



An Overview of NASA's Laboratory Astrophysics Program

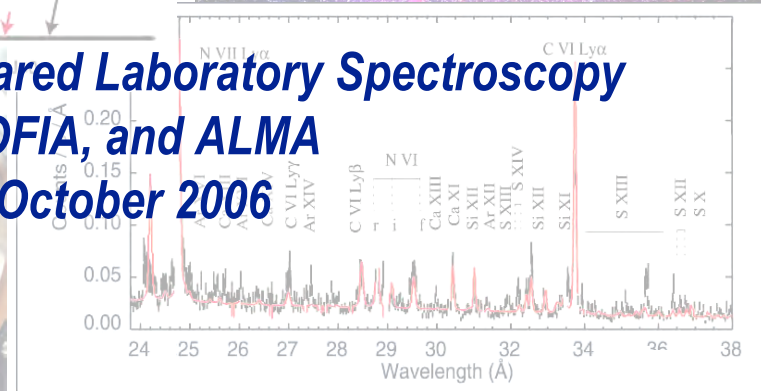
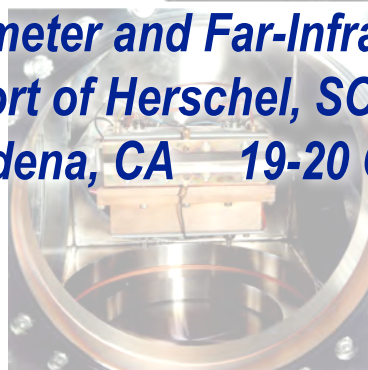
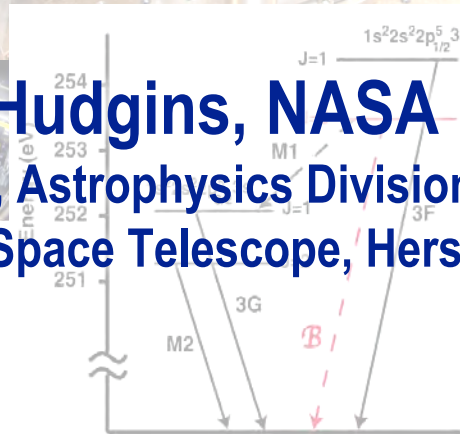
Dr. Douglas M. Hudgins, NASA Headquarters

Discipline Scientist, Astrophysics Division R&A Programs

Program Scientist, Spitzer Space Telescope, Herschel Space Observatory

*Workshop on Submillimeter and Far-Infrared Laboratory Spectroscopy
in Support of Herschel, SOFIA, and ALMA*

Pasadena, CA 19-20 October 2006





Program Overview

The Laboratory Astrophysics Program is one component of the Astrophysics Division's Astronomy and Physics Research and Analysis (APRA) Program. The APRA components are:

- Laboratory Astrophysics
- UV/visible Detectors
- Suborbital Science
- IR/Submillimeter Detectors
- Supporting Technology
- Ground-Based Observing

The total budget for the APRA Program is ca. \$25M

Responsible Officials:

- Astrophysics R&A Programs Lead: Wilton Sanders
- Lab Astro Discipline Scientists: Hashima Hasan, Doug Hudgins, Pam Marcum, Rick Harnden (High Energy)



Program Overview

The APRA/LabAstro program supports basic science investigations that do not require access to the space environment, but which enable or contribute significantly to space astronomy and astrophysics goals.

The program can be categorized as follows:

- **UV/visible studies:** electronic spectroscopy and other fundamental electronic properties of atomic and molecular species and ions; the composition and distribution of I/S dust as well as its extinction characteristics and interactions with UV/visible photons.
- **Infrared studies:** vibrational/rovibrational spectroscopy and other fundamental vibrational characteristics of molecular species and ions; the IR characteristics and composition of I/S dust and ices; low lying electronic transitions of atoms and molecules.
- **Submillimeter/THz:** rotational spectroscopy of interstellar molecules; identification and distribution of molecular species;
- **ISM Processes:** physics of highly energetic regions (e.g. plasmas, shocks); interstellar chemistry; chemical dynamics in astrophysical environments (e.g. collisional cross sections, ionization/recombination processes)
- **Theory:** limited to the areas of Atomic and Molecular Astrophysics.



