National Aeronautics and
Space Administration

SCIENCE MISSION DIRECTORATE

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Associate Administrator
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November 1, 2017

NASA SCIENCE

SCIENCE HIGHLIGHTS

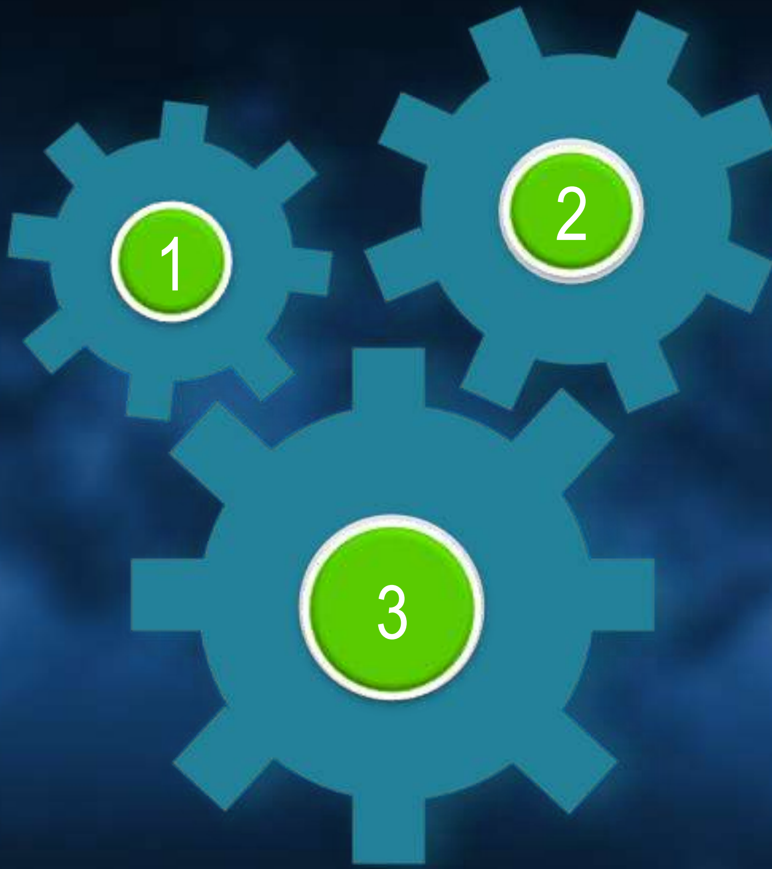
Overview of SMD's high impact, integrated and multi-faceted portfolio

SMD UPDATES

Personnel and schedule updates, and public/private partnership activities

BALANCED PORTFOLIO MANAGEMENT

Independent review of WFIRST and Class D Strategy



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SCIENCE BY THE NUMBERS

Spacecraft
105 missions
88 spacecraft

CubeSats
17 science missions
11 technology demonstrations

Balloon Payloads
13 science payloads
1 HASP with up to 12 student experiments

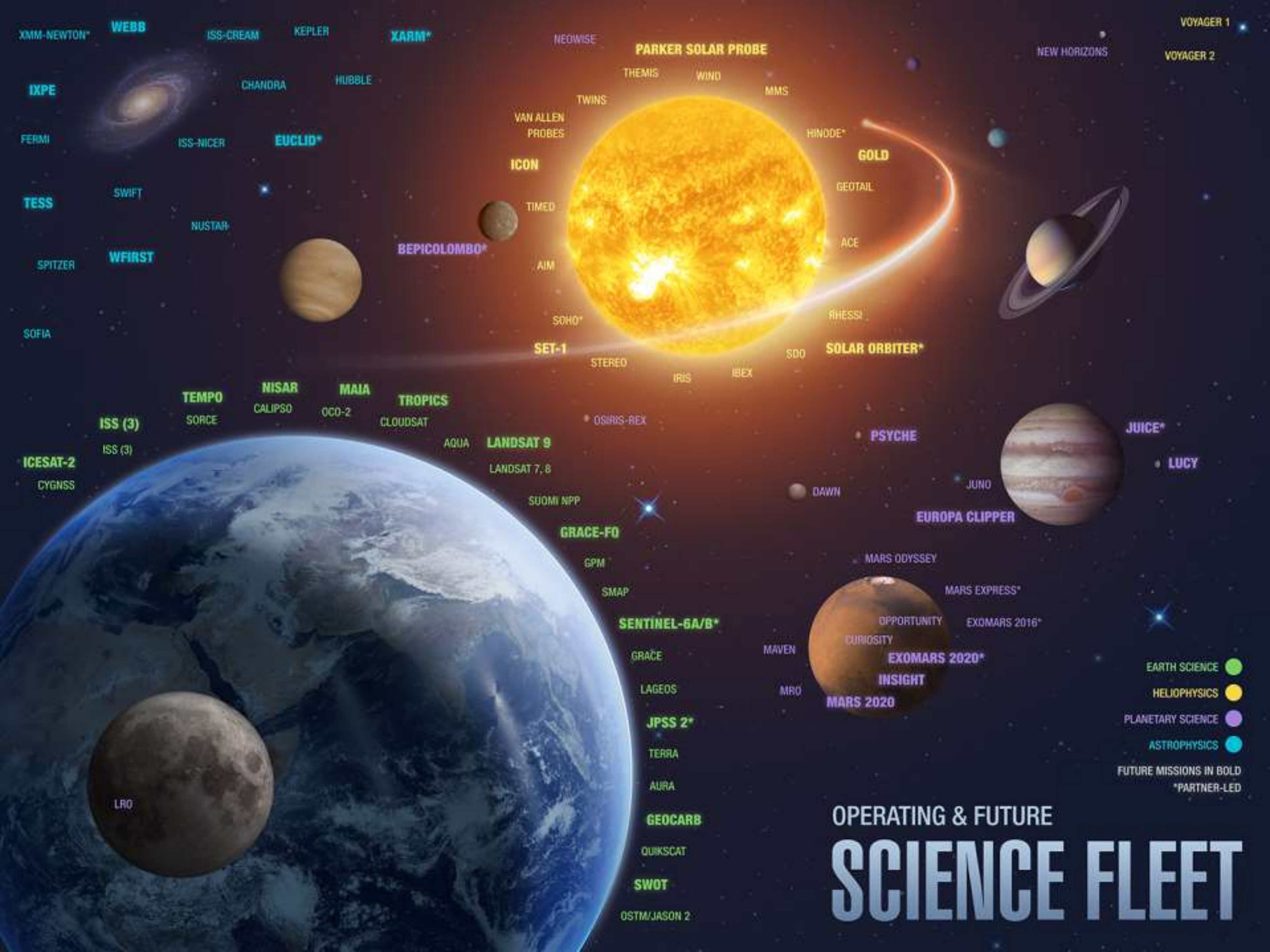
Sounding Rocket Flights
16 science missions
3 technology/ student missions

Earth-Based Investigations
25 major airborne missions
8 global networks

Technology Development
~$400M invested annually

Research
$10,000^+$ U.S. scientists funded
$3,000^+$ competitively selected awards
~$600M awarded annually

