National Aeronautics and Space Administration

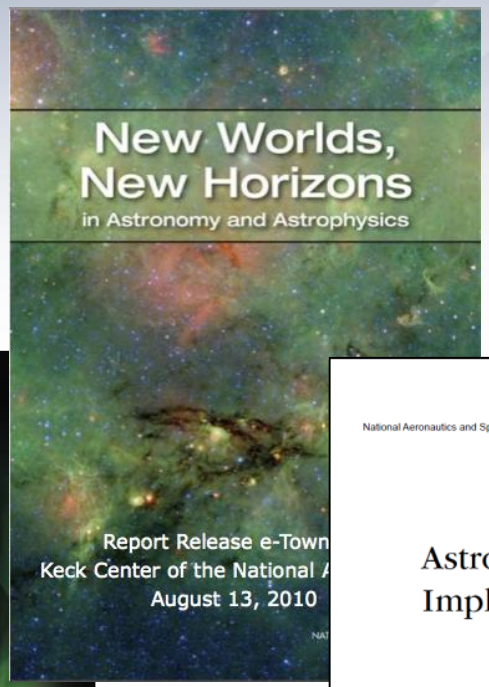
Astrophysics

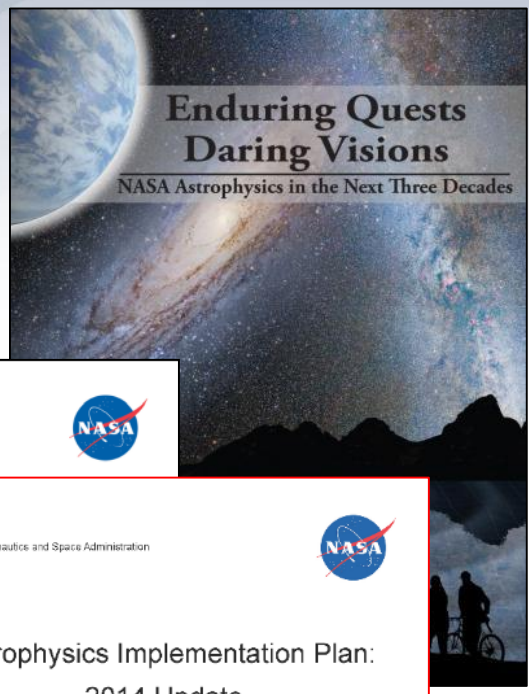


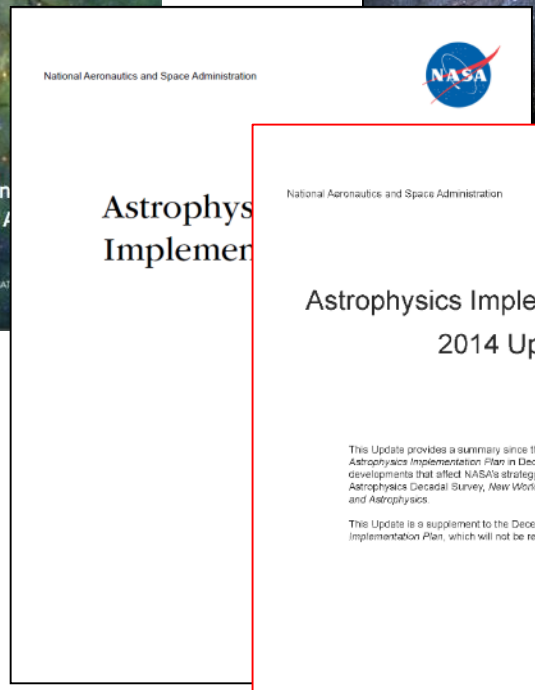

NAC Science Committee
NASA Headquarters
March 10, 2016

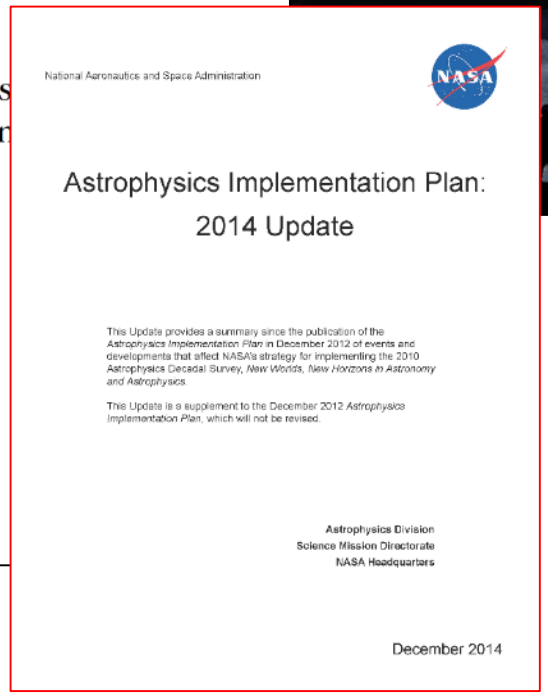
Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

