National Aeronautics and Space Administration

NASA Report to CAA

March 4, 2014

Astrophysics

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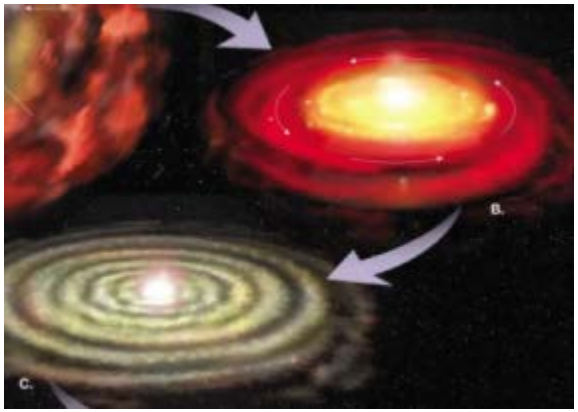
Why Astrophysics?

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

1. How did our universe begin and evolve?

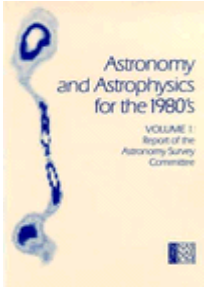


2. How did galaxies, stars, and planets come to be?

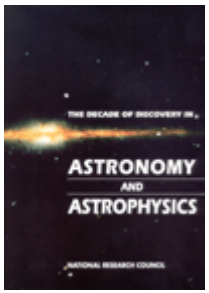
3. Are We Alone?

