National Aeronautics and Space Administration

How NASA is preparing for Astro2020 and what lessons learned might be most important

Astrophysics

Paul Hertz
Director, Astrophysics Division
Science Mission Directorate
@PHertzNASA

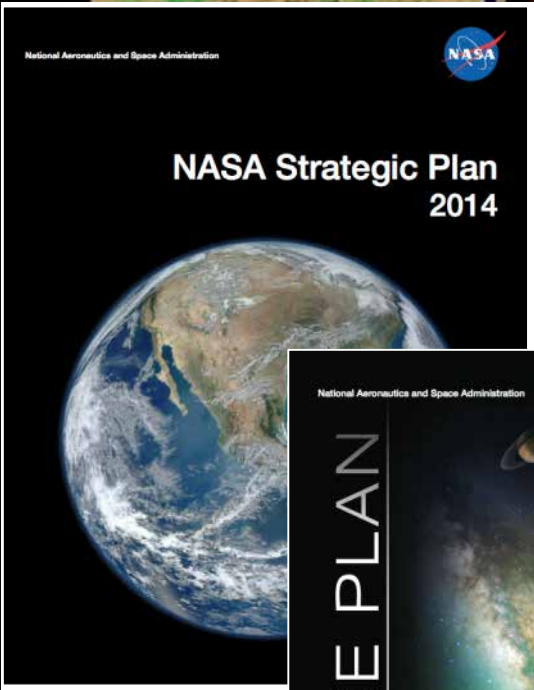
www.nasa.gov

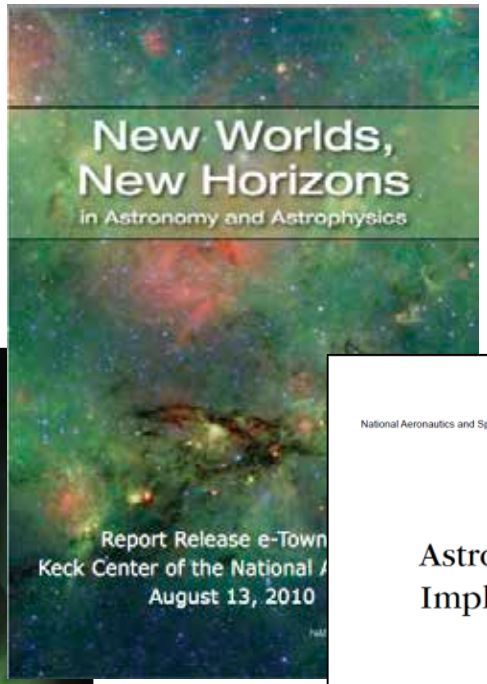
Space Studies Board
November 4, 2015

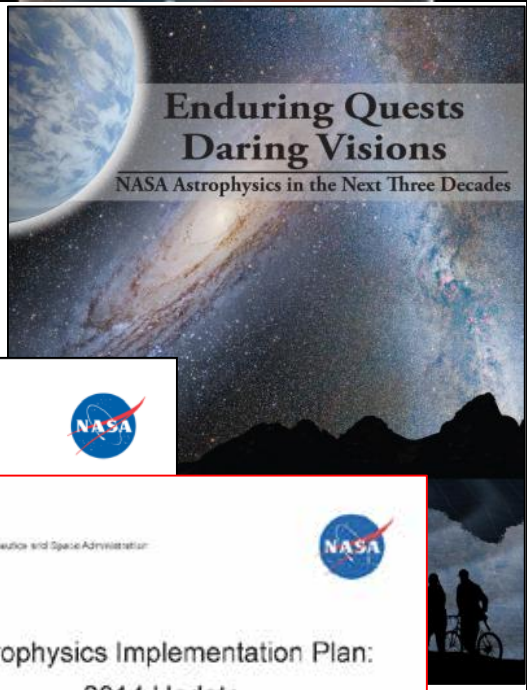
Outline

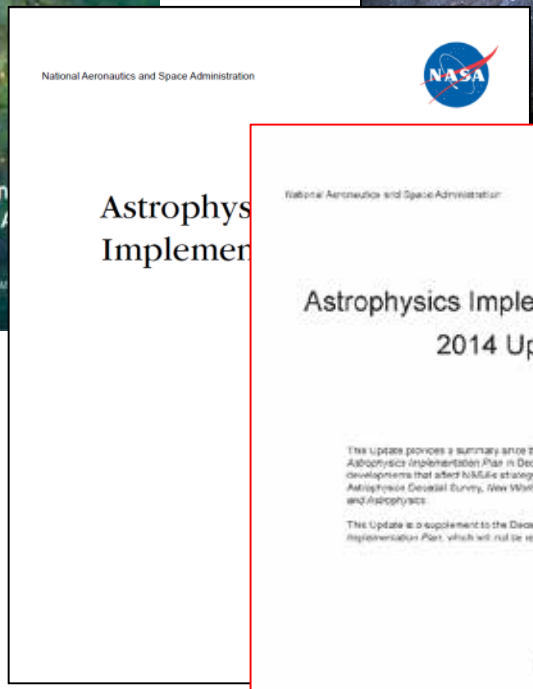
- Progress toward Astro2010
- Planning for Astro2020
- Lessons Learned – a personal selection
- Statutory constraints on Decadal Surveys (Appendix)

Astrophysics Driving Documents









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

Progress Toward Decadal Survey Priorities

- The 2010 Decadal Survey recommended a coordinated program of research, technology development, ground-based facilities, and space-based missions to address the most compelling science questions.
- The budget environment does not allow the recommendations of the Decadal Survey to be implemented as written.
  - Choices have been made.
  - NASA Astrophysics has kept the community informed of our progress through Town Halls, Implementation Plan Updates, and Newsletters.
  - NASA Astrophysics obtains frequent community input via advisory committees (CAA, AAAC, APS) and community groups (e.g., PAGs, SAGs, SIGs, CSTs, SDTs, SWGs, etc.).
- NASA Astrophysics is addressing all of the recommendations in the Decadal Survey. Substantial progress is being made toward Decadal Survey priorities.
  - The James Webb Space Telescope (JWST) remains on schedule and within budget for a launch in October 2018.
  - Preformulation for the Wide-Field Infrared Survey Telescope (WFIRST) using Astrophysics Focused Telescope Assets (AFTA) is well underway.