Astrophysics Driving Documents







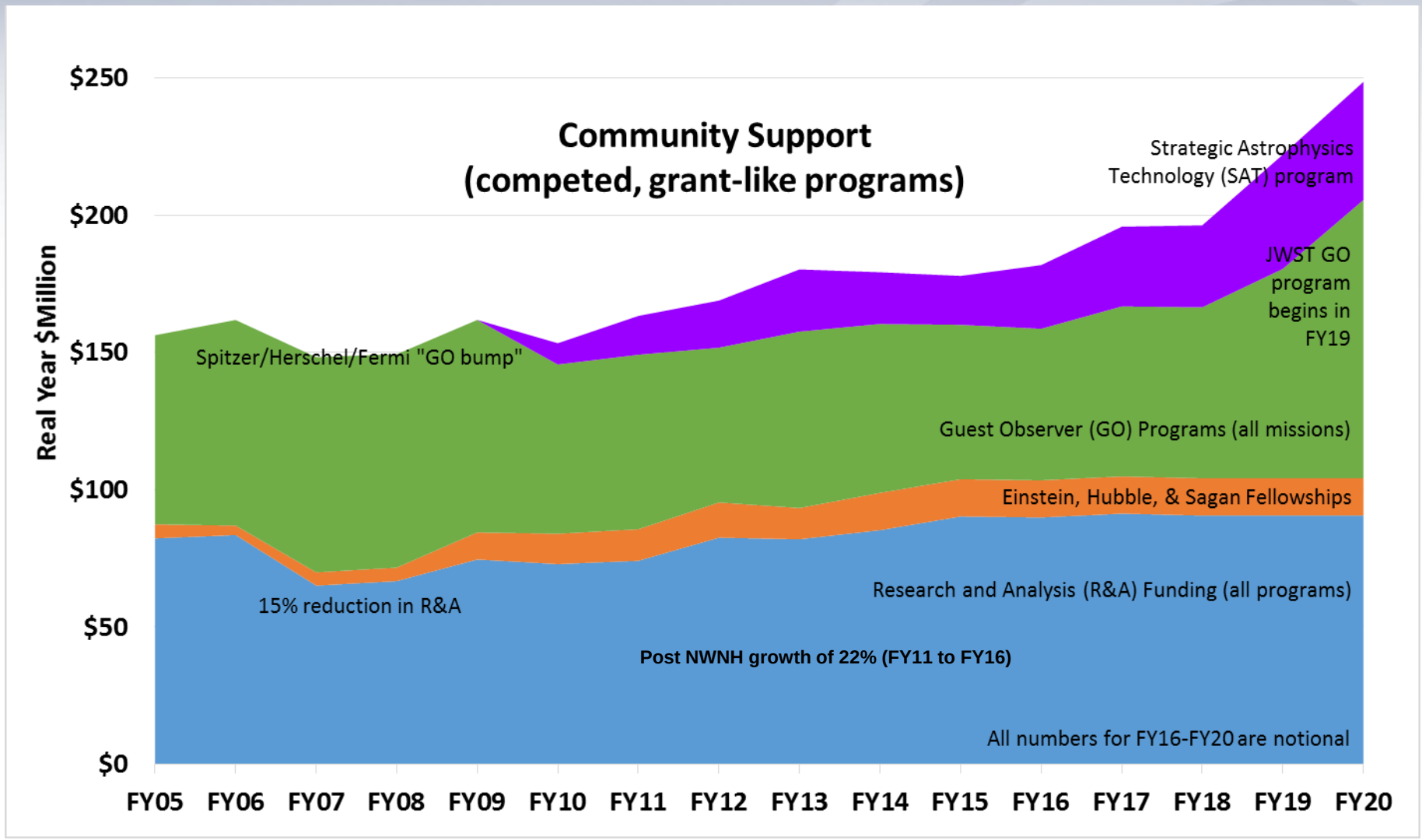


http://science.nasa.gov/astrophysics/documents

Astrophysics - Big Picture

- **The FY16 appropriation and FY17 President's budget request provide funding for NASA astrophysics to continue its programs, missions, projects, and supporting research and technology.**
  - The total funding (Astrophysics including JWST excluding STEM) remains at ~$1.35B.
  - Fully funds JWST to remain on plan for an October 2018 launch.
  - Funds WFIRST formulation (new start) starting in February 2016.
  - Will require some adjustments to FY16 plans in response to appropriation levels.
  - Will require some adjustments to FY17 proposal depending on Senior Review outcome.
- **The operating missions continue to generate important and compelling science results, and new missions are under development for the future.**
  - Chandra, Fermi, Hubble, Kepler/K2, NuSTAR, Spitzer, Swift, ESA's XMM-Newton all operating well; Senior Review is in Spring 2016 for FY17 and beyond.
  - SOFIA is in 5-year prime operations as of May 2014; HAWC+ 2nd generation instrument to begin commissioning in Spring 2016; 3rd generation instrument concept studies selected; Senior Review for SOFIA is in Spring 2018.
  - ESA's LISA Pathfinder successfully launched on December 3, 2015.
  - JAXA's Hitomi (neé ASTRO-H) successfully launched on February 17, 2016.
  - Missions under development for launch include NICER (2017), ISS-CREAM (2017), TESS (2017), JWST (2018), ESA's Euclid (2020), WFIRST (mid-2020s).
  - 5 SMEX and MO concept studies selected in 2015; MIDEX AO in 2016; NASA joining ESA's Athena X-ray observatory and ESA's L3 gravitational wave observatory.
- **Progress being made toward recommendations of the 2010 Decadal Survey.**
  - NRC Mid Decade Review (with NSF, DOE) underway; Jackie Hewitt (MIT) is chair; NRC Mid Decade Review committee report expected in May 2016.