These national strategic drivers are enduring

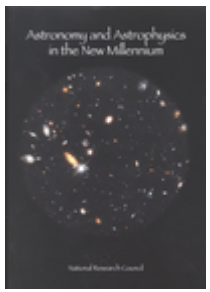
1972



1982

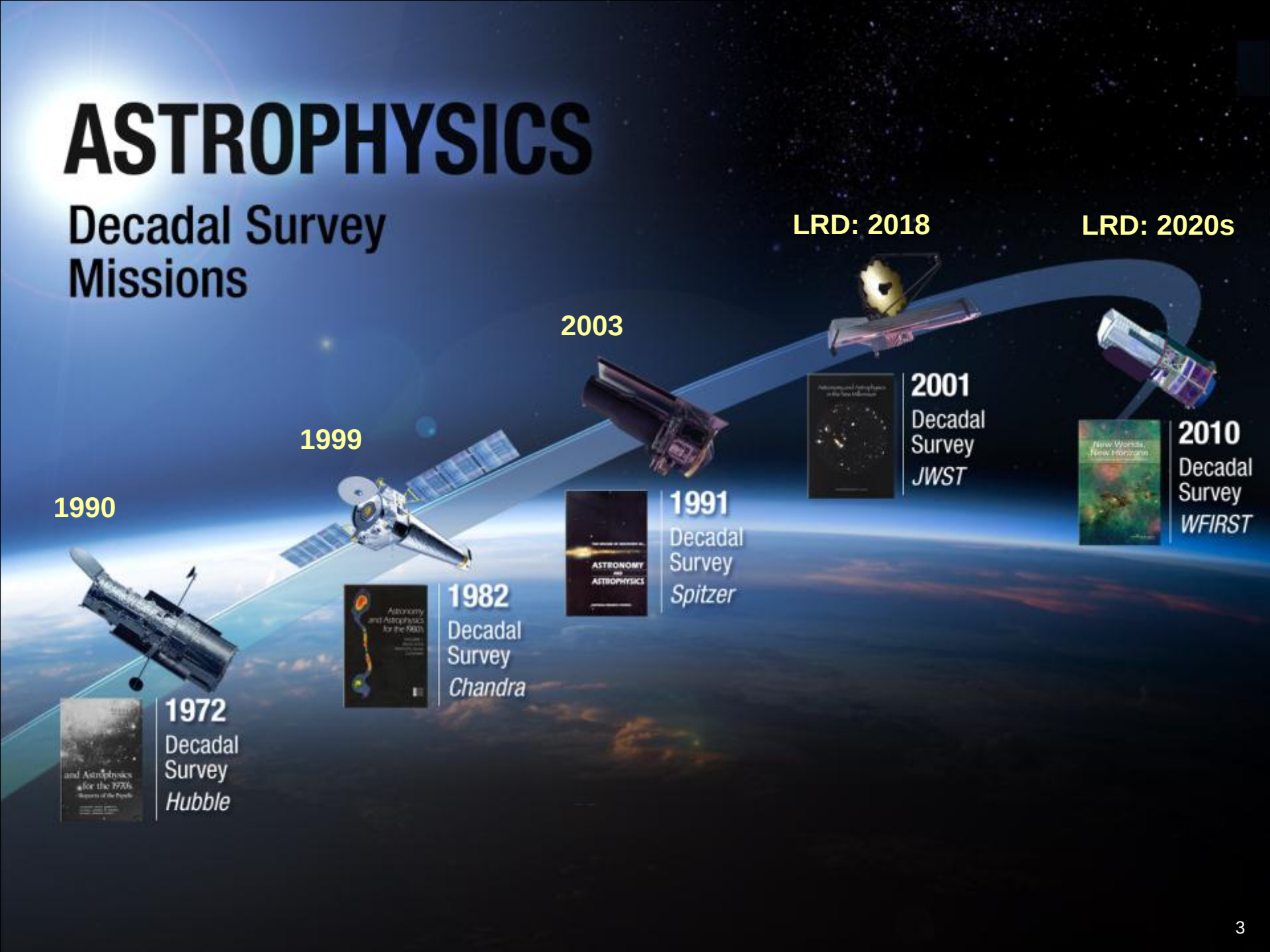


1991



2001

2010


ASTROPHYSICS
Decadal Survey
Missions
LRD: 2018
LRD: 2020s
2003
1999
1990
2001
Decadal
Survey
JWST
2010
Decadal
Survey
WFIRST
1991
Decadal
Survey
Spitzer
1982
Decadal
Survey
Chandra
1972
Decadal
Survey
Hubble

The Big Picture

- This remains a time of scientific opportunity for NASA Astrophysics.
  - We are poised to answer the most compelling science questions.
  - The budget for NASA astrophysics, which includes JWST, continues at ~$1.3B in FY14.
  - NASA continues to operate large and small space-based observatories spanning the electromagnetic spectrum, including multiple Great Observatories.
  - The James Webb Space Telescope, the highest priority of the community, is on schedule and fully funded for an October 2018 launch.
  - NASA continues to develop Explorer missions and contributions to international missions for launch this decade, and an Explorer AO is planned for late 2014 to select two more Explorer projects.
  - NASA continues to support individual investigators for data analysis, theory, and technology investigations through open, competitive, peer reviewed processes.
  - NASA is preparing for a new strategic NASA Astrophysics mission to follow JWST as soon as funding becomes available; the preparation includes preformulation studies of WFIRST-AFTA.
- The budgetary future remains uncertain.
  - Priorities must be used to guide difficult budget choices.

