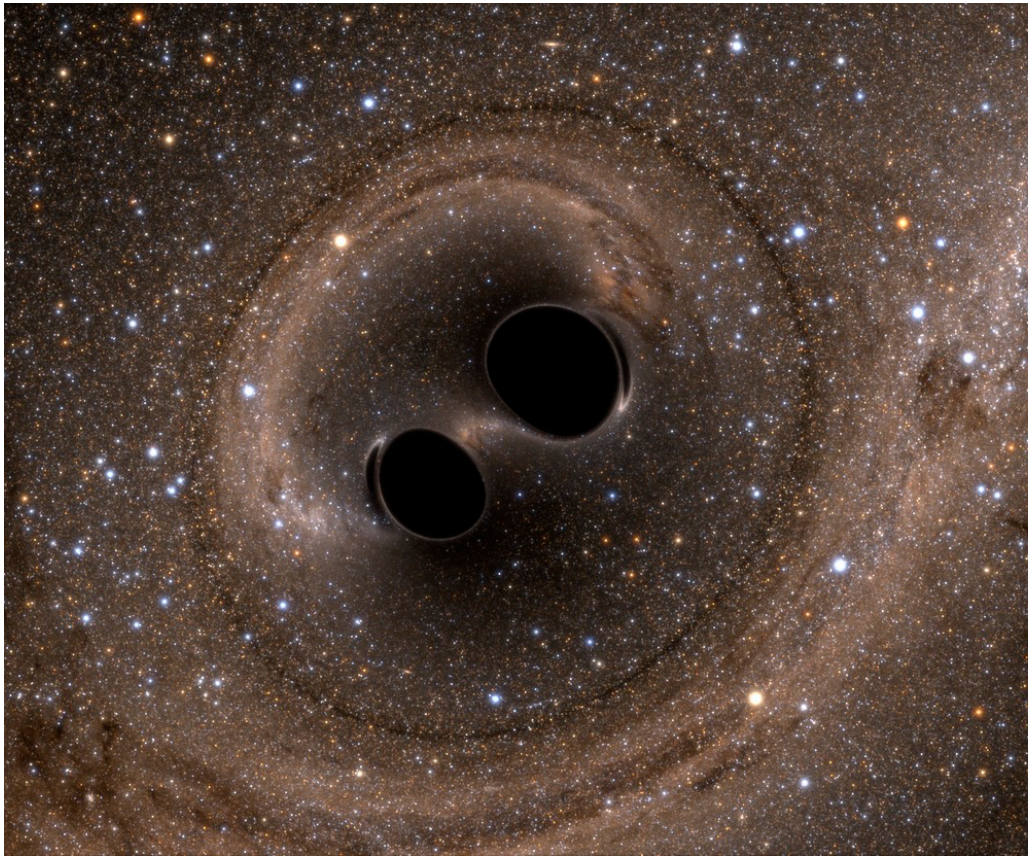
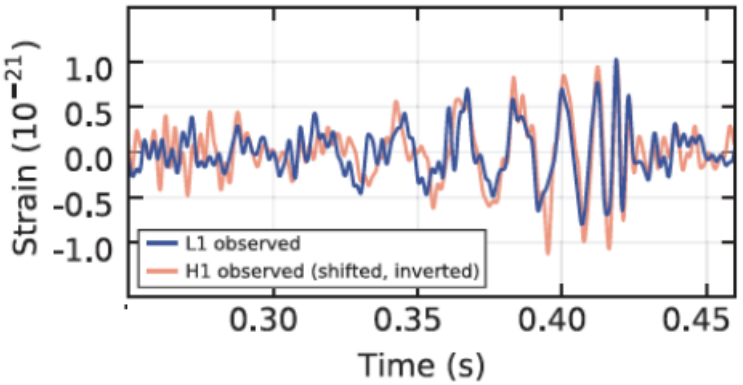
# Astronomy and Astrophysics Advisory Committee (AAAC)

*Angela Olinto, University of Chicago, Chair*






Report of March 15, 2016

http://www.nsf.gov/mps/ast/aaac/reports/annual/AAAC_2015-16_Report.pdf

# Astronomy and Astrophysics Advisory Committee (AAAC)

## 2015-2016

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Dr. Klaus Honscheid, The Ohio State University

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Dr. Suzanne Staggs, Princeton University

Dr. Jean Turner, University of California, Los Angeles

Dr. Martin White, University of California, Berkeley

# AAAC

The **Astronomy and Astrophysics Advisory Committee** was established under the **National Science Foundation Authorization Act of 2002 Public Law 107-368** and amended by SEC. 5 of P.L. 108-423 (the **Department of Energy** High-End Computing Revitalization Act of 2004), to:

(1) **assess, and make recommendations** regarding, the **coordination** of astronomy and astrophysics programs of the **Foundation and the National Aeronautics and Space Administration, and the Department of Energy**;

(2) **assess, and make recommendations** regarding, the **status of the activities** of the Foundation and the National Aeronautics and Space Administration, and the Department of Energy **as they relate to the recommendations contained in the National Research Council's 2010 report entitled New Worlds, New Horizons in Astronomy and Astrophysics, and the recommendations contained in subsequent National Research Council reports of a similar nature;**

(3) not later than **March 15** of each year, transmit a report to the **Director, the Administrator of the National Aeronautics and Space Administration, the Secretary of Energy, the Committee on Commerce, Science and Transportation of the United States Senate, the Committee on Energy and Natural Resources of the United States Senate, and the Committee on Science, Space, and Technology of the United States House of Representatives**, on the Advisory Committee's findings and recommendations under paragraphs (1) and (2).

