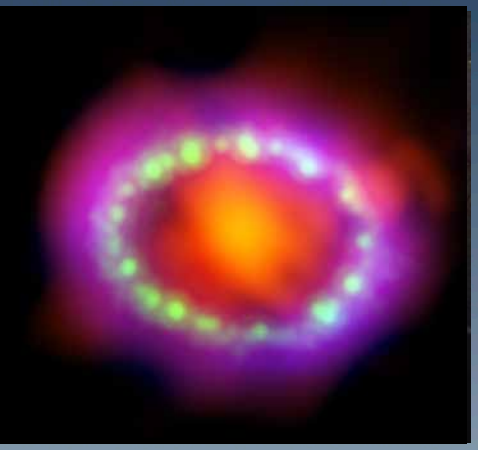
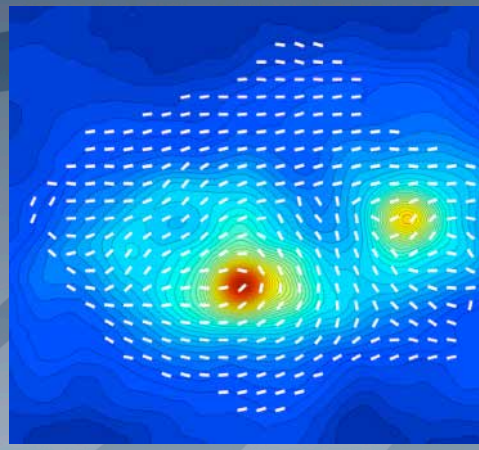
National Aeronautics and Space Administration

Astrophysics



NASA Update
AAAC Meeting
June 22, 2017

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

NASA Astrophysics

General Update

Astrophysics - Big Picture (1 of 2)

- **The FY17 appropriation and FY18 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, Explorers mission development, increased funding for R&A, new suborbital capabilities, continued technology development.
  - FY17 Consolidated Appropriation is less than planning budget; reductions to plans are required.
  - FY18 President's Budget Request balances current science and future missions.
- **NASA continues to prioritize implementation of the recommendations of the 2010 Decadal Survey.**
  - National Academies' 2016 Midterm Assessment Report validates NASA's progress.
  - NASA is conducting large and medium mission concept studies for 2020 Decadal Survey.

Astrophysics - Big Picture (2 of 2)

- **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 (Chandra, Fermi, Hubble, Kepler, NuSTAR, Spitzer, Swift, XMM); next Senior Review in 2019.
  - SOFIA is adding new instruments: HAWC+ instrument commissioned; HIRMES instrument in development; next gen instrument call planned.
  - ISS-NICER launched on June 3, 2017.
  - NASA missions under development making progress toward launches: ISS-CREAM (August 2017), TESS (2018), Webb (2018), IXPE (2020), GUSTO (2021), WFIRST (mid-2020s).
  - Independent WFIRST technical/management/cost review underway.
  - Partnerships with ESA and JAXA on future missions create additional science opportunities: Euclid (ESA; 2020), XARM (JAXA; 2021), Athena (ESA; 2028), LISA (ESA; 2034).
  - Explorer AOs are being released every 2-3 years: MIDEX/MO proposals received in December 2016, IXPE downselected in January 2017, GUSTO downselected in March 2017, MIDEX/MO selections in Summer 2017, next SMEX/MO AO in 2019.

FY17 Consolidated Appropriations Bill (H.R. 244)

	FY 2017 Request	FY 2017 Omnibus Conference	Change from FY2016 Enacted	Change from FY2017 Request
NASA TOTAL	19,025.1	19,653.3	368.3	628.2
Science	5,600.5	5,764.9	175.5	164.4
Earth Science	2,032.2	1,921.0	0.0	-111.2
Planetary	1,518.7	1,846.0	215.0	327.3
Europa	49.6	275.0	100.0	225.4
Astrophysics	781.5	750.0	-17.6	-31.5
STEM Activation[1]	25.0	37.0	0.0	12.0
JWST	569.4	569.4	-50.6	0.0
Heliophysics	698.7	678.5	28.7	-20.2

Note 1: $37.0M for STEM Activation is to be derived equally from Planetary Science and Astrophysics, and continue to be administered by Astrophysics.

FY17 Consolidated Appropriations Bill (H.R. 244)

- The FY17 Appropriation for Astrophysics resulted in a reduction of $63.0M for Astrophysics (including Webb) relative to the FY16 funding level.

$M	FY16 Actual	FY17 Request	FY17 Approp	
Webb	620.0	569.4	569.4	Planned decrease of $50.6M
Astrophysics	762.4	781.5	750.0	Down $31.5M from FY17 request
Astrophysics w/ Webb	1,382.4	1,350.9	1,319.4	Down $63.0M from FY16 actual

- The FY17 Appropriation for Astrophysics resulted in a reduction of $31.5M for Astrophysics (including Webb) relative to the FY17 budget request.
- The FY17 Appropriation for Astrophysics resulted in a reduction of up to $47.4M for Astrophysics programs excluding Webb, Hubble, SOFIA, WFIRST, relative to the FY17 budget request.

FY17 Consolidated Appropriations Bill (H.R. 244)

	FY17 Request	FY17 Approp	Language from Conference Committee Report
Total	1,350.9	1,319.0	
Webb	569.4	569.4	Includes $569.4M for Webb
WFIRST	90.0	105.0	Includes $105M for WFIRST; Committee directs NASA to cap WFIRST life cycle costs at no more than $3,500M through the end of its prime mission
SOFIA	83.8	85.2	Provides $85.2M for SOFIA
Hubble	97.3	98.3	Provides $98.3M for Hubble Space Telescope
Mirror Tech	-	5.0	Includes up to $5M for segmented aperture telescope activities
Starshade	-	-	Supports continued appropriate technology development for a starshade
STEM Activation	25.0	18.5	Includes $37M for STEM Activation programs, derived from Planetary Science and Astrophysics
Rest of Astrophysics	485.4	438.0	

- Up to $47.4M reduction to “Rest of Astrophysics” (Astrophysics excluding Webb, WFIRST, SOFIA, Hubble) relative to FY17 request; 11% reduction with 4 months remaining in FY17

FY18 President's Budget Request

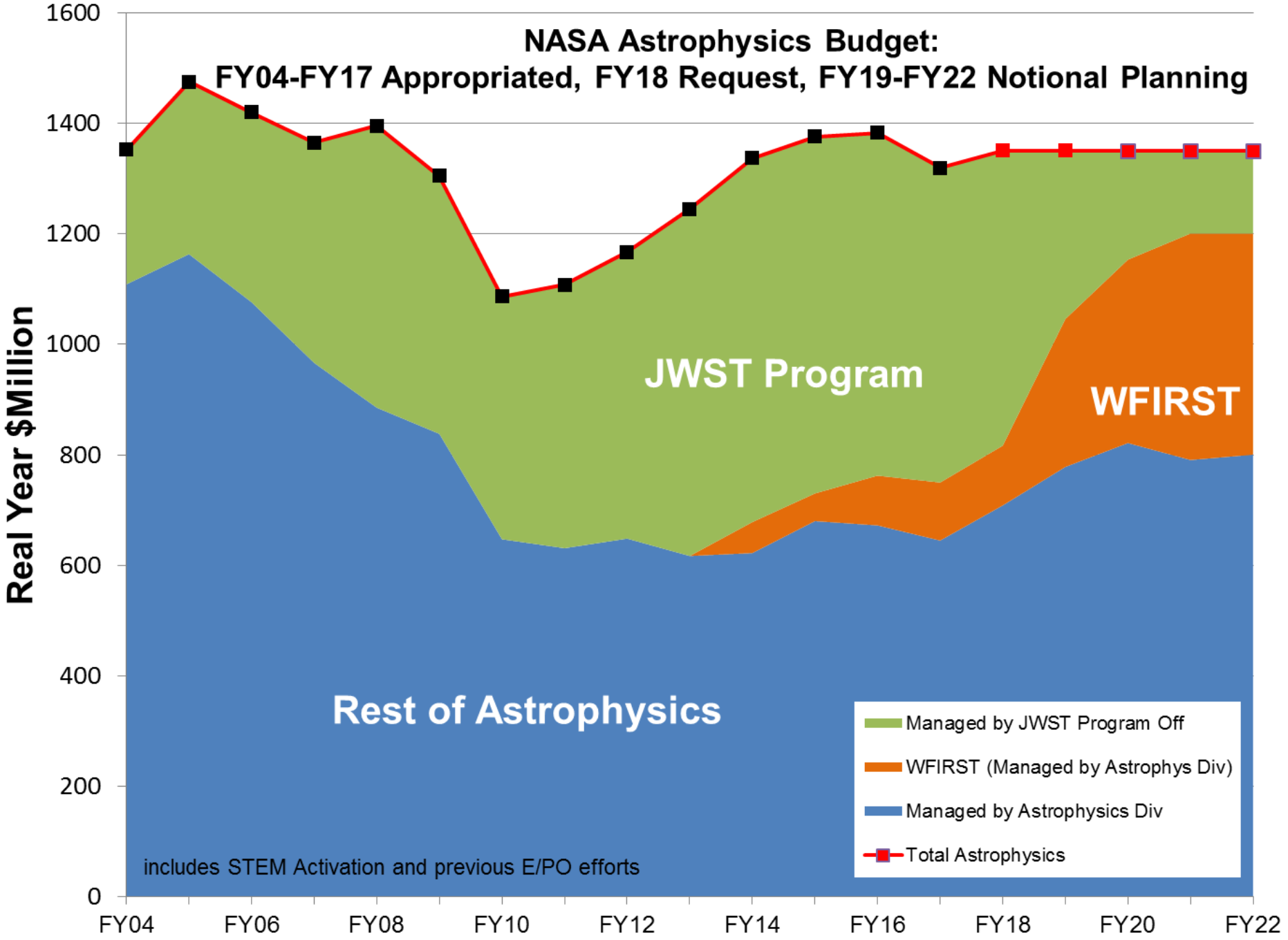
$M	FY16 Actual	FY17 Omnibus	FY18 Request	Change from FY16	Change from FY17
NASA	19,285	19,653	19,092	-1.0 %	-2.9%
SMD	5,584	5,765	5,712	+2.3 %	-0.9 %
Earth Science	1,927	1,921	1,754	-9.0 %	-8.7 %
Heliophysics	647	679	678	+4.8 %	-0.1 %
Planetary Science	1,628	1,846	1,930	+18.6 %	+4.6 %
Astrophysics (including Webb)	1,382	1,319	1,350	-2.3%	+1.6 %

- Maintains commitment to studying our home planet and the universe
- Enables our wide ranging science work on many fronts, which continues to lead the world in its size, scope, and scientific output.
- Reinvigorates robotic exploration of the solar system, including funding for a Europa Clipper mission to fly repeatedly by Jupiter's icy ocean moon Europa.
- Maintains a robust Earth Science program while terminating several missions.
- Supports initiatives that use smaller, less expensive satellites and/or public-private partnerships to advance science, in keeping with recent National Academies recommendations.

FY18 President's Budget Request

	Actual	Enacted	Request	Notional			
Budget (in $ millions)	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022
Astrophysics Research	193	--	204	221	225	262	288
Cosmic Origins	196	--	192	190	142	158	156
Physics of the Cosmos	125	--	100	109	111	94	94
Exoplanet Exploration	141	--	176	351	473	476	440
Astrophysics Explorer	108	--	145	175	201	212	222
James Webb Telescope	620	569	534	305	197	150	150
Total Astrophysics	1382	1319	1350	1350	1350	1350	1350

- Supports an SMD-wide CubeSat/SmallSat initiative that uses smaller, less expensive satellites to advance science in a cost-effective manner.
- Reflects more efficient operations of the Hubble Space Telescope, without impact to science.
- Reflects efficiencies realized by the SOFIA in the past few years. SOFIA will participate in the 2019 Astrophysics Senior Review.

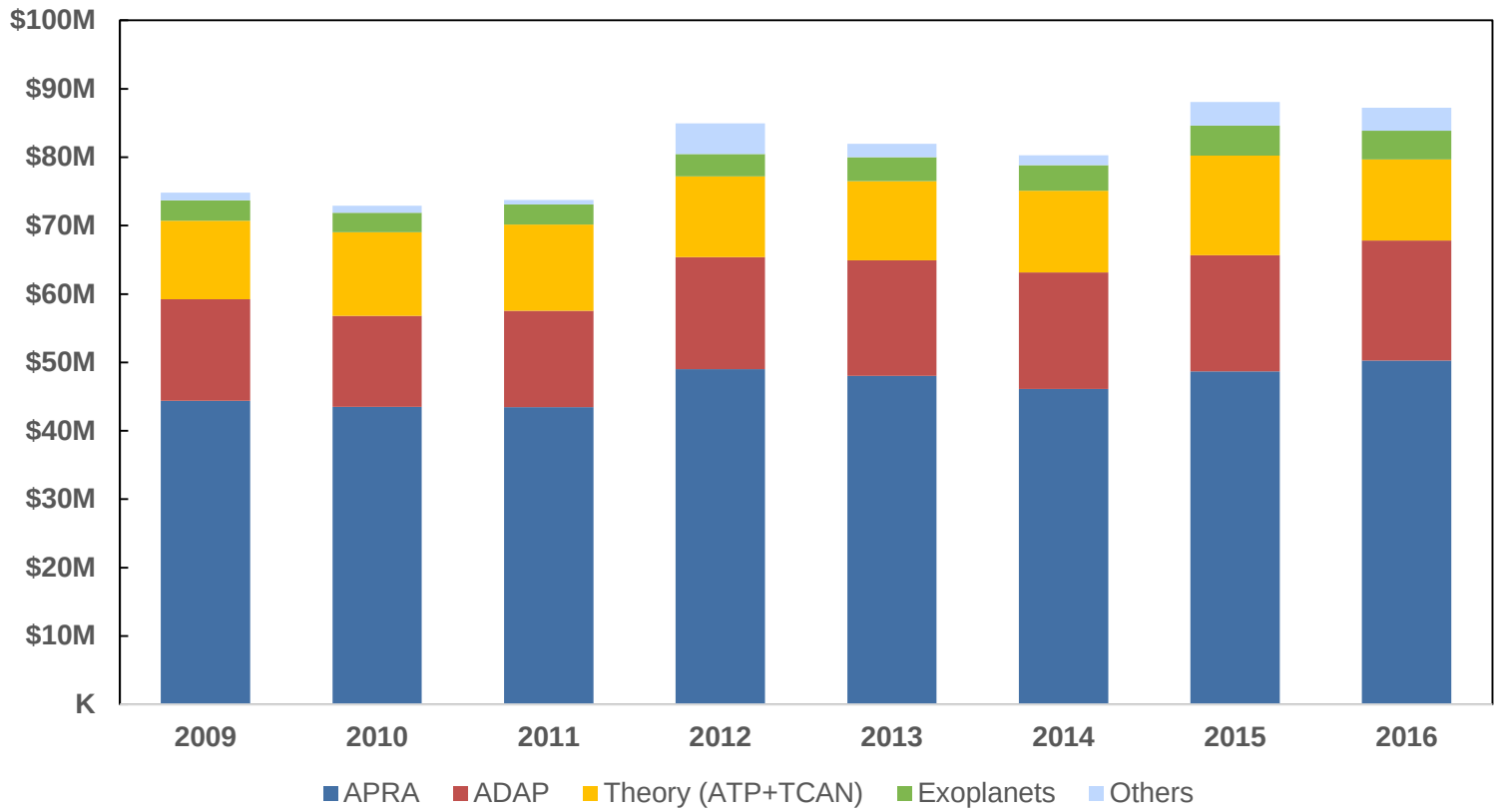

NASA Astrophysics Budget:
FY04-FY17 Appropriated, FY18 Request, FY19-FY22 Notional Planning
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
FY04
FY06
FY08
FY10
FY12
FY14
FY16
FY18
FY20
FY22
JWST Program
WFIRST
Rest of Astrophysics
includes STEM Activation and previous E/PO efforts
Managed by JWST Program Off
WFIRST (Managed by Astrophys Div)
Managed by Astrophysics Div
Total Astrophysics