Progress Toward Decadal Survey Priorities

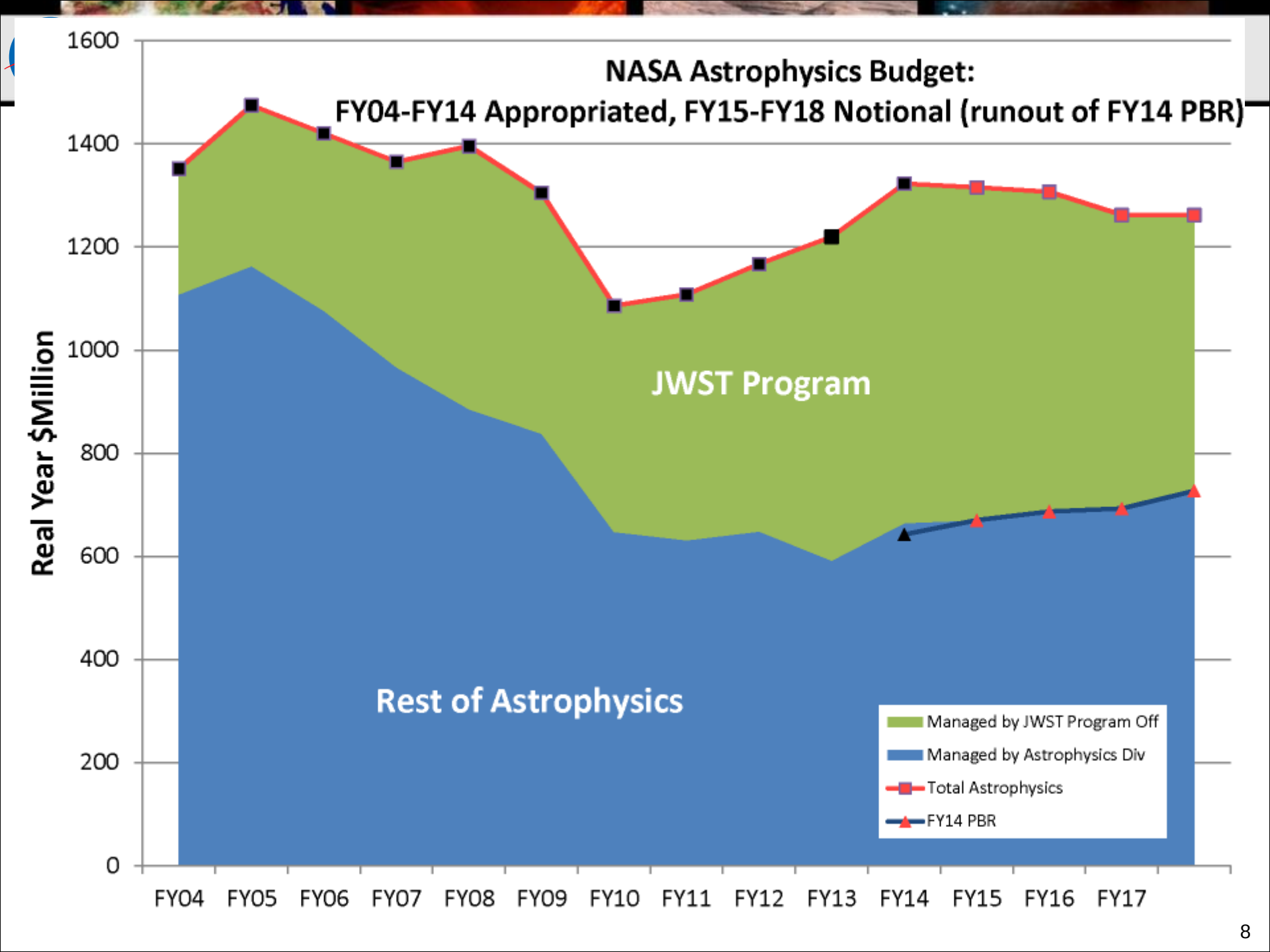
The NASA FY14 Appropriation and the notional out years in the President's Budget Request for FY14 support	
L1. WFIRST	Preformulation and focused technology development for AFTA (a 2.4m version of WFIRST) are underway to enable a new start NET FY17
L2. Augmentation to Explorer Program	Increased from ~$90M in FY07 and ~$115M/yr in FY10 to ~$140M/yr in FY16 and beyond; supports AOs in 2014, ~2016/2017, …
L3. LISA	Strategic technology investments including LISA Pathfinder plus discussing partnership in ESA's L3 gravitational wave observatory
L4. IXO	Strategic technology investments plus discussing partnership in ESA's L2 X-ray observatory
M1. New Worlds Technology Development Program	Focused technology development for a coronagraph on WFIRST; mission concept studies and strategic technology investments
M2. Inflation Probe Technology Development Program	Three balloon-borne investigations plus strategic technology investments
Small. Research Program Augmentations	Increased from $65M (FY07) to $74M (FY10) to $82M (FY12 and beyond)

