AAAC Proposal Pressures Study Group

Interim Report Summary

Priscilla Cushman
University of Minnesota
Nov 2, 2015
NAC Science Committee Meeting

AAAC Proposal Pressures Study Group

Established Summer 2014

Gather relevant proposal and demographic data from both the agencies and the community in order to understand how the funding environment over the last 10 years has affected researchers and projects. We will compare funding models across agencies and determine appropriate metrics for evaluating success. This will allow us to provide data-driven projections of the impact of such trends in the future, as well as that of any proposed solutions.

Members

Priscilla Cushman (AAAC Chair) Minnesota.
Jim Buckley (AAAC) Washington U.
Todd Hoeksema (AAS CAPP) Stanford
Chryssa Kouveliotou (APS) GWU
James Lowenthal (AAS CAPP) Smith College
Angela Olinto (AAAC) Chicago
Brad Peterson (NASA NAC) Ohio State
Keivan Stassun (APS) Vanderbilt University

Agency Contact Persons

NSF/AST: Jim Ulvestad, (Jim Neff)
NSF/PHY PA: Jim Whitmore, Jean Cottam
NASA/APD: Paul Hertz, Hashima Hasan, Linda Sparke (Dan Evans)
DOE/HEP Cosmic Frontier: Kathy Turner (Michael Cooke)
NASA/HPD: Arik Posner
NASA /PSD: Jonathan Rall
AAS: Joel Parriott
NRC (NAC): David Lang, James Lancaster

The **Astronomy and Astrophysics Advisory Committee** – advises NSF, NASA and DoE

How are we doing on our "Mission"?

Gather relevant proposal and demographic data from agencies and community

- A lot has been done (collected in a wiki at the moment, better repository??))
  - *Answered some outstanding questions*
- More is required
  - *Fill in gaps in solar and planetary, track merit over more years (NASA)*
  - *Measure science output. Track population (APS, AAS, AIP), Fold in DOE CF*

in order to understand how the funding environment over the last 10 years has affected researchers and projects.

- Requires AIP survey: loss of scientific talent, effect on young researchers
- Better model of proposal repeats on overall success rates

We will compare funding models across agencies and determine appropriate metrics for evaluating success.

- Models understood, but merit is hard to track (relying on NASA)

This will allow us to provide data-driven projections of the impact of such trends in the future, as well as that of any proposed solutions.

- Very difficult! Comparison with DOE CF may prove illuminating

Many areas of scientific research are experiencing declining selection rates

Where do we get our data from ? What agencies are our "clientele"

AAAC interacts primarily with NSF/AST, NASA/APD, DOE/HEP Cosmic Frontiers, with increasing overlap with NSF/PHY program in particle astrophysics and gravitational physics, planetary science, and solar and space physics in both NSF & NASA, and the NSF polar program.

NSF Division of Astronomical Sciences: Very extensive database, all proposals traced by reviewer and proposer. Demographic data kept. Queries need to be properly formulated.

NSF Division of Physics: Access to NSF database, but not as extensively mined.

NASA Astrophysics Segregated by competition. (e.g. linking ATP-2012 with anything else has to be done by hand). Some has been done for certain years, but trends are more difficult. Demographic data is not available.

NASA Heliophysics Similar

NASA Planetary Science Similar

DOE High Energy Physics: Hard to connect new comparative review process (2012) to old. Mostly spreadsheet data from the proposal panel organizers.

The AAAC Subcommittee met monthly throughout 2014/2015 Compiled the Statistics and refined our mission.

Immediate Goals:

Produce a short status document for the 2015 AAAC March Report

DONE

Produce a longer report for the 2016 AAAC March Report

The interim report is supporting information for such a report

The Report addresses:

Definition of the problem across agencies

First attempt to find the cause

We rule out a lot of proposed reasons

What are the impacts of falling success rates?

Effects on the Agencies (finding reviewers, running panels, etc)

Effects on Researchers (folded in data from the Von Hippel survey)

The Interim Report

Impact of Declining Proposal Success Rates on Scientific Productivity

Discussion Draft for AAAC Meeting, November 12-13, 2015

Authors: Priscilla Cushman, Todd Hoeksema, Chryssa Kouveliotou, James Lowenthal, Brad Peterson, Keivan Stassun, Ted Von Hippel

Purpose

- Inform the mid-decadal committee of what we have learned so far, in time for their deliberations
- Provide the AAAC with a document which can be used in the drafting of the 2016 March Report
- Inform the community in order to gather comments and advice (arXiv:1510.01647)

In writing this report, we found that a useful way to restate our goal became:

Can we define/justify threshold success rates?

What is optimum for a healthy competitive environment?

What represents a catastrophic level for Astronomical sciences in the US?

Success Rates across agencies. 2004 - 2014

	Selection rate trend	Funding trend ($M) *(corrected $2004)*
NSF/AST AAG	30% → 15%	31 → 44 (35)
NASA/AST R&A (*APRA, ADAP, ATP, OSS, WPS)*	30% → 18%	71 →80 (64)
NASA Planetary	40% → 20%	1730 → 1730(1380)
NASA Heliophysics R&A	35% → 15%	
NSF/PHY PA	45% → 39%	15 → 20 (16)
NSF Heliophysics	varies 20% - 50% (no trend)	
DOE/HEP Cosmic *(only since 2012)*	~60%	1.6 - 3.4 - 4.4 - 3.3

DOE: High Energy Physics at the Cosmic Frontier

Success rates much higher

- Different Mode: Mostly block grants with multiple PIs.
- Stable number of Universities,

  applying every 3 yrs, staggered by years
- $$ awarded depends on who is up for renewal
- Comparative review process began in 2012

  Energy, Intensity, Cosmic separately reviewed
- Most proposals are not funded at their requested rate. (50% of request)
- New proposals are more than twice as likely not to be funded

DOE HEP at the Cosmic Frontier

	FY12			FY13			FY14			FY15		
	Amount	# props	# PI's	Amount	# props	# PI's	Amount	# props	# PI's	Amount	# props	# PI's
Request	$3.3M	10	20	$7.7M	28	54	$7.5M	28	38	$6.8	27	43
Funded	$1.6M	6	13	$3.4M	18	27	$3.2M	19	25	$3.3	14	22
Success rate	48%	60%	65%	44%	64%	50%	43%	68%	66%	48%	52%	51%

Summary of Proposal Pressure

- The proposal selection rate for NSF Astronomical Sciences and NASA Astrophysics has been halved, approaching 15% in the last decade.