NASA Astrophysics

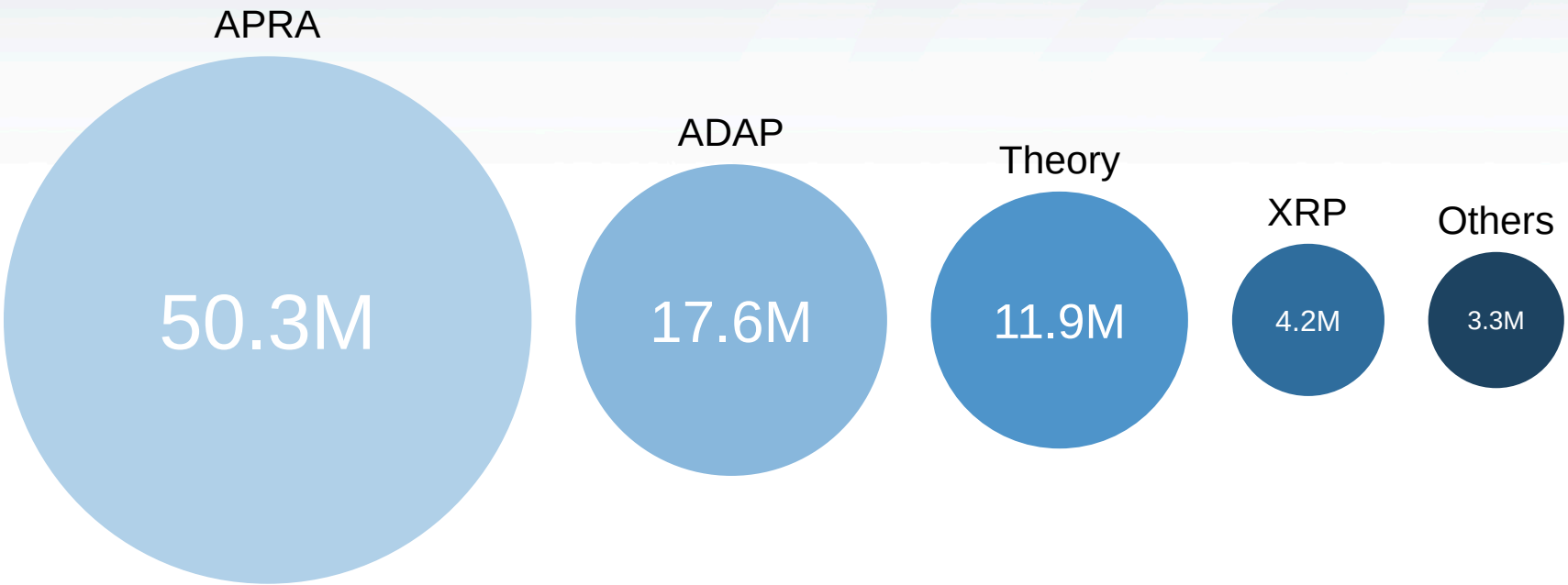
Research and Analysis Update

Historical Budget Trends

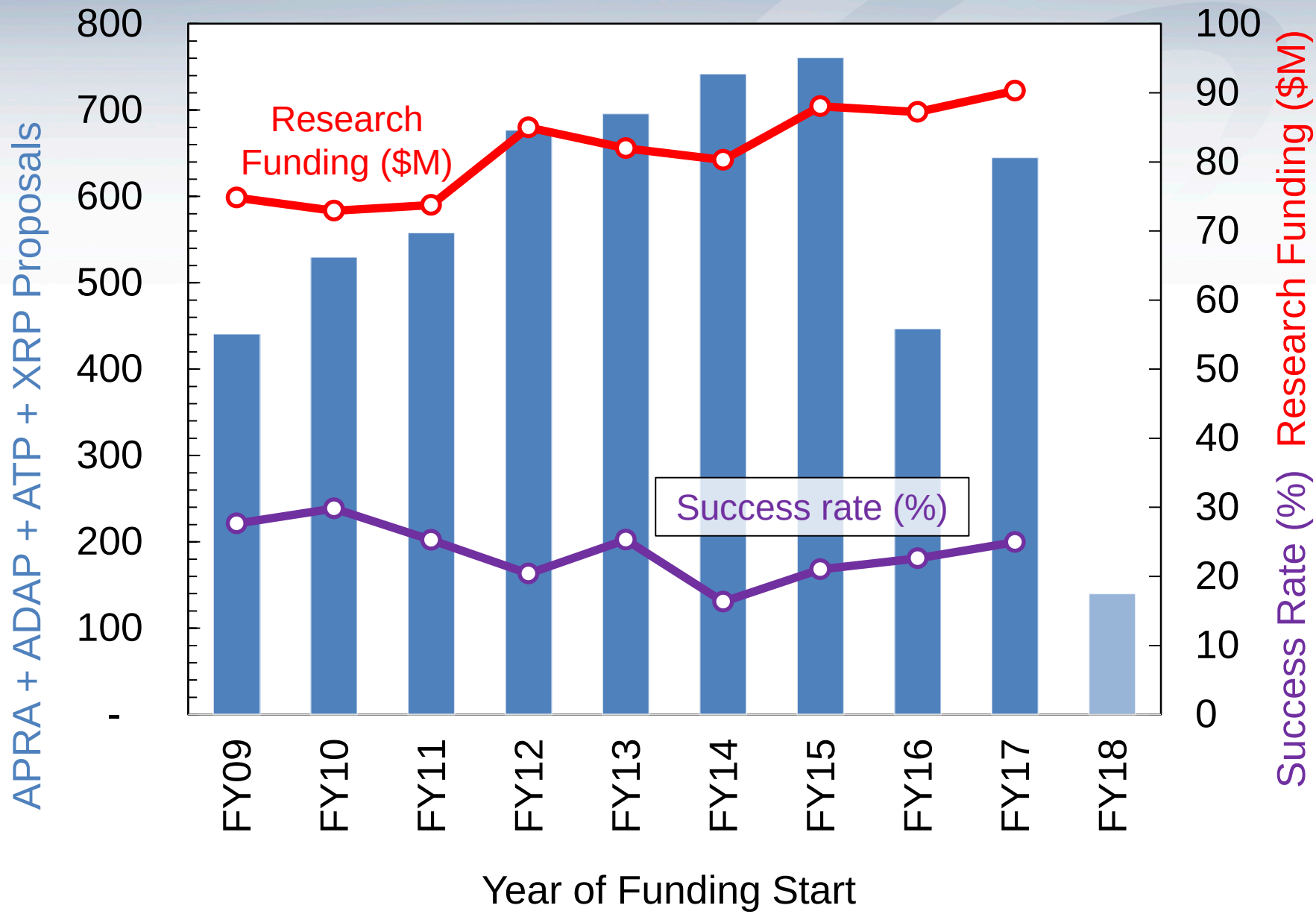
Program	2009	2010	2011	2012	2013	2014	2015	2016
APRA	$44 M	$44 M	$43 M	$49 M	$48 M	$46 M	$49 M	$50 M
ADAP	$15 M	$13 M	$14 M	$16 M	$17 M	$17 M	$17 M	$18 M
Theory (ATP+TCAN)	$11 M	$12 M	$13 M	$12 M	$12 M	$12 M	$15 M	$12 M
Exoplanets (XRP)	$3 M	$3 M	$3 M	$3 M	$4 M	$4 M	$4 M	$4 M
Others	$1 M	$1 M	$1 M	$5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



FY16 Spending Summary



Program Pressure



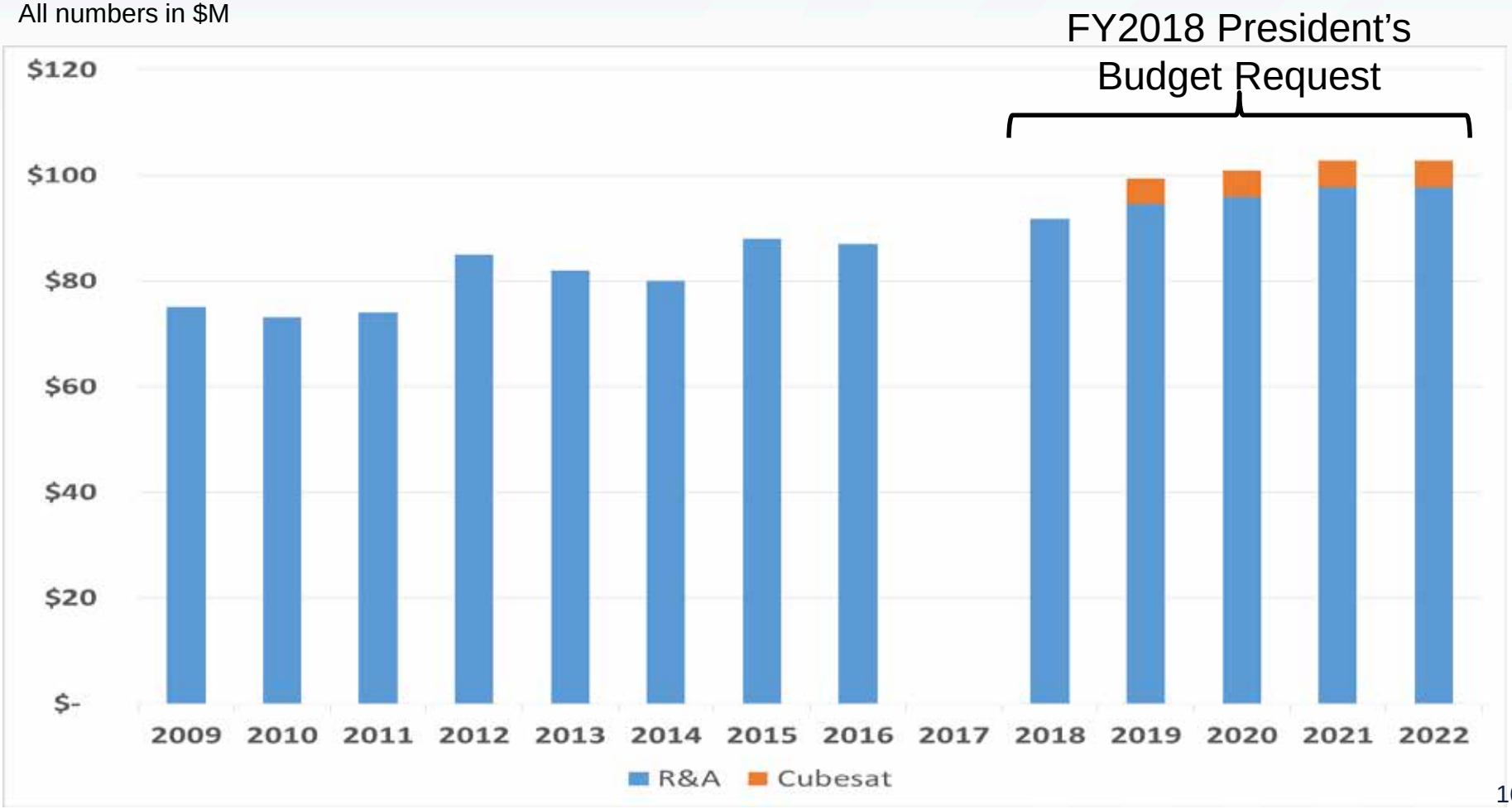
NASA Astrophysics Postdoctoral Fellowships
Einstein, Hubble, and Sagan Fellowships

- 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.

Proposed Future Budget

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
R&A	$ 75	$ 73	$ 74	$ 85	$ 82	$ 80	$ 88	$ 87		$ 92	$ 95	$ 96	$ 98	$ 98
Cubesat											$ 5	$ 5	$ 5	$ 5
Total	$ 75	$ 73	$ 74	$ 85	$ 82	$ 80	$ 88	$ 87		$ 92	$ 100	$ 101	$ 103	$ 103

All numbers in $M



NASA Astrophysics

Missions Update

Astrophysics Missions in Development

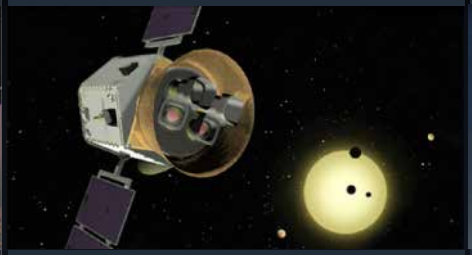
ISS-NICER
6/2017
NASA Mission

Neutron Star Interior Composition Explorer

ISS-CREAM
8/2017
NASA Mission

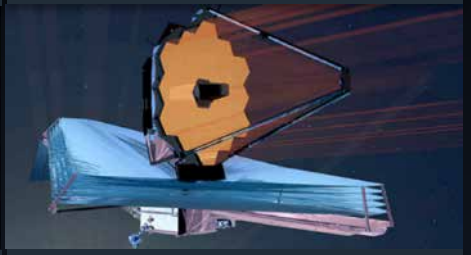
Cosmic Ray Energetics And Mass

TESS
3/2018
NASA Mission



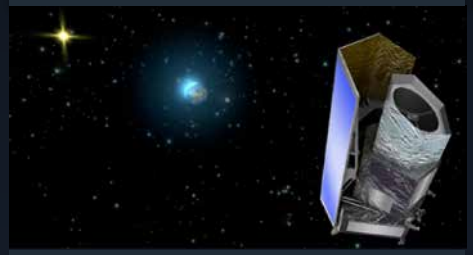
Transiting Exoplanet Survey Satellite

Webb
10/2018
NASA Mission



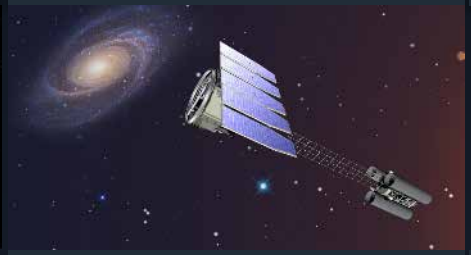
James Webb Space Telescope

Euclid
2020
ESA-led Mission



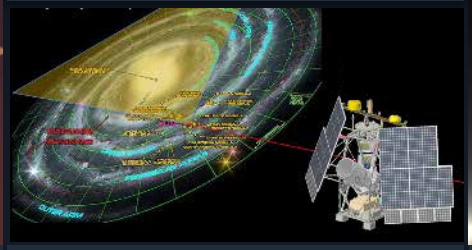
NASA is supplying the NISP Sensor Chip System (SCS)

IXPE
2020
NASA Mission



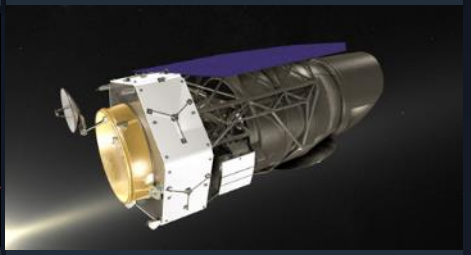
Imaging X-ray Polarimetry Explorer

GUSTO
2021
NASA Mission



Galactic/ Extragalactic ULDB Spectroscopic Terahertz Observatory

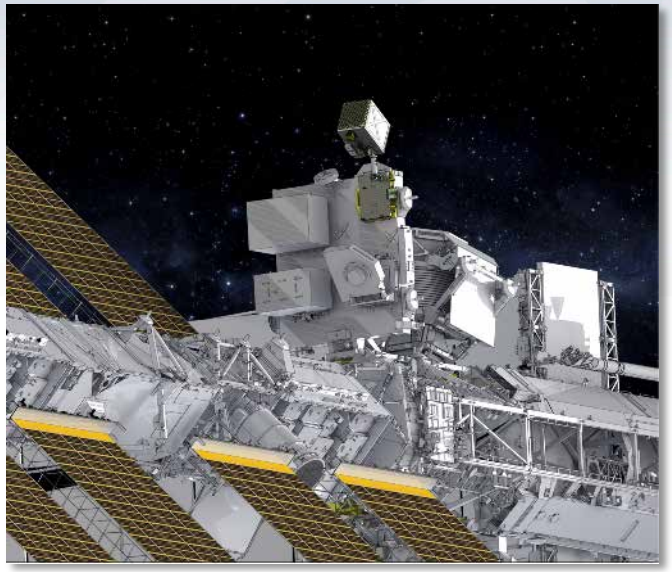
WFIRST
Mid 2020s
NASA Mission

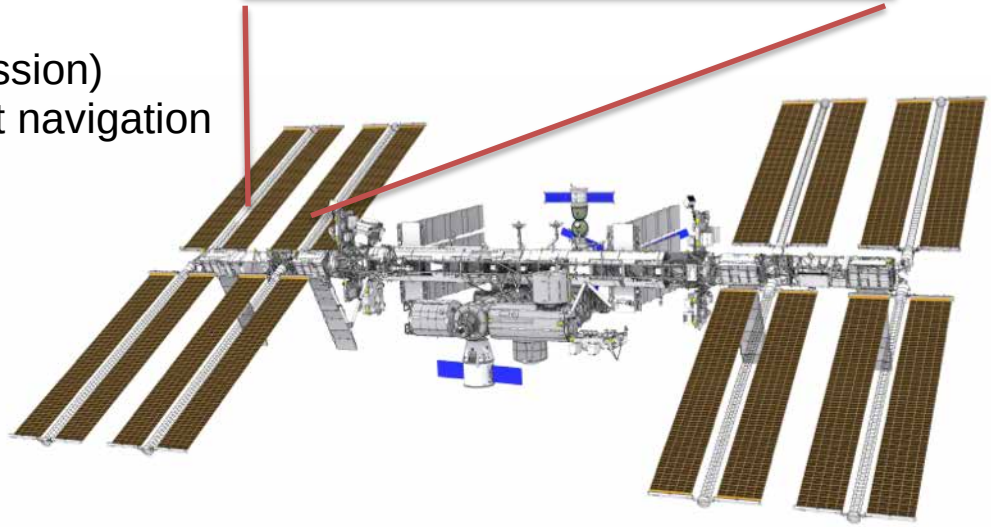


Wide-Field Infrared Survey Telescope

Neutron star Interior Composition Explorer (NICER)

