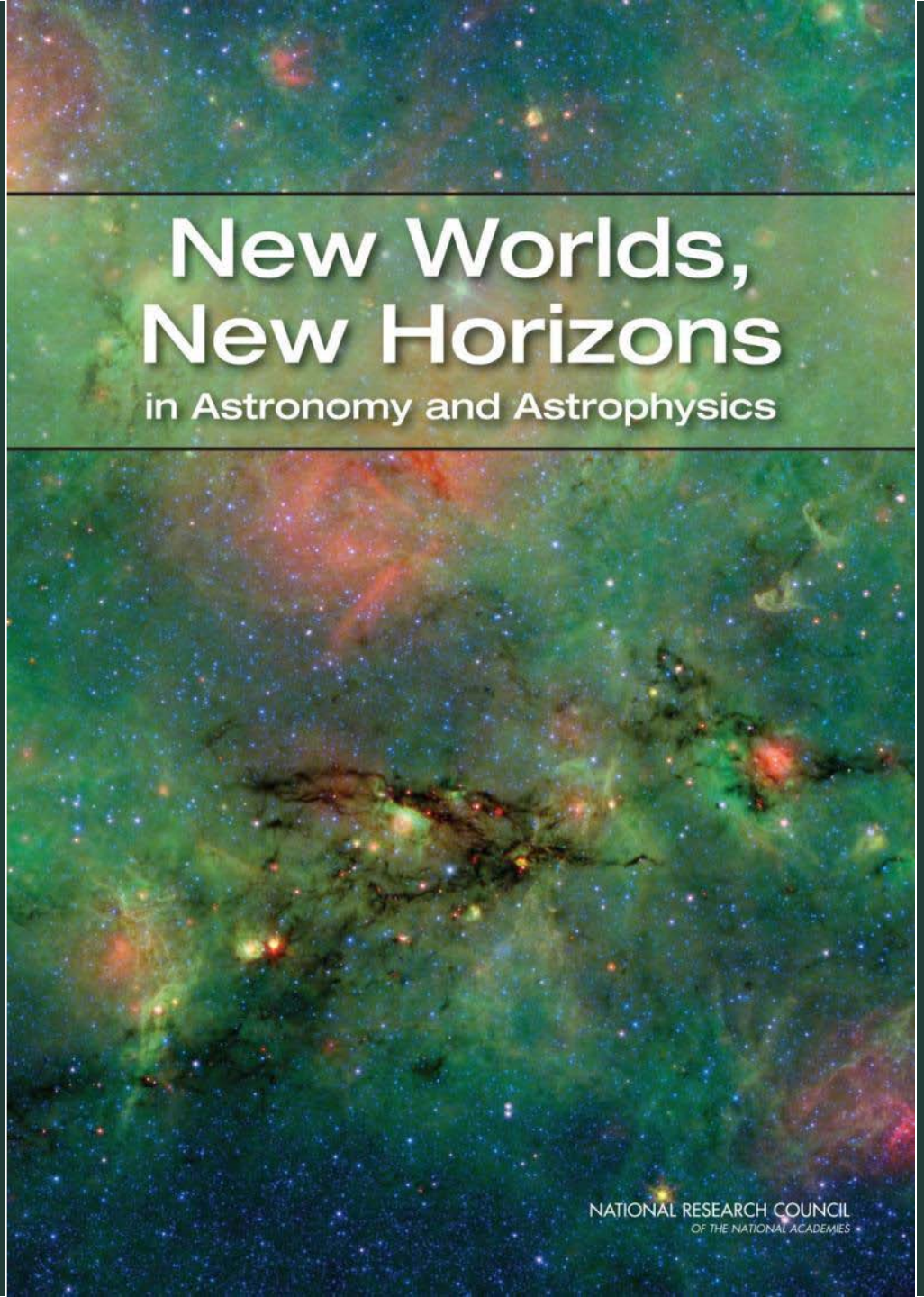

New Worlds,
New Horizons
in Astronomy and Astrophysics
NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Report Contents