- Similar trends observed in NASA Heliophysics and Planetary Science Divisions

- Trends can be seen overall, but details in individual programs are complicated
  - Programmatic changes or cancellations/suspensions
  - Fewer statistics
  - Changes in the size of awards

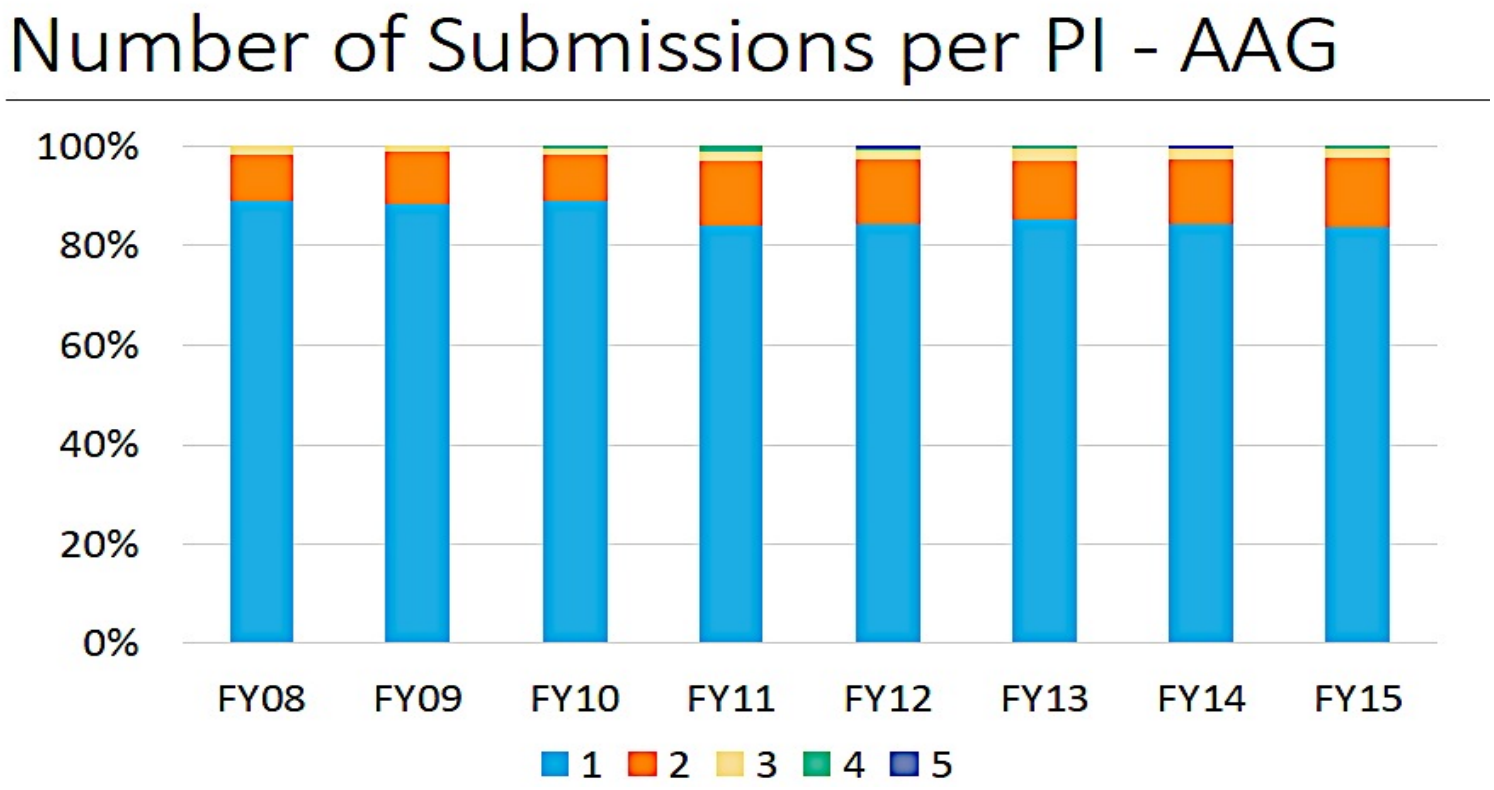
- NSF Particle Astrophysics and Heliophysics programs are highly variable
  - Again, program size makes statistics difficult
  - Trend is downward

- DOE High Energy Physics Program has a different funding model
  - Success rate has stayed stable above 50% in Cosmic Frontier
  - Only 4 years of comparative review panel data available

