National Aeronautics and Space Administration

SDT Interim Reports

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Astrophysics

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Astrophysics Strategy

- 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.
  - Implementation of this strategy described in Astrophysics Implementation Plan (2012), available at http://science.nasa.gov/astrophysics/documents/)
- The following studies are underway, and interim reports will be presented to CAA today:
  - 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.
- A probe-class mission has an LCC of ~$1B (FY15$) including formulation, development, launch, and prime mission operations.

Charters support Astrophysics Implementation Plan

Charter for the Science and Technology Definition Teams (STDTs) for

Probe-Class Exoplanet Direct Imaging Mission Concepts

Purpose

The Astrophysics Division, through its Exoplanet Exploration (ExEP) Program Office, is initiating mission concept studies of probe-class missions to advance the science of an exoplanet characterization and imaging mission as prioritized in the Astronomy and Astrophysics 2010 Decadal Survey[1]. In this context, the designation as "probe-class" is taken to mean missions with a total life cycle cost (LCC) not to exceed $1B. The highest priority Decadal Survey medium scale recommendation is a New Worlds Technology Development Program in preparation for an exoplanet imaging mission beyond 2020, including precursor science activities. The Decadal Survey's proposed program is designed to allow a habitable Exoplanet imaging mission to be well formulated in time for consideration by the 2020 Decadal Survey.

Two Science and Technology Definition Teams (STDTs) for probe-class exoplanet direct imaging mission concepts are chartered to define reference mission concepts of high scientific, technical, and programmatic merit that would both advance the compelling scientific priorities articulated in the Decadal Survey and which could be started within the current decade and within the Astrophysics Division's current budget profile. As described in the NASA Astrophysics Strategic Implementation Plan[2], if a large mission like WFIRST cannot be started this decade, then an Exoplanet probe which is technologically ready would be a candidate for a probe to start this decade as early as FY2017. An FY 2017 new start, followed by efficient development for the selected mission, requires mature technology by the end of this decade. The mission concept studies will identify technology requirements, and these will be used to guide technology investments during this decade.

Leading toward the NRC Mid-Decade Review, the results of the concept studies will be considered by the NASA Astrophysics Division and jointly evaluated along with studies from other Astrophysics programs. The probe-scale mission concepts developed by the STDTs are intended to be representative of concepts that are fully responsive to the constraints described above. They are not intended to be the only possible probe-scale exoplanet mission concepts for consideration by the Astrophysics Division in its strategic planning.