# AAAC Report

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The Honorable John Thune, Chairman
Committee on Commerce, Science and Transportation
United States Senate
Washington, DC 20510

The Honorable Lisa Murkowski, Chairwoman
Committee on Energy & Natural Resources
United States Senate
Washington, DC 20510

The Honorable Lamar Smith, Chairman
Committee on Science, Space and Technology
United States House of Representatives
Washington, DC 20515

Senator Bill Nelson, Ranking Member, Committee on Commerce, Science and Transportation, United States Senate
Senator Maria Cantwell, Ranking Member, Committee on Energy & Natural Resources United States Senate
Representative Eddie Bernice Johnson, Ranking Member, Committee on Science, Space, and Technology, United States House of Representatives
Senator Ted Cruz, Chairman, Subcommittee on Space, Science, and Competitiveness, Committee on Commerce, Science and Transportation, United States Senate
Senator Gary Peters, Ranking Member, Subcommittee on Space, Science, and Competitiveness, Committee on Commerce, Science and Transportation, United States Senate
Senator Richard Shelby, Chairman, Subcommittee on Commerce, Justice, Science, and Related Agencies, Committee on Appropriations, United States Senate
Senator Barbara Mikulski, Ranking Member, Subcommittee on Commerce, Justice, Science, and Related Agencies, Committee on Appropriations, United States Senate
Senator Lamar Alexander, Chairman, Subcommittee on Energy and Water Development, Committee on Appropriations, United States Senate
Senator Dianne Feinstein, Ranking Member, Subcommittee on Energy and Water Development, Committee on Appropriations, United States Senate

Representative Barbara Comstock, Chairwoman, Subcommittee on Research and Technology, Committee on Science, Space and Technology, United States House of Representatives
Representative Daniel Lipinski, Ranking Member, Subcommittee on Research and Technology, Committee on Science, Space and Technology, United States House of Representatives
Representative Mike Simpson, Chairman, Subcommittee on Energy and Water Development and Related Agencies, Committee on Appropriations, United States House of Representatives
Representative Marcy Kaptur, Ranking Member, Subcommittee on Energy and Water Development, Committee on Appropriations, United States House of Representatives
Representative John Culberson, Chairman, Subcommittee on Commerce, Justice, Science and Related Agencies, Committee on Appropriations, United States House of Representatives
Representative Mike Honda, Acting Ranking Member, Subcommittee on Commerce, Justice, Science and Related Agencies, Committee on Appropriations, United States House of Representatives
Representative Brian Babin, Chairman, Subcommittee on Space, Committee on Science, Space, and Technology, United States House of Representatives
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Dr. J.D. Kundu, Program Examiner, NSF, Office of Management and Budget
Dr. Grace Hu, Program Examiner, NASA, Office of Management and Budget
Dr. Avital Bar-Shalom, Program Examiner, DOE, Office of Management and Budget
Dr. James Ulvestad, Director, Division of Astronomical Sciences, National Science Foundation
Dr. David Boboltz, Acting Deputy Division Director, Division of Astronomical Sciences, National Science Foundation
Dr. Christopher Davis, Program Director, Division of Astronomical Sciences, National Science Foundation

# Executive Summary

US investment in astronomy and astrophysics continues to create an **outstanding portfolio of preeminent research facilities that have revolutionized our understanding of the Universe**, fascinating the public and inspiring new generations of scientists and engineers.

The Astronomy and Astrophysics Advisory Committee (AAAC) is chartered to assess and make recommendations regarding the coordination of NSF, NASA, and DOE astronomy programs and the status of the activities relative to the priorities of the National Research Council (NRC) decadal survey New Worlds, New Horizons in Astronomy and Astrophysics (NWNH) and its predecessors. This AAAC report summarizes the progress in astronomy and astrophysics and the support by the agencies over the last year.

**The past year witnessed momentous scientific results, excellent agency coordination, and continuous progress toward the construction of the top priorities in NWNH.** The challenging budget environment has strained the balance of the portfolio, causing a significant decline of success rates in competed grants as discussed in the attached "**Competed Grant Success Rates in US Astronomy and Astrophysics**" report.

# Science Highlights

**Advanced LIGO**

reported the first ever detection of gravitational waves, opening a new field of gravitational wave astronomy.

**Dark Energy Survey (DES)**

17 new satellites of Milky Way & new dwarf galaxies in a nearby galaxy cluster

3rd (of 5) year completed: weak lensing mass maps influenced by dark energy & dark matter

**Planck**

released science results for cosmic microwave background (CMB) include polarization

**Kepler and the K2 missions.**

> 4,000 exoplanet candidates - some orbit and transit close-by stars

**ALMA**

observed the early stage of planet formation around single and binary stars.

***FINDING:*** ***Thanks to US investment in basic research at NSF, NASA, and DOE, the US program in Astronomy and Astrophysics has achieved spectacular breakthroughs over the past year.***

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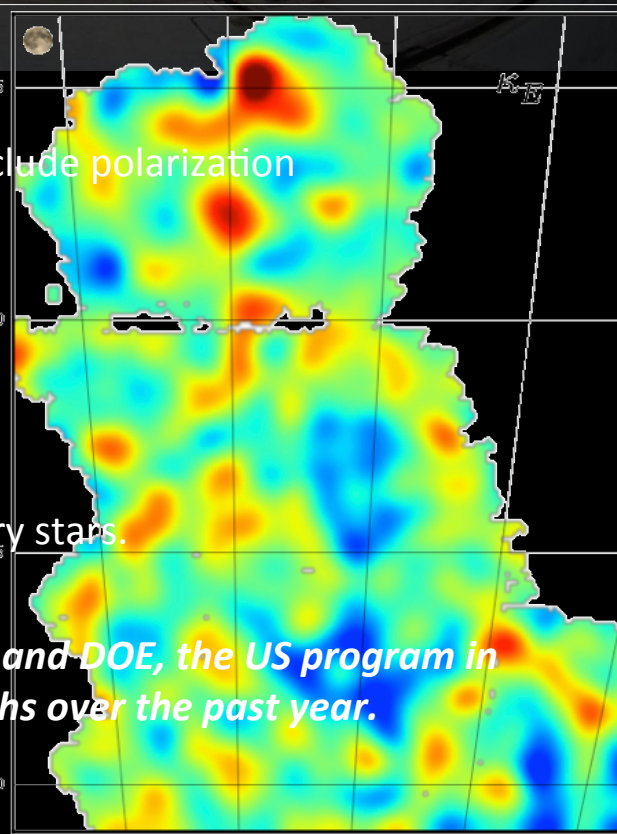