Next, drill down to understand demographics

Most NSF/AST and NASA/APD Proposals are Single Proposals

Proposal Increase → The Actual Number of Unique PIs is rising



NSF Astronomy: Slow rise from ~11% to ~ 16% Multiple Proposals

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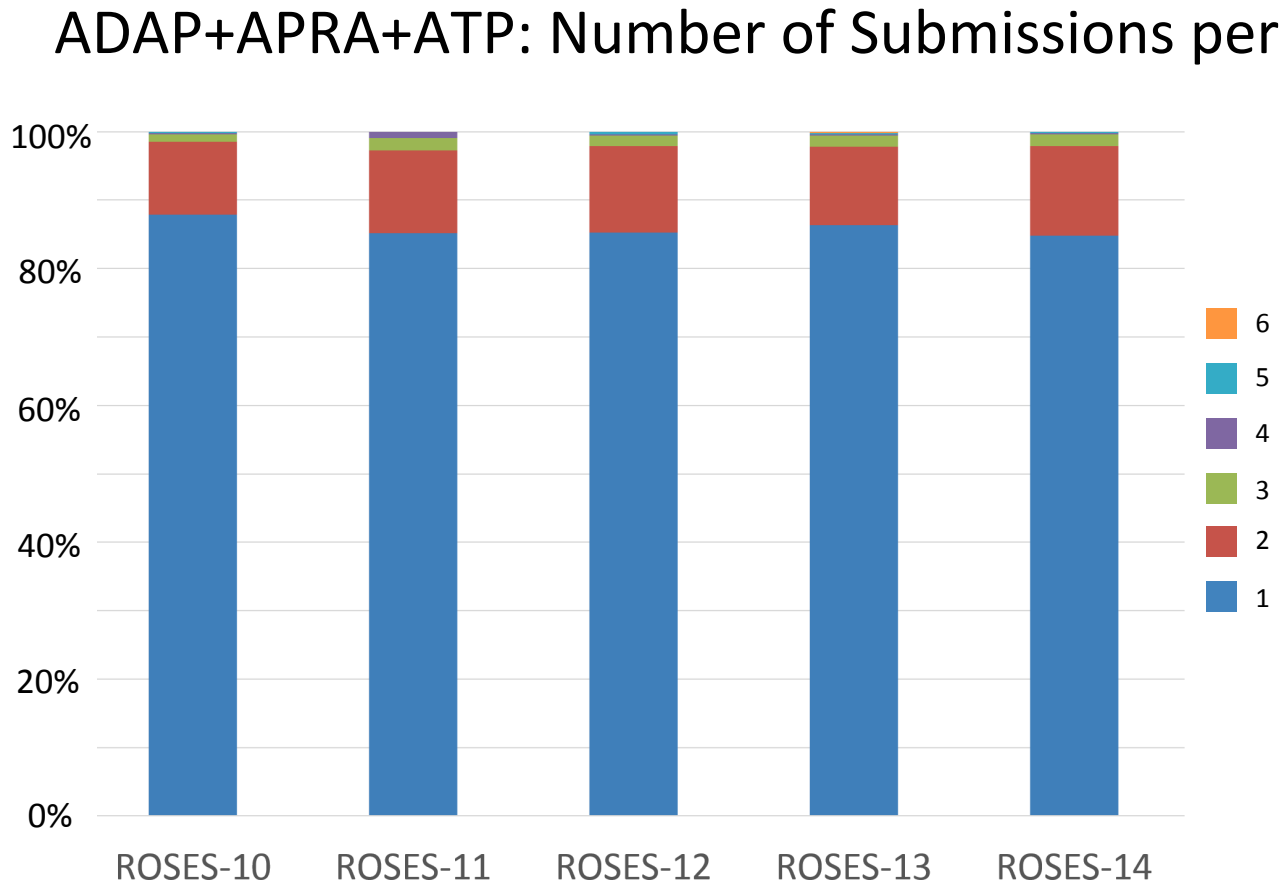


NASA: Multiple proposals are sitting at around 15%

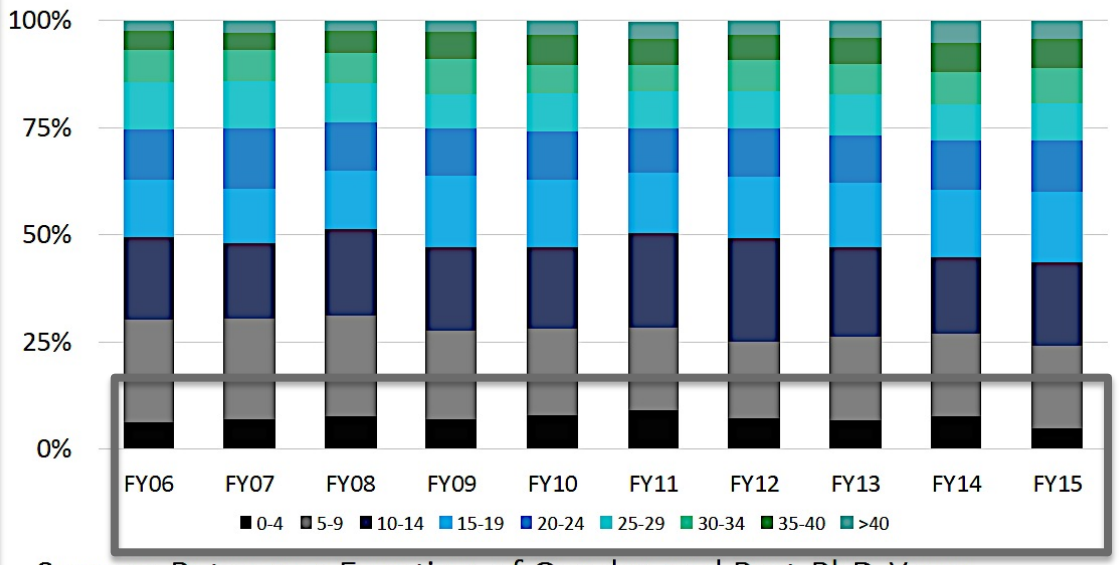
Fraction of Proposals by age of PI (NSF/AST)

No "Postdoc Problem"