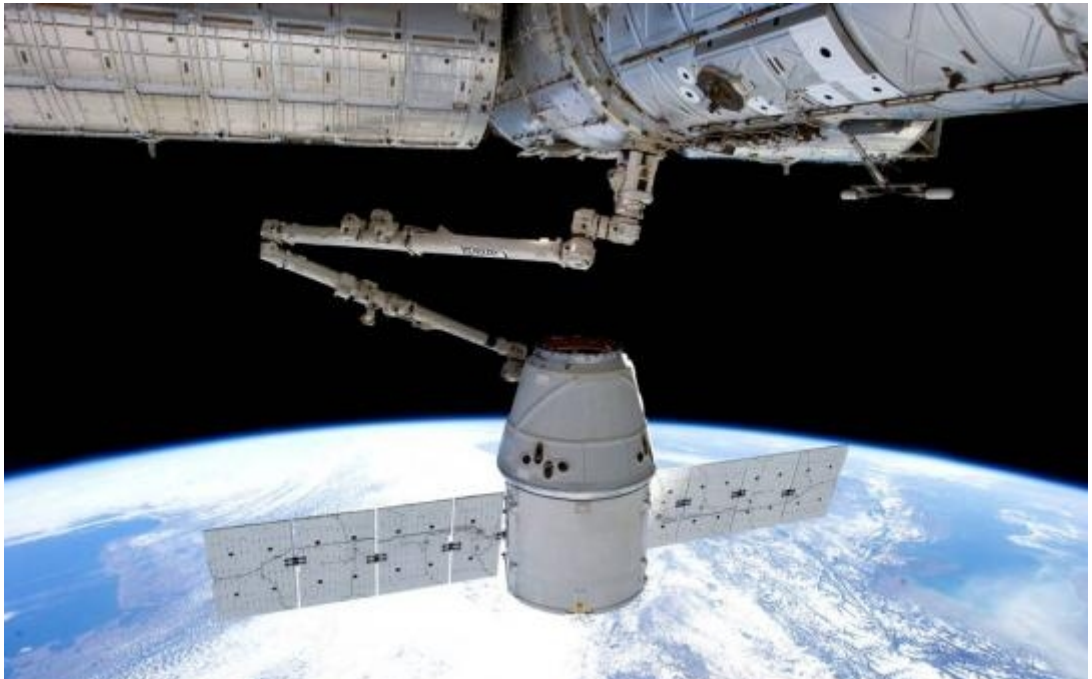
- ***Science:*** Understanding ultra-dense matter through observations of neutron stars in the soft X-ray band
- ***Launch:*** June 3, 2017, SpaceX-11 resupply
- ***Platform:*** ISS ExPRESS Logistics Carrier (ELC), with active pointing over nearly a full hemisphere
- ***Duration:*** 1 month calibration + 18 months prime mission + TBD extended mission (Senior Review)
- ***Instrument:*** X-ray (0.2–12 keV) “concentrator” optics and silicon-drift detectors. GPS position & absolute time reference
- ***Enhancements:***
  - Guest Observer program (in extended mission)
  - Demonstration of pulsar-based spacecraft navigation
- ***Status:***
  - Delivered payload to KSC in June 2016
  - Payload integrated into Dragon trunk in April 2017
  - Launch from KSC on June 3, 2017
  - Arrive at ISS on June 5, 2017





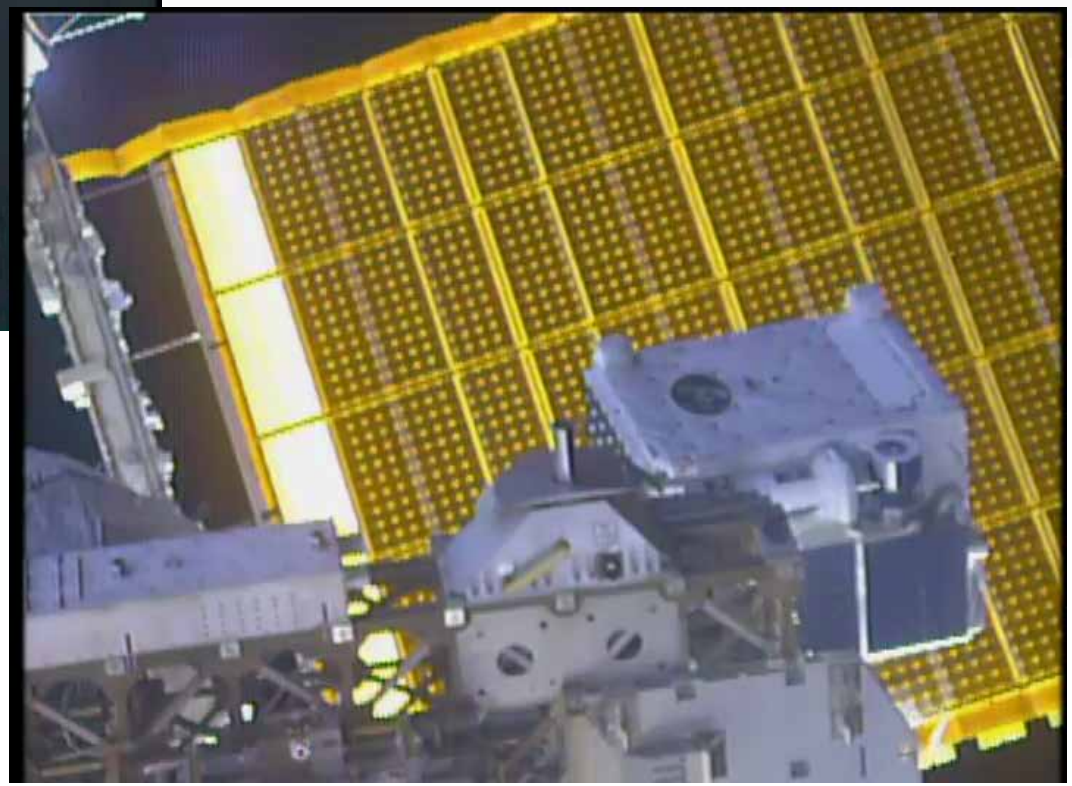
https://heasarc.gsfc.nasa.gov/docs/nicer/

NICER Launch: June 3, 2017



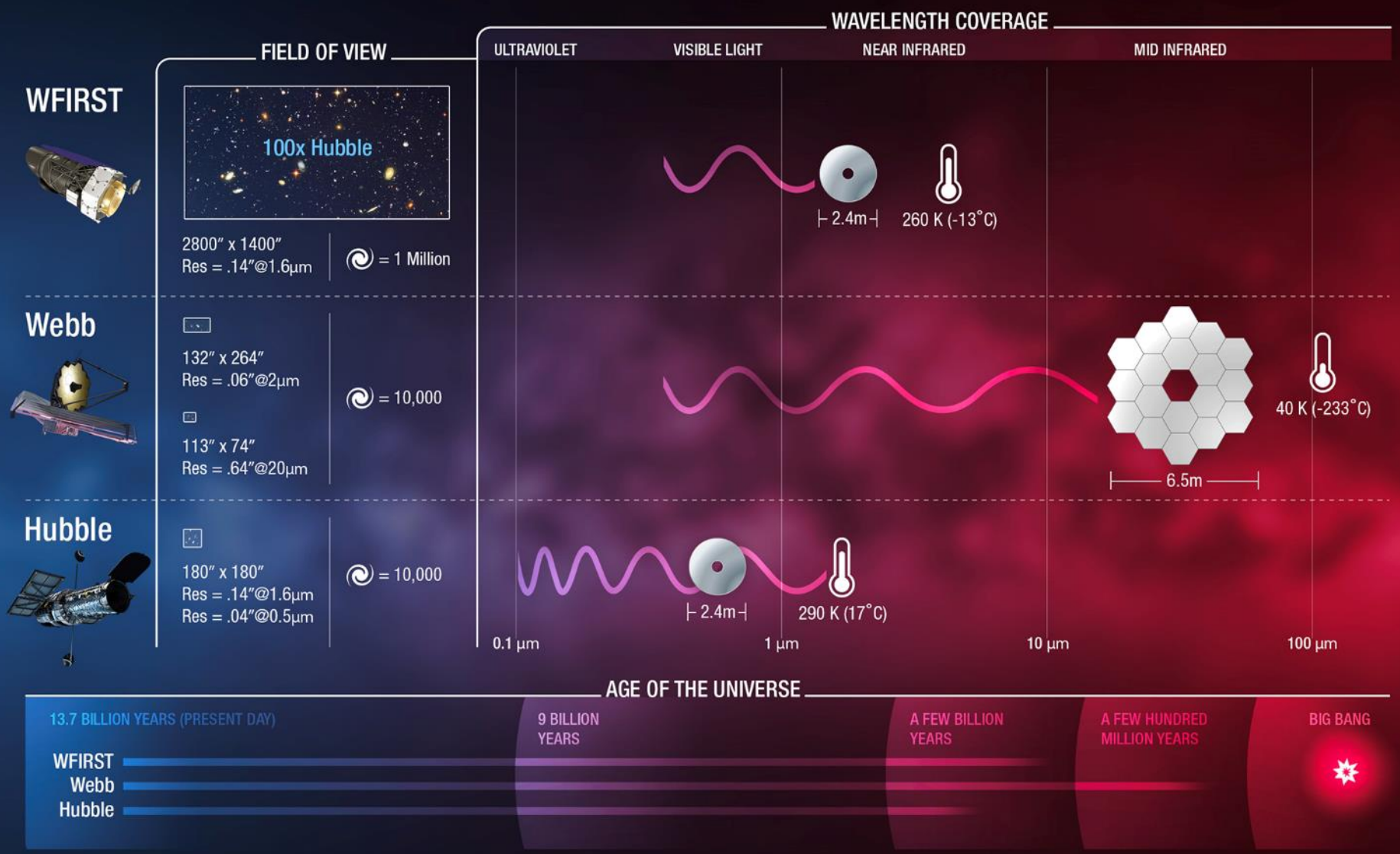
Launch June 3, 2017
ISS Arrival June 5, 2017
Deploy June 11, 2017
Checkout June 2017
Start science July 2017

NICER Installation on ISS

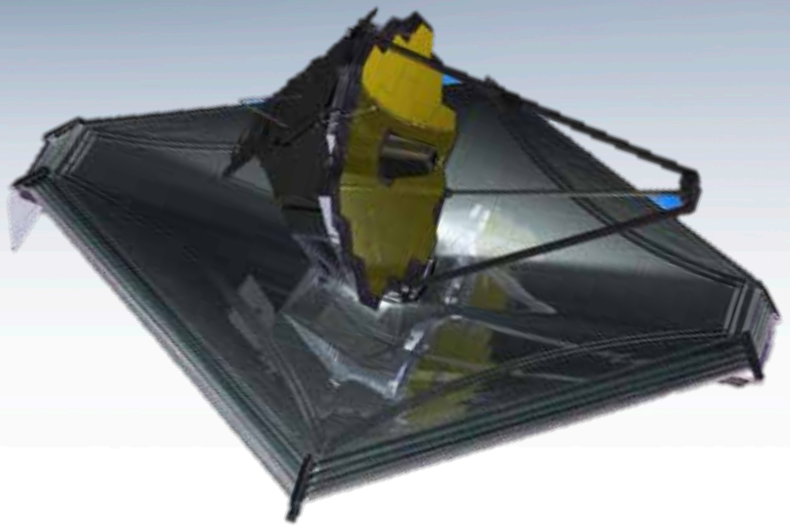


https://www.youtube.com/watch?v=sDd2PjbXEg8

GREAT OBSERVATORIES



Webb
James Webb Space Telescope



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

RECENT ACCOMPLISHMENTS:

- Completed spacecraft bus assembly
- Completed ambient testing of combined telescope and instruments
- Shipped science payload to JSC for end-to-end testing
- Issued calls for Early Release Science Notices of Intent

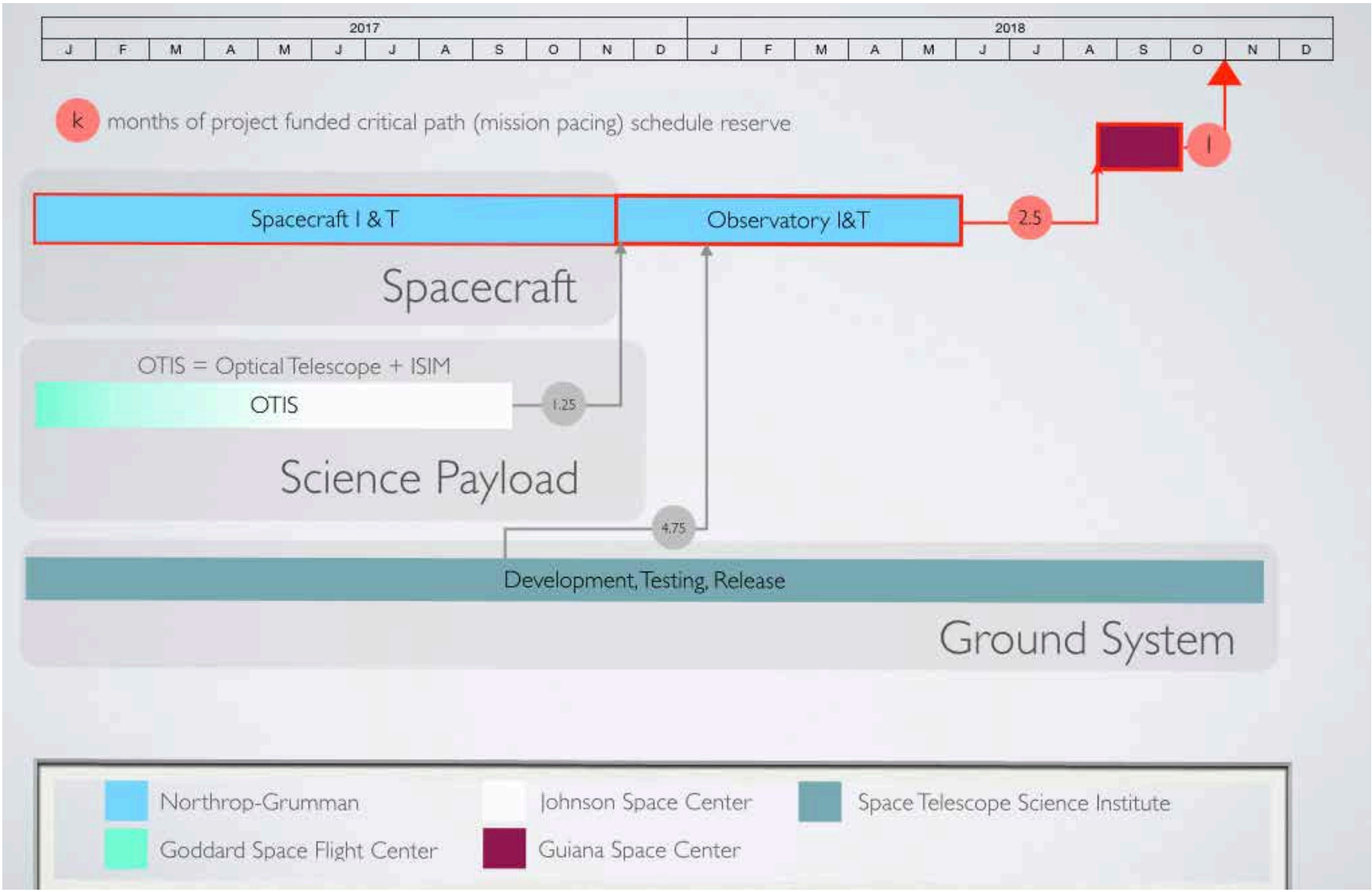
2017 Plans:

- Integrate spacecraft and sunshield
- Cryo-vacuum testing of the science payload at JSC
- Flight operations rehearsals and training

http://jwst.nasa.gov/

Webb remains on track for an October 2018 launch

Simplified JWST Schedule



OTIS (Telescope + Instruments)

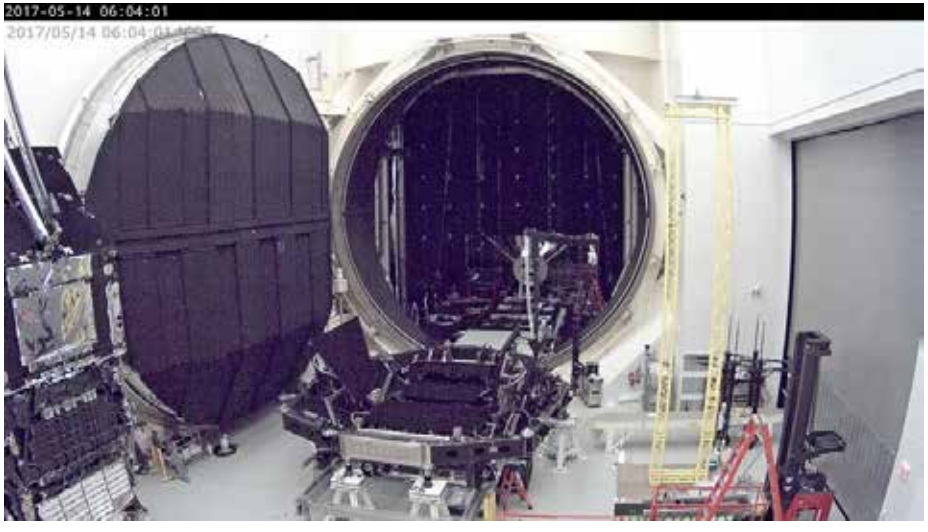
SPACECRAFT

- Spacecraft and sunshield integration underway
- All components delivered except deployable radiator shields and actuators (not planned for delivery yet anyway)

Second sunshield mid-boom installation

UPS ready for installation onto spacecraft

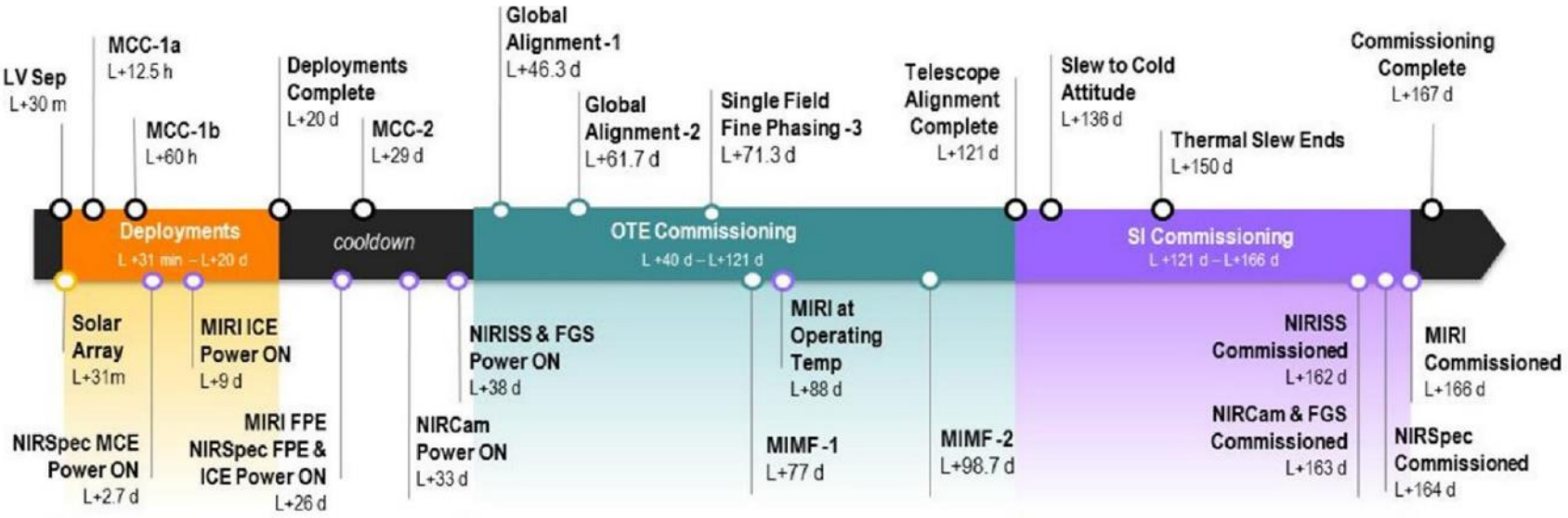
OTIS @ JSC



OTIS @ JSC

COMMISSIONING TIMELINE

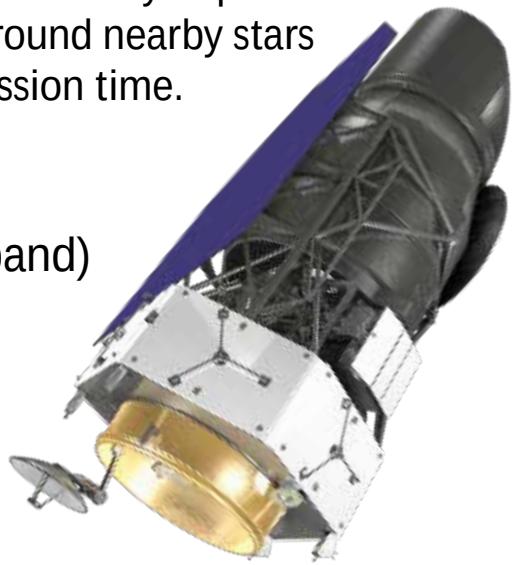
- Soon after launch the spacecraft is controlled from the Mission Operations Center at STScI
- Telescope commissioning will take almost 3 months
- Commissioning of the science instruments will start 4 months after launch and is completed in 1.5 months.
- 0.5 months are held on reserve to the nominal start of Cycle 1 science in April 2019

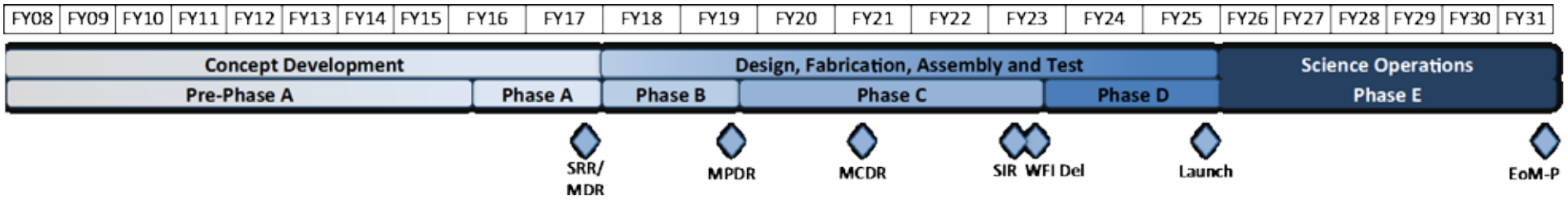


WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
DARK ENERGY • EXOPLANETS • ASTROPHYSICS

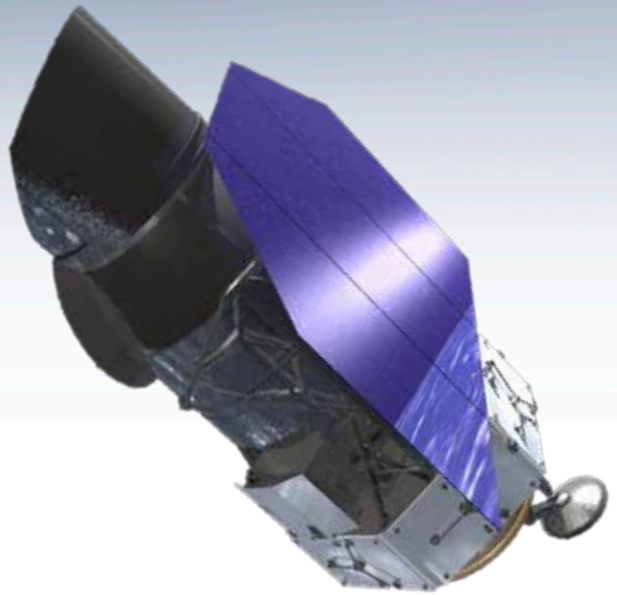
Basic Facts

- **Objectives:**
  - Characterize the history of cosmic acceleration and structure growth
  - Understand how planetary systems form and evolve and determine the prevalence of planets in the colder outer regions
  - Understand the compositions and atmospheric constituents of a variety of planets around nearby stars and to determine the properties of debris disks around nearby stars
  - A peer-reviewed Guest Observer program allocated 25% of mission time.
- **Mission Duration:** 6 ¼ years
- **Orbit:** Sun-Earth L2
- **Ground Stations:** Near Earth Network (Ka-band, S-band)
- **Space Network:** S-band for launch
- **Ground System:** MOC/Science Center/IOC
- **Launch Vehicle:** Delta IV Heavy or Falcon Heavy
- **Launch Site:** Eastern Range





WFIRST
Wide-Field Infrared Survey Telescope



Wide-Field Infrared Survey Telescope

Top priority of 2010 Decadal Survey

Science themes: Dark Energy, Exoplanets, Large Area Near Infrared Surveys

Mission: 2.4m widefield telescope at L2; using existing hardware, images 0.28deg^2 at 0.8-2μm

Instruments (design reference mission): Wide Field Instrument (camera plus IFU), Coronagraph Instrument (imaging/IFS)

Phase: Currently in Formulation (Phase A)

https://wfirst.gsfc.nasa.gov/

CURRENT STATUS:

- Successfully completed three-year technology demonstration activities on WFIRST's two critical mission technologies (near infrared detectors and coronagraph technologies)
- Completed industry formulation studies on Wide Field Instrument Optomechanical Assembly
- Conducting WFIRST Independent External Technical/Cost/Management Review (WIETR) in response to findings and recommendations in National Academies' Midterm Assessment
  - NASA is managing WFIRST with major emphasis on cost control
  - WFIRST will proceed to SRR/MDR and KDP-B after responding to WIETR recommendations
- WFIRST does not have a starshade; but NASA is studying a starshade for the next Decadal Survey's consideration.
  - Starshade compatibility is being studied during Phase A; mandated minimum impact on WFIRST.
  - NASA will decide by fall 2017 whether to maintain starshade compatibility.
- Jeff Kruk is new Project Scientist following loss of Neil Gehrels

WFIRST Observing TIme

Q: What fraction of WFIRST observing time has been set aside for a specific survey, investigator, or observation?

WFIRST Observing TIme

Q: What fraction of WFIRST observing time has been set aside for a specific survey, investigator, or observation?

A: **0%**

Surveys for the Community

- **WFIRST is a mission conducting major surveys for the community along with a guest observer program for individuals or small groups.**
  - The existing Formulation Science Working Group (FSWG) is in place only during formulation. It will be disbanded in early 2021. Present plans from the FSWG only establish a design reference mission – no time allocated.
  - *All* WFIRST observing time is available – no particular survey implementations or investigators have been selected yet.
  - *All* data provided in the WFIRST archive are publicly available – there will be no proprietary period.
  - A new "Operations Science Working Group" will be selected via an open competition to conduct the survey observations.

0% Allocated

Time 100% Available

Data 100% Public

Participation 100% Open

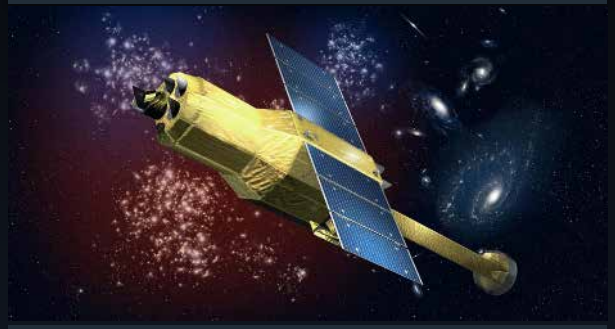
WFIRST Independent Review

- WFIRST is the highest priority large space mission from the 2010 Decadal Survey in Astronomy and Astrophysics
  - The 2016 Astrophysics Midterm Assessment recognized the continued compelling science value of WFIRST.
  - After several years of mission concept studies and technology investments, NASA began formulation of WFIRST in 2016
- Two National Academies studies have recommended that NASA conduct an independent technical/management/cost (TMC) review of WFIRST before beginning Phase B and before proceeding to the Preliminary Design review
  - Both reports expressed concern that mission cost growth could endanger the balance of NASA's astrophysics program and the alignment of its scientific priorities with those put forward by the Decadal Survey.
  - The studies are the 2014 WFIRST/AFTA study (F. Harrison et al.) and the 2016 Astrophysics Midterm Assessment (J. Hewitt et al.)
- NASA is implementing these recommendations and establishing the WFIRST Independent External TMC Review (WIETR)
- The Review will begin as soon as the panel members are identified
  - Once begun, the review should take several months
  - The WFIRST System Requirements Review (SRR) / Mission Design Review (MDR), planned for Summer 2017, and beginning of Phase B, planned for Fall 2017, will be deferred until after the WIETR so that any findings and recommendations can be incorporated into the WFIRST project plan

Astrophysics Missions under Study

XARM
2021

JAXA-led Mission



NASA is supplying the SXS Detectors, ADRs, and SXTs

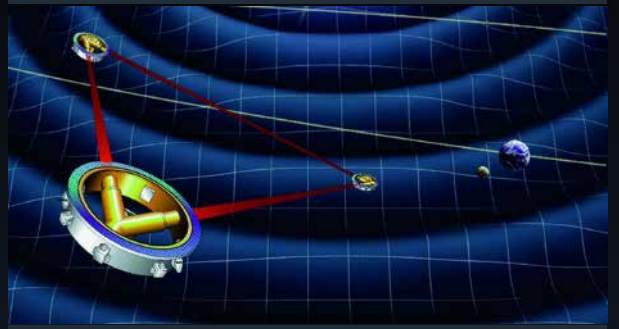
Athena
Late 2020s

ESA-led Mission

NASA is supplying elements for both instruments

LISA
Mid 2030s

ESA-led Mission



NASA is developing technology for both the payload and the mission

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
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/

Selected Probe Mission Concept Studies

PI	Affiliation	Short title
Jordan Camp	NASA GSFC	Transient Astrophysics Probe
Asantha Cooray	Univ. California, Irvine	Cosmic Dawn Intensity Mapper
Bill Danchi	NASA GSFC	Cosmic Evolution through UV Spectroscopy Probe
Jason Glenn	Univ. of Colorado	Galaxy Evolution Probe
Shaul Hanany	Univ. of Minnesota	Inflation Probe
Richard Mushotzky	Univ. of Maryland	High Spatial Resolution X-ray Probe
Angela Olinto	Univ. of Chicago	Multi-Messenger Astrophysics Probe
Peter Plavchan *	Missouri State Univ.	Precise Radial Velocity Observatory
Paul Ray	Naval Research Lab	X-ray Timing and Spectroscopy Probe
Sara Seager *	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

2020 Decadal Survey

Notional Schedule

2018 March	Astro 2020 proposal submitted to Agencies
2018 December	Chair nominated
2019 January	AAS Town Hall
2019 Feb/March	Committee begins meeting
2019 May/June	Panels begin meeting
2020 May	Panels complete reports and deliver to Committee
2020 August	Review of survey and panel reports begins
2020 December	Astro 2020 completed and report released to Agencies and public

Revised
June 3, 2017

NASA Astrophysics

Backup

More Selected Mission Updates

Astrophysics Missions in Operation

	Phase	2017 GO	Notes
Hubble	Extended	Yes	
Chandra	Extended	Yes	
XMM-Newton (ESA)	Extended	Yes	
Spitzer	Extended	Yes	EOM in 2019
Swift	Extended	Yes	
Fermi	Extended	Yes	
Kepler	Extended	Yes	EOM in ~2019
NuSTAR	Extended	Yes	
SOFIA	Prime	Yes	
LISA Pathfinder (ESA)	Extended		EOM in 2017
NICER	Checkout		Science in July