- Executive Summary
- Chapter 1: 2020 Vision (Overview)
- Chapter 2: On the Threshold (Science)
- Chapter 3: Partnership in Astronomy and Astrophysics
- Chapter 4: Astronomy in Society
- Chapter 5: Sustaining the Core Research Program
- Chapter 6: Preparing for Tomorrow
- Chapter 7: Realizing the Opportunities (Decade Program)
- Appendixes:
    - Science Frontiers
    - Program Prioritization
    - Cost, Risk, and Technical Evaluation Process
    - Mid-Scale Projects

Astro2010

Charge led to

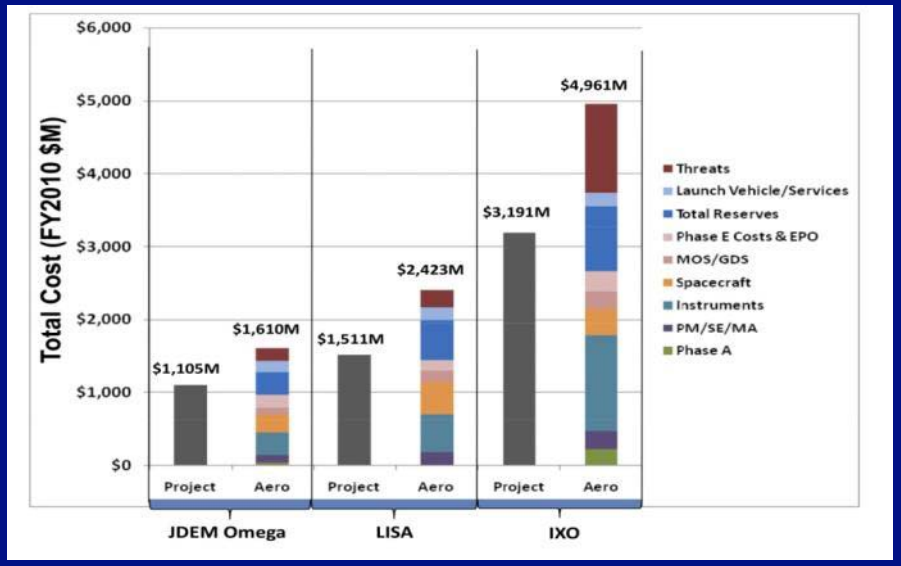
- Significant community engagement
- Science First
- Independent analysis of risk, technical readiness, schedule, and life cycle costs.
- Recommended program under different budgetary scenarios
- Consideration of unstarted projects from previous surveys - no “grandfathering”

