

2010 NASA Laboratory Astrophysics Workshop
Gatlinburg, TN, 26-28 October 2010

The Status of NASA's Laboratory Astrophysics Program

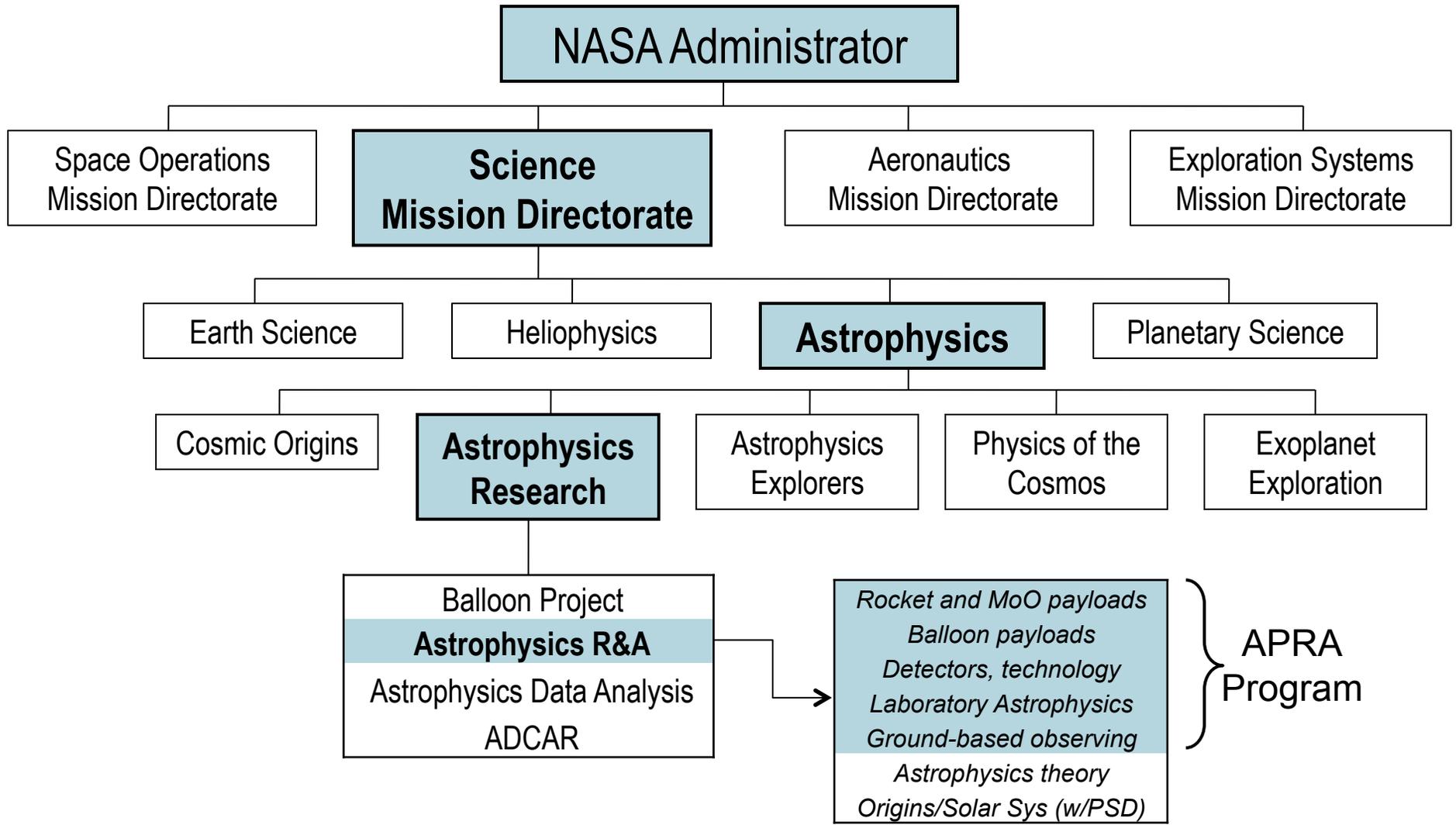
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NASA Organizational Context



