National Science Foundation Update AAAC Meeting

2017 June 21

Edward Ajhar

Deputy Division Director (acting)

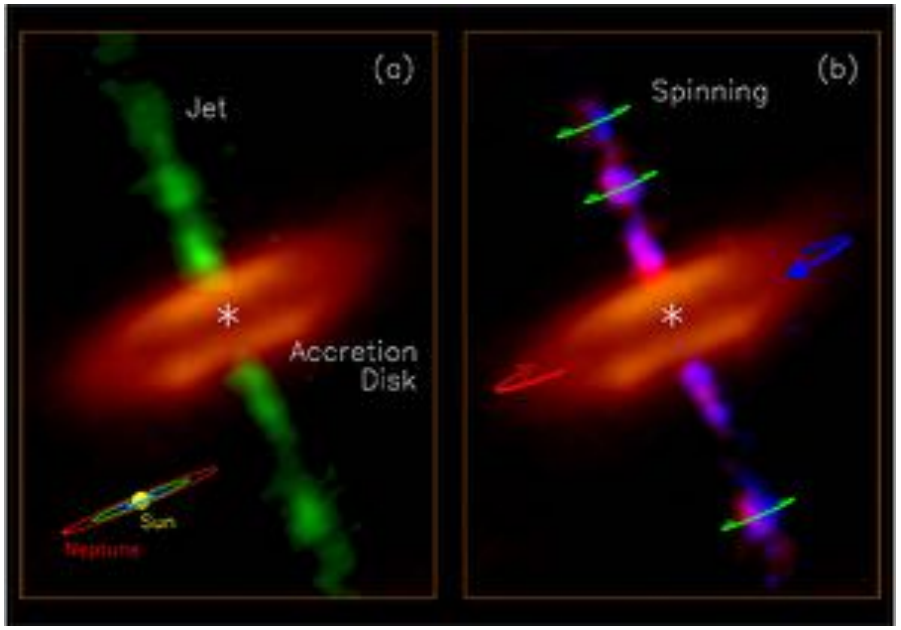
Division of Astronomical Sciences (AST)

Overview

- AST Science and Facility Highlights
- AST Staffing Update
- FY 2017 and 2018 Budget Update
- AST Individual Investigator Programs
- AST Divestment and Environmental Reviews

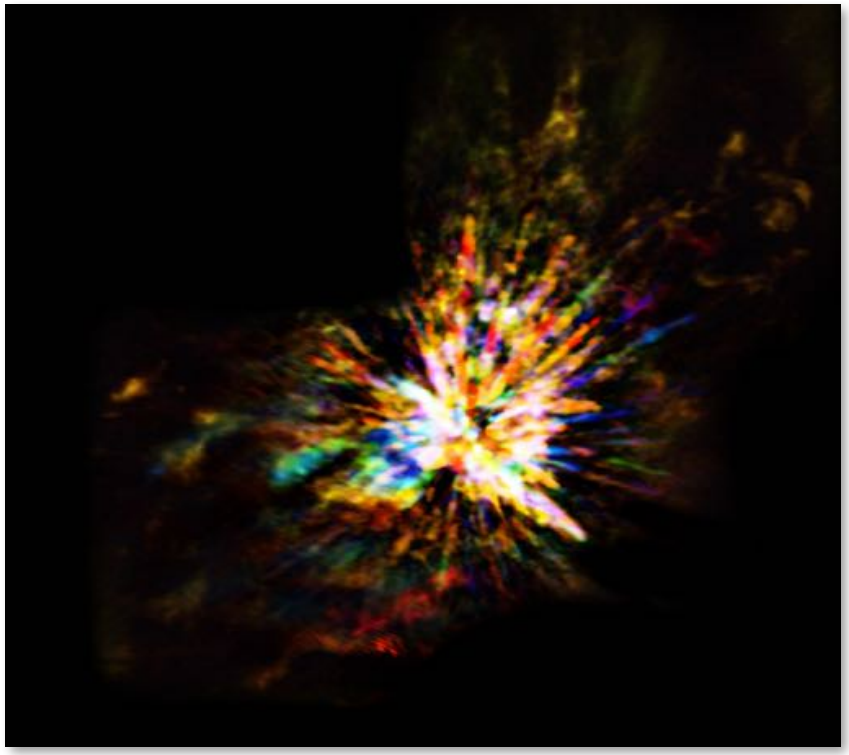
Spinning Jet Imaged by ALMA

- "A Rotating Protostellar Jet Launched from the Innermost Disk of HH 212," by Lee et al. to appear in the journal Nature Astronomy.
- ALMA can detect and measure jet rotation around protostars.
- Jet carries angular momentum. Such observations constrain theories of jet formation.
- ALMA technique can be used on extragalactic jets.



Credit: ALMA (ESO/NAOJ/NRAO)/Lee et al.

Explosive Star Formation Seen with ALMA



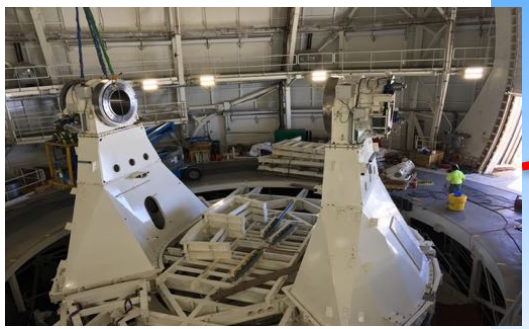
Credit: ALMA (ESO/NAOJ/NRAO), J. Bally; B. Saxton (NRAO/AUI/NSF);
Gemini Observatory/AURA

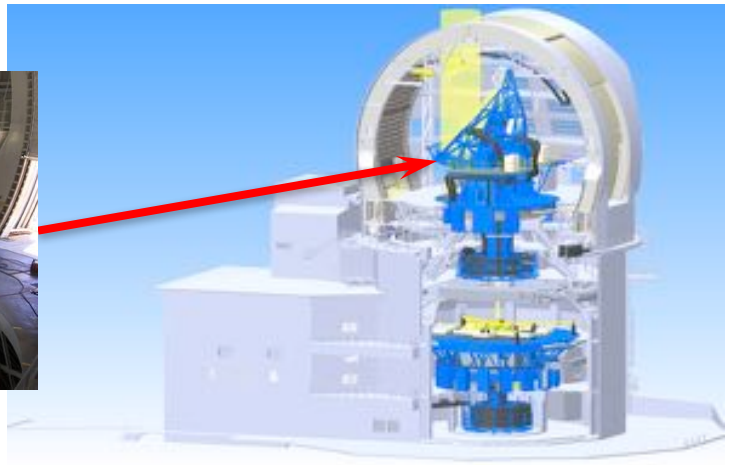
- Bally (U. Colorado) and collaborators imaged the densely-packed star-forming region “Orion Molecular Cloud 1” with ALMA.
- Image shows molecular CO gas color-coded by the expansion velocity, ranging up to +/-150km/s.
- Explosive event believed to have been triggered by the merger or near-collision of two forming stars which released gravitational potential energy, ejecting stars and gas.
- Streamers point toward high proper motion, shock-excited Fe and H2 gas seen in earlier near-infrared images with Gemini.