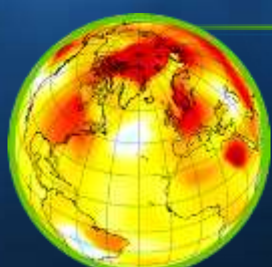
As of October 20 2017


XMM-NEWTON*
WEBB
ISS-CREAM
KEPLER
XARM*
NEOWISE
PARKER SOLAR PROBE
NEW HORIZONS
VOYAGER 1
VOYAGER 2
IXPE
CHANDRA
HUBBLE
THEMIS
WIND
MMS
TWINS
VAN ALLEN PROBES
HINODE*
GOLD
FERMI
ISS-NICER
EUCLID*
ICON
GEOTAIL
TESS
SWIFT
TIMED
NUSTAR
ACE
BEPICOLOMBO*
SPITZER
WFIRST
AIM
RHESSI
SOHO*
SOFIA
SET-1
STEREO
IRIS
IBEX
SDO
SOLAR ORBITER*
TEMPO
NISAR
MAIA
TROPICS
SORCE
CALIPSO
OCO-2
CLOUDSAT
OSIRIS-REX
PSYCHE
JUICE*
ISS (3)
ISS (3)
AQUA
LANDSAT 9
LANDSAT 7, 8
LUCY
ICESAT-2
CYGNSS
JUNO
DAWN
SUOMI NPP
EUROPA CLIPPER
GRACE-FO
GPM
MARS ODYSSEY
SMAP
MARS EXPRESS*
SENTINEL-6A/B*
OPPORTUNITY
EXOMARS 2016*
CURIOSITY
MAVEN
EXOMARS 2020*
GRACE
INSIGHT
LAGEOS
MRO
MARS 2020
JPSS 2*
TERRA
AURA
LRO
GEOCARB
QUIKSCAT
SWOT
OSTM/JASON 2
EARTH SCIENCE
HELIOPHYSICS
PLANETARY SCIENCE
ASTROPHYSICS
FUTURE MISSIONS IN BOLD
*PARTNER-LED
OPERATING & FUTURE
SCIENCE FLEET