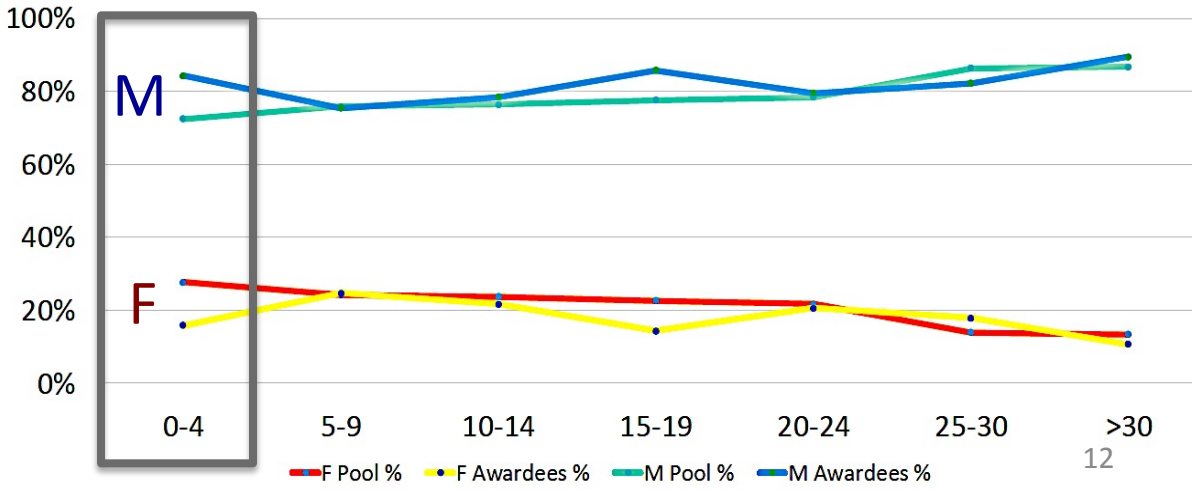
The suggestion that recent generous postdoc fellowship programs and targeted encouragement have boosted one segment of the population that is now moving through the system as an increased PI pool

… is NOT true.

Years Post-PhD of AAG Principal Investigators



Success Rates as a Function of Gender and Post-PhD Years – AAG FY11-14

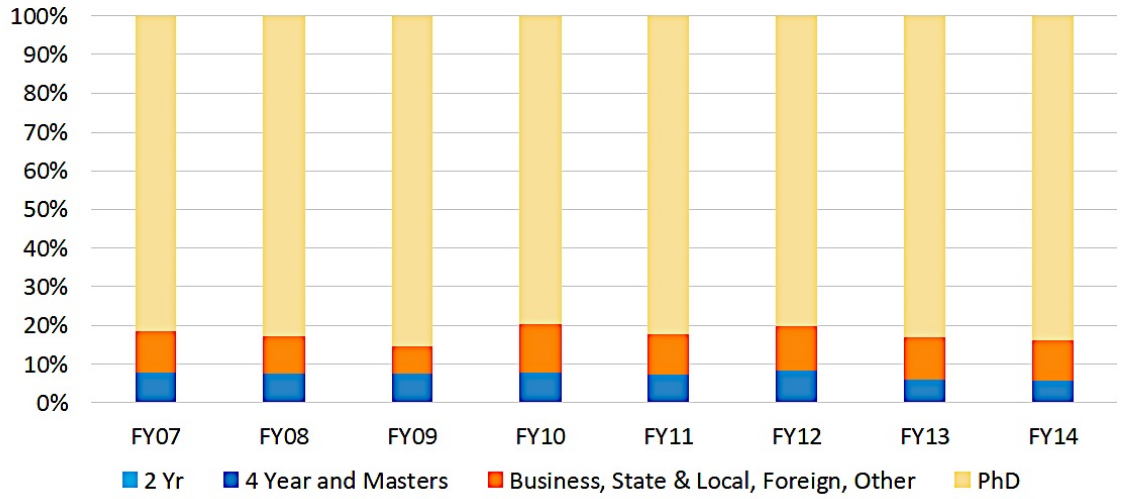


Result doesn't depend on gender. Slight increase in women in the younger pool is encouraging.

Institutional Affiliation (NSF/AST and NASA)

NSF

Proposals from Different Institution Types – AAG



Suggestion:
More proposers from smaller non-traditional institutions?

NOT true.

NASA

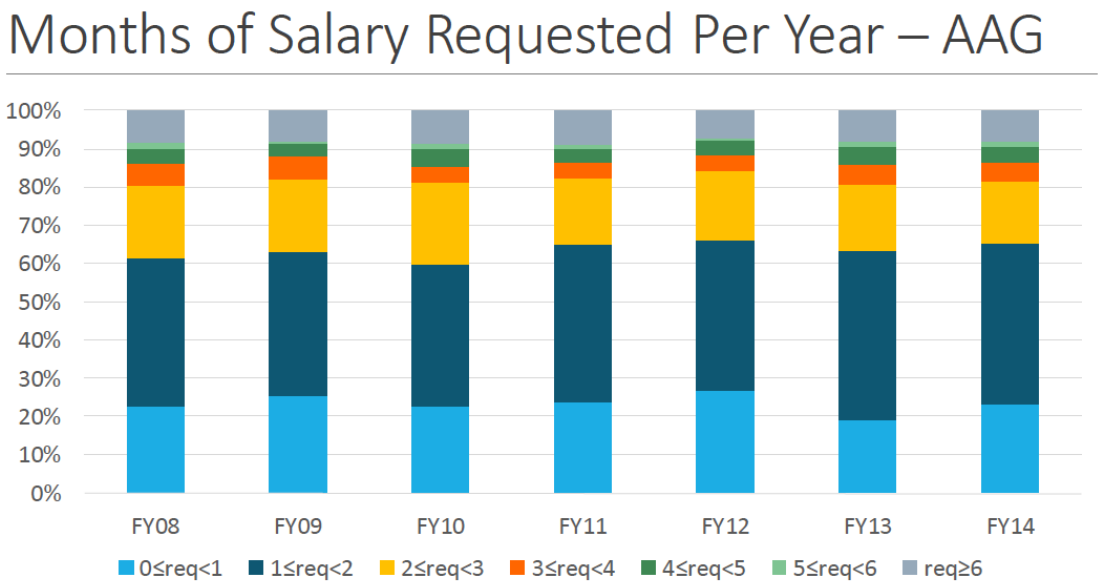
Year	Very High Research Activity Universities (107 in the US)				Other Universities		Research Institutes			
	Public		Private				NASA operated or funded**		Other***	
	# Grants	# Unique Institutions	# Grants	# Unique Institutions	# Grants	# Unique Institutions	# Grants	# Unique Institutions	# Grants	# Unique Institutions
2010	53	27	24	10	14	10	18	4	14	9
2011	46	26	23	13	14	12	15	5	30	15
2012	48	21	26	15	10	10	22	5	20	11
2013*	22	15	15	9	9	6	5	2	13	7

*Does not include APRA, which was carried over to 2014
** Includes NASA field centers plus JPL and STScI
*** Includes, e.g., SAO, Carnegie, SwRI, LBNL

There is NO evidence that Budgets themselves are going up

The median proposal request (NSF/AST AAG): $93k/y ➔ $150k/yr over the last 25-year period corresponds to a 12% reduction in constant 2015 dollars.