NSF's Daniel K. Inouye Solar Telescope

- Science Driver: Determining the nature of solar magnetism and how these magnetic fields drive the phenomena collectively know as space weather.
- Location: Haleakala, Maui, Hawai'i
- Hawaii Supreme Court affirmed construction permit (October 2016)
- Planned Completion: Early 2020

DKIST will be the world's flagship facility for ground-based solar astronomy.





Large Synoptic Survey Telescope

- Ten year survey of tens of billions of objects in space and time
- F1.2, 8.4m primary, FOV 3.5d (9.6 sq d)
- 3.2 Gigapixel camera, 2 second readout, ~15 TB per night
- 825 visits per pointing (main survey = 18,000 sq d)
- ~10 M alerts per night, 60 second latency
- Construction progressing, 1 October 2022 start date for survey

Construction in May 2017 after 16 inches of snow …

… compared to artist's impression

Images credit LSST Project/NSF/AURA

AST Staffing Update

Division of Astronomical Sciences (AST)

Office of the Division Director

Ralph Gaume
Acting Division Director

Edward Ajhar
Acting Deputy Division Director

Craig McClure
Program Support Manager

Donna O'Malley
Financial & Operations Specialist

Vernon Pankonin
Senior Advisor

Elizabeth Pentecost
Project Administrator

Administration

Allison Farrow
Program Specialist

Stephanie Hill
Program Assistant (Student)

Diana Phan
Program Analyst

Matthew Viau
Program Specialist

Individual Investigator Programs and Astronomy & Astrophysics Research Grants

James Neff
Program Director
IIP Coordinator; Education & Special Programs (REU, PAARE)

Richard Barvainis
Program Director
Extragalactic Astronomy & Cosmology

Glen Langston
Program Director
Galactic Astronomy

Harshal Gupta
Program Director
Astronomy & Astrophysics Postdoctoral Fellowships

Faith Vilas
Program Director
Solar and Planetary Research Grants

Linda French
Program Director
CAREER; SPG; AAG

Hans Krimm
Program Director
Stellar Astronomy & Astrophysics

Peter Kurczynski
Program Director
Advanced Technologies & Instrumentation, Major Research Instrumentation

Facilities, Mid-Scale, & MREFC Projects

Christopher Davis
Program Director
Gemini Observatory

Philip Puxley
Program Director
National Radio Astronomy Observatory and ALMA

David Boboltz
Program Director
National Solar Observatory

Nigel Sharp
Program Director
Large Synoptic Survey Telescope

Edward Ajhar
Program Director
Green Bank Observatory, Long Baseline Observatory

Joe Pesce
Program Director
Arecibo Observatory

Vernon Pankonin
National Optical Astronomy Observatory

Richard Barvainis
Mid-Scale Innovations Program

ESM

Thomas Wilson
Program Director

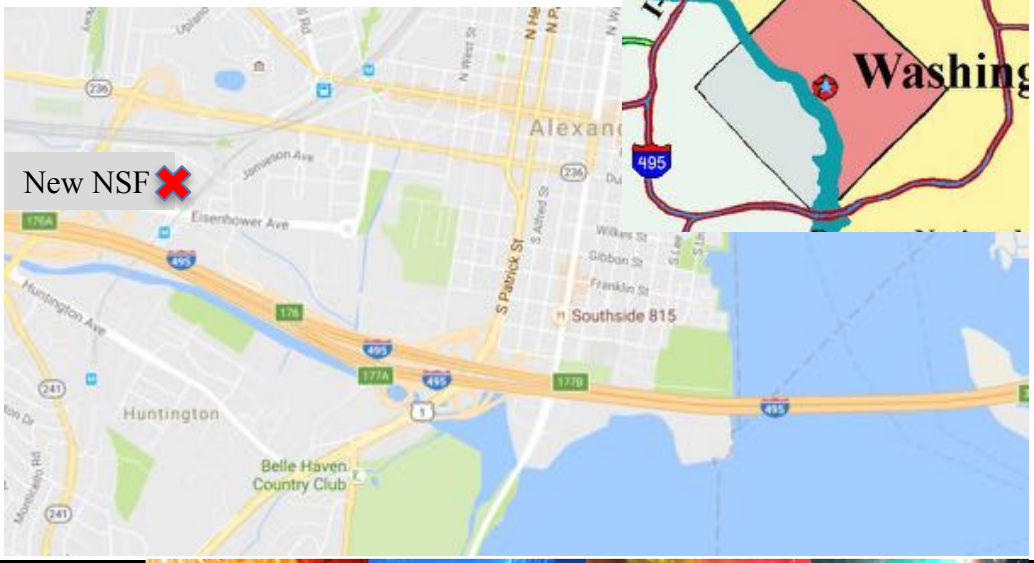
Joe Pesce
Program Director

Staff Additions

- Two new program officers to staff ESM. Tom Wilson retiring in early December.
- New IPA rotator starting in the fall to succeed Joan Wrobel, who returned to NRAO in May.
- Harshal Gupta was Fed. Temp. and is now permanent Fed.
- Ken Johnston just joined as an Expert.

NSF Is Moving!

- NSF will move from its current location in Arlington, Virginia to a location in Alexandria, Virginia in July-September 2017.
- The Directorate for Mathematical and Physical Sciences, including AST, is scheduled to move over the extended Labor Day weekend in September (Sept 2-4).



FY 2017 & 2018 Budget Update

FY 2017 Appropriation

- FY 2017 appropriation passed by Congress in early May (with <5 months left in FY 2017).
  - Essentially flat with respect to FY 2016.
- FY 2017 plan submitted to Congress via OMB.
  - Expect AST budget to be approximately flat.
- Processing of awards hampered by late budget and early financial closeout.