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# Interagency Coordination and Cooperation

Successful examples:

**NSF + DOE:**

SDSS, **DES**, VERITAS –

starting **DESI** and **LSST**

**NASA + DOE:**

Fermi Gamma-ray Space Telescope

**NASA + NSF**

Space + Ground based telescope follow ups

NOAO **WIYN 3.5 m**: NASA-NSF Exoplanet Observational Research (NN-EXPLORE) partnership: **Extreme Precision Doppler Spectrometer**

***FINDING:*** ***US agencies work well together to support the priorities of the scientific community, both in collaboration on large managed projects and in coordination of diverse research programs.***

# Interagency Coordination and Cooperation

***Dark Energy Projects Coordination***

*FINDING: Some **unique information** in the high quality data that will be obtained in several future surveys— particularly LSST, Euclid, and WFIRST — will be significantly enhanced by **combining their analysis at an early "pixel" stage**, rather than a more highly reduced catalog stage.*

*RECOMMENDATION: Where it can improve overall science productivity and efficiency, **cooperation in database design and data sharing** is encouraged among US agencies, international agencies, and scientific collaborations.*

***Near Earth Objects and Ground-Based Telescopes***

*FINDING: The most cost effective approach to discovering and mapping the orbits of earth-threatening solar system objects ("Near Earth Objects" or NEOs) is likely to **include a significant contribution from ground-based telescope facilities**. Achieving the congressionally mandated goals will likely require cooperation between **NSF and NASA.***

# Interagency Coordination and Cooperation

***CMB-S4***

*FINDING:* *With its history of successes funded by NASA, NSF, and DOE,* ***CMB science crosses the boundaries of agencies****. Third generation ground-based efforts and suborbital payloads are now reaching the sensitivity for ground-breaking discoveries of CMB B-modes.*

*FINDING:* *The scientific community studying the cosmic microwave background has made significant progress on a* ***unified strategy for a fourth generation****, ground-based survey of the Universe ("CMB-S4"), orders of magnitude more capable than current experiments, with enormous potential for new scientific discovery****. A larger role of DOE coordinated with NSF is important to realize the great scientific potential of CMB-S4****.*

*RECOMMENDATION:* *We encourage DOE, NSF, and the university community to continue working toward a plan for a future (Stage 4) ground-based CMB experiment.*

# Status and Implementation of Decadal Surveys II

***NWNH Implementation***

*FINDING:* ***The agencies are working together to ensure that the highest priorities of NWNH, WFIRST and LSST, are moving forward****. WFIRST has recently successfully moved into the formulation phase under the guidance of NASA, and LSST is well into the construction phase, with the camera under construction under DOE support and facility construction in the MREFC line at NSF led by AST.*

*FINDING: The* ***NSF MSIP program is funded at a level well below that envisioned in NWNH****, but is becoming the only mechanism available for funding the high priority activities advocated in NWNH. NSF/AST is funding MSIP at the highest level commensurate with program balance. The program is supporting a larger number of projects with a lower budget and* ***not able to support the higher cost projects as envisioned by NWNH****.*

*FINDING: Budgetary constraints have* ***not allowed progress*** *on recommendations for a US partnership in an optical/infrared* ***Giant Segmented Mirror Telescope (GSMT)****.*

*FINDING: Budgetary constraints have not allowed progress on a major new X-ray telescope (IXO). NASA is working towards* ***US participation in the ESA ATHENA*** *project providing future resources for the US astronomy and astrophysics.*

# Status and Implementation of Decadal Surveys III

*FINDING: The international CTA consortium is moving forward to build the CTA observatory. US participation at a more modest level than envisioned by NWNH would still enable US access and leadership roles. US funding for CTA may be attainable through competed mid-scale funding such as the MSIP program in NSF/AST and mid-scale program of NSF/PHY.*

*FINDING: **Gravitational wave astrophysics is now a reality**. This exciting new field, at the frontier of physics and astrophysics, **will benefit greatly from cooperation among agencies as it continues to develop and generate new science areas in its wa**ke.*

*RECOMMENDATION: the AAAC encourages NASA to continue working toward a plan **to develop a space-based gravitational wave observatory** as envisioned by NWNH, **through participation in the ESA L3 gravitational wave effort.***

*RECOMMENDATION: The agencies should continue to **pursue international partnership**s in order to further accomplish the goals of NWNH. The **AAAC's "Principles for Access to Large Federally Funded Astrophysics Projects and Facilities**" should guide the process.*

# International Coordination and Cooperation

A&Aph is an international enterprise with opportunities for partnerships and challenges 2013-2014 AAAC report:

***PRINCIPLES FOR ACCESS TO LARGE ASTROPHYSICS PROJECTS AND FACILITIES***

THE PRIMARY GOAL OF THE ASTROPHYSICS COMMUNITY IS TO PRODUCE THE BEST SCIENCE RESULTS

GLOBAL COORDINATION

OPEN DATA

OPEN ACCESS

OPPORTUNITY TO CONTRIBUTE

**RECIPROCITY**

# Status of the NSF/AST Portfolio Review

***KPNO 2.1m telescope***: NSF selected Robo-AO (Caltech-led consortium for robotically operated autonomous laser adaptive optics system) in November 2015. Robo-AO has taken over operations for FY 2016-2018. NSF feasibility study for future options.

***WIYN telescope***: new Extreme Precision Doppler Spectrometer supported by NASA. An NSF/NASA MOU is in place. NSF supports its 40% share of ops. Addresses *NWNH* priority of high-precision radial velocity surveys of nearby stars

***KPNO Mayall telescope***: Planning continues for the installation of the Dark Energy Spectroscopic Instrument (DESI) on the Mayall 4m telescope in 2018. DOE to fund telescope operations and survey.

***Green Bank Telescope:***

Future options for the Green Bank Telescope are currently under feasibility study and various partners have begun partial funding of operations

**SOAR:** the SOAR agreement expires in 2018 and the NSF will reassess at that time its participation in SOAR in view of its possible role in the LSST era.