Or Researchers seeking soft money support to pay their own way



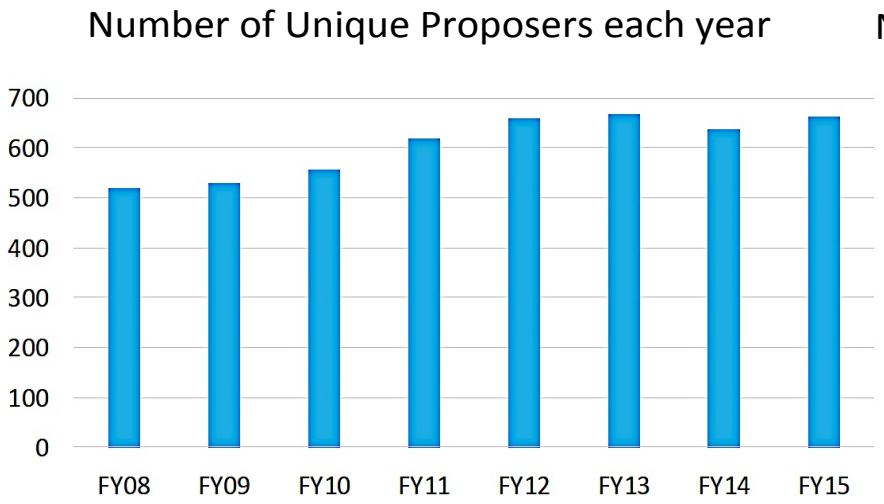
Flat: 80-85% of the proposals request < 3 mo. Summer salary

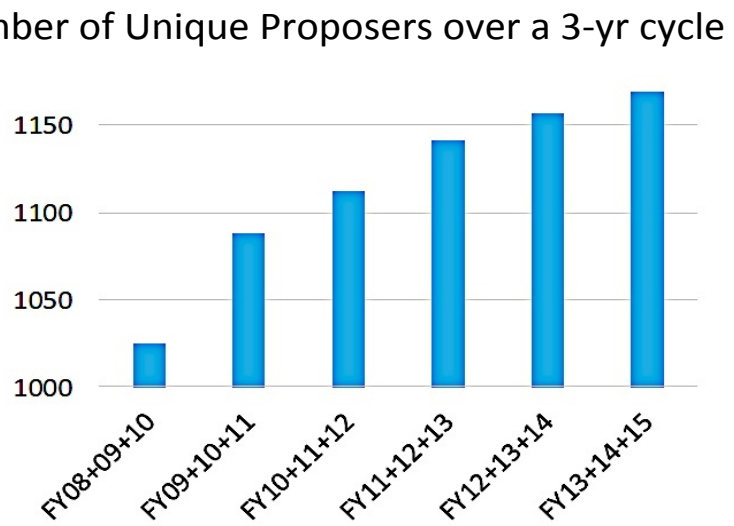
It is consistent with increased pressure on faculty for outside funding

7% of AAS members proposed to NSF/AAG in 1990

15% of AAS members do now.

Is Selection Rate being driven by Repeat Proposals?





Although the number of proposers is ~ 520/yr in FY 08-10
The number of proposers per year averaged over 3 years is ~ 342
This is the number (with repeat proposals removed) to compare to "population growth"
~ 34% of the proposals are resubmissions.

In 2014 ~ 40% of the proposals are resubmissions.

Proposal spiral: Ever more unique PIs reapply in consecutive years, accelerating the rise in proposal numbers and falling selection rate. This is not a driver now, but may be if the success rate dips below 10%.

Do these numbers just reflect a growth in the community?

We need to refine this - it is crucial to identifying our proposer pool

	1990	2000	2006	2009	2014	Rate of Increase
NSF Proposals	238	320	514	556	732	8.6%/yr (24 yrs) 6.3%/yr last 5 yrs
Unique Proposers				520	630	4.2%/yr
Unique proposers over 3 yr cycle				1025 (342)	1160 (387)	**2.6%/yr**
NASA Proposals				~ 440	~ 720	13%/yr (5 yrs)
AAS Full Members	3414	4022		4192	4135	Highly variable
APS DAP (all members)		1600	1901	2164	2681	4.8%/yr
Astro Faculty (AIP data)			1600		1920	2.5%/yr

- If the number of POOR Proposals is increasing

  Good Science is still being performed

  But the agencies are overwhelmed with paperwork and panels

  The solution to a glut of bad proposals is filtering

However,

- If Excellent Proposals are being rejected

  Then good science is not getting funded

  and the field will fall behind those countries willing to spend

It becomes important to define a Figure of Merit to look at trends in

Meritorious Proposal Success Rates

and

Science Output from successful proposals (number of papers? citations?)

