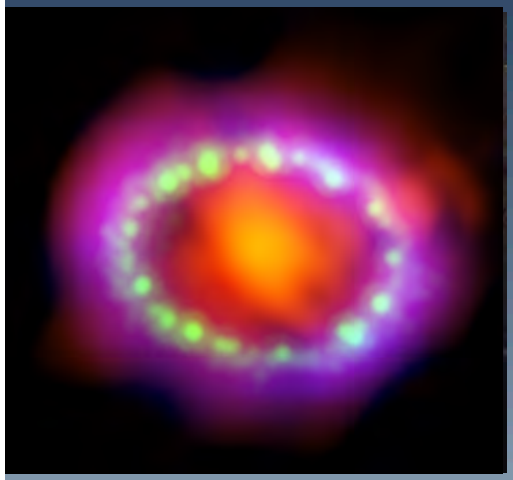
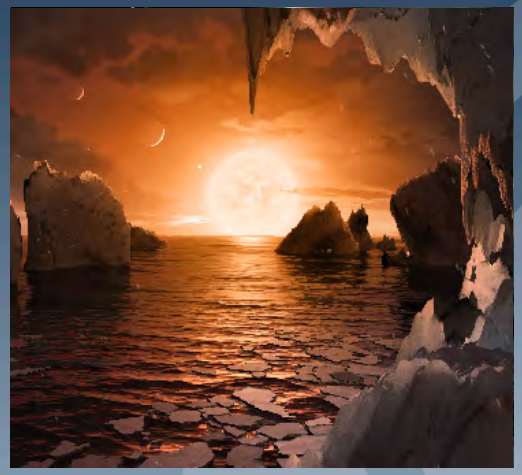
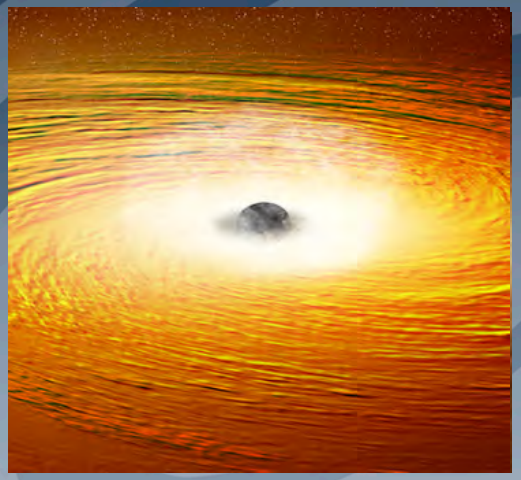
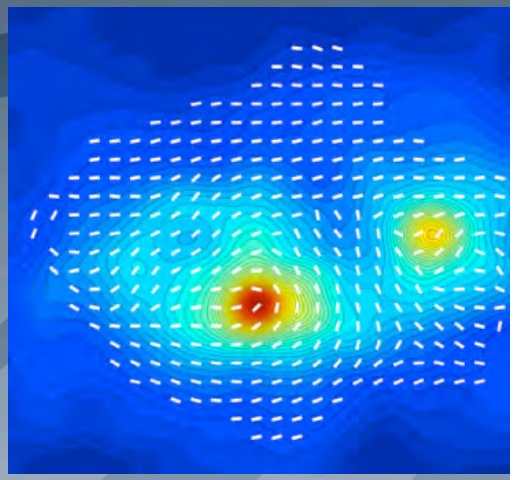
National Aeronautics and Space Administration

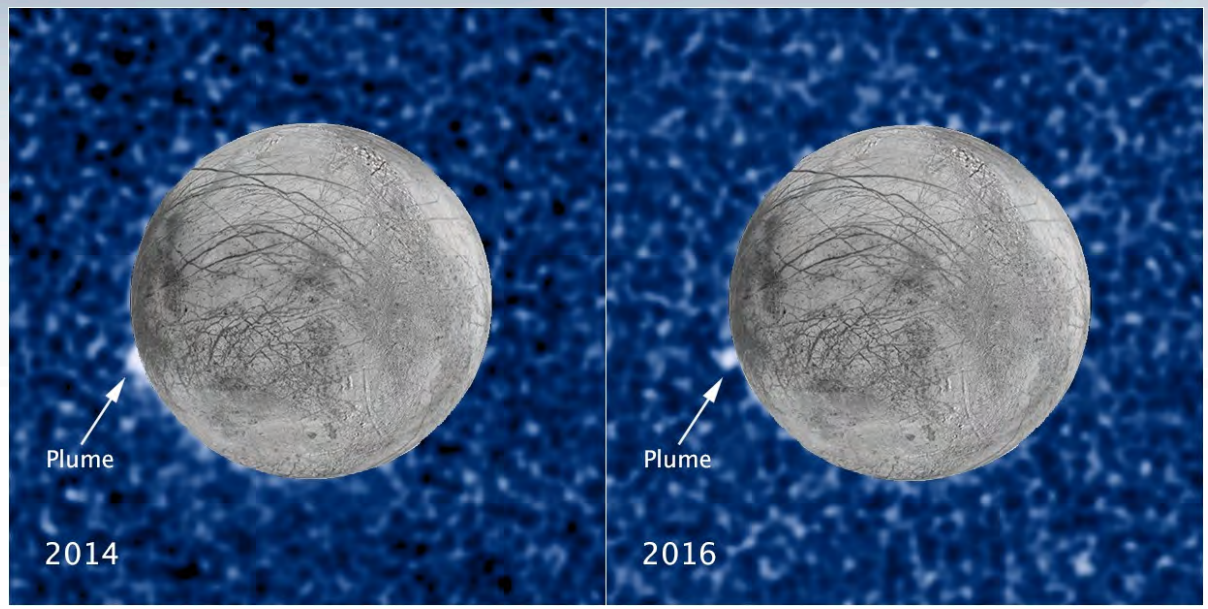
Astrophysics

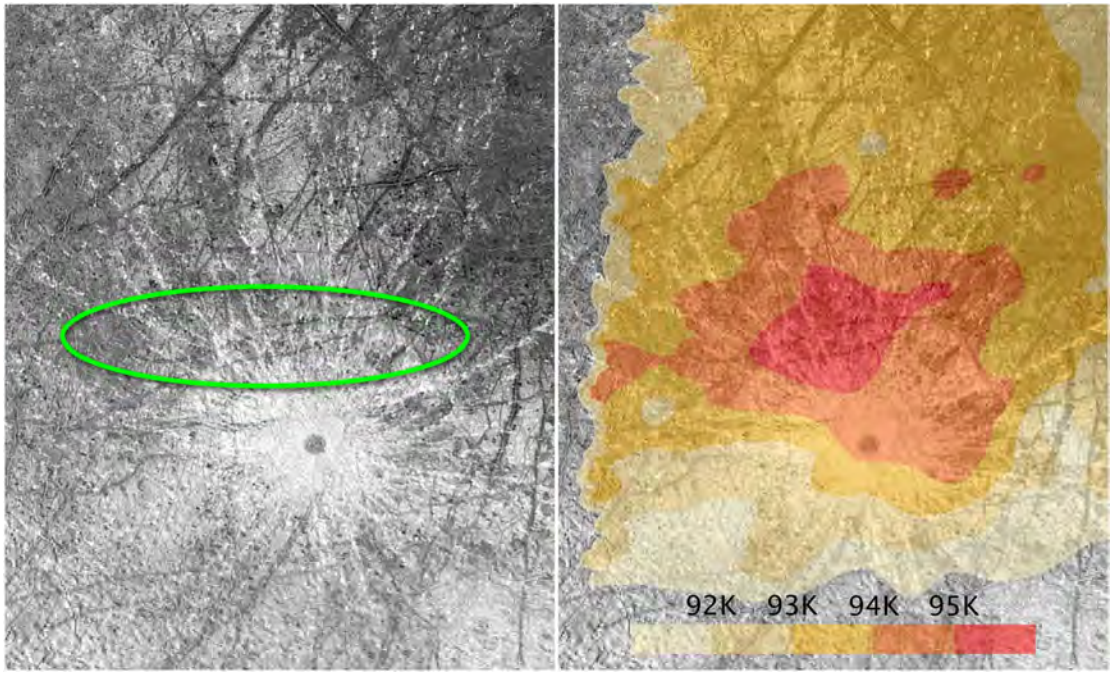
Space Telescope Users Committee
May 4, 2017

Michael Garcia
NASA HQ
HST Program Scientist
APRA, Athena Program Scientist
LUVOIR, IXPE Deputy PS
APRA-UV/Vis Program Scientist
Astrophysics CubeSat POC