Astrophysics Budget Strategy

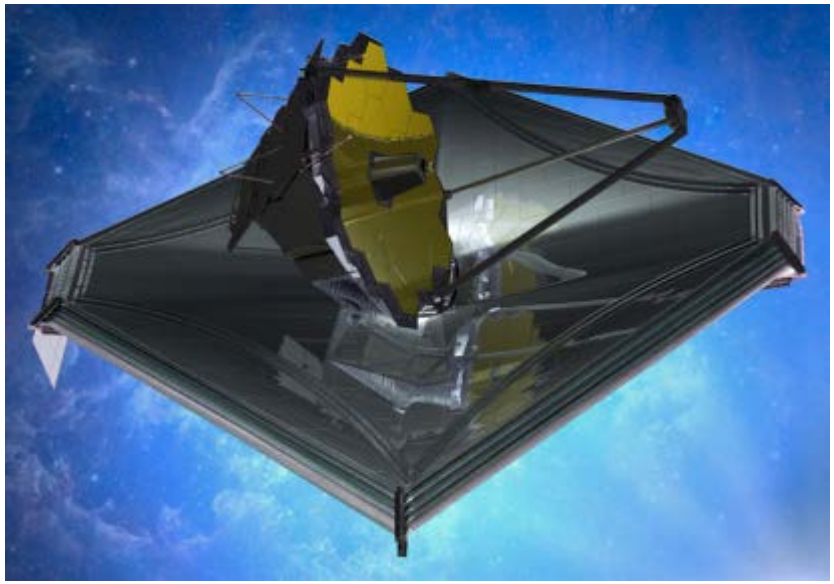
- Use the scientific priorities of the 2010 Decadal Survey to guide strategy and inform choices.
- There is inadequate available budget to implement the 2010 Decadal Survey recommendations as written.
- A goal is to be prepared to start a new strategic NASA Astrophysics mission to follow JWST as soon as funding becomes available, while continuing to advance Decadal Survey science during the interim.
  - WFIRST-AFTA (WFIRST using existing 2.4 m telescopes)
  - Moderate missions ("probes") derived from the science objectives of the prioritized missions and recommendations in the 2010 Decadal Survey are being studied, in addition to a large mission (WFIRST), to be prepared for a mid-decade decision.
- As appropriate, collaborate with international partners to realize Decadal Survey priorities and recommendations.
  - Partner on ESA's Euclid mission (complements WFIRST commitment)
  - Partner on ESA's L2 x-ray observatory (responds to IXO recommendation)
  - Partner on ESA's L3 gravitational wave observatory (responds to LISA recommendation)

FY14 Budget Appropriation

- President requested $642M for Astrophysics and $658M for JWST.
  - Request includes full funding required for JWST; new projects for TESS, NICER, Euclid; mission extensions per 2012 Senior Review; core funding for research and suborbital projects; planning budget wedge for strategic mission starting in FY17.
  - Request includes no funding for E/PO.
- Final FY14 Appropriation is $668M for Astrophysics and $658M for JWST.
  - JWST plan for 2018 launch is fully funded.
  - Budget is $26M higher for Astrophysics than requested, including $56M directed funding for WFIRST/AFTA studies (compared with $13M planned).
  - Remainder of Astrophysics (other than JWST and WFIRST/AFTA) must be adjusted to accommodate the ~$20M difference. This will be determined through development of the NASA FY14 operating plan.
  - Appropriated budget does not included any restoration of funding for E/PO, but it does direct SMD to continue conducting E/PO and to consider consolidation at the Division level.
- FY15 President's budget request will be released on March 4 (top level only) and March 10 (full details)


NASA Astrophysics Budget:
FY04-FY14 Appropriated, FY15-FY18 Notional (runout of FY14 PBR)
Real Year $Million
1600
1400
1200
1000
800
600
400
200
0
JWST Program
Rest of Astrophysics
Managed by JWST Program Off
Managed by Astrophysics Div
Total Astrophysics
FY14 PBR
FY04
FY05
FY06
FY07
FY08
FY09
FY10
FY11
FY12
FY13
FY14
FY15
FY16
FY17

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

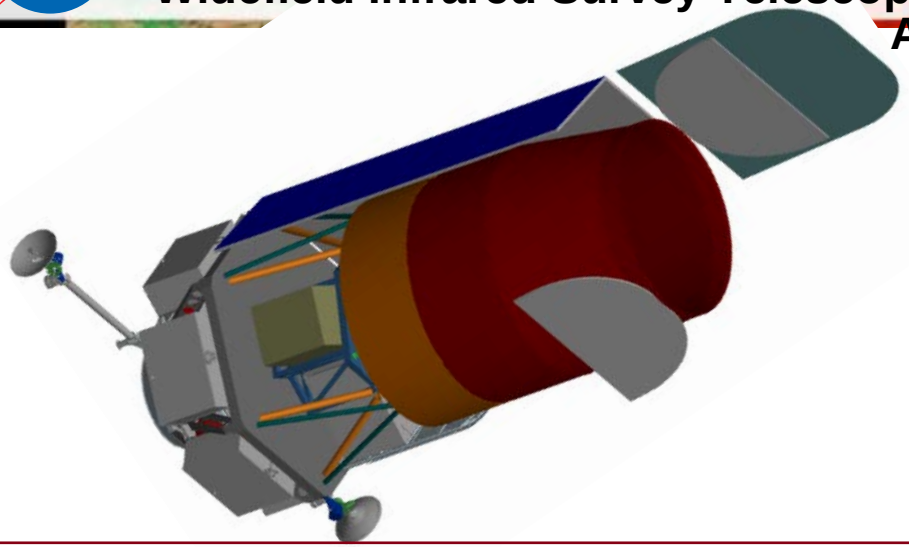
Partners: ESA, CSA

CURRENT STATUS:

- Project has entered its long and challenging Integration and Test activities.
- Technical progress continues to be significant.
  - Instruments are delivered and in integration & test phase.
  - All optics are complete (primary segments, secondary, tertiary and fine steering mirrors) and delivered to GSFC.
  - Telescope wings are complete; backplane support fixture and center section are complete.
  - Spacecraft completed Critical Design Review (Jan 2014).
- Project is performing within the budget, to schedule.
  - Government shutdown did not impact October 2018 launch date.
- FY14 is the peak funding year with many critical activities.

WFIRST – AFTA

Widefield Infrared Survey Telescope with Astrophysics Focused Telescope Assets



- **Top priority in 2010 Decadal Survey**
- **Study Baseline Payload:**
  - 2.4m existing telescope assets
  - Widefield imager
  - Coronagraph
- **Science objectives:**
  - Determine the expansion history of the Universe and the growth history of its largest structures
  - Complete the statistical census of planetary systems
  - Produce a deep map of the sky at NIR wavelengths
  - Directly image giant planets and debris disks
  - General observer program

CURRENT STATUS:

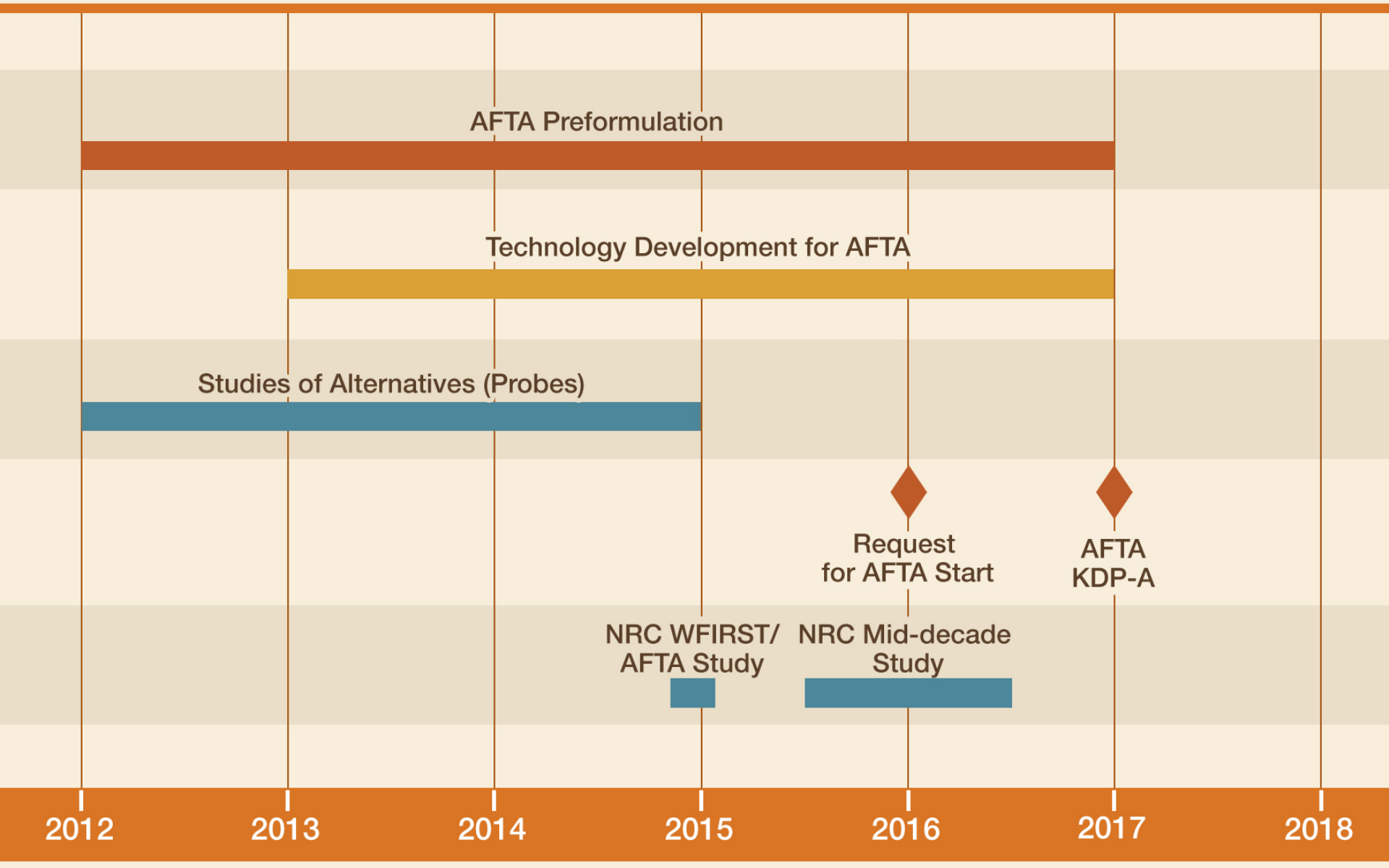
- May 2013, NASA Administrator Bolden directed Astrophysics Division to study WFIRST-AFTA and preserve option for FY17 new start if budget is available
  - No decision expected before early 2016
- Currently in pre-formulation phase
  - NRC study report due mid-March 2014.
  - SDT final report due Jan 2015
- Maturing key technologies to TRL 5 by FY17 and TRL 6 by FY19
  - Infrared detectors for wide field imager
  - Internal coronagraph for exoplanet characterization