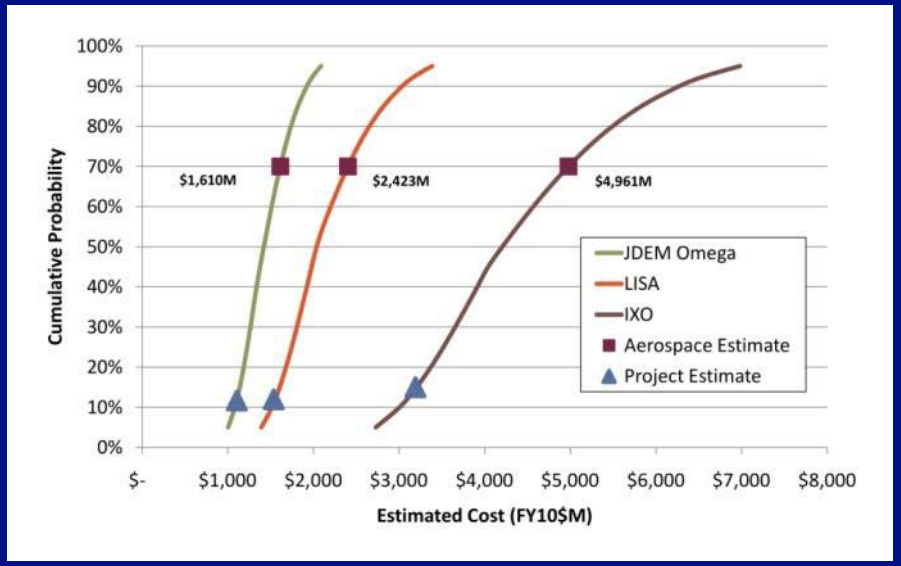
Optimizing the Recommended Program

- Prioritizing based on science objectives
- Building upon existing astronomical enterprise
- Evaluating cost risk and technical readiness
- Maximizing scientific return under highly constrained budget guidelines
- Choosing most urgently needed activities from long list of compelling ideas and concepts
- Considering international and private partnerships

Cost, Risk, and Technical Evaluation

- Early call for Notices of Intent followed by open Request for Information
  - Activities selected by PPPs and committee for a 2nd Request for Information
- Subset selected by PPPs and committee for CATE review
  - Independent cost appraisals
  - Evaluations of technical readiness schedule and risk assessment





Large Scale Space Program - Prioritized

1. Wide Field InfraRed Survey Telescope (WFIRST)

1. Explorer Program Augmentation

2. Laser Interferometer Space Antenna (LISA)

3. International X-ray Observatory (IXO)

Medium-Scale Space Program - Prioritized

1. New Worlds Technology Development Program

2. Inflation Technology Development Program

Large-scale Ground-based Program - Prioritized

1. Large Synoptic Survey Telescope (LSST)
2. Mid-Scale Innovations Program
3. Giant Segmented Mirror Telescope (GSMT)
4. Atmospheric Cerenkov Telescope Array (ACTA)

Medium-scale Ground-based Program

1. Cerro Chajnantor Atacama Telescope (CCAT)

Small-scale Program (Ground and Space – not prioritized)

Program Augmentation	Agency
Advanced Technologies and Instrumentation	NSF
Astronomy and Astrophysics Grants (including Lab. Astro.)	NSF
Astrophysics Theory Program	NASA
Intermediate Technology Development	NASA
Laboratory Astrophysics	NASA
Sub-orbital Program	NASA
Telescope System Instrument Program	NSF

New Initiatives	Agency
Development of future UV-optical space capability	NASA
Leadership in Gemini international partnership (increment)	NSF
Participation in JAXA's SPICA mission	NASA
Theory and Computation Networks	NASA, NSF, DOE

Small-scale Investments

- Target work-force development
  (TSIP, Sub-orbital, AAG, ATP)
- Address changing role of computation and theory
  (TCN)
- Support current/upcoming facilities
  (Gemini, Lab Astro, TCN)
- Develop technology for future
  (NSF ATI, NASA Tech. Dev.)