Program Overview

<u>Classification</u>	<u>PI</u>	<u>Title</u>	<u>Institution</u>
Infrared	Bernath	Infrared and Near Infrared Emission Spectroscopy of Astrophysical Molecules	Univ of Arizona
	Gerakines	Laboratory Studies of Interstellar Solid Carbon Dioxide	Univ of Alabama
	Hofmeister	Distinguishing Grain-Size and Temperature Effects on the Infrared Fingerprints of Astrominerals: A Quantitative Laboratory Approach	Washington Univ
	McCall	Infrared Spectroscopy of C60, C60+, and Other Molecular Ions of Astrophysical Interest	Univ of Illinois
ISM Processes Chemistry	Snow	Gas Phase Chemistry of Molecules and Ions of Astrophysical Interest	Univ of Colorado
	Vidali	Molecular Hydrogen Formation: Experimental Study of the Effects of Composition and Morphology of Dust Grains	Syracuse Univ
ISM Processes Dynamics	Ferland	Molecular Hydrogen in the Interstellar Medium: Unraveling the Message of Its Spectrum	Univ of Kentucky
	Stancil	Computation of Atomic and Molecular Parameters	Univ of Georgia
	Manson	Photoionization, Recombination and Related Processes in Astrophysically Important Atoms and Ions in the X-Ray and UV/Optical Ranges	Georgia State Univ
	Tayal	Collisions of Electrons and Photons with Ions of Astrophysical Interest	Clark Atlanta Univ
	Chutjian	Electron Collisions with Highly Charged Ions: Basic Astrophysical Phenomena and Measurement of Absolute Collision Strengths	JPL
	Gorczyca	Improved Simulations of Astrophysical Plasmas: Computation of New Atomic Data	Western Michigan Univ
ISM Processes High Energy	Ji	Laboratory Study of Magnetorotational Instability in a Gallium Disk	Princeton Plasma Physics Lab
	Laming	Radiative Shock Instabilities: A Novel Laboratory Astrophysics Approach	Naval Research Lab
	Bannister	Improved Electron Impact Ionization Data for Modeling Cosmic Plasmas: New Measurements and Theoretical Calculations	Oak Ridge Nat'l Lab