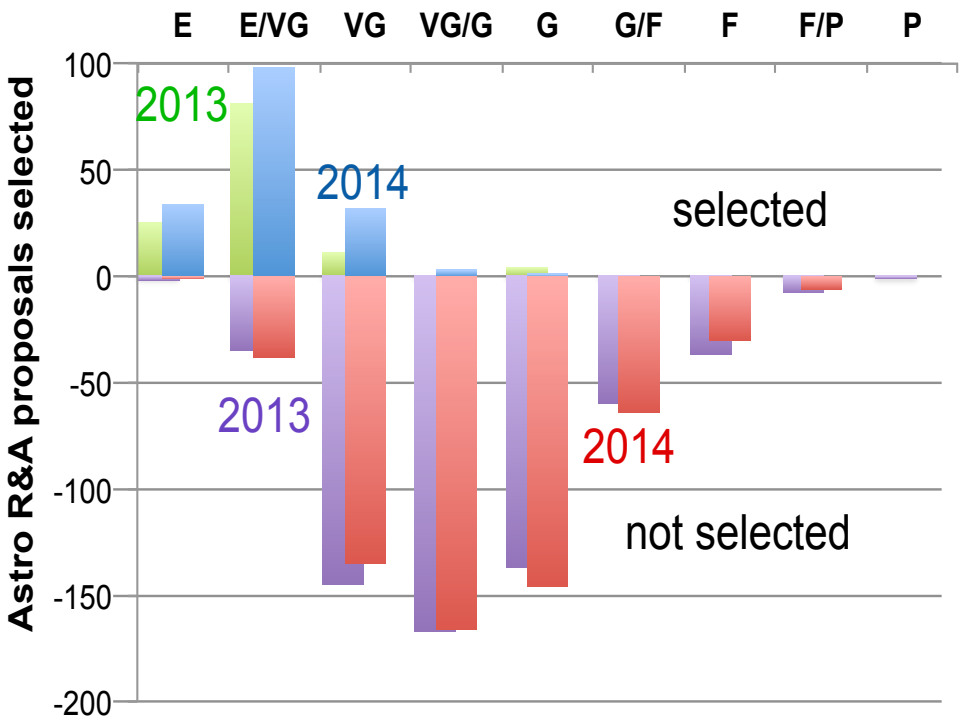
Is the number of Meritorious Proposals funded going down?

Reviewer rating is not a good merit indicator for NSF or DOE/HEP Cosmic Frontier
NASA reviewer ratings are more stable,
(but anecdotal evidence for NSF and DOE is in line with data from NASA)

2012-2014 (NASA/APD R&A)
Success rate for ≥ VG = 46%
Success rate for VG = 14%

Hard to get data for earlier,
but we do have the following benchmark

2007-8 (All SMD ROSES)
Success rate for VG = 45%



The Loss is in the VG category,
while VG/E and E remain stable at >75% and >90% respectively

http://science.nasa.gov/media/medialibrary/2014/04/09/2014.03.27_ApS_RA_final-2.pdf

Summary of Demographics
Only collected for NSF and NASA

- The number of proposers is going up, not just the number of proposals.
  Multiple proposals from the same PI is mostly not a driver

- The rise in the number of proposers is not coming disproportionately
  from new assistant professors or research scientists
  or from non-traditional institutions

- They do not represent a shift in gender or race

- The merit category that is being depleted has a rating of VG
  Very Good proposals are not being funded

- Initially unsuccessful proposals are being resubmitted at a higher rate

- Budgets from proposers are not growing, not even keeping up with inflation

- The number of unique proposers seems to track an increase in the size of the field, combined with an increase in the fraction seeking federal funding

Impact on Researchers

Is there a proposal success-rate floor?

A healthy level of competition
identifies the best science and boosts productivity.

Unhealthy success rates
discourage innovation and cause inefficiencies.

- Probability of success / failure
- Cost to scientific productivity
- Cost of review process
- Impact on health of discipline
- Impact on U.S. competiveness

This data is not available in Agency Statistics

Devise a Survey to be administered to AAS, APS members by AIP

But then…

A new paper appeared which addressed some of our questions

Recruited its author to help with the new survey

Incorporated any relevant previous findings into our Interim Report

Von Hippel and Von Hippel
http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118494

Size of sample = 113 astronomers (85 male, 25 female; 63 NASA, 50 NSF)
and 82 psychologists (NIH)

Success rate in Survey respondants (they are fairly representative)

31% NASA (compared to 28% from agency stats for that year)

18% NSF (compared to 26% for that year)

Cumulative Probability of Proposer Failure vs. Success Rate

PROPOSAL SUCCESS RATE	P (no funding) 1 try	P (no funding) 2 tries	P (no funding) 3 tries	P (no funding) 4 tries	P (no funding) 5 tries
10%	90%	81%	73%	66%	59%
15%	85%	72%	61%	52%	44%
20%	80%	64%	51%	41%	33%
25%	75%	56%	42%	32%	24%
30%	70%	49%	34%	24%	17%
35%	65%	42%	27%	18%	12%

Table 1. *Probabilities of unfunded proposals for different hypothetical funding rates and number of proposal attempts. The green shaded cell represents the state of the field circa 2003 (see Fig. 1). The red shaded cell represents the impending situation expected by FY2018 in the absence of portfolio rebalancing. The yellow shaded cell is the nominal "absolute minimum" benchmark identified here as the point at which new researchers spend more time proposing than publishing papers; it is not a sustainable benchmark and should be regarded as a temporary acceptable minimum.*

Assuming independence in funding probabilities from one proposal to the next, the chance of failing to obtain any grants after n attempts is $(1—\text{funding rate})^n$

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30%	70%	49%	34%	24%	17%
35%	65%	42%	27%	18%	12%

P(present funding | past funding) = 17 out of 35 proposers ~ 50%

P(present funding | no past funding) = 1 out of 15 proposers ~ 7%.

The Matthew Effect - New/unfunded researchers suffer decreased success rates.

