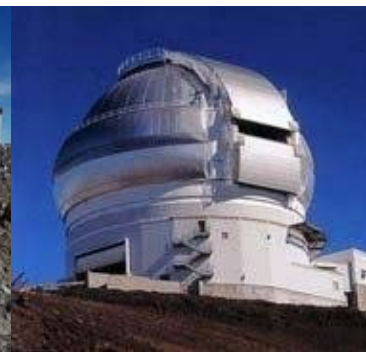


AAAC NSF/AST Update

Richard Green
Division Director,
MPS/AST

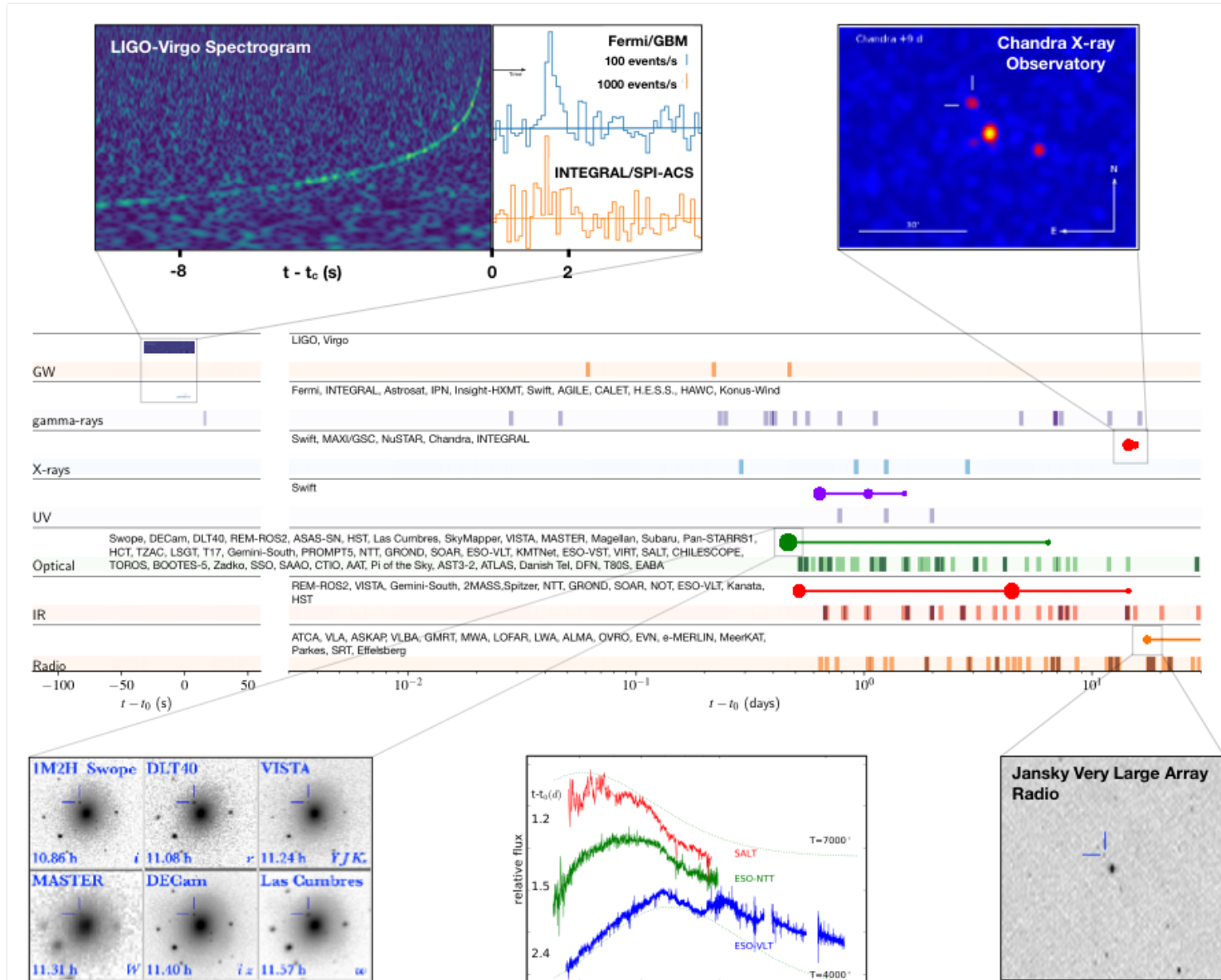


AST Mission: Enable breakthrough science



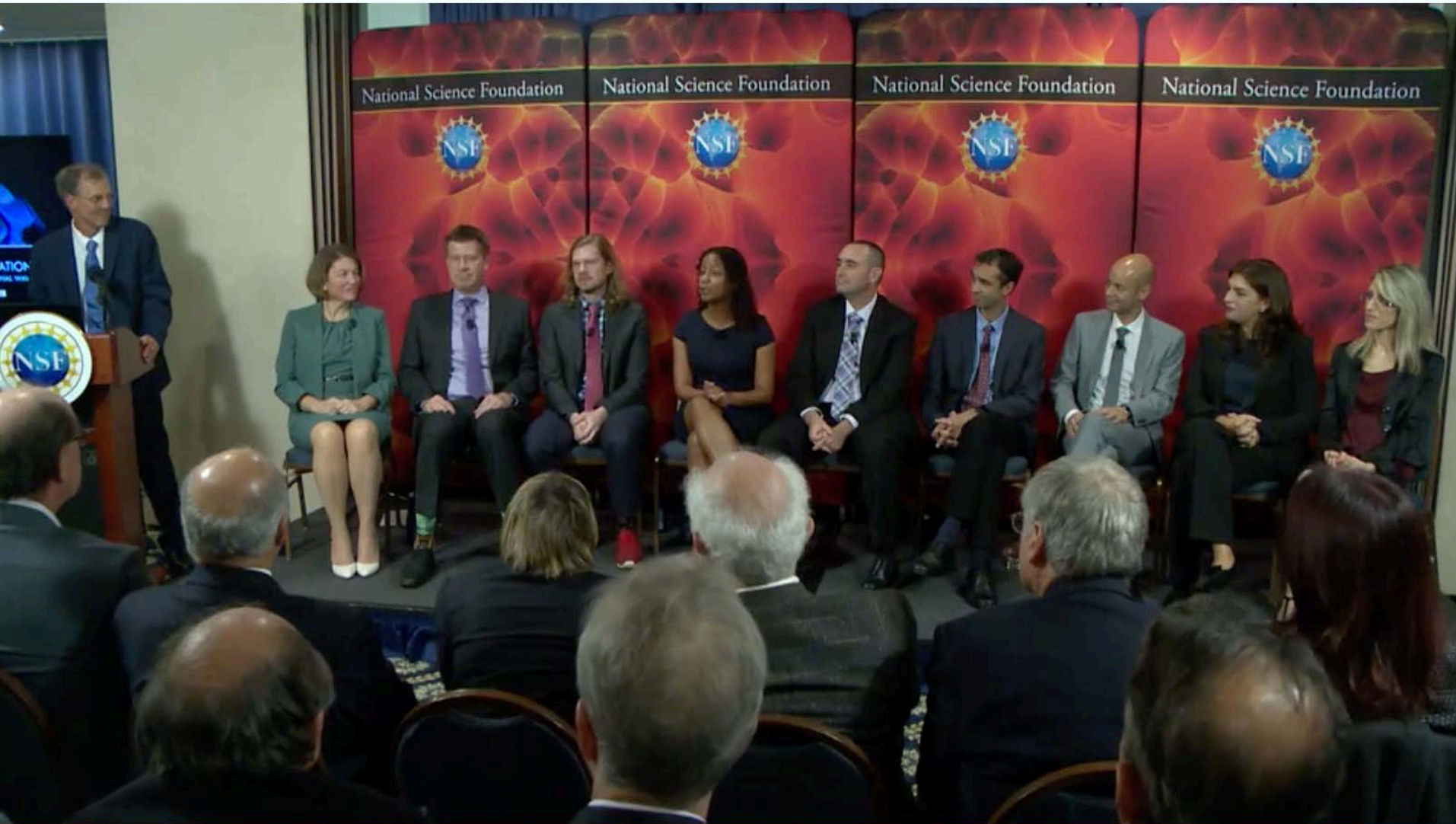


Binary Neutron Star Merger in NGC 4993





Binary Neutron Star Merger in NGC 4993



NSF's 10 "Big Ideas" for Future Investment

RESEARCH IDEAS

MATHEMATICAL
STATISTICAL
COMPUTATIONAL
FOUNDATIONS
ANALYTICS
DISCOVERY
EDUCATION
WORKFORCE
DATA SCIENCE
FUNDAMENTAL RESEARCH
MACHINE
LEARNING
RESEARCH
DATA
CYBERINFRASTRUCTURE
MODELING
DATA
MINING
CHALLENGES
DOMAIN
SCIENCE
STATISTICS
INTERVIEW
OF THINGS
HUMAN DATA
MICROSCOPY

HARNESSING THE DATA REVOLUTION

Harnessing Data for 21st Century Science and Engineering

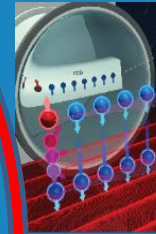
Work at the Human-Technology Frontier: Shaping the Future