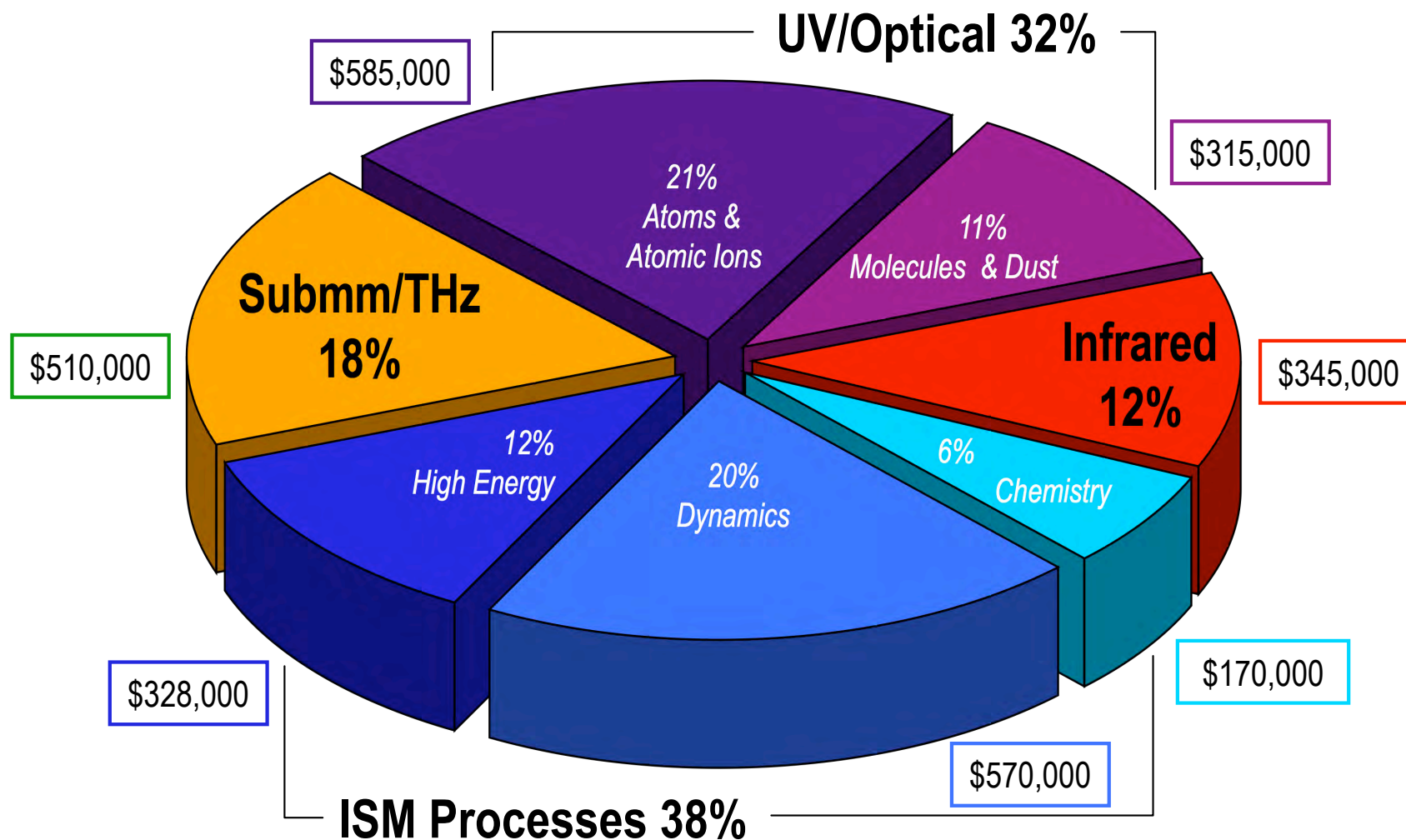
Program Overview

<u>Classification</u>	<u>Last</u>	<u>Title</u>	<u>Institution</u>
Submm/THz	Herbst	Submillimeter-wave Laboratory Spectroscopic Investigations	Ohio State Univ
	Blake	Terahertz (THz) Laboratory Spectroscopy in Support of the SOFIA and Herschel Heterodyne Receiver Programs	Caltech
	Ziurys	Sub-Millimeter Spectroscopy of Astrophysically Significant Metal Hydride Species	Univ of Arizona
	Pearson	Submillimeter and Far Infrared Laboratory Spectroscopic Investigations of CH ⁺ and Isotopic CH	JPL
	Drouin	Measurements of State-to-State Collision Rates for Water	JPL
UV/Optical Atoms & atomic ions	Lawler	VUV Laboratory Astrophysics with a Spatial Herodyne	Univ of Wisconsin
	Babb	Pressure-broadening of Alkali Atom Resonance Lines for Modeling Atmospheres of Extrasolar Giant Planets and Brown Dwarfs	Harvard-SAO
	Federman	Oscillator Strengths for Ultraviolet Atomic and Molecular Transitions	Univ of Toledo
	Nahar	Atomic Data for Multi-Wavelength Spectroscopy of Iron in Astrophysical Plasmas	Ohio State Univ
	Beiersdorfer	Spectral Catalogue of High-Z Ions for Astrophysical Diagnostics in the Extreme Ultraviolet	Lawrence Livermore Lab
	Reader	Expansion of the Online NIST Atomic Spectra Database of Atomic Transition Probabilities, Wavelengths, and Energy Levels	NIST
UV/Optical Molecules & dust	Head-Gordon	Modeling Electronic Spectra of Polycyclic Aromatic Hydrocarbons	Univ of California, Berkeley
	Salama	UV-Visible-NIR Laboratory Spectroscopy of Carbon-Bearing Molecules and Ions in Support of Space Missions	NASA Ames