FY 2017/2018 Budget

$M	FY 2016 Actual	FY 2017 Request Disc.	FY 2017 Approp.	FY 2018 Request
NSF Total	7494	7564	7472	6653
NSF R&RA	5998	6079	6034	5362
MPS	1349	1355	---	1219
AST	246.6	247.7	---	221.2

FY 2017/2018 Budget

$M	FY16 Funding	FY17 Pres. Budget	FY18 Pres. Budget
AST Total	246.4	247.7	221.2
Facility Operations	149.1	155.2	154.8
AAG+ATI	57.4	51.4	41.2
Education/CAREER	10.5	10.9	9.6
MSIP	19.3	18.0	6.0
Other (mostly grants)	10.1	12.2	9.6
MREFC	113.0	87.1	77.8

Looking Ahead: FY 2018 Budget

Markup, reconciliation of appropriation bills

THE WHITE HOUSE
WASHINGTON

BUDGET

NSF

BUDGET

2018 Request

May 2017

U.S. HOUSE OF REPRESENTATIVES

House Budget Resolution

UNITED STATES SENATE

Senate Budget Resolution

FY 2018 Pres. Budget Request

- Pres. Budget Request is 1st step in budgeting process.
- AST FY 2018 Request will
  - Largely preserve facility budgets
  - Preserve existing CGIs (multi-year grants)
  - Reduce MSIP budget to $6M, down from $18M
  - Reduce AAG+SPG budget to $40.0 (from $43.4)
  - ATI program delayed

AST Budget Pressures

- Must plan for possibility of no budget increases for the balance of the decade or perhaps decreases of >10%
- Need to balance facilities, small and mid-scale programs and individual investigator grants
- Mid-decadal survey report stated
  - *"The LSST operations cost of $8 million at first, growing to $25 million, will be an additional burden on the AST budget in the first half of the next decade. The committee strongly supports the goal of a balanced program that includes facilities, medium scale initiatives, and small-scale initiatives. Maintaining this balance is a challenge at the current level of funding."*

AST Individual Investigator Programs

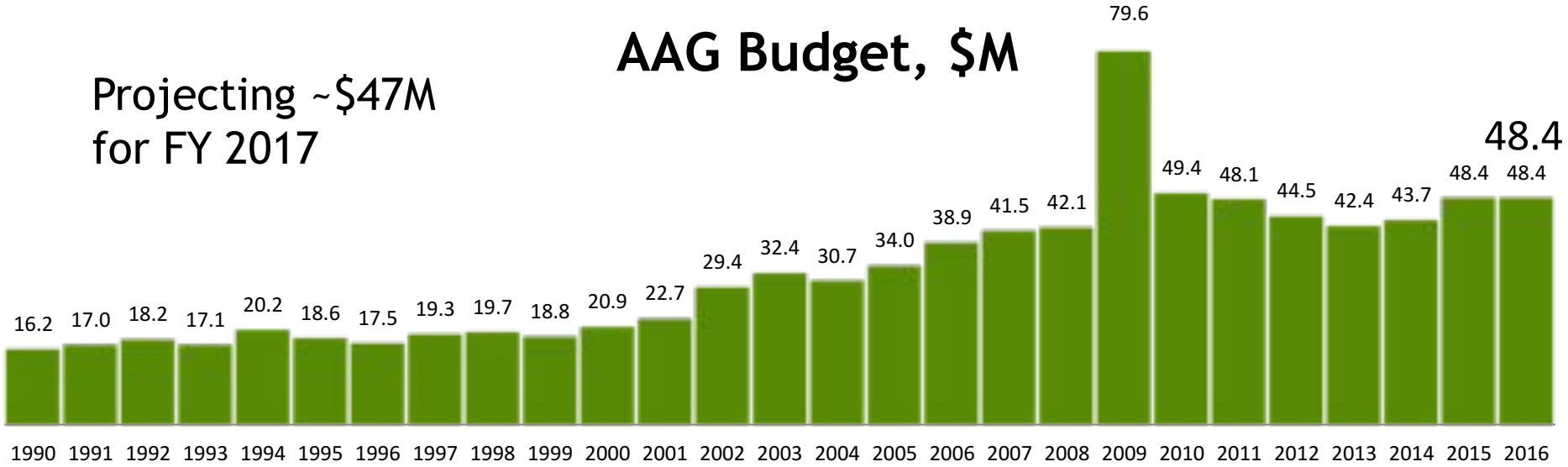
FY 2017 Status

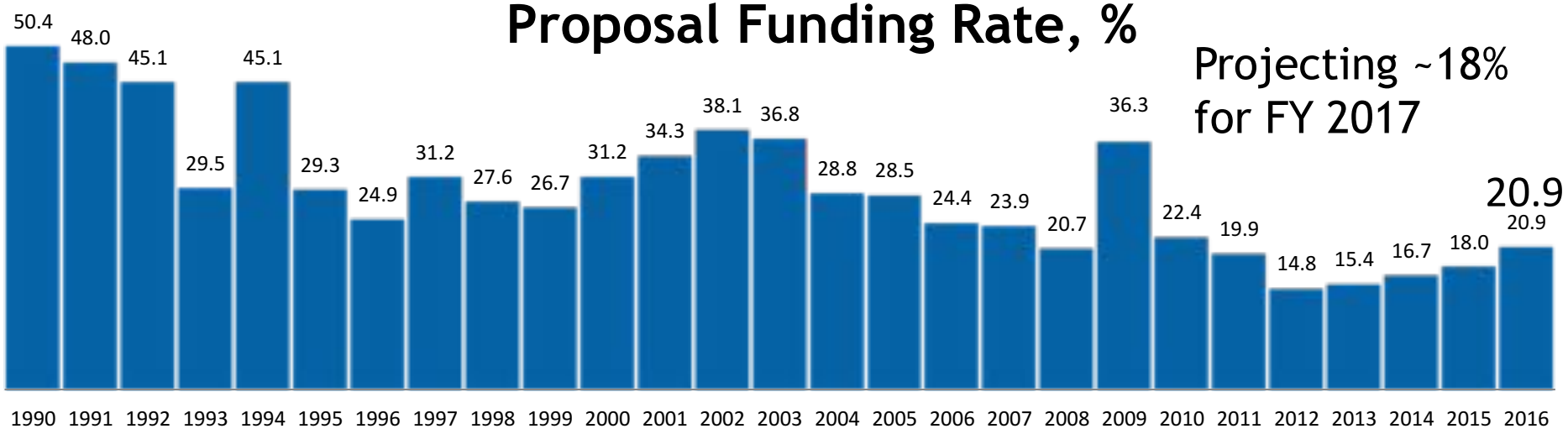
- NSF has a goal of achieving “Division Director concurrence” on 75% of all proposals within six months of submission deadline (up from 70% previously).
  - In FY 2017, AST achieved 78% on AAG, nearly 100% on AAPF and CAREER, over 60% on the Advanced Technologies and Instrumentation (ATI) program.
  - Currently in process of completing the balance of awards and declines.
- AST continues its strategic review of instrumentation programs to evaluate potential overlap in the goals of the programs.

