AAAC

Debra Fischer

NSF MPS/AST DD

Facility news

Grants updates

AST Budget Update

Astro2020

- Recommendations for Major Facilities
- Recommendations for State of the Profession

Facility News

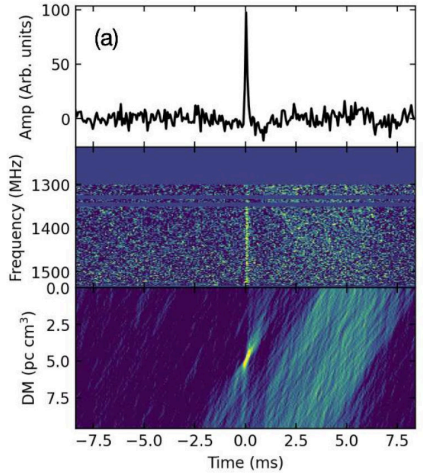
Arecibo Observatory: Current Status

Emergency cleanup is complete!

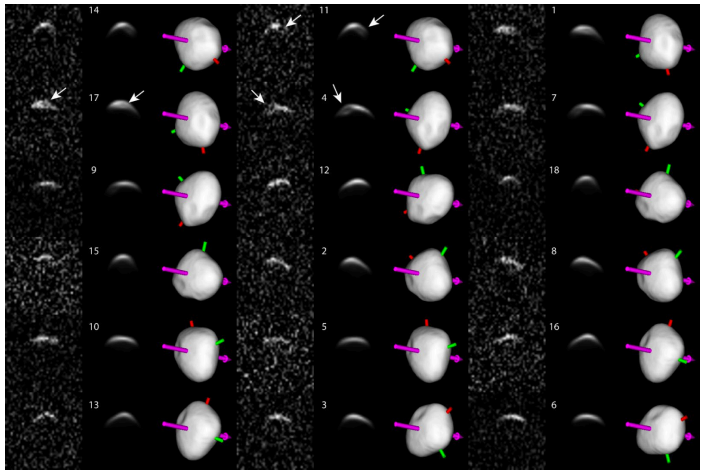
The emergency cleanup team safely removed approximately 14,000 damaged panels, or ~35% of the reflector area. Once the fallen platform (left, Dec 2020) was removed, the team repaired 225 feet of concrete rim wall and installed erosion control measures, including the use of coconut fiber matting and seeding, to secure the slope and encourage native vegetation growth (right, Dec 2021). All debris has been removed, and remaining structures stabilized.

Arecibo Observatory: Current Status

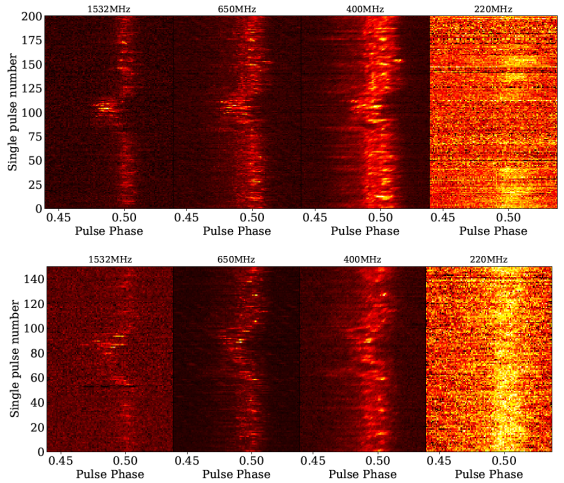
The Arecibo Observatory (not the 305-m dish) is still functioning! The 12-m antenna was repaired and is functional (uncooled receiver) and working on the cooled receiver. Educational programs continue (some held virtually due to COVID-19), and scientists continue to analyze and publish existing data. Instrumentation that was not associated with the 305-m telescope, such as the Lidar and other optical observing tools, is being maintained or improved.



Search for fast radio transients (Perera et al, 2022)



Delay-Doppler imaging of asteroid 16 Psyche (Shepard et al, 2021)



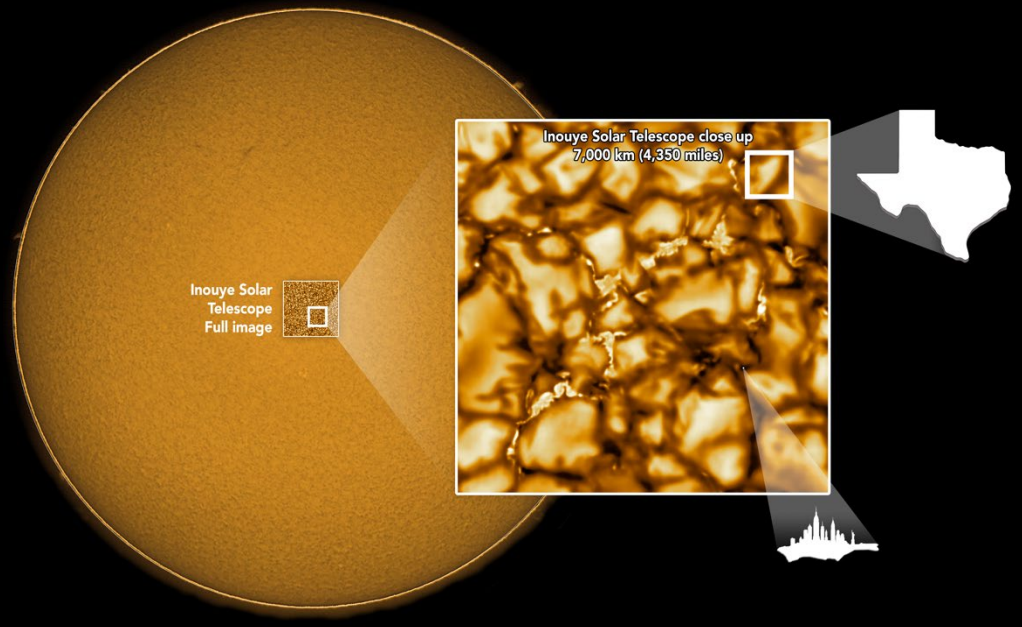
Multifrequency observations of PSR B0919+06 (Rajwade et al, 2021)

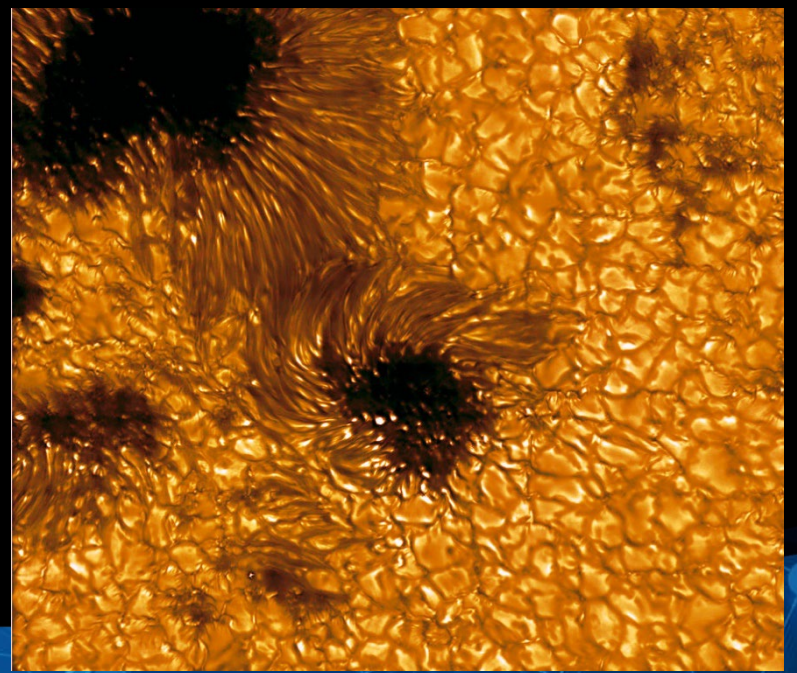
NSF is considering a broad range of options for the future of Arecibo Observatory. No decisions have been made at this time.

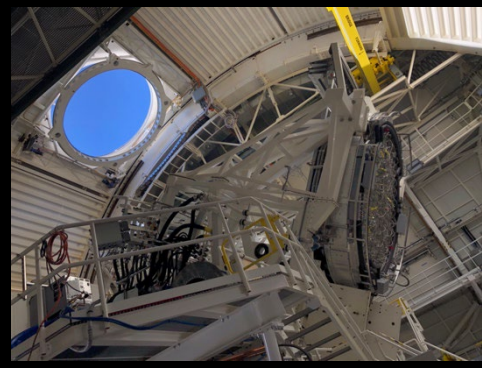
Daniel K. Inouye Solar Telescope

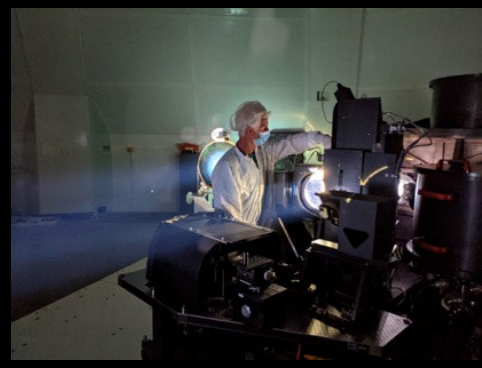
The largest, most powerful solar observatory on planet Earth

Now in operation!