# Status of the NSF/AST Portfolio Review

**VLBA:** Future options for VLBA are currently under feasibility study and various partners have begun partial funding of continuing operations. VLBA will be separated from NRAO in FY15.

**McMath-Pierce Solar telescope (Kitt Peak) and Dunn Solar Telescope (Sacremento Peak):** Operating partners are still being sought, and future options for both are currently under feasibility study.

**GONG/SOLIS**: SOLIS was moved off KPNO, and GONG is under refurbishment. An MOU with NOAA is currently in draft form, and NOAA is partly funding space weather operations with GONG.

**Arecibo:** Future options for Arecibo are currently under feasibility study. Responses to NSF Dear Colleague letter for concepts for future operations received on January 15, 2016. NSF evaluation is underway. NSF Division of Atmospheric and Geospace Sciences (in the Directorate for Geosciences), which partners with NSF/AST and the NASA Planetary Sciences Division in funding Arecibo, to receive the report of their own portfolio review before summer 2016.

**University Radio Observatories:** NSF eliminated funding for URO and opportunity to compete allowed through MSIP. The Combined Array for Research in Millimeter Astronomy (CARMA) was recently decommissioned and the site returned to its original state

# Status of Portfolio Review Implementation

**_NSF AST_ PRC Recommendations**

*FINDING: The NSF Division of Astronomical Sciences has done a **commendable job of finding creative solutions to respond to the recommendations made by the Portfolio Review Committee (PRC)** while limiting permanent shut down of a number of facilities. These actions serve to reduce the amount the NSF/AST is spending on the operating budgets of legacy facilities and thus move closer to the desired balance in the portfolio recommended by the PRC.*

*FINDING: **Divestments recommended by the Portfolio Review are proceeding, but at a slower pace than anticipated** due to the complexities of decommissioning and the ongoing searches for operating partners.*

*FINDING: The loss of open access facilities results in a cost to the US user communities, in terms of loss of open nights and access to a variety of instruments.*

*RECOMMENDATION: **Strong efforts by NSF for facility divestment should continue as fast as is practical.** Efforts to explore partnerships, interagency cooperation and private resources to maintain some access to facilities for the US community that may mitigate the loss of open access should continue. Transferring the cost of operating a facility outside of the NSF/AST budget is preferable to complete loss of a capability from the suite of capabilities used by US researchers.*

# Budget Summary

**NASA**

| Program | FY15 | FY16 | FY17 Disc | FY17 Man | FY17 Tot |
|---|---|---|---|---|---|
| **NASA Astrophysics**[vi] | $730.7 | $731.0 | $671.5 | $85.0 | $756.5 |
| WFIRST [vii] | $50.0 | $90.0 | $14.0 | $76.0 | $90.0 |
| SOFIA | $70.0 | $85.2 | $83.8 | $0 | $83.8 |
| HST | $98.6 | $98.3 | $97.3 | $0 | $97.3 |
| Physics Cosmos | $104.1 | TBD | $88.1 | $6.0 | $94.1[viii] |
| Research [ix] | $201.7 | TBD | $223.1 | $3.0 | $226.1 |
| **JWST** | $645.4 | $620.0 | $569.4 | $0 | $569.4 |
| **Total** | $1375.4 | $1351.0 | $1240.9 | $85.0 | $1325.9 |

[vi]STEM education not included

**NSF**

| Program | FY15 | FY16 | FY17 Disc | FY17 Man | FY17 Tot |
|---|---|---|---|---|---|
| **R&RA AST** | $245.2 | $246.7 | $247.7 | $14.9 | $262.6 |
| Research | $67.7 | $63.3 | $58.3 | $14.9 | $73.2 |
| Education | $5.5 | $6.5 | $6.0 | $0 | $6.0 |
| Facilities | $148.5 | $148.2 | $155.2 | $0 | $155.2 |
| MSIP | $13.0 | $19.3 | $18.0 | $0 | $18.0 |
| Res. Resour. | $10.7 | $10.5 | $10.3 | $0 | $10.3 |
| **MREFC** | $144.8 | $200.3 | $193.1 | $0 | $193.1 |
| DKIST | $25.1 | $20.0 | $20.0 | $0 | $20.0 |
| LSST | $79.6 | $99.7 | $67.1 | $0 | $67.1 |

# Budget Summary

**DOE**

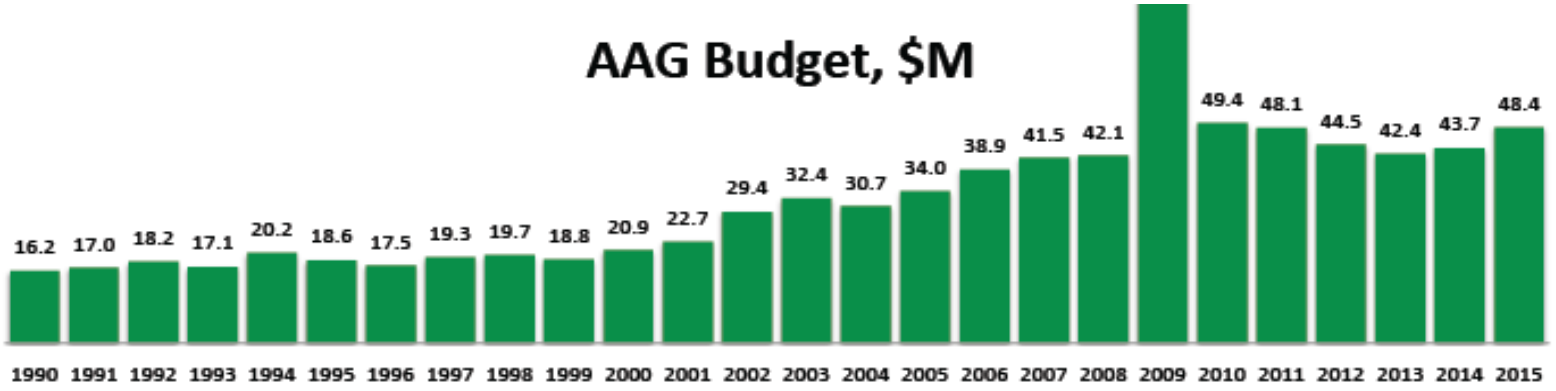
| Program | FY15 | FY16 | FY17 Disc | FY17 Man | FY17 Tot |
|---|---|---|---|---|---|
| **Science** | $5068.7 | $5350.2 | $5572.1 | $100 | $5672.1 |
| **High Energy Phys** | $766.0 | $795.0 | $817.9 | TBD | TBD |
| **Cosmic Frontier** | $106.9 | $130.6 | $130.1 | TBD | TBD |
| LSST | $35.0 | $40.8 | $45.0 | $0 | $45.0 |
| DESI | $3.9 | $10.3 | $10.0 | $0 | $10.0 |
| LZ | $3.1 | $10.5 | $10.5 | $0 | $10.5 |
| SuperCDMS-SNOlab | $2.3 | $2.5 | $4.0 | $0 | $4.0 |