Hubble Observes Recurring Plume from Europa

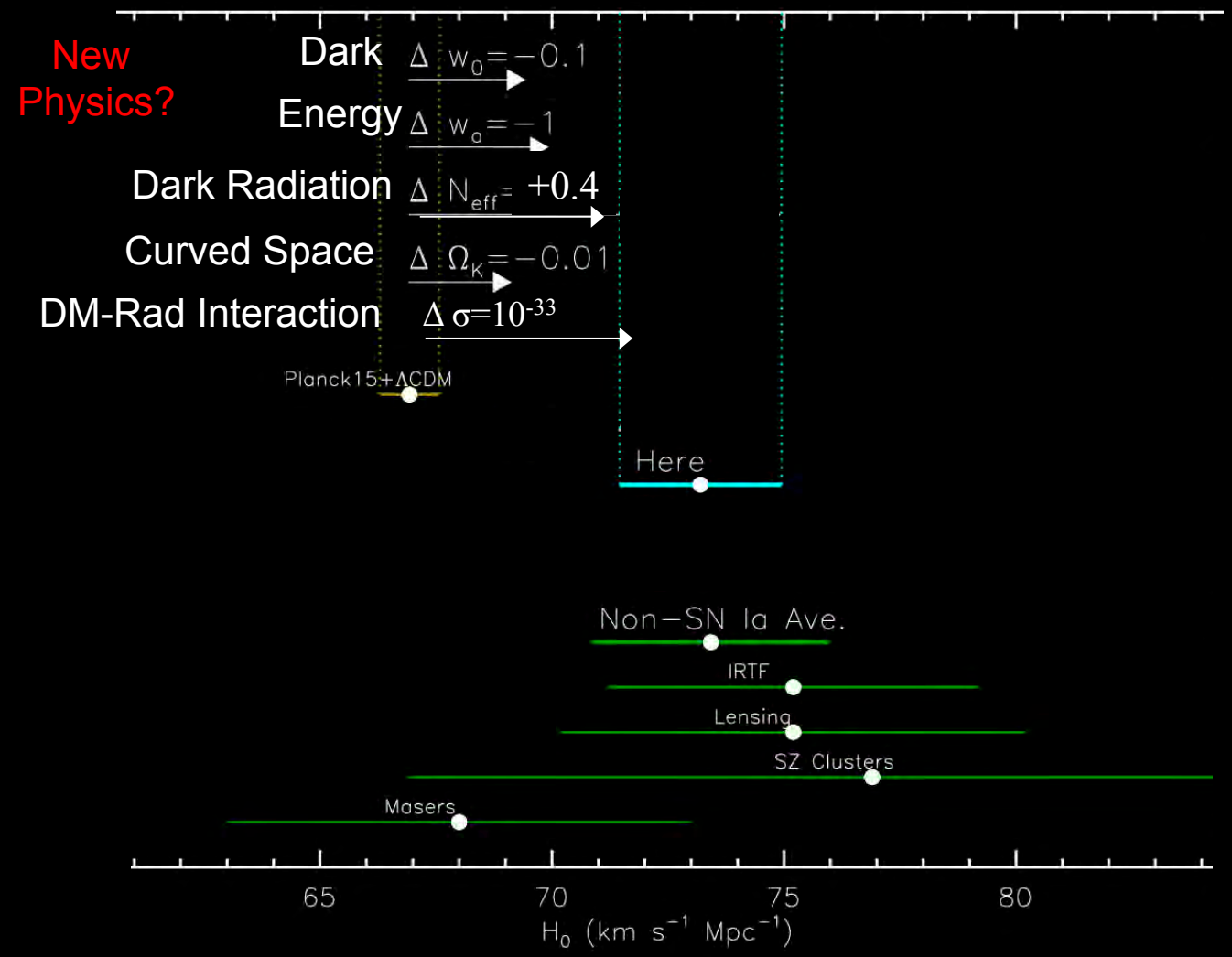


Credits: NASA/ESA/STScI/USGS



Adam Riess – SH0ES, H_0

H_0, Measured vs. Predicted from Initial Conditions (CMB)



- 3.4 σ tension!
- New Physics* ?
- Planck vs WMAP vs I?

* "If a persuasive case can be made that a direct measurement of H_0 conflicts with these estimates, then this will be strong evidence for additional physics beyond the base ΛCDM model. "-Planck Team Paper, 2015

Really Huge!

https://youtu.be/GArzzBiJy-E?t=82

President’s weekly address

NASA Transition Authorization Act of 2017

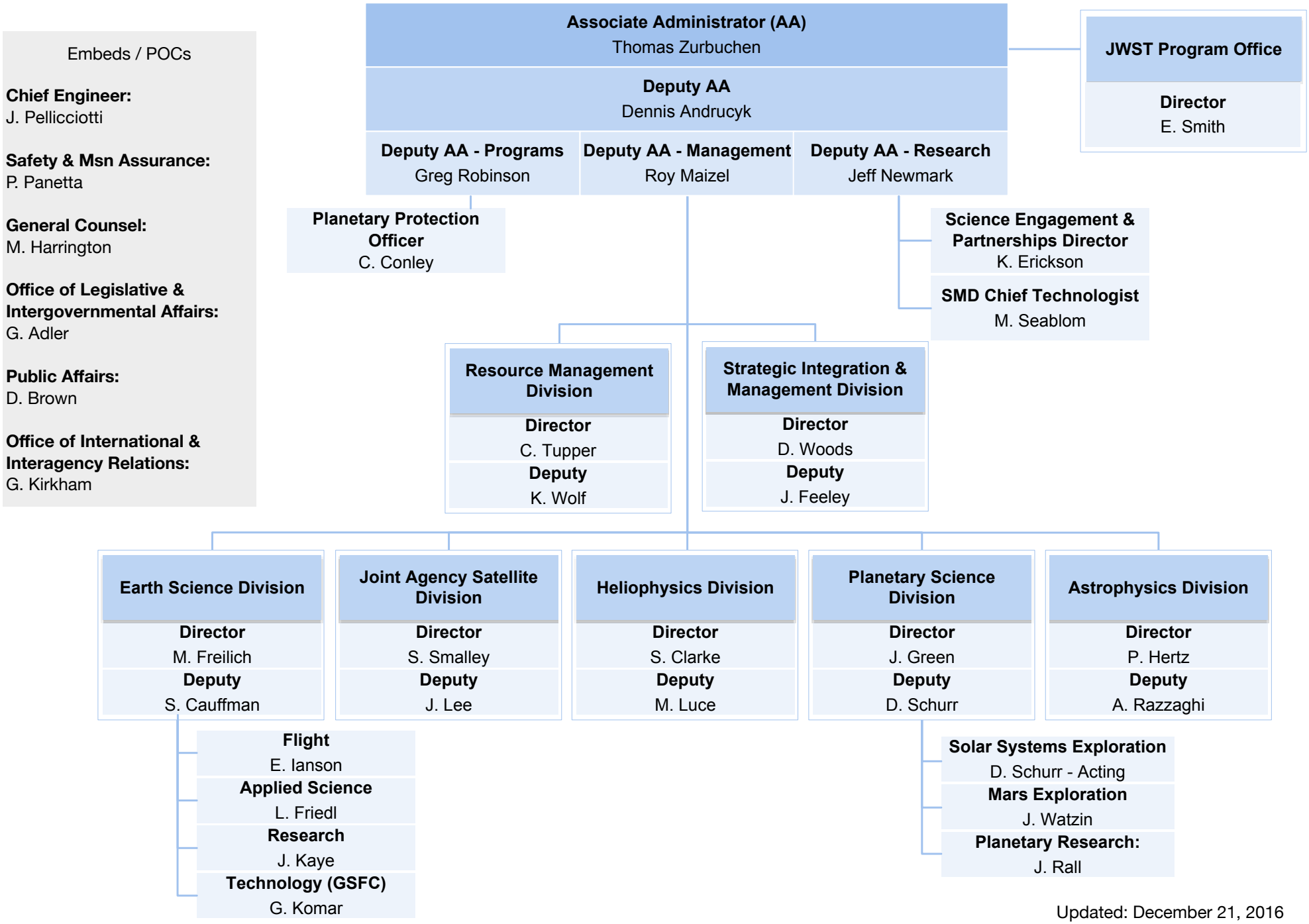
Language relevant to NASA Astrophysics includes:

- Calls for a balanced portfolio of space science missions and directs NASA to **follow the Decadal Survey**, but adjusting "mission priorities, schedule, and scope in light of changing budget projections"
- Notes the value of Webb and includes a requirement that NASA maintain a robust surveillance of the performance and cost of Webb
- Notes the value of the WFIRST mission
- Expands the list of purposes for NASA to include astrobiology
- Requires senior reviews be conducted **every three years** versus the current requirement for every two years
- Forbids NASA from terminating SOFIA before December 31, 2017
- Requires NASA to contract with the National Academies to develop a science strategy for the study and exploration of extrasolar planets; due in 18 months
- Requires NASA to contract with the National Academies to develop a science strategy for astrobiology; due in 18 months

Plus a whole lot of reports

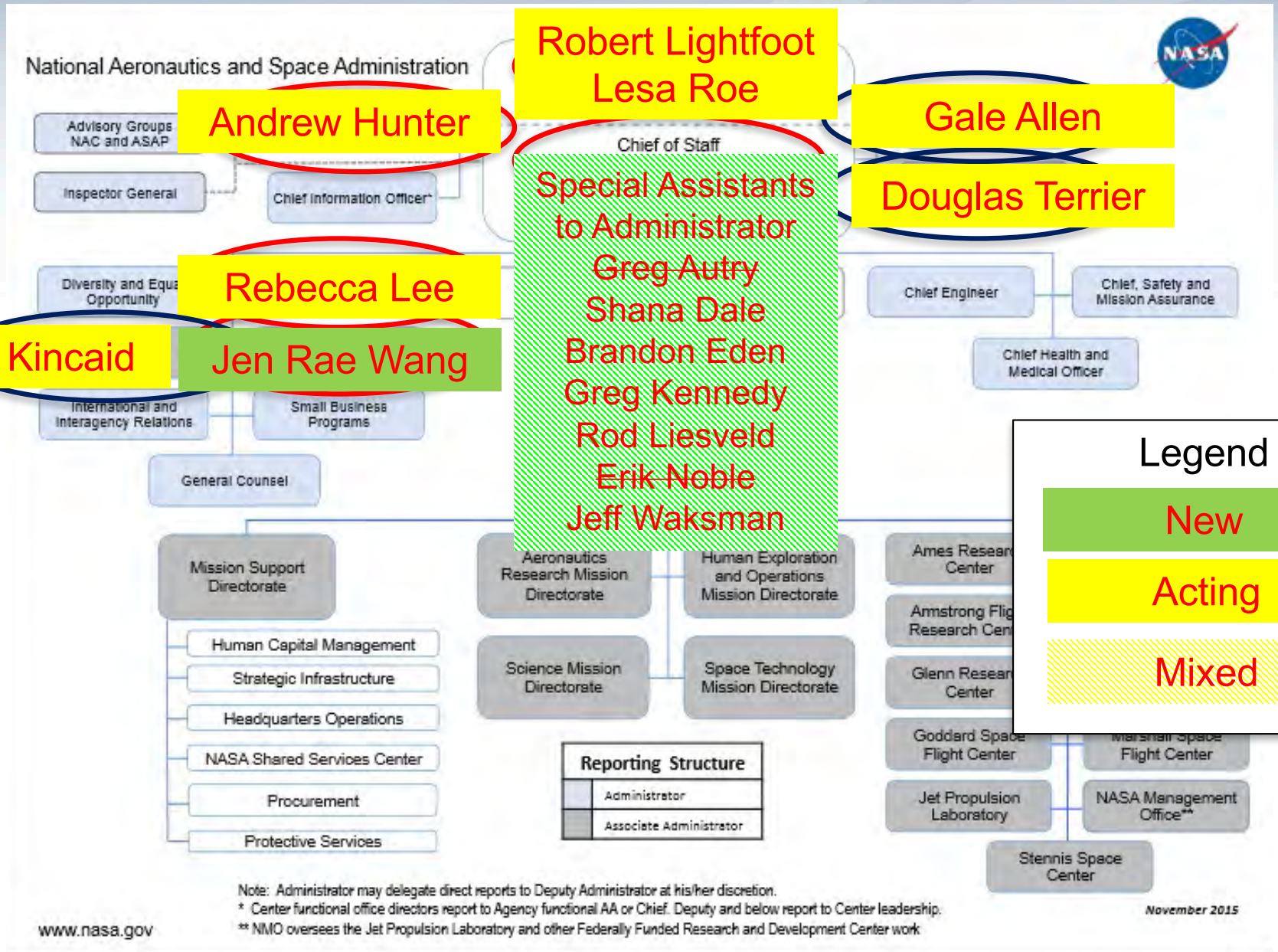
NASA Astrophysics

Big Picture



Updated: December 21, 2016

2017 Transition



FY17 Consolidated Appropriations Bill (H.R. 244)