KEY SCIENCE THEMES

Discovering the Secrets of the Universe

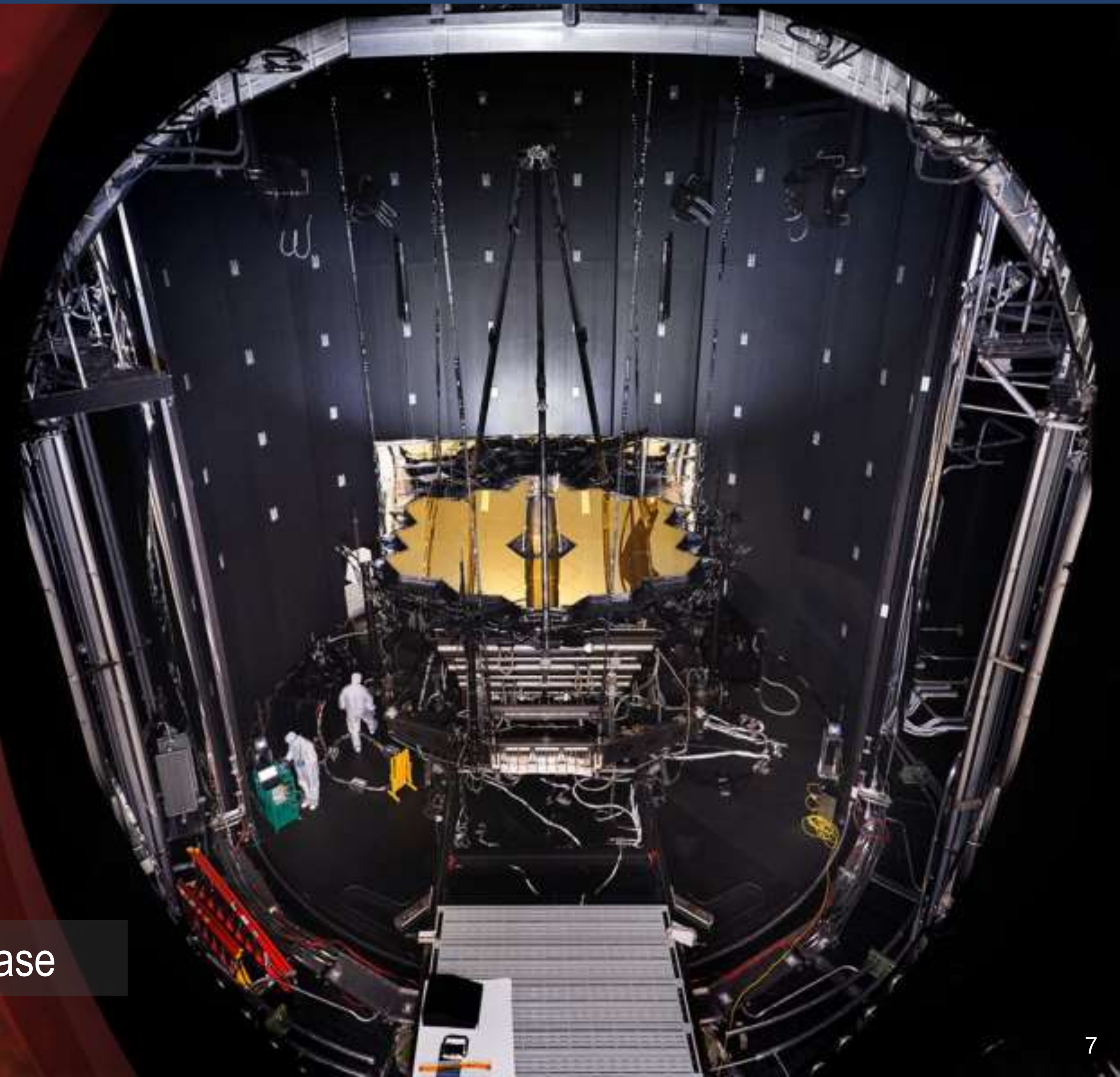
Searching for Life Elsewhere



Safeguarding and Improving Life on Earth

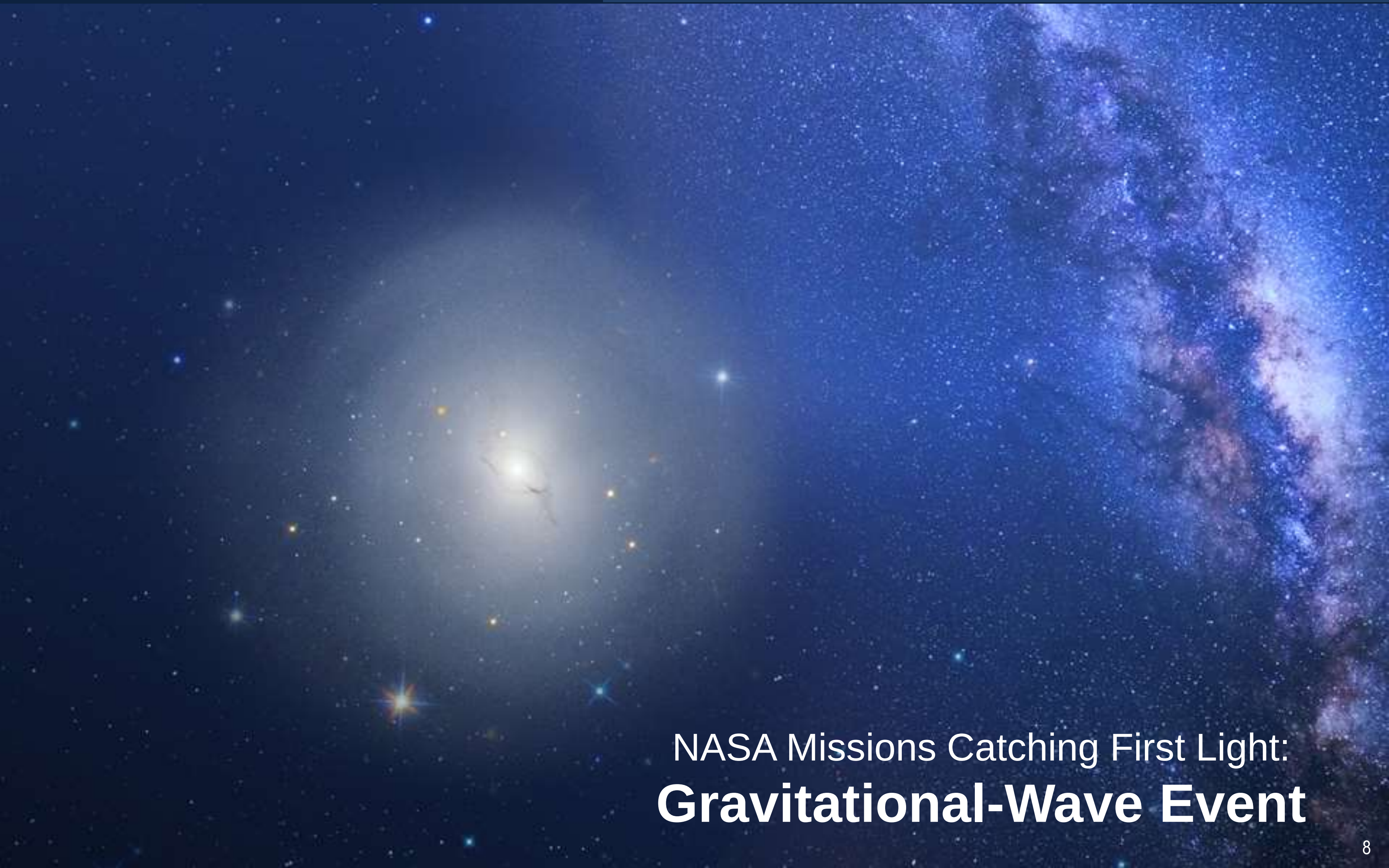
Webb

The James Webb
Space Telescope



Cryogenic-vacuum testing phase

EMERGING SCIENCE AREAS



NASA Missions Catching First Light:

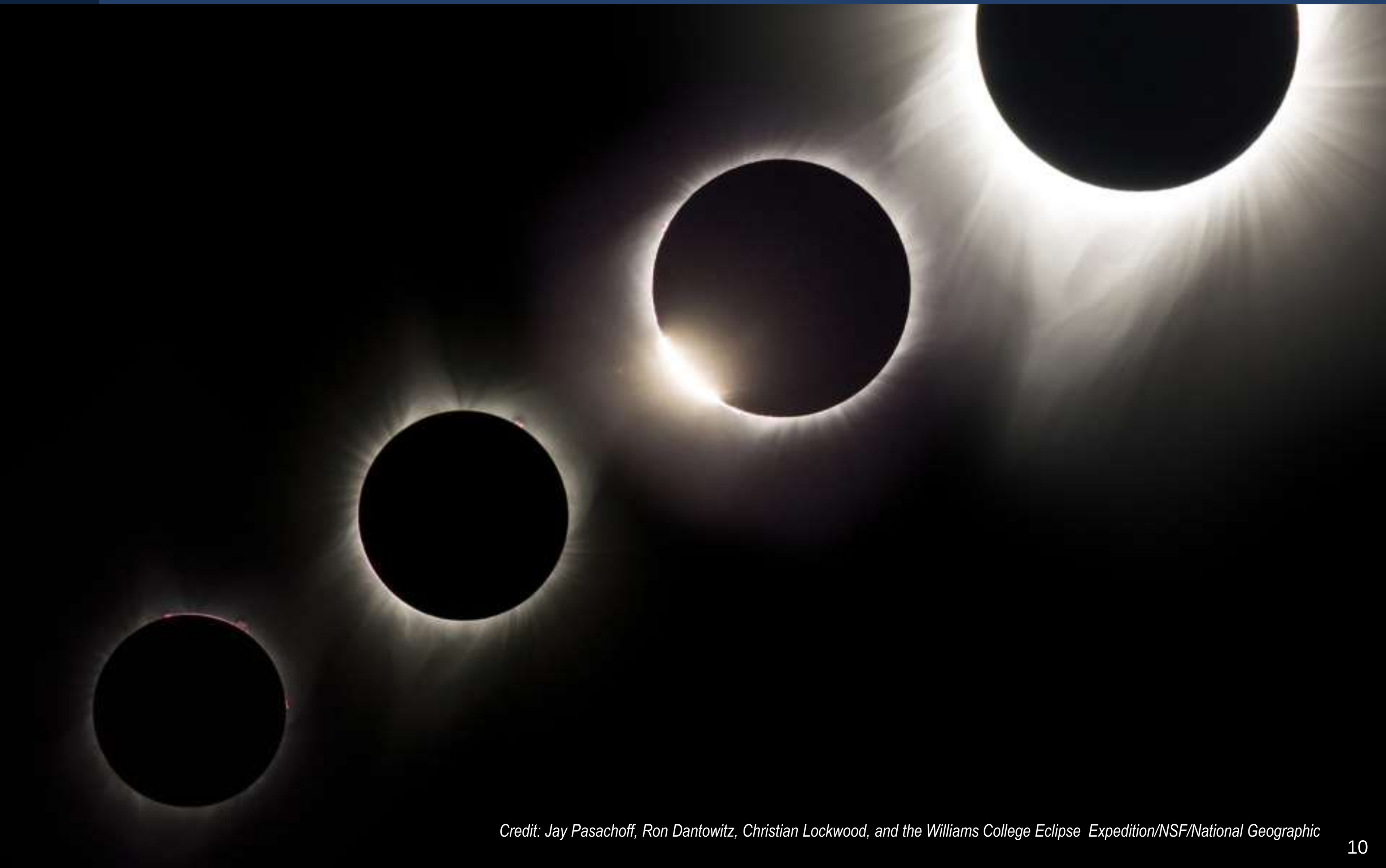
Gravitational-Wave Event

DISCOVERING THE SECRETS OF THE UNIVERSE

Dr. Eugene Parker Meets Parker Solar Probe at JHU/APL
October 3, 2017

PARKER
Solar Probe

ECLIPSE 2017: TOTAL ECLIPSE ACROSS AMERICA



Credit: Jay Pasachoff, Ron Dantowitz, Christian Lockwood, and the Williams College Eclipse Expedition/NSF/National Geographic

ECLIPSE 2017: TOTAL ECLIPSE ACROSS AMERICA

- NASA’s biggest digital event (web, social, streaming) ever measured
- Biggest *government* event in history of Digital Analytics Program (2012); comparable to Super Bowls, Masters, major news/entertainment events
- Estimates of TV content: Aired on 57 outlets in 8 states and 22 countries worldwide, ***potential*** *maximum audience* of more than 600 million