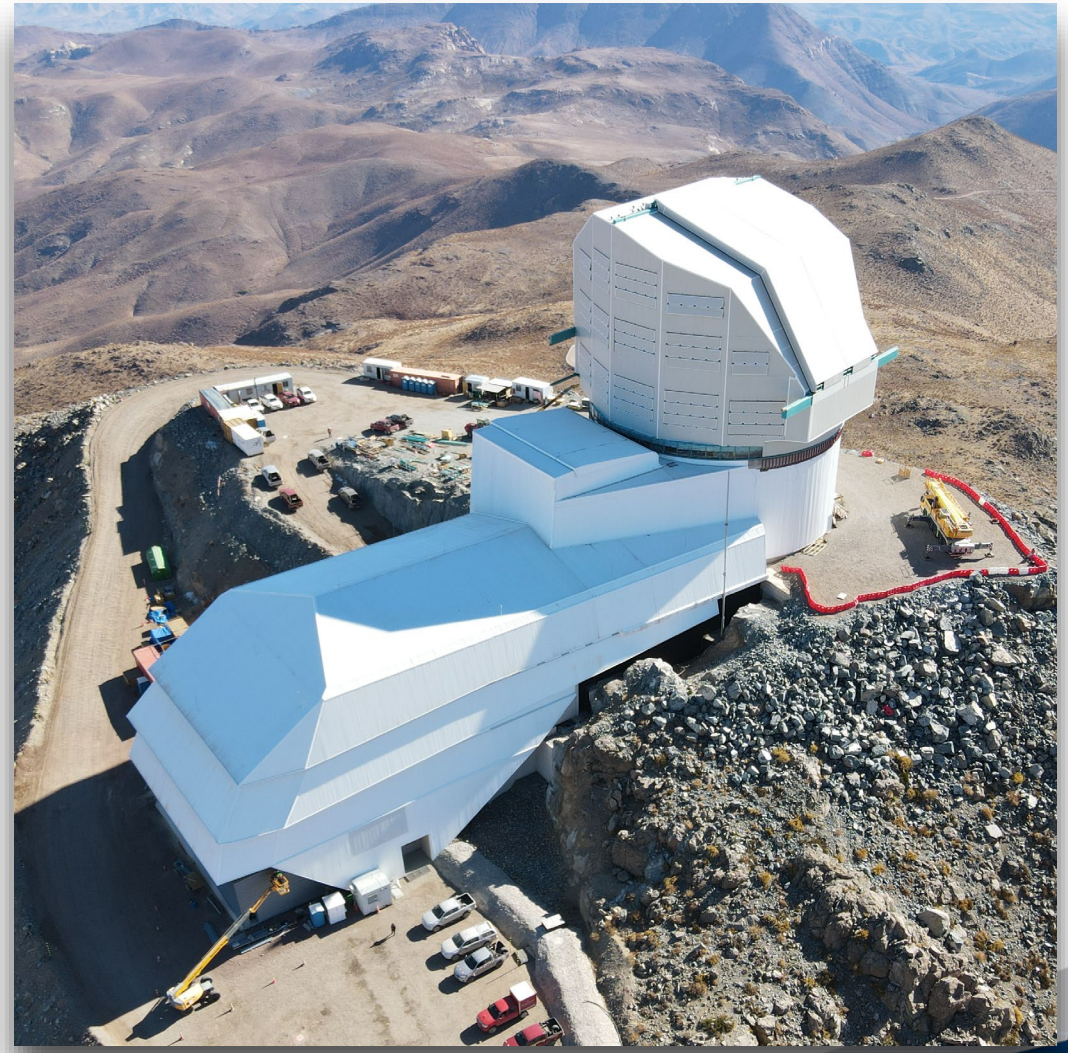
DKIST: Enabling a New Era of Multi-Messenger Astrophysics

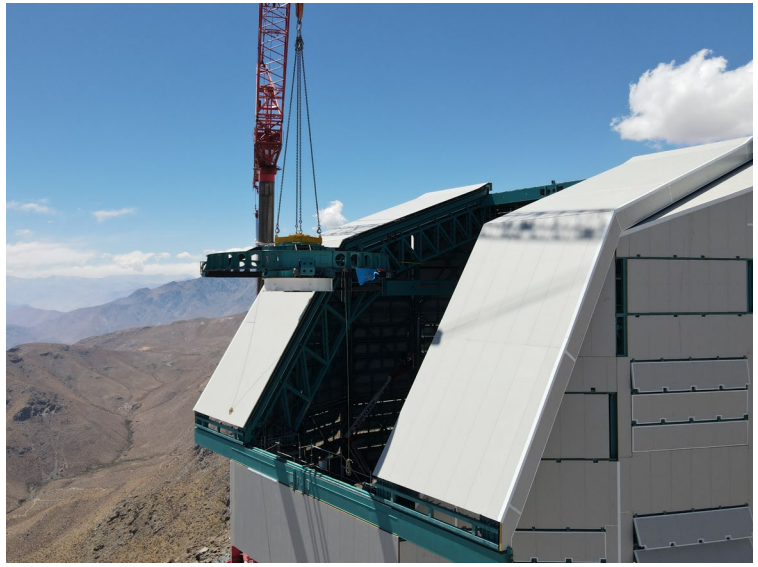
- The Sun is our nearest laboratory for stellar astrophysics
- In-situ measurements of particles and fields with Parker Solar Probe and Solar Orbiter
- High-resolution electromagnetic imaging and spectroscopy with DKIST

National Science Foundation | U.S. DEPARTMENT OF ENERGY OFFICE OF SCIENCE

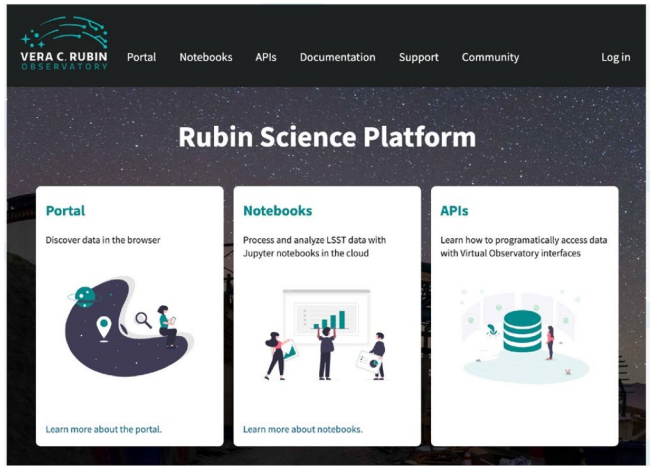
Vera C. Rubin Observatory

- NSB authorized additional funding to cover known COVID delays to construction (December 2021).
- Construction completion expected July 2024.
- NSF and DOE closely coordinate COVID schedule impacts.
- Good progress on construction through 2021!





Telescope mount top end lifted into dome (Mar. 2021)

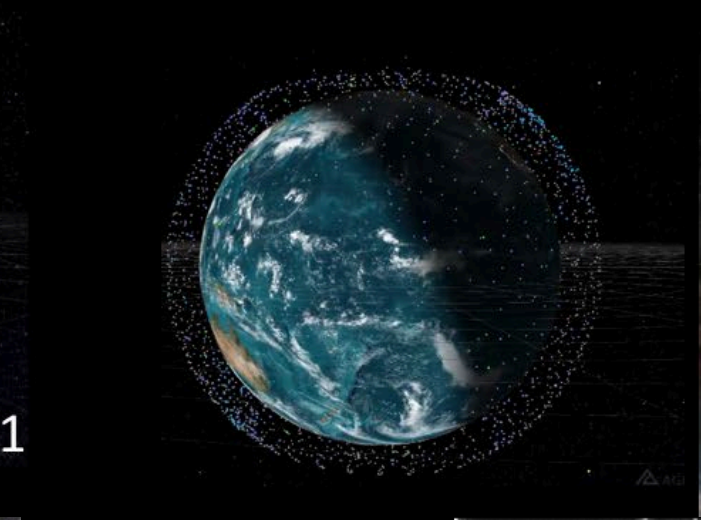


Data Preview Zero launched (June 2021)

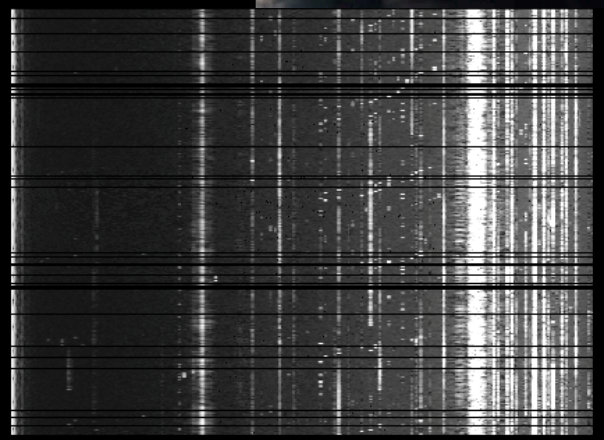
All filters arrived at SLAC (Sep. 2021)

Camera surrogate mass removed and reinserted into the telescope mount assembly (Nov. 2021)

Key issue: Constellations of satellites in low Earth orbit – proposed population exceeding 50,000 in coming decade



optical interference



radio interference

Siting telescopes in remote locations is no longer sufficient for protection.