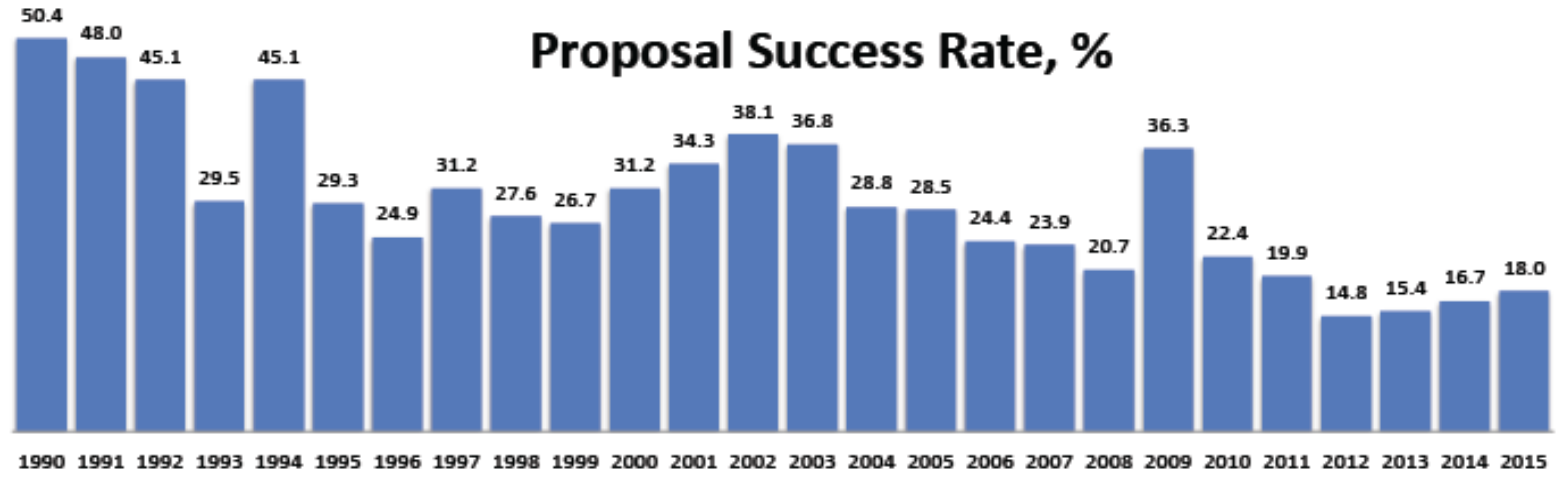
*FINDING: Spending for astronomy and astrophysics research **continues to lag the optimistic scenarios included in NWNH**. Lack of a **consistent funding stream** puts some of the agency programs at risk and does not support the long term planning needed to execute the decadal survey plan.*

*RECOMMENDATION: We urge **that the full programmatic funding required by the three agencies to execute their FY 2017 plans**, as described in their budget requests, **be provided**.*