  - NASA initiating large mission concept studies as input for 2020 Decadal Survey.

Core Research Support for the Community



Proposal Selections in 2015

Status: January 1, 2016

	Proposal Due Date	Notify Date	Days past received	Number received	Number selected	% selected
Kepler K2 GO – Cycle 1	Sep 23, 2014	Jan 16, 2015	115	92	36	39%
Swift GI – Cycle 11	Sep 25, 2014	Jan 6, 2015	123	165	39	24%
Roman Tech Fellows	Nov 6, 2014	Feb 3, 2015	89	8	3	38%
NuSTAR GO – Cycle 1	Nov 25, 2014	Apr 17, 2015	143	193	35	18%
Fermi GI – Cycle 8	Jan 22, 2015	June 26, 2015	155	190	36	19%
NESSF-15	Feb 6, 2015	June 2, 2015	116	134	10	7%
Kepler K2 GO –					35	46%
Chandra GO –					75	30%
APRA (Basic R					40	27%
SAT (Technolo					9	32%
Hubble GO – C					61	23%
EPDS (Doppler Spectr)	Apr 24, 2015	July 2, 2015	69	6	2	33%
ADAP (Data Analysis)	May 15, 2015	Sep 29, 2015	137	250	51	20%
Exoplanet Research	May 22, 2015	Oct 15, 2015	146	43	7	16%
Kepler K2 GO – Cycle 3	Jul 1, 2015	Oct 14, 2015	105	72	32	44%
SOFIA GI – Cycle 4	Jul 10, 2015	Oct 22, 2015	104	155	82	53%
Spitzer GO – Cycle 12	Sep 11, 2015	Oct 26, 2015	45	104	31	30%
SOFIA 3rd Gen Instrument	Oct 7, 2015	Dec 10, 2015	64	3	2	67%
WFIRST Sci. Inv. Teams	Oct 15, 2015	Dec 18, 2015	64	38	12	32%
Swift GI – Cycle 12	Sep 25, 2015	Dec 30, 2015	106	165	39	24%

100% of 2015 selections announced within 155 days

R&A Selection Rate: 24%
GO Selection Rate: 28%

2016 Senior Review Timeline

Action	Date	Done
Draft Call for Proposals issued	August 20, 2015	✓
Deadline to send comments on draft to NASA	September 10, 2015	✓
Final Call for Proposals issued	September 25, 2015	✓
Senior Review Proposals due	January 22, 2016	✓
Main panel meets in Washington, DC	February 22-25, 2016	✓
HST review and site visit in Baltimore, MD	March 8-10, 2016	✓
CXO review and site visit in Cambridge, MA	March 22-24, 2016	
Delivery of panel reports to NASA HQ	April 2016	
NASA Response/direction to projects. Reports released on APD website.	May-June 2016	