From these admittedly low stats, an average 20% success rate overall actually means ~10% for recently unfunded proposers

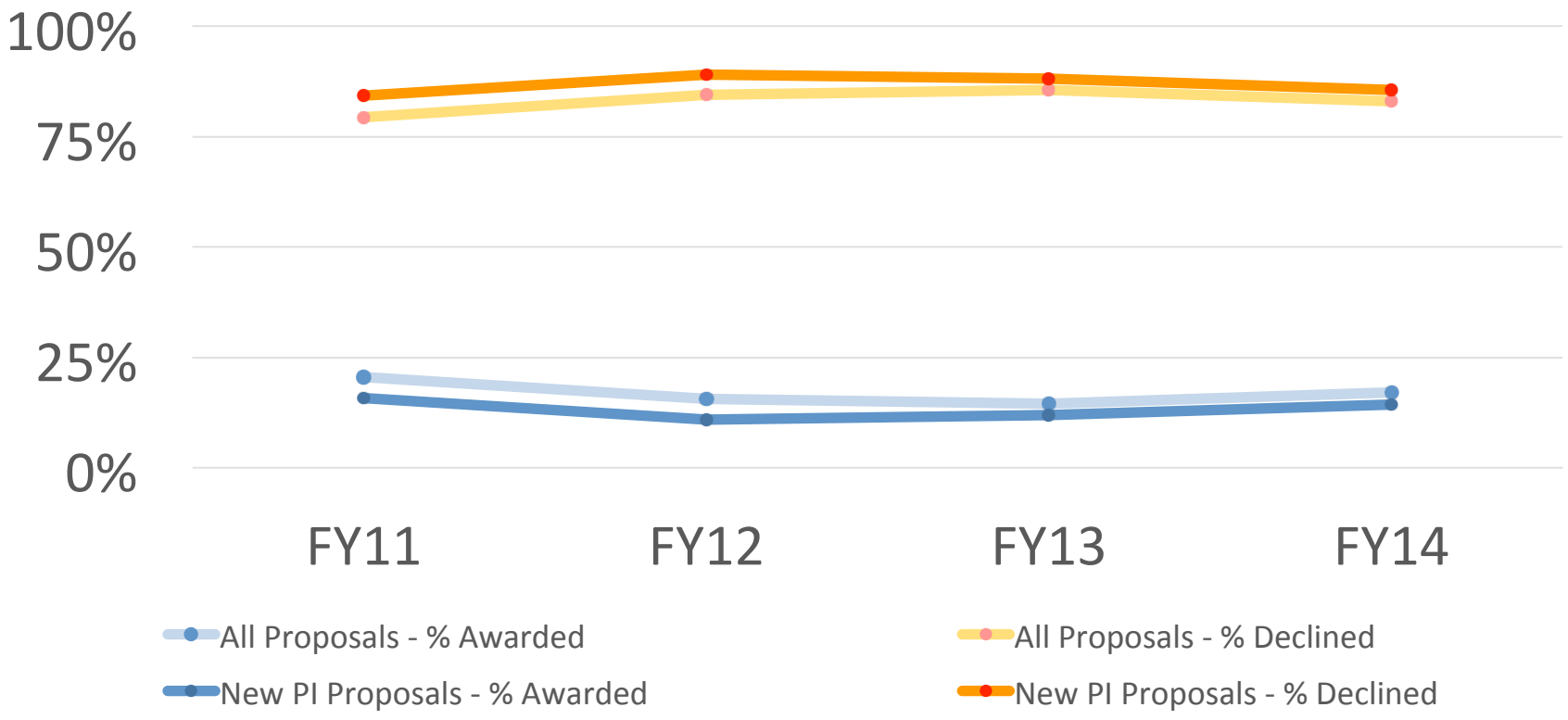
N.B. One-half of [NSF] new investigators never again receive NSF funding after their initial award. (2008 AAAS report)

New Investigators – NSF/AAG FY11-14

What is the Matthew Effect for NSF/AST ?
Rate of acceptance for new PIs is close to that for old.

Need to remove bias from natural progression of retirements coupled to the increase in total number of proposers (who must be new)

Success Rates
New PI/Old PI: 77% 71% 82% 85%



DOE HEP "Matthew Effect"

From Glen Crawford. HEPAP Presentation April 2015

About 43% of the 2015 3-yr proposals reviewed were from research groups that received DOE HEP funding in FY14.

Overall success rate of reviewed proposals in FY15 for previously (newly) funded groups: 78% (20%)

New PI/Old PI =26%

Overall success rate of reviewed Senior Investigators in FY15 for previously (newly) funded groups: 81% (19%)

Clear Differences which depend the Agency funding model

High Energy Physics research style (inherited by Cosmic Frontier) is very different than Astronomical Sciences but may be changing.

The Opportunity Cost of Writing Proposals

Von Hippel & Von Hippel survey:

PI: Takes 116 hours to write a proposal

Co-I: Takes 55 hours

That translates into a number something like 0.4 papers.

With success rates at 20%

the time cost of writing a successful proposal is greater than the time it takes to write 2 papers.

The typical astronomy grant results in about 8 publications.
As success rates fall even further, new researchers with success rates at 6% will spend more time writing proposals than would be spent writing the papers that result from a successful proposal.

Summary & Remarks

- Increase in the number of PIs and in many programs long no-growth budget profiles have led to decreasing proposal success rates.
- The cause does not lie in changing demographics, proposal quality, grant size.
- The tendency to recycle proposals exacerbates the problem.
- Lower success rates stress the agencies, reviewers, the community, and the nation.
- Success rates greater than 30% are healthy.
- Success rates of 15% are not sustainable – anecdotally people are leaving, panels are more risk averse, and new researchers are not entering the field.

The solutions are not clear.

More funding

Rebalancing the program

Fiddling with the process – grant size, grant opportunities

Decreasing the size of the U.S. astronomical science community

– strategically or not

FUTURE PLANS

- We will continue to work with AAAC to produce the best data for the 2016 March Report

  The AAAC report will be formal:

  A Set of findings and recommendations that go to congress
  Pass a formal approval process
  No time for any further survey

- In Parallel, we are committed to a new survey:

  Higher Statistical Samples
  Specifically investigate impact of possible "solutions"
  Sent to AAS, APS members, administered by AIP

- Continue to refine data from Agencies

- Analyze the survey and combine it with improved data
  Publish a Paper by summer of 2016

Backup Slides for Discussion

Pages from our wiki:
State of Play

Impact on Researchers Requires a Survey

Answer these questions with a scale: strongly agree <--> neutral <--> strongly disagree)

- How would the following actions by the funding agencies affect you?
  - Limiting applicants to one PI or CoI proposal per year:
    - would increase the time I could spend on my research
    - would reduce my chances for tenure.
    - would cause me to leave the field.
    - would reduce the number of proposals I submit.
    - would improve the quality of those proposals I submit
    - would reduce the size of my research group
  - Calling for proposals every other year
    - Etc..
  - Introducing a pre-proposal stage
    - Etc…
  - Introducing an exploratory stage with minimal funding.
    - Etc…
  - Reducing the amount of funding for individual proposals
    - Etc..