Astrophysics R&A

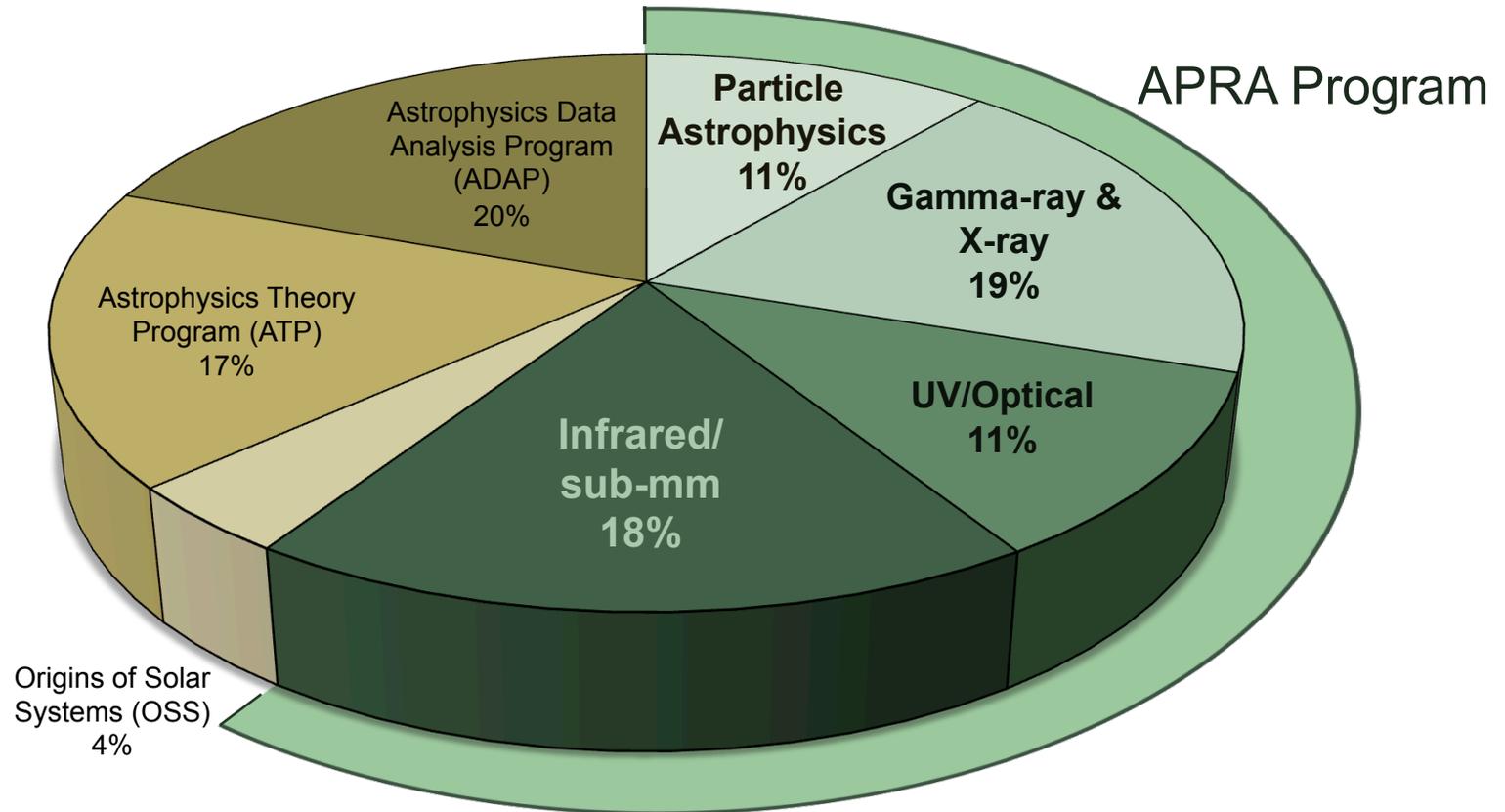
- Astrophysics Theory Program (ATP)
- Origins of Solar Systems (with Planetary Science Division)
- Astrophysics Research & Analysis (APRA)
 - **Categories of Investigations**
 - *Suborbital (Balloons and Sounding Rockets)*
 - *Detector Development*
 - *Supporting Technology (Optics, Coatings, Coronagraphs...)*
 - **Laboratory Astrophysics**
 - *Ground-based*
 - **Disciplines**
 - *IR/Sub-mm**
 - *UV/Optical**
 - *X-Ray/Gamma-Ray**
 - *Particle Astrophysics**
 - *Exoplanets (Tech. Research, suborbital)*
 - *Fundamental Physics (from ATP)*