Recent Major Activities of the Agencies

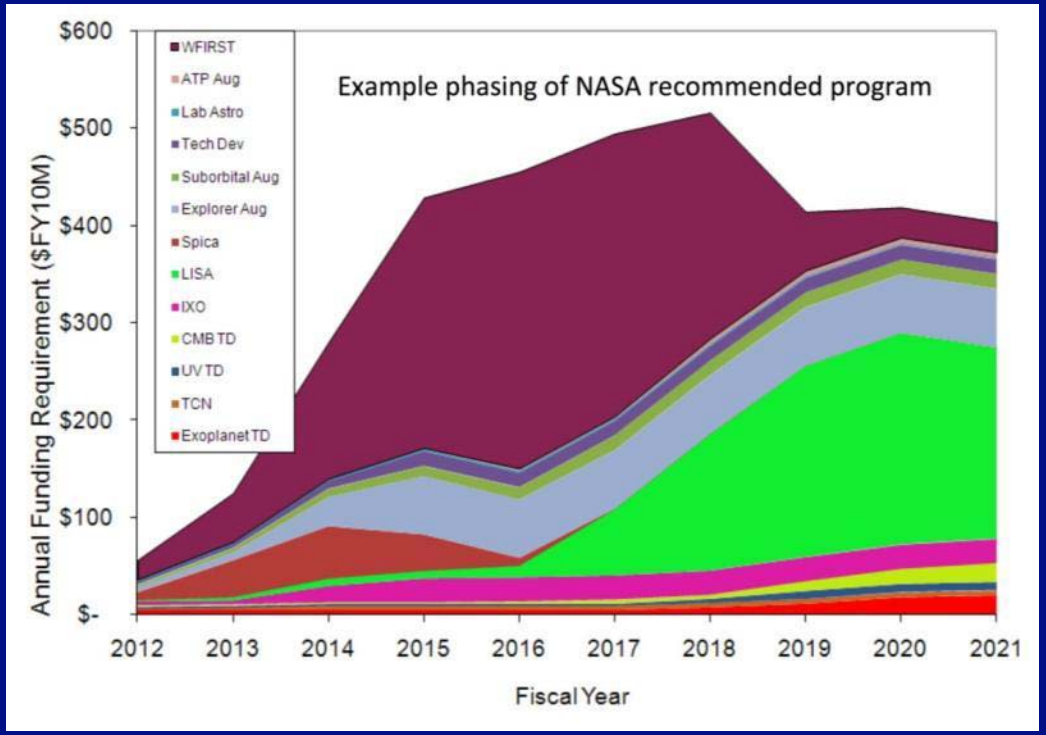
- NSF
  - ALMA construction finished in 2012 (operations costs ramp-up)
  - ATST construction start in 2011; completion ~2017
  - EVLA upgrade completion 2012
  - Other AANM priorities TSIP, CARMA, VERITAS, SPT completed
  - GSMT, LSST, SKA, FASR not started
  - evolution in VLBA, Arecibo, Gemini, NOAO
  - 55% of budget to run facilities and 25% to individual investigators
- NASA
  - JWST schedule unknown
  - Fermi and SDO launched
  - DDAA priority SIM not started
  - AANM priorities Con-X, LISA, EXIST, ARISE not started
  - AANM recommended tech dev for TPF halted and SAFIR not realized
  - Explorer program slowed
  - Imminent ramp-down of the “great observatories” program
- DOE
  - Fermi partnership a success

Budgetary Context

- Agency Guidelines
  - NSF and DOE – constant budgets in fixed dollars ($FY2010)
  - NASA – constant real year dollars (declining budget in $FY2010)
- Survey Budgets (the optimistic scenario)
  - NSF and DOE – "doubling" = 4% per year growth in $FY2010
  - NASA – constant in $FY2010 dollars
- Notional "sand charts"
  - Exhibit possible spending profiles consistent with committee budgets and the recommended program, i.e. phasing
  - Allowed the committee to examine possible programmatic scenarios
  - Provide advice in less optimistic budget scenarios