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

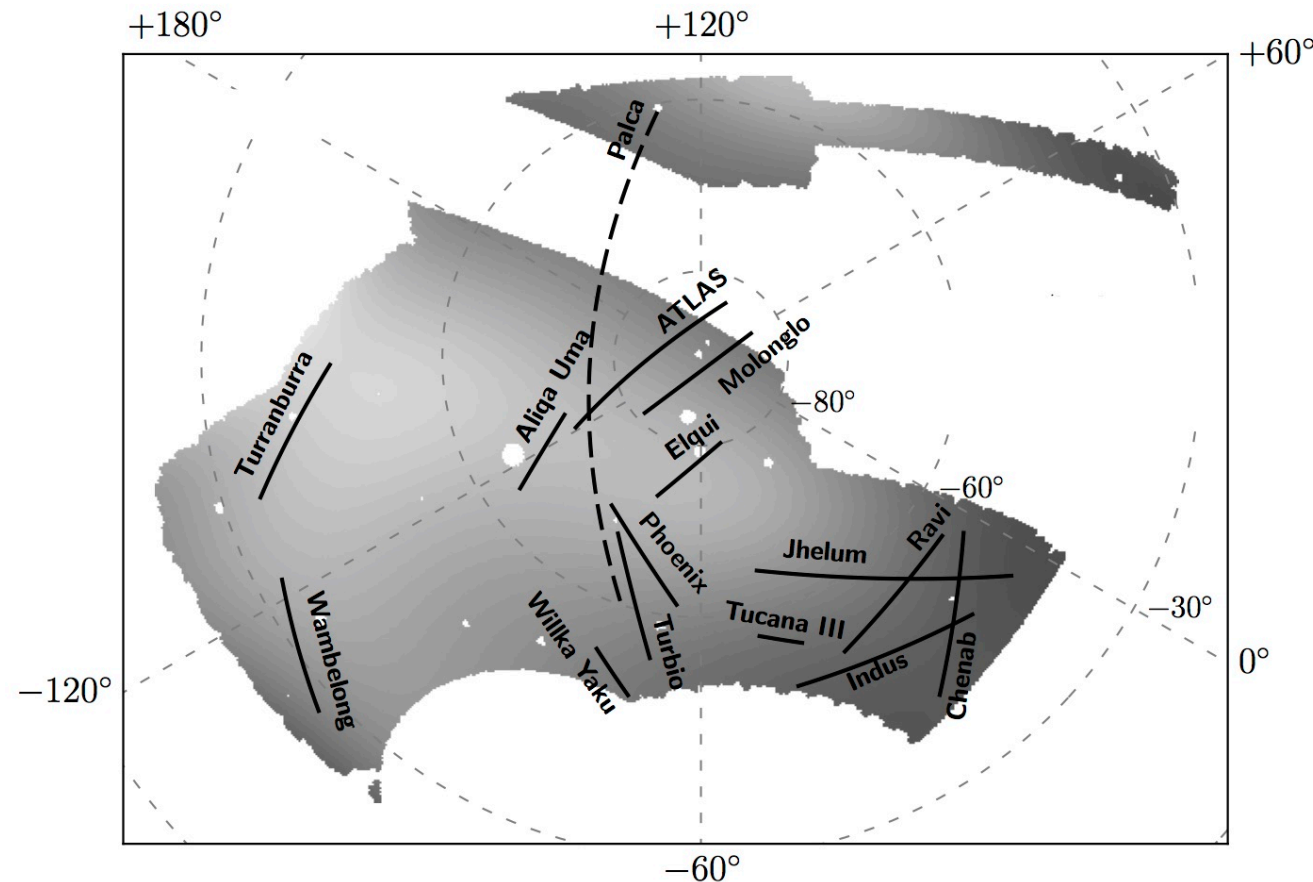


Growing Convergence Research at NSF



NSF INCLUDES: Enhancing STEM through Diversity and Inclusion

Dark Energy Survey Releases 3 Years of Data



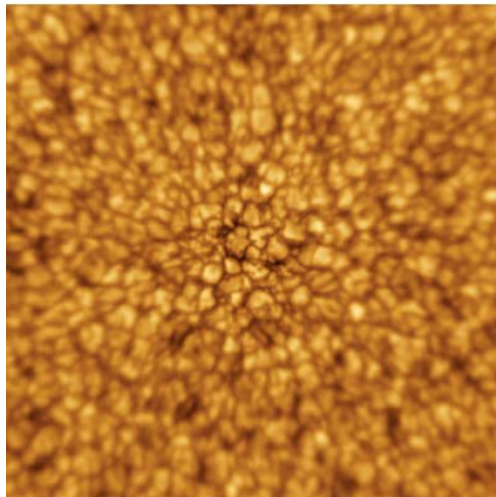
Credit: Shipp et al, arxiv
1801.03097 (2018)

The DES collaboration analyzed 3 years of imaging data from the Dark Energy Camera on the NOAO Blanco 4m telescope. In 5000 sq deg to $g \sim 23.5$ with $<1\%$ uncertainty, they discovered 11 new stellar streams out to 50 kpc, along with 4 previously known. The investigation is supported jointly by NSF and DOE.

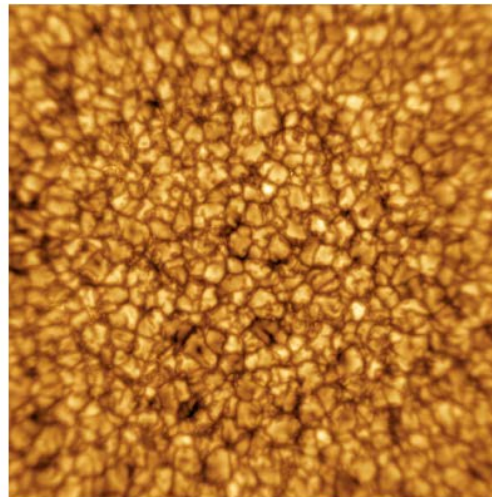


Solar Multi-Conjugate Adaptive Optics (MCAO)

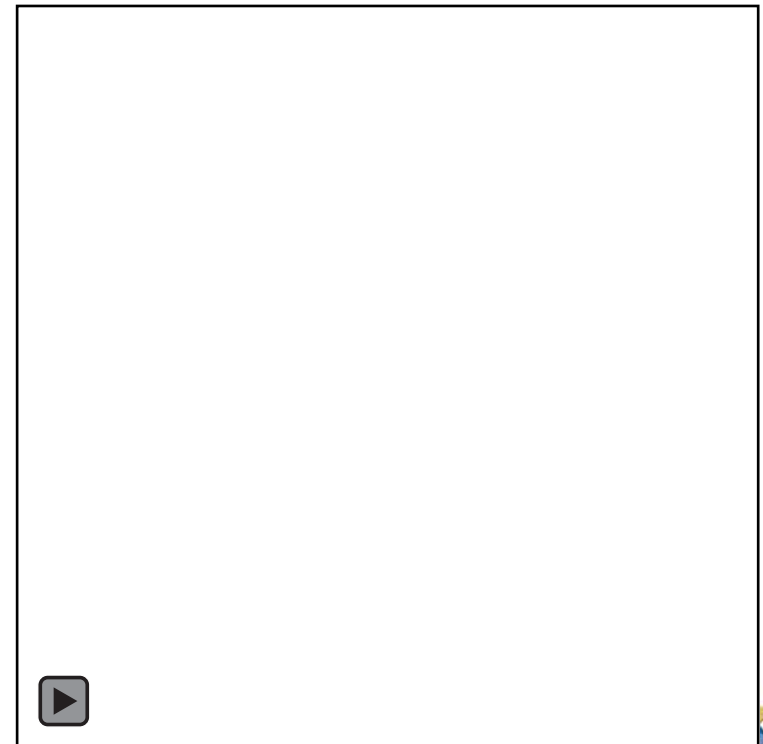
- MCAO under development at Big Bear Solar Observatory
- Uses 3 deformable mirrors to compensate for turbulence at 3 different heights in the atmosphere
- NSO personnel leading the effort
- NSF funded through AST-ATI award and just renewed
- Pathfinder for DKIST next-generation AO system



classical adaptive optics



multi-conjugate adaptive optics



AST Mission

- The National Science Foundation's Division of Astronomical Sciences has a mission of enabling excellence in US ground-based astronomy.
- The Division invests in three approaches:
 - Supporting the programs of individual investigators,
 - Providing access to world-class research facilities and datasets, and