**denotes reservoir of program funds*

Structure of the APRA Panel Review

	Suborbital	Detectors	Supporting Technology	Ground-Based	Lab Astro
Radio/Sub-mm	<u>2010 Review: 32 proposals, 2 panels</u>				Lab Astro 2 - Molecules & Dust 2010 Review: 13 proposals
Infrared					
UV/visible	<u>2010 Review: 22 proposals, 1 panel</u>				Lab Astro 1 - Atoms & Atomic Ions 2010 Review: 10 proposals
X-Rays	<u>2010 Review: 21 proposals, 2 panels</u>				
Gamma-Rays					
Exoplanet Exploration	<u>2010 Review: 18 proposals, 1 panel</u>				
Particle Astrophysics	<u>2010 Review: 19 proposals, 1 panel</u> (7 investigations)				

FY10 Astrophysics R&A funding distribution



Total FY2010 Funding (\$73M) and split between disciplines/programs are very similar to FY2009.

Composition of the Lab Astro Program in FY10

Title	PI	Institution	Title	PI	Institution
Rate Coefficients and Neutral Products for Electron-Ion Dissociative Recomb.	Adams, Nigel	U. Georgia	Precision Infrared Spectroscopy of Astrophysically Important Molecular Ions	McCall, Benjamin	U. Illinois
The Spectroscopy of Molecular Hydrogen: Cross Sections and Oscillator Strengths	Ajello, Joseph	NASA JPL	Negative Molecular Ions And Other Exotic Molecules In Space	McCarthy, Michael	Harvard-SAO
The Coolest Iron-Peak Species in Astrophysics	Bautista, Manuel	Viginia Tech	Comprehensive Wavelengths and Energy Levels of Fe II, Cr II and Other Iron-Group Elements	Nave, Gillian	NIST
THz Time Domain Spectroscopy in Support of Herschel/SOFIA	Blake, Geoffrey	Caltech	Laboratory Spectroscopy of the Major Sources of Far Infrared Line Confusion	Pearson, John	NASA JPL
Electron Collisions with Highly Charged Ions	Chutjian, Ara	NASA JPL	High Energy Laboratory Astrophysics using an X-Ray Microcalorimeter with an EBIT	Porter, Frederick	NASA GSFC
Measurements of State-to-State Collision Rates for Water	Drouin, Brian	NASA JPL	Excitation of Fine Structure Infrared Lines and Line Ratios	Pradhan, Anil	Ohio State
Time-Domain THz Spectroscopy of Astrophysical Dust and Ice Analogs	Gerakines, Perry	U. Alabama, Birmingham	Expansion of the NIST Atomic Spectra Online Database	Reader, Joseph	NIST
Improved Simulations of Astrophysical Plasmas	Gorczyca, Thomas	Western Michigan	Diagnostic Properties of Astronomical Silicates in the Mid-Infrared to Millimeter	Rinehart, Stephen	NASA GSFC
Magnetorotational Instability and Hydrodynamic Stability in a Laboratory Flow	Ji, Hantao	Princeton	Spectroscopy of Astrophysically Significant Carbon Molecules and Ions	Salama, Farid	NASA ARC
Atomic Data for X-ray Photoabsorption	Kallman, Timothy	NASA GSFC	Low Temp. Dielectronic Recomb. Rate Coeff.s for Photoionized Cosmic Plasmas	Savin, Daniel	Columbia
Far Infrared and Sub-mm Spectroscopy of Cationic Polycyclic Aromatic Hydrocarbons	Kong, Wei	Oregon State	Spectroscopic Studies of Collisional and Photoionized Plasmas Using EBITS	Silver, Eric	Harvard-SAO
Lab Astrophys. using Synchrotron Radiation and a Spatial Heterodyne Spectrometer	Lawler, James	U. Wisconsin	Gas Phase Chemistry of Molecules and Ions of Astrophysical Interest	Snow, Theodore	U. Colorado
High-Resolution Spectra of Dimethyl Ether and Sulfur Dioxide	Lee, Timothy	NASA ARC	Charge Exchange Calc.s for Heliospheric/ Planetary X-ray Emission Modeling	Stancil, Phillip	U. Georgia

Good News: Astro2010 Decadal Survey

The Astro 2010 Decadal Survey was strongly supportive of Laboratory Astrophysics:

- Needed to achieve science goals of space missions/ground facilities.
- NASA/NSF/DOE should all work together to support (NASA/APRA, NSF/AAG, unique DOE facilities called out explicitly).
- Emphasized importance of adequate support for both facilities and core activities.
- recommended a significant increase in NASA's investment in the field.