Images: Screen shots from animations based on applications filed with the ITU and the U.S. FCC. Credit: SSC.

Recent NSF activities related to new satellite constellations

Optical and Infrared

- 2 NSF-funded workshops: NOIRLab + AAS
  - SATCON1 – July 2020
  - SATCON2 – July 2021
- NSF's Rubin Observatory working closely with satellite operators; NSF's NOIRLab active in Dark and Quiet Skies
- NSF/Satellite Industry Association joint technical presentation for the USA to UN Committee on the Peaceful Uses of Outer Space (COPUOS), NSF contributing to upcoming COPUOS STSC preparations

Radio Frequency

- Spectrum coordination agreements
  - SpaceX (signed 2019)
    - Being updated (new & modified FCC license)
  - Other US-licensed operators to come
- R&D on satellite interference mitigation/coexistence
  - Spectrum Innovation Initiative
  - SWIFT program

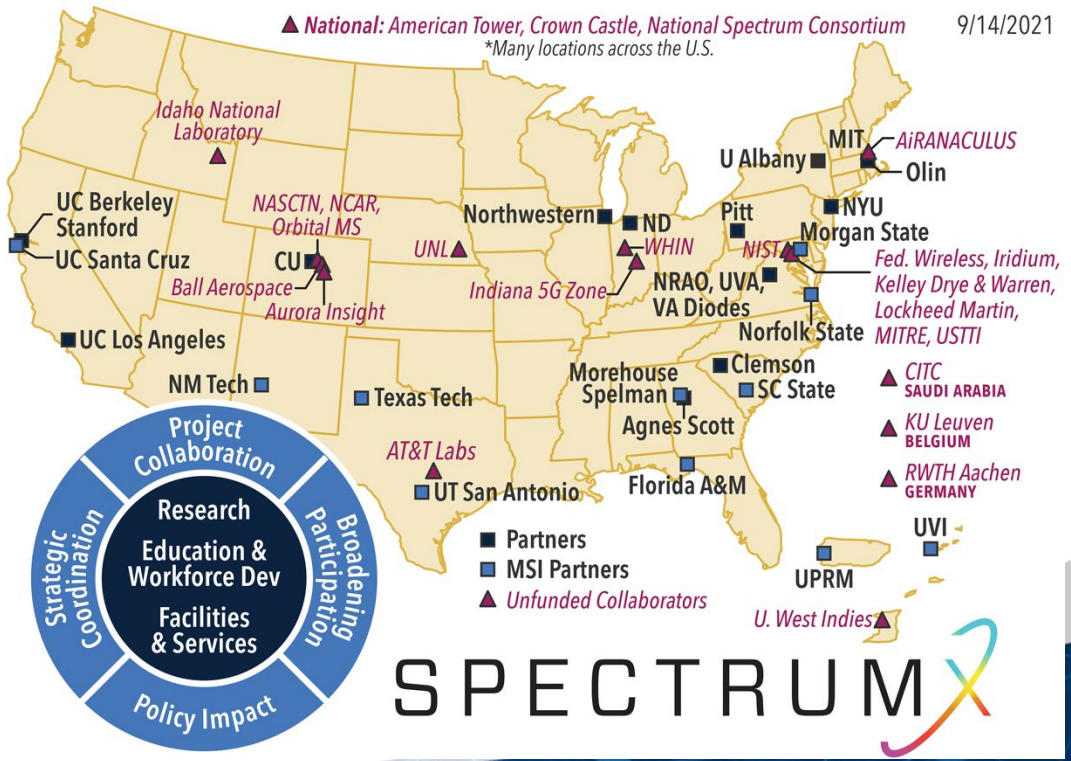
- NSF-supported JASON study (July 2021)
  - Optical impacts on NSF/Rubin Observatory
  - Mitigation opportunities
  - Good practices for satellite vendors
- Analytic study of radio interference, including
  - Single-dish telescopes
  - Interferometers
  - Cosmic Microwave Background-Stage 4

SATCON1: https://aas.org/satellite-constellations-1-workshop-report SATCON2: https://aas.org/satellite-constellations-2-workshop
NSF/SIA briefing to UN COPUOS: https://www.unoosa.org/oosa/en/ourwork/copuos/technical-presentations.html
JASON study: https://www.nsf.gov/news/special_reports/jasonreportconstellations/

SpectrumX: An NSF Spectrum Innovation Center (September 2021)

- The first national center focused on the transformation of radio spectrum management
  - Research, Collaboration and Workforce
- Maximize the benefits of the radio spectrum for society – Center has a strong focus on passive services, including radio astronomy and NRAO

- A partnership on multiple levels
  - Created by NSF under MOA with NTIA, FCC
  - Participants: 29 institutions (12 minority serving)
    - led by University of Notre Dame
    - grow into a hub for all stakeholders
  - Expertise: convergence across field boundaries
    - communications, passive science, sensing, radio technology, policy/economics, data science, control systems
- Federal investment $25m over 5 years



SpectrumX site: https://www.spectrumx.org

Key Issue:

Reduce carbon emissions associated with our research - directly affecting observatories (smoke, fires, degraded seeing)

- Energy budgets of facilities (communicating with directors)
- Travel (meetings, observing)
- Share the astronomical perspective with students and the public

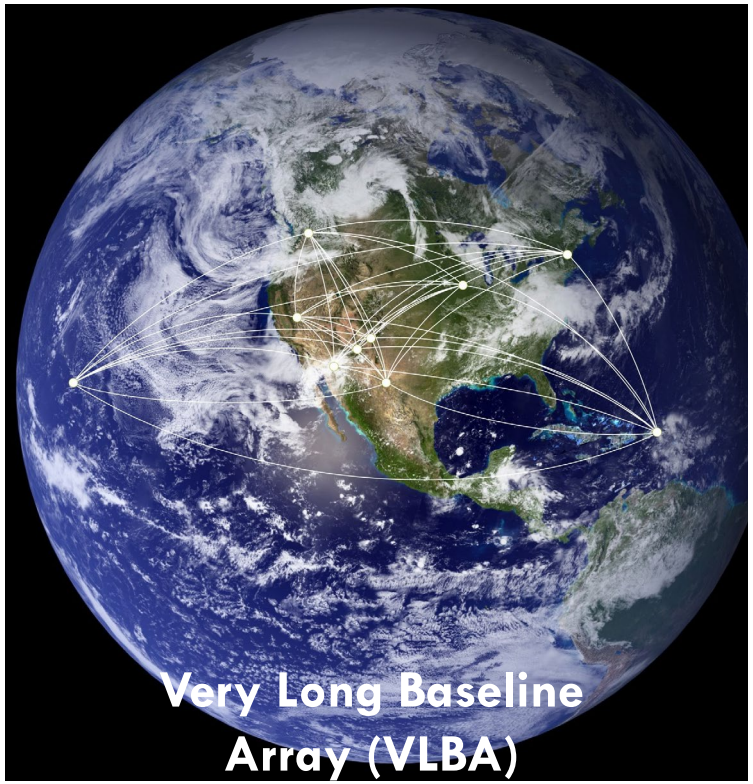
Facility Management

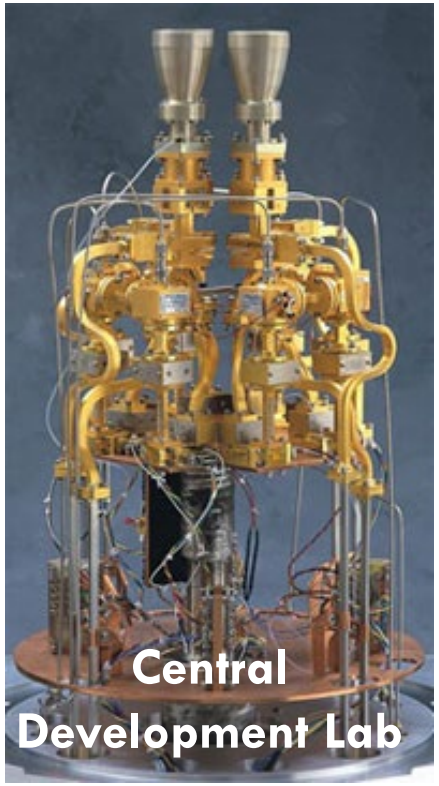
1950 Congressional Act: support basic science across the nation, do not operate laboratories

