Key Issues in the NSF Division of Astronomical Sciences

Presentation to BPA / SSB

Debra Fischer, NSF AST DD

My priorities as NSF AST DD:

Promote excellence in science
Develop the workforce with diversity and inclusion
Strive for a balanced portfolio
Sustainability and reducing GHG emissions

Key Issues in the NSF Division of Astronomical Sciences

FY 2022 Programs

Acronym	Program Name	Deadline	Program Lead
CAREER*	Faculty Early Career Development Program	26 Jul 21	S. Higdon
REU Sites*	Research Experiences for Undergraduates	28 Aug 21	J. Higdon
AAPF	Astronomy & Astrophysics Postdoctoral Fellowships	15 Oct 21	Gupta
AAG	Astronomy & Astrophysics Research Grants	15 Nov 21	Sharp (EXC), Langston (GAL), Krimm (SAA), Sollitt (PLA)
ATI	Advanced Technology and Instrumentation	15 Nov 21	Ninkov
MRI*	Major Research Infrastructure	19 Jan 22	Ninkov

FY2022 Budget Request

- Total FY2022 REQUEST shows strong support in AST funding
- Support for major new Astro2020 initiatives will come from the top line Arecibo cleanup costs wrapping up, still shared
- At MPS level, probable continued investments in LEAPS and Ascend programs to promote broader participation
- House mark for NSF top line down from request (+14% vs +20%)

DIVISION OF ASTRONOMICAL SCIENCES (AST)

$294,050,000
+$17,000,000 / 6.1%

AST Funding
(Dollars in Millions)

	FY 2020 Actual	FY 2021 Estimate	FY 2022 Request	Change over FY 2021 Estimate Amount	Change over FY 2021 Estimate Percent
Total	**$279.10**	**$277.05**	**$294.05**	**$17.00**	**6.1%**
Research	**64.99**	**52.92**	**72.47**	**19.55**	**36.9%**
CAREER	4.74	4.81	4.81	-	-
Education	**4.27**	**4.60**	**5.10**	**0.50**	**10.9%**
Infrastructure	**209.85**	**219.53**	**216.48**	**-3.05**	**-1.4%**
Arecibo Observatory[1]	3.75	12.68	8.00	-4.68	-36.9%
AST Portfolio Review Implementation	0.05	-	-	-	N/A
Green Bank Observatory[2]	9.42	8.90	9.12	0.22	2.5%
Midscale Research Infrastructure	23.30	20.80	19.50	-1.30	-6.3%
National Radio Astronomy Observatory (NRAO)	85.75	88.13	91.16	3.03	3.4%
NRAO O&M	*38.48*	*39.45*	*40.53*	*1.08*	*2.7%*
Atacama Large Millimeter Array (ALMA)	*47.27*	*48.68*	*50.63*	*1.95*	*4.0%*
National Solar Observatory (NSO)	21.79	22.09	25.46	3.37	15.3%
NSO O&M	*4.78*	*4.55*	*5.88*	*1.33*	*29.2%*
Daniel K. Inouye Solar Telescope (DKIST) O&M[3]	*17.01*	*17.54*	*19.58*	*2.04*	*11.6%*
NSF's National Optical-Infrared Astronomy Research Lab (NOIRLab)	57.86	57.93	54.44	-3.49	-6.0%
NOIRLab O&M (Mid-Scale Observatories & Community Science and Data Center)[4]	*35.54*	*29.95*	*26.26*	*-3.69*	*-12.3%*
Gemini Observatory O&M	*22.31*	*22.98*	*22.98*	-	-
Vera C. Rubin Observatory O&M	*0.01*	*5.00*	*5.20*	*0.20*	*4.0%*
Research Resources	7.92	7.00	8.80	1.80	25.7%

[1] Includes $28.88 million in FY 2021 and $15.0 million in FY 2022 in supplemental funding for cleanup of the Arecibo site.

[2] FY 2020 Actual includes $1.75 million from a technical deobligation/reobligation action from a previous award.

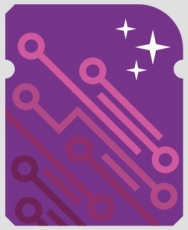
[3] FY 2021 Estimate excludes funding of $2.0 million for cultural mitigation activities as agreed to during the compliance process.