SOFIA
Stratospheric Observatory for Infrared Astronomy

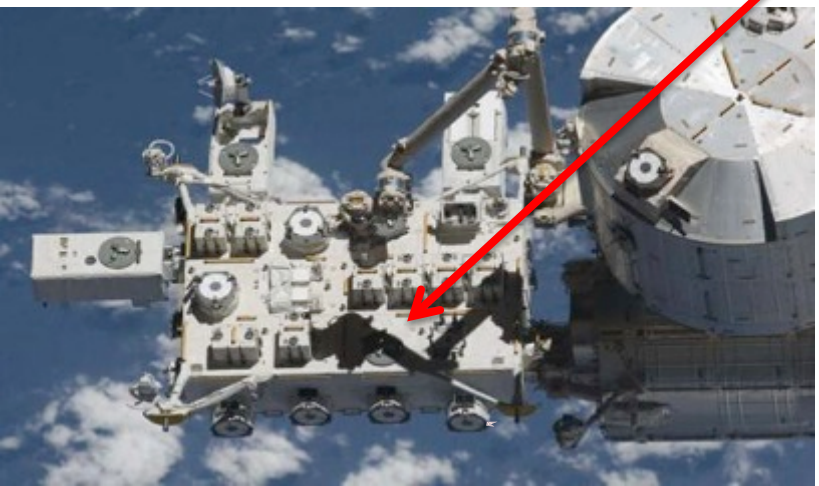
- **World's Largest Airborne Observatory**
- 2.5-meter telescope
- 80/20 Partnership between NASA and the German Aerospace Center (DLR)
- Science Center and Program Management at NASA-Ames Research Center
- Science Flight Operations at NASA-Armstrong Flight Research Center
- Four U.S. and two German science instruments commissioned
  - Provide imaging, spectroscopy, photometry and polarization-mapping with emphasis across mid- and far-infrared wavelengths
  - Advanced science instruments under development for future operation

CURRENT STATUS:

- In prime mission operation since May 2014
- Observing status:
  - 535 observing hours awarded for Cycle 5 which started in February 2017.
  - Commissioned new Upgraded German REceiver for Astronomy at Terahertz (upGREAT) High Frequency Array (HFA) in October 2016.
  - High-resolution Airborne Wideband Camera-plus (HAWC+) commissioning completed in December 2016.
  - High Resolution Mid Infrared Spectrometer (HIRMES) instrument under development.
  - Next Gen instrument solicitation planned

https://www.sofia.usra.edu/

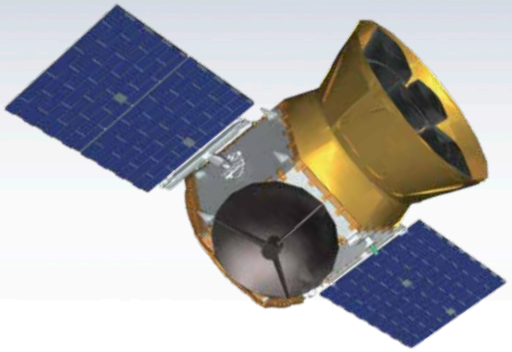
CREAM
Cosmic Ray Energy and Mass



- July 2015: CREAM delivered to KSC and stored at KSC until launch P
- August 2017 (TBC): Launch on SpaceX-12 commercial resupply service (CRS) flight to ISS.

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

TESS
Transiting Exoplanet Survey Satellite



CURRENT STATUS:

- Both instrument and spacecraft bus completion are planned for late-June early July 2017.
- Observatory integration beginning in mid-Summer 2017 with completion by the end of fall 2017.
- All four flight cameras are assembled and now in testing.

SCHEDULE:

- mid-Summer thru Fall 2017 – Observatory integration and test
- Summer 2017 – SIR & 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)

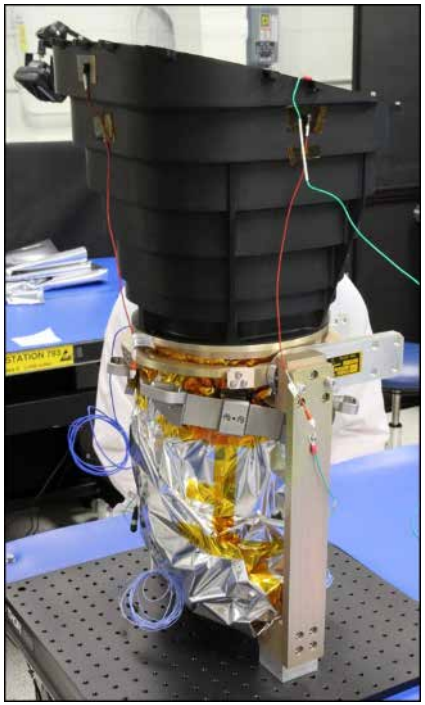
Mission: All-Sky photometric exoplanet mapping mission.

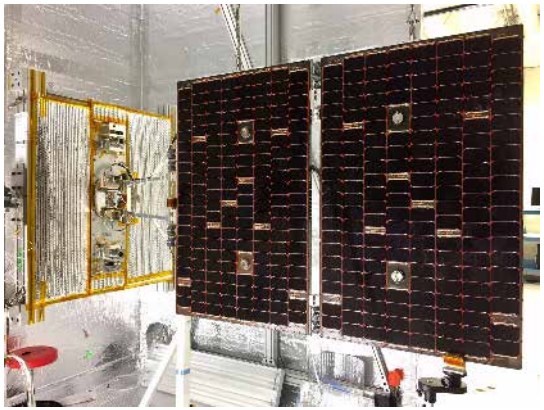
Science goal: Search for transiting exoplanets around the nearby, bright stars.

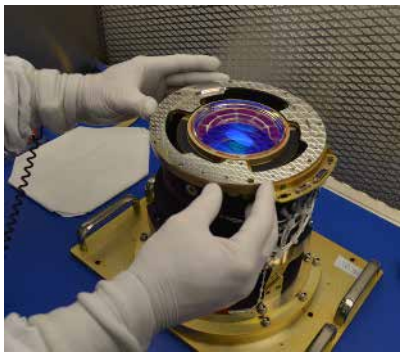
Instruments: Four wide field of view (24x24 degrees) CCD cameras with overlapping field of view, operating in the Visible-IR spectrum (0.6-1 micron).

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).

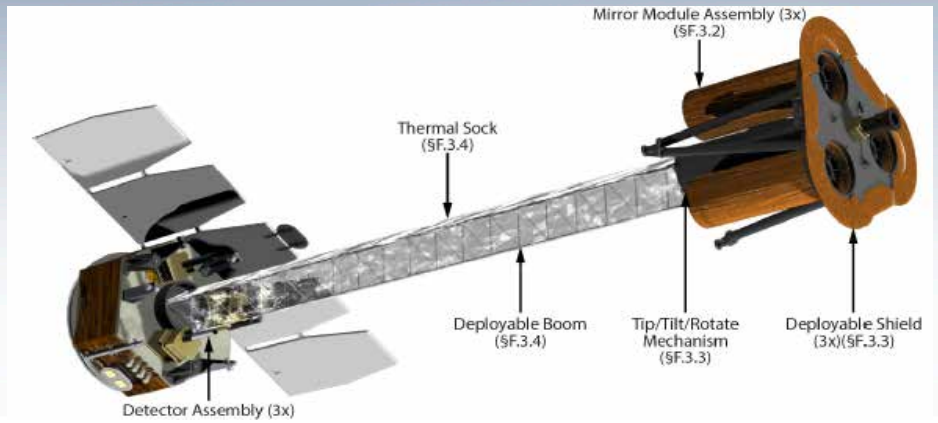
http://tess.gsfc.nasa.gov/



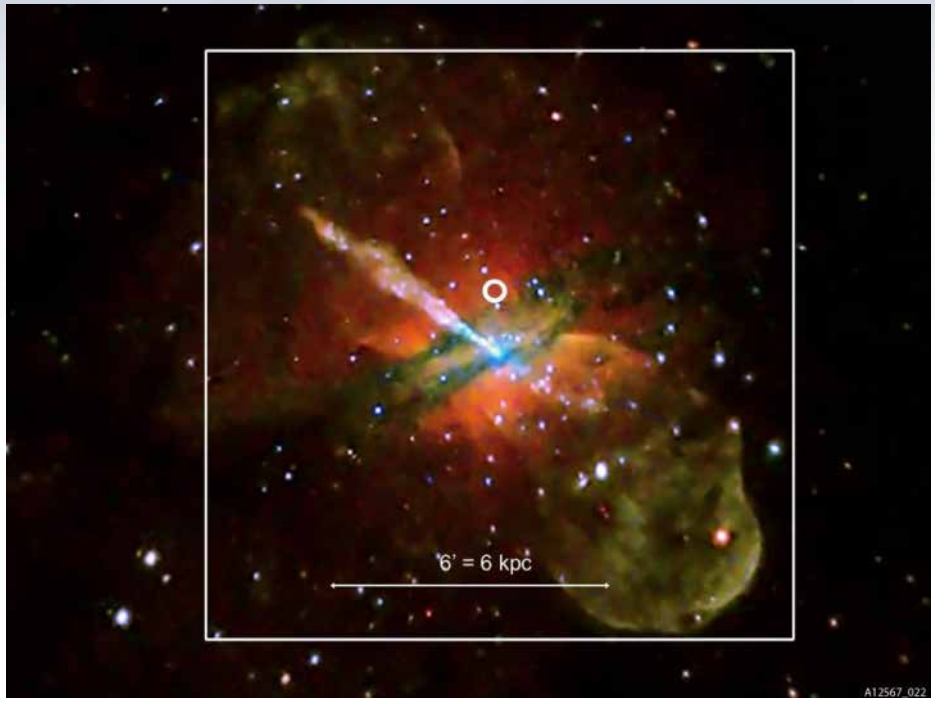




Imaging X-ray Polarimetry Explorer (IXPE)



- Next Astrophysics SMEX: IXPE, PI: Martin Weisskopf, MSFC (announced January 2017)
- IXPE has a 2-8 keV energy range, proportional counter energy resolution, 11´ FOV, and ≤ 30" angular resolution
- IXPE targets AGNs and microquasars, pulsars and pulsar wind nebulae, magnetars, accreting X-ray binaries, supernova remnants, the Galactic center.
- Addresses fundamental questions about:
  - the geometries of the flows, emission regions, and magnetic fields
  - physical processes leading to particle acceleration and X-ray emission
  - physical effects of gravitational, electric, & magnetic fields at their extreme limits



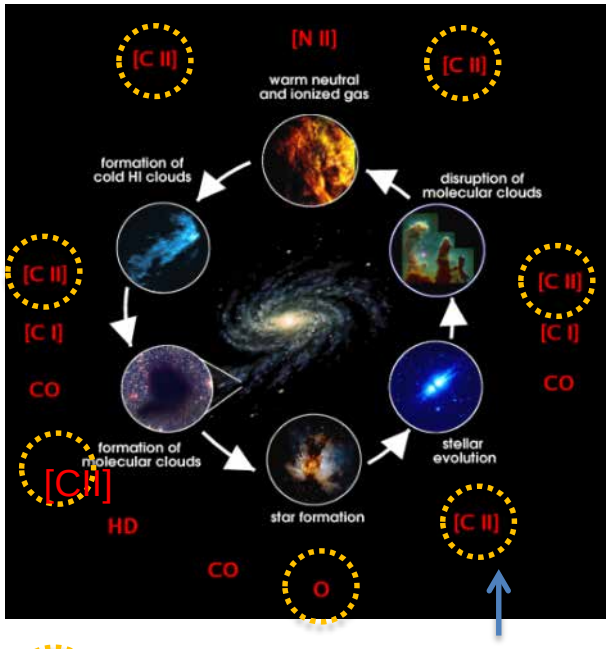
Chandra image of Cen A, showing soft X-rays (red) and hard X-rays (blue). The jet extends 4 arcmin NE from the core. The white circle denotes IXPE's 30 arcsec half-power diameter (HPD); the white square, the IXPE detector's field of view (FOV). The imaging capability of IXPE enables mapping the X-ray polarization degree and position angle and thus the magnetic-field geometry in X-ray emitting regions along the jet.

GUSTO Suborbital Explorer (MO)

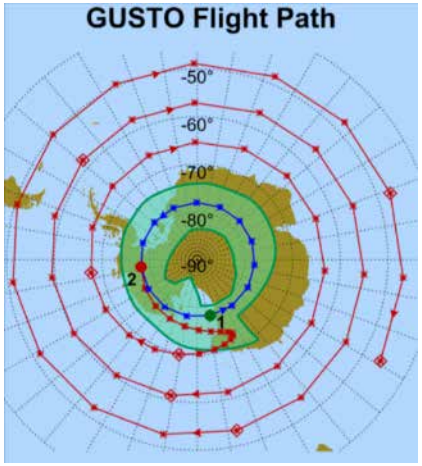
GUSTO (Galactic/Extragalactic ULDB Spectroscopic Terahertz Observatory) led by PI Chris Walker from the University of Arizona, is an Astrophysics Explorer (MO) balloon mission and is an advanced version of STO-2 balloon payload.

GUSTO uses large-scale surveys & spectral diagnostics of the Interstellar Medium (ISM) to answer key questions about the Life Cycle of the ISM and massive star formation.

GUSTO Payload



GUSTO surveys will provide Milky Way and Large Magellanic Cloud (LMC) templates from which star formation can be understood throughout cosmic time.
~300 dedicated SOFIA flights would be required to equal the GUSTO survey

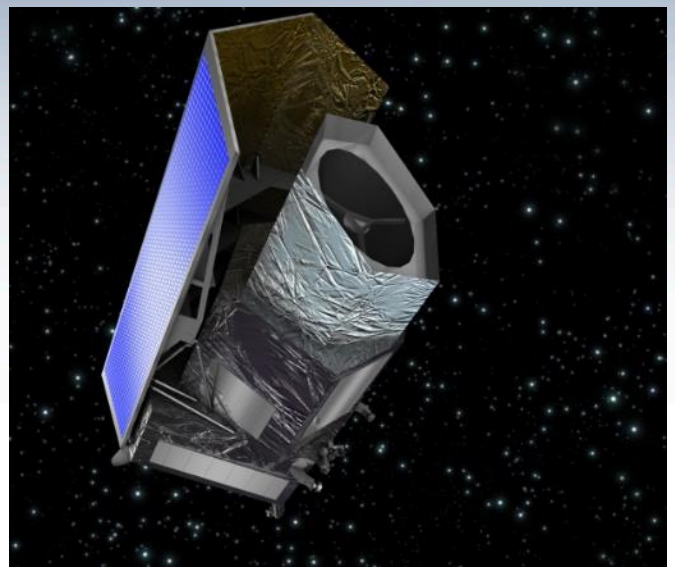


Flight Strategy, Launch from McMurdo on a SPB and allow payload to leave continued. Instrument recovery preferred, but optional. Target 100 day, acceptable baseline 29 days, cryogenic for ~160 days.

Brightest Line in *the FIR over cosmic times.*

GUSTO Lines

Euclid



- ESA Mission with NASA Collaborating
- ESA Cosmic Vision 2015-2025 Mission, M-Class
- Category 3 - Risk Class B
- Optical and NIR Observatory with 1.2-m Telescope
- U.S. Providing Characterized NIR Detectors
- Launch Date: Dec 2020
- ~70 U.S. Science Team members selected by NASA HQ
- Euclid NASA Science Center at IPAC

http://sci.esa.int/euclid/

BACKGROUND:

- Use two independent probes (weak lensing and galaxy clustering) to examine the nature of dark energy and dark matter, the initial conditions of the Universe, and the growth of large-scale structure.
- Examine expansion and star formation history of the Universe, investigate galaxy formation and evolution, conduct a deep NIR survey to explore the high-redshift Universe.