Recommendations

General: *“NASA and NSF support for laboratory astrophysics [...] should continue at current or higher levels over the coming decade because these programs are vital for optimizing the scientific return from current and planned facilities.”*

Specific: *“Herschel, JWST, SPICA, and IXO [...] will place new demands on basic nuclear, ionic, plasma, atomic, and molecular astrophysics. Care should be taken to ensure that these needs are met. An increase by \$2 million per year in the funding of the present program is recommended.”*

Good News: Astro2010 Decadal Survey

Additional Significant Observations:

- Short-term funding for laboratory astrophysics, for example that tied to observing cycles, is inadequate for the health of stable laboratory astrophysics programs, and some source of stable base funding is needed to support experimental facilities.
- National Laboratories may be the most dependable long-term reservoir of [Laboratory Astrophysics] capability, as most of these topics are no longer central to the interests of basic physics at universities.
- The work of compiling the data into useful catalogs and databases is probably still best done by astronomers, and it is vital to maintain databases of important astrophysical results. This might be done at national labs or at major data centers, but needs to be coordinated among all investigators.

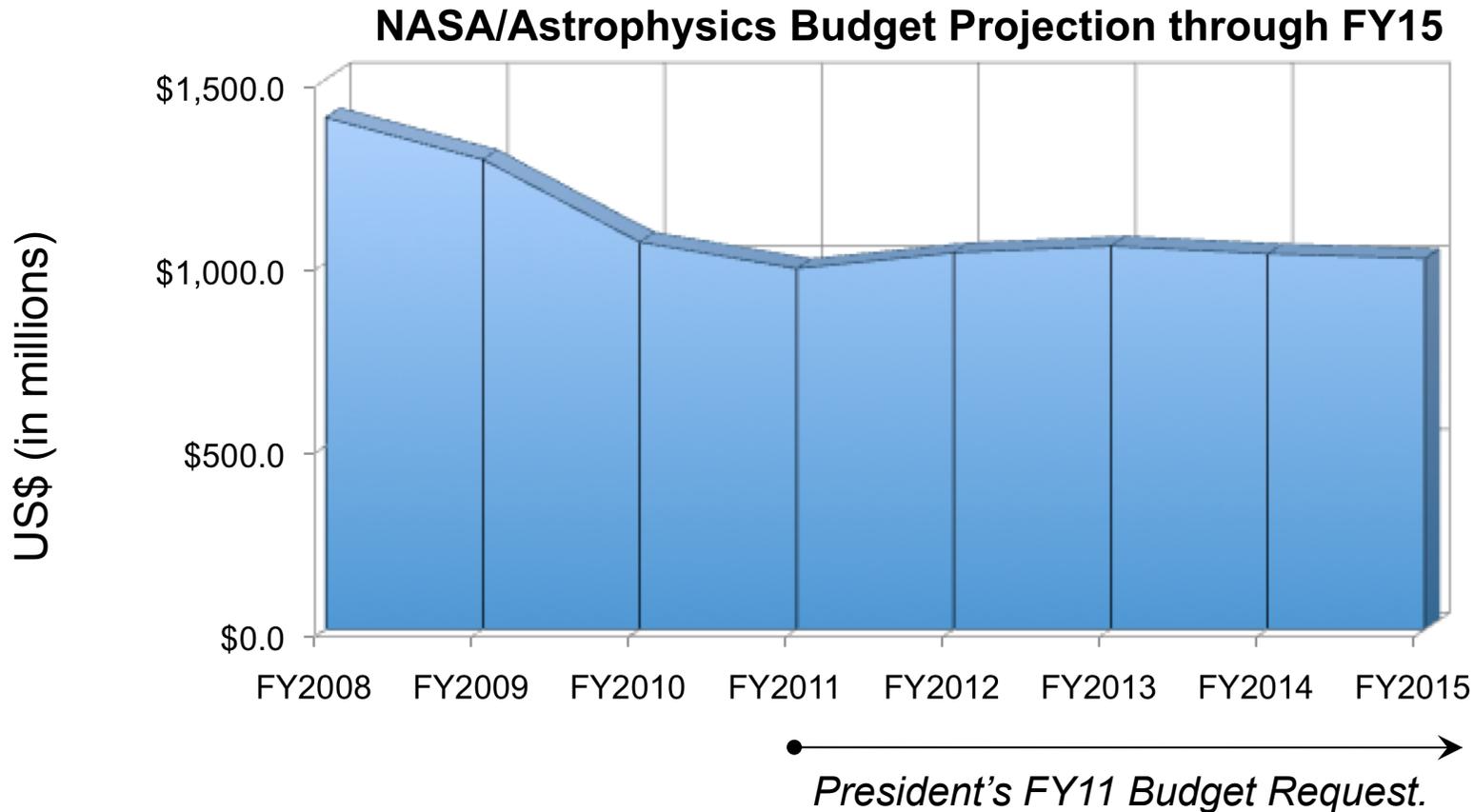


Astro2010 Decadal Survey Recommendations

Program Scale	Recommendation	Science	Total Cost (U.S. share)	Launch Date
Large	WFIRST (potential interagency & international partnerships)	Dark energy, exoplanets, and infrared survey-science	\$1.6B	2020
Large	Explorer Program Augmentation	Enable rapid response to science opportunities; augments current plan by 2 MIDEXs, 2 SMEXs, & 4 MoOs	\$463M	Ongoing