  - Explorer AOs are being issued every 2-3 years.
  - Highly leveraged partnerships with the European Space Agency (ESA) are advancing the science of LISA and IXO.
  - Investments in technology, suborbital investigations, core research, and other Decadal Survey priorities are yielding science in this decade and preparing for the next decade.

Progress Toward Decadal Survey Priorities

The NASA FY15 Appropriation, the President's FY16 Budget Request, and the notional out year budget planning guidance in the President's FY16 Budget Request, support:	
Complete JWST	JWST remains within budget guidelines and on track for an October 2018 launch.
Large-scale 1. WFIRST	Preformulation and focused technology development for WFIRST-AFTA (a 2.4m version of WFIRST with a coronagraph) are underway to enable a new start. Budget line established for an Astrophysics Decadal Strategic Mission.
Large-scale 2. Augmentation to Explorer Program	Astrophysics Explorers planned budget increased to support cadence of four AOs per decade including SMEX AO in Fall 2014 and MIDEX AO in late 2016/early 2017.
Large-scale 3. LISA	Discussing partnership on ESA's L3 gravitational wave observatory and participating in ESA-led assessments in 2014-2015. Strategic astrophysics technology (SAT) investments plus support of LISA Pathfinder.
Large-scale 4. IXO	Pursuing a partnership on ESA's L2 Athena X-ray observatory; the Athena study phase, with U.S. participation, is underway. Strategic astrophysics technology (SAT) investments.
Medium-scale 2. Inflation Probe Technology Development Prog	Balloon-borne investigations plus strategic astrophysics technology (SAT) investments. Studying partnership on JAXA's LiteBIRD.