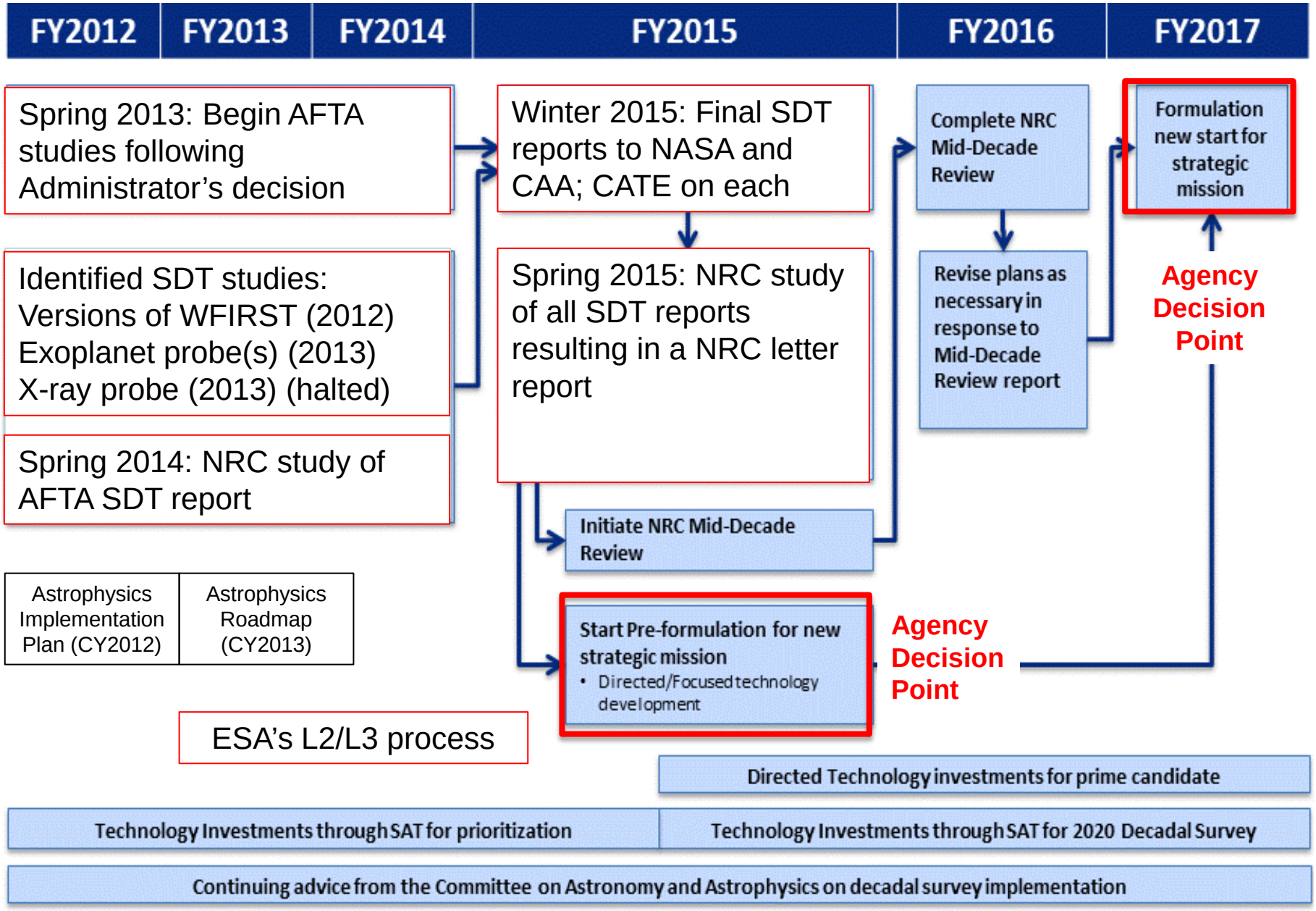
⇦ Responsive to 2010 Decadal Survey

⇦ Consideration by 2020 Decadal Survey

⇦ Backup to WFIRST/AFTA

⇦ Guide technology investments

Implementing the Decadal Survey



Astrophysics Strategy

- WFIRST
  - Science Definition Team (SDT) co-chaired by Paul Schechter and Jim Green studied two design reference missions (DRMs) (2010-2012)
    - Interim DRM / DRM1: WFIRST as described in New Worlds, New Horizons (July 2011)
    - DRM2: Assume JWST, Euclid, LSST and eliminate any duplication + reduce costs (August 2012)
  - Second SDT co-chaired by David Spergel and Neil Gehrels studied WFIRST using 2.4m telescope assets (2012-2015)
    - AFTA: Assume use of existing 2.4m telescopes, include optional coronagraph (May 2013)
    - NRC ad hoc study chaired by Fiona Harrison addresses responsiveness of this concept (2014)
    - Interim report today
  - All WFIRST SDT reports at http://wfirst.gsfc.nasa.gov/science/

Astrophysics Strategy

- LISA
  - Community Science Team (CST) co-chaired by Rainer Weiss and Ned Wright (2011-2012)
  - Charter: Are there probe-class mission concepts that address decadal survey recommendations for a gravitational wave observatory?
    - CST report concluded no (August 2012)
    - CST report at

      http://pcos.gsfc.nasa.gov/studies/gravitational-wave-mission.php
  - No probe-class gravitational wave mission study has been undertaken

Astrophysics Strategy

- IXO
  - Community Science Team (CST) chaired by Joel Bregman (2011-2012)
  - Charter: Are there probe-class mission concepts that address decadal survey recommendations for an X-ray observatory?
    - CST report concluded yes; the most IXO science can be addressed with a single-instrument calorimeter mission (August 2012)
    - CST report at http://pcos.gsfc.nasa.gov/studies/x-ray-mission.php
  - Probe-class X-ray calorimeter mission study was begun by a SDT co-chaired by Jay Bookbinder and Ann Hornschemeier (2013)
  - X-ray probe study terminated when ESA selected an X-ray observatory as L2
    - NASA discussing partnership with ESA on L2
    - Delivers more science for less US funding on approximately same timescale as a potential X-ray probe
    - X-ray probe charter at