The National Radio Astronomy Observatory (NRAO)

- ALMA, VLA ,and VLBA fully operational
- VLA Sky Survey (VLASS) continues
- ngVLA prototype antenna production in process


Karl G. Jansky Very Large Array (VLA)

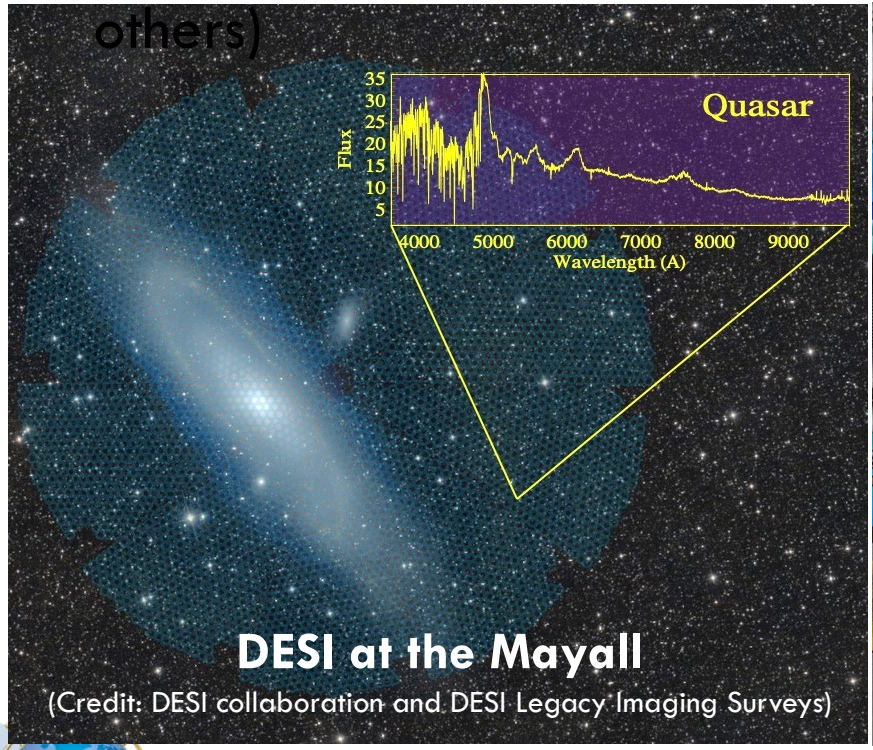

Very Long Baseline Array (VLBA)


Central Development Lab


Atacama Large Millimeter/submillimeter Array (ALMA)

NOIRLab Observatories

- KPNO, CTIO, and Gemini fully operational through 2021
- DOE's DESI and NASA's NEID instruments commissioned on NOIRLab Telescopes
- NSF funds recommissioning of NEWFIRM/Blanco and ISPI/SOAR (incl. new detector)
- Blanco's Dark Energy Survey Public Data-Release 2 released (6 yrs of data; 5000 sqr degs)
- CSDC's Astro Data Lab incorporates data from DESI Legacy Survey DR9 (among others)



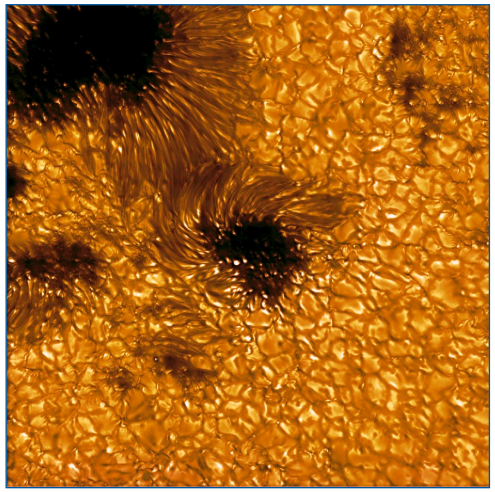
DESI at the Mayall
(Credit: DESI collaboration and DESI Legacy Imaging Surveys)

NEID at WIYN

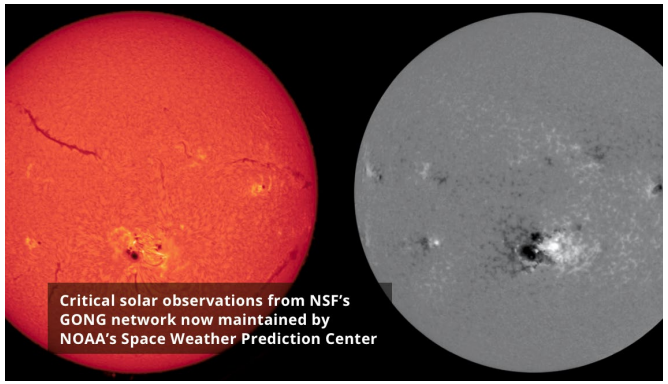

NEWFIRM
shipped to Chile


DECam's millionth image!

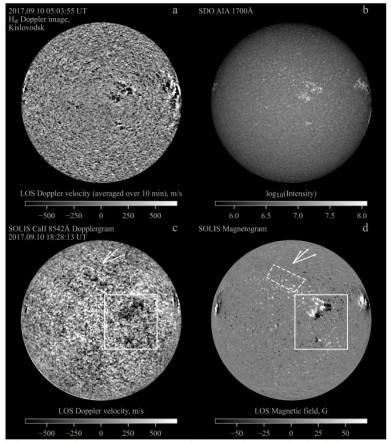
National Solar Observatories (NSO)



DKIST Operations Begin!
First Observations Planned for February 2022



NSF and NOAA signed a 5 year Interagency Agreement (IAA) for GONG operations



Analysis of 2015 SOLIS data shows roots of the solar wind in the chromosphere.

Green Bank Observatory

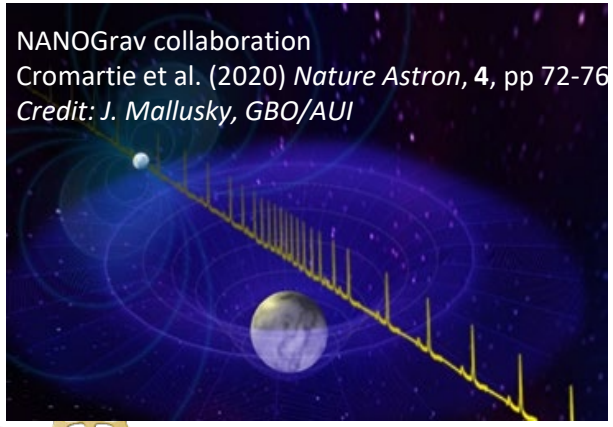
Robert C. Byrd 100 m Green Bank Telescope (GBT)
World's largest fully steerable single dish radio telescope

- New Director: Jim Jackson (October 2021); Karen O'Neil served 15 yrs
- Science operations continue with COVID-19 protocols in place
- GBT poised to play key role in Astro2020 high priority areas: pulsar timing; radio cameras; and RFI mitigation
- New development: radar transmitter

Science highlights

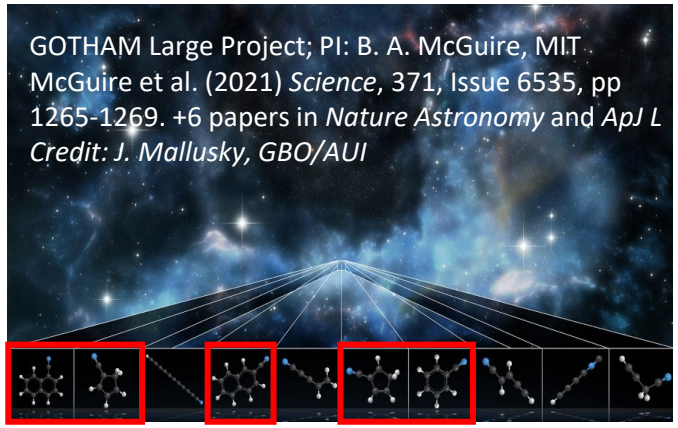
Pulsar timing/compact objects

Most massive neutron star detected



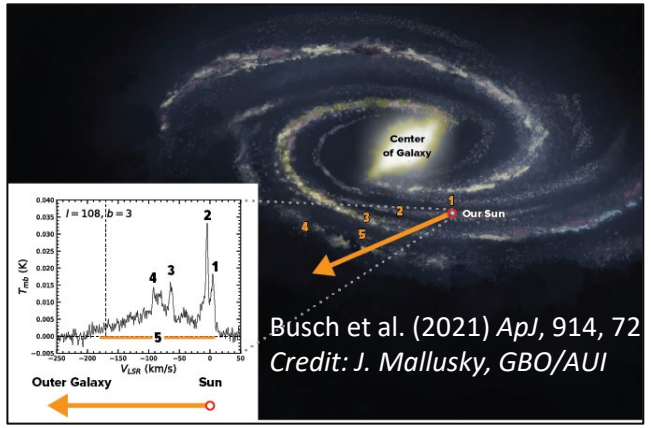
Astrochemistry

Direct detection of small PAHs



Galactic structure

Thick disk of CO-dark gas in Outer Galaxy



Solar System studies

Radar imaging of Tycho

Summary: NSF Facility support (through FFRDCs and CA)