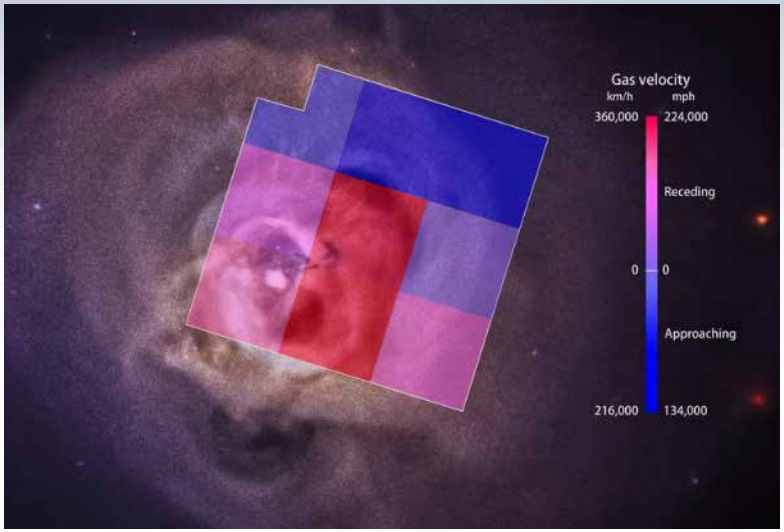
NASA CONTRIBUTION:

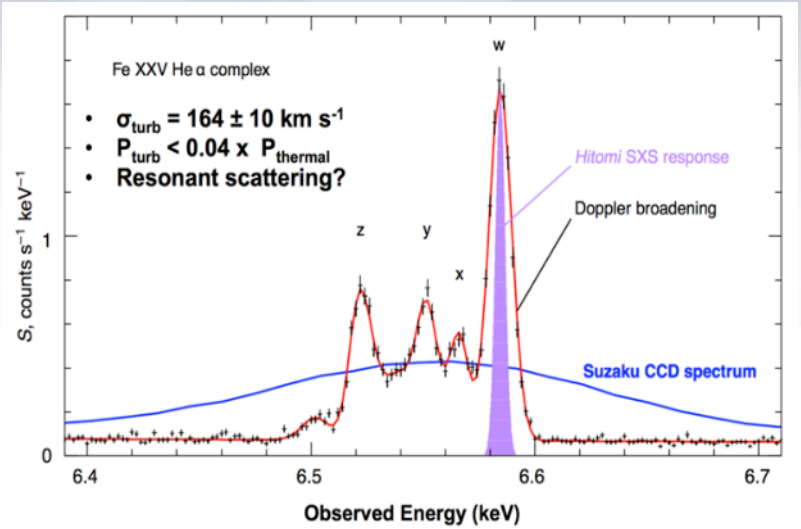
- Flight detectors for the NISP instrument: Multiple number of Sensor Chip Systems (SCS) where each chip consists of 2k x 2k HgCdTe array.
- NASA funded US Science Team.
- Ground system node and U.S. science center.

CURRENT STATUS:

- Flight hardware is being fabricated.
- First NASA flight units delivered to ESA in March 2017.
- ESA working toward a Dec 2020 launch date.

X-ray Astronomy Recovery Mission

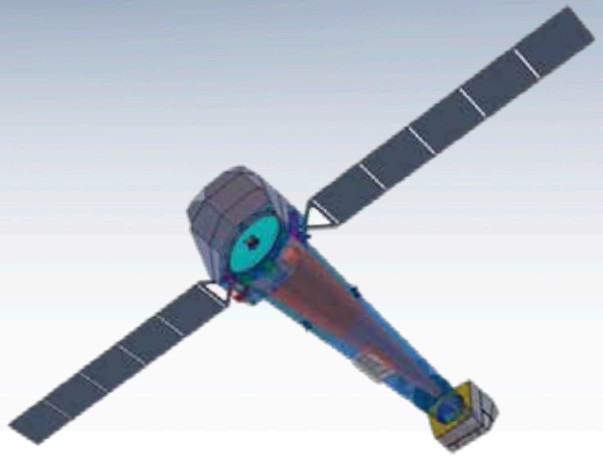




- XARM is the successor to Hitomi.
- Designed to provide breakthrough advances in our knowledge of winds, outflows, clusters, and dark matter.
- Mission will include an X-ray microcalorimeter and an X-ray imager.
- XARM approved by Japanese Diet, NASA formulation this summer.
- US Community Involvement
  - The US science community should expect a high level of involvement in the planning and execution of the XARM science mission.
  - NASA will openly solicit US participation at an appropriate time.

Athena

Advanced **T**elescope for **H**igh **En**ergy **A**strophysics



Second ESA Cosmic Vision Large mission

- L-class with NASA/JAXA participation
- Decadal Survey recommendation
- Large X-ray mirror, X-ray Integral Field Unit (XIFU) and Wide Field Imager (WFI) instruments

Launch Date: 2028

Breakthrough Capabilities:

- High Throughput, High spectral resolution X-ray Astronomy, Wide FOV
- 10x Chandra area, 100x improved non-dispersive spectral resolution, 5x FOV.

Enabling Technologies: Silicon pore optics, 3000+ pixel microcalorimeter (XIFU), large DEPFET array (WFI)

Science Objectives: The Hot and Energetic Universe: How does ordinary matter assemble into the large scale structures that we see today? How do black holes grow and shape the Universe?

CURRENT STATUS:

- Selected as second Large mission in ESA Cosmic Visions Program.
- Currently in 2-year Study Phase.
- NASA budgeting for a $100M-$150M hardware contribution, plus a U.S. GO program and a U.S. data center.
- NASA will contribute to both the X-IFU and the WFI.
- NASA and ESA are discussing other possible NASA contributions to the observatory.
- NASA and U.S. community involvement in Athena Science Study Team (including its SWG) and Instruments facilitated via series of RFI and CAs.
- Athena team will expand at Adoption in 2020; NASA anticipates this will provide an opportunity to expand U.S. community involvement.

www.the-athena-x-ray-observatory.eu

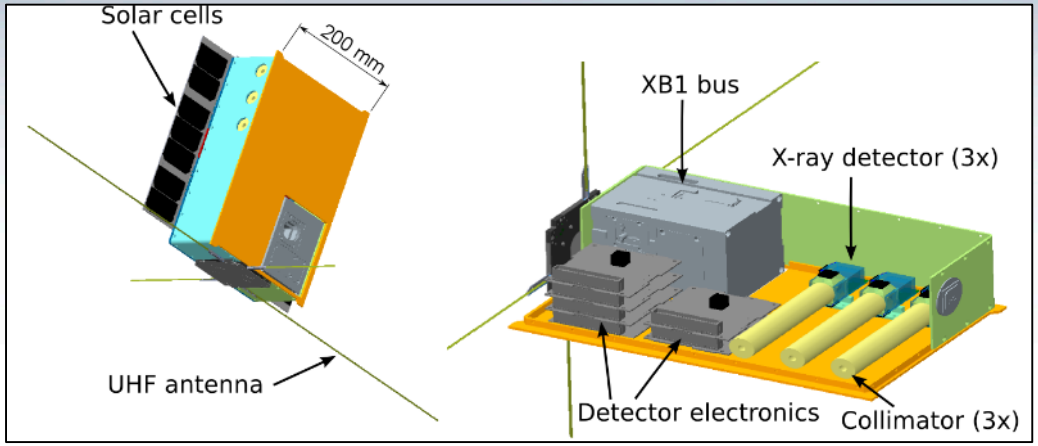
Status of the Large 3 (L3) Mission

- NASA established an L3 Study Office at Goddard Space Flight Center within the PCOS/COR Program Office in January 2017.
  - The L3 Study Office will coordinate technology development for the NASA hardware contribution to L3
  - The L3 Study Office will implement directions for US participation in the ESA-led mission concept study.
- The LISA Consortium has submitted a proposal to ESA for a space-based gravitational wave observatory in January 2017 in response to ESA's call for proposals for its "Gravitational Wave Universe" theme.
  - The proposal identifies laser interferometry as the baseline for the proposed mission, based on a three-arm architecture. ESA will announce proposal selection in June 2017
  - US participation was led by the NASA-appointed L3 Study Team. 21 US scientists (out of 82 total) are named as the core team on the LISA proposal.
- Technical Interchange Meetings were held between ESA and NASA in ESTEC, Netherlands, in early May to discuss the ESA Phase 0 study, possible NASA hardware contributions, and NASA participation in ESA system engineering activities.
- NASA is funding technology development in the following areas, as discussed in the LISA consortium proposal:
  - Phasemeters, microthrusters, lasers, telescopes, charge management system

https://www.elisascience.org/

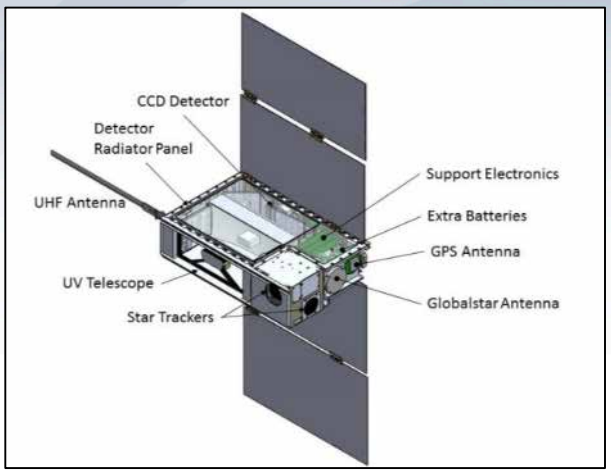
NASA Astrophysics CubeSats

HaloSat (X-ray)



- **PI**: Phil Kaaret, U Iowa
- **Co-I** at WFF, GSFC, JHU, CNRS
- **LRD**: Spring 2018, APRA-2014 selection
- **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 minimum, 1 year goal

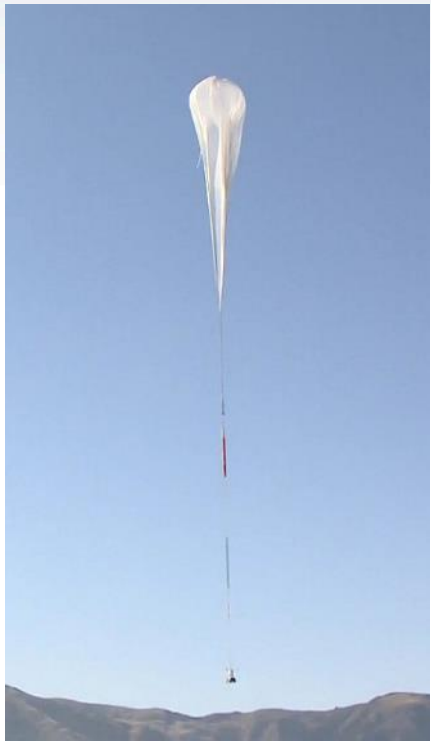
CUTE (UV)



- **PI**: Kevin France, Colorado U
- **LRD**: Spring 2020, APRA-2015 selection
- **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.
- **Operations**: 1 month minimum, 6 month full survey of 14 exoplanets.

2017 Balloon Campaigns

- Completed Spring FY17 Super Pressure Balloon Campaign @ New Zealand
  - **EUSO (**Extreme Universe Space Observatory on a Super Pressure Balloon) A. Olinto, U of Chicago -
    - **Launched:** April 24 from Wanaka, New Zealand.
    - First experiment to observe individual Ultrahigh Energy Cosmic Rays from top of the atmosphere using air fluorescence.
    - **Flight duration:** 12.2 days: Flight terminated due to (suspected) leak in super pressure balloon. Balloon and payload was dropped into the Pacific Ocean ~255 miles SE of Easter Island.
- Summer FY17 Conventional Balloon Campaign @ Palestine, TX (June 2017).
  - PIPER (Primordial Inflation Polarization Explorer)/A. Kogut/GSFC.
  - BETTI (Balloon Experimental Twin Telescope for Infrared Interferometry)/S. Rinehart/GSFC.
  - Superbit (Balloon-borne Imaging Telescope)/W. Jones/Princeton.
- Fall FY17 Conventional Balloon Campaign @ Fort Sumner, NM
  - PIPER (Primordial Inflation Polarization Explorer)/A. Kogut/GSFC.
  - FIREBALL (Faint Intergalactic medium Redshift Emission Balloon)/ C. Martin/Caltech
- Winter FY18 Long Duration Balloon Campaign in Antarctica (December 2017)
  - Payloads TBD



EUSO-SPB launch from Wanaka NZ

https://www.nsbf.nasa.gov/index.html

2017 & early 2018 Sounding Rocket Launches

CHESS3
(Colorado High-resolution Echelle Stellar Spectrograph)

PI - **K. France** / Univ. of Colorado **Jun 2017**
Technology development for future UV missions, characterizing ISM towards nearby stars.

DEUCE
(Dual-channel Extreme Ultraviolet Continuum Experiment)

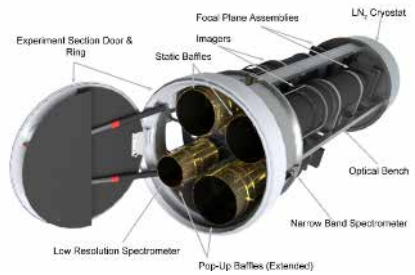
PI - **J. Green** / Univ. of Colorado **Oct 2017**
Technology development for future UV missions, physics of re-ionization from B stars at extreme UV.

Micro-X

PI - **E. Figueroa** / Northwestern Univ. **~Feb 2018**
Characterize plasma conditions in Puppis A SNR using Transition-Edge Sensors.

CIBER-2
(Cosmic Infrared Background Experiment)

PI - **J. Bock** / Caltech **Mar 2018**
Characterize the extragalactic near-infrared background light.



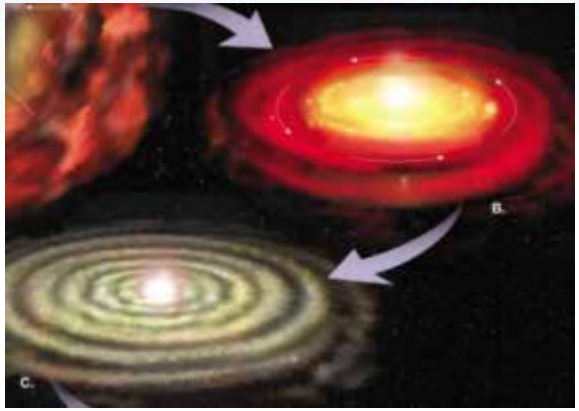
NASA Astrophysics

Backup

Why Astrophysics?

Astrophysics is humankind's scientific endeavor to understand the universe and our place in it.

1. How did our universe begin and evolve?

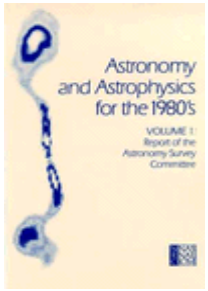


2. How did galaxies, stars, and planets come to be?

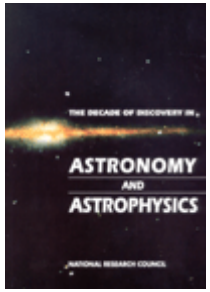
3. Are We Alone?