      http://pcos.gsfc.nasa.gov/studies/x-ray-probe-2013-2014.php

Astrophysics Strategy

- New Worlds
  - Study to determine: Can a coronagraph on WFIRST/AFTA address decadal survey recommendations for New Worlds technology development and demonstration?
    - Incorporated into WFIRST/AFTA study
    - NRC ad hoc study chaired by Fiona Harrison addresses responsiveness of this concept (2014); Report in March 2014
  - Studies to determine: Are there probe-class mission concepts that address decadal survey recommendations for a New Worlds observatory?
  - Science & Technology Definition Teams (STDTs) established in 2013
    - Charters at http://exep.jpl.nasa.gov/stdt/
  - Exoplanet Coronagraph Probe (Exo-C) STDT chaired by Karl Stapelfeldt (2013-2015)
    - Interim report today
  - Exoplanet Starshade Probe (Exo-S) STDT chaired by Sara Seager (2013-2015)
    - Interim report today

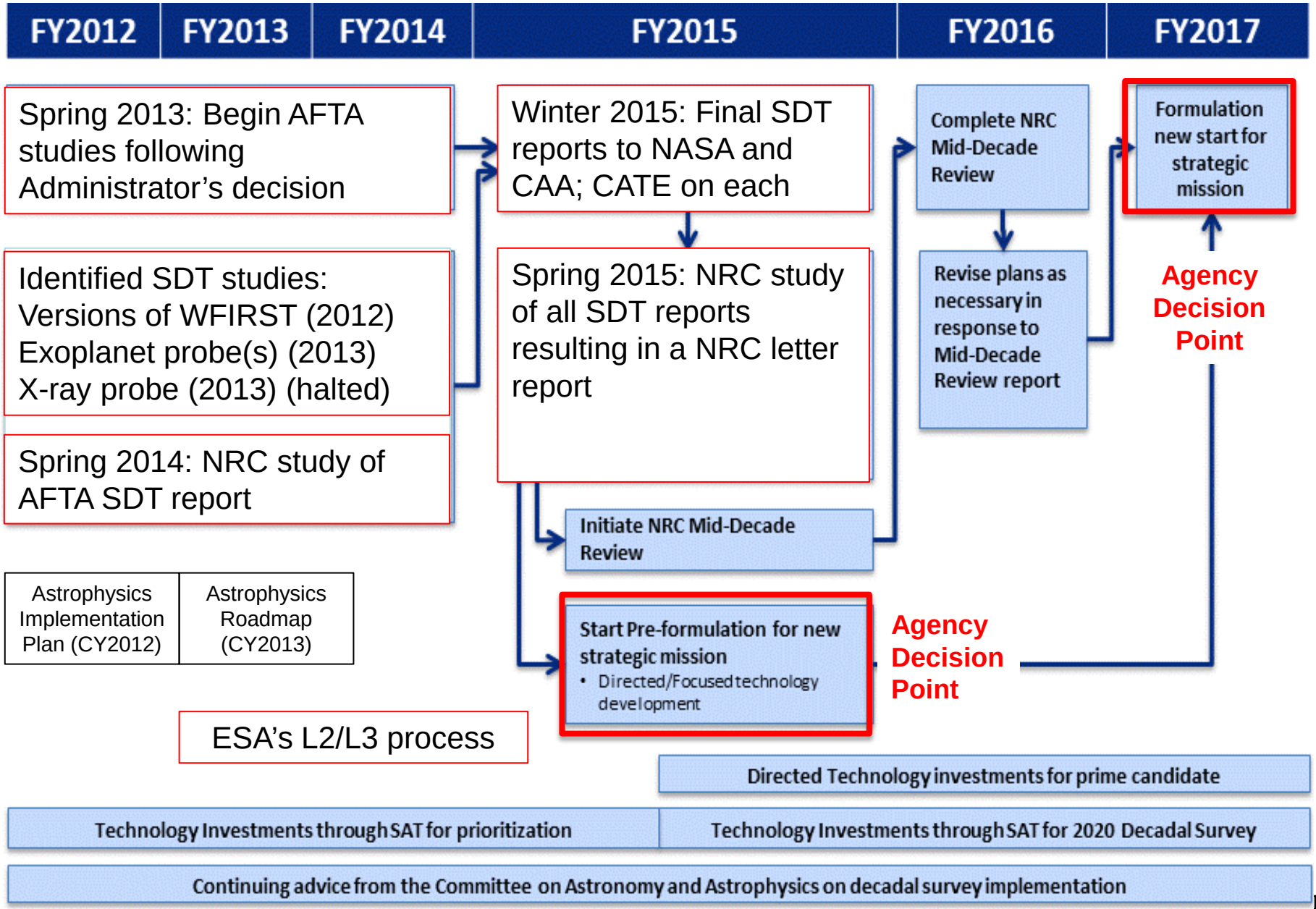
Astrophysics Strategy

- Inflation Probe
  - Decadal Survey recommends
    - Pursuing CMB technology development program as lower priority than other recommendations when budget is constrained (p. 237-238)
    - Probing CMB polarization through ground based and suborbital investigations prior to embarking on mission studies and mission-enabling technology development (p. 217)
  - NASA has not, at this time, undertaken mission concept studies for an Inflation Probe

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)