Solar and Planetary Research Grants (SPG) Pilot Program

- In FY 2017, AST is running a pilot program with NO PROPOSAL DEADLINE for SPG (NSF 16-602).
  - Purposes: Understand and resolve issues with proposal handling, merit review, and funding; alleviate impact of life events for proposers; investigate impact on proposal load over the year; enable proposal file updates for minor errors.
  - Declined proposals may not be resubmitted for 12 months
  - So far, 76 proposals received, 66 reviewed on 3 panels

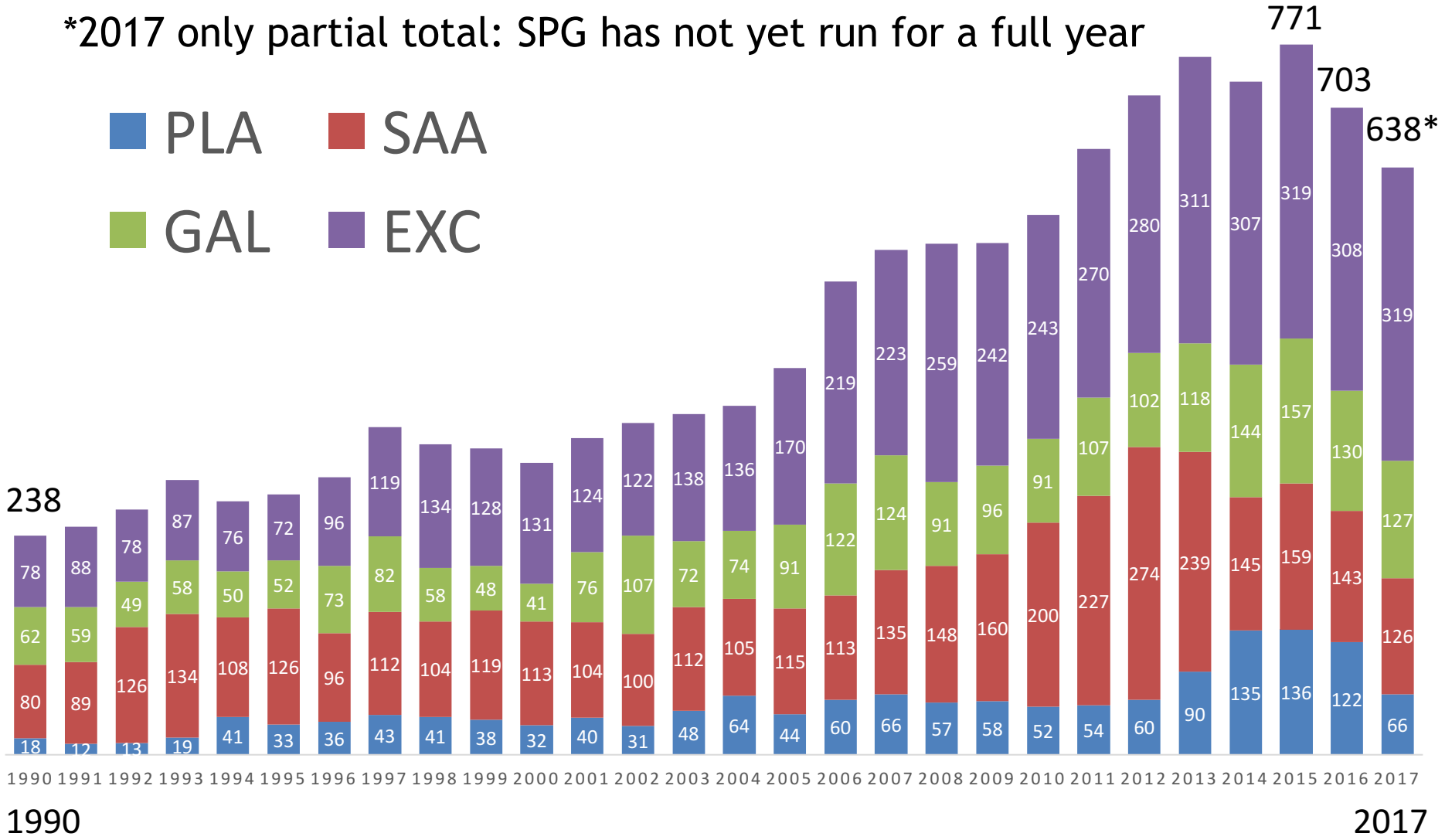
AAG Funding History, 1990-2016





Proposals in AAG, 1990-2017

*2017 only partial total: SPG has not yet run for a full year



AST Divestment and Environmental Reviews

AST Divestment Background

- AST's Overall Goals
  1. Provide **open access** to the broad astronomy community for merit-reviewed science on **leading-edge facilities**.
  2. Provide **robust grants program** to support forefront research on leading-edge facilities and development of the next generation of scientists.
  3. Provide **robust instrumentation program** to support development of the next generation of instruments and facilities.
  4. Maintain **balance** among facilities, individual investigator, and instrumentation grants programs.

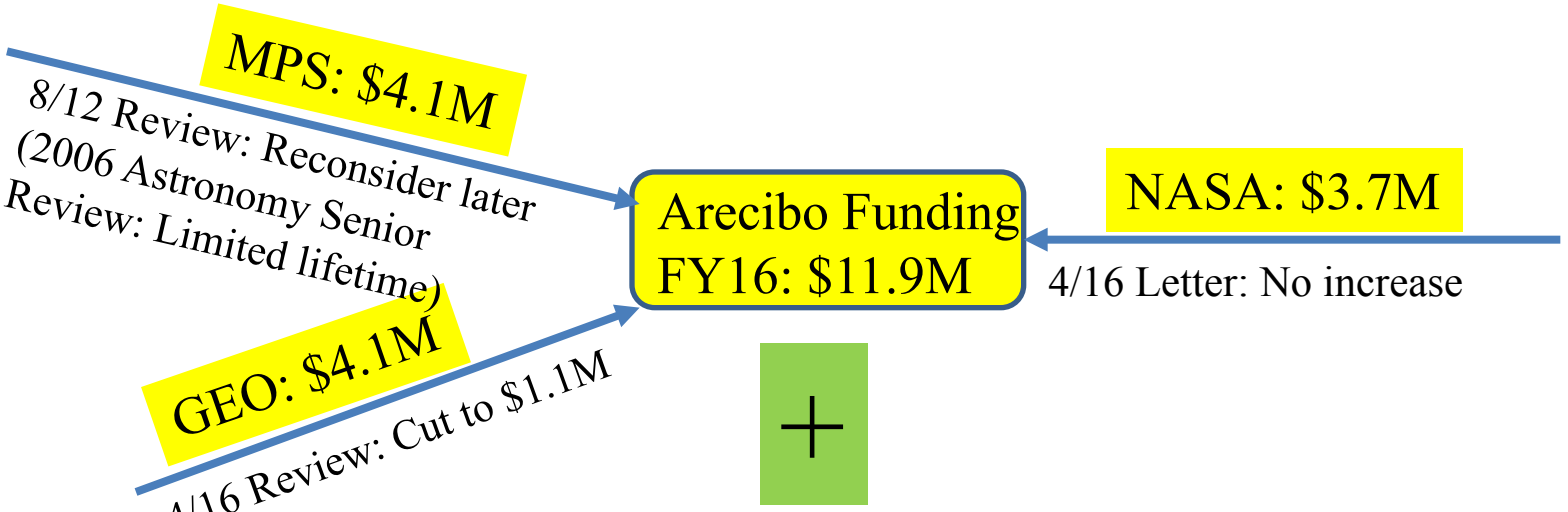
AST Divestment Summary

- NSF has been aggressively pursuing divestment of lower priority facilities.
  - Numerous community committee recommendations to pursue collaborations.
  - To date, implementation of Portfolio Review recommendations by means of cuts to facilities and new collaborations has saved about $15 million in annual facility spending.

