US Decadal Surveys

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Multiple Decadal Surveys

- Astrophysics started the process in the 1960s

- Today, there are surveys for Planetary, Heliophysics, Earth Science from Space, Ocean Science, Polar Science,…

What is a Decadal Survey?

- Reviews a science discipline's progress and prioritize science at the frontier
- Most importantly, the report prioritizes scientific project (or measurements) for the coming decade into a realistic program
- Goal is to reach consensus on a visionary 10-year program to advance the highest-priority science.

Who are the Customers?

- NASA and other science agencies
- White House (Office of Management and Budget/ Office of Science and Technology Policy)
- Congress
  - **Valued as a consensus science policy rather than lobbying by special interests**
- University Leadership + Other Research Leaders

NAS and Decadal Surveys

- What is the NAS?
- Role of Space Studies Board and its subpoenas (Committee on Astronomy and Astrophysics)
- Who makes up the survey committees and its subcommittees?

Statement of Task

STATEMENT OF TASK

- The Committee on Astro2010 will survey the field of space- and ground-based astronomy and astrophysics, recommending priorities for the most important scientific and technical activities of the decade 2010-2020.
- The principal goals of the study will be to carry out an assessment of activities in astronomy and astrophysics, including both new and previously identified concepts, and to prepare a concise report that will be addressed to the agencies supporting the field, the congressional committees with jurisdiction over those agencies, the scientific community, and the public.

APPROACH

The committee will address the future of U.S. astronomy and astrophysics by formulating a decadal research strategy with recommendations for initiatives in priority order within different categories (related to the size of activities and their home agencies). In addition to reviewing individual initiatives, aspects of infrastructure, and so on, the committee will take a comprehensive look at the U.S. astronomy and astrophysics program and make a judgment about how well the program addresses the range of scientific opportunities and how it might be optimized. The guiding principle in developing the decadal research strategy and the priorities will be maximizing future scientific progress.

Science Prioritization

- Science Panels get input from community (100s of white papers) on top priorities for different subfields. Each panel has 10-20 members and the white papers involve 1000s of astronomers.
  - Panels:
    - Cosmology and Fundamental Physics
    - Galactic Neighborhood
    - Galaxies across Cosmic Time
    - Stars and Stellar Evolution
    - Planetary Systems and Star Formation

Top Science Questions

TABLE A.1 Summary of Science Frontiers Panels' Findings

Panel	Science Questions		Area(s) of Unusual Discovery Potential
Cosmology and Fundamental Physics	CFP 1	How did the universe begin?	Gravitational Wave Astronomy
	CFP 2	Why is the universe accelerating?	
	CFP 3	What is dark matter?	
	CFP 4	What are the properties of neutrinos?	
Galactic Neighborhood	GAN 1	What are the flows of matter and energy in the circumgalactic medium?	Time-Domain Astronomy Astrometry
	GAN 2	What controls the mass-energy-chemical cycles within galaxies?	
	GAN 3	What is the fossil record of galaxy assembly from the first stars to the present?	
	GAN 4	What are the connections between dark and luminous matter?	
Galaxies Across Cosmic Time	GCT 1	How do cosmic structures form and evolve?	The Epoch of Reionization
	GCT 2	How do baryons cycle in and out of galaxies, and what do they do while they are there?	
	GCT 3	How do black holes grow, radiate, and influence their surroundings?	
	GCT 4	What were the first objects to light up the universe, and when did they do it?	
Planetary Systems and Star Formation	PSF 1	How do stars form?	Identification and Characterization of Nearby Habitable Exoplanets
	PSF 2	How do circumstellar disks evolve and form planetary systems?	
	PSF 3	How diverse are planetary systems?	
	PSF 4	Do habitable worlds exist around other stars, and can we identify the telltale signs of life on an exoplanet?	
Stars and Stellar Evolution	SSE 1	How do rotation and magnetic fields affect stars?	Time-Domain Surveys
	SSE 2	What are the progenitors of Type Ia supernovae and how do they explode?	
	SSE 3	How do the lives of massive stars end?	
	SSE 4	What controls the mass, radius, and spin of compact stellar remnants?	