Large	LISA (requires ESA partnership)	Open low-frequency gravitational-wave window for detection of black-hole mergers and compact binaries and precision tests of general relativity	\$2.4B (\$1.5B)	2025
Large	IXO (partnership with ESA and JAXA)	Black-hole accretion and neutron-star physics, matter/energy life cycles, and stellar astrophysics	\$5.0B (\$3.1B)	2020s
Medium	New Worlds Technology Development Program	Preparation for a planet-imaging mission beyond 2020, including precursor science activities	\$100-200M	>2020
Medium	Inflation Probe Technology Development Program	CMB/inflation technology development and preparation for a possible mission beyond 2020	\$60-200M	>2020
Small	Astrophysics Theory Program Augmentation	Broad	\$35M additional	
Small	(Definition of) a future UV-optical space capability	Technology development benefiting a future UV telescope to study hot gas between galaxies, the interstellar medium, and exoplanets	\$40M	
Small	Intermediate Technology Development Augmentation	Broad; targeted at advancing the readiness of technologies at TRL 3 to 5	\$2M/yr additional, increasing to \$15M/yr additional by 2021	
Small	Laboratory Astrophysics Augmentation	Basic nuclear, ionic, atomic, and molecular physics to support interpretation of data from JWST and future missions	\$2M/yr additional	
Small	SPICA instrument (U.S. contributions to JAXA-led mission; possibly w/ ESA)	Understanding the birth of galaxies, stars, and planets; cycling of matter through the interstellar medium	\$150M	
Small	Suborbital Program Augmentation	Broad, but including especially cosmic microwave background and particle astrophysics	\$15M/yr additional	
Small	Theory and Computation Networks (NASA, NSF, DOE)	Broad; targeted at high-priority science through key projects	\$5M/yr NASA	9