	FY 2017 Request[2]	FY 2017 Omnibus Conference	Change from FY2016 Enacted	Change from FY2017 Request
NASA TOTAL	19,025.10	19,653.30	368.3	628.2
Science	5,600.50	5,764.90	175.5	164.4
Earth Science	2,032.20	1,921.00	0	-111.2
Planetary	1,518.70	1,846.00	215	327.3
Europa	49.6	275	100	225.4
Astrophysics	781.5	750	-17.6	-31.5
Education[1]	25	37	0	12
JWST	569.4	569.4	-50.6	0
Heliophysics	698.7	678.5	28.7	-20.2

FY17 OmniBus and Astrophysics

- HST continues to operate at the top of its scientific productivity.
- HST has strong support inside and outside NASA.
- NASA will continue to operate HST as a Great Observatory as long as it is technically capable.
- NASA expects HST to continue producing great science until 2020 and beyond, enabling overlap with JWST.

- BUDGET Realities:
- FY17 CR and FY18 skinny budget are ~flat for Astrophysics.
- FY17 OmniBus increases NASA by $600M to $19.6B, but is a cut of $31.5M to Astrophysics relative to request.
- FY17 OmniBus has increase of $1M to HST ($97.3 -> $98.3).
- HST has a large 'un-costed' amount of funding: a standout in APD.
- Our new administration is focused on cost savings.
- *Lean Forward!* HQ has challenged the Project (GSFC) to find ways to spend down this large un-costed, while maintaining the current level of operations.

Future Budget Outlook

- In era of flat resources, how do we adjust to the large JWST GO program in FY20 and beyond?
- We are committed to the JWST GO program to realize the science of JWST.
- Current balance of R&A (tech devel = seed corn) to GO (harvest) is healthy.
- We are looking at maintaining this balance between all parts of APD, including GO, R&A, building missions, operating missions, Explorers, etc. This could imply a reduction in non-JWST GO programs.

NASA Astrophysics

Research and Analysis Update

ROSES-2017 Astrophysics R&A Elements

Supporting Research and Technology

- Astrophysics Research & Analysis (APRA)
- Strategic Astrophysics Technology (SAT)
- Astrophysics Theory Program (ATP)
- Theoretical and Computational Astrophysics Networks (TCAN)
- Exoplanet Research Program (XRP)
- Roman Technology Fellowships (RTF)

Data Analysis

- Astrophysics Data Analysis (ADAP)
- GO/GI programs for:
  - Fermi
  - Kepler/K2
  - Swift
  - NuSTAR
  - TESS
  - XMM

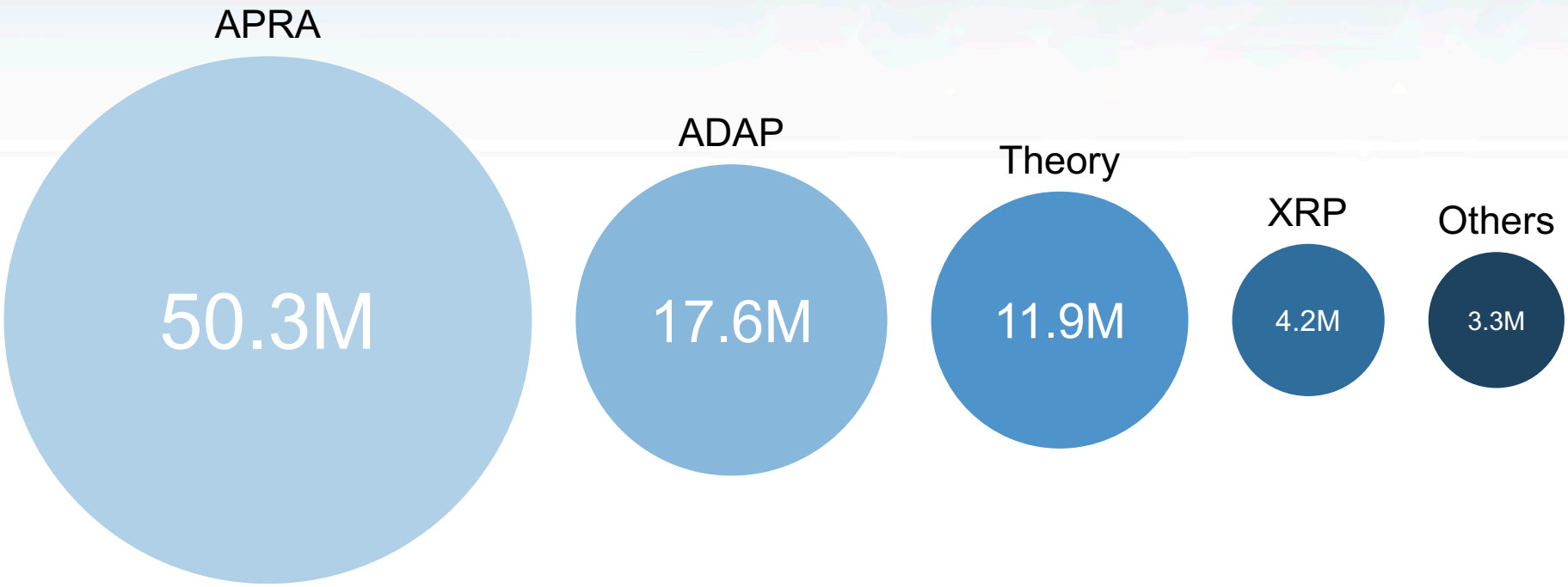
Mission Science and Instrumentation

- SOFIA next-generation instrumentation
- Sounding rocket, balloon, cubesat, and ISS payloads through APRA

Separately Solicited

- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Spitzer
  - Webb
- Postdoctoral Fellowships (Einstein, Hubble, Sagan)
- Graduate Student Fellowships (NESSF)

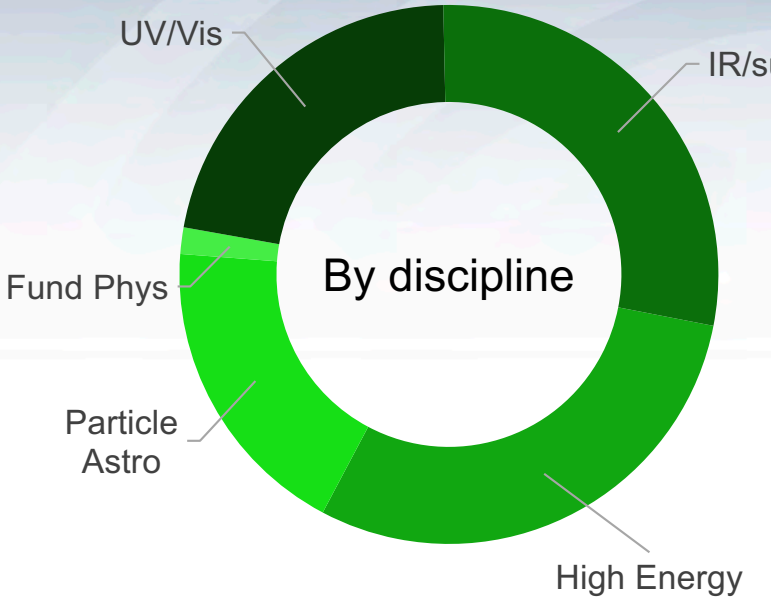
FY16 Spending Summary

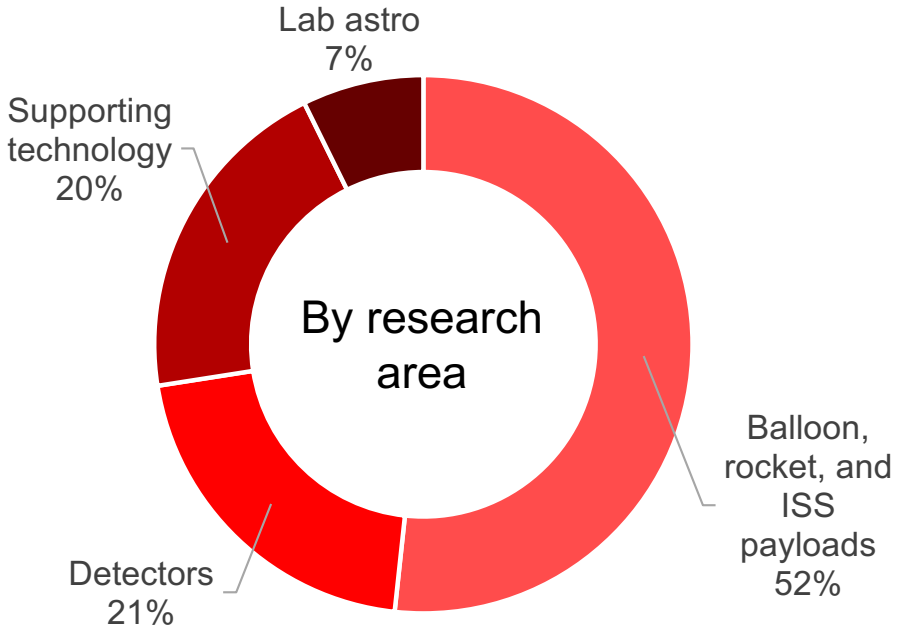


FY16 Spending Summary

APRA

50.3M



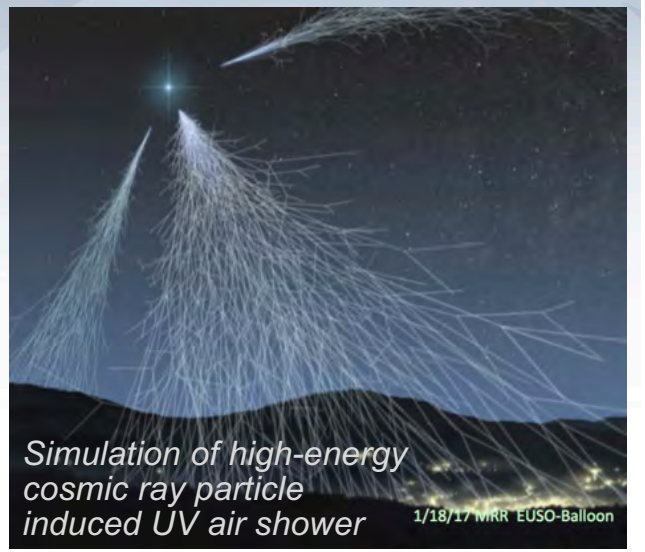


NASA Astrophysics Postdoctoral Fellowships
Einstein, Hubble, and Sagan Fellowships