 - Enabling the development of new instrumentation and next-generation facilities, all through competitive merit review.
- Other aspects distinguish the mission:
 - Encouraging broad understanding of the astronomical sciences by a diverse population of scientists, policy makers, educators, and the public at large
 - Supporting career development for students and early-career professionals as an explicit priority.
 - Engaging in numerous interagency and international collaborations.
- The formal mission statement is at <https://www.nsf.gov/mps/ast/about.jsp>



Inter-Agency Cooperation

- Recommendation: We recommend that DOE, NSF, and NASA continue their successful cooperation in Astronomy and Astrophysics.
- Response: NSF will continue cooperation and collaboration with NASA and DOE to exploit synergies and shared scientific priorities in Astronomy and Astrophysics.
- Current examples for NASA include co-sponsorship of the Decadal Survey, joint NSF-NASA FACA review panels (e.g. your committee), cooperation on space weather and solar research, joint ground-space observations of astrophysical objects (e.g., neutron star mergers), collaboration on the exoplanet research program (WIYN 3.5m telescope), cooperation on Near Earth Object detection and characterization (Arecibo, Green Bank, and future LSST Observatories), and semi-annual joint NSF-NASA staff meetings.
- Current examples for DOE include the Dark Energy Camera, Dark Energy Survey Instrument (DESI), LSST, and the CMB Task Force.