NASA

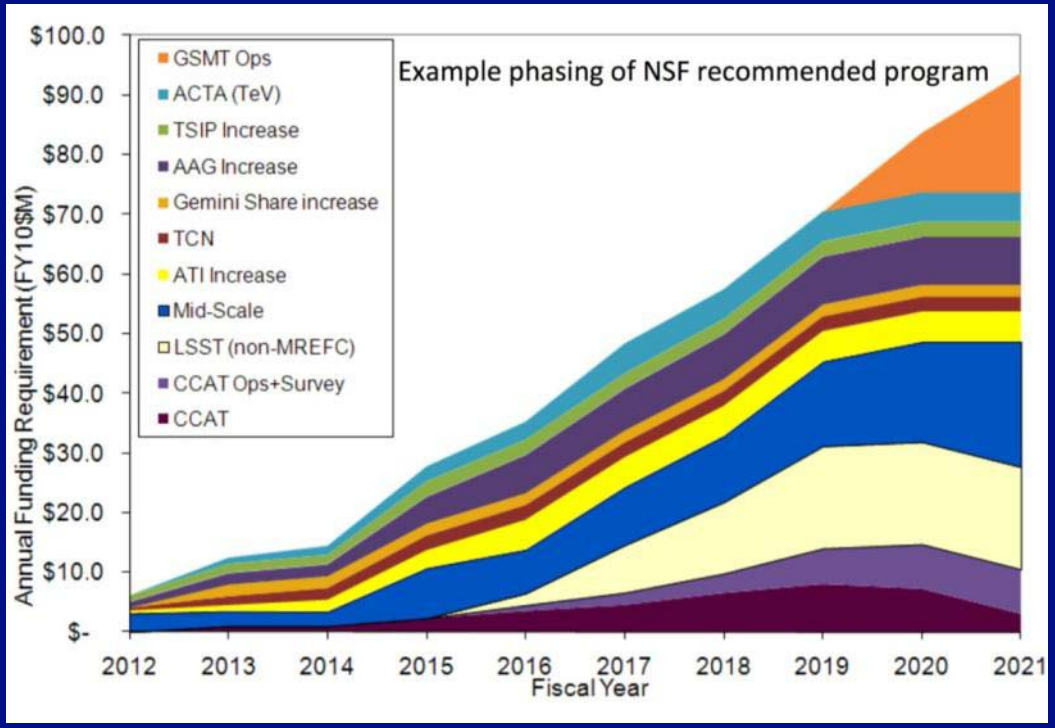
- Expectation under survey's budget scenario:
  - launch WFIRST
  - augment Explorers
  - start LISA
  - timely contribution to SPICA
  - advance
    - IXO
    - Exoplanet and Inflation technology development
- Details depend upon ESA negotiations and decisions



- If budgets are lower, SPICA contribution dropped and
  - First priority: WFIRST, Explorer augmentation and small program
  - Second priority: New Worlds (Exoplanet) Technology Development, LISA and IXO Technology Development
  - Third priority: Inflation Technology Development

NSF

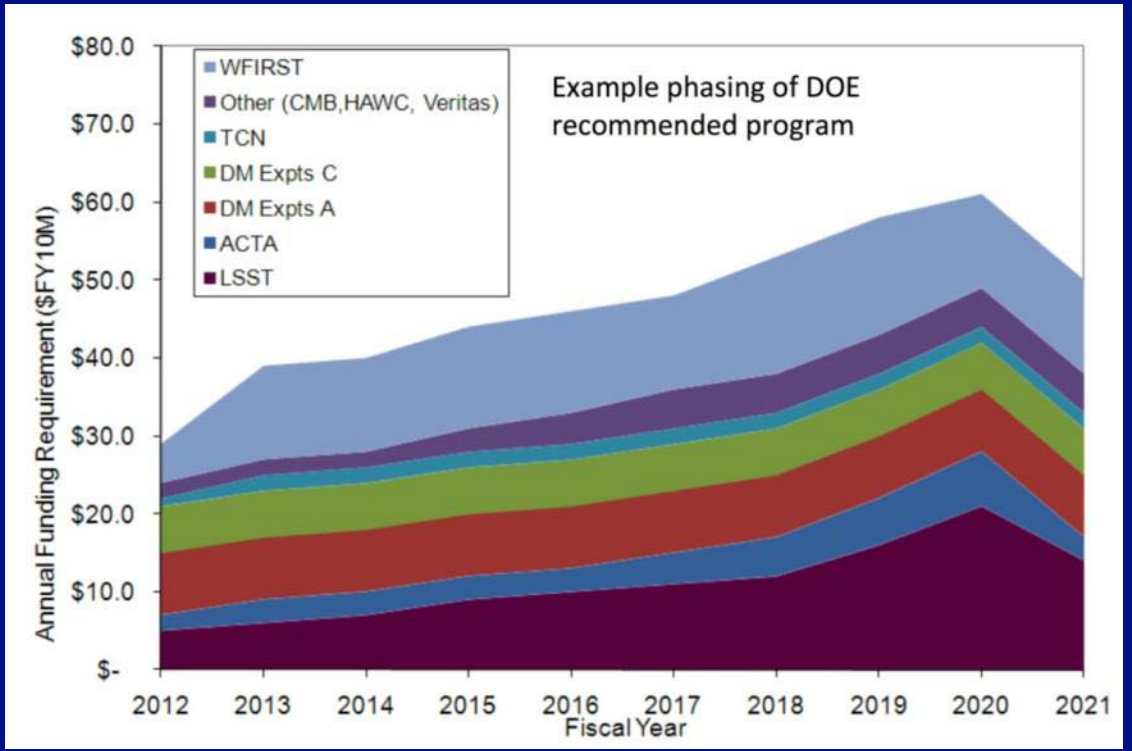
- Program dependent upon MREFC
  - early entry of LSST
  - followed by GSMT