Mission Prioritization

- NASA funds mission studies in advance of the decadal survey
- Independent missions are also proposed
- Prioritization panels (Electromagnetic Observations from Space; Optical and Infrared Astronomy from the Ground; Particle Physics and Gravitation; Radio, Millimeter and Submillimeter Astronomy from the Ground) study and cost missions
- Role of CATE (Cost and Technical Assessment) process

Central Committee

- Coordinate and structure process. Set up and select task forces
- Identify priorities for the decadal report
- Write decadal report (different audiences)

Priorities for Space

TABLE ES.5 Space: Recommended Activities—Large-Scale (Priority Order)

Recommendation	Launch Date[b]	Science	Technical Risk[c]	Appraisal of Costs[a]		Cross-Reference in Chapter 7
				Total (U.S. Share)	U.S. Share, 2012-2021	
1. WFIRST —NASA/DOE collaboration	2020	Dark energy, exoplanets, and infrared survey-science	Medium low	$1.6B	$1.6B	Page 205
2. Augmentation to Explorer Program	Ongoing	Enable rapid response to science opportunities; augments current plan by 2 Medium-scale Explorer (MIDEX) missions, 2 Small Explorer (SMEX) missions, and 4 Missions of Opportunity (MoOs)	Low	$463M	$463M	Page 208
3. LISA —Requires ESA partnership[d]	2025	Open low-frequency gravitational-wave window for detection of black-hole mergers and compact binaries and precision tests of general relativity	Medium[e]	$2.4B ($1.5B)	$852M	Page 209
4. IXO —Partnership with ESA and JAXA[d]	2020s	Black-hole accretion and neutron-star physics, matter/energy life cycles, and stellar astrophysics	Medium high	$5.0B ($3.1B)	$200M	Page 213

TABLE ES.4 Space: Recommended Activities—Medium-Scale (Priority Order)

Recommendation	Science	Appraisal of Costs[a]	Cross-Reference in Chapter 7
1. New Worlds Technology Development Program	Preparation for a planet-imaging mission beyond 2020, including precursor science activities	$100M to $200M	Page 215
2. Inflation Probe Technology Development Program	Cosmic microwave background (CMB)/ inflation technology development and preparation for a possible mission beyond 2020	$60M to $200M	Page 217

Priorities for Ground

TABLE ES.3 Ground: Recommended Activities—Large Scale (Priority Order)

Recommendation[b]	Science	Technical Risk[c]	Appraisal of Costs Through Construction[a] (U.S. Federal Share, 2012-2021)	Appraisal of Annual Operations Costs[d] (U.S. Federal Share)	Cross-Reference in Chapter 7
1. LSST —Science late 2010s —NSF/DOE	Dark energy, dark matter, time-variable phenomena, supernovae, Kuiper belt and near-Earth objects	Medium low	$465M ($421M)	$42M ($28M)	Page 223
2. Mid-Scale Innovations Program —Science mid-to-late 2010s	Broad science; peer-reviewed program for projects that fall between the NSF MRI and MREFC limits	N/A	$93M to $200M		Page 225
3. GSMT —Science mid-2020s —Immediate partner choice for ~25% federal share	Studies of the earliest galaxies and galactic evolution; detection and characterization of planetary systems	Medium to medium high	$1.1B to $1.4B ($257M to $350M)	$36M to $55M ($9M to $14M)	Page 228
4. ACTA —Science early 2020s —NSF/DOE; U.S. join European Čerenkov Telescope Array	Indirect detection of dark matter; particle acceleration and active galactic nucleus science	Medium low	$400M ($100M)	Unknown	Page 232