For more information:

http://science.nasa.gov/astrophysics/2016-senior-review-operating-missions/

ST-7/LISA Pathfinder
ST-7/Disturbance Reduction System (DRS)

- ESA Mission with NASA Collaborating
- Project Category: 3 Risk Class: C
- DRS flies on the ESA LISA Pathfinder spacecraft
- Sun-Earth L1 halo orbit
- Drag-free satellite to offset solar pressure
- Payload delivery: July 2009
- Launched: December 3, 2015 GMT
- LPF prime mission: 7 months
- Data Analysis: 12 months

http://sci.esa.int/lisa-pathfinder/

CURRENT STATUS:

- LISA Pathfinder successfully launched on December 3, 2015.
- Satellite reached Earth-Sun L1 on Jan 22 and all systems are nominal.
- Test masses released on Feb 15 (“Elwood”) and Feb 16 (“Jake”) are operating nominally.
- Began science operations on March 1, 2016.

  - ESA’s LISA Test Package for 90 days
  - NASA’s Disturbance Reduction System for 90 days
- ESA planning short (2-3 months) mission extension if all goes well

Hitomi (formerly ASTRO-H)
Soft X-ray Spectrometer and Soft X-ray Telescope Mirrors

- **Explorer Mission of Opportunity**
- **PI**: R. Kelley, Goddard Space Flight Center
- **Launch Date**: Feb 17. 2016 on JAXA H-IIA
- **Science Objectives**: Study the physics of cosmic sources via high-resolution X-ray spectroscopy. The SXS enables wide range of physical measurements of sources from stellar coronae to clusters of galaxies.
- **Operations**: Prime Mission is 3 years

CURRENT STATUS

The U.S. provided instrument contributions to the JAXA Hitomi mission.

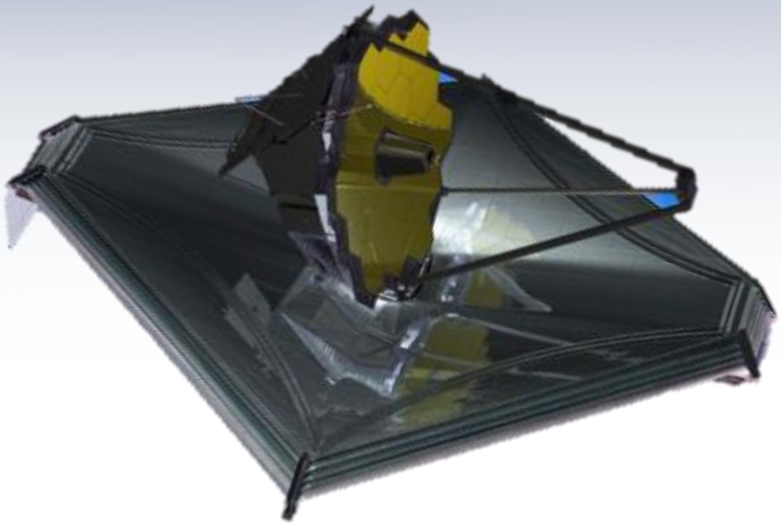
- Soft X-ray telescope mirrors (SXT-S and SXT-I)
- X-ray Calorimeter Spectrometer Insert (CSI), including Adiabatic Demagnetization Refrigerator (ADR) and ADR Controller
- Aperture Assembly
- X-ray Electronics Box (X-box)
- High Temperature Superconducting Leads

- Successfully launched from Tanegashima Space Center, Hitomi is continuing on-orbit checkout.

- Feb 25 – SXS first light ✓
- Feb 28 – Deployment of extendable optical bench ✓
- Mar 6 – Turn on SXI instrument
- April 8 – Open SXS gate valve
- Late Spring 2016 (TBC) – NASA Cycle 1 GO call