[4] Includes $2.0 million in FY 2020 for transition activities associated with the creation of NOIRLab, as well as special projects funding of $13.63 million in FY 2020, $9.44 million in FY 2021, and $5.13 million in FY 2022.

NOIRLab: combining OIR facilities
Proposal will be submitted Dec 17, 2021

CERRO TOLOLO

From the first observations in 1965, Cerro Tololo, located in Chile, has served as the principal platform for U.S. astronomical investigation of the southern skies.



COMMUNITY SCIENCE & DATA CENTER

Programs within the Community Science and Data Center support and enable a broad range of astronomical community science activities across the US ground-based optical and infrared system.

KITT PEAK

Founded in 1958, Kitt Peak National Observatory is home to one of the largest arrays of optical and radio telescopes in the world.

Formerly NOAO

GEMINI OBSERVATORY

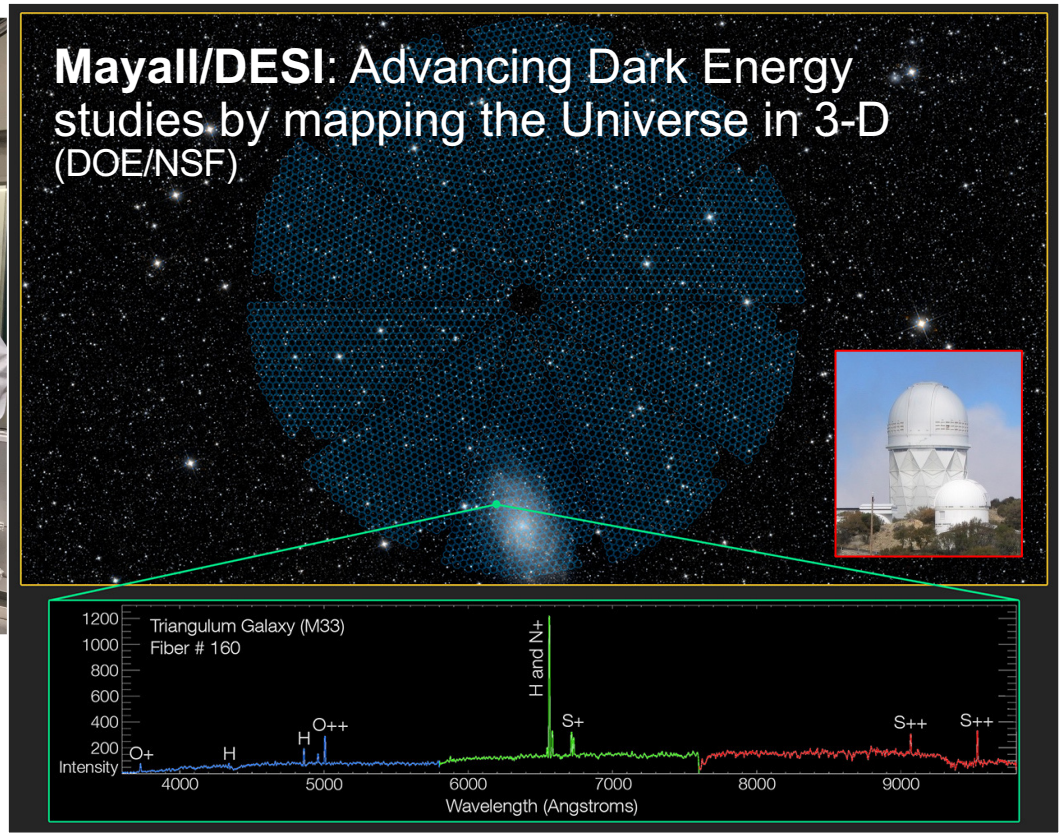
The Gemini Observatory consists of twin 8.1-meter diameter optical/infrared telescopes located on two of the best observing sites on the planet.

RUBIN OBSERVATORY

Vera C. Rubin Observatory, currently under construction on Cerro Pachón in Chile, is an 8-meter-class telescope coupled to a 3.2-gigapixel camera – the world's largest digital camera ever fabricated for optical astronomy.