These national strategic drivers are enduring

1972

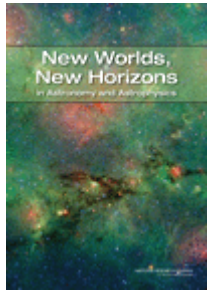


1982



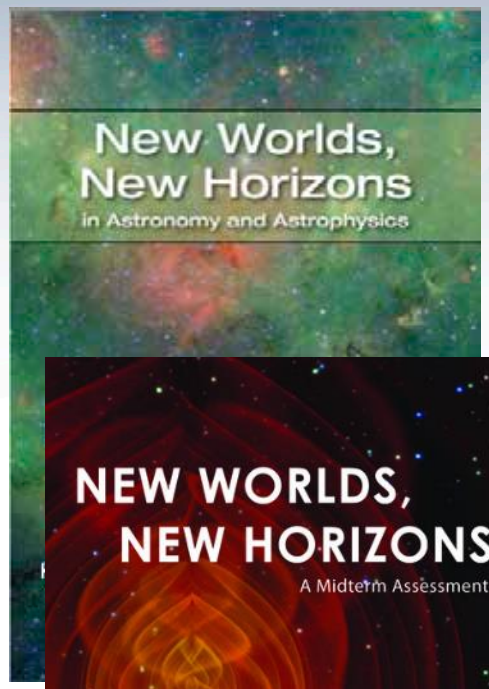
1991

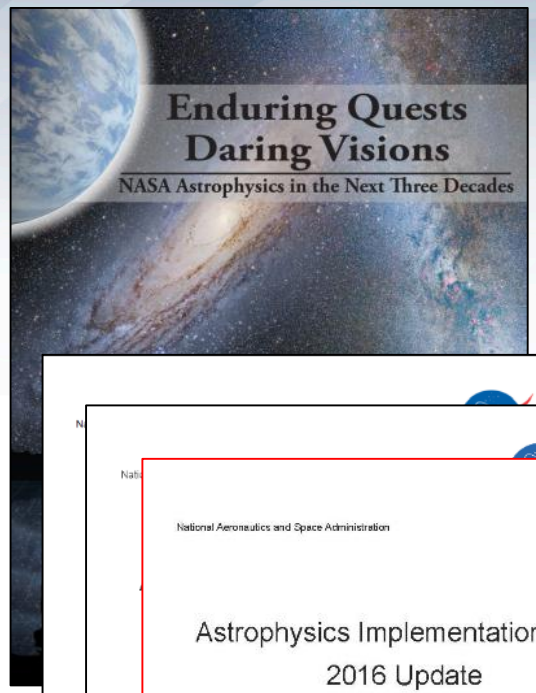
2001

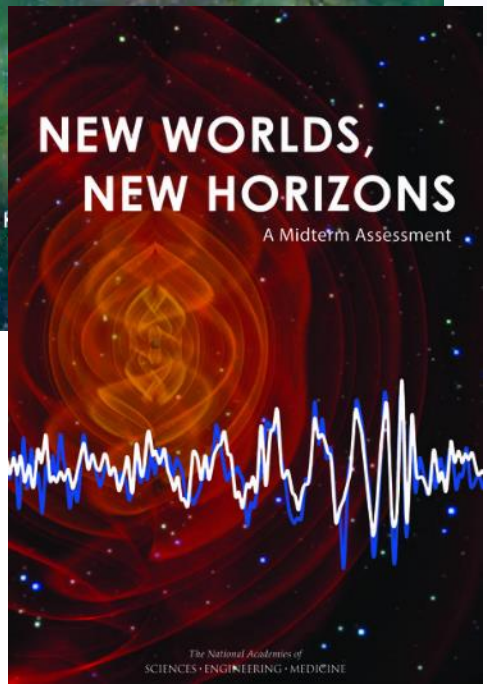


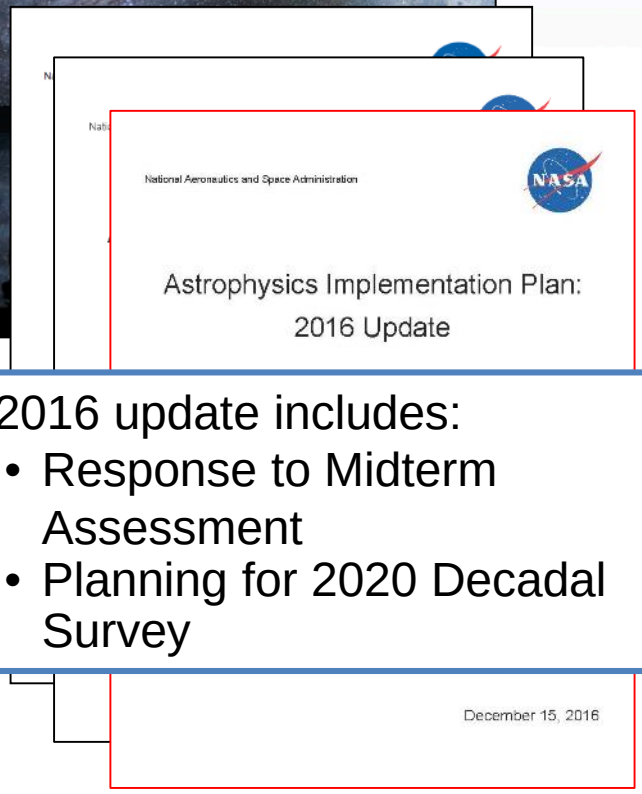
2010

Astrophysics Driving Documents









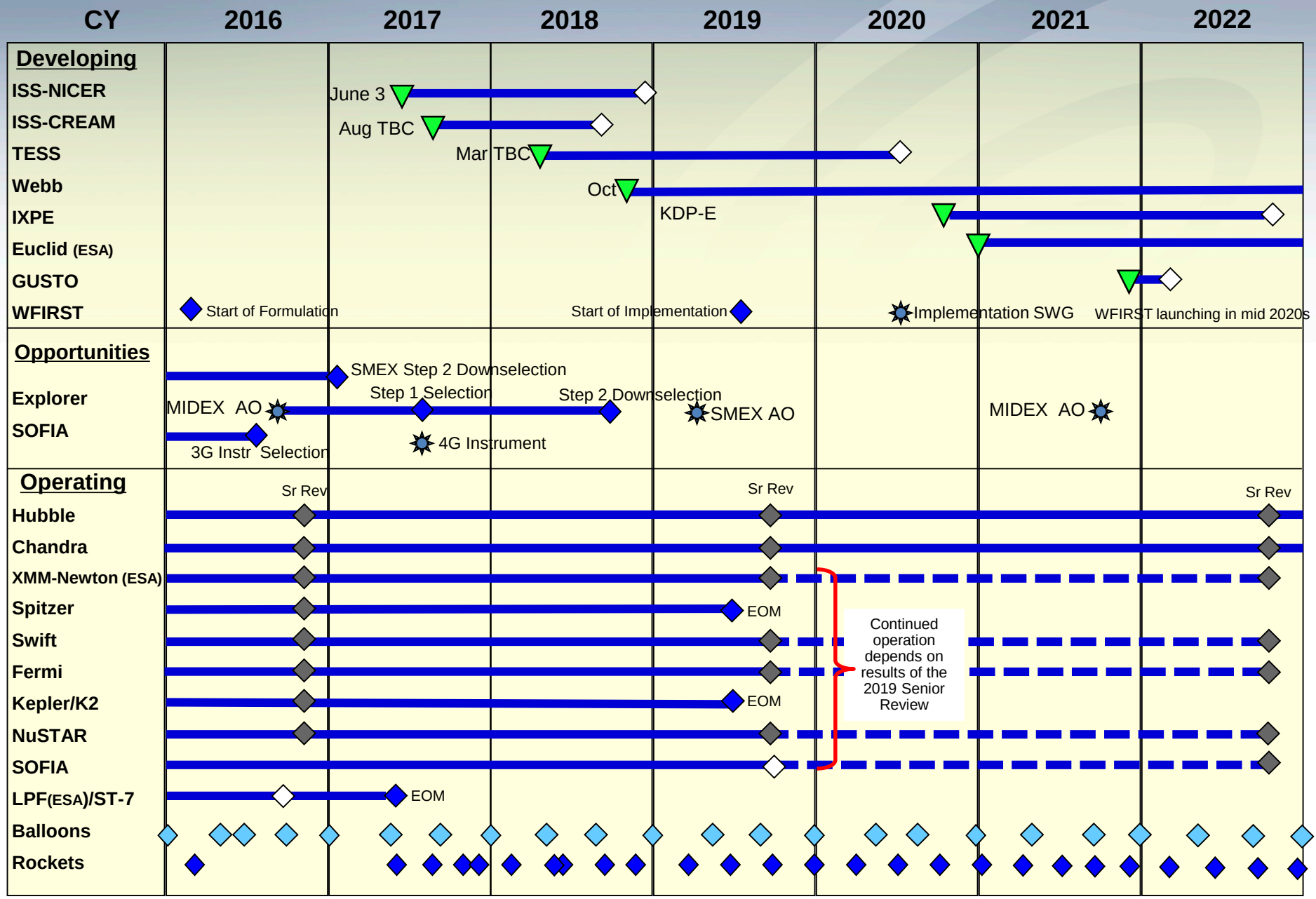
2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey

http://science.nasa.gov/astrophysics/documents

Astrophysics Science Mission Events

Last updated: May 8, 2017



Launch Date (mission 'working to' date) **Event Date** **End of Prime Mission** **Balloon Campaigns** **AO Release** (future is notional)

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, independent technical/management cost review
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

Change in NASA Advisory Committee

- The NASA Astrophysics Division has three Federal advisory committees:
  - National Academies' Committee on Astronomy and Astrophysics (CAA)
  - NSF/NASA/DOE Astronomy and Astrophysics Advisory Committee (AAAC)
  - NASA Astrophysics Advisory Committee (APAC)
- Astrophysics Advisory Committee (APAC) was previously called the Astrophysics Subcommittee of the NASA Advisory Council
- APAC has a new charter which allows it to
  - Send advice directly to the NASA Astrophysics Director
  - Have subordinate groups including the triennial Senior Reviews and the large mission concept Science and Technology Definition teams (STDTs)
- Current membership:

Natalie Batalha (ARC)	Mark Bautz (MIT)	Jamie Bock (Caltech)
Alan Boss (CIW)	Padi Boyd (GSFC)	Asantha Cooray (UC Irvine)
Neil Cornish (Montana St)	Brenda Dingus (LANL)	Debra Fischer (Yale)
Scott Gaudi (Ohio St) [Chair]	Jason Kalirai (STScI)	Feryal Ozel (Ariz) [Vice Chair]
Paul Scowen (Arizona St)	Yun Wang (IPAC)	Beth Willman (LSST Obs)

- Next meeting is July 19-20 at NASA HQ, Washington DC

https://science.nasa.gov/researchers/nac/science-advisory-committees/apac

Astrophysics Research 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 in ROSES for:
  - Fermi
  - Kepler/K2
  - Swift
  - NuSTAR
  - TESS (new)

Mission Science and Instrumentation

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

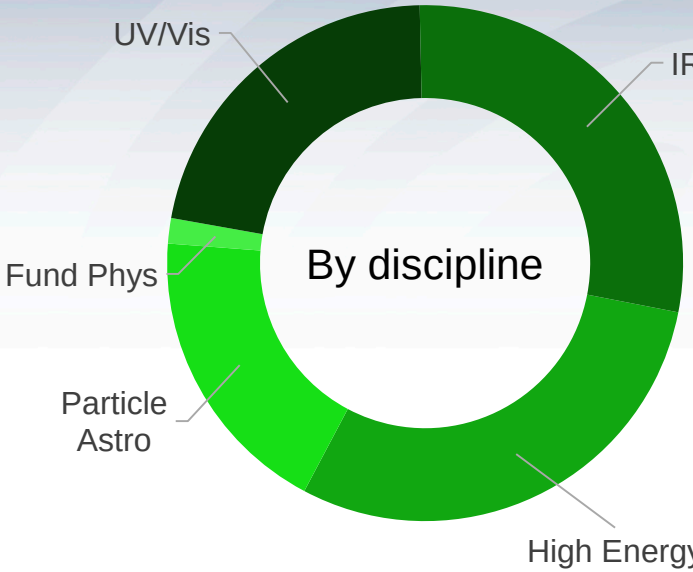
Separately Solicited

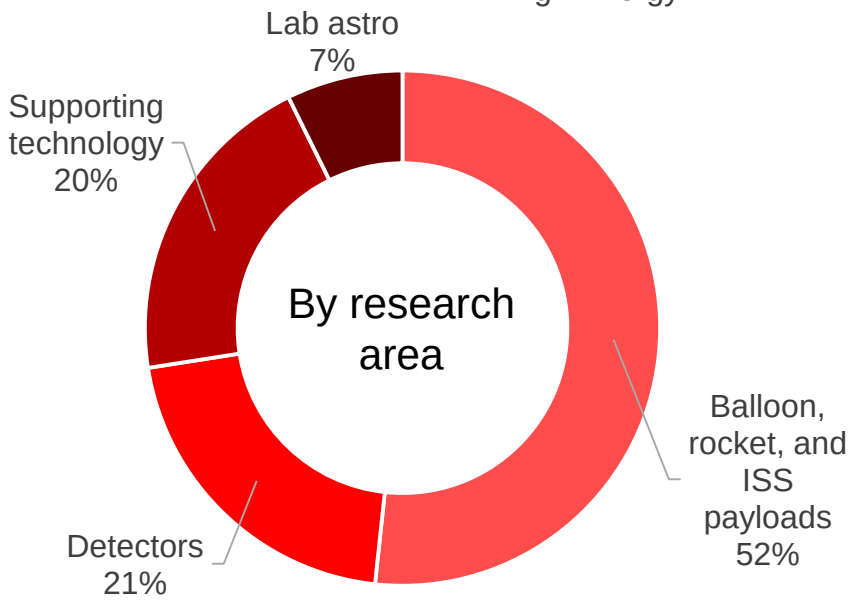
- GO/GI/Archive/Theory programs for:
  - Chandra
  - Hubble
  - SOFIA
  - Spitzer
  - Webb
- Postdoctoral Fellowships (Einstein, Hubble, Sagan)
- Graduate Student Fellowships (NESSF)

FY16 Spending Summary

APRA

50.3M





Recent Proposal Selections

Status: June 6, 2017

	Proposal Due Date	Notify Date	Days past received	Number received	Number selected	% selected
Fermi GI – Cycle 9	Jan 22, 2016	May 5, 2016	104	184	36	20%
NESSF-16	Feb 8, 2016	June 1, 2016	114	136	9	7%
Kepler K2 GO – Cycle 4	Mar 4, 2016	July 11, 2016	118	109	36	33%
Chandra GO – Cycle 18	Mar 15, 2016	July 18, 2016	125	556	168	30%
APRA (Basic Research)	Mar 18, 2016	Aug 13, 2016	148	157	64	41%
SAT (Technology)	Mar 18, 2016	Aug 15, 2016	150	29	7	24%
Hubble GO – Cycle 24	Apr 8, 2016	June 24, 2016	77	1094	245	22%
ADAP (Data Analysis)	May 13, 2016	Sep 22, 2016	132	238	45	19%
Exoplanet Research	May 23, 2016	Oct 7, 2016	134	47	9	19%
Spitzer GO – Cycle 13	June 8, 2016	Aug 5, 2016	58	115	49	43%
SOFIA GI – Cycle 5	July 1, 2016	Oct 25, 2016	116	179	71	40%
Astrophysics Theory	July 8, 2016	Dec 9, 2016	154	201	36	18%
Swift GI – Cycle 13	Sep 23, 2016	Jan 17, 2017	147	155	39	25%
Kepler K2 GO – Cycle 5	Dec 15, 2016	April 4, 2017	110	91	28	31%
NuSTAR GO – Cycle 3	Jan 27, 2017	May 10, 2017	103	217	80	37%
Fermi GI – Cycle 10	Feb 24, 2017	May 30, 2017	95	183	43	23%

100% of recent announcements within 154 days

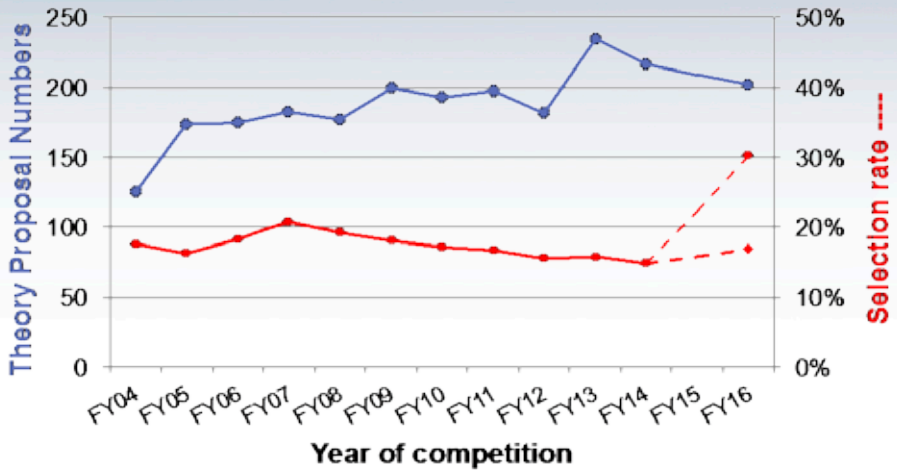
R&A Selection Rate: 23%; GO Selection Rate: 27%

Proposal Opportunities

	Proposal Due Date	Reference
SOFIA Cycle 6	June 30, 2017	www.sofia.usra.edu
Astrophysics Theory Program (ATP)	July 27, 2017	ROSES-17 D.4
Webb Early Release Science	August 18, 2017	jwst.stsci.edu
Keck Observing	September 14, 2017	nexsci.caltech.edu/missions/KSA/
Swift Guest Investigator - Cycle 14	September 21, 2017	ROSES-17 D.5
XMM-Newton - Cycle 17	October 6, 2017	heasarc.gsfc.nasa.gov
K2 Guest Investigator - Cycle 6	Fall 2017 (Step 0); Spring 2018 (Steps 1 and 2)	ROSES-17 D.7
NuSTAR General Observer - Cycle 4	Winter 2017/18	ROSES-16 D.10
Fermi Guest Investigator - Cycle 11	Winter 2017/18	ROSES-16 D.6
NESSF	Approx February 2018	NSPIRES
Webb General Observer Cycle 1	March 2, 2018	jwst.stsci.edu
Chandra General Observer - Cycle 20	Approx March 2018	cxc.harvard.edu
Nancy Grace Roman Technology Fellowship	March 15, 2017	ROSES-16 D.9
Strategic Astrophysics Technology (SAT)	March 15, 2017	ROSES-16 D.8
Astrophysics Research and Analysis (APRA)	March 15, 2017	ROSES-16 D.3
TESS Guest Investigator - Cycle 1	9 months before launch	ROSES-17 D.11
TCAN	Spring 2018	ROSES-17 D.12
SOFIA next-generation instrumentation	TBD	ROSES-17 D.13

ROSES-2017 Changes

Astrophysics Theory Program (ATP)



- ATP selection rates have been <20% for the past decade
  - Increases burden on proposers and reviewers
  - Most proposals rated VG do not receive funding
- Beginning in ROSES-2017, ATP proposals will be solicited every other year
- No reduction to ATP budget, twice as many selections, half as often
- Success rates likely to increase to ~30%

Theoretical and Computational Astrophysics Networks (TCAN)

- TCAN supports coordinated efforts in fundamental theory and computational techniques.
- TCAN aims to unite researchers in collaborative networks that cross institutional and geographical divides.
- NASA expects to issue a call for proposals for TCAN with its deadline late in the ROSES-2017 cycle (early CY 2018).