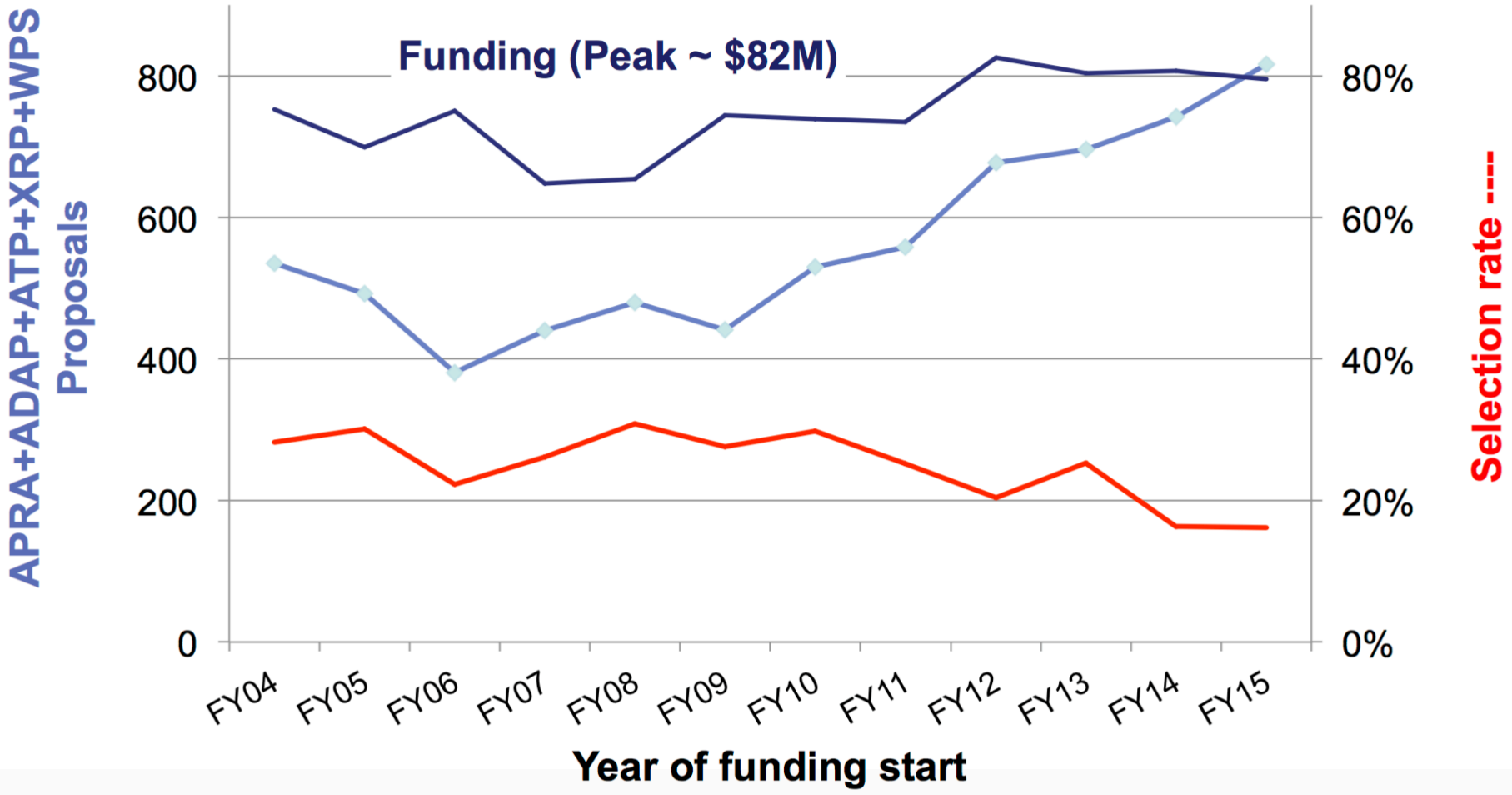
# Competed Grants falling success rates

**Flat funding of the core program correlates with a significant decline in proposal success rates**. From 2004 to 2014, the success rates in the **NSF/AST AAG** program declined from **30% to 17%** and **NASA/APD R&A** proposal success declined from **30% to about 20%**. Similar trends are observed in **NASA Planetary (40% to 20%), NASA Heliophysics (35% to 15%), and NSF/PHY PA (45% to 39%)**.



# Astrophysics ROSES selection rates



# significant growth in proposals in all subfields

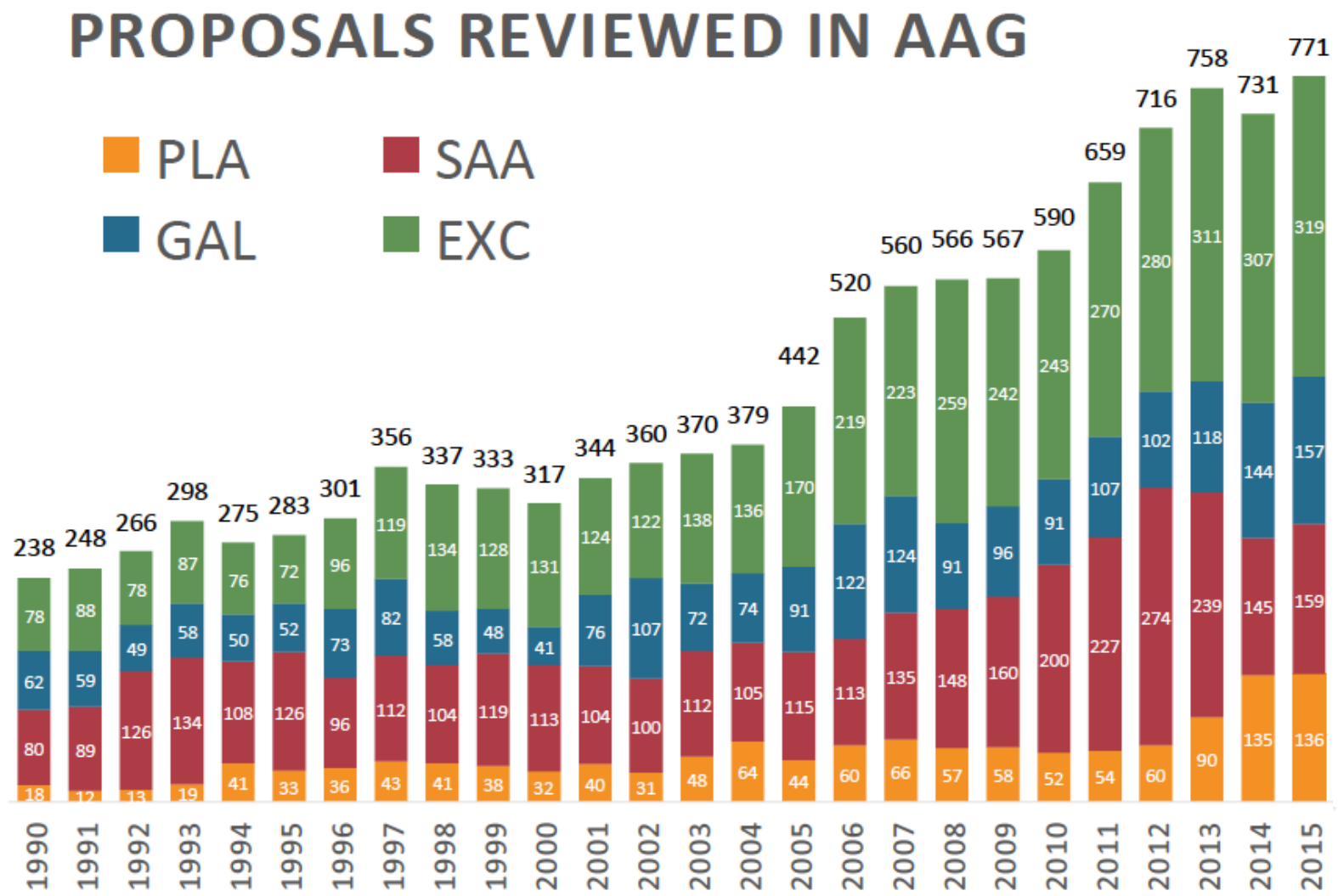



*Fig. 2 NSF/AST AAG Proposals divided by review sub-fields (EXC, GAL, SAA, PLA) from 1990 to 2015.*