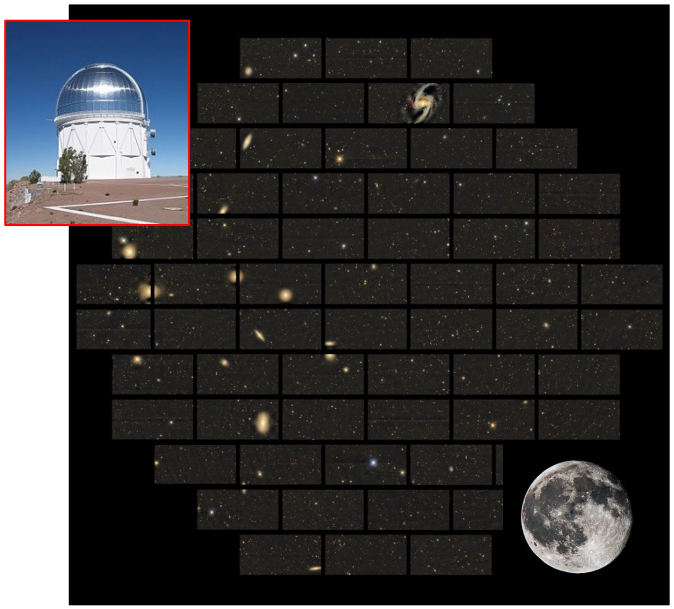
KPNO

WIYN/NEID: Searching for near-Earth-sized Exoplanets as part of NN-EXPLORE (NASA/NSF)



CTIO & Gemini

Blanco/DECam: 520 mega-pixel optical survey camera with a 3 sqr. deg. field-of-view



CSD
C
ANTARES
AEON

Gemini/SOAR/Blanco: Rapid Response to Time-Domain and Multi-Messenger Alerts

Rubin Observatory

- Re-baseline of operations underway
  - COVID delay of ~22 months at cost of >$60M
  - Project teams back on site, making excellent progress (now ~90% complete)

Impact of Satellite Constellations on Astronomy

Optical and Infrared

- 2 NSF-funded workshops
  - SATCON1 – July 2020
  - SATCON2 – July 2021
- NSF's Rubin Observatory working closely with satellite operators
- NSF/Satellite Industry Association joint technical presentation for the USA to UN Committee on the Peaceful Uses of Outer Space (COPUOS)

Radio Frequency

- Spectrum coordination agreements
  - SpaceX, 2019 (being updated; new & modified FCC license); other US-licensed operators to come
- NSF funds Committee on Radio Frequencies (NASEM)
- NSF head of delegation for ITU-R; WP 7D for Radio astronomy (recent report approved on Quiet Zones)
- R&D on satellite interference mitigation/coexistence

- 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

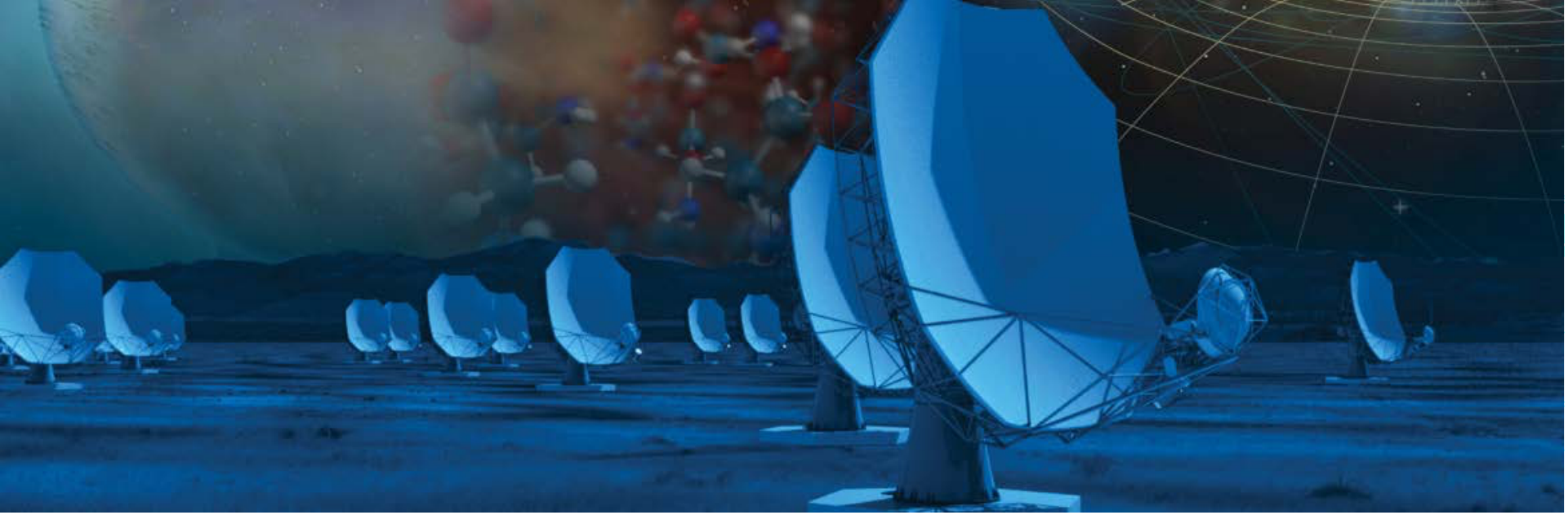
SATCON1: https://aas.org/satellite-constellations-1-workshop-report SATCON2: https://aas.org/satellite-constellations-2-workshop
NSF/SIA briefing to UN COPUOS: https://www.unoosa.org/oosa/en/ourwork/copuos/technical-presentations.html
JASON study: https://www.nsf.gov/news/special_reports/jasonreportconstellations/