AST Divestment Summary

- Dear Colleague Letter NSF 17-079, released April 27, gives status update.
- NSF has begun a formal environmental review process for some facilities where collaborations have not yet fully developed.
  - **Arecibo Observatory**
  - **Green Bank Observatory**
  - **Sacramento Peak Observatory**
  - Others may follow

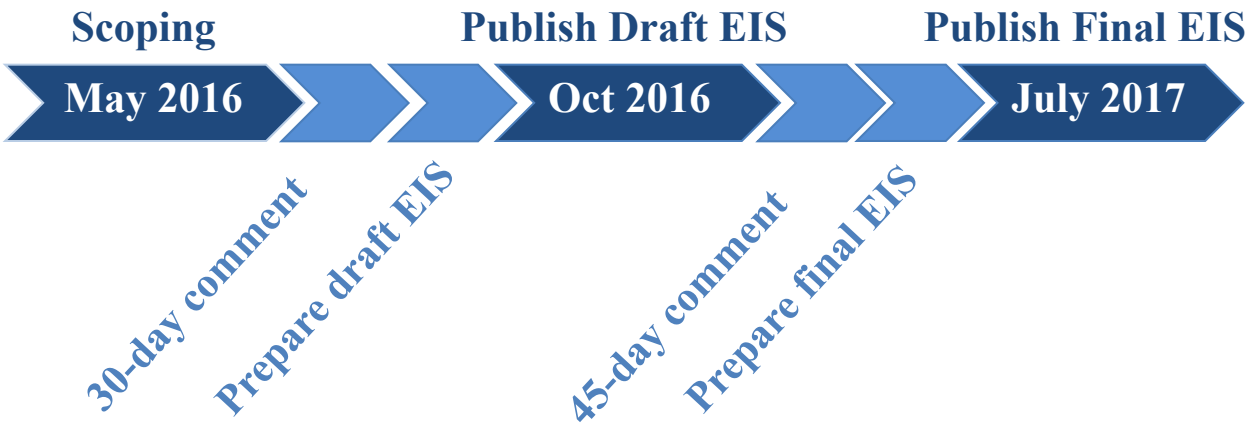
Arecibo Observatory: Lead Up to the EIS



01/2016: Dear Colleague Letter Replies to:
Concepts for Future Operation…
02/2016: Engineering Feasibility Study complete.
09/2016: End of current Cooperative Agreement, now extended to March 31, 2018.

May 2016: Start Environmental Impact Statement (EIS) Process.

Arecibo: Environmental Impact Statement (EIS) timeline



Arecibo Draft EIS Alternatives Considered

- Continued NSF investment for science-focused operations (No-Action Alternative).
- Collaboration with interested parties for continued science-focused operations (Agency Preferred Alternative).
- Collaboration with interested parties for transition to education-focused operations.
- Mothballing of facilities.
- Partial deconstruction and site restoration.
- Full deconstruction and site restoration.

Arecibo Management Solicitation

- Intended to inform the EIS Agency Preferred Alternative: Collaboration with interested parties for continued operations.
- MPS/GEO Dear Colleague Letter 16-144, Sept 30, 2016: *Intent to Release Solicitation Regarding Future Continued Operations of Arecibo*
- Solicitation Released January 25, 2017.
- Proposals were due May 5, 2017. Now under review.
- Reduces NSF support from $8.2M/yr (FY16) to $2M/yr over 5 year award.
- Includes NASA Letter of continued support.
- Award made if and only if Record of Decision selects Collaboration alternative.

Project Year	FY	NSF		
		MPS/AST	GEO/AGS	**TOTAL**
1	18/19	$3,600,000	$3,550,000	**$7,150,000**
2	19/20	$2,500,000	$2,500,000	**$5,000,000**
3	20/21	$1,750,000	$1,750,000	**$3,500,000**
4	21/22	$1,250,000	$1,250,000	**$2,500,000**
5	22/23	$1,000,000	$1,000,000	**$2,000,000**

Arecibo: How the Parts Fit Together

- Science Priority
- Budget
- Programmatic considerations (collaborators, risk, viability)

Management Solicitation

National Historic Preservation Act Consultation

Endangered Species Act Compliance

Record of Decision will define the "Way Forward", which should be implemented (including any transition) by 31 March 2018.