AST Implementation

- High-demand Individual Investigator programs.
- Suite of forefront ground-based Optical/IR (OIR), Radio-Millimeter-Submillimeter (RMS), and Solar observing facilities plus data holdings supported by AST for merit-based access.
- Construction through the MREFC line of two major new facilities, DKIST and LSST.
- Reorganization of management of NSF OIR facilities to optimize time-domain science.
- Divestment of facilities given lower priority by external review process to accommodate operations of new facilities and maintain programmatic balance.
- Sponsoring National Academies decadal survey to set future priorities for scientific direction and facilities development.



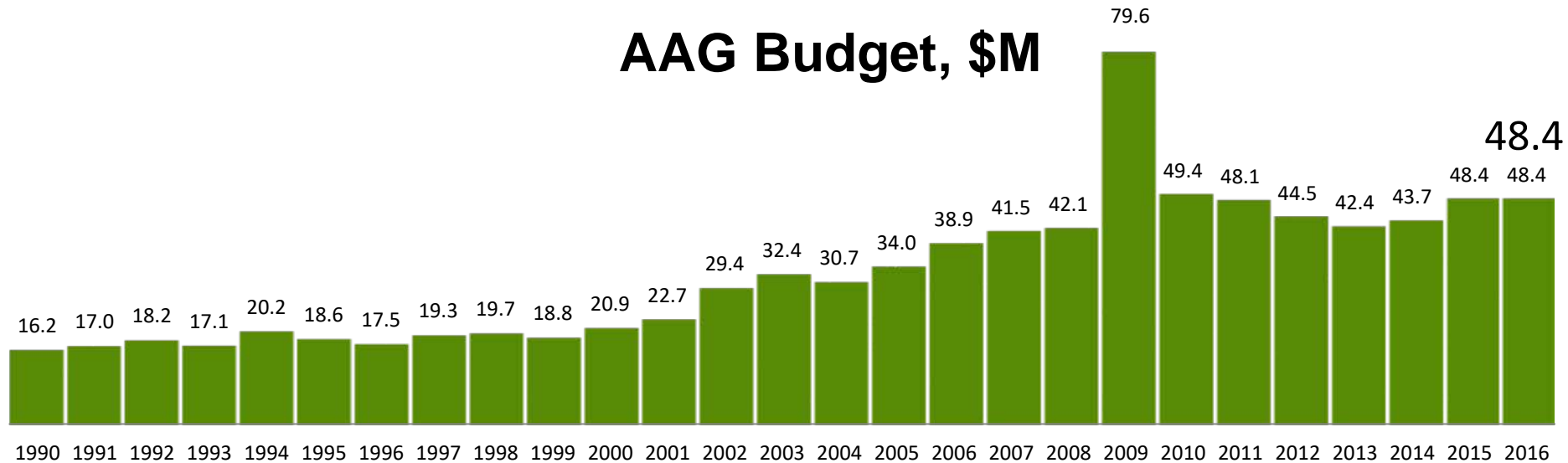
Individual Investigator Programs—1000 proposals/yr

- Astronomy and Astrophysics Research Grants—700 prop.
 - Solar and Planetary (now with no deadline)
 - Stellar Astronomy
 - Galactic Astronomy
 - Extragalactic Astronomy and Cosmology
- Mid-Scale Innovations Program—40 pre-proposals
- Advanced Technologies and Instrumentation—60 prop.
- CAREER—60 prop.
- Astron. and Astrophys. Postdoc. Fellowships—100 prop.
- REU—20 prop.
- Partnerships in Astronomy and Astrophysics Research and Education—5-10 prop.

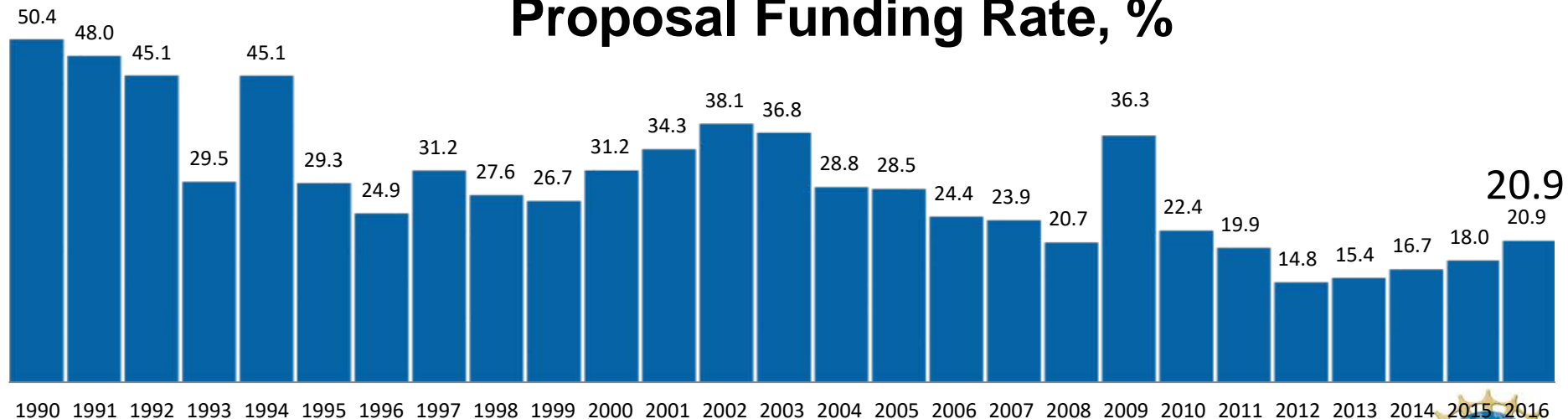


AAG Funding History, 1990-2016

AAG Budget, \$M



Proposal Funding Rate, %



Current Forefront Facilities

- OIR
 - Gemini North and South 8-m telescopes
 - National Optical Astronomy Observatory
 - CTIO - Blanco and SOAR 4m class telescopes in Chile
 - KPNO - Kitt Peak operations in Arizona
 - Community Science and Data Center
- RMS
 - National Radio Astronomy Observatory
 - ALMA – Atacama Large Millimeter Array - Chile
 - JVLA – Jansky Very Large Array – New Mexico
 - CDL – Central Development Lab – Virginia
- Solar
 - National Solar Observatory
 - Legacy telescopes in NM and AZ transitioning
 - Lab and Data Center in Colorado