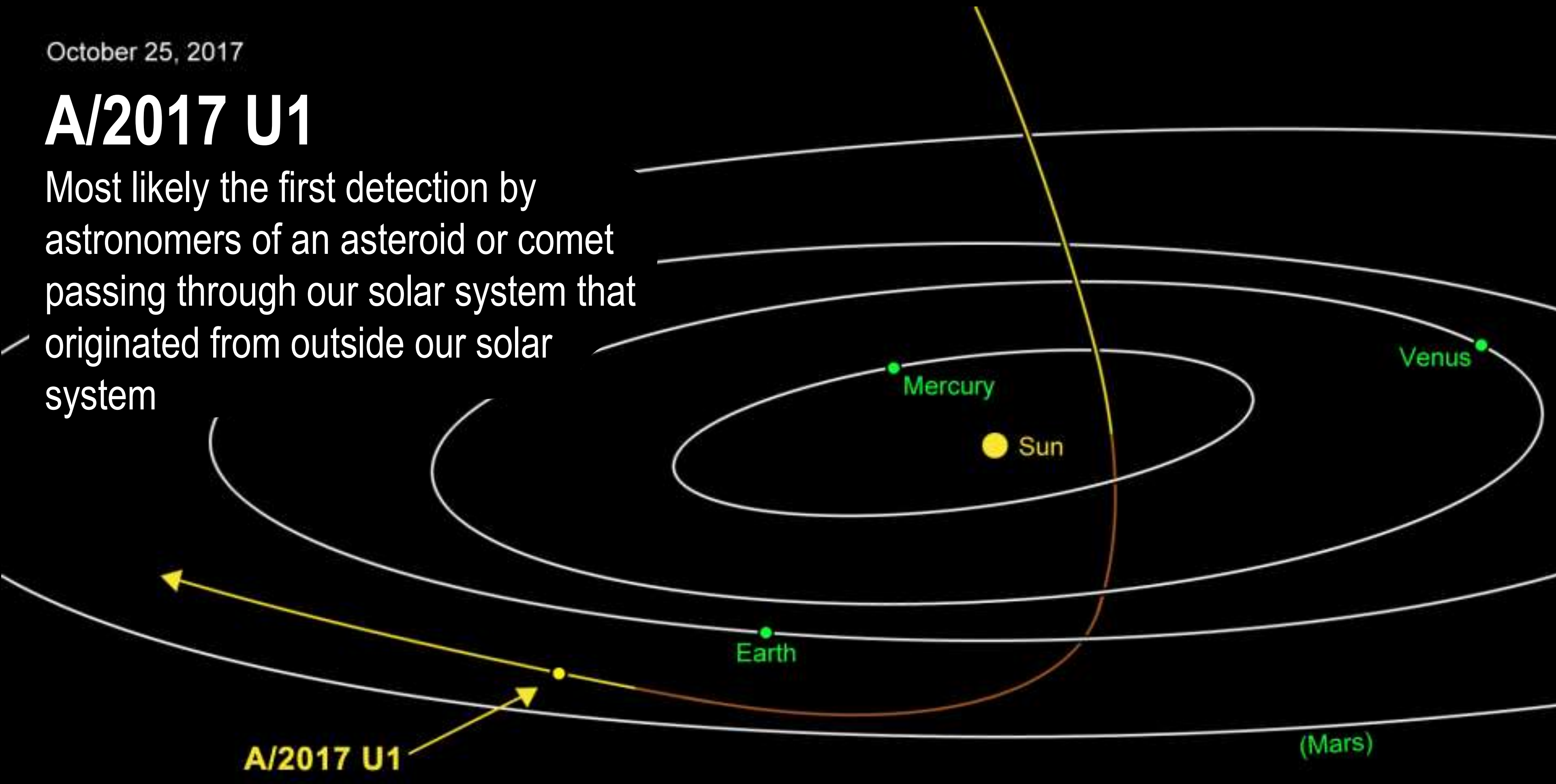
Cassini

Grand finale

October 25, 2017

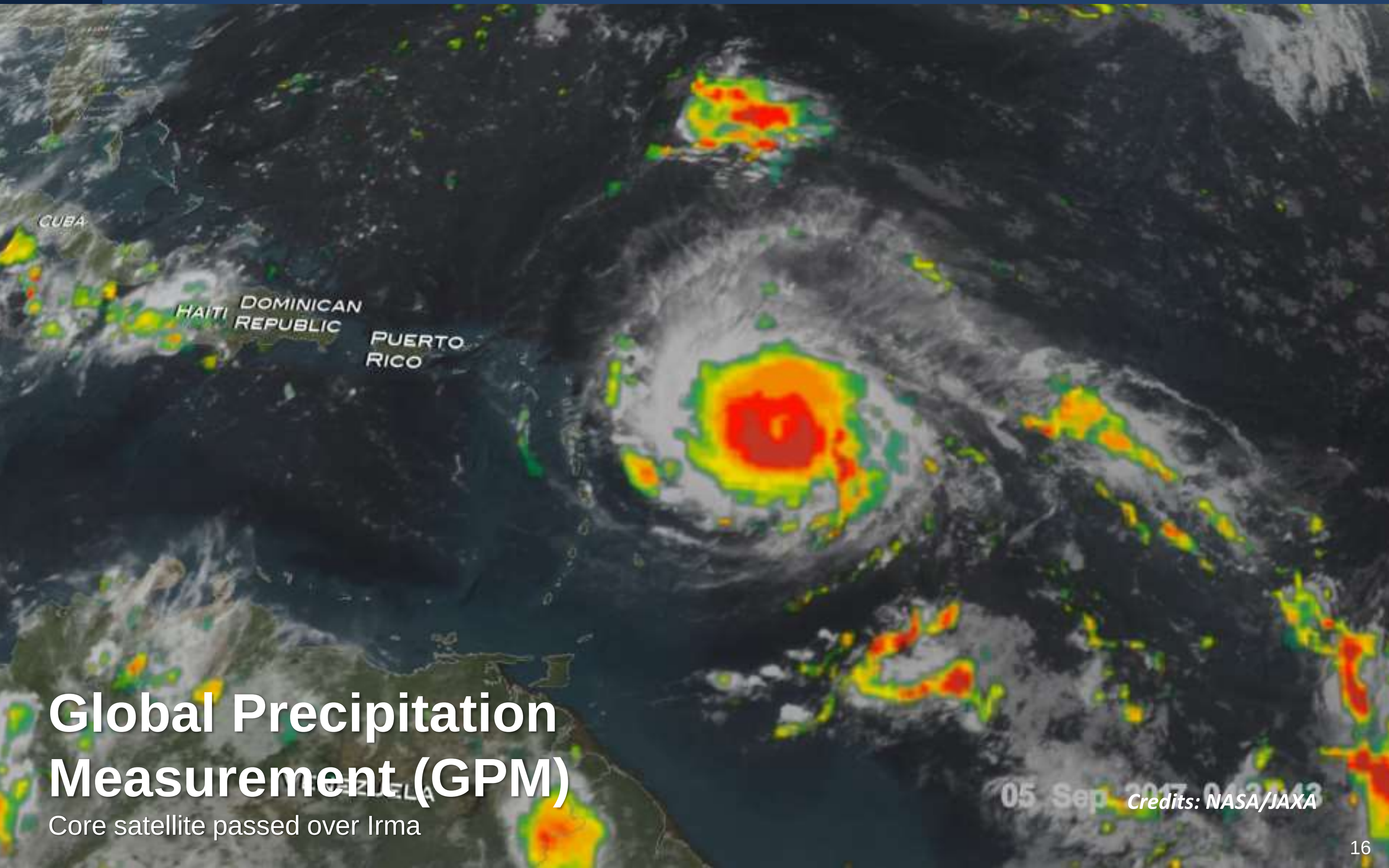
A/2017 U1

Most likely the first detection by astronomers of an asteroid or comet passing through our solar system that originated from outside our solar system




2018 AAAS ANNUAL MEETING Advancing Science: Discovery to Application
Science
$15
13 OCTOBER 2017
sciencemag.org
AAAS
EYE IN THE SKY
Measuring carbon from space p. 186