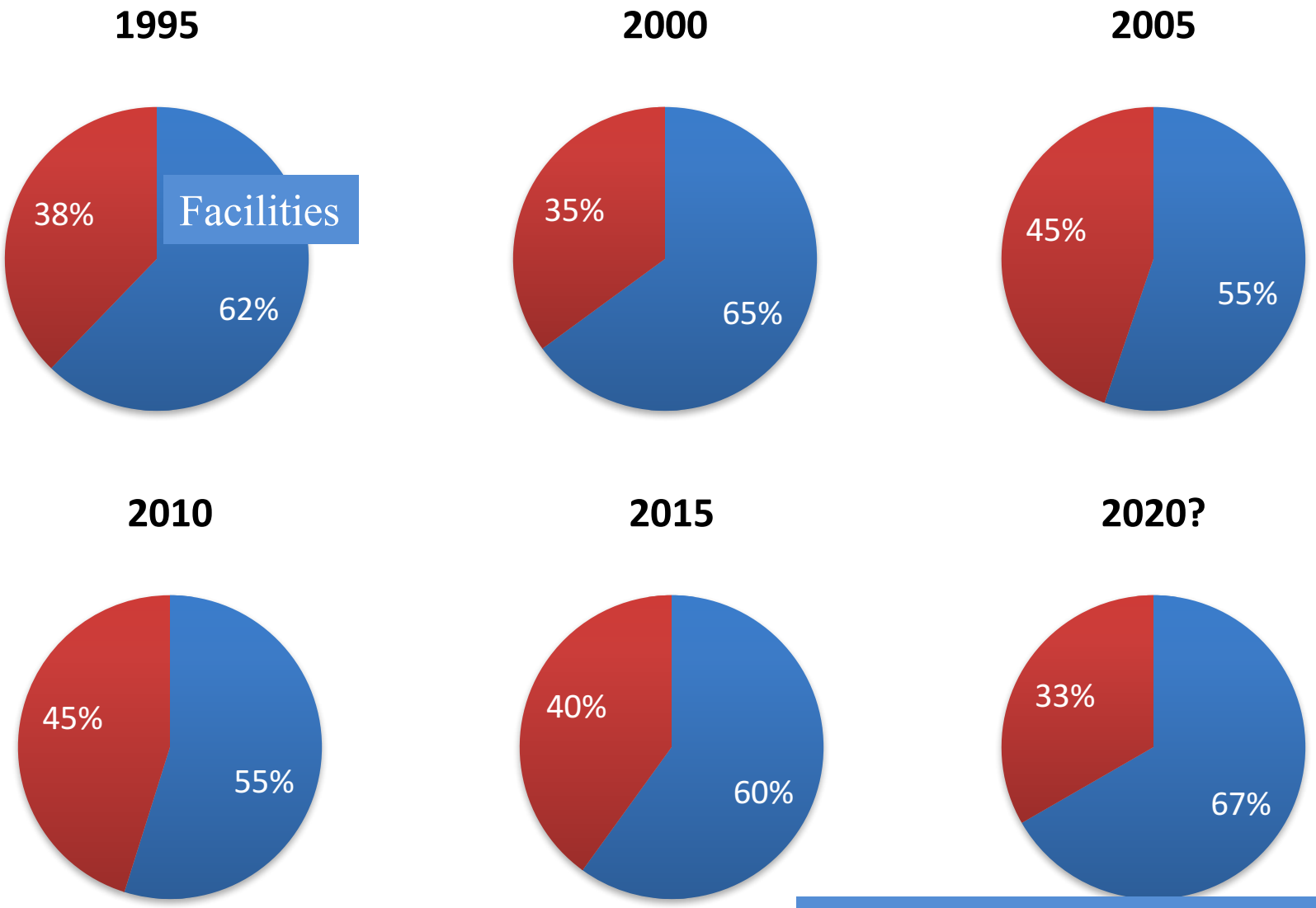
Divestment Facility Summary

Telescope	Status
KPNO 2.1m	Caltech-led consortium (Robo-AO) operating for FY 2016-2018.
Mayall 4m	Slated for DESI; bridge from NSF to DOE; NSF/DOE MOU for transition.
WIYN 3.5m	NOAO share to NASA-NSF Exoplanet Observational Research Program; NSF/NASA MOU in place; NASA instrument selected.
GBO	~25% collaboration for basic scope; started EIS process on October 19. DEIS under prep. Working to establish federal or other collaborations.
LBO/VLBA	Separation from NRAO in FY 2017; IAA with US Navy in place.
McMath-Pierce	Limited partner opportunities; very small user community. RFP issued.
GONG/SOLIS	SOLIS is off Kitt Peak; GONG refurbishment; Interagency Agreement with NOAA signed (NOAA sharing GONG operations costs).
Sacramento Pk.	University consortium in development, and NSF funded NMSU for transition to consortium; started EIS process; completion in 2017.
Arecibo	Formal EIS process under way, and issuance of Record of Decision targeted for 2017. Draft EIS released October 28. Final EIS under prep.
SOAR	Post-2020 status to be reviewed.

Questions?

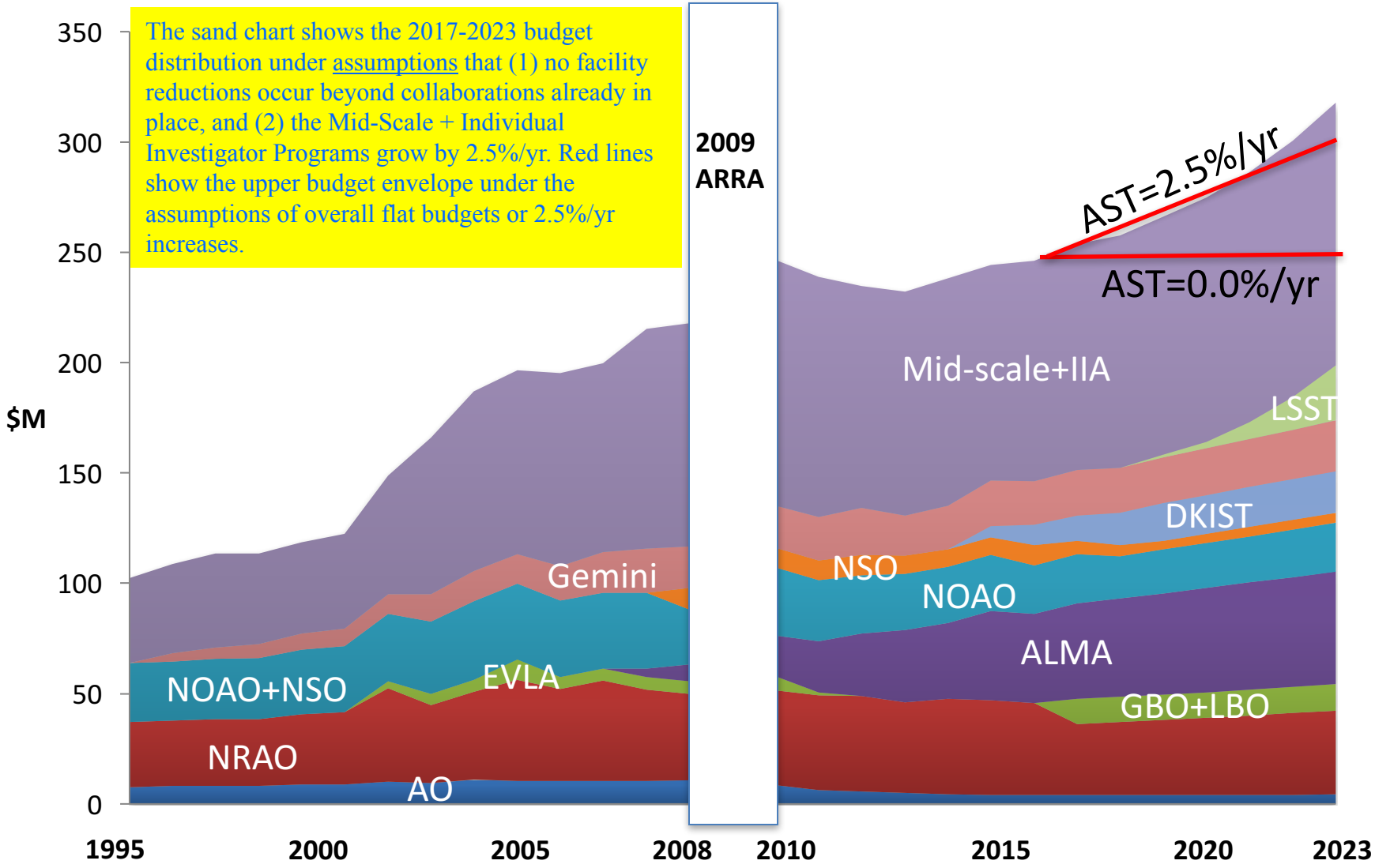
Backups

Historical Funding Breakdown



Assumes flat budget, currently planned facility evolution.

