National Aeronautics and Space Administration

Planning for the Mid-Decade Review

Astrophysics Subcommittee
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Astrophysics

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Planning for the 2015 Mid-Decade Review

- The Mid-Decade Review will be conducted during 2015-2016
  - Discussions of the Statement of Work will begin with the NRC towards the end of 2014.
- This presentation will review many of the activities that NASA has undertaken in response to the Large-scale and Medium-scale recommendations
- Request to the Astrophysics Subcommittee for tactical input:

  Are there other activities that NASA should undertake in preparation for the Mid-Decade Review?

2005 Mid Decade Review

- **Charge**: An NRC committee will prepare a short report reviewing the scientific discoveries and technical advances in astronomy and astrophysics over the 5 years since the publication of the decadal survey, Astronomy and Astrophysics in the New Millennium (AANM). It will address the implications of scientific and technical developments as well as changes in the federal program. It will assess progress toward realizing the vision for the field articulated in AANM and supplemented by Connecting Quarks with the Cosmos.
- **Outcome**: Several major discoveries since 2000 – dark energy, BH/Galaxy connection, exoplanets – validate the Decadal Survey, do not require its revision
- **Highlights of report**:
  - importance of breadth and balance in science program
  - need for internal Agency strategic planning
  - collaborations and partnerships (DOE, NSF, etc.)
  - need for independent cost assessment

Progress Toward Decadal Survey Priorities

The NASA FY14 Appropriation, the President's FY15 Budget Request, and its **notional out years support:**	
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 NET FY2017. Planning budget proposed for an Astrophysics Decadal Strategic Mission.
Large-scale 2. Augmentation to Explorer Program	Astrophysics Explorers planned budget increased to ~$150M/yr by FY16; supports decadal cadence of AOs including AO for SMEX AO in Fall 2014 (FY2015) and EX AO in ~FY2017.
Large-scale 3. LISA	Strategic astrophysics technology (SAT) investments including LISA Pathfinder plus discussing partnership on ESA's L3 gravitational wave observatory – participating in ESA-led assessments in 2014-2015.
Large-scale 4. IXO	Strategic astrophysics technology (SAT) investments plus pursuing partnership on ESA's L2 Athena X -ray observatory. Athena study phase, with U.S. participation, is underway.
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.

Progress Toward Decadal Survey Priorities

The NASA FY14 Appropriation, the President's FY15 Budget Request, and its **notional out years support:**	
Medium-scale 2. Inflation Probe Technology Development Program	Three balloon-borne investigations plus strategic astrophysics technology (SAT) investments.
Small-scale. Research Program Augmentations	Increased annual R&A budget from $74M (FY10) to $82M (FY12 and beyond). 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.
Small-scale. Future Ultraviolet-Visible Space Capability	Strategic Astrophysics Technology (SAT) investments.
Small-scale. SPICA (U.S. contribution to JAXA-led)	Not supported as a strategic contribution; candidate for Explorer Mission of Opportunity.

Looking toward the 2015 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)

Mid-Decade Review: LISA

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)

NASA actions and plans

- Participate in LISA Pathfinder
  - Hardware contribution, mission participation, data analysis participation
- Invest in technologies through SAT (through SAT-2013 review)
  - J. Camp, TRL-5 laser system (2014-2015)
  - W. Klipstein, Phase measurement system development (2012-2015)
  - J. Lipa, Advanced laser frequency stabilization (2013-2014) (w/ STMD)
  - J. Livas, Telescope for a space-based GW mission (2012-2015)
  - J. Ziemer, Colloid microthruster propellant feed system (2013-2014)
- Participate in ESA-led assessment studies
- Contribute to ESA's L3 GW observatory (planned)

Mid-Decade Review: IXO

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

- IXO: If IXO is L1, conduct review then (maybe) invest immediately in technology. By mid-decade, invest aggressively in technology. (p. 214, p. 215)

NASA actions and plans

- Invest in technologies through SAT and directed (through SAT-2013 review)
  - M. Bautz, Directly deposited blocking filters (2012-2014)
  - C. Kilbourne, High resolution imaging spectrometer (2012-2015)
  - R. McEntaffer, Off-plane grating arrays (2012-2014)
  - P. Reid, Electroplated grazing incidence optics (2012-2014) (w/ STMD)
  - M. Schattenburg, Critical angle transmission gratings (2012-2013)
  - W. Zhang, Next generation X-ray optics (2012-2014)
- Pursue partnership on ESA's L2 Athena mission (2013-2028)
  - US member on Science Study team
  - Discussions underway for mission hardware contribution, US membership on science team, US science data center, US GO program

Mid-Decade Review: New Worlds

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

- 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)

NASA actions and plans

- Invest in technology through SAT (years)
  - High contrast imaging testbeds
  - See next chart for selected investigations
- Downselect coronagraph technology for WFIRST coronagraph technology demonstration instrument
  - Technology development within WFIRST/AFTA study
  - Occulting mask coronagraph
  - Phased induced amplitude apodization complex mask coronagraph
- Conduct mission concept studies for exoplanet probes
  - Includes technology “tall poles” lists
  - S. Seager et al., Starshade exoplanet probe
  - K Stapelfeldt, Coronagraph exoplanet probe

- E. Bendek, Direct Imaging with Astrometric Determination (2015-2016)
- P. Bierden, MEMS Deformable Mirror Technology Development (2012-2013)
- S. Casement, Starshade Stray Light Mitigation (2014-2015)
- W. Cash, Development of Formation Flying Sensors (2015-2016)
- M. Clampin, Visible Nulling Coronagraph Technology Maturation (2010-2011)
- D. Figer, A Photon-Counting Detector for Exoplanet Missions (2010-2011)
- T. Glassman, Starshade Performance in the Field (2014-2015)
- O. Guyon, Phase-Induced Amplitude Apodization Coronagraphy (2010-2013)
- M. Helmbrecht, Testing of MEMS Deformable Mirrors (2012-2013)
- J. Kasdin, Starshades for Exoplanet Imaging and Characterization (2010-2013)
- J. Kasdin, Wavefront Control Using Deformable Mirrors (2012-2013)
- J. Kasdin, Verification/Formation Flying of an External Occulter (2014-2016)
- J. Krist, Performance Limits of Internal Coronagraphs (2010-2011)
- R. Lyon, Visible Nulling Coronagraph Technology Maturation (2012-2013)
- R. Lyon, Segmented Aperture Nulling Coronagraphy (2015-2016)
- C. Noecker, Speckle Sensing for Internal Coronagraphs (2010-2011)
- J. Sandhu, Visible Nulling Coronagraph Technology (2012-2013)
- G. Serabyn, Deep Starlight Rejection with a Vortex Coronagraph (2012-2013)
- S. Shaklan, Coronagraph Starlight Suppression Model Validation (2012-2013)
- J. Trauger, Advanced Hybrid Lyot Coronagraph Technology (2010-2011)

Mid-Decade Review: Inflation Probe

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

- Inflation Probe: If B-mode detected, conduct review then (maybe) invest in technology for an all-sky mission. (p.198, p.217)

NASA actions and plans

- Science and technology development through three balloon payloads
  - S. Hanany, E and B Experiment (EBEX)
  - A. Kogut, Primordial Inflation Polarization Explorer (PIPER)
  - W. Jones, Spider
- Science and technology development through ground based investigations
  - Technology for BICEP-2 detectors, etc.
- Invest in technology through SAT (years)
  - J. Bock, Antenna-coupled superconducting detector arrays (2012-2014)

Looking toward the Mid-Decade Review

Are there other activities that NASA should undertake in preparation for the Mid-Decade Review?