Impact on Researchers Requires a Survey

2. Personal Choices, tracking futures

- If my proposal is rejected, (choose one answer that best represents your action)
  - I resubmit the same proposal the next year
  - I submit a different type of proposal the next year
  - I support my research on someone else's grant
  - I submit a similar proposal to a different federal funding source
  - I submit a similar proposal to a private funding source
  - I concentrate on other aspects of my job (e.g. teaching)
- If I am unsuccessful at obtaining federal funding for 5 years, I am most likely to
  - Switch research fields
  - Switch jobs into something that does not require resea
  - Concentrate on non-federal funding sources
  - Move to another country in order to pursue the same research field

3. Demographics

PLEASE ADD YOUR SECTIONS HERE

Additional information from AAS and APS to augment Survey

aaac:aas

Table of Contents

American Astronomical Society

Questions and Available Data

- Our digital job register data goes back to 2003.
- Our digital membership data goes back at least 10 years.
  - Demographic information is self-reported and not broadly consistent with federal standards of classification.
  - Our membership data will have the unclear bias of "people who choose to be AAS members."
  - It is not obvious how this would bias the information.
    - Possible examples:
      - Are we undersampling small institutions?
      - Are some other institutions over or under-represented based on local department culture?
      - Are astronomers from certain types of institutions more likely to be AAS members?
  - In addition, the overlaps between our membership and the proposing-and-funded or proposing-and-not-funded cohorts are unclear.
- We think we could provide a secondary estimate of the field demographics to compare to the agencies' datasets, but as a primary source, our data would introduce unclear biases.
- Draft v2 of our proposed AAS member survey on grant proposal success rates available here

Links to Existing talks, trending graphs, relevant information

- Click on **Resources**

More Agency Statistics and Analysis

Sharpen arguments from the Agency statistics.

The Longer report on Proposal Pressures that was not in finished form by the March 2015 AAAC re
What are the questions not yet answered, what additional information is required to make a case.

Further analysis of the proposal per year and proposal per 3 year NSF data

A few more snapshots of the NASA Astrophysics merit criteria.

Explore further effect of pre-proposal strategy on those that have tried it

Detailed comparison of DOE Cosmic Frontier model vs NSF, NASA wrt results. Any lessons to be learned?

Better data on cost per proposal and number of PI's on proposals, etc

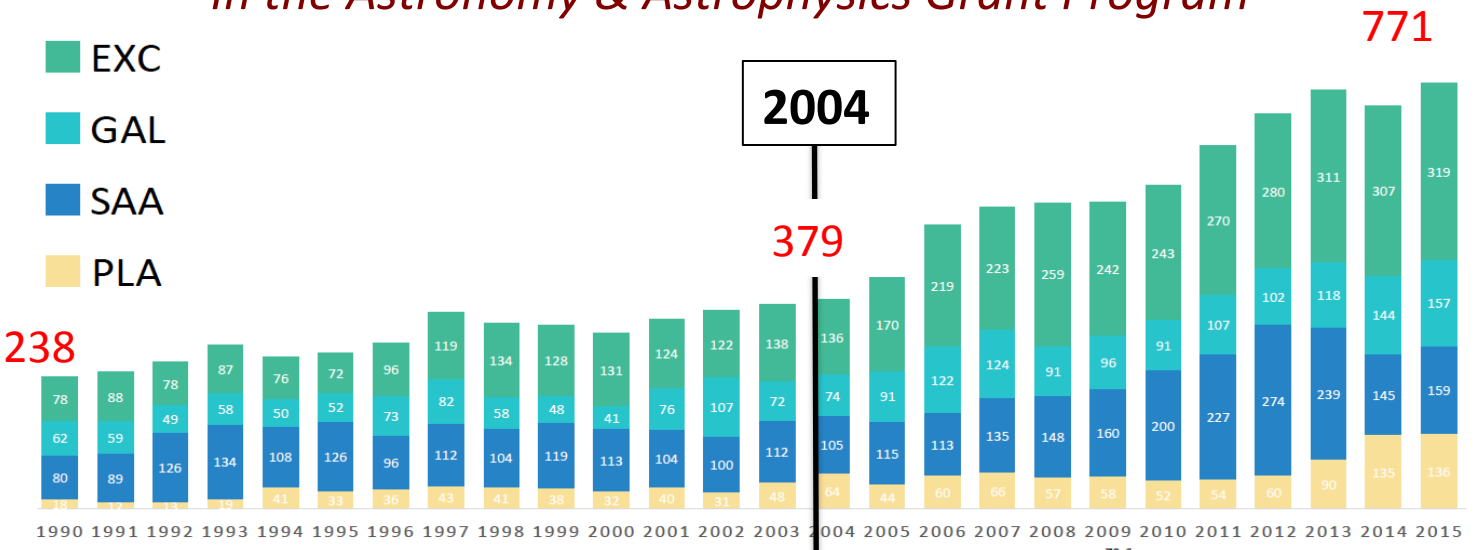
Investigate the trend on the average funding per proposal in both agencies

Bring the Heliophysics and Planetary stats up to the level of NASA/APD and NSF/AST

Proposal Pressure in NSF/AST

In the Astronomy & Astrophysics Grant Program

Number of AAG Proposals by program and year



AAG Budget $M

AAG Proposal Success Rate