- In event NSF budget is as projected by agency, there can be no new starts without closure of major facilities following senior review
- If moderate budget increase
  - First priority is small program (including time-critical Gemini augmentation), Mid-scale Innovations program, and starting LSST operations.
  - Second priority is GSMT operations, and starting ACTA

DOE

- Survey's budget scenario allows investment in
  - LSST
  - WFIRST
  - other PASAG recommendations.



- In lower budget scenarios, DOE participation in LSST is recommended ahead of WFIRST as contribution relatively larger and technical role relatively more critical

- Small-scale program and ACTA have lower priority

Other Recommendations & Conclusions

- International Matters: collaboration, coordination; open skies
- Stewardship of the Survey: independent, strategic advisory group
- Benefits to the Nation: STEM literacy; technology spin-offs; citizen science
- Astronomers: career mentoring; demographics; public policy
- Computation and Data: archive and curate data
- Laboratory Astrophysics: support at current or higher levels
- NSF/AST Senior Review: conduct early in decade
- NOAO and Gemini: explore management and operations consolidation
- Solar Astronomy: maintain multidisciplinary ties
- Radio Astronomy: SKA pathfinder opportunities

Stewardship of the Survey

- Several recommendations in this report are conditional upon technical developments, outcomes of scientific observing programs and decisions taken by international and private partners over the next five years.

- It is imperative that the agencies receive the best independent strategic advice in a timely manner to assess progress toward the recommended goals and to make deferred choices

- RECOMMENDATION: NASA, NSF, and DOE should on a regular basis request advice from an independent standing committee constituted to monitor progress toward reaching the goals recommended in the decadal survey of astronomy and astrophysics, and to provide strategic advice to the agencies over the decade of implementation. Such a decadal survey implementation advisory committee (DSIAC) should be charged to produce annual reports to the agencies, the Office of Management and Budget, and the Office of Science and Technology Policy, as well as a mid-decade review of the progress made. The implementation advisory committee should be independent of the agencies and the agency advisory committees in its membership, management, and operation.

Summary

- This is an extraordinary time in the study of the cosmos, but also a time of serious constraints on federal discretionary budgets.
- The recommended program is science-driven and will enable progress across a large swath of research and open up more discovery space.
- A balanced program should be maintained throughout the decade. Effective international, public-private and inter-agency collaboration is required for success of the program.
- A serious effort has been made to appraise activity cost, risk and technical readiness.
- Mid-decade decisions should be made based on recommendations from an independent, strategic advisory committee.
- Astro2010 has had unprecedented involvement and support by the astronomical community and immense effort by the committee, panels and consultants, as well as the strong cooperation of the agencies and professional societies.