DKIST Current Construction Site



Operations in 2019

LSST Current Construction Site

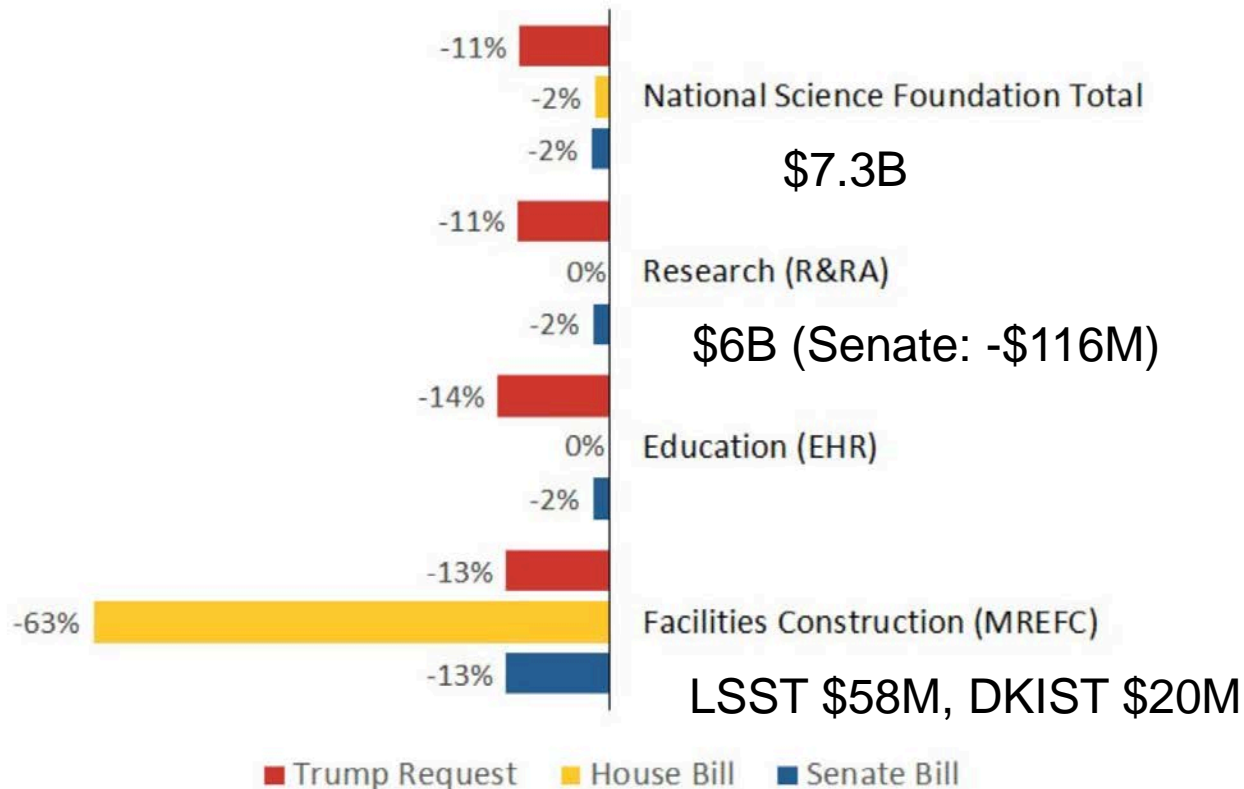


Operations in 2022

FY 2018 Budget Proposals

NSF FY18 Budget Proposals

(% change from FY17 enacted)



American Institute of Physics | aip.org/fyi



FY 2018 Budget

- Currently under a continuing resolution through Feb. 8, 2018
- Potential risks to AST budget and operations after Feb. 8...
 - Range of R&RA from President's FY 2018 request of -11% to House appropriation of flat funding
 - Under House or Senate bills sequestration is likely to be triggered
 - Budget Control Act of 2011 set spending caps for 10 years
 - Debt ceiling likely to come up again in March
 - Possibilities of another government shutdown, more continuing resolutions.