Progress Toward Decadal Survey Priorities

The NASA FY15 Appropriation, the President's FY16 Budget Request, and the notional out year budget planning guidance in the President's FY16 Budget Request, support:	
Medium-scale 1. New Worlds Technology Development Program	Focused technology development for a coronagraph on WFIRST, strategic astrophysics technology (SAT) investments, and exoplanet probe mission concept studies. Established partnership with NSF to develop extreme precision Doppler spectrometer as facility instrument. Exozodi survey using LBTI.
Small-scale. Research Program Augmentations	Increased annual R&A budget by 10% from FY10 to FY12 and another 10% from FY14 to FY16. Within R&A: established Theoretical and Computational Astrophysics Networks (TCAN) program with NSF; funding available for astrophysics theory; funding available for lab astrophysics; funding available for suborbital payloads.
Small-scale. Intermediate Technology development Augmentation	Established competed Strategic Astrophysics Technology (SAT) program element; directed technology funding for WFIRST and other large-scale decadal priorities (e.g., WFIRST coronagraph, Athena).
Small-scale. Future Ultraviolet-Visible Space Capability	Strategic Astrophysics Technology (SAT) and Astrophysics R&A (APRA) investments; mission concept studies.
Small-scale. SPICA (U.S. contribution to JAXA-led)	Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity.

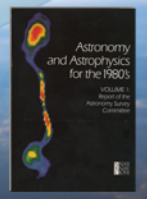
Progress Toward Decadal Survey Priorities

The NASA FY15 Appropriation, the President's FY16 Budget Request, and the notional out year budget planning guidance in the President's FY16 Budget Request, support:	
Decadal survey implementation advisory committee	The CAA and AAAC fulfil the "regular basis" portion of this recommendation. The Midterm Committee fulfills the "mid-decade review" portion of the recommendation.
Balanced program	NASA has made difficult choices to address multiple Decadal Survey recommendations including maintaining a balanced program within a constrained budget environment. The current and planned portfolio includes all of the elements of a balanced program.
International collaboration and reciprocity	75% of NASA astrophysics missions are international; all include reciprocity and public data. "Principles for Access to Large Federally Funded Astrophysics Projects and Facilities" developed in conjunction with AAAC, OSTP, NSF, and DOE.
Societal benefits	NASA has removed education activities from missions, but left missions responsible for communication and public outreach. SMD will manage a competed education program of approximately the same size as the legacy program that it replaces ($42M in FY15).