# Competed Grants falling success rates

During the same period **no significant changes occurred** in

- proposer **demographics** (seniority, gender, and institutional affiliation)
- funding requests **among budget categories** (e.g., indirect costs, publications, computing, subcontracts, participant support, travel, equipment, fringe, personnel)
- proposal **budgets - kept in line with inflation** (AAG av. $93k/year to $150k/year).
- less than **3 months of salary per year** requests (AAG around 80% to 85%)
- The **distribution by type of institutions** of proposing PIs also remained steady with 80% to 85% being PhD granting institutions.

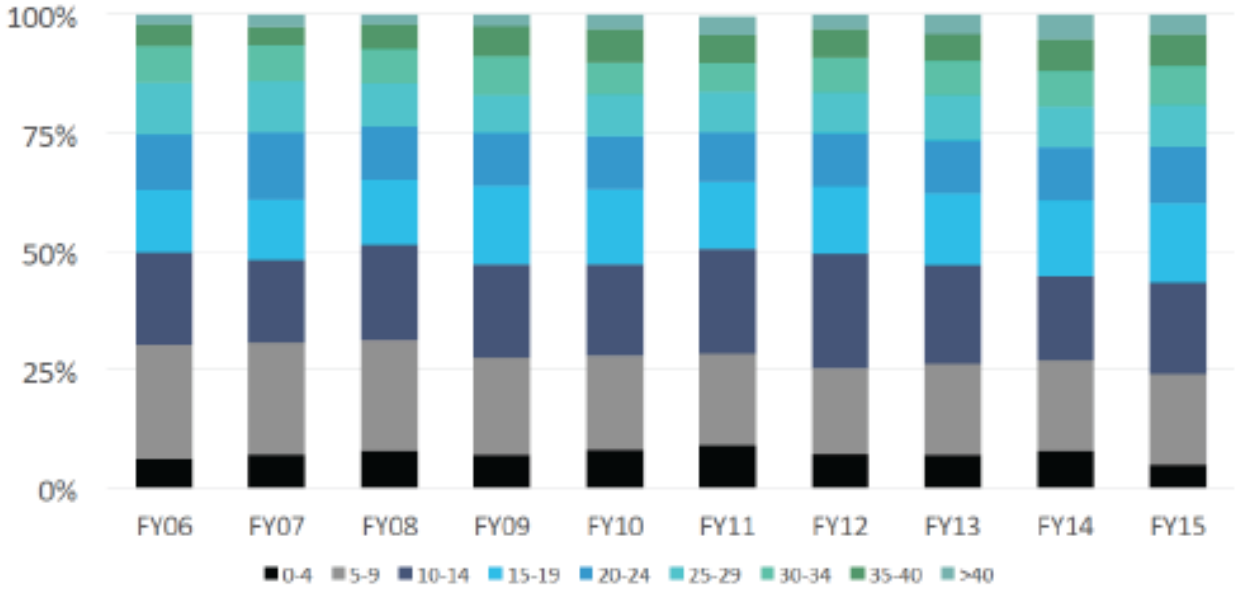



*Figure 3. Distribution of submitted AAG proposal PIs versus seniority as measured by years after PhD.*

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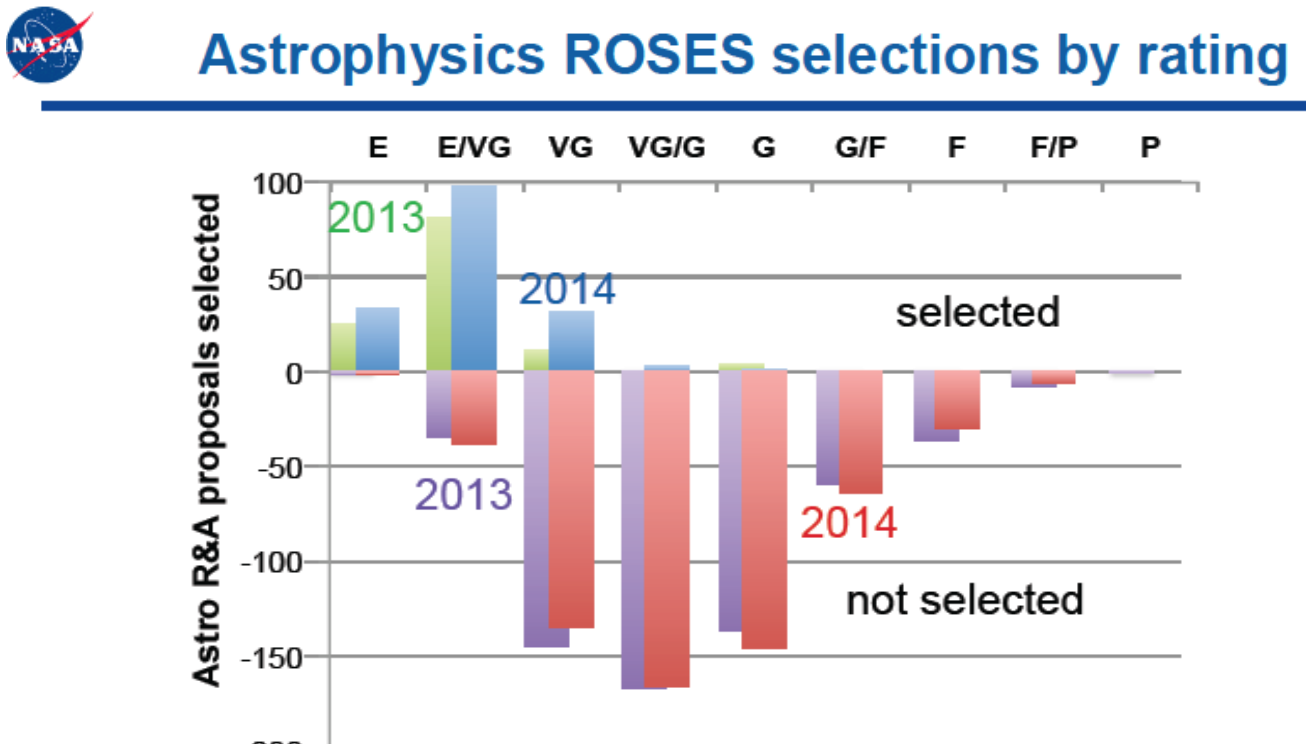
- the **distribution of proposal merit**