Program Overview

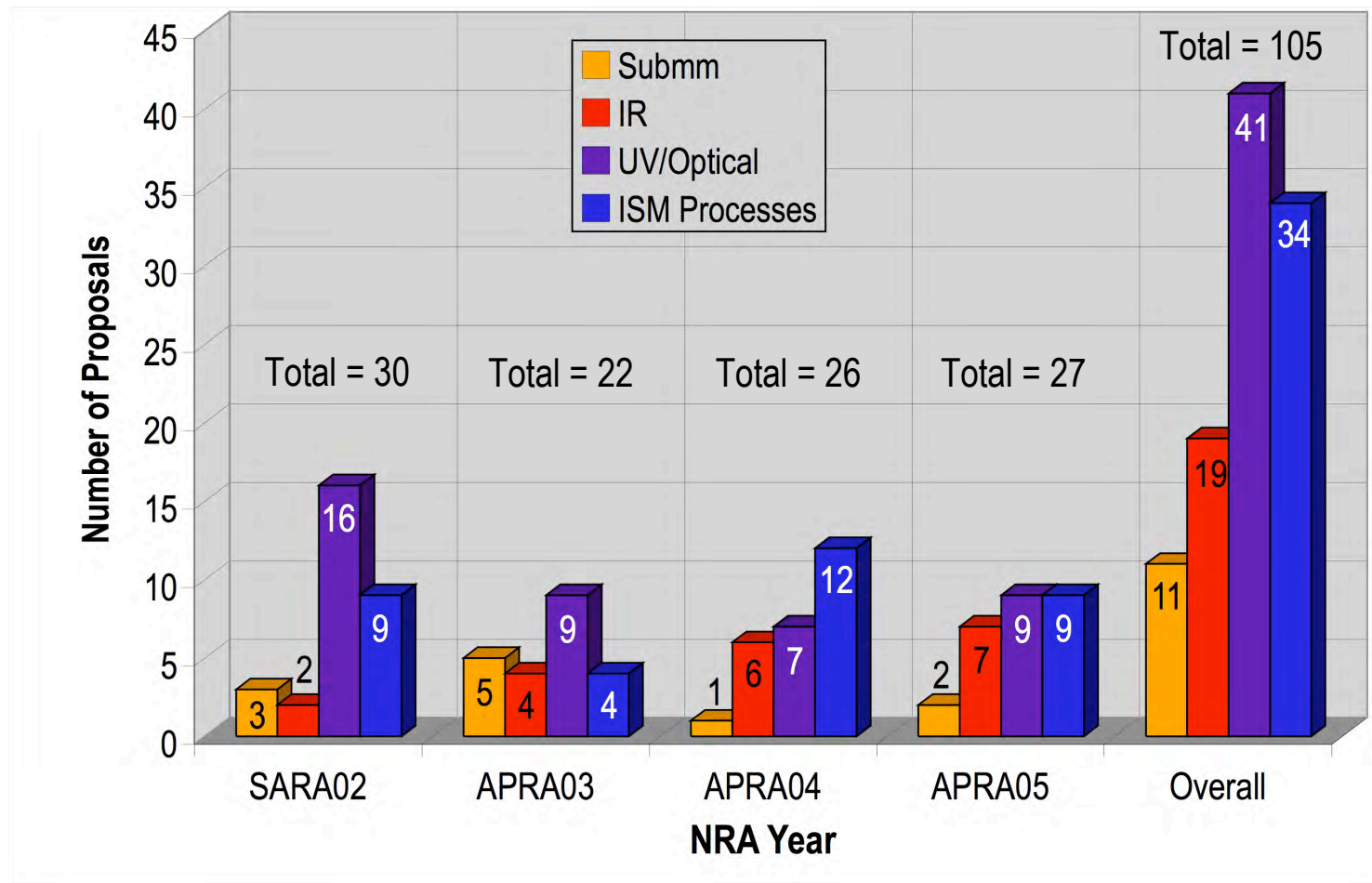
Total Lab Astro Budget = \$2,823,000 spread across 28 investigations