Implementing the Decadal Survey



Backup

ASTROPHYSICS

Decadal Survey Missions

LRD: 2018

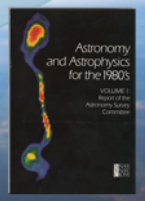
LRD: 2020s

2003

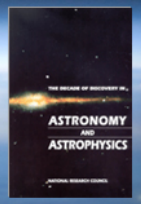
1999

1990

1972 Decadal Survey *Hubble*

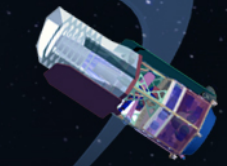


1982 Decadal Survey *Chandra*



1991 Decadal Survey *Spitzer*

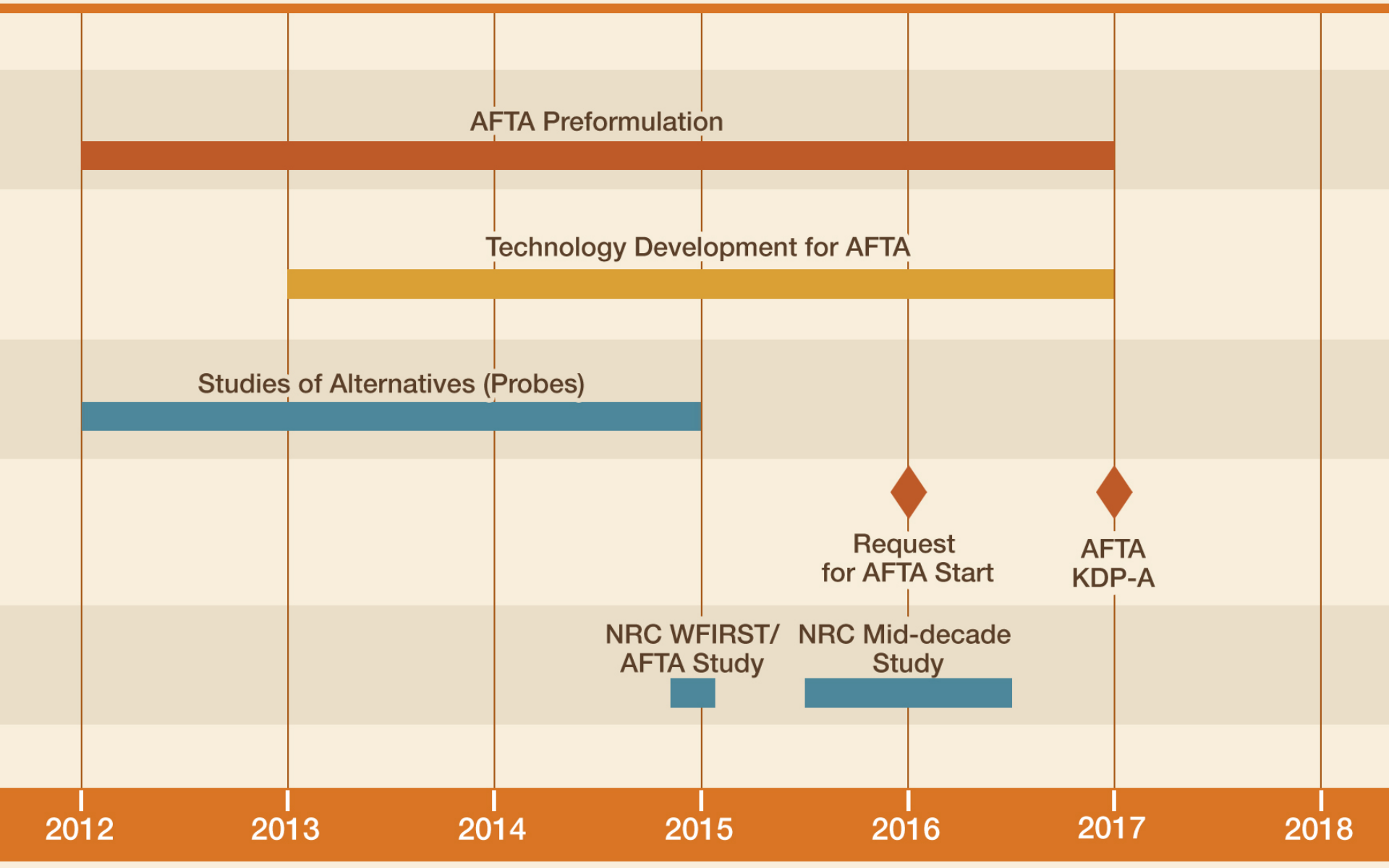
2001 Decadal Survey *JWST*



2010 Decadal Survey *WFIRST*

Plan for WFIRST-AFTA Preformulation

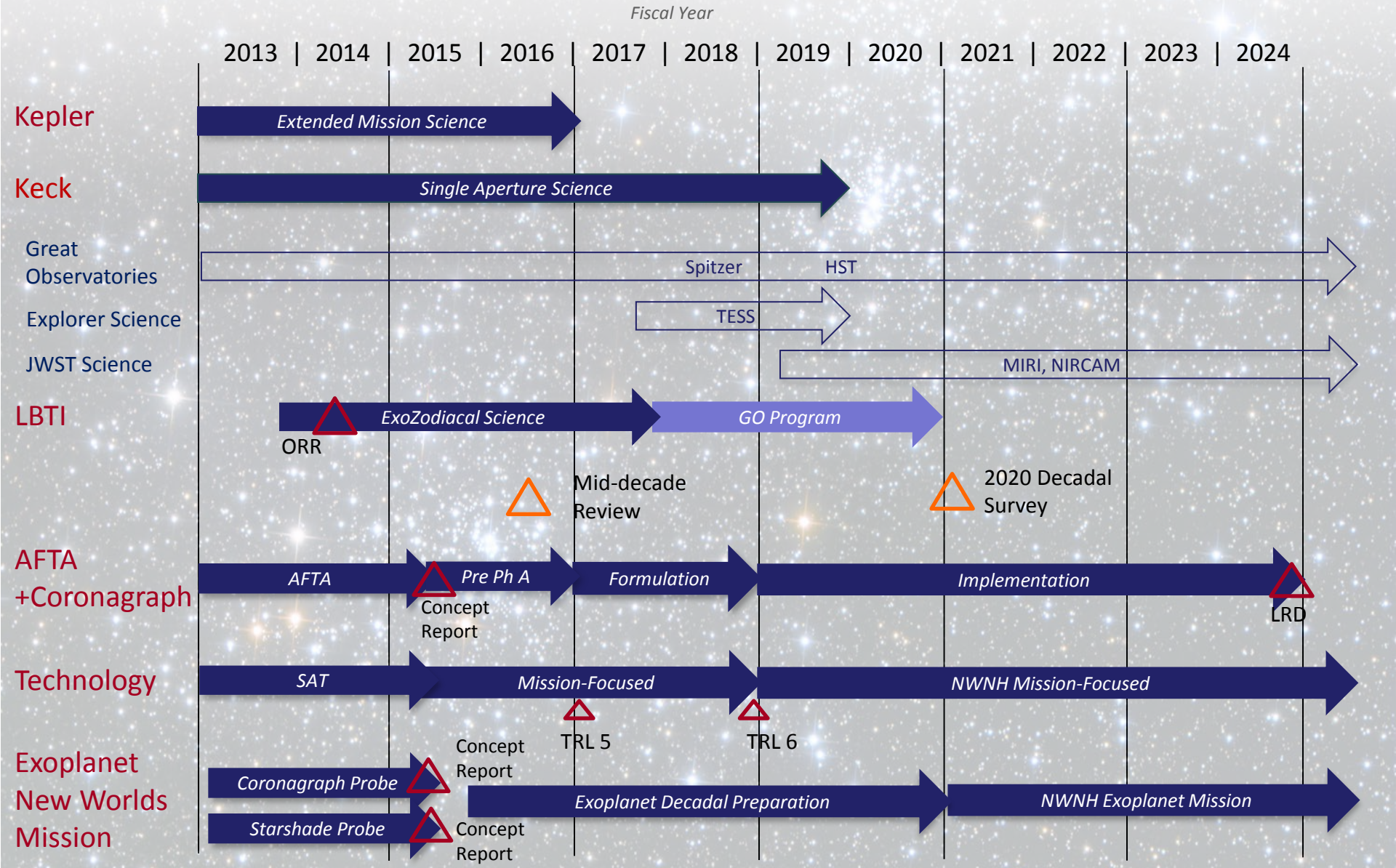
Widefield Infrared Survey Telescope using Astrophysics Focused Telescope Assets