DKIST

- Focus 12kW of solar power on the 4-m mirror
- Observe all day, make ice all night
- Resolve to 25 km: plasma kinetic scales, magnetic fields
- Commissioning begins end of CY21

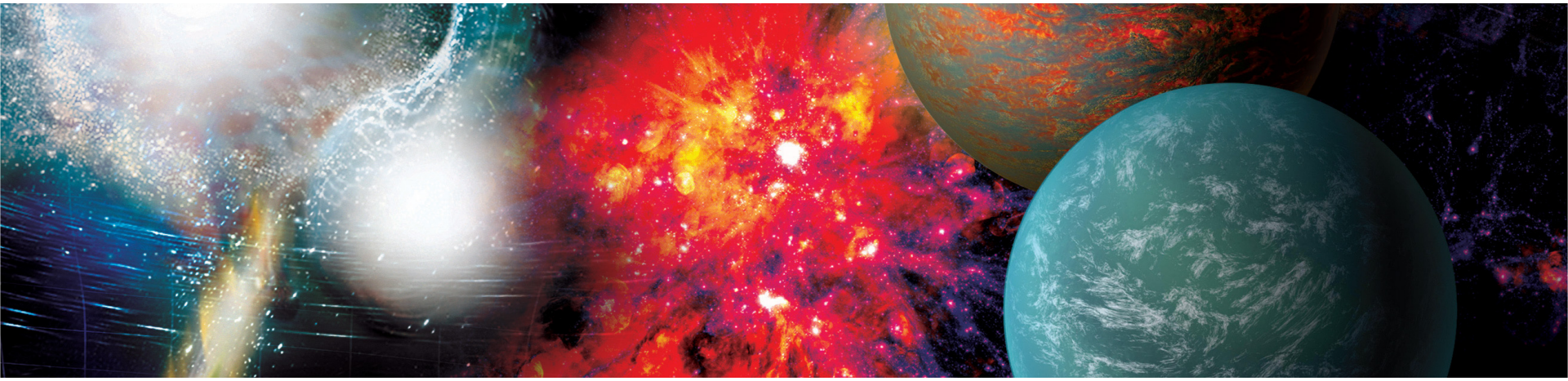
Arecibo

- Emergency clean-up complete by Dec 3, 2021
- Intact dish components and towers being stabilized
- Historic buildings repaired
- Salvage committee identifying objects of value



NRAO currently operating as usual

- VLA, ALMA and VLBA fully operational
- NRAO management devised Covid-safe practices for maintenance and operations



Astro 2020

Three themes touch fundamental and profound questions of humanity and our cosmos.

1. "Worlds to Suns"
   - step-by-step path to identify and characterize Earth-like exoplanets and use atmospheric spectroscopy to search for biosignatures.
2. "New Messengers and New Physics"
   - time-domain multi-messenger astrophysics across wavelengths, cosmic rays, neutrinos, and gravitational waves, to trace the earliest stages of the observable universe
3. "Cosmic Ecosystems"
   - formation and evolution of stars and galaxies from the Big Bang to today and coupling with the intergalactic medium.