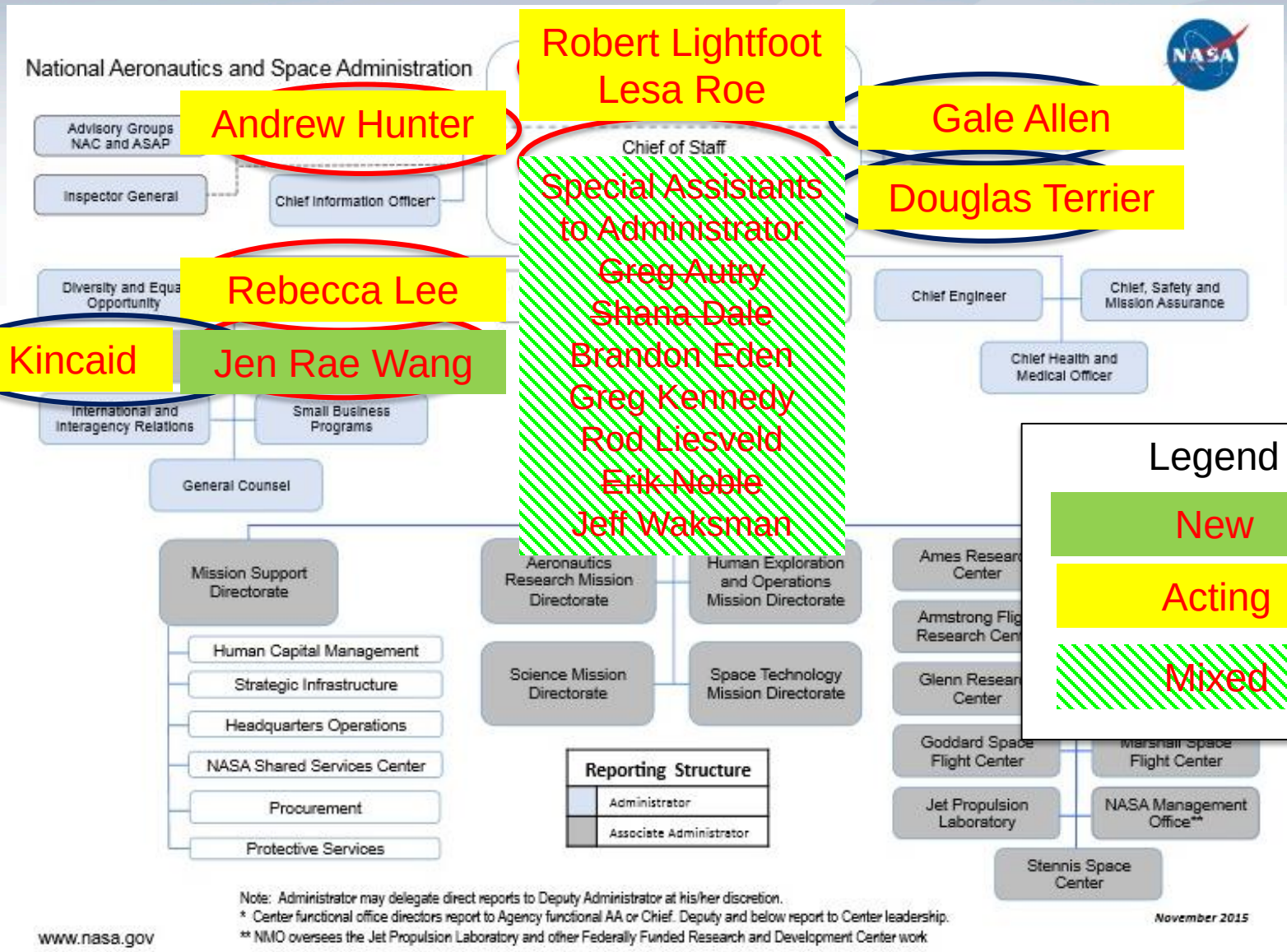
Internal Funding Model for NASA Civil Servant Scientists
Goals

- The amount of directed Research and Analysis (R&A) work at the Centers will be increased
  - This will result in a decrease in R&A proposals from NASA Center scientists
  - NASA civil servant scientists may still compete for R&A, but in reduced numbers
  - Mission AOs and mission-funded guest observer (GO) programs will not be directed
- All directed R&A work will be collaboratively planned between the Centers and HQ/SMD Divisions
  - The amount and type of directed work will vary between individual Centers and Divisions
- All directed R&A work will be peer reviewed
  - This will include both initial and periodic external peer reviews
- The fraction of R&A funding going to the Centers will remain consistent with historical levels and the increase in directed R&A work at the Centers will not impact the balance between internal and external funding

Internal Funding Model for NASA Civil Servant Scientists
Changes

- NASA is adjusting its internal funding model for civil servant scientists to include more directed work for critical-sized groups
  - This is an internal realignment to use NASA civil servant scientists more efficiently
  - It focuses on work that can best be done or only be done at NASA Centers
  - It does not affect the balance between internal and external funding
  - All directed work will be externally reviewed
- Objectives and benefits of this new model
  - Enhance the value of Agency funds by having the NASA civil servant scientists work on tasks that are substantial, strategic, focused, and that enable the broader science community, rather than compete with the external science community
  - Ensure that NASA civil servant scientists advance tasks that meet NASA objectives and can best/only be done at NASA Centers, resulting in science, technology, capabilities, and missions that are tightly integrated
  - Ensure a critical mass of selected capabilities necessary to conduct complex research on key topics
  - Adopt a strategic implementation that will reduce the number of proposals written by NASA civil servant scientists and improve the efficiency of inherently governmental work
- There will be no change in the balance of the research budget allocated between NASA civil servant scientists and the external community
  - The new funding model is designed to be neutral regarding the fraction of funding going to the external scientific community

2017 Transition



NASA Transition Authorization Act of 2017

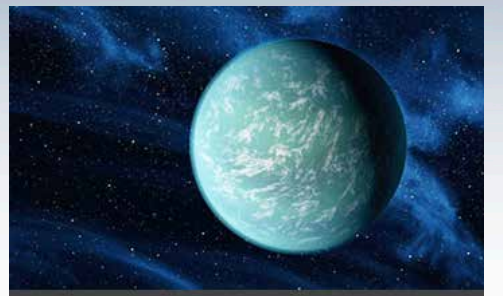
Language relevant to NASA Astrophysics includes:

- 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

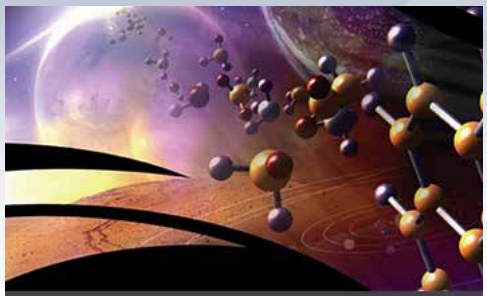
Plus a whole lot of reports

Habitable Exoplanet Imaging Mission (HabEx)

https://www.jpl.nasa.gov/habex



The primary goal of HabEx is to image and study habitable exoplanets. However, it will also study the full range of exoplanets within the systems.



HabEx will search for potential signs of habitability in the atmospheres of exoplanets by seeking signs of water and other biosignature gases, including oxygen and ozone.

With a large aperture optical/infrared space-based telescope, it will be possible for HabEx to study a broad range of Galactic and extragalactic astrophysics.

- Study Leads:
  - Community Chairs: Scott Gaudi (Ohio State), Sara Seager (MIT)
  - Study Scientist: Bertrand Mennesson (JPL), Study Manager: Keith Warfield (JPL)
- 9 science and technology working groups
- Building upon the Exo-C and Exo-S probe study reports
- Currently studying trades for a 4-m monolithic-mirror telescope with coronagraph and/or starshade source suppression
  - Additional trade study planned for a 6.5-m segmented mirror
- Investigating optical, UV and NIR for suitable molecular biosignatures
  - R ~ 100, IWA $\lesssim$ 0.1 arcsec, planet-star contrast ~ 10^{-10}
- Potential general astrophysics instrumentation under investigation:
  - Imaging ~ FOV 3'x3', UV spectrograph R ~ 5,000, λ > 100nm, multi-object spectroscopy

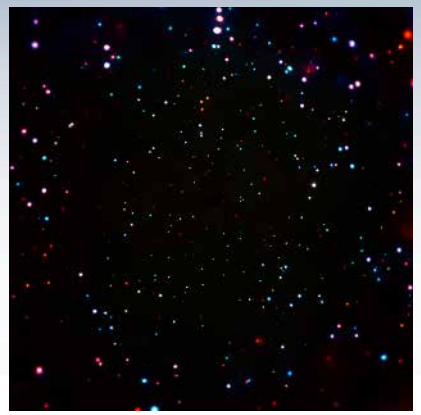
Large UV/Optical/IR Surveyor (LUVOIR)

https://asd.gsfc.nasa.gov/luvoir/

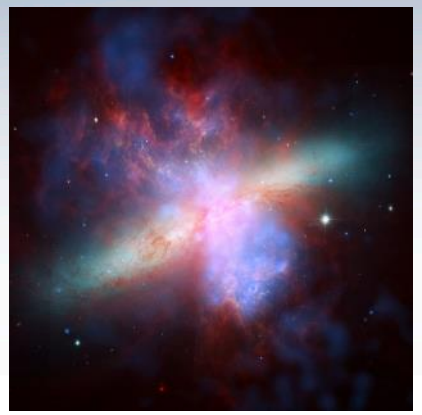
- The STDT decided in November 2016 to study two distinctly sizes of LUVOIR mission (15-m and ~9-m telescopes; Architecture A and B, respectively).
  - Architecture A will have four instrument bays. Three instruments will be designed at GSFC (a coronagraph, a UV multi-object spectrograph, and a wide-field imager). A fourth instrument will be studied by a European consortium, with leadership from the French Space Agency (CNES). Architecture B will have a different combination of three instruments.
  - The Architecture A telescope and its three US instruments completed their detailed design studies in May 2017. The integrated mission study for Architecture A will wrap up in July 2017. Design studies for Architecture B will begin in Sept 2017.
- The LUVOIR team has developed several observation simulation tools, available at https://asd.gsfc.nasa.gov/luvoir/tools/. Work has begun on writing the Interim Report.
- LUVOIR capabilities were presented at the Planetary Science Vision 2050 workshop and at the HST/JWST 5 conference the week of March 20.
- A Cooperative Agreement Notice (CAN) was issued for industry partners to contribute to the LUVOIR System Studies. In April 2017, two one-year awards were given to:
  - Northrop Grumman, Harris Corporation, and Ball Aerospace to jointly address all of the topics described in the solicitation.
  - Lockheed Martin to develop their vibration isolation precision pointing system (Disturbance Free Payload).

Lynx

http://wwwastro.msfc.nasa.gov/lynx/

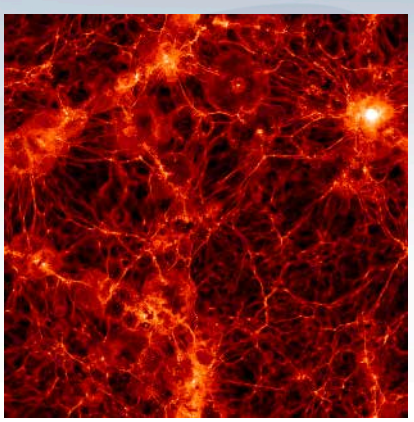


Black hole seeds at z≈10



Solving galaxy formation

Stellar birth and death

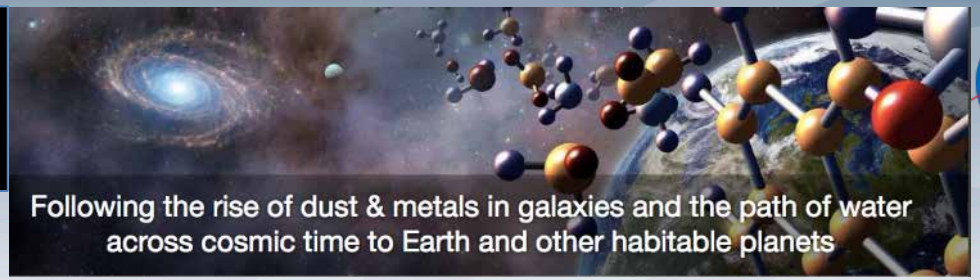


Baryons in the cosmic web

A very high angular resolution, very large area X-ray Observatory for the 2030s

- Study Leads:
  - Community Chairs: Feryal Özel (Arizona), Alexey Vikhlinin (SAO)
  - Study Scientist: Jessica Gaskin (MSFC), Study Manager: Karen Gelmis (MSFC)
- 10 science, optics, and instrumentation working groups, over 200 members
- Currently studying trades for a 3m diameter x 10m focal length telescope.
  - Also considering 6m diameter x 20m focal length configuration.
- MSFC Advanced Concepts Office studies underway.
- Instruments under consideration include a High Definition X-ray Imager (HDXI), a large-format X-ray calorimeter, and a grating spectrometer.
- Extensive engagement with industry.
- “From Chandra to Lynx” workshop, August 8-10, Cambridge, MA

ORIGINS Space Telescope



http://origins.ipac.caltech.edu/
https://asd.gsfc.nasa.gov/firs/

- A large (~9m), cold (~4K) telescope, 6—600 mm with a 0.3 sq degree FOV.
- Community Chairs: Margaret Meixner (STScI), Asantha Cooray (UC Irvine)
  - GSFC Study team: Ruth Carter, Dave Leisawitz, Johannes Staguhn
  - 7 science and technology working groups / groups + wiki open to community
- In current design, telescope has a 9.1 m segmented primary (building on Webb + Herschel lessons + SAFIR, SPICA)
- 5 instruments under study (2 GSFC, 1 JPL, 1 CNES and 1 JAXA)
  - Mid-IR instrument w/ coronagraph for molecular biosignatures (e.g., water, ozone, methane) + inner regions proto-planetary disks / far-out Saturn/Jupiters
  - Mid-IR medium-res spectrometer & FIR high-res spectrometer for rise of metals, dust, disk masses across all evolutionary stages of a proto-planetary disk, co-evol black holes and galaxies + water across cosmic time
  - FIR Imager / Polarimeter for large galaxy surveys, solar system science, and ISM energetics (polarimetry)
  - Heterodyne spectrometer for Galactic star formation and ISM studies
- Second concept design study planned

Preparing for the 2020 Decadal Survey
Large Mission Concepts

	Community STDT Chairs	Upcoming Meetings
Habitable Exoplanet Imaging Mission www.jpl.nasa.gov/habex	Scott Gaudi Sara Seager	August 1-4 @ JPL
Large UV/Optical/IR Surveyor asd.gsfc.nasa.gov/luvoir	Debra Fischer Bradley Peterson	July 5 @ STScI
Lynx X-ray Surveyor wwwastro.msfc.nasa.gov/lynx	Feryal Ozel Alexey Vikhlinin	August 8-10 @ SAO
Origins Space Telescope asd.gsfc.nasa.gov/firs	Asantha Cooray Margaret Meixner	June 14-15 @ Washington DC

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