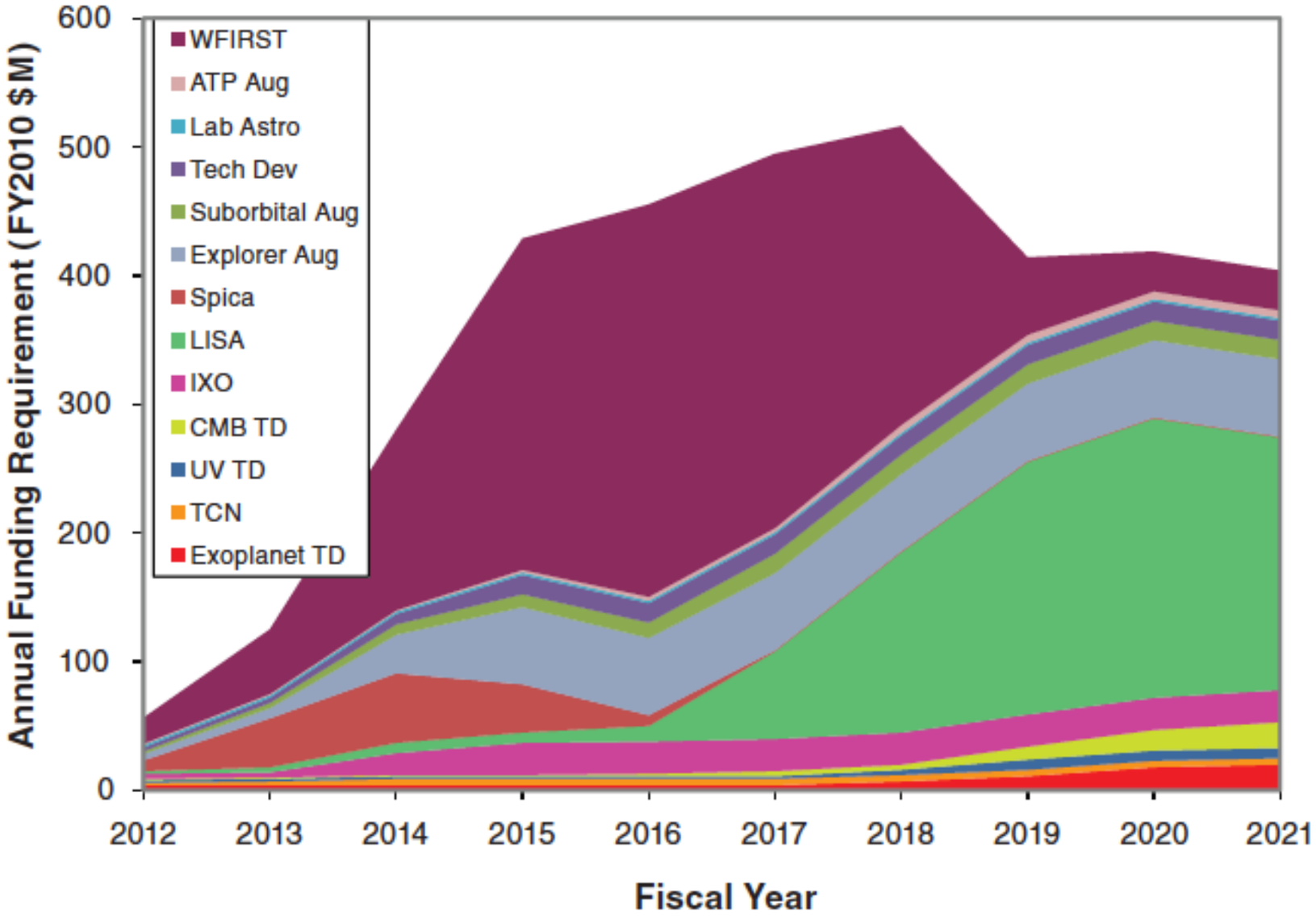

FIGURE 7.12 Astro2010-recommended program for NASA—example phasing. This sandchart is the outcome of a committee exercise carried out in FY2010 dollars to show that the phased program recommended would fit within the budget constraints adopted by the committee in developing its recommendations. The profiles and budget costs will vary on a project-by-project and program-by-program basis and should not be taken as representing a literal recommended program. The sandcharts are presented here to show, as an existence proof, that within a budget that is flat for the decade in FY2010 dollars the Astro2010-recommended new initiatives and program augmentations are implementable within NASA SMD spending limits.

Challenges for AST2020

- How do we prioritize and plan international projects?
    - Leadership (JWST) + Followership (Planck, Hitomi).
- How do we control cost growth?
- How to maintain flexibility and continuity? How do we respond to opportunities (2.4 meter telescopes) and obstacles (JWST cost growth)