This is the first decadal study to address State of the Profession. **"Start here"**:

Fund people and develop the workforce

- Support opportunities for the workforce (DEI)
- Increase transparency (in budgets and proposal statistics)
- Work toward carbon neutrality in research
- Plus-up AAG and protect against budget erosion from O&M of facilities
- Increase support for ATI – we need inventors and makers

These directions are well aligned with priorities articulated by the Office of the Director and many NSF initiatives (PAARE, ASCENDS, LEAPS)

To tackle the grand and exciting themes, the report calls out the tools necessary for our community to effectively make progress on these questions:

1. Extremely Large Telescopes (US-ELT) *to study exoplanets, identify faint MMA sources, and study the composition of distant, and early, galaxies as they form*
2. Cosmic Microwave Background (CMB-S4) *to probe the earliest stages of the universe, seeds of galaxy formation, and a new window on transients*
3. Next Generation Radio Array (ngVLA) *to explore the formation of planets with exquisite resolution as well as the dynamics of formation of the earliest galaxies*
4. Tools and technology development (ATI, data science), *to support theory and midscale initiatives*

The recommendations for the NSF are synergistic with recommendations to NASA and DOE. In preparation for Decadal, NASA had 4 flagship concept studies and the recommendation was to essentially to do them all (2 as probes, one as a large UVOIR space observatory).

The complementary NSF investments would maximize success of other agency strategies. For example: NASA missions are all sky, so need to have northern and southern sky coverage with ELTs or risk paying for $20B missions w/o follow-up ability for US.

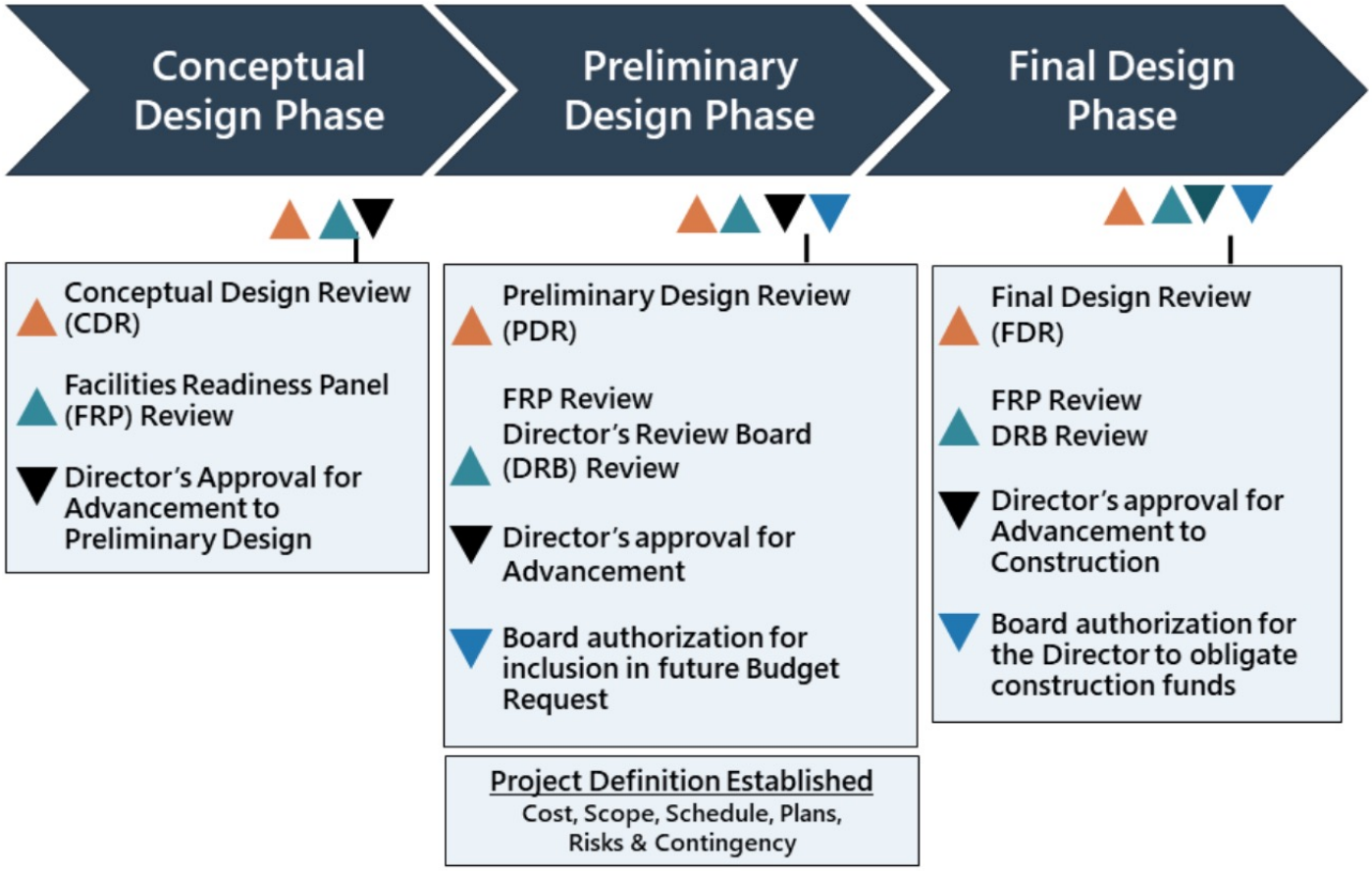
Helpful recommendations:

1. Use panel reviews to assess project readiness (including funding) and portfolio reviews to check programmatic balance
2. Plan for O&M (before FDR)
3. Use midscale programs.

There are important international and public-private partnerships associated with facility recommendations (ELTs have a 3:1 or 4:1 partnership investment) and synergy with PHY and OPP in “New Messengers New Physics.”

The ambitious scale exceeds the MPS AST budget. Progress will need support from cross-Foundation programs (MREFC, MRI, MSRI).

MREFC Process for Major Facilities (>$100M)



- Projects can enter at any point before PDR
- OMB must approve inclusion in Budget Request
- Congress provides authorization & appropriation

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

AST Division Programs

Individual Investigators

AAG

* CAREER

AAPF

ATI

* MRI

* REU

Research

Technology/ Instrumentation

Education and Special Programs

Mid-scale

MSIP

Facilities

ALMA

NRAO

Gemini

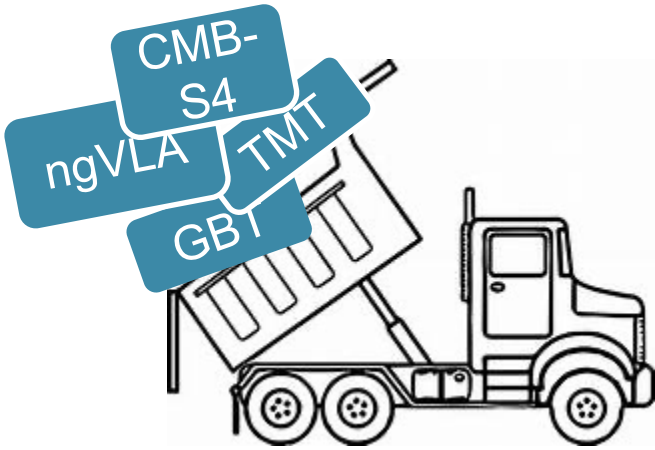
NOAO

Rubin

Arecibo

NSO

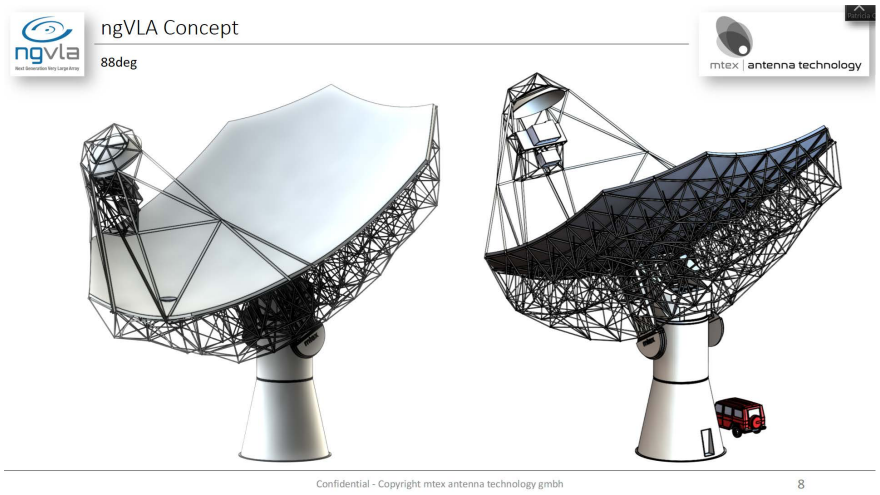
GBO



* NSF Wide

Pre-2020:

- ✓ Provided support for TMT and GMT
- ✓ Established a US-ELT office at NOIRLab
- ✓ Funding provided for a prototype antenna for ngVLA (a possible future MREFC project)
- ✓ Development funding for CMB-S4



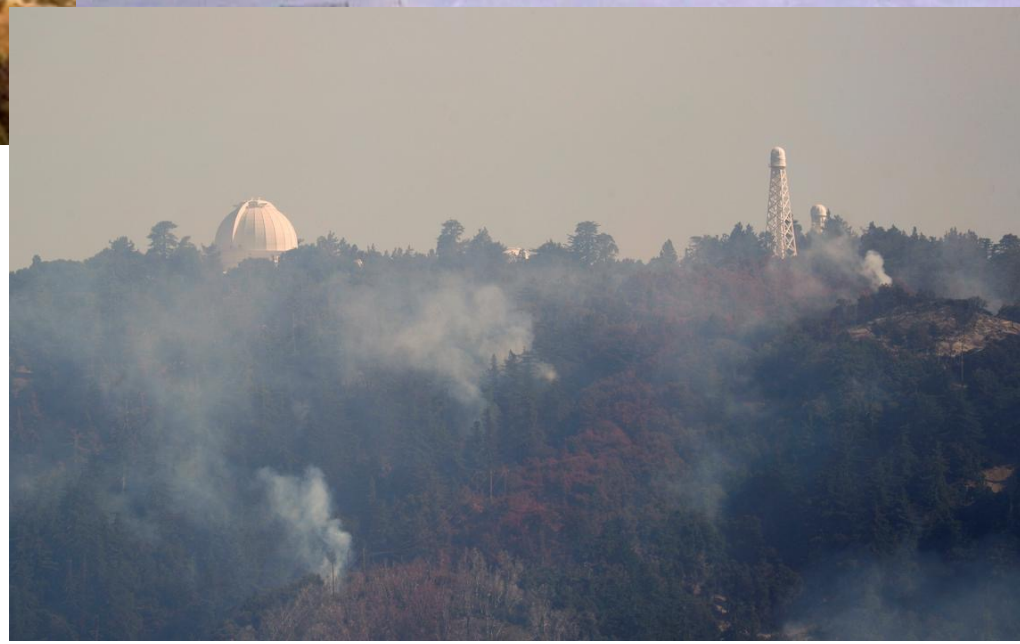
In the coming weeks:

- ✓ Internal to NSF
  - We have set up focus groups in AST to study 2020
    - how are we already aligned?
    - Are there ways to make early progress?
  - Communicate and coordinate within the NSF

- ✓ External to NSF
  - Meet with the community to explain processes
  - Start planning for external reviews for large facilities

This is a negotiation phase – a time to figure out what we may be able to do and how we might do it.

Reducing GHG emissions



Effects of climate change are impacting our ability to do research.

The existential threat has an enormous impact to humanity.