Proposal Submissions

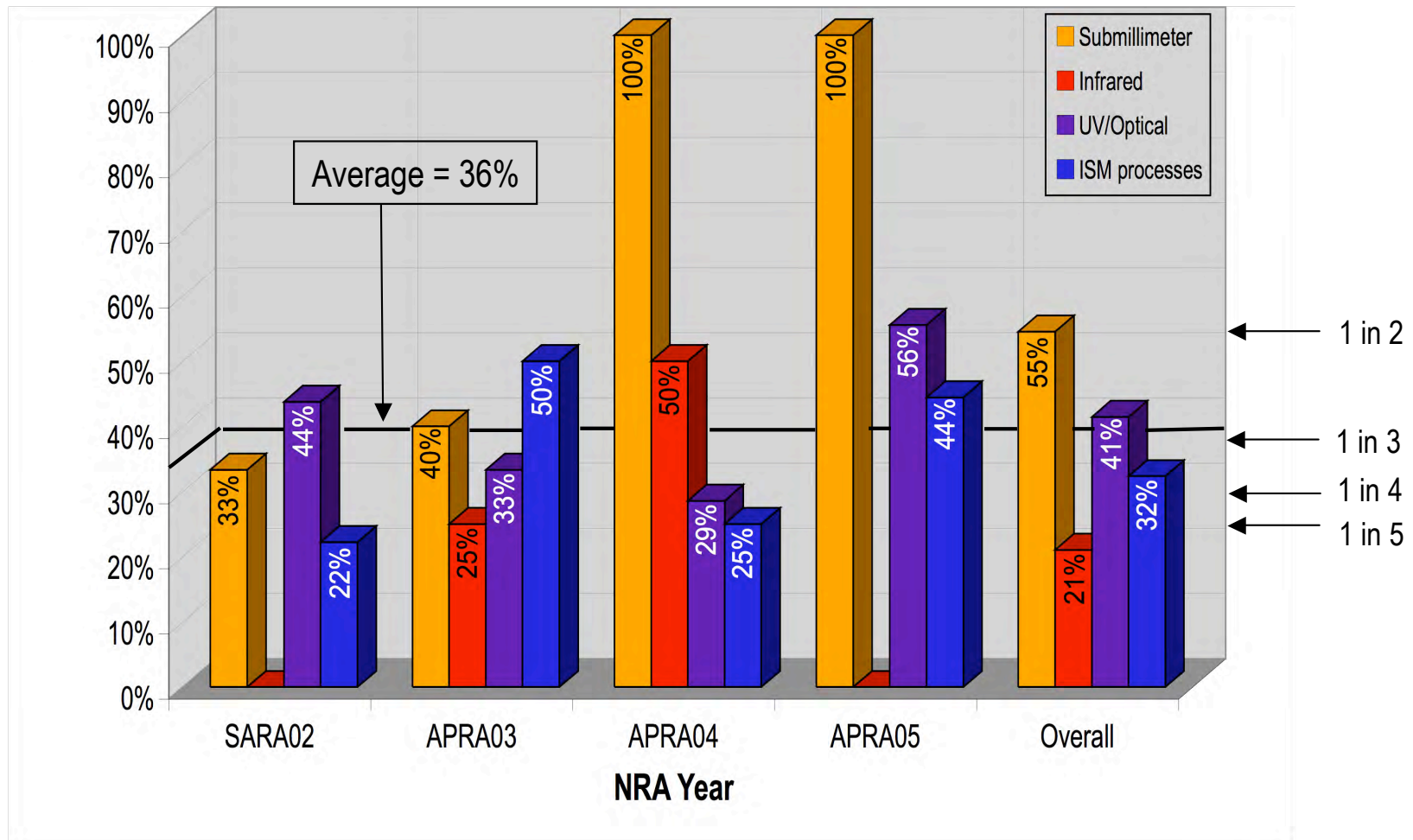
Proposals Submitted to Laboratory Astrophysics Program by Research Area