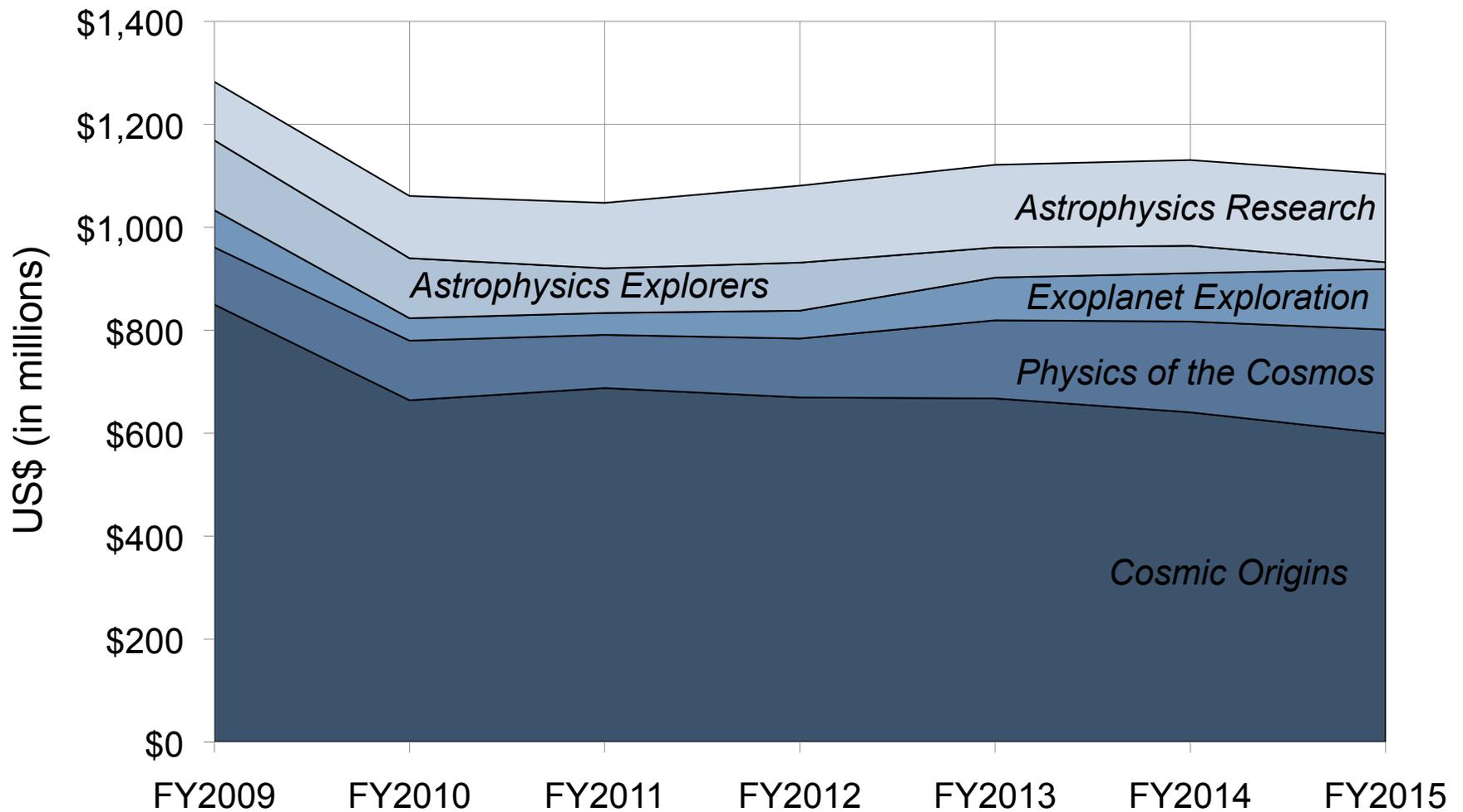
Bad News: Astrophysics Division Budget Profile

The projected budget for NASA's Astrophysics Division is essentially flat at around US\$1B through the middle of the decade; down from ca. \$1.5B in FY06.



Good News: Astrophysics Research Budget Profile

Current projections have the Astrophysics Research budget growing by >50% by mid-decade.