Mission description:

- #1 Large-Scale Priority: Widefield infrared survey telescope for Dark Energy, Exoplanets, IR Surveys
- #1 Medium-Scale Priority: Development and demonstration of technology for direct imaging and characterization of exoplanets

Plan for WFIRST-AFTA Preformulation

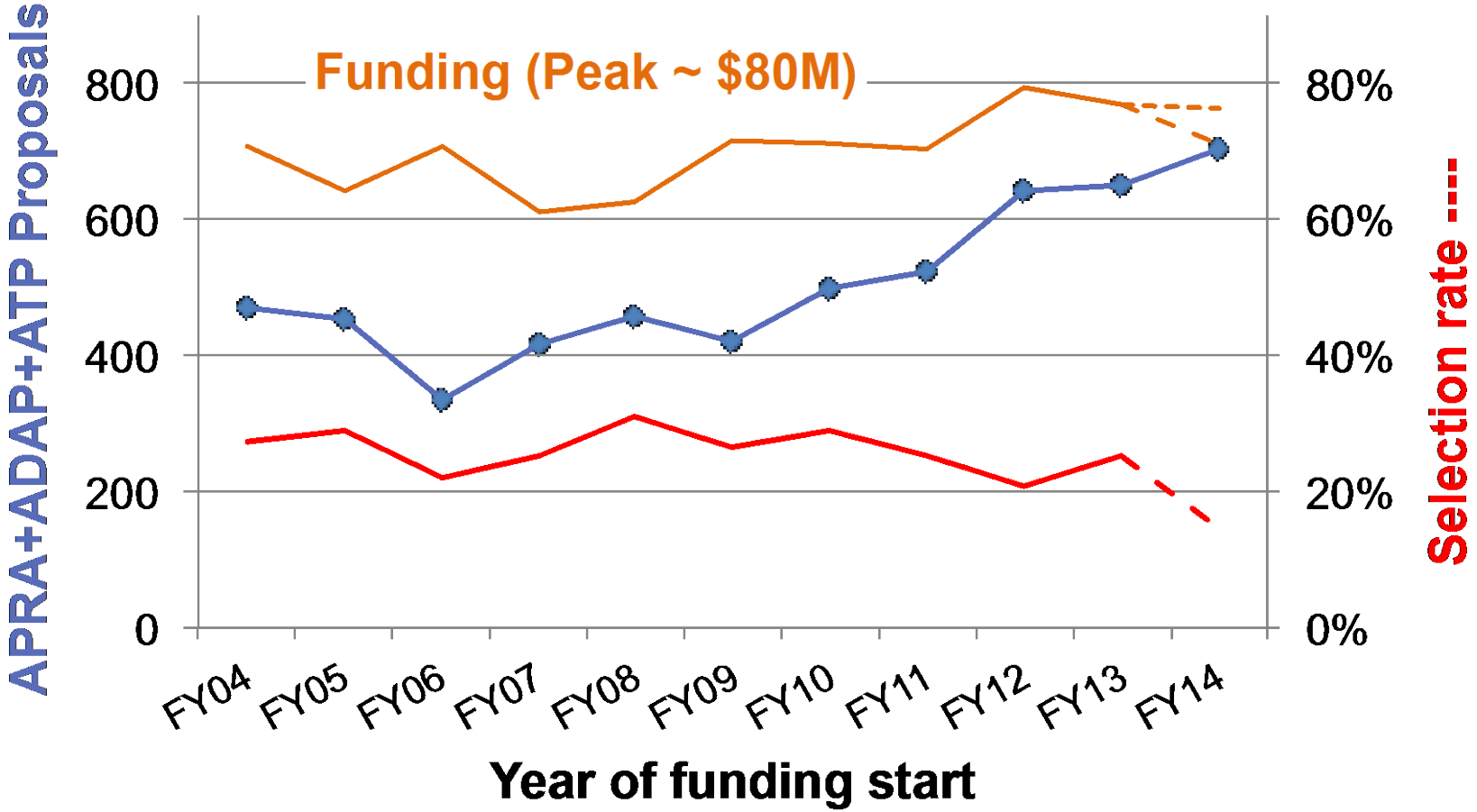
Widefield Infrared Survey Telescope using Astrophysics Focused Telescope Assets