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

JWST
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

2015 Accomplishments

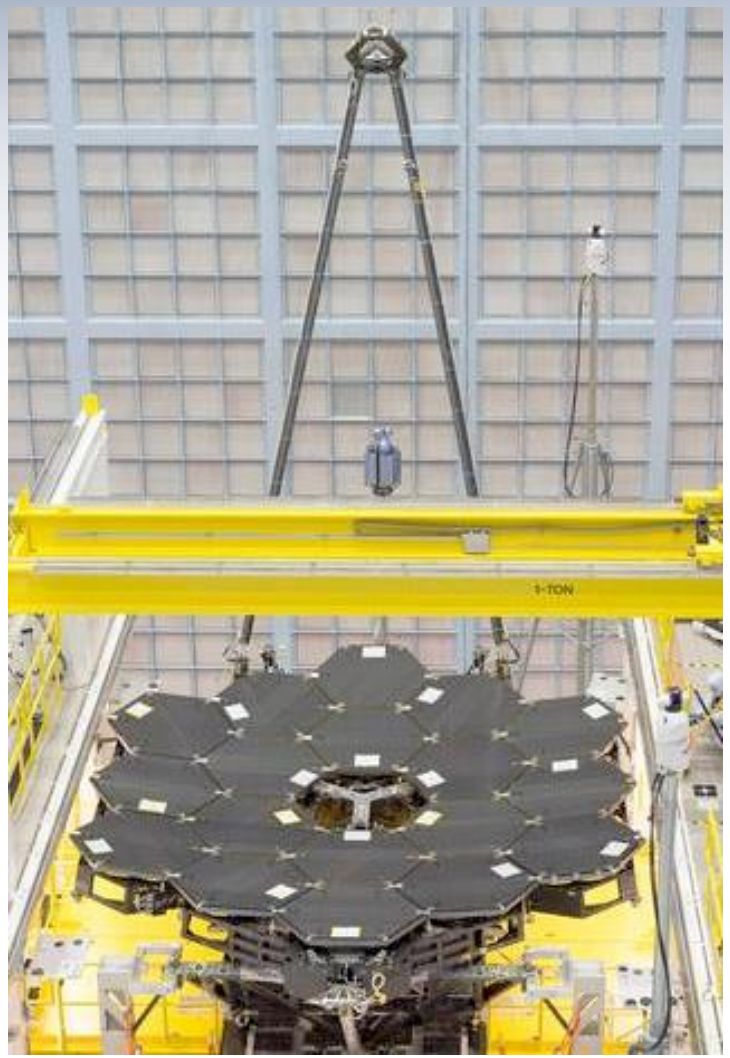
- Completed Telescope Structure
- Completed second Telescope Pathfinder test at JSC
- All updates/fixes made to ISIM following 2nd cryovacuum test
- Spacecraft Bus Structure delivered to I&T
- Final ISIM cryovacuum test started
- Mirror installation onto Telescope Structure started

2016 Plans

- Complete ISIM cryovacuum testing ✓
- Complete mirror installation ✓
- Install ISIM into Telescope Structure
- Complete Flight Sunshield Membranes
- Conduct final GSE test at JSC before test of Flight telescope and instruments

http://www.jwst.nasa.gov/

JWST Hardware Progress



JWST remains on track for an October 2018 launch within its replan budget guidelines