SAFEGUARDING AND IMPROVING LIFE ON EARTH



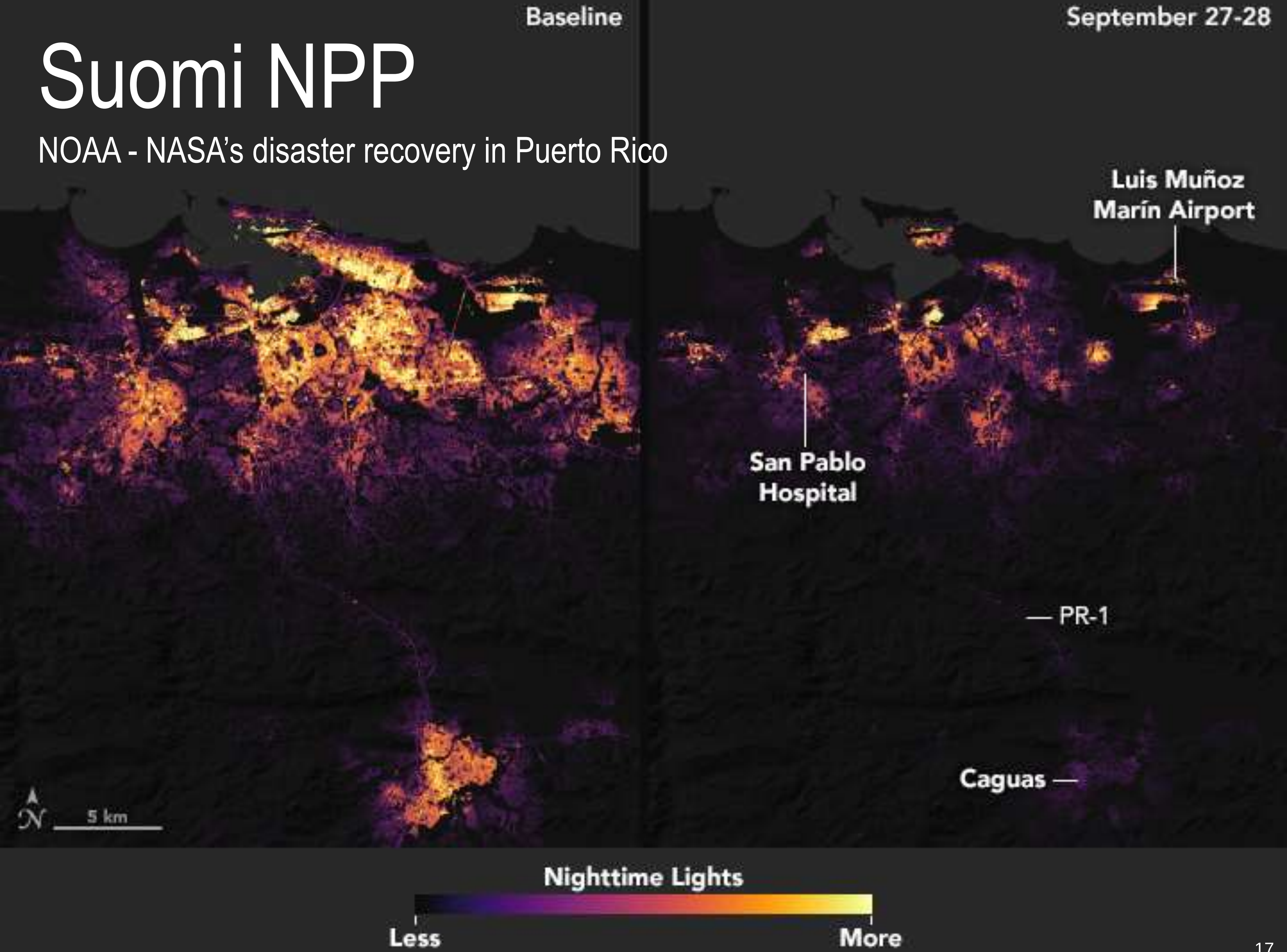
Global Precipitation Measurement (GPM)

Core satellite passed over Irma

Credits: NASA/JAXA

Suomi NPP

NOAA - NASA's disaster recovery in Puerto Rico



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PERSONNEL UPDATES

- Deputy Associate Administrator for Research call for applicants closed
- Heliophysics Division Director call for applicants closed
- Planetary Protection Officer transitioned to Office of Safety and Mission Assurance

INTERNAL SCIENTIST FUNDING MODEL (ISFM)

Guiding Principles of the New Model

- Civil servant (CS) scientists at NASA have a different overall set of responsibilities than academic or industry scientists
- The quality of research accomplishments from Centers is excellent and process changes must incorporate external review to maintain this excellence
- Each Mission Directorate (SMD, ARMD, STMD, HEOMD) currently supports CS scientists differently
  - The new model does not preclude differences, but establishes some commonality, especially as they relate to roles, principles, and directed activities
- The time civil servant scientists spend writing proposals should be redirected to time spent on research
- Surveys have shown that CS scientists do not receive the majority of their support through Research and Analysis (R&A) funding

INTERNAL SCIENTIST FUNDING MODEL (ISFM)

The New Model

- New directed work will be negotiated between HQ and the Centers
  - All proposed work packages are strategic, forward leaning, substantive, and appropriate for each Center's assigned research leadership
- The work will undergo periodic, independent peer reviews to assure quality of the funded work
- Negotiations and reviews will be established between an appropriate level of Center management and the HQ sponsoring directorate management
- To initiate the negotiations, Centers and HQ will jointly develop new work packages of directed research
- Funding to NASA CS scientists should remain approximately the same as under the current, all-competition, model

LATEST PARTNER UPDATES

- Spitzer RFI issued October 13, 2017
  - POC: Dr. Jeff Hayes, PE Spitzer Mission
  - Responses due 4:00 p.m. Eastern time, November 17, 2017
- Planetary Defense RFI released October 12, 2017
  - POC: Dr. Kelly Fast, Near-Earth Object Observations Program Manager
  - Deadline: 11:59 p.m. Eastern time, November 13, 2017
- GeoCarb, newest Class D mission, successfully passed System Requirements Review/Mission Design Review (SRR/MDR) and Science Mission Directorate Key Decision Point-B (KDP-B)
  - Earth Venture Mission-2 (EVM-2) at the University of Oklahoma
  - GeoCarb payload will be hosted on PI-procured SES commercial satellite
  - Partners include: Lockheed Martin Commercial Civil Space; SES Government Solutions; Colorado State University; JPL; GSFC; ARC

LATEST INFORMATIONAL UPDATES

- NAS Study of Laboratory Facilities for Extraterrestrial Samples to address:
  - Analytical capabilities required to support PSD (and partner) analysis and curation of existing and future extraterrestrial samples
  - Whether current sample laboratory support infrastructure and NASA's investment strategy meet analytical requirements for decadal missions
  - How NASA can ensure the science community stay abreast of evolving techniques and be at the forefront of sample analysis