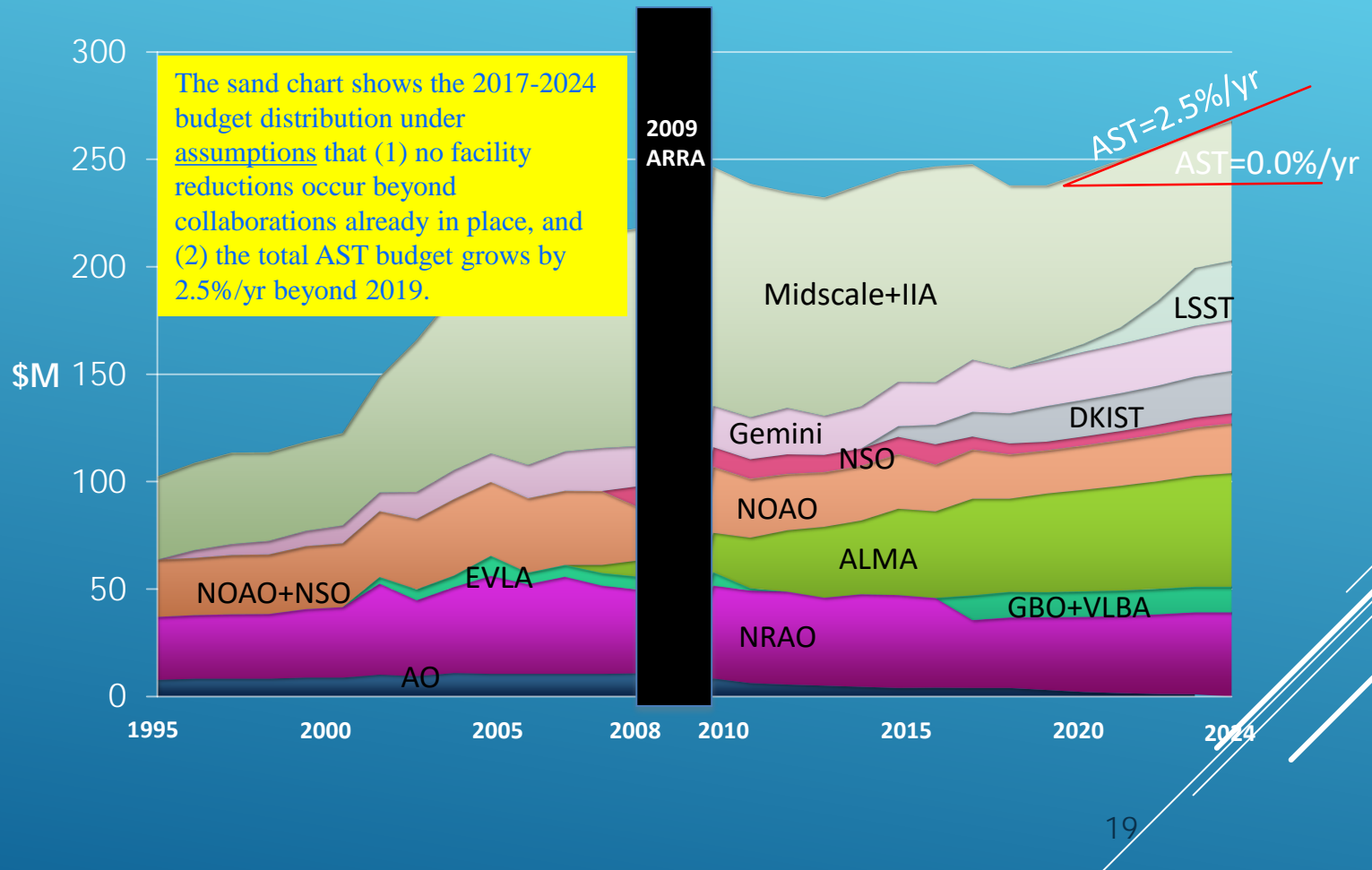


AST Budget Considerations

- NSF practice is that operations costs of MREFC-funded major new facilities are borne by the Division that is the host discipline.
- AST is absorbing DKIST operations into current budget planning.
- LSST operations are the next wedge. In the event of continued flat funding (or less) and no change in policy, a major realignment of facility support will be required to preserve a balance with the grants program.
- In the short term, the reduction in the FY18 President's budget was allocated to Individual Investigator and instrumentation grants, with some restoration possible at Congressional appropriations levels. (With no restoration, success rate predicted to be ~18%.)



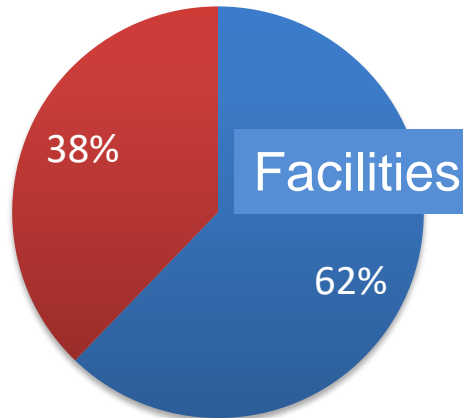
HYPOTHETICAL BUDGET RUNOUT FOR AST



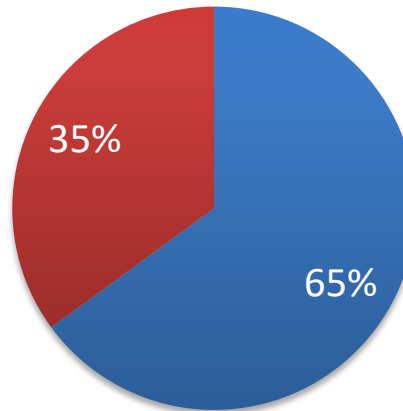


Historical Funding Breakdown

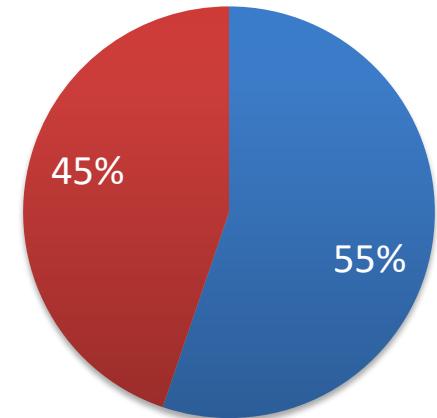
1995



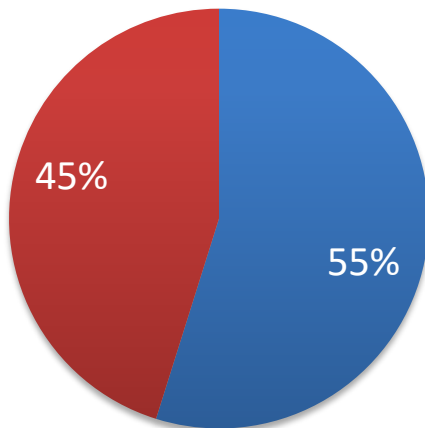
2000



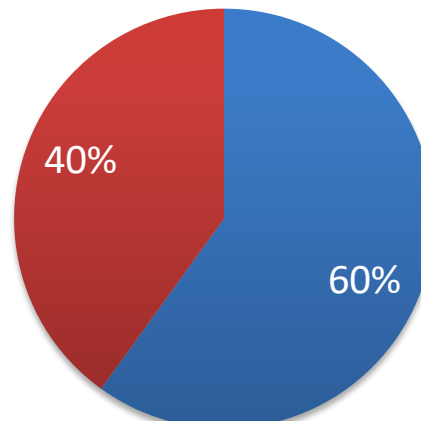
2005



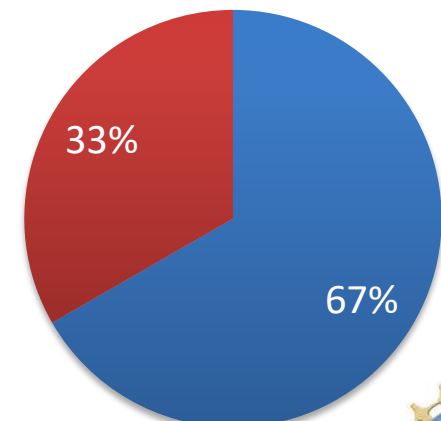
2010



2015



2020?