- The balance in $$ between research grants & the postdoctoral fellowships program has changed from 10:1 to 6:1 over the last decade. With the proposed changes we will restore this balance and increase funding to R&A.
- Starting with the Call for Proposals in CY 2017, the total number of new fellows chosen annually will be reduced from ~33 per year to ~24 per year.
  - Frees up additional ~$6M for R&A after fully implemented
- The ~24 new fellows will be selected so that the science done by the fellows will span the entire breadth of NASA astrophysics.
- There will be **one** application for the fellowship program (as opposed to three separate ones in the past).
- There will be a **single joint review** (as opposed to three separate reviews in the past) of the applications to be held in the Washington DC area annually.
- Details of the implementation plan are being worked out now.

Extreme Universe Space Observatory (EUSO) on a Super Pressure Balloon (SPB)

- First experiment ever to observe individual Ultrahigh Energy Cosmic Rays from near top of the atmosphere using air fluorescence. Ultimate goals: Discover the most energetic astrophysical accelerators; Discover cosmogenic neutrinos; Study particle interactions 10^5-10^9 times accelerator energies.
- **EUSO-SPB Science Team**
  - PI: Angela V. Olinto, University of Chicago.
  - NASA Institutions: University of Chicago, Colorado School of Mines, MSFC, UA Huntsville, CUNY.
  - Contributions from JEM-EUSO Collaborations in Italy, France, Germany, Japan, Poland, Mexico.
- **Refractor Telescope 1.2 m x 1.2 m x 3 m; 1020 kg.**
  - Lightweight Fresnel Lenses with wide Field of View (11°)
  - Ultrafast UV camera (2,304 pixels multi-anode photomultiplier tube images every 2.3 micro-seconds.
  - Energy Threshold: ~ EeV (10^{18} eV).
  - Ground equivalent Trigger Aperture ~500 km^2 sr @ 10 EeV.
  - Data 0.2 Hz trigger; ~ Gb/day downlink; ~3 GB/Day w/ 10 hour darkness.
  - Infrared Camera for cloud monitoring.
- **Ready for launch March 25, 2017 from Wanaka, New Zealand.**
  - Authority-to-Proceed meeting Mar 22.



Simulation of high-energy cosmic ray particle induced UV air shower

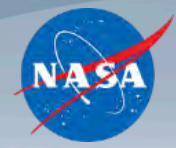

EUSO-SPB at hang test in Palestine, TX 2016-11-19

SMD CubeSat/SmallSat Approach

- A National Academies Report (2016) concluded that CubeSats have proven their ability to produce high-value science. In particular, CubeSats are useful as targeted investigations to augment the capabilities of larger missions or to make a highly-specific measurement. Constellations of 10-100 CubeSat/SmallSat spacecraft have the potential to enable transformational science.

- SMD is developing a directorate-wide approach that has four objectives:
  - Identify high-priority science objectives in each discipline that can be addressed with CubeSats/SmallSats
  - Manage program with appropriate cost and risk
  - Establish a multi-discipline approach and collaboration that helps science teams learn from experiences and grow capability, while avoiding unnecessary duplication
  - Leverage and partner with a growing commercial sector to collaboratively drive instrument and sensor innovation

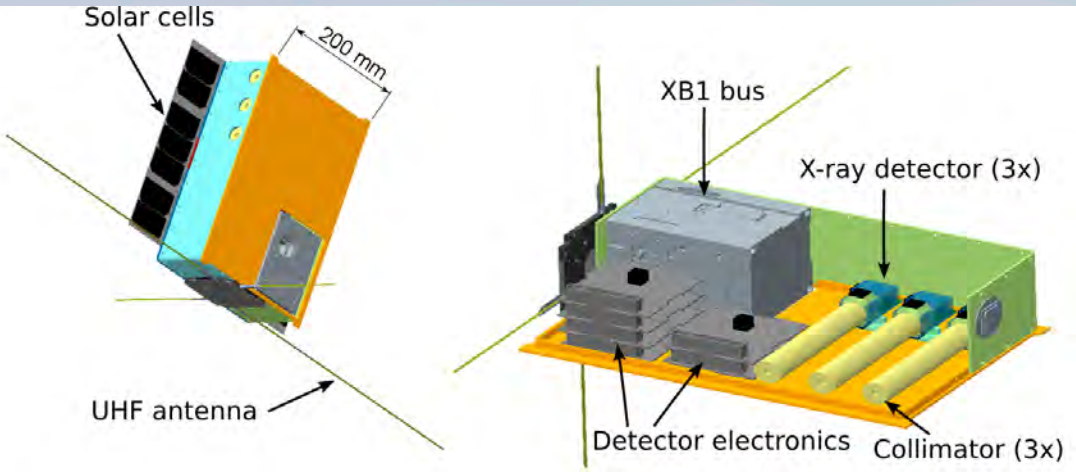
Astrophysics CubeSat/SmallSat Approach



- Astrophysics CubeSats are solicited annually via ROSES/APRA (D.3).
- CubeSats are reviewed along with other sub-orbital proposals; they compete with balloons and sounding rockets (and potentially ISS attached payloads).
- The largest CubeSats that are eligible for CSLI (=launch at no cost to PI) are 6U.
- Astrophysics shares in the SMD wide appropriation for CubeSats.
- Over the past 4 years we have received ~10 CubeSat proposals/year; 2 have been selected.
- Overall selection rate within APRA is ~25%, CubeSats is ~5%.
- Are larger CubeSats possible in future?

HaloSat

A CubeSat to study the hot Galactic Halo



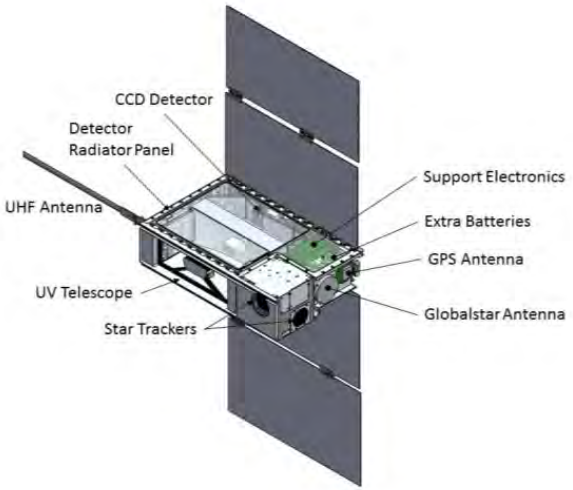
- **PI**: Phil Kaaret, U Iowa, Co-I WFF, GSFC, JHU, CNRS
- **LRD**: 3 years from initiation
- **Science Objectives:** HaloSat will map the distribution of hot gas in the Milky Way and determine whether it fills an extended, and thus massive halo, or whether the halo is compact, and thus does not contribute significantly to the total mass of the Milky Way.
- **Operations**: 2 month min, 1 year goal

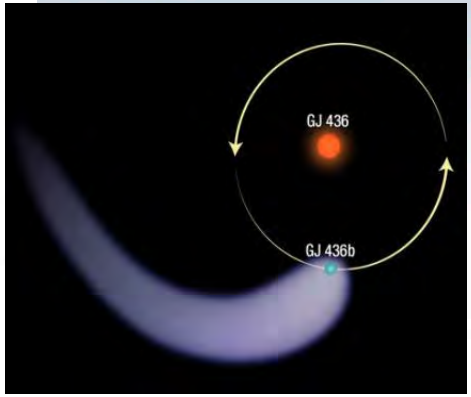
Key Facts:

- **Science**: Constrain the mass and spatial distribution of hot gas associated with the Milky Way by mapping the emission in the O VII and O VIII lines. This goal can be achieved by mapping the summed intensity of the O VII and O VIII lines to derive a total emission measure for each field. Limit background from SWCX via observing only at night.
- **Technologies:** 6U CubeSat advancing science, using COTS technologies. Blue Canyon Technologies bus, WFF design and assembly, Amptex commercial detectors, 100 square degree FOV.
- **Timeline:** APRA-2014 selection, LRD June 2018
- **Orbit**: ISS like.