UPCOMING OPPORTUNITIES

FY 2017

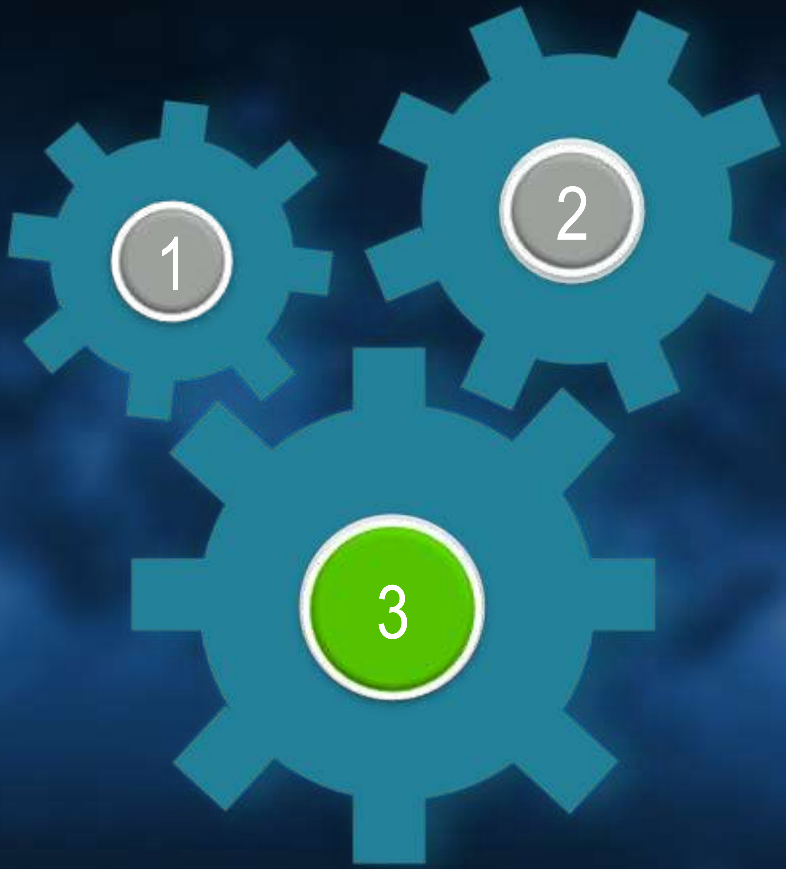
- AO, New Frontiers (Proposals in review)
- ROSES NRA, February 2017 (Released)
- SALMON-3 AO (Released)
- AO, Martian Moons eXploration (MMX) Instrument (Proposals in review)
- AO, STP-5 (IMAP) and Missions of Opportunity, Heliophysics (Released)
- NRA, Earth Venture Suborbital-3, Q4
- PEA (SALMON-3), SIMPLEx-2 for SmallSat Missions of Opportunity, Q4

FY 2018 Planned

- ROSES NRA, February 2018
- AO, STP Missions of Opportunity, Heliophysics, NET Q1
- AO, Heliophysics Explorers (MIDEX) and Missions of Opportunity, NET Q2
- AO, Earth Venture Instrument-5, NET Q2
- NRA, SOFIA Next Generation Instrumentation, NET Q2

FY 2019 Planned

- ROSES NRA, February 2019
- AO, Discovery, Q2
- AO, Living With a Star (Geospace Dynamics Constellation) and Missions of Opportunity, NET Q2
- AO, Astrophysics Small Explorer (SMEX) Missions & Missions of Opportunity, NET Q3
- AO, Earth Venture Instrument-6, NET Q4
- AO, Earth Venture Mission-3, NET Q4



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NASA'S LARGE, STRATEGIC MISSIONS REPORT: RECOMMENDATIONS

MISSIONS

- NASA should continue to plan for large strategic missions as a primary component for all science disciplines as part of a balanced program that also includes smaller missions (see Chapter 1)

WIETR Charter and Purpose

Terms of Reference Questions

The WIETR panel was charged by NASA SMD Associate Administrator Thomas Zurbuchen to conduct an assessment of the WFIRST Project that addressed the following questions:

A. Are the technical requirements understood and reasonable?
   a. Are the technical requirements aligned with the mission's science goals?
   b. Are there any (obvious) science/technical requirements descopes that the Project should consider that could result in acceptable science return as well as lower cost, earlier launch, or reduced risk?

B. Are the scope and cost/schedule understood and aligned?
   a. What is the likely range of probable cost and schedule, and what are the drivers?
   b. How do non-optimal funding profiles affect the cost/schedule of the mission? What is the impact of staying within the funding profile guidelines and KDP-A total cost guidelines?
   c. Are there any (obvious) design/acquisition/technical trades that the Project should conduct that could result in lower cost, earlier launch, reduced cost of science and mission operations, or reduced technical risk?

C. Are the management processes in place adequate for a project of this scope and complexity?

D. Are the benefits of the coronagraph to NASA objectives commensurate with the cost and cost risk of development?
   a. Are the science/technical requirements, resource (budget, schedule) allocation, and risk posture appropriate for a technology demonstration instrument?
   b. Does the technology demonstration require a space mission?
   c. What are the cost and schedule savings (if any) of removing the coronagraph from the mission at this stage?

WIETR Panel Membership/Consultants

Member	Affiliation
Peter Michelson	Co-Chair – Stanford Univ/CTS
Orlando Figueroa	Co-Chair – NASA Retired/CTS
Dan Woods	Executive Secretariat – NASA SMD
Bob Bitten	Aerospace Corp
Roger Brissenden	Harvard-Smithsonian/CTS
David Charbonneau	Harvard-Smithsonian/CTS
Eileen Dukes	CTS
Daniel Eisenstein	Harvard-Smithsonian/CTS
Dave Kusnierkiewicz	Applied Physics Laboratory
William Green	Caltech – Retired/CTS
Lynne Hillenbrand	Caltech
Anne Kinney	W.M. Keck Observatory/CTS
James Lloyd	Cornell University/CTS
Dimitri Mawet	Caltech/CTS
Gary Rawitscher	NASA SMD
Mark Saunders	NASA – Retired/CTS
Pete Theisinger	Jet Propulsion Laboratory – Retired/CTS

Consultants	Affiliation
Bob Kellogg	Aerospace Corp
Eleanor Ketchum	National Reconnaissance Office
Tom Magner	Applied Physics Laboratory
Michael Paul	Applied Physics Laboratory
Justin Yoshida	Aerospace Corp
Joan Zimmermann	Ingenicomm, Inc.

Key WIETR Findings-1

- The WFIRST planned science surveys program and system design offer groundbreaking and unprecedented survey capabilities to the Dark Energy, Exoplanets, and Astrophysics communities.
- The WFIRST team has done a considerable amount of work for a project that has yet to enter KDP-B, particularly in areas that minimize development and cost risk; key processes for execution and control are in place, and the science and mission system concepts are mature.
- The WFIRST Project and Subsystem Management, Science, Systems Engineering, and Business Management personnel are very experienced, including in the management of large/flagship missions, and have the necessary skills to lead a mission of the level of complexity of WFIRST.
- The WFIRST Project has been methodical, thorough, and inclusive in the analysis and derivation of the science and corresponding technical and data requirements, however, additional work is needed to: 1) negotiate and codify them clearly and unambiguously, 2) include Programmatic Direction that should be codified as Level 1 requirements; and 3) develop a plan to comprehensively validate them.
- The Wide-Field Instrument (WFI) is the primary instrument of WFIRST; a tremendous science capability that will be substantially more capable than Euclid, far better than HST or JWST, and well beyond what is possible from the ground in the conduct of faint infrared surveys that remain of high science interest.

Key WIETR Findings-2

- NASA has made a series of decisions (most notably: the 2.4m telescope, addition of a Coronagraph Instrument (CGI), In-house/Out-of-house or hybrid acquisition strategy, Dual Science Centers, Robotic Servicing, Star Shade) that set boundary conditions and the stage for an approach and mission system design that is more complex than probably anticipated from the point of view of scope, complexity, and the concomitant risks of implementation.

- The CGI Team has made remarkable progress towards advancing technology. Accommodation of the CGI, however, has been one of the mission system design and programmatic drivers. Expectations regarding performance requirements, status as science versus technology secondary payload and concomitant risk classification, science community engagement, interfaces to the Exoplanet Program and its longer term plans, and risk classification, all paint an inconsistent story that is certain to present risks to the primary mission well into the verification and validation program.