Arecibo

NRAO

- ALMA
- VLA
- VLBA

Green Bank Observatory

NSO

- DKIST
- GONG
- Sac Peak (SSO)

NOIRLab

- Rubin
- Gemini N
- Gemini S
- Blanco (DOE DES, NEWFIRM)
- WIYN (NEID)
- Mayall (DOE DESI)
- SOAR

Grants Updates

Partnerships in Astronomy & Astrophysics Research and Education

- Broaden participation in astronomy
- Partnerships that
  - Strengthen education infrastructure
  - Strengthen research capacity
  - Create opportunities for student and faculty research
- Pathways into the research enterprise
  - Increase recruitment, retention and success
  - Foster a diverse, inclusive and equitable environment

New Programs to Broaden Participation

MPS-Ascend = Mathematical and Physical Sciences Ascending Postdoctoral Research Fellowships

- Supports postdoctoral fellows who will broaden the participation of groups that are underrepresented in MPS fields in the U.S.
- Facilitates career development and transition to a faculty position
- Six Astronomy awards made in FY21; review process underway for FY22

New Programs to Broaden Participation

MPS-LEAPS = Launching Early-Career Academic Pathways in the Mathematical and Physical Sciences

- Emphasis on supporting pre-tenure faculty at minority-serving institutions (MSIs), predominantly undergraduate institutions (PUIs), and Carnegie Research 2 (R2) universities
- Similar to CAREER with additional focus on broadening participation
- Three Astronomy awards made in FY21; review process underway for FY22

New Programs to Broaden Participation

APS PAARE = Partnerships in Astronomy & Astrophysics Research and Education

- stimulating the development of formal, long-term partnerships that provide authentic pathways into research and broaden the participation of individuals from groups underrepresented in astronomy.
- Proposals due Feb 7, 2022

AST Budget Update

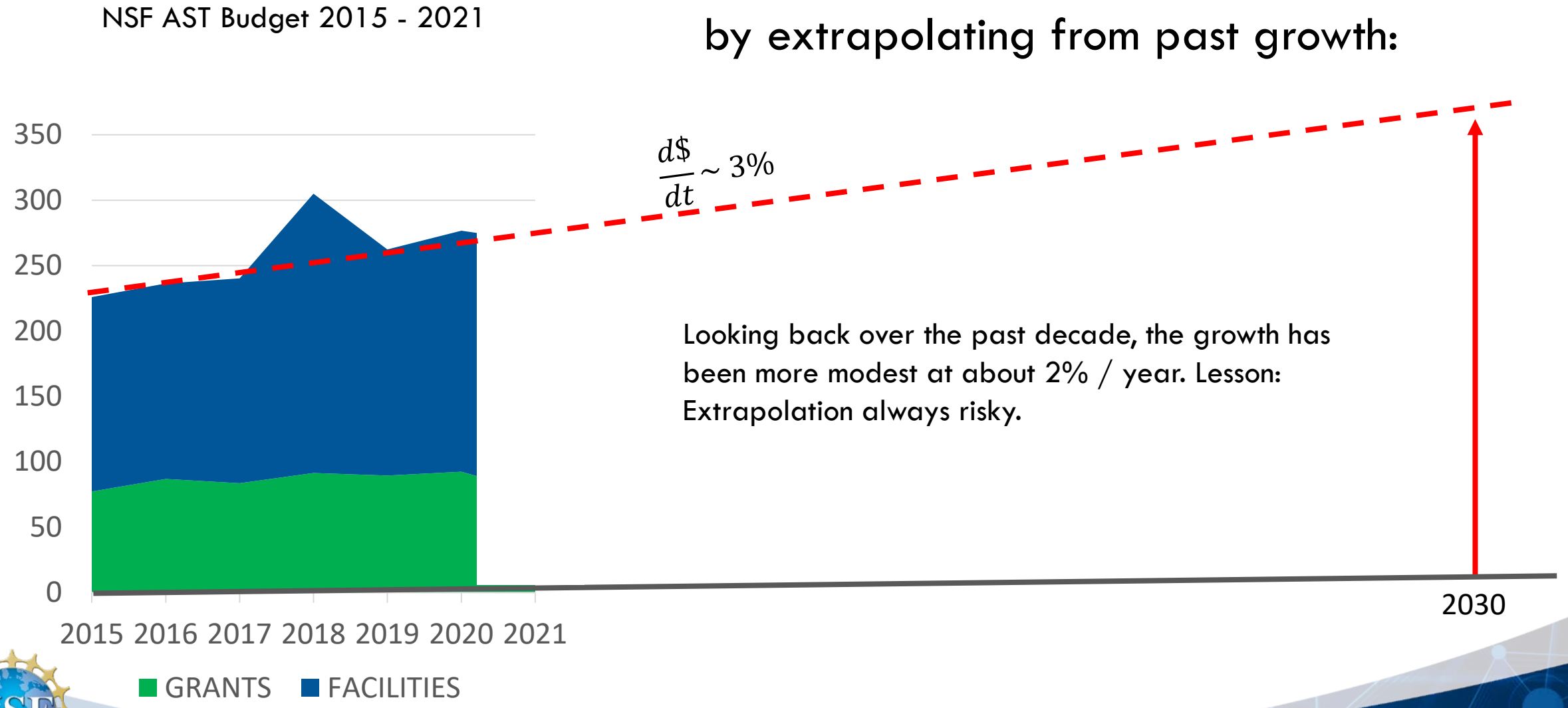
How is the AST budget allocated?

- AST budget is allocated by OD => MPS => AST and not fixed
- Budgets in future years are unknowable (however we have operated FFRDCs with out-year budgets with built in 3-4% increases each year)
- There is a tradition that Facility budgets are funded first; this has historically left IIP as the "bank" for variability in the AST budget

I am committed to keeping IIP healthy, consistent with the Astro2020 recommendation: Do this first!

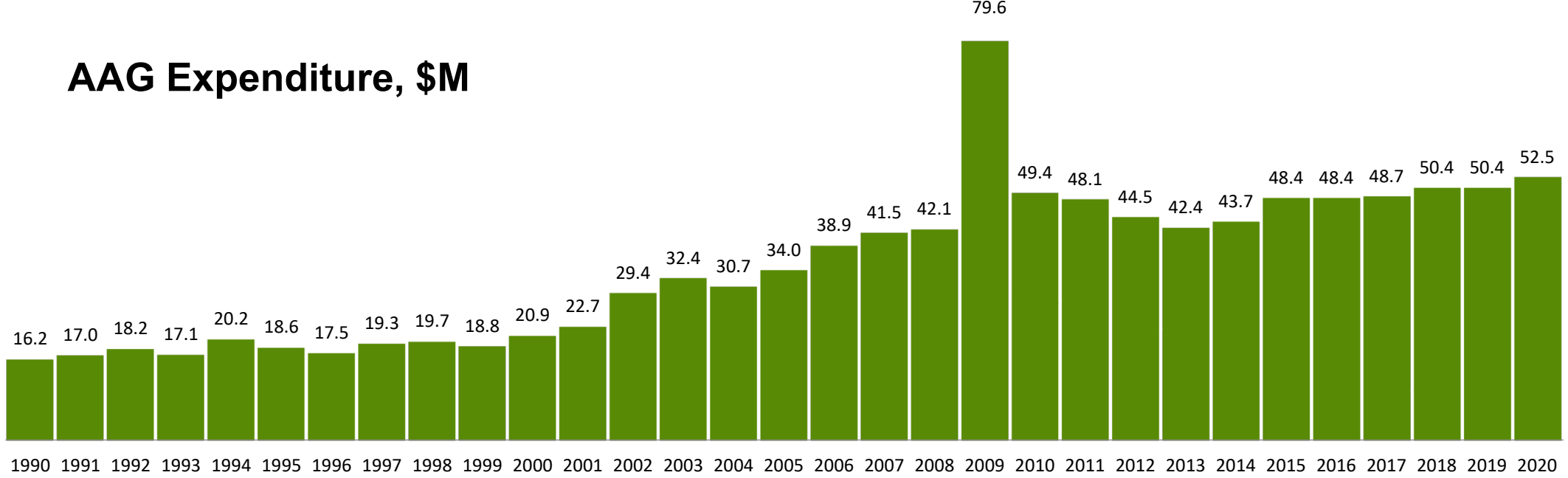
Looking forward to a Portfolio Review: to consider balance and or our ability to do new things.