Proposal Success Rates

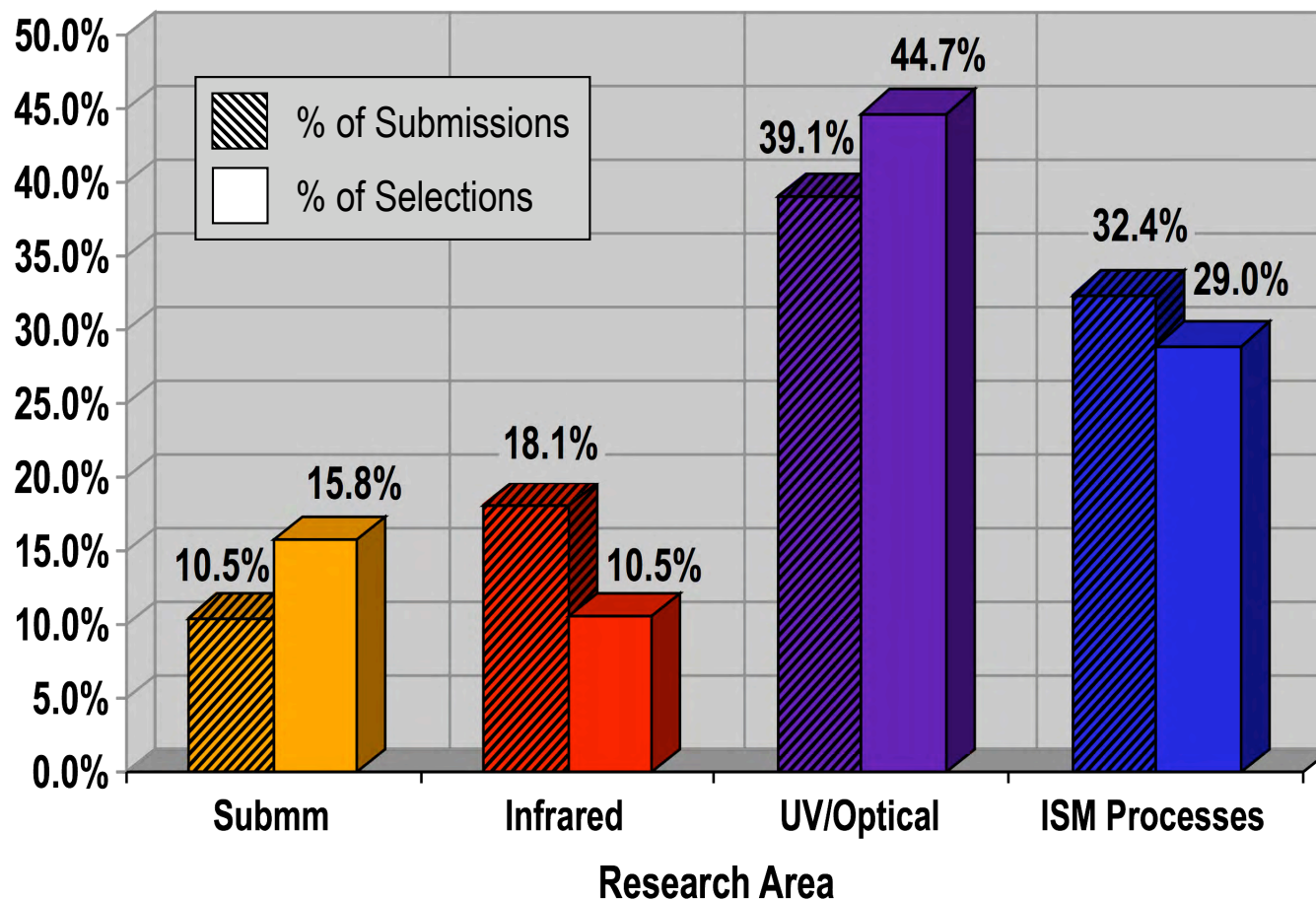
...By Research Area





Proposal Success Rates

...By Comparison of Composition of Submissions and Selections.