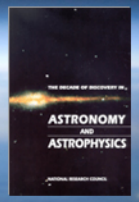
ASTROPHYSICS

Decadal Survey Missions

1972
Decadal Survey
Hubble



1982
Decadal Survey
Chandra

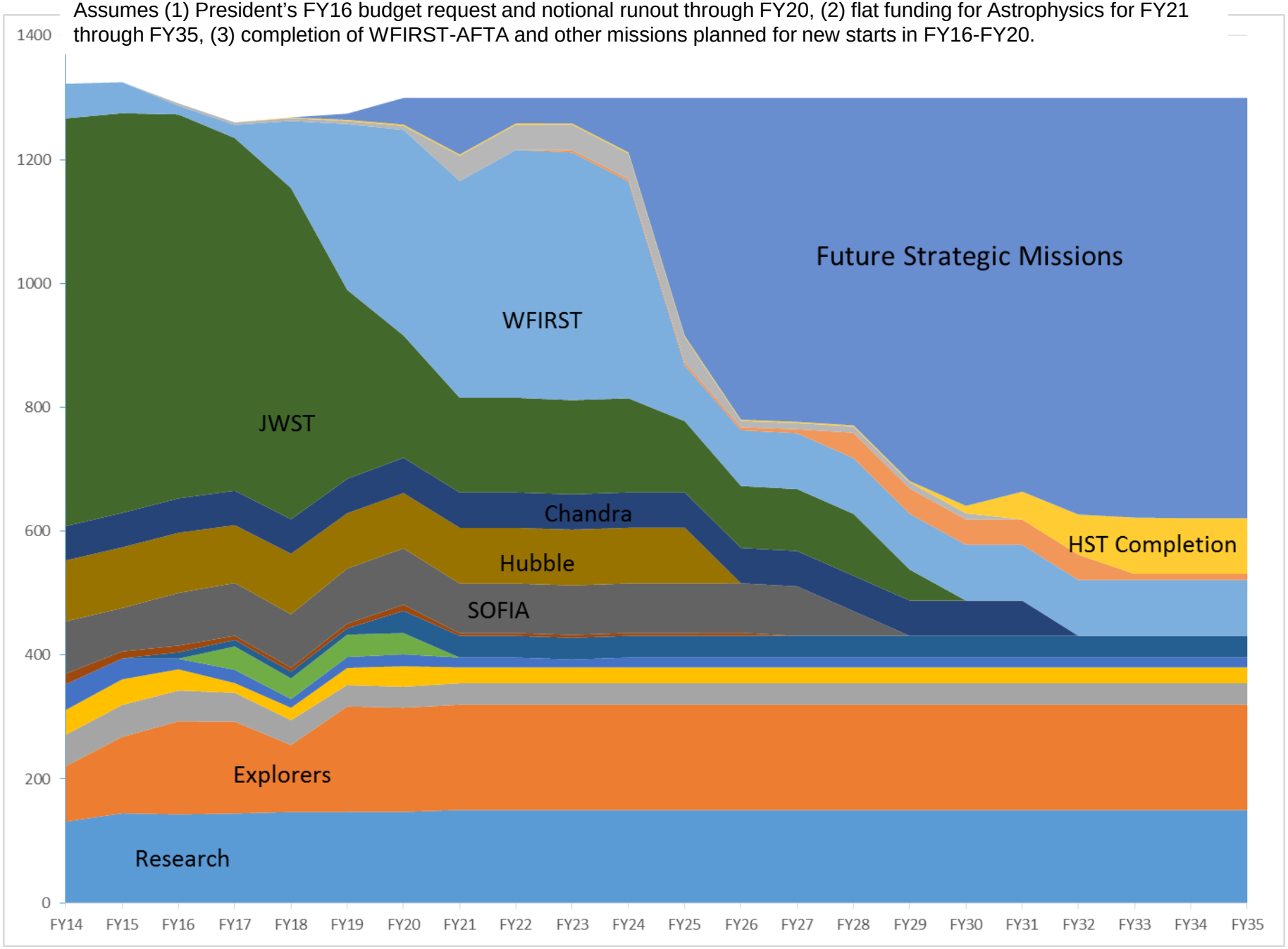


1991
Decadal Survey
Spitzer, SOFIA

2001
Decadal Survey
JWST

2010
Decadal Survey
WFIRST

Assumes (1) President's FY16 budget request and notional runout through FY20, (2) flat funding for Astrophysics for FY21 through FY35, (3) completion of WFIRST-AFTA and other missions planned for new starts in FY16-FY20.



The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

- "Moreover, the period between decadal surveys is an ideal time to work on mission concepts and to bring them up to a minimal standard of development. … The Astrophysics Division of SMD recently proposed just such an activity to prepare for Astro2020. The opportunity of using the time between surveys to update the science and formulate possible missions is arguably the best way to achieve the goals of a two-phase process, without prolonging the decadal survey process."
- "Some pre-work with the scientific community and its representative groups prior to the official start of a survey could help ensure the survey completion in the minimum possible time. Such pre-work could reduce the pressure on a survey to define and refine concepts for study very early in its discussions. A recent policy announcement by the director of NASA's Astrophysics Division aims to do just this."
- "Best Practice: Agencies, committees of the Academies', community workshops and meetings, and white papers can contribute to pre-survey science priority identification as preparation for, and a valuable contribution to, the next survey. These activities can also spur early development, evaluation, and maturation of concepts for new missions for potential priorities well in advance of the survey itself."