Since the out-year budgets are unknowable, make a guess for the future by extrapolating from past growth:

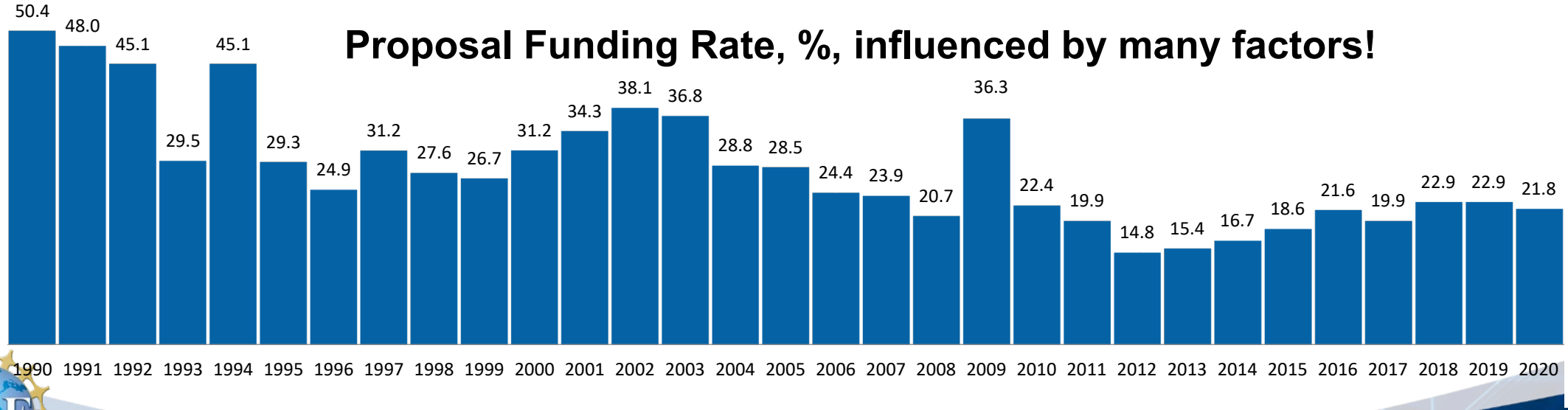


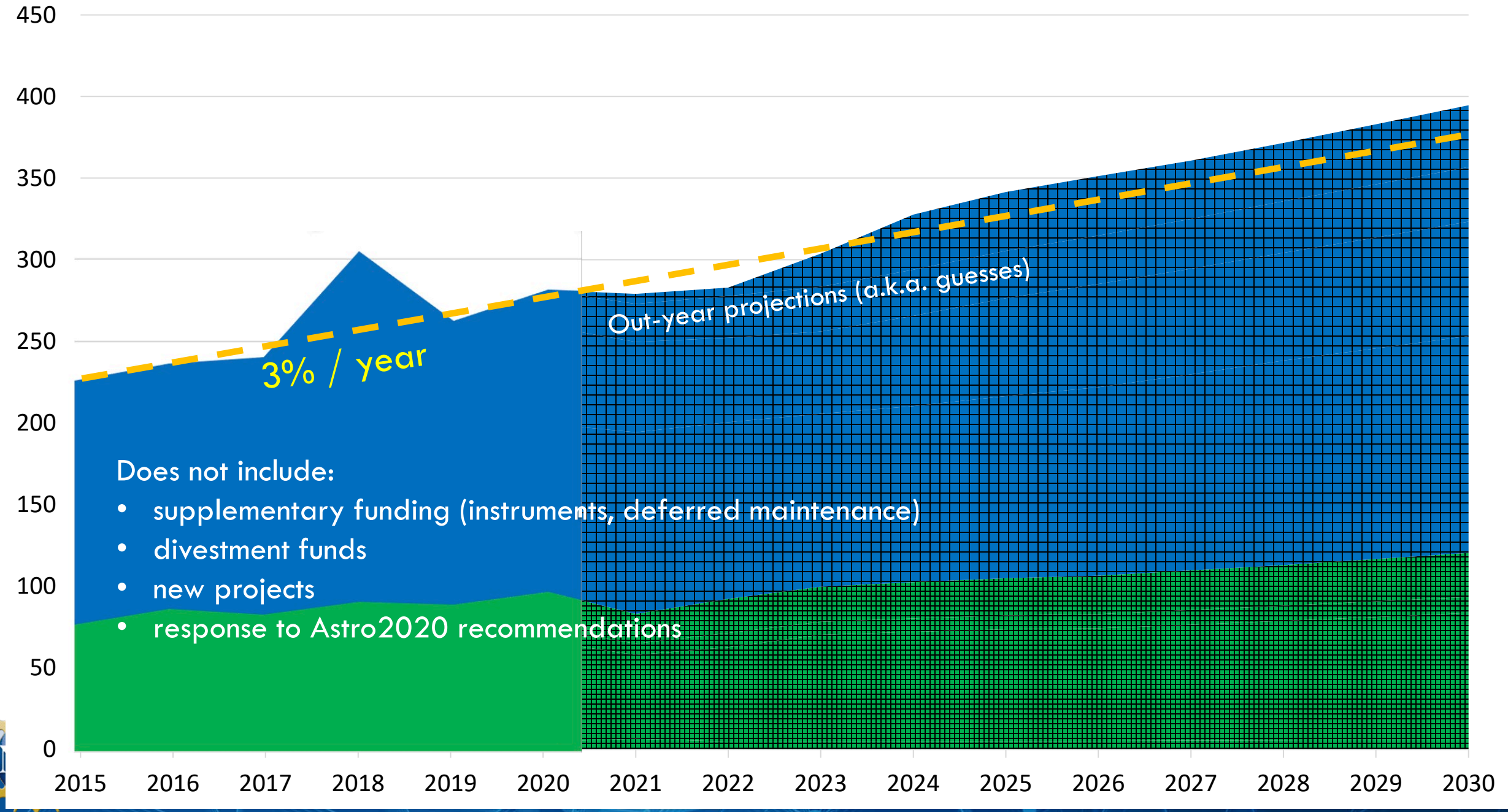
Looking back over the past decade, the growth has been more modest at about 2% / year. Lesson: Extrapolation always risky.

AAG Expenditure, $M



Proposal Funding Rate, %, influenced by many factors!

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3% / year
Out-year projections (a.k.a. guesses)
Does not include:
• supplementary funding (instruments, deferred maintenance)
• divestment funds
• new projects
• response to Astro2020 recommendations

Astro2020

Astro 2020 recommended: "Start here"

Fund people and develop the workforce

- Augment and protect individual investigator grants
- Build opportunities for diversity in workforce
- Increase transparency (in budgets and proposal statistics)
- Reduce carbon footprint associated with research

Aligned with existing MPS and AST initiatives supporting students, postdocs and early-career faculty from under-represented groups. With a complex future (artificial intelligence, robotics), the NSF workforce development provides a pathway to creative analytical skills and jobs that inherently offer flexibility and adaptability.

Astro2020 midscale recommendations

to support research and workforce:

- Sustain instrumentation
- laboratory astrophysics
- data science and archives

"Mid-scale research infrastructure and cyberinfrastructure….must be growth areas for NSF…" NSB-2018-40

Science-centered

Astro2020 describes a pathway to major scientific breakthroughs
The discoveries will impact the lives of our citizens
The science is timely – the work will be done (hopefully with U.S. leadership)

Astro 2020 Science:

Three science themes addressing fundamental and profound questions for humanity and for understanding our place in the space and time of the Cosmos.

A step-by-step path to discovering habitable worlds and life elsewhere.

Time-domain multi-messenger astrophysics to trace the earliest stages of the observable universe

Formation and evolution of stars and galaxies from the Big Bang to today

The Tools

Major facilities needed to make substantial progress on science questions.

