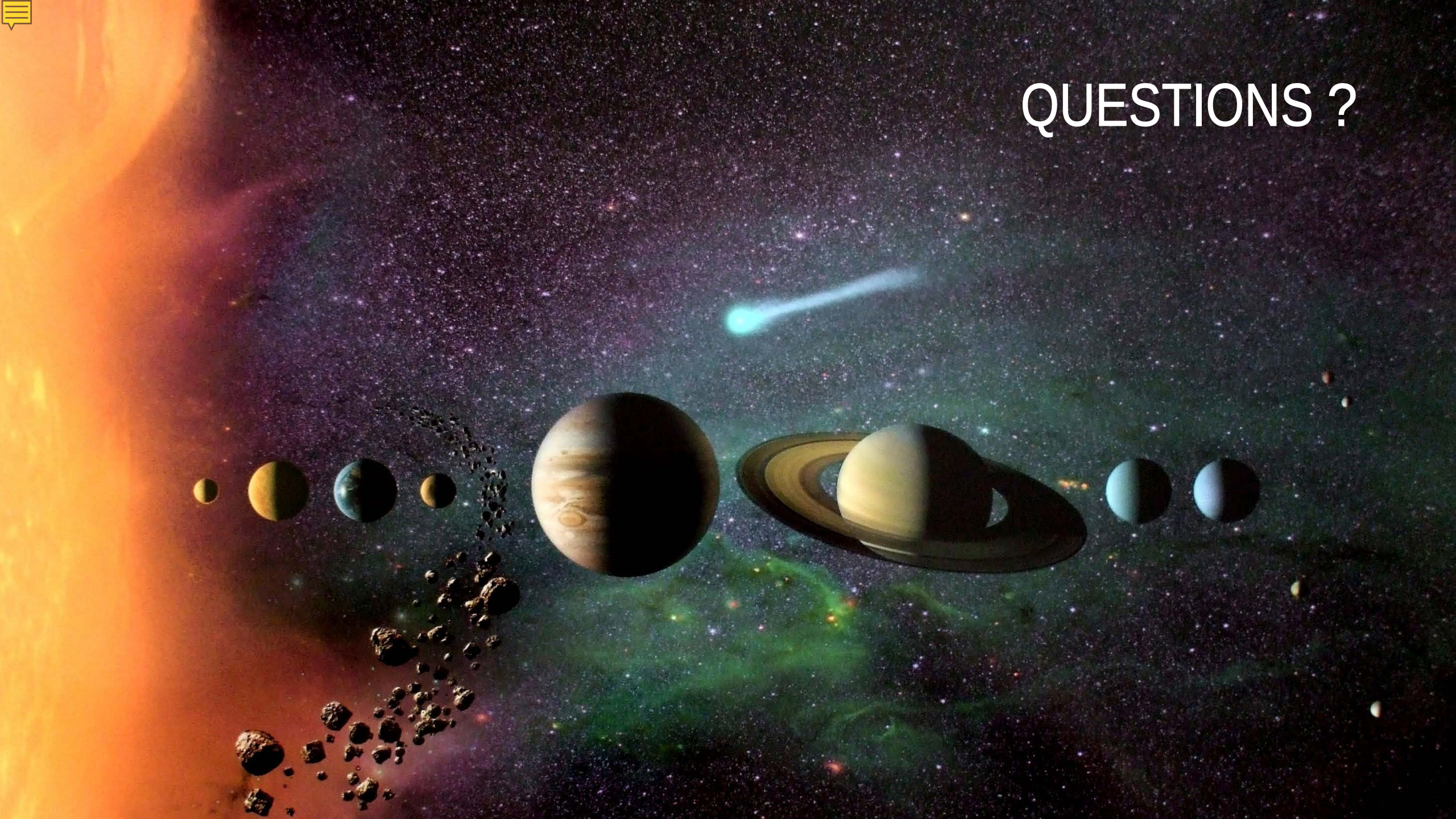
- Finding 7: OPAG requests clarification of the process NASA intends to use for identifying targets for mission studies. Specifically, we encourage NASA to provide timely input regarding the scope, prioritization, and limiting number of new mission studies that can be completed in time to be useful to the next Decadal Survey. It is very desirable to have this information well before the next OPAG meeting scheduled for September 2018.
- NASA Response: PSD relies on CAPS to provide the list of missions to be studied in advance of the next Decadal Survey. PSD is currently considering the recommendations from the Decadal Survey Midterm report on this topic.

Response to OPAG Findings from Feb. Meeting (8)

- Finding 8: OPAG encourages PSD to have a sustained technology program for outer planetary missions. ColdTech has been advantageous, but it was a single call and should be repeated with direct application to the OPAG goals. A sustained investment in these technologies is needed. Some technologies, Astrodynamics for one, are not funded at all and could enable many new mission concepts.
- NASA Response: PSD recognizes that technology needs are important for all mission destinations; therefore, the overall PSD budget and the impact to the planetary portfolio of sustained support for such technology development must be carefully considered

CAPS Priority Areas Candidates for Large or Medium Class Mission Studies (Unprioritized)

Venus exploration missions (assigned to gsfc but team has not formed yet)	Additional concepts beyond the Venera-D orbiter and lander
Lunar science missions	Understanding interior processes and polar volatiles (Volatiles SAT Team-2)
Mars sample-return next-step missions	Mission elements beyond Mars 2020 necessary for second and third phases of a Mars sample-return campaign
Mars medium-class missions	Multiple mobile explorers, polar explorers, & life-detection. Investigations responsive to new discoveries
Dwarf planet missions (starting to move forward JPL)	Large- & medium-class mission concepts to Ceres, Pluto, Triton
Io science (NEW FRONTIERS FIVE)	Reexamine mission to Io
Saturn system missions	Affordable, large strategic missions that visit multiple targets
Dedicated space telescope for solar system science	Dynamic phenomena on planetary bodies


QUESTIONS ?