# Competed Grants falling success rates

*FINDING:* *Over the last decade proposal success rates in* ***Astronomy and Astrophysics have dropped significantly****. This is not principally the result of a decline in proposal merit, changing demographics, or an increase in the average funding request per proposal (beyond inflation). Rather this is* ***a consequence of flat or declining budgets for individual investigator grants, more investigators, and a larger proportion of multiple and resubmitted proposals.***

*In the absence of facility divestment by NSF/AST over the coming years, proposal success rate is expected to decline even further.*

The number of unique proposers per 3-year funding cycle has grown from 1025 during the 2008-2010 period to 1160 during 2013-2015, representing an average growth of 2.5% per year. This can be compared to the AAS full membership, which has grown from 3000 to 4500 over the years from 1990 to 2014, representing an average growth of 2.1% per year. Another indicator of new proposers is the growth in Astronomy faculty members of about 2.3% per year from 2006 to 2014, which was compiled by AIP[3].

From 2008 to 2015, the number of AAG proposals grew from 566 to 771 representing a 36% growth or an average ~5% growth per year. The character of this growth is sporadic with large fluctuations. To get a sense of the many factors involved one can assume the growth of the community to be about 2 to 2.5% per year on average, thus there is an additional factor of 2.5 to 3% per year that has affected the growth in number of proposals.

The number of single proposals submitted per PI in AAG has grown by about ~2.8% per year from 2008 to 2015. Multiple proposals submitted by the same PI to AAG on a given year can explain an additional average yearly growth of about ~2% from 2008 to 2015 on the total number of proposal. The contributions from multiple proposals nearly doubled from 56 in 2008 to 106 in 2015 with large fluctuations. In principle, this effect could be effectively controlled if NSF/AST limits the number of proposals submitted by individual PIs to AAG each year. Currently, NSF/AST strongly suggests that researchers voluntarily limit themselves in a "Note about FY16 AAG Proposals".[4] While this limit is one option to lessen the burden on proposers and reviewers, one award may be insufficient to support the personnel and other resources needed for the success of a given project.

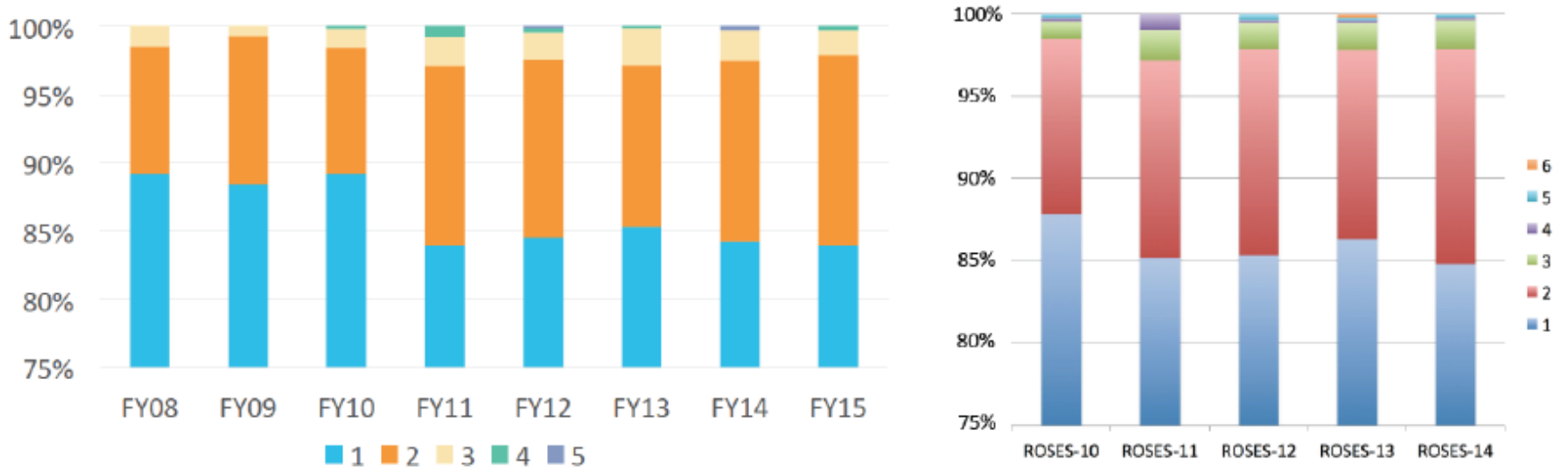



*Figure 4. percent of PIs that submit multiple proposals to NSF/AST AAG from FY08 to FY15 (left[5]) and NASA/APD ADAP, APRA, and ATP from 2010 to 2014. Numbers next to each color represent the percent of PIs submitting 1, 2, 3, 4, and 5 proposals per year. (Includes only PIs, not Co-Is.)*

# Competed Grants falling success rates

*FINDING:* *A very low proposal success rate* ***impacts both researchers and the agencies****. Researchers spend more time resubmitting meritorious but unfunded proposals and serving on review panels. Some researchers may elect to leave the field or decide not to pursue original and potentially transformative research. Agencies must manage the increased workload, staffing problems, and increased costs associated with reviewing more proposals.*

*RECOMMENDATION:* *Community based groups, such as the AAS and the APS, should study the recent and projected growth of the leading US astronomy and astrophysics research community for* ***the next decadal survey planning exercise of the end of this decade****.*