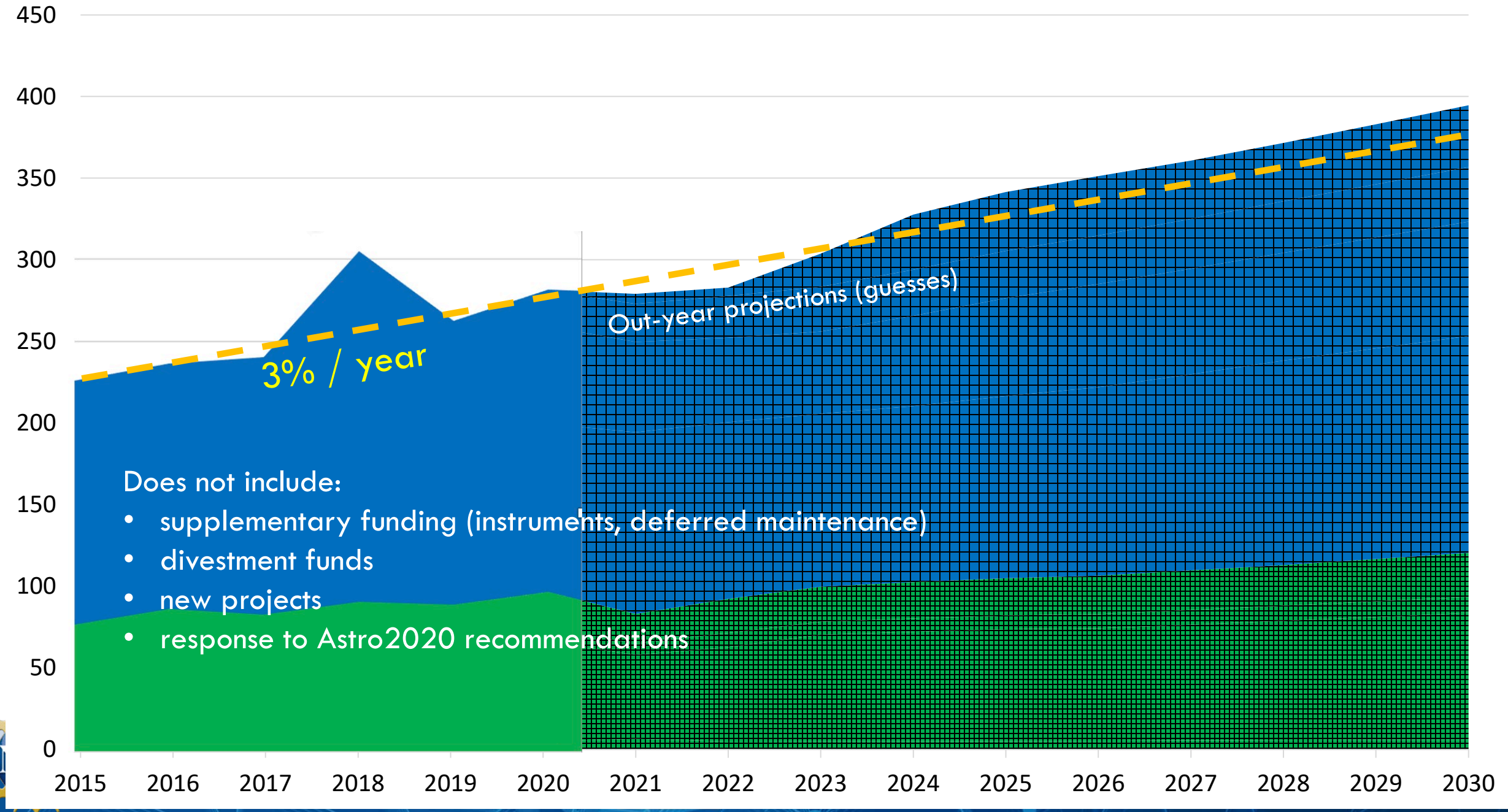
Top major facility recommendation: Extremely Large Telescopes (US-ELT)

To study exoplanets, carry out follow-up on faint sources (Rubin discoveries) and track the composition and structure of distant young galaxies as they form.

Two second-ranked major facility recommendations (equal weighting):

(2a) CMB-S4 probe the earliest moments of the universe, seeds of galaxy formation.

(2b) (ngVLA) formation of planets and the earliest galaxies, Earth orientation (GPS and global navigation satellites).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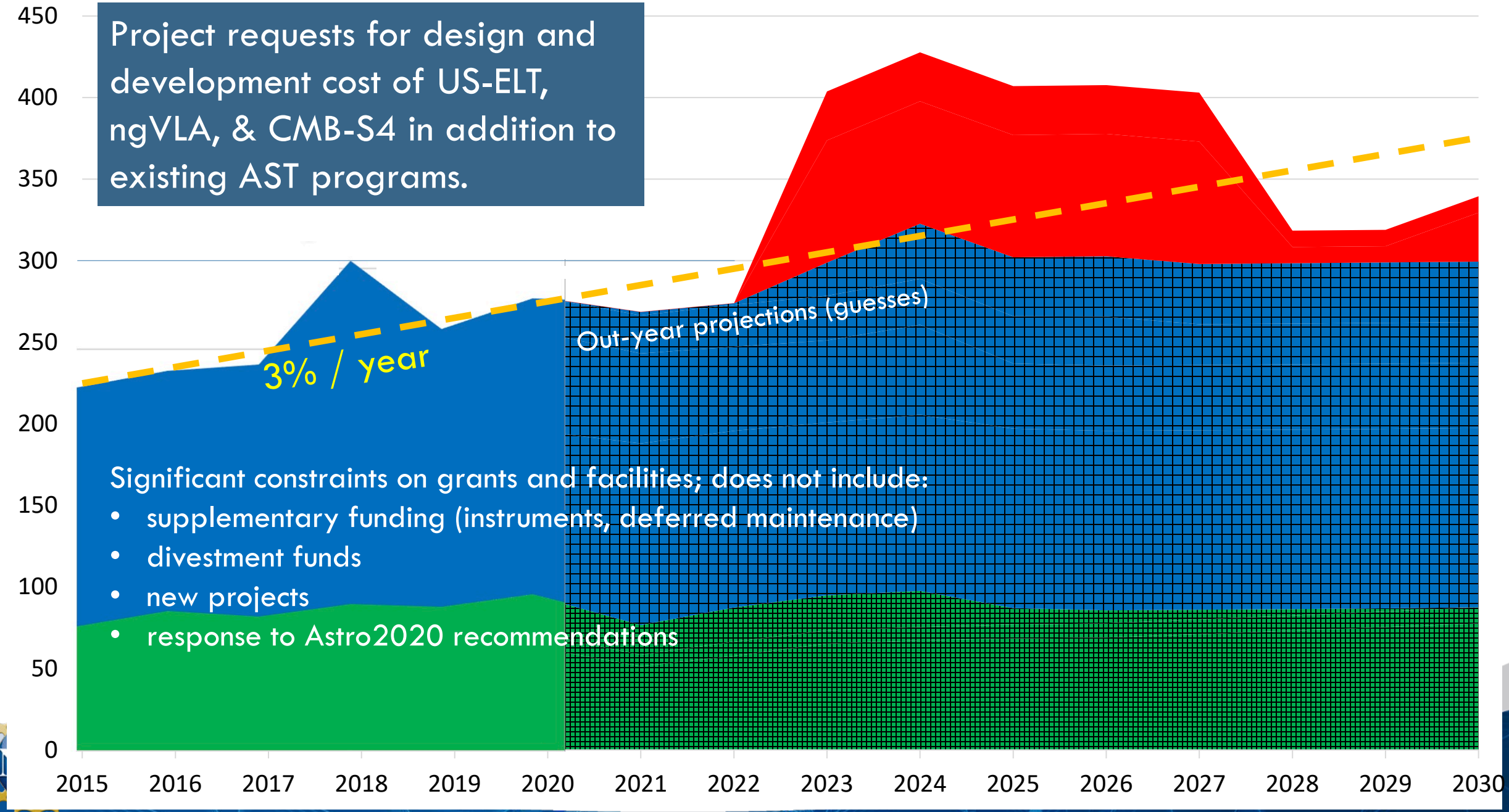
3% / year
Out-year projections (guesses)
Does not include:
• supplementary funding (instruments, deferred maintenance)
• divestment funds
• new projects
• response to Astro2020 recommendations


Project requests for design and development cost of US-ELT, ngVLA, & CMB-S4 in addition to existing AST programs.
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2024
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2026
2027
2028
2029
2030
3% / year
Out-year projections (guesses)
Significant constraints on grants and facilities; does not include:
• supplementary funding (instruments, deferred maintenance)
• divestment funds
• new projects
• response to Astro2020 recommendations

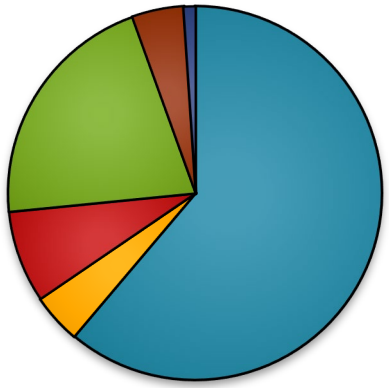
AST Division Programs

Individual Investigators
(Lead: Hans Krimm)

- AAG
- CAREER
- AAPF
- ATI
- * MRI
- REU
- ESP
- PAARE

Mid-scale
(Lead: Nigel Sharp)