http://jwst.nasa.gov/webcam.html

Astrophysics Missions in Development

NICER
3/2017

NASA Mission

Neutron Star Interior Composition Explorer

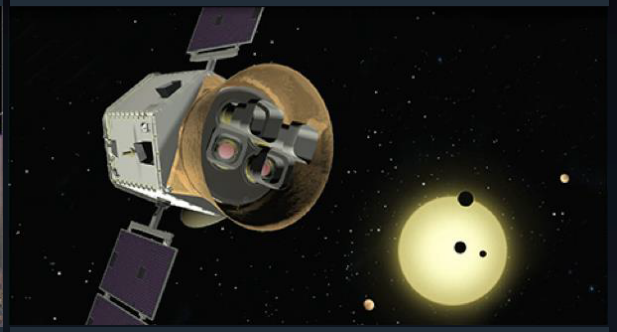
CREAM
7/2017

NASA Mission

Cosmic Ray Energetics And Mass

TESS
8/2017

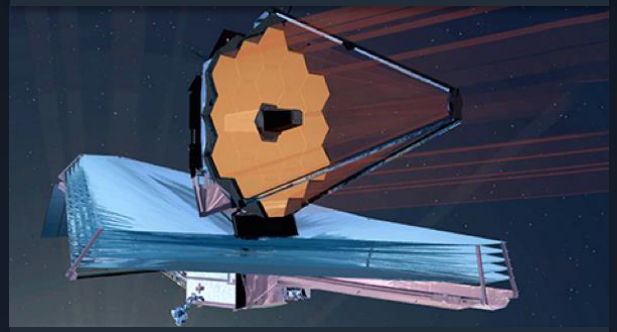
NASA Mission



Transiting Exoplanets Survey Satellite

JWST
10/2018

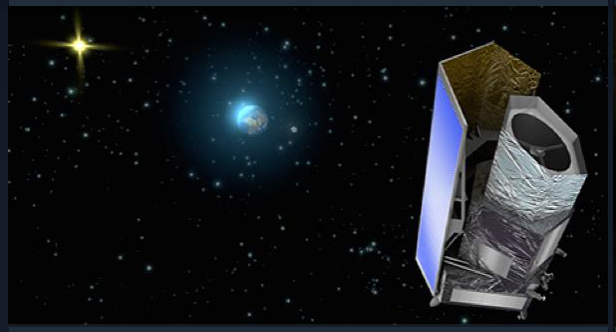
NASA Mission



James Webb Space Telescope

Euclid
2020

ESA-led Mission



NASA is supplying the NISP Sensor Chip System (SCS)

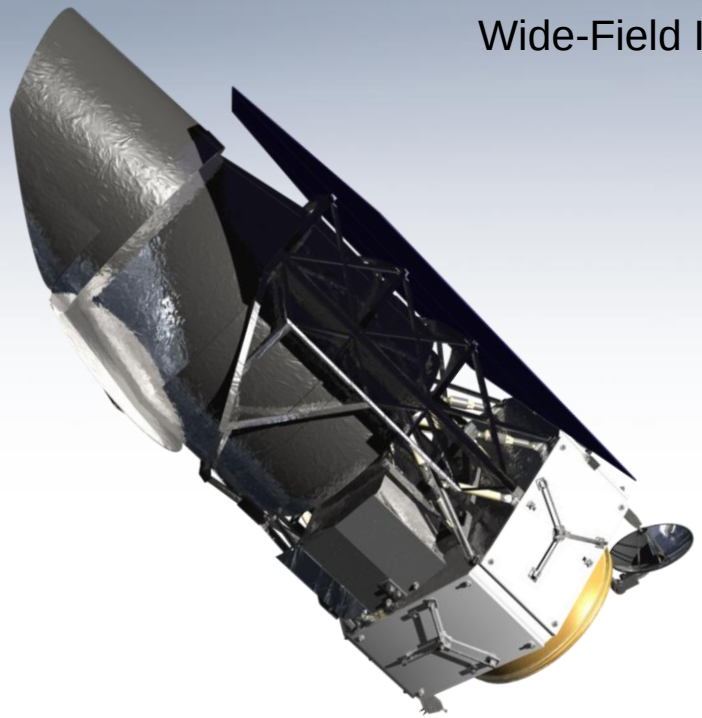
WFIRST
Mid 2020s

NASA Mission

Wide-Field Infrared Survey Telescope

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)

CURRENT STATUS:

- Completed Mission Concept Review (MCR) held in December 2015
- Formulation Science Investigation Teams selected in December 2015; first meeting held February 2016.
- Industry RFI released July 2015; RFP for industry studies released in January 2016; Proposals received from industry in February 2016 to support Wide-field Instrument Concept Study.
- Passed Key Decision Point A (KDP-A) in Feb 2016
  - Official start of formulation phase
  - Supported by FY16 appropriation and FY17 request
  - Developed and signed Formulation Authorization Document (FAD), Project Formulation Agreement (PFA), and preliminary Program Level Requirements Appendix (PLRA).
  - Successful KDP-A DPMC held January 26, 2016.
  - Successful KDP-A APMC held February 17, 2016.
- Schedule under revision to account for FY16 appropriation of $90M and FY17 budget request of $90M. Notional runout of FY17 budget request provides in-guide budget supporting launch in mid-2020s.

http://wfirst.gsfc.nasa.gov/

WFIRST has begun Formulation

FY16 Appropriation

Outyears are notional planning from FY16 President's budget request

($M)	2014	2015	2016	2017	2018	2019	2020
Astrophysics*	$678	$685	$731	$707	$750	$986	$1118
JWST	$658	$645	$620	$569	$535	$305	$198
Total	$1336	$1330	$1351	$1273	$1285	$1291	$1316

*** Excludes "SMD STEM Activities" in all years.**

- Provides $90M for WFIRST and directs NASA to start Formulation.
- Provides full funding ($85M) for SOFIA operations and places SOFIA into the 2018 Astrophysics Senior Review.
- Provides full funding ($98M) for continued Hubble operations.
- Provides $37M for SMD STEM education activities.
- Requires reduction of $36M in rest of Astrophysics portfolio.