NOIRLab facilities: 8700 tons CO2 equivalent in FY2019

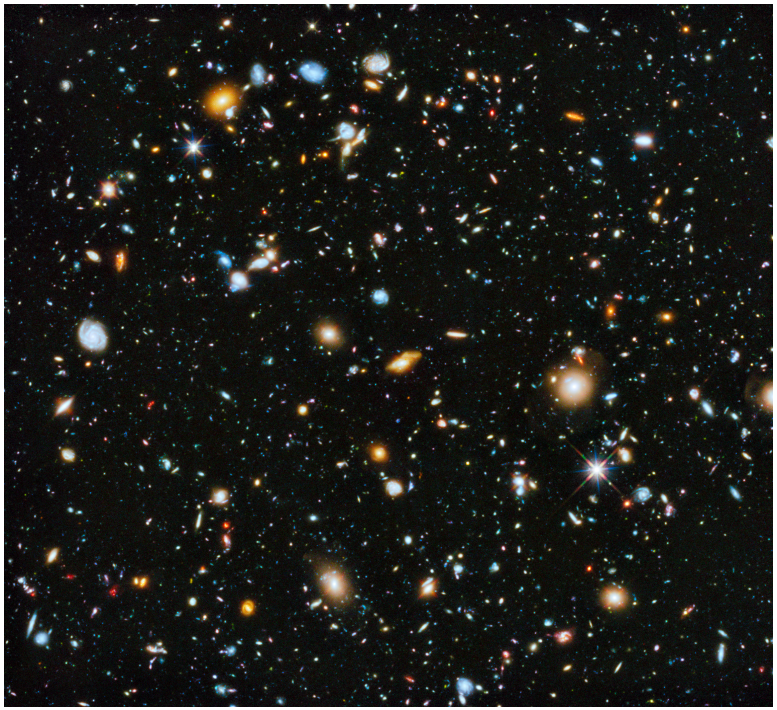
Reduce GHG emissions

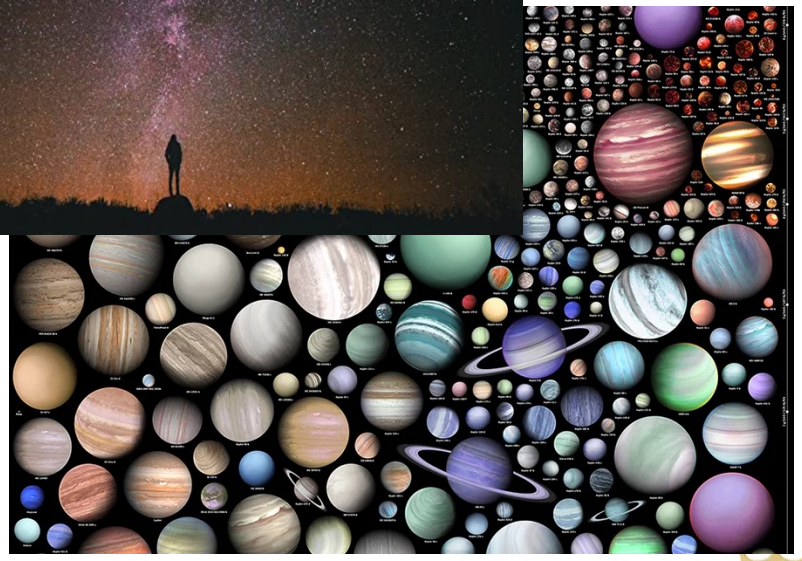
- Energy audits at facilities
- Reduce travel
- Goal: Build international collaborations (ESO)
- Invest in PV arrays, wind turbines, geothermal heating

Cost savings, energy security and stability

Astro 2020 Vision

When there are inspirational breakthroughs in any field, the excitement elevates all science.





The discoveries that will emerge from the vision of Astro2020 is guaranteed to be among the greatest discoveries that have been made by humankind.

The workforce development implemented to make those discoveries will change peoples lives.

I look forward to working with all of you to facilitate the scientific vision of Astro2020!

Questions / comments?

COVID RESPONSE

- March 16, 2020 NSF implemented 100% telework posture
- NSF employees can now access building, but vast majority still telework
- Anticipated to remain in liberal telework posture for (at least) the next few months
- Minimal work-related travel; travel now approved for vaccinated employees
- All NSF meetings/panels 100% video conference
- On-going discussions regarding post-COVID hybrid work-place
- NSF is providing COVID relief in FY 2021 and FY2022
  - $600M provided as part of $1.9T American Rescue Plan Act of 2021

    Prioritize students, postdocs, early career scientists

COVID RESPONSE

- All Facilities operational, under COVID protocols to ensure safety. Facilities utilized COVID telework flexibilities
- Situation is improving and most facilities are moving back towards more normal operations, but some experienced significant delays (e.g., Rubin)
- Vaccination mandates may have staffing impacts
- COVID flexibilities provided to individual investigators.
- COVID will impact the ability to respond to Astro2020: the forecasts given to the decadal panel from 2019 were PRE-COVID. The existing construction projects have seen significant delays and cost increases due to COVID, which impacts the potential MREFC wedge.
- Especially severe impact on our ability to do construction and get personnel to Antarctica. This has caused a change in planning for Antarctic infrastructure. Inevitably, that will have an impact on construction of major projects at the South Pole this decade, notably including CMB-S4 and IceCube nextGen.