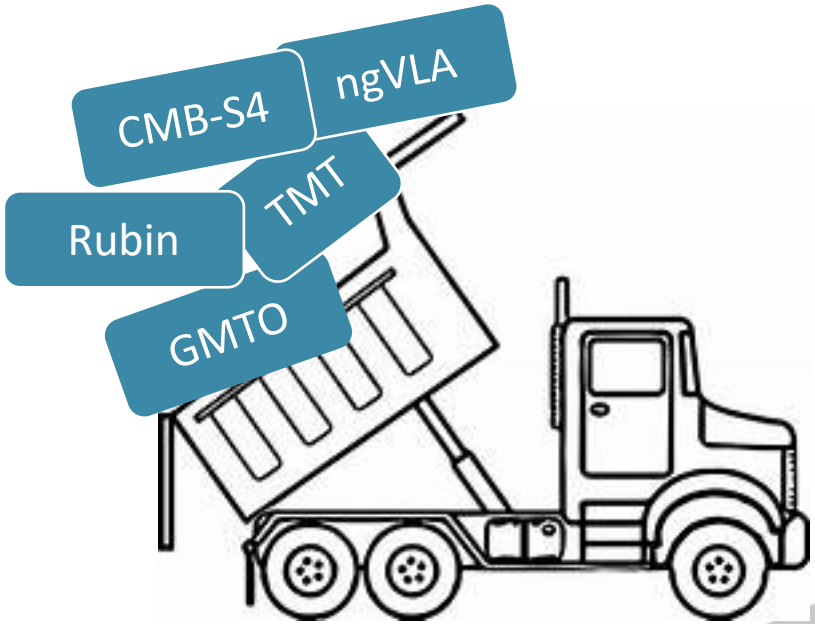
- MSIP
- * MSRI 1
- * MSRI 2



Facilities
(Sr Advisor: Ashley Vanderley)

- ALMA
- GBO
- Arecibo
- Gemini N
- Gemini S
- DKIST
- NOIRLab
- NSO
- NRAO

Astro 2010 recommendation:
Facilities: 55% of the AST budget (60%)
AAG: 25% of the AST budget (20%)



* Outside AST budget

Decadal Study Recommendations:

Source of the recommendation	Project	Actions
Astro*2010*	DKIST	Ramp up $20M / yr in 2022
Astro*2010*	Rubin	Ramp up to $20M in 2023 and $35M / yr in 2024
Astro2020	Increase AAG by $16M / yr	
Astro2020	ATI from $8 to $14 / yr	
Astro2020	MSIP to $50M / yr	
Astro2020	US-ELTs	Design / Development funding FY24-FY30 comes from AST budget
Astro2020	ngVLA	
Astro2020	CMB-S4	

Life cycle for facilities

1. Design and development
2. Construction
3. Operations and management
4. Supporting research grants – as new facilities are added, we need to increase the grants line
5. Deferred maintenance and supplement requests
6. Data management
7. End of life: divestment and restoration

Astro2020 State of the Profession

State of the Profession was the largest activity undertaken by the decadal committee.

- 11 recommendations
- 9 Recommendations directed at NSF
  - 2 on Spectrum
- 2 Recommendations to the community at large

Recommendation 1

Funding agencies should increase funding incentives for improving diversity among the college/university astronomy and astrophysics faculty—for example, by increasing the number of awards that invest in the development and retention of early- career faculty and other activities for members of underrepresented groups.

Response:

- ***MPS LEAPS and ASCEND***
- ***Grow support for AAG***

Recommendation 2

NASA, NSF, and DOE should reinvest in professional workforce diversity programs at the division/directorate levels with purview over astronomy and astrophysics. Because academic pipeline transitions are loss points in general, supporting the creation and continued operation of "bridge" type programs across junctures in the higher-education pipeline and into the professional ranks appear especially promising.

Response

- ***PAARE***

Recommendation 3

NSF, NASA, and DOE should implement undergraduate and graduate "traineeship" funding, akin to the NIH MARC and NIH "T" training grant programs, to incentivize department/institution-level commitment to professional workforce development, and prioritize interdisciplinary training, diversity, and preparation for a variety of career outcomes.

Responsive Activity:

- ***MPS Participates in NRT.***
- ***AST has staff representation in that program.***

Recommendation 4

NASA and NSF should continue and increase support for postdoctoral fellowships that provide independence while encouraging development of scientific leaders who advance diversity and inclusive excellence (e.g., NASA Hubble Fellows program, NSF Astronomy and Astrophysics Postdoc program).

Responsive Activity:

- ***MPS ASCEND***
- ***Increased advocacy for AAPF Budget***

Recommendation 5

NASA, NSF, DOE, and professional societies should ensure that their scientific integrity policies address harassment and discrimination by individuals as forms of research/scientific misconduct.

Responsive Activity:

- ***Would require federal definition and regulation to be changed.***
- ***OSTP/OMB action required.***

Recommendation 6

NASA, NSF, and DOE should implement a cross-agency committee or working group tasked with establishing a consistent format and policy for regularly collecting, evaluating, and publicly reporting demographic data and indicators pertaining at a minimum to outcomes of proposal competitions

Responsive Activity:

- ***Interagency working group to be formed with NASA APD, DOE, and AST.***
  - ***Initially at program level. Later to be expanded to include relevant authorities.***
- ***There are laws and regulations governing these activities. Changes would require exemptions or support from NSF OGC and OSTP.***
- ***AAAC guidance would be helpful here***

Recommendation 7

The astronomy community should, through the American Astronomical Society in partnership with other major professional societies (e.g., American Physical Society, American Geophysical Union, International Astronomical Union), work with experts from other experienced disciplines (such as archaeology and social sciences) and representatives from local communities to define a Community Astronomy model of engagement that advances scientific research while respecting, empowering and benefiting local communities.

Responsive Activity:

An NSF team is engaging with local communities (e.g., Arizona, Hawai'i)

Recommendation 8

The National Science Foundation should work with the appropriate federal regulatory agencies to develop and implement a regulatory framework to control the impacts of satellite constellations on astronomy and on the human experience of the night sky. All stakeholders (U.S. astronomers, federal agencies, Congress, satellite manufacturers/operators, and citizens who care about the night sky) should be involved in this process. This is an international issue; therefore, international coordination is also vital.

Response:

- ***ESM Office responsibilities include interference at optical frequencies***
  - ***ESM Office is pursuing collaborative approaches to establish industry-endorsed best practices (see Dark & Quiet Skies industry sub-working group recommendations)***
  - ***NSF is funding research in optical interference mitigation (e.g., detector improvements, satellite darkening)***
  - ***International coordination is being promoted via UN COPUOS and other venues***
  - ***NSF working with NTIA, FCC, State and other federal agencies to develop appropriate response***

Recommendation 9

To ensure that the skies remain open to radio astronomy, NSF, in partnership with other agencies, should support and fund a multi-faceted approach to the avoidance and mitigation of radio-frequency interference. It is critical that the astronomical community formally monitor commercial and federal uses of the spectrum managed by the Federal Communications Commission and the National Telecommunications and Information Administration and actively participate in the spectrum management process by seeking critical primary allocations to radio astronomy in the high-frequency bands above 95 GHz, by providing comments to filings for spectrum allocations, and by supporting the efforts of the Committee on Radio Frequencies, the National Radio Astronomy Observatory, and the Electromagnetic Spectrum Management division of NSF. To be most effective, international coordination is required.

Response:

- ***NSF funds the NAS Committee on Radio Frequencies, and spectrum efforts at NRAO, GBO, Arecibo Observatory***
- ***NSF has established the Spectrum Innovation Initiative to support and fund progress in the avoidance and mitigation of RFI, including research, collaboration, and workforce development***
- ***NSF ESM Office actively participates in the Interdepartment Radio Advisory Committee (IRAC) and advocates on behalf of radio astronomy on a daily basis***
- ***NSF leads ITU Working Party responsible for Radio Astronomy; actively advocates for astronomy interests (e.g., bolometers, low frequency, mm-wave)***
- ***Ample primary RAS allocations exist above 95 GHz; NSF focuses on preserving this spectrum access***

Recommendation 10

The astronomy community should increase the use of remote observing, hybrid conferences, and remote conferences, to decrease travel impact on carbon emissions and climate change.

Response:

- ***NSF can participate through continuation of remote panels (concern about professional networking for early career people)***
- ***Energy audits at facilities, support green power infrastructure***

A huge thank you to the AAAC! We know this service takes a lot of your valuable time. The AAAC-catalyzed discussion and cooperation between NSF, NASA, DOE has a significant impact with more communication, ideas and brainstorming occurs that makes our community stronger.

Thanks to my NSF AST colleagues who provided slides and input for this presentation. I am surviving here with your help.

Special thanks to Martin Still for herding all the cats and their diverging schedules in this meeting!


NSF