Major Activities for CY 2014

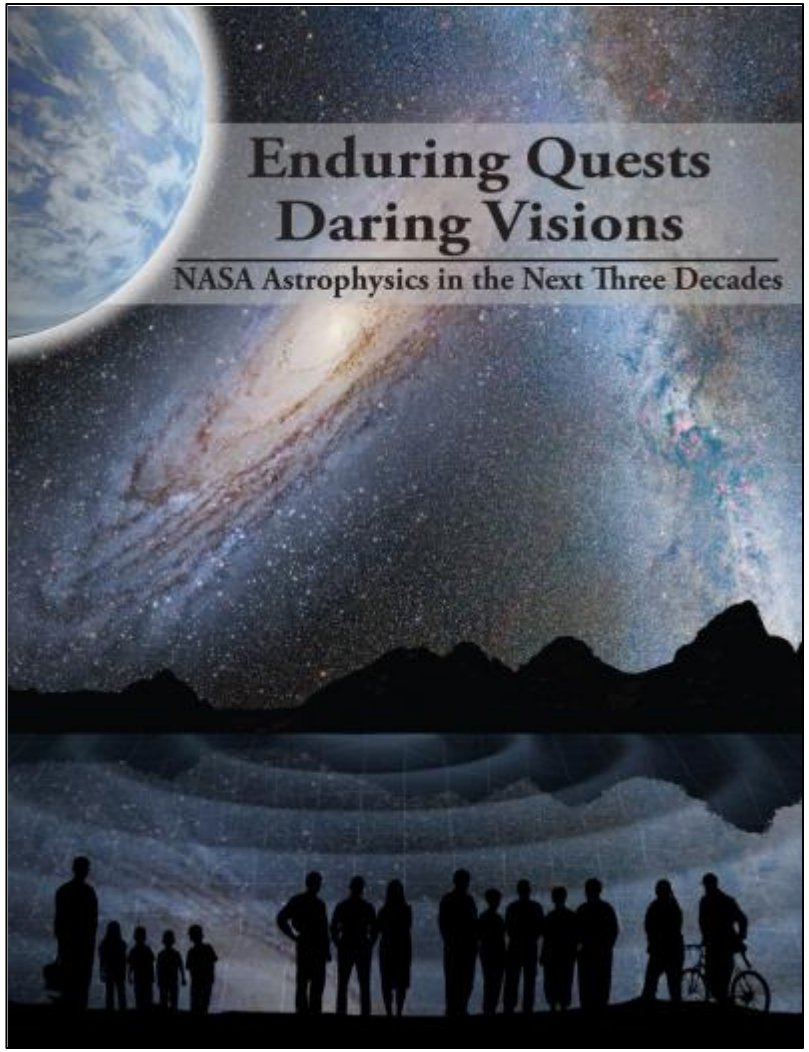
- ✓ Confirm NICER Explorer Mission of Opportunity (launch in 2016) (February 2014)
- Achieve SOFIA Full Operational Capability (FOC) milestone (March 2014)
- Begin Euclid detector flight build (launch in 2020) (March 2014)
- Senior Review for Operating Missions (March 2014)
- Deliver ASTRO-H soft X-ray spectrometer to JAXA (launch in 2015) (April 2014)
- Complete and test JWST instrument suite (launch in 2018) (Summer 2014)
- AO for Small Explorer (SMEX) and Mission of Opportunity (Fall 2014)
- Deliver ISS-CREAM for launch to Space Station (launch in 2014) (Fall 2014)
- Confirm TESS Explorer Mission (launch in 2017) (Fall 2014)
- Commission three more SOFIA instruments: FLITECAM, FIFI-LS, EXES (throughout 2014)
- Participate in ESA's L2 (X-ray observatory) Mission Study (launch in 2028) (throughout 2014)