Exoplanet Exploration: A Decade Horizon

NASA-sponsored efforts

ExoPlanet Exploration Program



Charter to the STDTs

Among the products to be delivered by the STDTs, working with the Exoplanet Exploration Program Office, will be a Mission Concept Report from each team that includes:

1. Science return (baseline and minimum requirements) from a cost-driven, probe-scale mission that is traceable to the recommendations of the Astronomy and Astrophysics Decadal Survey.
2. Observatory performance requirements that meet the science requirements.
3. An interim Architecture Trade Study within each STDT to select from various options an architecture and instrument(s) to develop in greater detail for the DRM and for documentation in a detailed Mission Concept Report.
4. A Design Reference Mission (DRM) that describes quantifiable science objectives, the measurements required to meet those objectives, the fundamental instrument and mission requirements that allow those measurements to be executed, and an observing timeline that quantifies the science yield during the mission lifetime.
5. Sufficient detail and fidelity to allow the design to be evaluated through an independent cost appraisal and technical evaluation (CATE).
6. The Report will include a top-level schedule for formulation, implementation, and operations and will also include an assessment of top technical risks to achieving the baseline science requirements.
7. The Report will assess the current state of technology needs for the selected architecture, and identify needed technologies to be
2019. Any required technologies must be brought
of a PDR within the anticipated budget profile of
Each STDT will recommend a PDR readiness
assessment.

⇦ Products for Mission Concept Reports

Timeline ⇨

STDT Timeline

5/2/2013	Announcement of Membership
7/1-2/2013	Joint Kickoff Meeting (face-to-face or web connect) for both STDTs with Exoplanet Exploration Program Office and Study Office. Introduction of trade criteria. Will include both parallel and combined sessions.
On or before 1/31/2014	Briefing of the Architecture Trade Study to Exoplanet Exploration Program
3/2014	Interim Mission Concept Report delivered to NASA HQ; interim report briefing by STDT Chairs to NASA HQ and CAA.
11/2014	Preliminary report as input to CATE
No later than 1/31/2015	Final Mission Concept Report delivered to NASA HQ; final report briefing by STDT Chairs to NASA HQ and CAA
2/15/2015	STDT Chairs present Final Reports to the NASA HQ
2/27/2015	CATE completed and delivered to NASA HQ

Viable Architectures Must Meet These Key Assumptions

KA-1. Baseline concepts will be < $1B FY15

- Costs in FY15 dollars
- Includes Formulation (Phases A, B), Implementation (C-E and closeout F), and launch services
- Includes technology development during Phases A-B to reach TRL 6 end of Phase B
- Does not include GO Program
- No international cost contributions (except science): all costs are borne by NASA
- Includes 30% reserves on all costs except launch services

KA-2. Launch Vehicles - Only the NLS II launch vehicles are to be used

KA-3. Mission Reliability will be class B per NPR 8705.4

KA-4. Contingency (heritage-based expected growth) and Margin (unexpected growth)

- Contingency: 2% for build-to-print, 15% for modified design, 30% for new design
- Margin: 25% on mass and power; 100% on data storage

KA-5. No X-Band Downlink

- Due to heavy use of X-band spectrum, future non-Earth Science missions are required to use other frequencies for science data return

KA-6. Minimum Propellant

- Concepts must carry enough propellant to achieve either their primary science goals or to support 5 years of operations, whichever is greater.
  - Operations beyond primary science (extended mission) are not included in the cost estimate