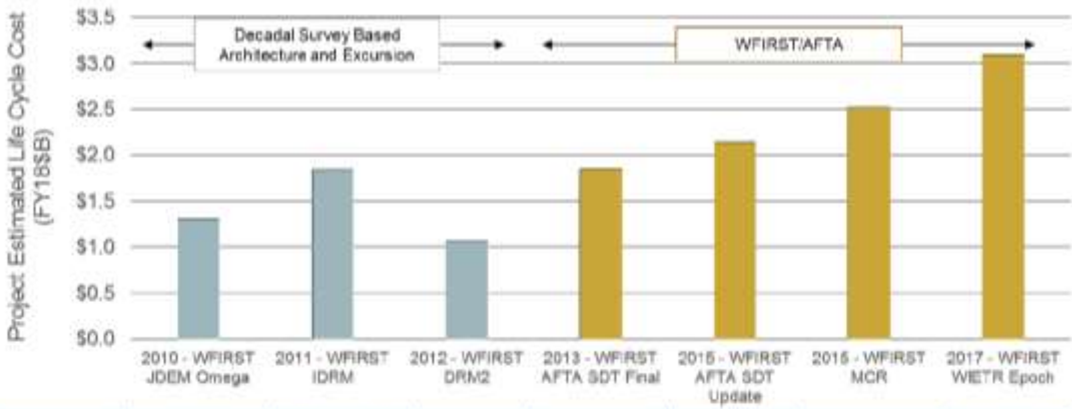
- The Class B risk classification for the WFIRST mission is not consistent with the uniform application of NASA policy for strategically important missions with comparable levels of investment and risks, most if not all of which are Class A missions.

- The management agreement signed at KDP-A for the WFIRST life-cycle cost and the budget profile provided as guidance to the Project are inconsistent with the scope, requirements, and the appropriate risk classification for the mission.

- There is an urgent need (before the SRR/MDR) for NASA to conduct a top-to-bottom cost-benefit assessment to balance scope, complexity, and the available resources.

- The NASA HQ-to-Program governance structure is dysfunctional, and should be corrected for clarity in roles, accountability, and authority.

WFIRST Project's Design Model Costs from Decadal to Current (FY18$B)



Attribute	WFIRST Decadal	WFIRST IDRM	DRM2	AFTA SDT	SDT Update	@ MCR	2017 WFIRST WIETR Epoch
Concept Constraint	Decadal Survey Concept	Follows Decadal Survey	Minimize Cost	Incorporate AFTA Telescope	Add Coronagraph	Same Architecture	Same Architecture
Telescope dia	1.5 m	1.3 m	1.1 m	2.4 m	2.4 m	2.4 m	2.4 m
Payload Complement	NIR/Vis imager, NIR Spec + FGS	NIR/Vis imager, NIR Spec + FGS	NIR imager/Spec + FGS	NIR imager/Spec + IFC-Spec	NIR imager/Spec, IFC-Spec, AGS + Coronagraph	NIR imager/Spec, IFC-Spec, AGS + Coronagraph	NIR imager/Spec, AGS + Coronagraph
Orbit	L2	L2	L2	Inclined GEO	Inclined GEO	L2	L2
Serviceable?	No	No	No	Yes	Yes	Yes	Yes
Dry Mass	2,424 kg	2,336 kg	1,868 kg	4,520 kg	4,861 kg	6,877 kg	7,324 kg
Launch Veh.	Atlas V 511	Atlas V 511	Falcon 9 v1.1	Atlas V 541	Delta IV-Heavy	Delta IV-Heavy	Falcon 9-Heavy
Lifetime	5 years	5 years	3 years	5 years	5 years	6 years	5 years

NOTES:

1. The bar chart is provided to illustrate the evolution and differences in scope and other parameters.
2. All estimates prior to WIETR are based on ideal budget profiles at a pre-Phase A level of maturity.
3. 2010 WFIRST JDEM Omega Cost Analysis and Technical Evaluation estimate was $1.9B (FY18$).
4. The 2017 – WIETR column shows the Budget Option 1, as submitted by the Project in FY17 (PPBE19), which constrains the profile in FY18 and FY19.

WFIRST DIRECTION

- SMD Associate Administrator directed Goddard Space Flight Center to study modifying the current WFIRST design, the design that was reviewed by the WIETR, to reduce cost and complexity sufficient to have a cost estimate consistent with the $3.2B cost target set at the beginning of Phase A

- The following constraints and changes are directed to begin this design modification study *as noted in the next two charts*

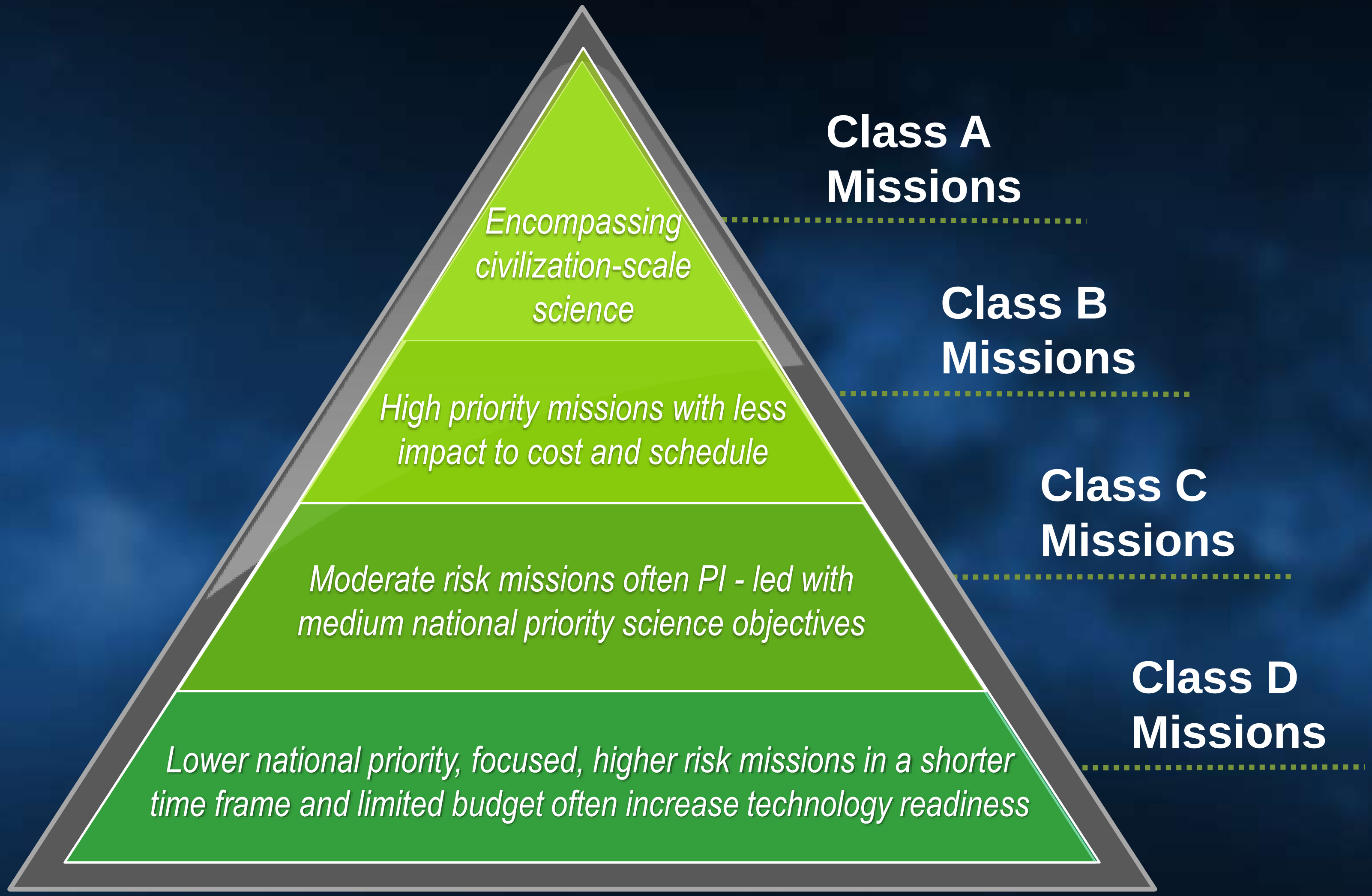
WFIRST DIRECTION (CONT'D)