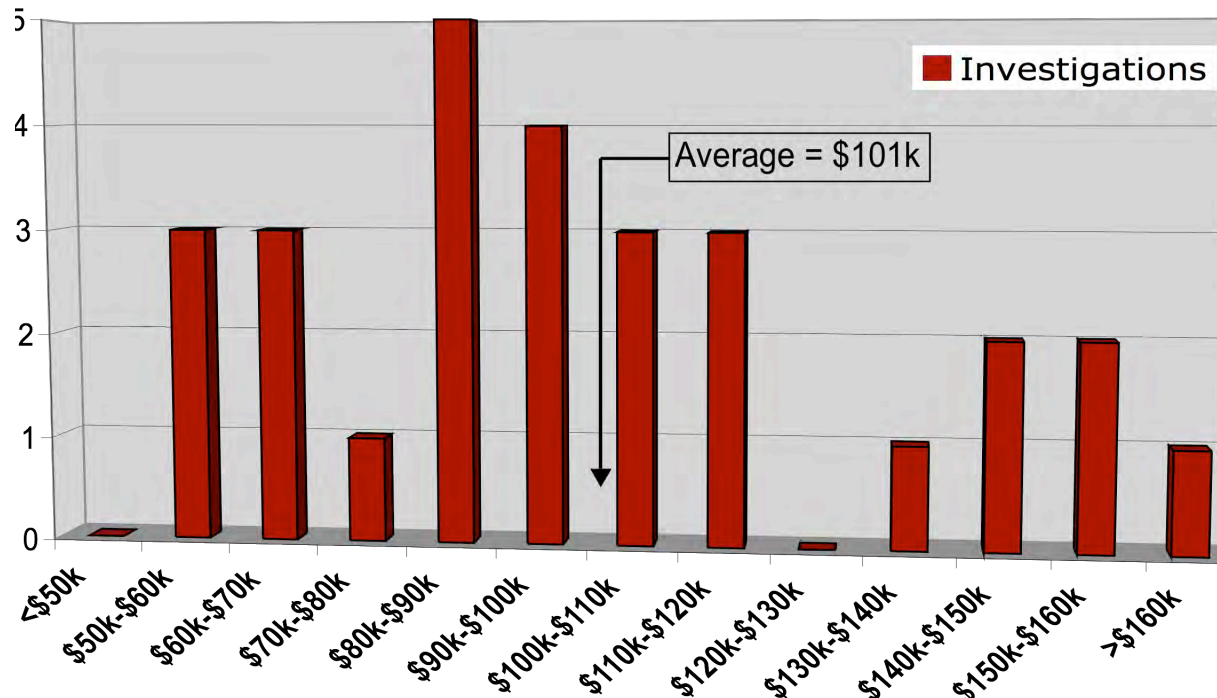




Key Challenges

Trying to do Champagne Science on Budweiser Budgets

- *The cost of sophisticated laboratory studies is more akin to that of technology development than data analysis*
- *Starving groups out of business; field is drying up.*
- *Difficult to attract talented new researcher.*