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015) Chapter 2, pp. 18-19

Preparing for the 2020 Decadal Survey
Large Mission Concepts

- Study 3-4 large mission concepts as candidate prioritized large missions
  - Science case
  - Technology assessment
  - Design reference mission with strawman payload
  - Cost assessment
- Charge to the PAGS (January 2015)
  - “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.”

Preparing for the 2020 Decadal Survey
Large Mission Concepts

Community workshops

- January 3, 2015: PAGs charged @ AAS, Seattle. All PAGs meet.
- February 10-11, 2015: ExoPAG SIG #1 meeting @ JPL, Pasadena
- March 10, 2015: COPAG Virtual Town Hall
- March 19, 2015: Joint PAG EC meeting @ STScI, Baltimore
- April 11-14, 2015: PhysPAG SIGs meet @ Am Phys Soc, Baltimore
- June 2, 2015: ExoPAG Virtual Meeting
- June 3-5, 2015: COPAG Far-IR Workshop @ Pasadena
- June 13-14, 2015: ExoPAG meeting @ AbSciCon, Chicago
- June 25-26, 2015: COPAG UV/Vis SIG meeting @ Greenbelt
- July 1, 2015: PhysPAG session @ HEAD Symposium, Chicago
- July 3, 2015: Joint PAG EC Chair telecon
- July 13, 2015: Joint PAG EC Chair telecon with Paul Hertz
- July 14, 2015: ExoPAG Virtual Meeting
- August 7, Joint PAG Splinter Session @ IAU GA, Honolulu
- August 18, 2015: ExoPAG Virtual Meeting
- August 20, 2015: COPAG Virtual Town Hall
- August 31, 2015: Joint PAG Present @ AIAA Space 2015 Pasadena
- October 7, 2015: Deliver reports to Hertz
- October 21-22, 2015: Astrophysics Subcommittee Meeting

Preparing for the 2020 Decadal Survey
Large Mission Concepts

- NASA Plan for Community Input
  - 2015: PAGs gather community input on selecting concepts for study
  - 2016: Appoint STDT and Center study office, STDT assesses technology
  - 2017: Fund technology development through SAT, STDT develops DRM
  - 2018: STDT submits DRM for cost assessment
  - 2019: STDT issues report and provides input to Decadal Survey

Preparing for the 2020 Decadal Survey
Medium Mission Concepts (Probes)

- In Astrophysics, there is a large gap between Large Strategic Missions (>$1B) and MIDEX Explorer Missions (<$400M)
  - Medium strategic missions, between $500M and $1B, are called Astrophysics Probes
  - Examples include Spitzer, Kepler, Fermi

- What was done 10 years ago?
  - Origins Probes Mission Concepts (2004)
    - ROSES call for quick (~9 month) paper concept studies
    - ~9 concepts selected in 2004; total ~$1M ($100K average)
  - Astrophysics Strategic Mission Concepts Study (ASMC; 2007)
    - ROSES call for ~1 year concept studies with mission design lab run
    - ~19 ASMC concepts selected in 2008; total $13M ($700K average)

- What was the result in Astro2010
  - No medium missions prioritized or recommended
  - Prioritized medium activities for space are
    - New Worlds technology development
    - Inflation Probe technology development

Preparing for the 2020 Decadal Survey
Medium Mission Concepts (Probes)