($M)	FY16 Request	FY16 Approps	Delta
JWST	$620	$620	--
WFIRST	$14	$90	+$76
SOFIA	$85	$85	--
Hubble	$97	$98	+$1
Rest of Astrophys*	$493	$457	-$36 (-7%)
Total	$1309	$1351	+$42

* Excludes "SMD STEM Activities."

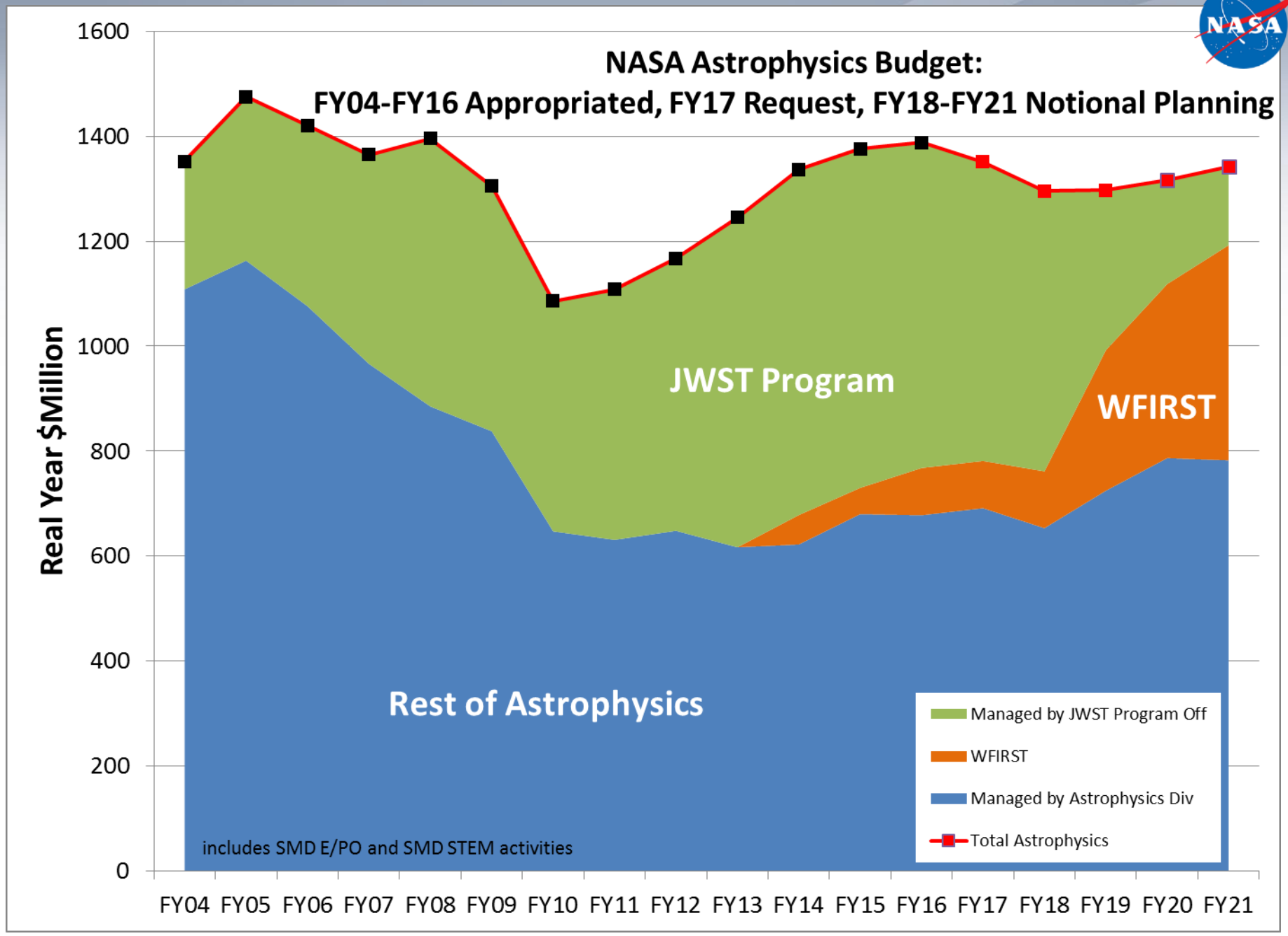
FY17 Budget Request

Outyears are notional planning from FY17 budget request

($M)	2015	2016	2017	2018	2019	2020	2021
Astrophysics*	$685	$731	$757	$737	$967	$1094	$1168
JWST	$645	$620	$569	$534	$305	$197	$150
Total*	$1330	$1351	$1326	$1271	$1272	$1291	$1318