Proposal numbers grow faster than funding

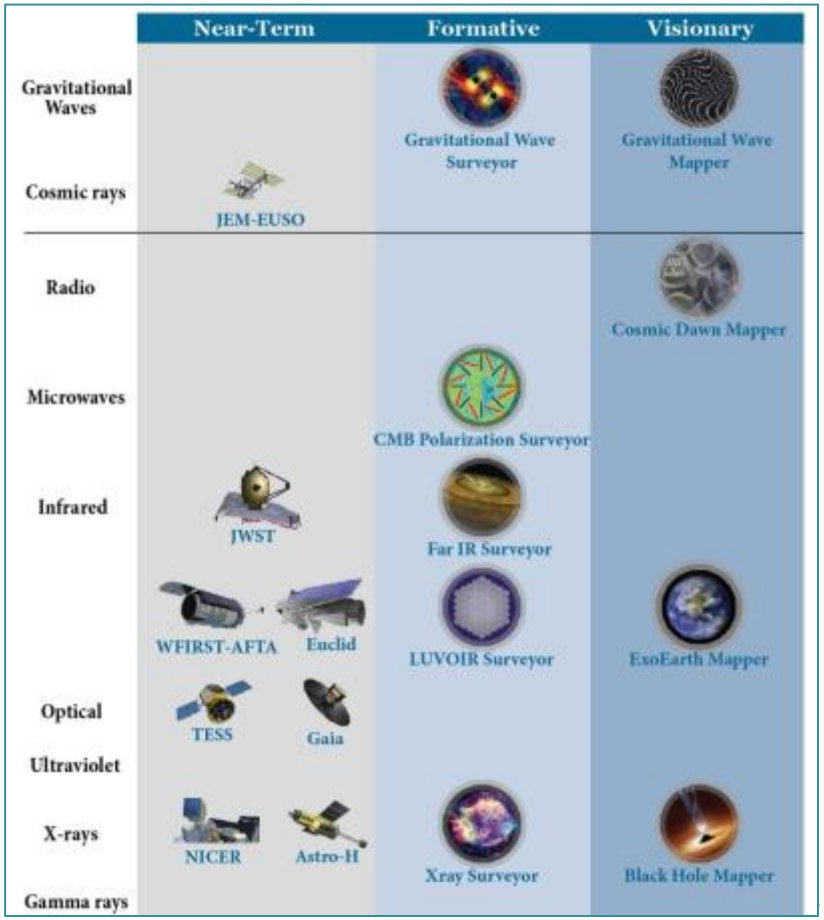


To develop metrics for the Research Program, the Astrophysics Division is undertaking a pilot study with ADS. This will track published papers from research awards, using the (required) acknowledgement of grant numbers (or proposal numbers) in the text.

Enduring Quests, Daring Visions



- A 30 year vision to address the enduring questions:
  - Are we alone?
  - How did we get here?
  - How does the universe work?



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

Looking toward the Mid-Decade Review

The usual charge to a mid-decade review (paraphrased)

- Assess how NASA is doing implementing the recommendations and priorities of the Decadal Survey, in the context of post-Survey changes and constraints

Directions in New Worlds, New Horizons relevant to NASA (paraphrased)

- LISA: If LISA is not L1, or LISA Pathfinder is not successful, or equal partnership is not possible, then conduct review to reconsider LISA's prioritization. (p.9, p.213)
- IXO: If IXO is L1, conduct review then (maybe) invest immediately in technology. By mid-decade, invest aggressively in technology. (p. 214, p. 215)
- New Worlds: If precursor science is favorable, conduct review then (maybe) downselect technology and invest to ready a mission for the 2020 decadal survey. (p.20, p.195, p.216)
- Inflation Probe: If B-mode detected, conduct review then (maybe) invest in technology for an all-sky mission. (p.198, p.217)
- DSIAC: Conduct review to see whether any contingencies have occurred and recommend action. (p.102)

Astrophysics Missions timeline