CUTE

A CubeSat to study atmospheres and B-fields in ExoPlanets





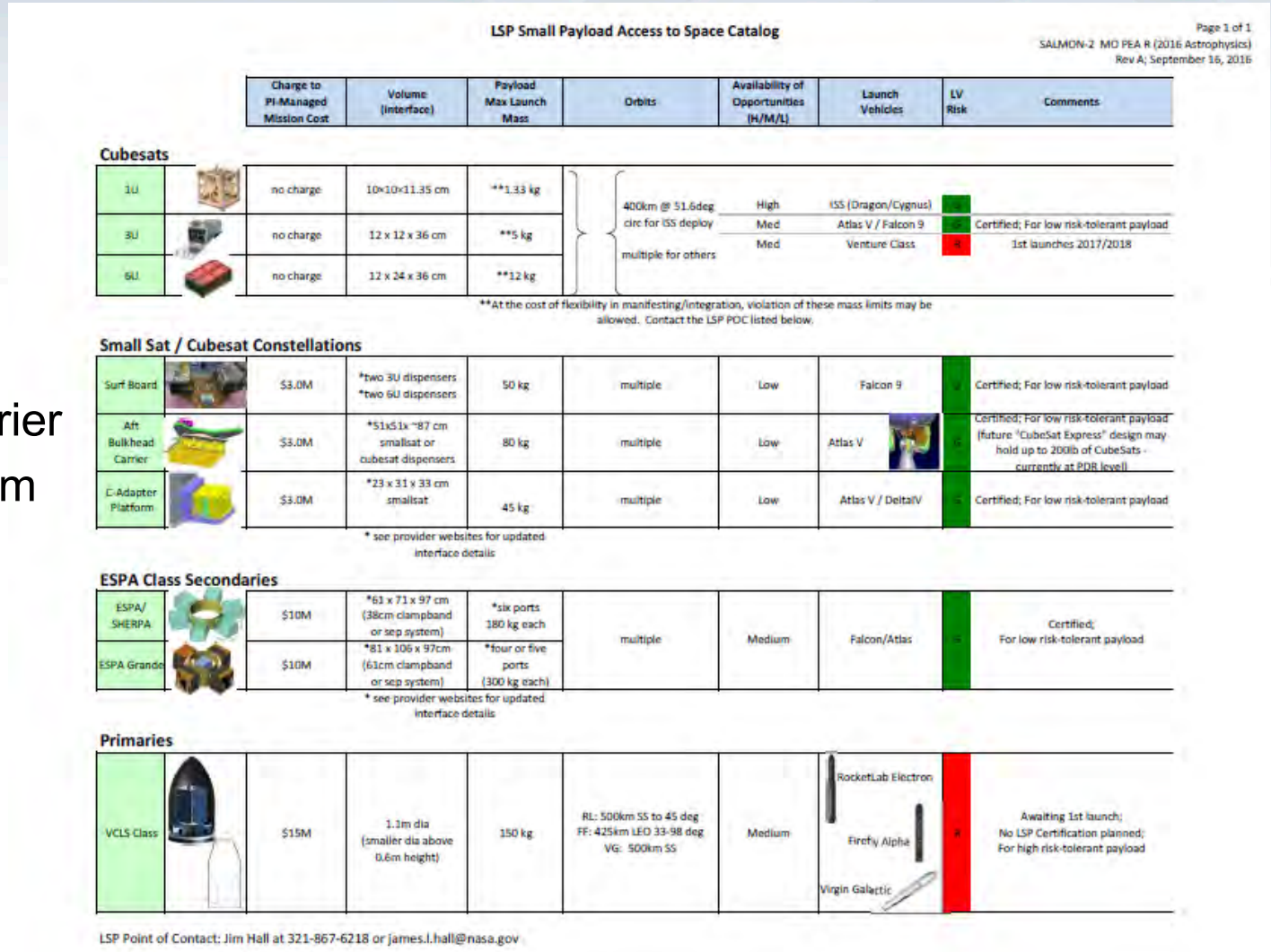
- **PI**: Kevin France, CU, multiple s/r programs, two Helio cubesats at CU.
- **LRD**: 3 years from initiation
- **Science Objectives:** The Colorado Ultraviolet Transit Experiment (CUTE) will take multiple medium resolution UV spectra of hot Jupiters during transit, in order to measure the composition of the atmosphere being ablated away. Magnetic fields may be detected via the presence of tori or bow shocks. 14 targets.
- **Operations**: 1 month minimum, 6 month full survey of 14 exoplanets (2 done to date)

Key Facts:

- **Science**: The atmosphere on two hot Jupiters is observed to be ablating away due to early ingress/late egress in the UV or X-ray. The UV has multiple diagnostic lines which can determine the structure and geometry of the atmospheres. This would be the first UV survey of hot Jupiter atmospheres. This would compliment the sole existing APD cubesat, which is X-ray.
- **Technologies:** 6U CubeSat advancing science, using COTS technologies. Blue Canyon Technologies bus, e2v UV-CCD, exiting cubesat downlink station.
- **Timeline:** APRA-2015 proposal, Selected Feb 2017. LRD mid 2019.
- **Orbit**: ISS like okay, sun synchronous better

Example: Rideshare Catalog
From 2016 Astrophysics Explorers MO Solicitation

- CubeSats
  - 1U, 2U, 3U, 6U
  - Constellations of CubeSats
- Small Sat ?
  - Surf Board
  - Aft Bulkhead Carrier
  - C-Adapter platform
- ESPA Class Secondaries
  - ESPA/SHERPA
  - ESPA Grande
- Nano-Launch/VCLS
  - Virgin/ Launcher-One
  - Rocket Lab



LSP Small Payload Access to Space Catalog

Page 1 of 1
SALMON-2 MO PEA R (2016 Astrophysics)
Rev A; September 16, 2016

		Charge to PI-Managed Mission Cost	Volume (interface)	Payload Max Launch Mass	Orbits	Availability of Opportunities (H/M/L)	Launch Vehicles	LV Risk	Comments
Cubesats									
1U		no charge	10×10×11.35 cm	**1.33 kg	400km @ 51.6deg circ for ISS deploy; multiple for others	High	ISS (Dragon/Cygnus)	G	
3U		no charge	12 x 12 x 36 cm	**5 kg		Med	Atlas V / Falcon 9	G	Certified; For low risk-tolerant payload
6U		no charge	12 x 24 x 36 cm	**12 kg		Med	Venture Class	R	1st launches 2017/2018
Small Sat / Cubesat Constellations									
Surf Board		$3.0M	*two 3U dispensers *two 6U dispensers	50 kg	multiple	Low	Falcon 9	G	Certified; For low risk-tolerant payload
Aft Bulkhead Carrier		$3.0M	*51x51x ~87 cm smallsat or cubesat dispensers	80 kg	multiple	Low	Atlas V	G	Certified; For low risk-tolerant payload (future "CubeSat Express" design may hold up to 200lb of CubeSats - currently at PDR level)
C-Adapter Platform		$3.0M	*23 x 31 x 33 cm smallsat	45 kg	multiple	Low	Atlas V / DeltaIV	G	Certified; For low risk-tolerant payload
ESPA Class Secondaries									
ESPA/ SHERPA		$10M	*61 x 71 x 97 cm (38cm clampband or sep system)	*six ports 180 kg each	multiple	Medium	Falcon/Atlas	G	Certified; For low risk-tolerant payload
ESPA Grande		$10M	*81 x 106 x 97cm (61cm clampband or sep system)	*four or five ports (300 kg each)					
Primaries									
VCLS Class		$15M	1.1m dia (smaller dia above 0.6m height)	150 kg	RL: 500km SS to 45 deg FF: 425km LEO 33-98 deg VG: 500km SS	Medium	RocketLab Electron; Firefly Alpha; Virgin Galactic	R	Awaiting 1st launch; No LSP Certification planned; For high risk-tolerant payload

** At the cost of flexibility in manifesting/integration, violation of these mass limits may be allowed. Contact the LSP POC listed below.

* see provider websites for updated interface details

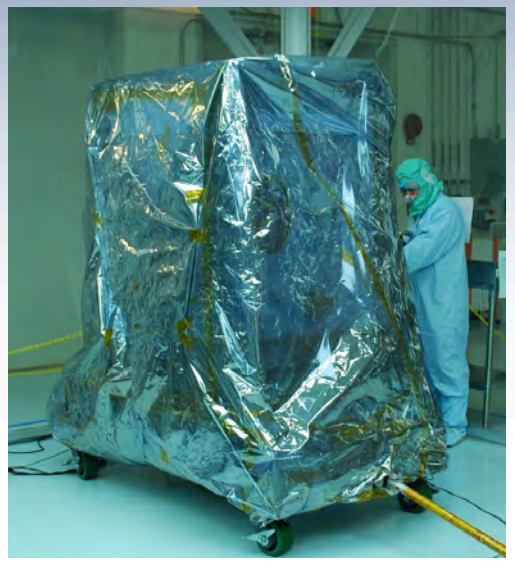
* see provider websites for updated interface details

LSP Point of Contact: Jim Hall at 321-867-6218 or james.l.hall@nasa.gov

NASA Astrophysics

Near Term Launches:

NICER
Neutron star Interior Composition Explorer



NICER in storage at KSC

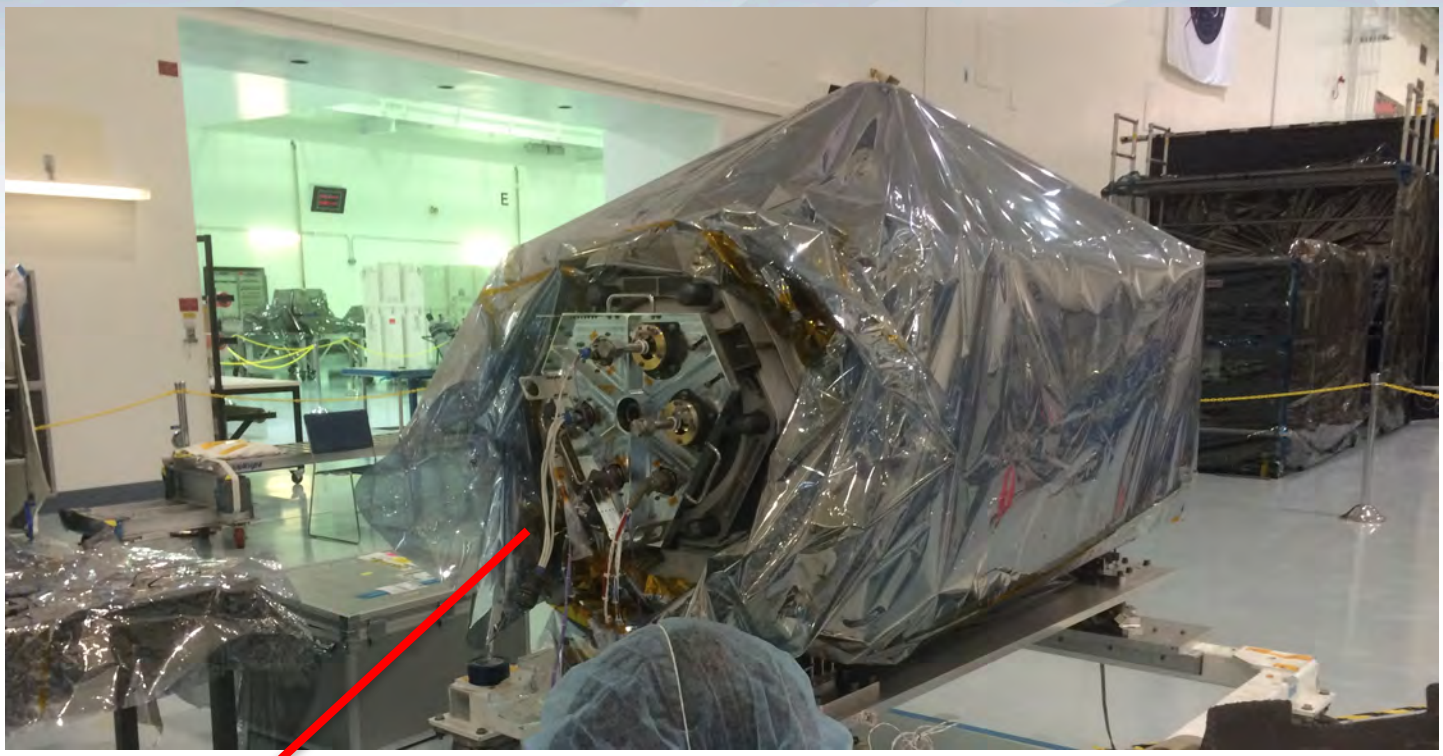
- **Explorer Mission of Opportunity**
- **PI:** Keith Gendreau, GSFC
- **Launch:** June 2017 on Space-X Falcon 9
- **Science Objectives:** Perform high-time-resolution and spectroscopic observations of neutron stars in the .2-12 keV energy range to study the physics of ultra-dense matter in the core of neutron stars.
- **Instrument:** X-ray Timing Instrument uses X-ray concentrators and detectors to detect X-ray photons and return energy and time of arrival.
- **Platform:** Located externally on the ISS, ExPRESS Logistics Carrier 2, Starboard 3 site
- **Operations:** Operated on a non-interference basis for 18 months
- **SEXTANT** for Pulsar navigation demo funded by NASA's Space Technology Mission Directorate

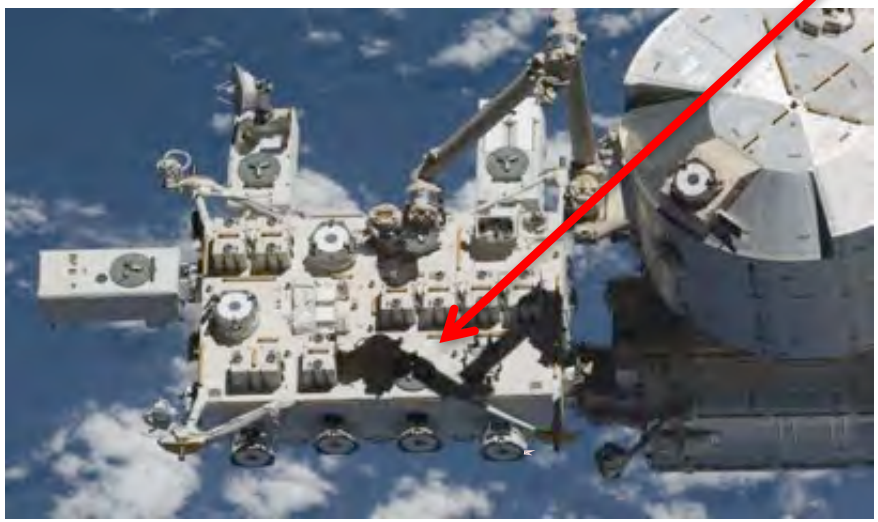
CURRENT STATUS:

- All subsystems/sub-assemblies have completed fabrication and environmental testing ✓
- The NICER payload completed final integration and test ✓
- December 2015: Pre-environmental Review ✓
- January 2016: Start Phase D ✓
- February 2016: Start of payload environmental testing ✓
- April 2016: Completion of payload environmental testing ✓
- June 2016: Payload delivered to KSC and stored at KSC until launch ✓
- April 2017: Handover of payload to Space-X ✓
- June 1 2017 (TBC): Launch on SpaceX-11 commercial resupply service (CRS) flight to ISS

https://heasarc.gsfc.nasa.gov/docs/nicer/

CREAM
Cosmic Ray Energy and Mass



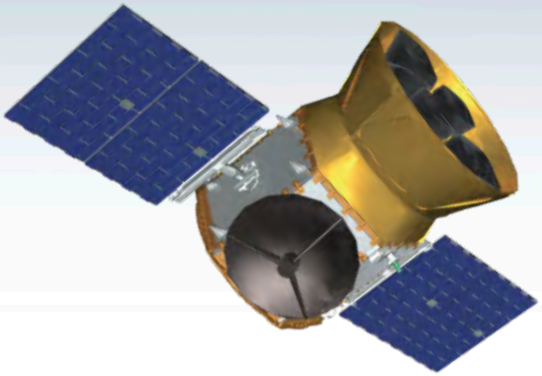


- July 2015: CREAM delivered to KSC and stored at KSC until launch ✓
- August 2017 (TBC): Launch on SpaceX-12 commercial resupply service (CRS) flight to ISS pending review of recent SpaceX pad anomaly.

http://cosmicray.umd.edu/iss-cream/

TESS

Transiting Exoplanet Survey Satellite



CURRENT STATUS:

- Both instrument and spacecraft bus are currently on schedule to be delivered in April 2017 to begin Observatory Integration in May 2017.
- All four flight cameras are assembled, and now in testing.

SCHEDULE:

- May - November 2017 – Observatory integration and test
- late June 2017 – KDP-D
- January 2018 – Delivery to KSC payload processing facility.
- March 2018 – Launch readiness date from Cape Canaveral FL.

Medium Explorer (MIDEX) Mission

PI: G. Ricker (MIT)

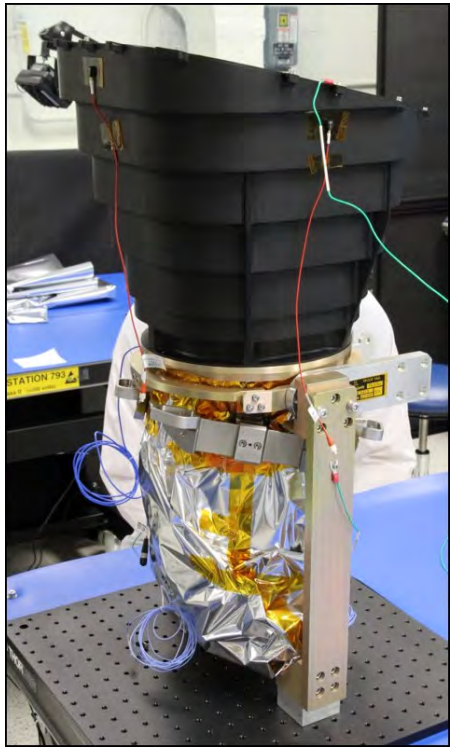
Mission: All-Sky photometric exoplanet mapping mission.

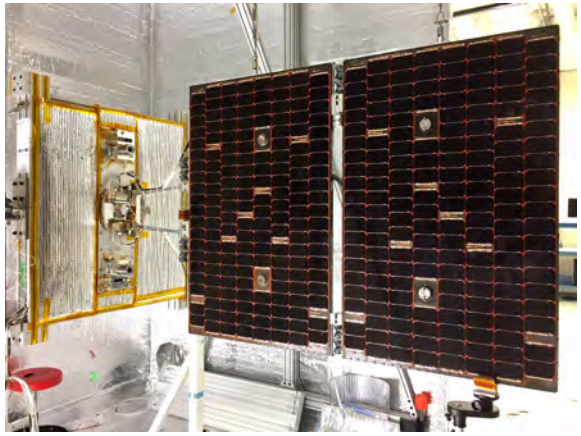
Science goal: Search for transiting exoplanets around the nearby, bright stars.

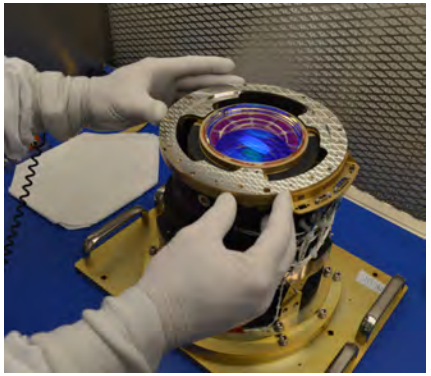
Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view, operating in the Visible-IR spectrum (0.6-1 micron).

Operations: NLT June 2018 launch with a 3-year prime mission including 2 years of spacecraft operations and an additional 1 year ground-based observations and analysis. High-Earth elliptical orbit (17 x 58.7 Earth radii).

http://tess.gsfc.nasa.gov/

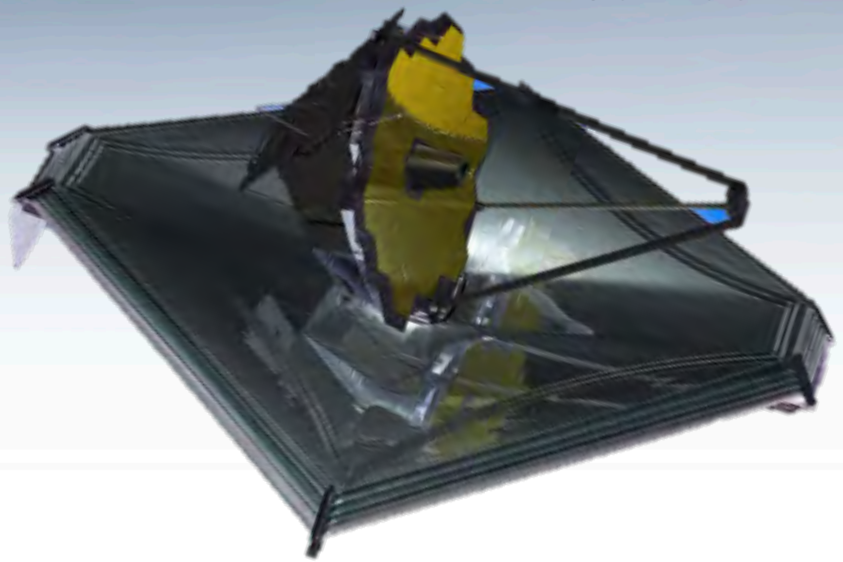






Webb

James Webb Space Telescope



RECENT ACCOMPLISHMENTS:

- Completed spacecraft bus assembly
- Completed ambient testing of combined telescope and instruments
- Issued calls for Early Release Science Notices of Intent

Large Infrared Space Observatory

Top priority of 2000 Decadal Survey

Science themes: First Light; Assembly of Galaxies; Birth of Stars and Planetary Systems; Planetary Systems and the Origins of Life

Mission: 6.5m deployable, segmented telescope at L2, passively cooled to <50K behind a large, deployable sunshield

Instruments: Near IR Camera, Near IR Spectrograph, Mid IR Instrument, Near IR Imager and Slitless Spectrograph

Operations: 2018 launch for a 5-year prime mission

Partners: ESA, CSA

http://jwst.nasa.gov/

JWST remains on track for an October 2018 launch

NASA Astrophysics

Preparing for the 2020 Decadal Survey

HabEx, LUVOIR, Lynx, OST
Large Mission Concept Studies

Astrophysics Probes
Medium-class Mission Concept Studies

Preparing for the 2020 Decadal Survey
Large Mission Concepts

	Community STDT Chairs	Center Study Scientist	Study Lead Center	HQ Program Scientist
Habitable Exoplanet Imaging Mission www.jpl.nasa.gov/habex	Scott Gaudi* Sara Seager	Bertrand Mennesson	JPL	Martin Still
Large UV/Optical/IR Surveyor asd.gsfc.nasa.gov/luvoir	Debra Fischer* Bradley Peterson	Aki Roberge	GSFC	Mario Perez (M. Garcia)
Lynx X-ray Surveyor wwwastro.msfc.nasa.gov/lynx	Feryal Ozel* Alexey Vikhlinin	Jessica Gaskin	MSFC	Dan Evans
Origins Space Telescope asd.gsfc.nasa.gov/firs	Asantha Cooray* Margaret Meixner	David Leisawitz	GSFC	Kartik Sheth

* Astrophysics Advisory Committee member

http://science.nasa.gov/astrophysics/2020-decadal-survey-planning/

Astrophysics Probes

- In August 2016, NASA issued a solicitation requesting proposals for mission concept studies for medium-size missions (Probes)
  - 27 proposals were received on November 15, 2016, spanning a broad range of science disciplines
- The proposals were evaluated by peer review
  - Reviewers evaluated the proposals based on intrinsic science merit, relevance to NASA, value of the study in the context of other studies, and likelihood that the mission concept is Probe-class (<$1B).
  - Each panel was requested to provide general guidelines on how to assemble the Probes portfolio.
  - Panels recommended proposal selection spanning a broad range of science disciplines and mission concepts.
- NASA has selected 10 proposals for mission concept studies involving a PI-led science team and NASA mission design labs at JPL and Goddard.
  - An independent cost assessment of the resulting mission concepts will be conducted by NASA
- The results of the mission concept studies will be provided by NASA to the 2020 Decadal Committee for their consideration

Selected Probe Mission Concept Studies

PI	Affiliation	Short title
Camp, J.	NASA GSFC	Transient Astrophysics Probe
Cooray, A.	Univ. California, Irvine	Cosmic Dawn Intensity Mapper
Danchi, W.	NASA GSFC	Cosmic Evolution through UV Spectroscopy Probe
Glenn, J.	Univ. of Colorado	Galaxy Evolution Probe
Hanany, S.	Univ. of Minnesota	Inflation Probe
Mushotzky, R.	Univ. of Maryland	High Spatial Resolution X-ray Probe
Olinto, A.	Univ. of Chicago	Multi-Messenger Astrophysics Probe
Plavchan, P. *	Missouri State Univ.	Precise Radial Velocity Observatory
Ray, P.	Naval Research Lab	X-ray Timing and Spectroscopy Probe
Seager, S. *	MIT	Starshade Rendezvous Mission

* Partial Selections

The Selection Document and Probes Implementation Plan are posted at
https://science.nasa.gov/astrophysics/2020-decadal-survey-planning

Astrophysics Division, NASA Science Mission Directorate

Resource Management
Omana Cawthon+
Clemencia Gallegos-Kelly+
Debra Mcneill+

Director
Paul Hertz

Deputy Director
Andrea Razzaghi

Lead Secretary: Kelly Johnson
Secretary: Kyle Nero
Program Support Specialist: Jackie Mackall

Cross Cutting
Technology Lead: Billy Lightsey*
Education POC: Hashima Hasan (Lead Comm Team)
Public Affairs Lead: Kartik Sheth
Information Manager: Lisa Wainio*
Strategic Planning: Rita Sambruna

Astrophysics Research

***Program Manager*: Dan Evans**
Program Support: Ingrid Farrell*
Astrophysics Data Analysis: Doug Hudgins
Astrophysics Theory: Keith MacGregor*
Exoplanet Research: Martin Still*
APRA lead: Michael Garcia*
Cosmic Ray, Fund Physics: Thomas Hams*, Vernon Jones, Keith MacGregor*, Rita Sambruna
Gamma Ray/X-ray: Dan Evans, Michael Garcia*, Stefan Immler*, Rita Sambruna,Wilt Sanders
Optical/Ultraviolet: Michael Garcia*, Hashima Hasan, Mario Perez*, Martin Still*
IR/Submillimeter/Radio: Dominic Benford*, Doug Hudgins, Kartik Sheth, Eric Tollestrup*
Lab Astro: Doug Hudgins
Theory & Comp Astro Net: Keith MacGregor*
Roman Tech Fellows: Billy Lightsey*
Data Archives: Hashima Hasan
Astrophys Sounding Rockets: Wilt Sanders
Balloons Program: Vernon Jones(PS), Mark Sistilli (PE)

Programs / Missions & Projects

Exoplanet Exploration (EXEP)

Program	**Doug Hudgins**	**John Gagosian**
Keck	Hashima Hasan	Mario Perez*
Kepler/K2	Mario Perez*	Jeff Hayes
LBTI	Doug Hudgins	Mario Perez*
NN-EXPLORE	Doug Hudgins	Mario Perez*
WFIRST	Dominic Benford*	John Gagosian

Cosmic Origins (COR)

Program	**Mario Perez***	**Shahid Habib**
Herschel	Dominic Benford*	Jeff Hayes
Hubble	Michael Garcia*	Jeff Hayes
SOFIA	Hashima Hasan	Shahid Habib
Spitzer	Kartik Sheth*	Jeff Hayes
Webb^	Hashima Hasan	Ray Taylor^

Physics of the Cosmos (PCOS)

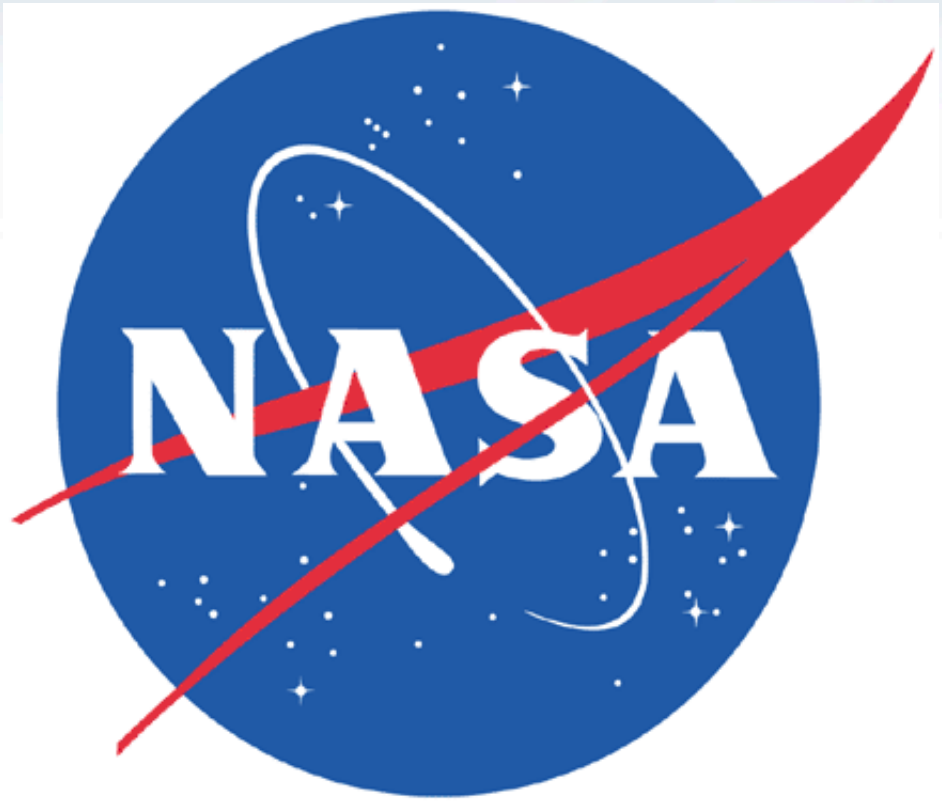
Program	**Rita Sambruna**	**Shahid Habib**
Athena	Michael Garcia*	Jeanne Davis
Chandra	Stefan Immler*	Jeff Hayes
Euclid	Eric Tollestrup*	Shahid Habib
Fermi	Stefan Immler*	Jeff Hayes
Planck	Rita Sambruna	Jeff Hayes
ST-7/LPF	Rita Sambruna	Shahid Habib
XMM-Newton	Stefan Immler*	Jeff Hayes

Astrophysics Explorers (APEX)

Program	**Wilt Sanders**	**Jeanne Davis**
GUSTO	Thomas Hams*	TBD
IXPE	Eric Tollestrup*	Mark Sistilli
NICER	Rita Sambruna	Jeanne Davis
NuSTAR	Lou Kaluzienski	Jeff Hayes
Swift	Martin Still*	Jeff Hayes
TESS	Martin Still*	Mark Sistilli
XARM	Dan Evans	Jeanne Davis

\+ *Member of the Resources Management Division*
* *Detailee, IPA, or contractor*
^ *Webb is part of the JWST Program Office.*