*** Excludes "SMD STEM Activities" in all years.**

- This budget request is an excellent budget request for NASA Astrophysics ($1,326M excluding STEM).
- It compares well with the FY16 Appropriation ($1,351M excluding STEM) and significantly exceeds the FY17 notional runout in the President's FY16 request for NASA Astrophysics including JWST ($1,276M excluding STEM).
- This budget request and the notional runout allows WFIRST to be executed without additional funding.
- This budget request and the notional runout support other Decadal Survey priorities.
  - Continued Explorer AOs at the Decadal Survey cadence of 4 per decade.
  - Partnerships on ESA's Athena X-ray observatory and L3 gravitational wave observatory.
  - Precursor exoplanet science and technology including Large Binocular Telescope Interferometer, Extreme Precision Doppler Spectrometer, and WFIRST Coronagraph.
  - Retains prior growth in R&A and suborbital programs.
- Senior Review funding may be inadequate to continue all currently operating missions.
  - FY16 budget for Six Senior Review missions is $62M. FY17 Senior Review budget is $37M.


NASA Astrophysics Budget:
FY04-FY16 Appropriated, FY17 Request, FY18-FY21 Notional Planning
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
JWST Program
WFIRST
Rest of Astrophysics
includes SMD E/PO and SMD STEM activities
Managed by JWST Program Off
WFIRST
Managed by Astrophysics Div
Total Astrophysics
FY04 FY05 FY06 FY07 FY08 FY09 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19 FY20 FY21

Preparing for the 2020 Decadal Survey
Large Mission Concepts

- NASA will study large mission concepts as input to the 2020 Decadal Survey
  - Science case
  - Technology assessment
  - Design reference mission with strawman payload
  - Cost assessment
- Charge to the Astrophysics Program Analysis Groups (PAGs): COPAG, ExoPAG, PhysPAG (December 2014)
  - "I am charging the Astrophysics PAGs to solicit community input for the purpose of commenting on the small set [of large mission concepts to study], including adding or subtracting large mission concepts."
- PAGs reported to the Astrophysics Subcommittee in October 2015
  - PAGs unanimously endorsed a common set of four mission concepts to study
  - Astrophysics Subcommittee reported to the NAC Science Committee that NASA should study these four mission concepts
  - All three PAG reports posted at **http://cor.gsfc.nasa.gov/copag/rfi/**

Preparing for the 2020 Decadal Survey
Large Mission Concepts

- STDTs have a significant role and responsibility
  - Develop science case
  - Flow science case into mission parameters
  - Vet technology gap list
  - Direct trades of science vs cost/capability

- STDT members will be appointed by NASA HQ
  - Community call for applications will be released via NSPIRES and Astrophysics Programs mailing lists on the day after the AAS Town Hall
  - Responses requested by February 1, 2016

- STDTs will be chartered and managed by HQ
  - Charter and management plan available at:

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

Preparing for the 2020 Decadal Survey
Large Mission Concepts

NASA is initiating community-led studies of the following four large mission concepts.

	Community STDT Chairs	Center Study Scientist	Study Lead Center	HQ Program Scientist
Far IR Surveyor	TBD	David Leisawitz	GSFC	Kartik Sheth
Habitable Exoplanet Imaging Mission	TBD	Bertrand Mennesson	JPL	Martin Still
Large UV/Optical/IR Surveyor	TBD	Aki Roberge	GSFC	Mario Perez
X-ray Surveyor	TBD	Jessica Gaskin	MSFC	Dan Evans


Formulation
Implementation
Primary Ops
Extended Ops
Spitzer
8/25/2003
Kepler
3/7/2009
WFIRST
Mid 2020s
Euclid (ESA)
2020
LISA Pathfinder (ESA)
12/3/2015
JWST
2018
Chandra
7/23/1999
XMM-Newton (ESA)
12/10/1999
TESS
2017
NuSTAR
6/13/2012
Swift
11/20/2004
Hitomi (JAXA)
2/17/2016
Fermi
6/11/2008
Hubble
4/24/1990
CREAM (on ISS)
2017
NICER (on ISS)
2017
SOFIA
Full Ops 5/2014