Assumes flat budget, currently planned facility evolution.



Background: AST Divestment

- AST Portfolio Review Report (MPSAC subcommittee) recommended divesting a number of telescopes from AST budget.
- Divestment needed to enable support of new highest priority facilities, while balancing support for individual investigator science.
- The process shows AST's seriousness in changing the complement of cutting edge national facilities and is scoped to save \$10-15M/yr for new operations.
- 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.
 - Embarked on preparation of formal Environmental Impact Statements (EIS) as part of the decision process for three facilities: Arecibo, Green Bank, Sacramento Peak.
- Status officially updated by NSF Dear Colleague Letter 17-079, April 27, 2017.





Divestment 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 under development.
GBO	Separation from NRAO in FY 2017; ~30% collaboration for basic scope; Draft Environmental Impact Statement (EIS) issued on Nov. 8, 2017.
LBO/VLBA	Separation from NRAO in FY 2017; MOA with US Navy in place for 50%.
McMath-Pierce	No obvious partner opportunities; possible public education use.
GONG/SOLIS	GONG refurbishment; Interagency Agreement with NOAA signed to share GONG operations costs. SOLIS moved from Kitt Peak to Big Bear.
Sacramento Pk.	Possible consortium but funding challenges; NSF funded NMSU for transition to consortium; started EIS process; completion in 2018.
Arecibo	EIS process concluded with issuance of Record of Decision in Nov 2017 . Negotiations nearly complete for new collaborator, reduced NSF share.
SOAR	Post-2020 status to be reviewed.



Arecibo Status

- NSF was near the conclusion of the Environmental Impact Statement process at the time Hurricane Maria hit Puerto Rico
- The facility sustained significant damage, but less than anticipated, considering that it was directly in the path of the hurricane.
- Estimates have been made for repair and restoration; the origin and schedule for funding depends on emergency relief funding.
- The Observatory has resumed regular scientific operation; impacts are low sensitivity at higher frequencies and limited radar capability for both atmospheric and planetary work.
- The Record of Decision was signed on November 15, 2017, with the preferred alternative being continuing operation with reduced NSF participation.
- Negotiations are now nearly complete with the preferred proposal team for transition to a new Cooperative Agreement on April 1.



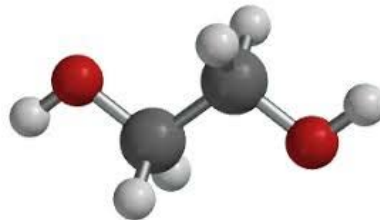
GBT Continues to do Great Science



Insights into nature of repeating FRB; Michilli et al (2018)
Nature 553, 181

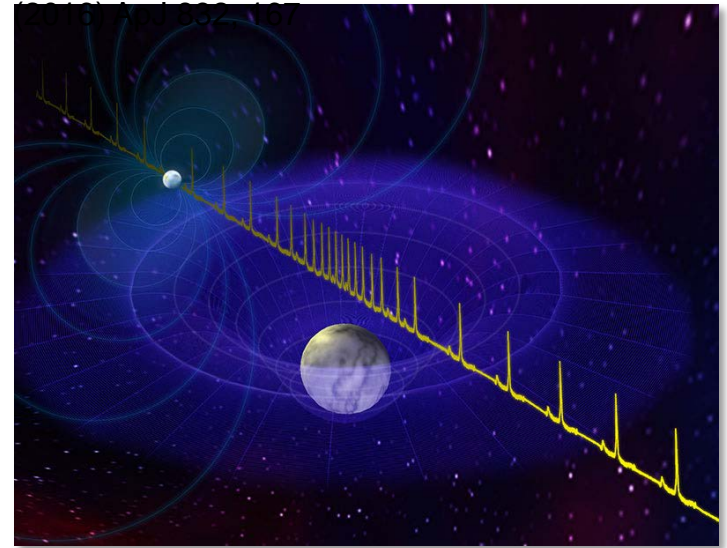


Wide-field mapping and ALMA follow-up;
e.g. Friesen et al (2017) ApJ, 843, 63



Organic molecules and precursors to life e.g. Rivilla
(2018) A&A, 598, 59

GR tests; a key part of the 'other' national
Gravitational Wave observatory; e.g. Fonseca et al
(2018) MNRAS, 477, 187

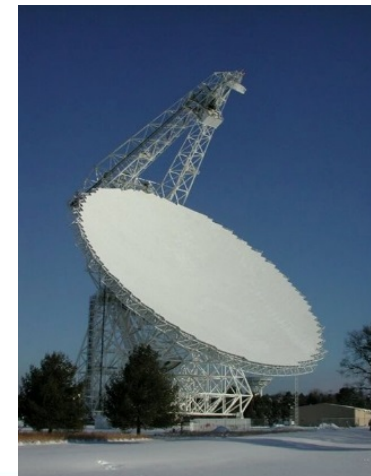


....continued NSF
funding is merited,
albeit at a reduced
level



Green Bank divestment status

- Draft EIS released Nov. 10th, followed by 45-day public comment period.
- Public meetings for comment on Draft EIS held Nov 30th.
- Jan 2018: Draft EIS public comment period ended
- Fall 2018: Final EIS anticipated; extension of current CA.
- Feb 2019: NSB Action Item on Record of Decision (ROD)
 - ROD issued
- Additional external funding needed.
- In FY 2017, Green Bank received 30% of \$12.4M base budget from non-NSF sources: Breakthrough Prize Foundation, University of West Virginia, and others.
- NSF/AST currently working to secure additional funding commitments.