- Paper mission concept studies leading to competed program
  - Fund ~10 paper mission concept studies selected through peer reviewed proposals submitted in response to a ROSES solicitation
  - NASA conducts a non-advocate, parametric cost assessment of final mission concepts
  - Decadal Survey selects most scientifically compelling mission concepts and recommends a competed Astrophysics Probes Program, similar to the New Frontiers Program
  - NASA ensures cost cap compliance through AO and TMC processes
- Full mission concept studies for Decadal Survey prioritization
  - Select ~3 full mission concept studies through TBD process
  - Full mission concept studies leading to CATE-able mission concepts
  - Decadal Survey prioritizes medium missions
- Paper mission concept studies leading to Decadal Survey prioritization
  - Paper mission concept studies with non-advocate cost assessment
  - Decadal Surveys identifies ~3 mission concepts studies for rapid design studies leading to CATE-able mission concepts
  - Conduct detailed study and better cost assessment of a few probes as additional exemplars

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Budget Uncertainty

- An important lesson learned has been that budget uncertainty complicates the development of an executable and affordable program. (S-4)
- A best practice might be to replace the extrapolations of a current or newly released budget with a baseline that reflects longer-term funding levels for NASA SMD and relevant partner agencies such as NSF and NOAA. (S-4)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Advice from SSB Standing Committees

- Lesson Learned: As long as the standing committee restricts its work to the existing program, there is no meaningful conflict that would preclude continuation of the SSB standing committees during the execution of a decadal survey. (4-7)
- Lesson Learned: The current [NRC] advisory structure does not provide an effective mechanism for short-term tactical guidance from the scientific community (i.e., tactical guidance for accomplishing strategic visions). (4-9)
- Best Practice: SSB standing committees can continue their work throughout the period when a new decadal survey is in progress in order to provide an uninterrupted channel of communication between SSB standing committees and NASA and other agencies, with respect to strategic issues that concern the current program. (4-7)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Survey of Science Priorities

- Lesson Learned: The community has many means, especially between decadal surveys, to address the evolution of science in the discipline. This forms the basis of a two-phase process without separating the decadal survey process itself in two. (2-19)
- Best Practice: Agencies, committees of the Academies', community workshops and meetings, and white papers can contribute to pre-survey science priority identification as preparation for, and a valuable contribution to, the next survey. These activities can also spur early development, evaluation, and maturation of concepts for new missions for potential priorities well in advance of the survey itself. (2-19)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Cost and Technical Evaluation (CATE)

- Lesson Learned: The tendency to over-define mission concepts in pursuit of more accurate cost evaluation can stifle creative approaches to addressing survey goals. (2-8)
- Best Practice: Decadal surveys can present their implementation strategies as reference missions—that is, a credible hardware configuration that can achieve the science goals and is sufficiently defined for robust cost evaluation—instead of blueprints for detailed implementation. (2-8)
- Lesson Learned: CATE involves assessment of a single point design to assess cost and technical risk. It is most useful as a reasonableness check on what is being recommended. Details used to support the CATE analysis are not necessarily indicative of how a mission will ultimately be implemented. (2-25)
- Best Practice: The survey committee can choose, and subsequently identify in its report, the role of the CATE in the survey. The CATE could provide, for example, a best-possible cost estimate for a point design or an independent, rough estimate for comparative purposes. (2-25)
- Best Practice: When drafting a decadal survey, it is important to clarify the intended use of the cost appraisal for each mission or facility. Is it for a configuration that is intended to serve as (1) a “proof of a concept” that merely establishes the scale of the project; (2) a cost estimated for a mature, well studied concept; (3) a cost cap; or (4) something else entirely. (3-19)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Cost and Technical Evaluation (CATE)