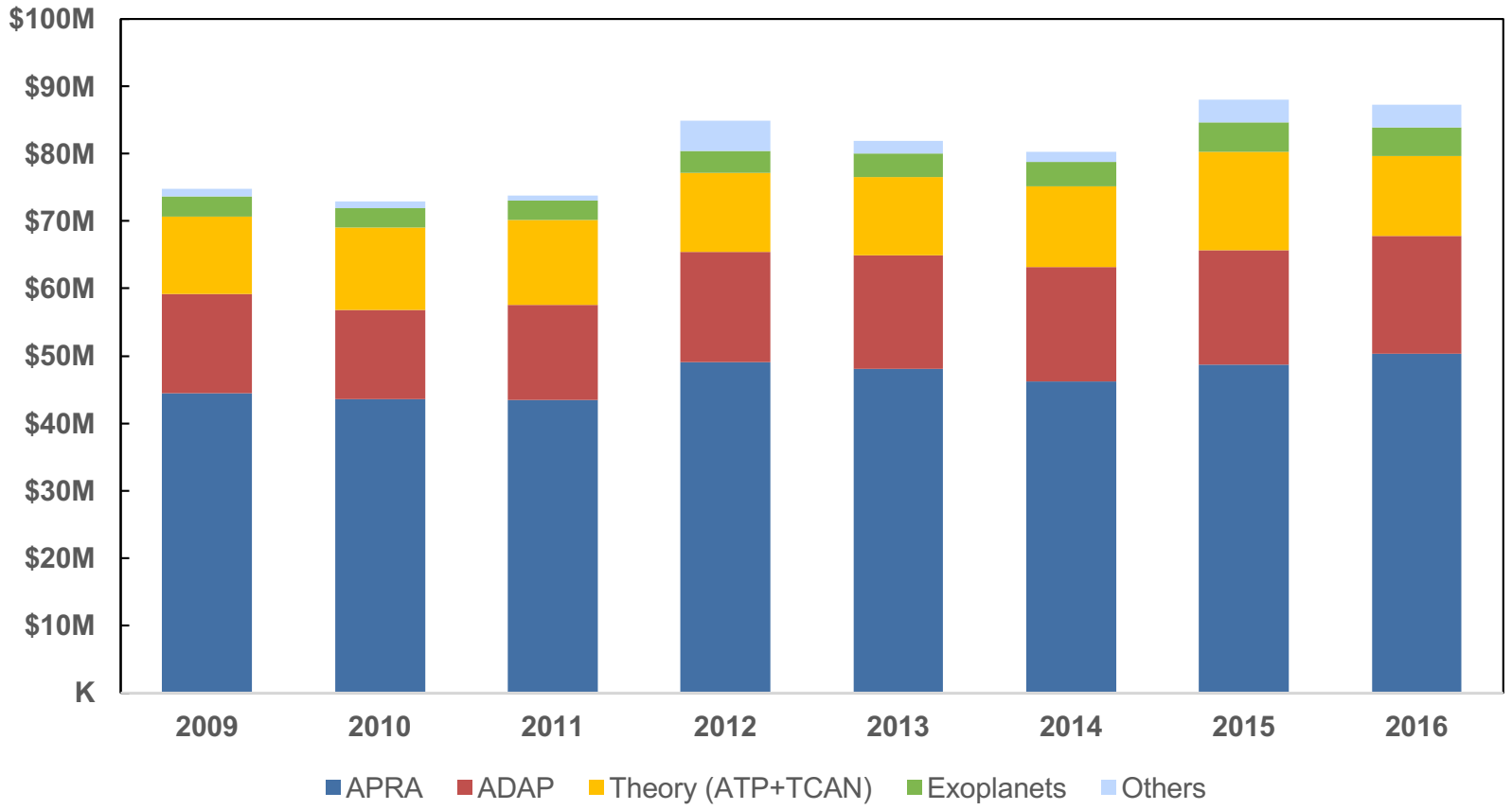
April 10, 2017



Astrophysics Division
Science Mission Directorate
National Aeronautics and Space Administration

Historical Budget Trends

Program	2009	2010	2011	2012	2013	2014	2015	2016
APRA	$44 M	$44 M	$43 M	$49 M	$48 M	$46 M	$49 M	$50 M
ADAP	$15 M	$13 M	$14 M	$16 M	$17 M	$17 M	$17 M	$18 M
Theory (ATP+TCAN)	$11 M	$12 M	$13 M	$12 M	$12 M	$12 M	$15 M	$12 M
Exoplanets (XRP)	$3 M	$3 M	$3 M	$3 M	$4 M	$4 M	$4 M	$4 M
Others	$1 M	$1 M	$1 M	$5 M	$2 M	$1 M	$3 M	$3 M
Total	**$75 M**	**$73 M**	**$74 M**	**$85 M**	**$82 M**	**$80 M**	**$88 M**	**$87 M**



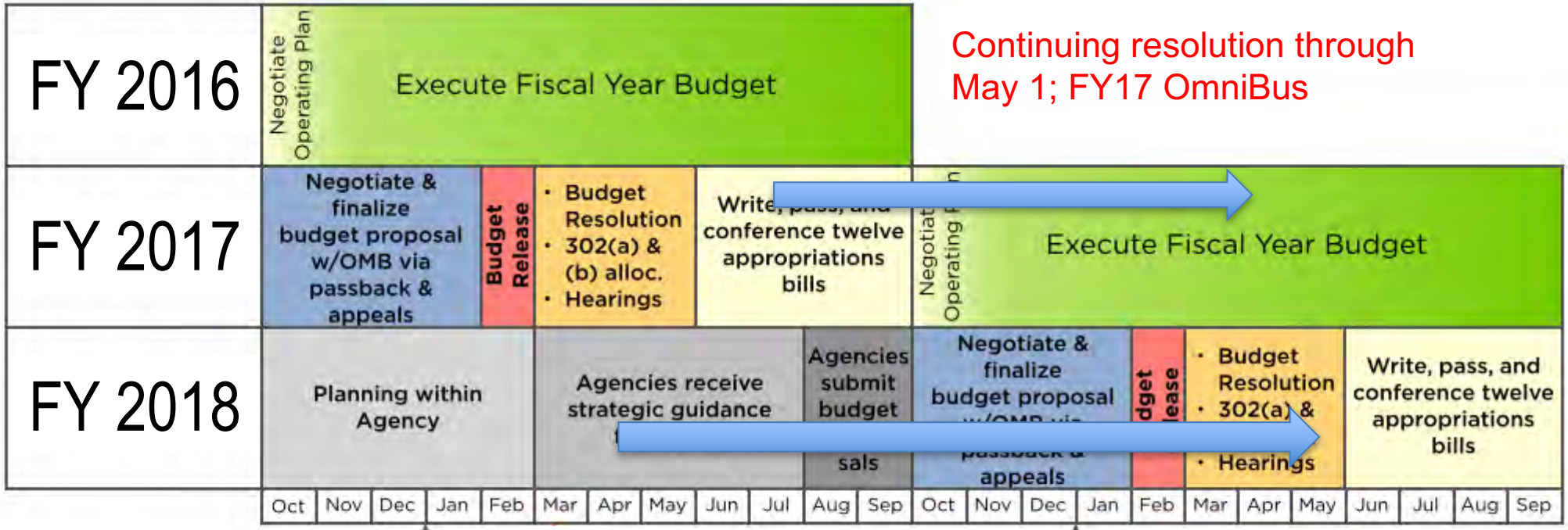
Astrophysics - Big Picture

- **The FY17 continuing resolution and FY17 budget request provide funding for NASA astrophysics to continue its planned programs, missions, projects, research, and technology.**
  - Total funding (Astrophysics including Webb) remains at ~$1.35B.
  - Funds Webb for an October 2018 launch, WFIRST formulation (new start), Explorers mission development, increased funding for R&A, new suborbital capabilities.
  - No negative impact from FY17 continuing resolution (through April 28, 2017).
  - Awaiting full FY18 budget request by new Administration in May 2017.
- **The operating missions continue to generate important and compelling science results, and new missions are under development for the future.**
  - Senior Review in Spring 2016 recommended continued operation of all missions.
  - SOFIA is adding new instruments: HAWC+ instrument commissioned; HIRMES instrument in development; next gen instrument call planned.
  - NASA missions under development making progress toward launches: ISS-NICER (2017), ISS-CREAM (2017), TESS (2018), Webb (2018), IXPE (2020), GUSTO (2021), WFIRST (mid-2020s).
  - Partnerships with ESA and JAXA on their future missions create additional science opportunities: Euclid (ESA), XARM (JAXA), Athena (ESA), L3/LISA (ESA).
  - Explorer AOs are being released every 2-3 years: MIDEX proposals received in December 2016, IXPE downselected in January 2017, GUSTO downselected in March 2017, MIDEX/MO selections in Summer 2017, next AO in 2018/2019.
- **Progress being made toward recommendations of the 2010 Decadal Survey.**
  - National Academies Midterm Assessment Report validates that progress.
  - NASA conducting large and medium mission concept studies for 2020 Decadal Survey.

Responding to the 2010 Decadal Survey
Responding to the Midterm Assessment

Prioritized Recommendation	NASA plans (partial list)
LARGE ACTIVITIES	
WFIRST	In Phase A, launch in mid-2020s, control costs
Explorers	Executing 4 AOs per decade, maintain cadence
LISA	Partnering on ESA's space-based gravitational wave observatory; increased contribution
IXO	Partnering on ESA's Athena x-ray observatory
MEDIUM ACTIVITIES	
Exoplanet technology	WFIRST coronagraph, reductions being considered for starshade and coronagraph technology development beyond the WFIRST coronagraph
Inflation Probe technology	3 balloon-borne technology experiments
SMALL ACTIVITIES	
R&A augmentations	R&A up 20% since FY10; not targeted except TCAN
Mid-TRL technology	Initiated Strategic Astrophysics Technology program; focused on identified missions
Suborbital missions	Initiated super pressure balloon capability

Federal Budget Cycle



Continuing resolution through May 1; FY17 OmniBus

Start of Calendar Year 2016

Skipped (which is normal for an Administration change)

Start of Calendar Year 2017

FY18 budget formulation delayed

Adapted by Kevin Marvel (AAS)
https://aas.org/files/budgetprocess_adaptedfromaaas.jpg
from budget presentation by Matt Hourihan (AAAS)
http://www.aaas.org/page/presentations

Program Pressure