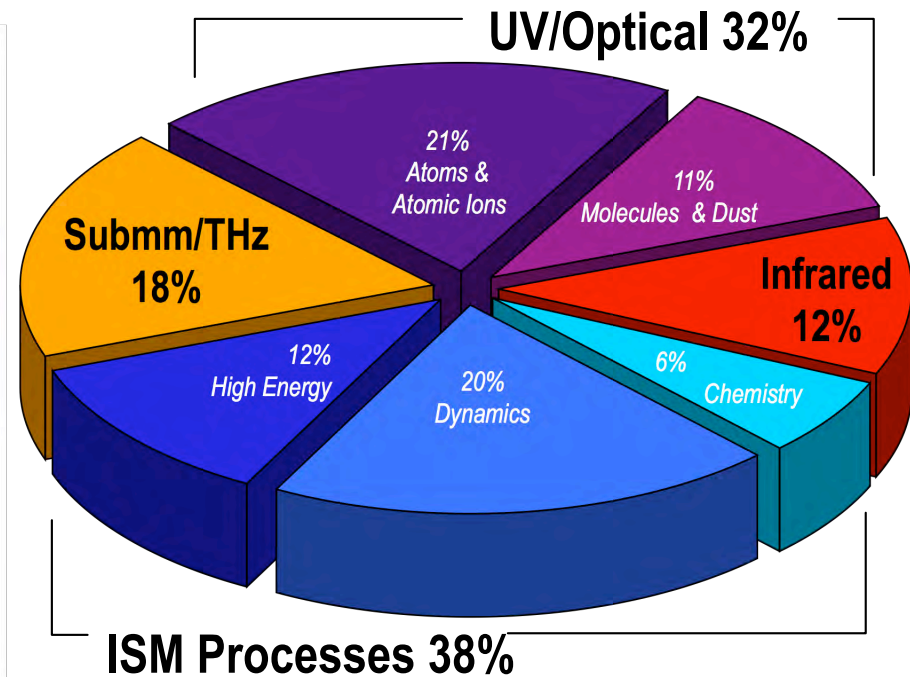
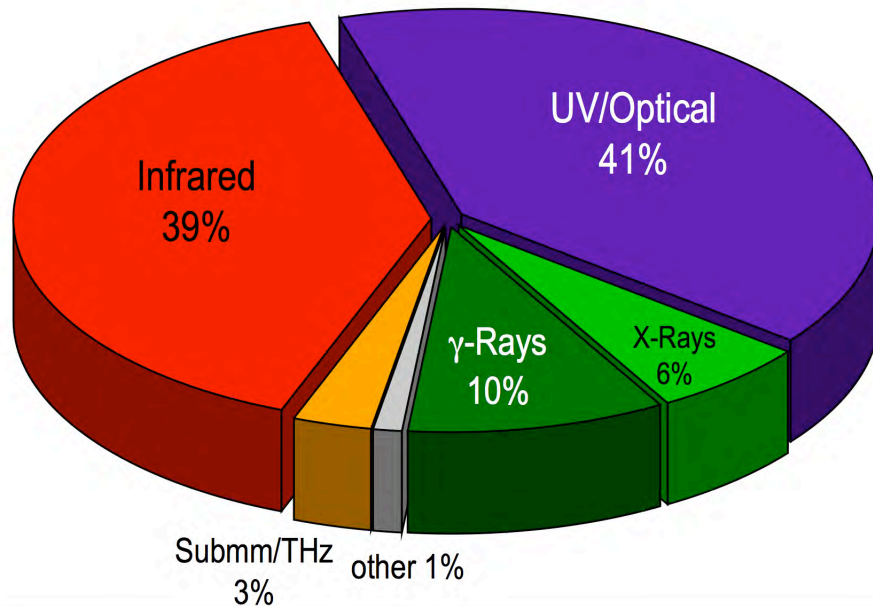


Key Challenges

What is the “right” mix for the program?

- *Is the current mix, the “right” mix?*
- *If not, how should they be prioritized, aligned with mission priorities?*
- *How can the program respond to near-term deficiencies in critical mission data?*

FY06 Astrophysics Division Mission Budget





Looking to the Future

The Science Mission Directorate (SMD) is currently facing a 15% across-the-board reduction in funding for R&A programs

- Total Astrophysics Division R&A Budget slated to decrease from \$65M in FY06 to \$55M in FY07 and remain essentially flat thereafter
- Lab Astro budget to decrease from \$2.8M to 2.5M and remain flat thereafter.
- Roughly 50% of Astrophysics locked into congressionally mandated programs (Hubble, JWST).
- FY07 budget appropriation will provide insight into future

“NASA needs to put more money into Laboratory Astrophysics Research” just isn’t going to fly in current budget environment--not even to address mission-critical data deficiencies.



Looking to the Future

Funding to address mission-critical data should be integrated into mission budget from the outset

- What is the logic of allowing the scientific output of a mission costing hundreds of millions or billions of dollars to be limited by a lack of reference data?
- Spitzer Space Telescope: A portion of Data Analysis funds set aside for Theory and Archival Research (includes Laboratory Astrophysics investigations).
- Problem 1: One year funding, initiated at time of launch.
- Problem 2: Modest grant size.
- Problem 3: Not built into Herschel data analysis budget. Possibilities:
 - Add money to Herschel budget to fund lab work - non-starter, see previous chart
 - Allow lab work to be funded out of Herschel data analysis funds - means less support for observations