- Best Practice: A two-step CATE process that allows more concepts to remain in consideration in the early stages of the survey includes a faster, cruder “cost box” analysis for a longer list of candidate concepts. This would be followed by a detailed CATE for candidates for the final program that require more detailed assessment due to their cost, complexity, risk, or importance to the community. (2-8)
- Best Practice: To prevent the CATE analysis from unnecessarily “driving” the decadal survey process, survey committees can consider implementation of a two-step CATE in which rough technical readiness and risk assessment feedback (accurate to a factor of two or three) would be provided for most, if not all, concepts early in the survey process. The more detailed and comprehensive CATE analysis (as used in recent surveys) would be reserved for those concepts that the committee identifies as worthy of further study. (2-25)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

Design Reference Missions

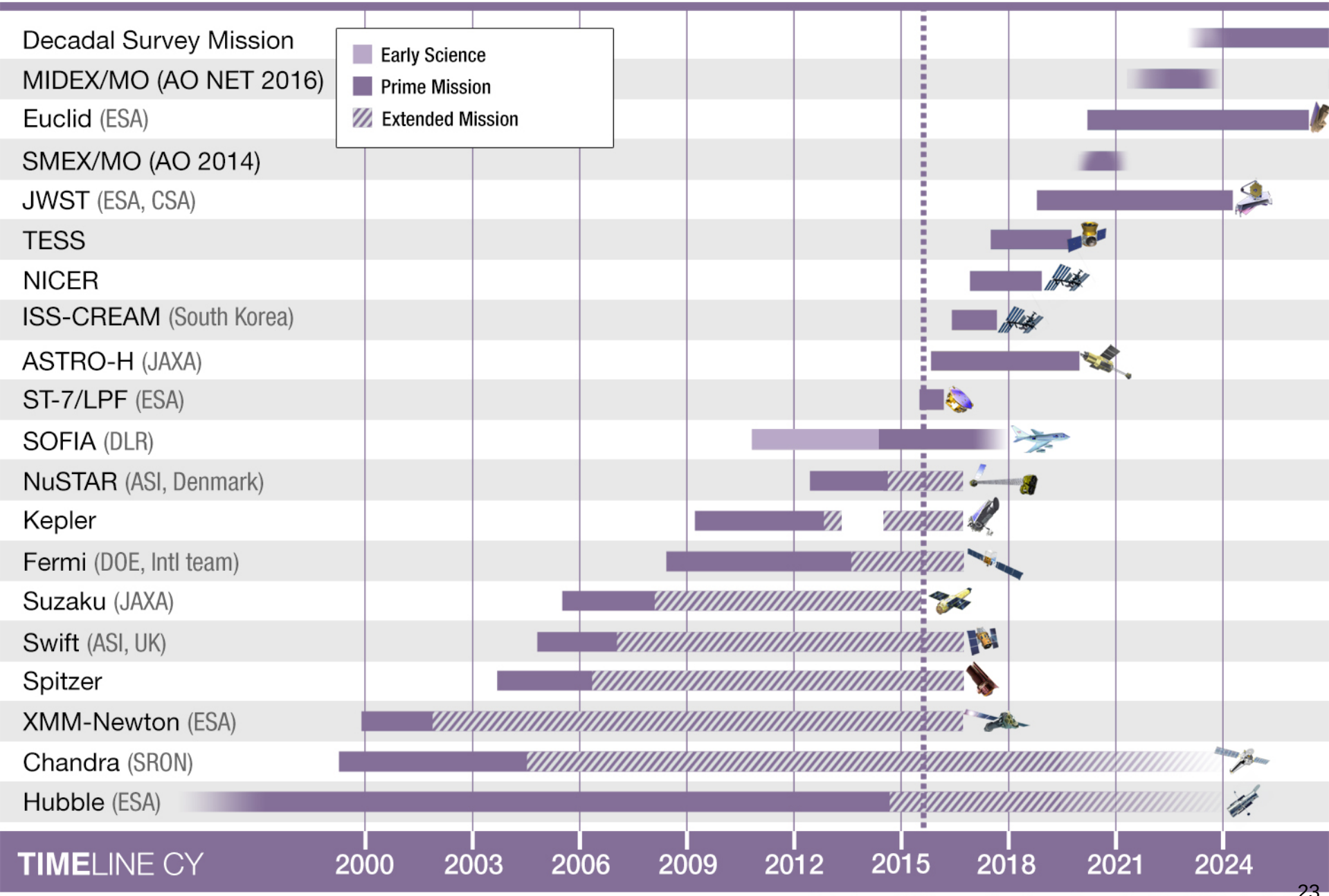
- Lesson Learned: It is important that decadal surveys explicitly note which proposed missions are reference missions—i.e., subject to further development—versus those intended as explicit implementation recommendations based on mature and well-refined concepts. (2-17)
- Lesson Learned: CATE involves assessment of a single point design to assess cost and technical risk. It is most useful as a reasonableness check on what is being recommended. Details used to support the CATE analysis are not necessarily indicative of how a mission will ultimately be implemented. (2-25)
- Best Practice: When recommending high-profile missions, survey committees are advised to explicitly state which aspects of the project are essential to retaining the mission's consensus priority and which can be further considered during design development to enable cost control. (3-10)
- Best Practice: When drafting a decadal survey, it is important to clarify the intended use of the cost appraisal for each mission or facility. Is it for a configuration that is intended to serve as (1) a "proof of a concept" that merely establishes the scale of the project; (2) a cost estimated for a mature, well studied concept; (3) a cost cap; or (4) something else entirely. (3-19)