- The basic architecture of the mission, including the use of the existing 2.4m telescope, a widefield instrument, and a coronagraph instrument, shall be retained
- The implementation of the mission risk classification shall be consistent with the findings of the WIETR report
- Reductions shall be taken in the widefield instrument
- The coronagraph instrument shall be treated as a technology demonstration instrument, consistent with the findings of the WIETR report; in addition, reductions shall be taken in the coronagraph instrument
- The cost of science investigations shall be reduced
- The additional use of commercial subsystems and components shall be considered for the spacecraft; however, serviceability for both the spacecraft and the payload will be retained

WFIRST DIRECTION (CONT'D)

- The modified WFIRST design being studied will still be capable of meeting and exceeding the science priorities set for WFIRST by the 2010 Decadal Survey in Astronomy and Astrophysics
- The WFIRST project and GSFC Center management should plan to report the results of this study at the SRRIMDR in February 2018, in time to support a Key Decision Point-B (KDP-B) Directorate Program Management Council in March or April2018
- In advance of KDP-B, an independent cost assessment will be conducted to validate the estimated cost as being consistent with the $3.2B cost target
- Dr. Paul Hertz, the Director of the Astrophysics Division, will work with GSFC to establish a WFIRST management process consistent with the findings of the WIETR report, that will result in a more interactive relationship, shortening the time to make decisions and reduce cost; will provide a revised budget profile for the WFIRST Project
- If the result of this study is the conclusion that WFIRST cannot be developed using the current 2.4m telescope architecture within the $3.2B cost target, SMD/AA will direct a follow-on study of a WFIRST mission consistent with architecture described by the Decadal Survey

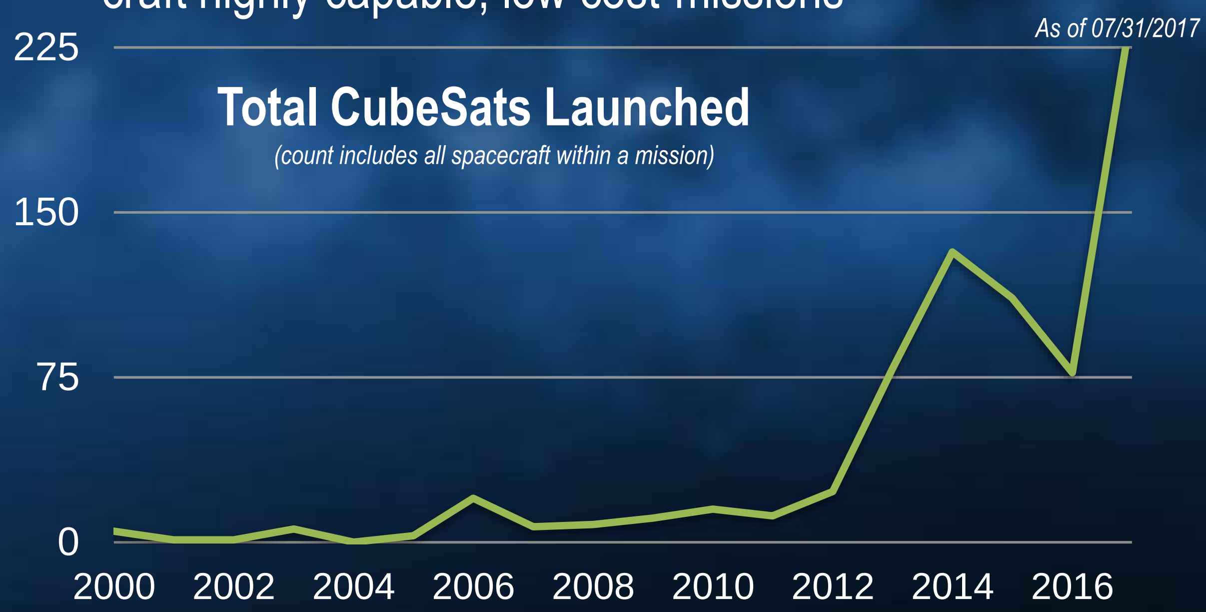
THE VALUE OF A BALANCED SMD PORTFOLIO



NEW CAPABILITIES FOR SCIENCE

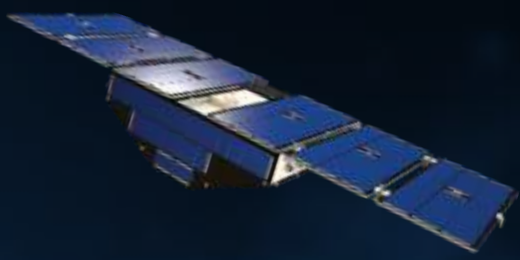
Significant increase in the capabilities of SmallSats/CubeSats over the past 5 years

- Science instruments have been miniaturized
- New, potentially disruptive small satellite platform technologies have advanced
- Industry and academia have exploited these trends to craft highly capable, low cost-missions

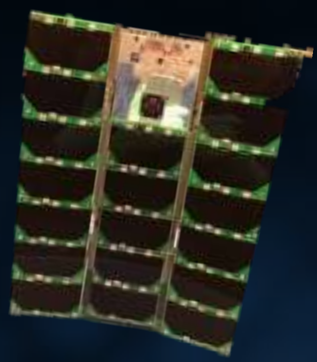


SMALLSATS CREATED NEW MISSION CLASSES

CYGNSS



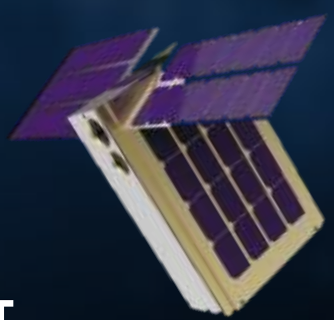
MinXSS



RAVAN

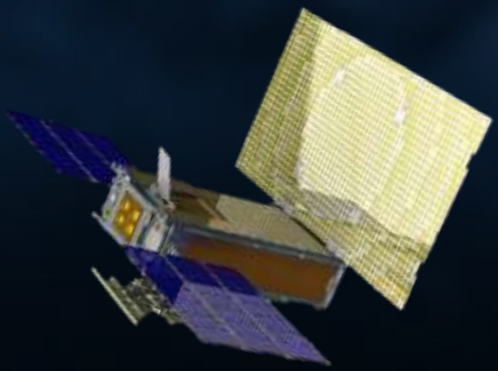
IN FLIGHT

LunaH - Map



TROPICS

MarCO



IN DEVELOPMENT

SMD CLASS-D STRATEGY

Accepting higher risk for scientific gain by implementing a tailored, streamlined classification approach

SMD IMPLEMENTATION

Reviews	Documentation	Performance Measurement
• Lifecycle Reviews conducted by project implementing institution • Only two NASA required reviews during the Project development lifecycle • Delegated Decision Authority • Review Teams as small as practicable	• Only final documentation submitted to NASA HQs for approval; no preliminary documentation • Final Project documentation approved at the Division Director level • Merging documentation encouraged • Tailoring Mission Assurance Requirements (MAR), with a goal to reduce documentation deliverables and reviews	• Formal Earned Value Management (EVM) and a certified EVM system is not required • 7 Basic principles apply: – Plan all work scope to completion using a Work Breakdown Structure (WBS) – Break down work scope into finite pieces specifically assigned for technical, schedule and cost objectives – control – Integrate program work scope, schedule, and cost objectives into performance measurement baseline – Use actual costs incurred and recorded – Assess accomplishments at work performance level – Analyze significant variances, forecast impacts, and prepare estimate at completion based on performance to date and remaining work performed – Use EVMS information in the organization's management processes

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