Hypothetical AST Budget Runouts



AST Divestment Summary

- National Academies report: New Worlds, New Horizons: A Midterm Assessment (2016) → FINDING 3-12: *Even following the divestment recommended by the Portfolio Review, the operations costs of ALMA, DKIST, and LSST will compromise the ability of the U.S. community to reap the scientific return from its premier ground-based facilities.*

AST Divestment: background

- AST's budget has remained approximately flat through FY 2017 while
  - Bringing ALMA to full operations.
  - Ramping up DKIST operations.
  - Preparing for LSST operations.
- National Academies report: New Worlds, New Horizons: A Midterm Assessment (2016) → FINDING 3-10: *The core grants programs AAG and ATI have declined in real-year dollars and dropped still further in purchasing power over the first half of the decade. This reduction in funding has contributed to a* ***substantial decline in grant funding rates, threatening the scientific productivity*** *of the U.S. ground-based astronomy program.*

Background: AST Divestment[1]

- AST Portfolio Review Report (MPSAC subcommittee), in August 2012, recommended divesting a number of telescopes from AST budget.
- Divestment needed to enable pursuit of highest-priority frontier science and balance the types of science opportunities.
- Subsequent AST actions:
  - Pursued funding collaborations aggressively.
  - Solicited input on innovative operations models.
  - Carried out engineering feasibility studies and baseline environmental reviews for many facilities.
  - Have embarked on preparation of formal Environmental Impact Statements (EIS) as part of the decision process for three facilities: Arecibo, Green Bank, Sacramento Peak (Arecibo process six months ahead of others)

[1] Current status documented by NSF Dear Colleague Letter 17-079, April 27, 2017.

AST Divestment Summary

- Facility divestment from AST budget was recommended in 2012, so portfolio could best address science of recent NRC decadal surveys.
- National Academies report: New Worlds, New Horizons: A Midterm Assessment (2016) → RECOMMENDATION 3-1: *The NSF should **proceed with divestment** from ground-based facilities that have a lower scientific impact, implementing the recommendations of the NSF Portfolio Review, which is essential to sustaining the scientific vitality of the U.S. ground-based astronomy program as new facilities come into operation.*

Environmental Review Process & Alternatives

- Collaboration Options
  - Collaboration with a federal agency or other entity with no substantial change in operations
  - Transferring ownership interest in the facilities to another entity
  - Other options have been pursued that are specific to individual telescopes or facilities. They may involve changes in scope or mission, or both.
- If no viable collaborations exist
  - Mothballing or site restoration

Environmental Review Process & Alternatives

- Proposed Divestment of AST Facilities May Trigger the Following Federal Environmental Statutes:
  - National Environmental Policy Act (NEPA)
  - Section 106 of the National Historic Preservation Act (NHPA)
  - Endangered Species Act (ESA)

Environmental Reviews - Targeted Timeline

- June-November 2016: Initial scoping periods for EIS processes (now completed)
- October 2016-August 2017: Release of Draft EISs, and comment periods for Draft EISs
- July 2017-December 2017: Release of Final EISs, and 30-day waiting periods
- August 2017-January 2018: Issuance of NSF Records of Decision

Sacramento Peak (Sac Peak) Observatory

- Sac Peak occupies 175 acres and operates under Land Use Agreement with U.S. Forest Service (Lincoln National Forest) in New Mexico
- May 2015: Met with National Solar Observatory (NSO) and representatives of universities seeking to create consortium to operate Sac Peak. Second meeting with NMSU Provost.
- February 2016 and February 2017: NM State Legislature declined to fund NMSU request for funds to enable consortium.
- July 2016: Received bridge proposal from NMSU for transition
- July 2016: Initiated environmental review
- August 2016: Recommended bridge funding
- October 2017: Temporary transfer of operations to NMSU while NSF determines the way forward

McMath-Pierce Solar Observatory

- Iconic solar telescope on Kitt Peak (Arizona).
- NSO has substantially reduced operations, and there is a very limited user community. NSO plans to cease operations in 2017.
- A potential consortium has been unsuccessful at raising funds to date.
- AURA has issued an RFP.
- May start formal environmental review following conclusion of RFP/solicitation process.

National Radio Astronomy Observatory (NRAO)

- Very Long Baseline Array (VLBA) and Green Bank Observatory (GBO) were separated from NRAO at start of FY 2017, as announced in NSF 13-074 (March 2013), which also solicited GBO and VLBA partnership ideas from community.
- VLBA became the Long Baseline Observatory (LBO) in FY 2017.
- Separation facilitates individual collaboration arrangements for these observatories, independent of complexities of larger NRAO.
- Partial collaborations were in place for both GBO and LBO

Long Baseline Observatory (LBO)

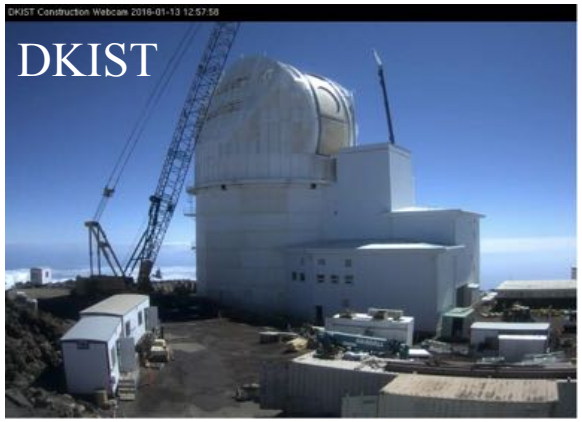
- On October 1, 2017, the stand-alone Long Baseline Observatory was initiated, with its operational instrument being the VLBA.
- VLBA consists of ten 2-acre sites — owned by federal government, universities or other state/regional entities.
- U.S. Naval Observatory (USNO) has been important user of VLBA for several years and contributes to its operations.
- USNO uses VLBA for daily measurements of Earth Orientation Parameters (EOP) and regular maintenance of overall Celestial Reference Frame.
  - Achieved by observing networks of natural radio sources (quasars) having positions known to sub-milliarcsecond accuracy (approximately the size of a ruler at the Moon).
- Beginning in FY 2017 USNO is a major funding partner with NSF through an Interagency Agreement. Formal environmental review has been postponed.

Green Bank Observatory (GBO)

- GBO is located on 2,200 acres of NSF-owned land in West Virginia.
- Breakthrough Prize Foundation established an agreement with managing organization for NRAO (Associated Universities, Inc.), supplying $2 million in FY 2016 for SETI.
- Other smaller partnerships are in place (WVU, NSF-funded Physics Frontier Center, Max-Planck Institute, Shanghai Observatory).
- Net collaborator (non-NSF) total at present is ~25-30% of GBO costs.
- NSF and AUI have ongoing discussions with U.S. companies and federal agencies regarding use for Space Situational Awareness and other technology activities.
- NSF is currently working with DoD OSD MD5: National Security Technology Accelerator to provide a substantial funding contribution to GBO operations.
- Formal environmental review process began in October 2016.

Why Does NSF Build and Operate Telescopes?

- To advance frontiers of astronomy, NSF must invest in advanced tools for specific science goals
  - Atacama Large Millimeter/submillimeter Array (ALMA): Understand processes of planet, star and galaxy formation
  - Daniel K. Inouye Solar Telescope (DKIST): Probe fundamental length scale of the Sun, to understand energy transport and origin of space weather.
  - Large Synoptic Survey Telescope (LSST): Understand nature of dark energy, the transient astronomical universe and contents of our Solar System.
- Goals <u>can only</u> be achieved from sites with the <u>best</u> observing conditions – low water vapor content, high atmospheric transparency and a high fraction of clear days/nights
  - Such conditions are found at high altitude in the altiplano of Chile, the highest peaks in Hawaii and Antarctica.