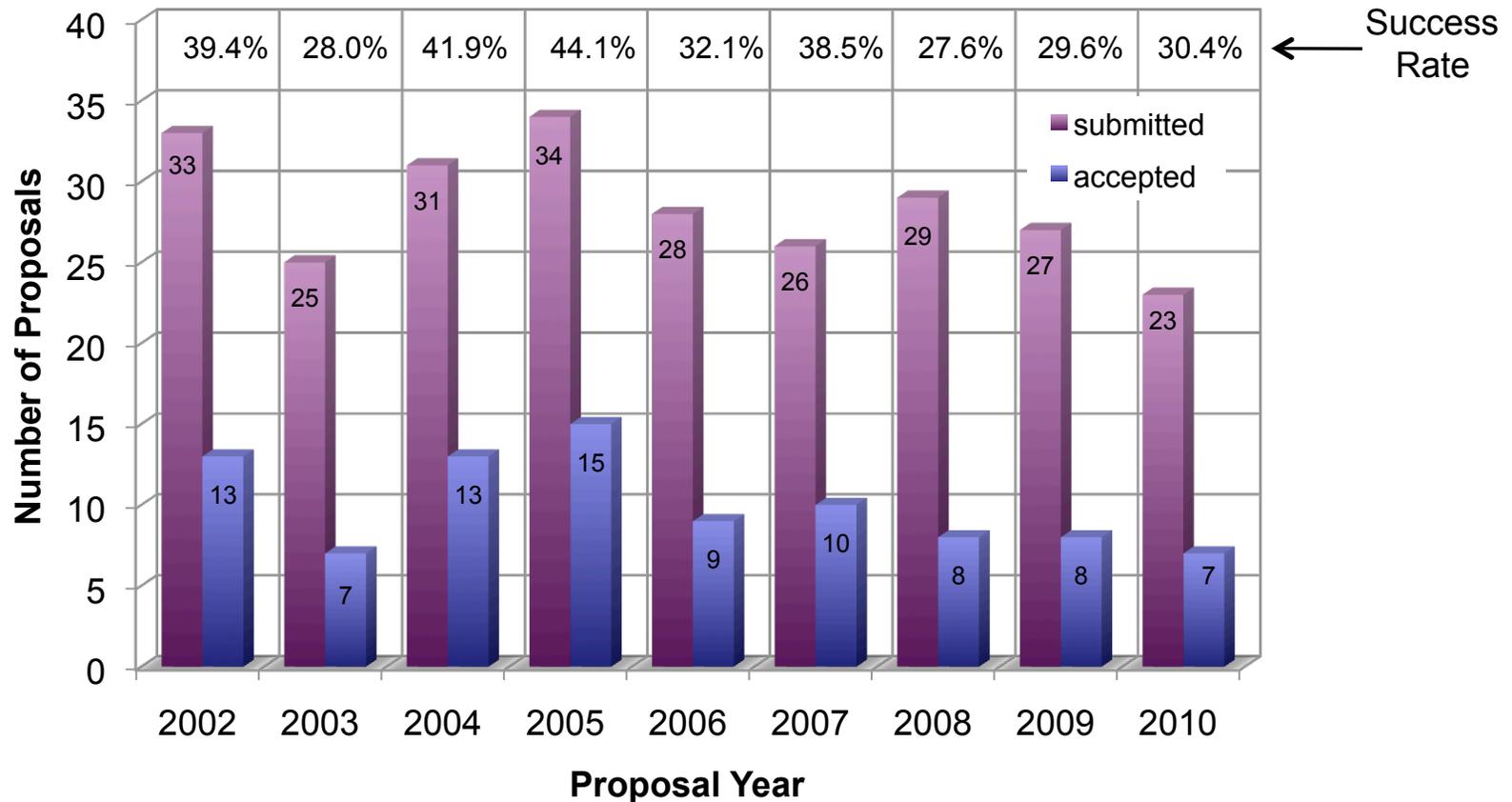


Bad News: Total Lab Astro Funding, FY06 – FY11

- The total amount of NASA funding for Laboratory Astrophysics investigations has decrease by 34% over the period FY06 – FY11; this is a steeper decrease than any other component of the Astrophysics R&A portfolio.
- The \$2M Laboratory Astrophysics augmentation called for in the Astro2010 would basically recoup these reductions and grow the program.



Lab Astro Proposal Statistics 2002-2010



- The number of Lab Astro proposals as a percentage of overall APRA proposal submissions has remained essentially flat at around 19% \pm 1% over this period; this year 16% (23/143).
- The success rate of Lab Astro proposals has been equivalent to the overall success rate of APRA proposals over this period.

Purpose of workshop:

- Review the current state-of-the art in laboratory astrophysics;
- Review the recommendations of previous LAWs and assess progress toward meeting those recommendations.
- Identify the critical data needs of NASA's current and future planned space astrophysics missions, and assess whether NASA-supported research efforts currently address those data needs;
- Assess the implications of the Astro2010 Decadal Survey for the field of laboratory astrophysics and NASA's laboratory astrophysics program;
- Deliverables:
 1. White Paper summarizing the key findings from the workshop for submission to NAC Astrophysics Subcommittee, Astrophysics Division
 2. Volume of science proceedings from the workshop.

Specific Issues/Questions for Consideration

- What steps could be taken to increase collaboration, cooperation, and communication within the NASA Laboratory Astrophysics Program.
- How should laboratory astrophysics databases be organized to minimize redundancy and cost, validated to ensure data consistency and quality, and curated to guarantee easy, widespread access by the community of data users?
- How might a new initiative to support laboratory astrophysics consortia (a.k.a. team awards, centers of excellence, a la NSF CCIs) be structured and implemented so as to augment the current program?
- What is the role of NASA's field centers and scientists in pursuing the Agency's critical Laboratory Astrophysics data needs?
- What steps can NASA take to attract new talent (e.g. graduate student/post doctoral fellowships, targeted proposal opportunities for junior faculty.)