Sacramento Peak divestment status

- EIS scoping meetings held July 21, 2016.
- Draft EIS expected to be released the 1st week of February, public meetings on Draft EIS later in February.
- National Solar Observatory will manage the Sacramento Peak facilities as long as there is operation of the Dunn Solar Telescope .
- New Mexico State University (NMSU) proposed to transition to DST operations by a NMSU-led consortium.
- NMSU proposal funded by NSF (\$1.2M) from Sept 2016 for 24 months.
- EIS process expected to conclude in second half of 2018.



Related Divestment Status

- Long Baseline Observatory has operated the VLBA since October 1, 2016, through a CA with AUI.
- US Naval Observatory provides funding to LBO for accurate determination of Earth Orientation Parameters.
- Fortunate that damage to St. Croix station from Hurricane Maria was relatively minor; critical to USNO continuing partnership.
- The Mayall 4m telescope on Kitt Peak will have its last public access night with its traditional instrument suite on Jan 31st. It will then undergo an upgrade in support of DOE-funded operations of the Dark Energy Spectroscopic Instrument (DESI), starting in 2019.



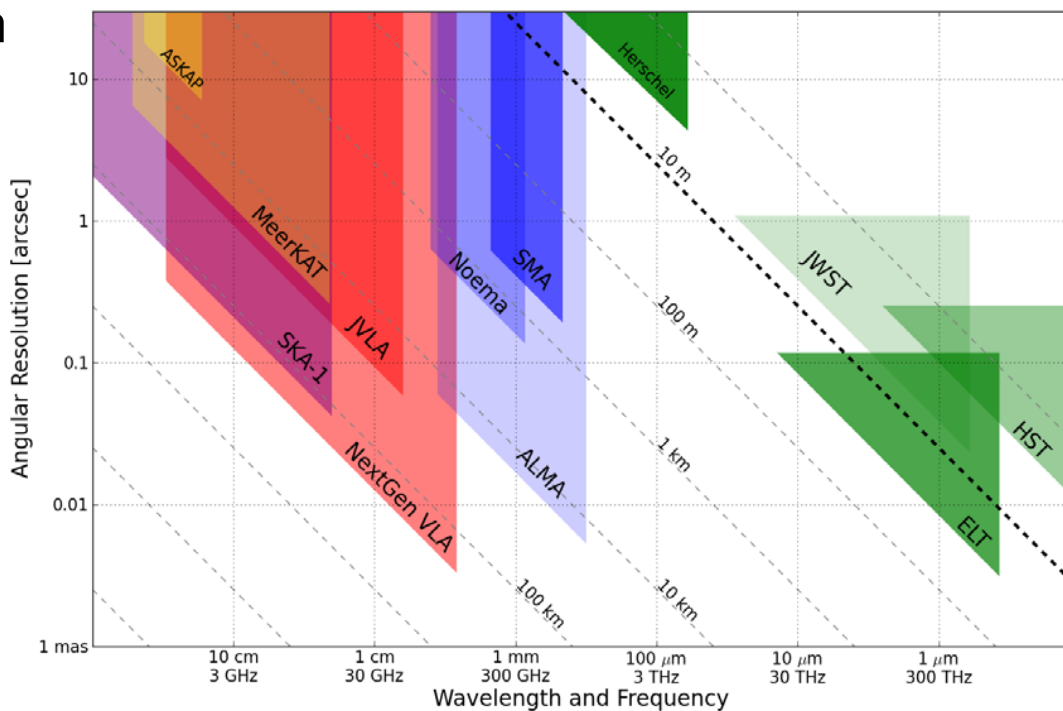
Decadal Survey

- Planning is now well underway for input to the next Decadal Survey.
- NSF/AST and NASA Astrophysics Division are the primary sponsors of the survey. DOE Cosmic Frontier in the Office of Science is also a sponsor.
- We provide a charge to the National Academies, then the entire process is organized by them.
- They submit a proposal for NSF's share, anticipated to be received this spring.
- That proposal will be reviewed jointly on behalf of NSF/AST and NASA Astrophysics Division.



AST Decadal Survey Preparations

- NRAO held a series of three Kavli-sponsored workshops to identify and prioritize the key scientific problems the RMS community would address in the coming decade.
- Many of the scientific goals can be achieved with a concept called Next Generation VLA, including
 - Unveiling the Formation of Solar System Analogues
 - Probing the Initial Conditions for Planetary Systems and Life with Astrochemistry
- Funded technical concept studies are underway within NRAO



AST Decadal Survey Preparations

- NOAO is collecting OIR community white papers
- Discussion and planning at public meeting Feb 20-21, 2018.
- Topics addressed to date include
 - Community participation in GSMT science
 - Dedicated wide-field spectroscopic survey telescope
 - Enhanced time-domain telescope network (GW follow-up)
 - Data science development for LSST and other large datasets





Cosmic Microwave Background (CMB)



- CMB Stage 4 goals: testing inflation, determining the number and masses of the neutrinos, constraining possible new light relic particles, providing precise constraints on the nature of dark energy, and testing general relativity on large scales.
- Two sites: South Pole and Atacama
- Fourteen small (0.5m) telescopes and three large (6m) telescopes, with 512K total detectors
- Report released to AAAC by its subcommittee on 10/23.



Decadal Survey

- We are now approaching the end of the current decade, with LSST development as a notable success.
- Other large projects in the 2010 queue will need to compete for a new prioritization in the 2020 survey.
- Reasonable expectation from recent past experience is that only the top-ranked large project will have a chance to be supported in the coming decade.



Budget Planning

- The necessity for divestment has been driven by our community's success in winning support for development of new facilities, which require operational support.
- AST planning must consider multiple levels:
 - As an executive agency, we must submit a budget based on OMB guidance. In the previous administration, that was an increase, now a decrease from previous levels.
 - Congressional appropriation for the last several years has been essentially flat in real dollars, so we consider that possibility in proposing changes that might not be required.
 - We retain the optimism that increased support can eventually be found for new facilities and their operations.
- NSF/AST remains optimistic that we can leverage a vital, competitive research program for our dynamic community.