Decadal Surveys in Astronomy

- AST relies on National Academies decadal surveys to set priorities for ground-based astronomy program
  - Such NRC studies have been carried out every 10 years since 1960 and are viewed as a successful model for building consensus in a scientific community
- Most recent survey, *New Worlds, New Horizons in Astronomy and Astrophysics* (*NWNH*), was released in 2010
  - *NWNH* assumed a 4%/year rise in AST purchasing power over decade
  - *NWNH* recommended "Senior Review" be carried out to prioritize existing vs. new activities in lower budget scenarios

AST Portfolio Review

- Portfolio Review Committee was commissioned in 2011 as broadly representative subcommittee of MPS Advisory Committee
  - Responsive to *NWNH* recommendation for review of ongoing activities in a more constrained budget outlook
  - Charged to recommend program that best addressed *NWNH* science questions within budget scenarios well below *NWNH* assumption (doubling in 10 years)
- Portfolio Review Committee reported out in August 2012
  - Recommended a balance of small, medium and large programs that would require divestment of a number of operating telescopes from AST budget
- Status of NSF responses has been reported regularly
  - Dear Colleague Letters, NSF 14-022 (Dec. 2013), NSF 15-044 (March 2015), NSF 17-
  - Regular (annual or more often) reporting to Astronomy and Astrophysics Advisory Committee, American Astronomical Society town halls, several National Research Council committees, and Congressional staff

Generic Divestment Response Process

- Pursuing collaborations with universities, institutes and federal agencies
- NSF contracted a consulting firm (CH2MHill) to undertake engineering/environmental feasibility studies that enable NSF to identify viable alternatives for facilities
- Now being followed (2016-2017) by environmental review processes that use viable alternatives informed by feasibility studies as starting points.
  - This review process and consideration of alternatives will occur as part of NSF's environmental compliance obligations under NEPA, NHPA and ESA, prior to selecting preferred alternatives.
  - "No decisions have been made" until reaching the Record of Decision at the end of the environmental review processes.

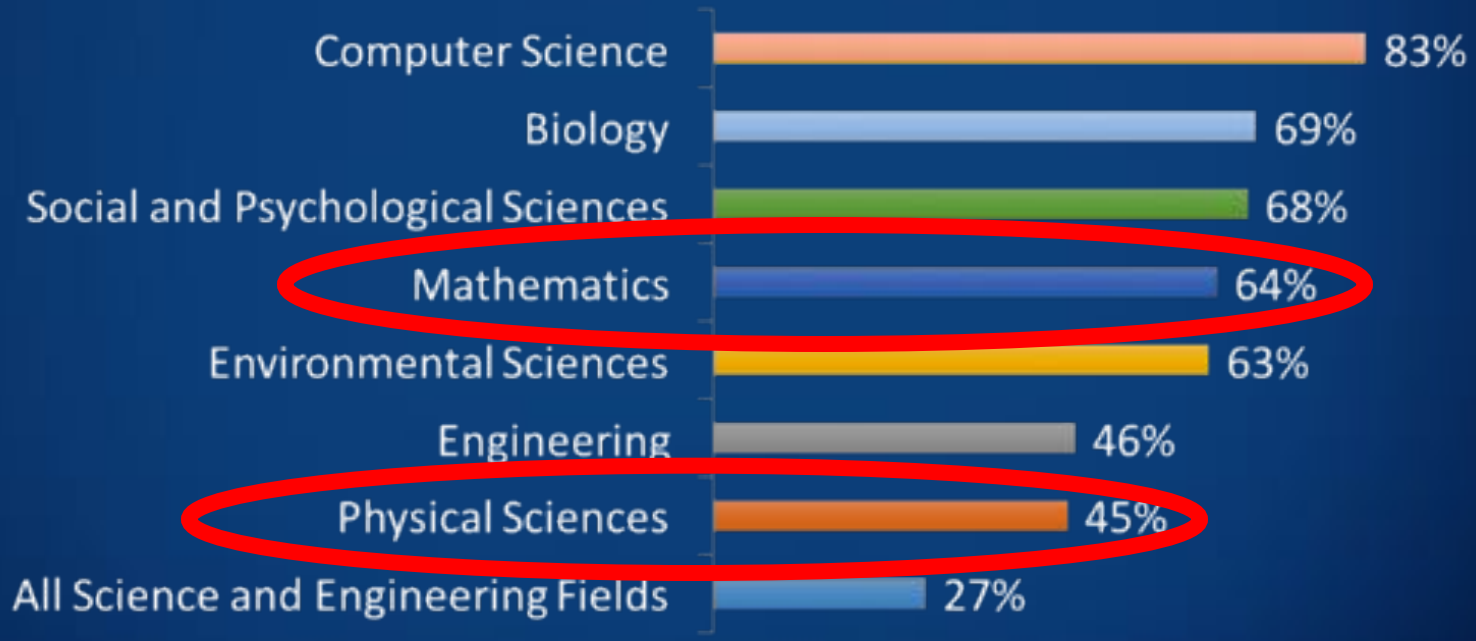
NATIONAL SCIENCE FOUNDATION

FISCAL YEAR 2018 BUDGET REQUEST

Dr. France A. Córdova
Director, National Science Foundation

NSF Support of Academic Basic Research in Selected Fields

(as a percentage of total federal support)



Note: Biology includes Biological Science and Environmental Science. Biology and Psychological Sciences exclude National Institutes of Health funding from the total amount of federal support.

Source: NSF/National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development

NSF FY 2018
Budget Request

Total: $6.65 billion

Continued Investment in NSF Research Infrastructure

Daniel K. Inouye Solar Telescope

LSST

RCRV

LIGO

CYBERINFRASTRUCTURE

ALMA

NSF's 10 Big Ideas

RESEARCH IDEAS

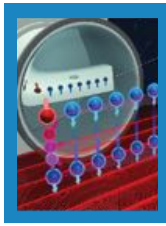
Harnessing Data for 21st Century Science and Engineering

Work at the Human-Technology Frontier: Shaping the Future

Navigating the New Arctic

Windows on the Universe: The Era of Multi-messenger Astrophysics

The Quantum Leap: Leading the Next Quantum Revolution



Understanding the Rules of Life: Predicting Phenotype

PROCESS IDEAS

Mid-scale Research Infrastructure

NSF 2026

Growing Convergence Research at NSF

NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

Principles Applied for FY 2018 Request

- Continue to fund all S&E disciplines
- Support early career
- Protect the core
- Roll back “accretions” (things scaled up since 2008)
- Cross disciplinary programs are important
- Strategic and prioritized reductions within directorates