The Space Science Decadal Surveys: Lessons Learned and Best Practices (NRC, 2015)

International Collaboration

- Lesson Learned: The potential for international collaboration, interagency cooperation, and inclusion of the private sector impacts science and mission prioritization across all disciplines. (2-14)
- Best Practice: Decadal survey committees are advised to determine a fair and consistent way to evaluate all international partnerships, which would be communicated to the panels early in the decadal process. The technical evaluation can be comprehensive and inclusive of the international portions and risks. However, assessment for affordability may need to be, in a pragmatic sense, for the U.S. portion only. (2-26)

Astrophysics Timeline



Dates beyond 2016 are contingent upon the results of the 2016 Senior Review

Appendix: Statutory Language on Decadal Surveys

Collected by Paul Hertz
Astrophysics Division Director
NASA

Statutory Language on Decadal Surveys

- Decadal Surveys are required by law
  - "The Administrator shall enter into agreements on a periodic basis with the National Academies for independent assessments, also known as decadal surveys, to take stock of the status and opportunities for Earth and space science discipline fields and Aeronautics research and to recommend priorities for research and programmatic areas over the next decade."
  - NASA Authorization Act of 2008, P.L. 110-422, Sec. 1104
- Mid-Term Reviews are required as well
  - "The performance of each division in the Science directorate of NASA shall be reviewed and assessed by the National Academy of Sciences at 5-year intervals."
  - NASA Authorization Act of 2005, P.L. 109-155, Sec. 301
- Using Decadal Surveys in NASA budget planning
  - "NASA shall take into account the current decadal surveys from the National Academies' Space Studies Board when submitting the President's budget request to the Congress."
  - NASA Authorization Act of 2010, P.L. 111-267, Sec. 805

Statutory Language on Decadal Surveys

- NRC independence in studies, including Decadal Surveys
  - "An agency may not use any advice or recommendation provided by the National Academy of Sciences … that was developed by use of a committee created by that academy under an agreement with an agency, unless the committee was not subject to any actual management or control by an agency or an officer of the Federal Government."
  - Federal Advisory Committee Act of 1972, as amended (FACA), P.L. 92-463, Sec. 15
- The Decadal Survey and independent cost assessment
  - "The agreements described in subsection(a) [for independent assessments, also known as decadal surveys] shall include independent estimates of the life cycle costs and technical readiness of missions assessed in the decadal surveys whenever possible."
  - NASA Authorization Act of 2008, P.L. 110-422, Sec. 1104