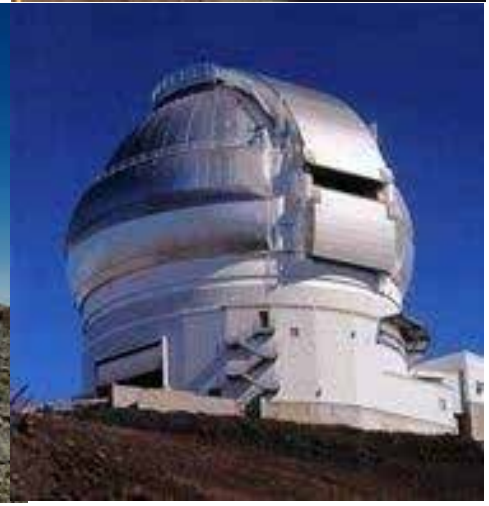
NSF AST Update for CAA
Nov 8, 2021 Presentation to CAA
Debra Fischer









CAA Agenda topics

Significant Program Changes and Developments

Facilities: science, milestones, opportunities and challenges

- NOIRLab
- Solar
- Radio
- Grants programs
- Impact of COVID

Preparations for Astro2020

NOIRLab

NSF's National Optical-Infrared Astronomy Research Laboratory NOIRLab
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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

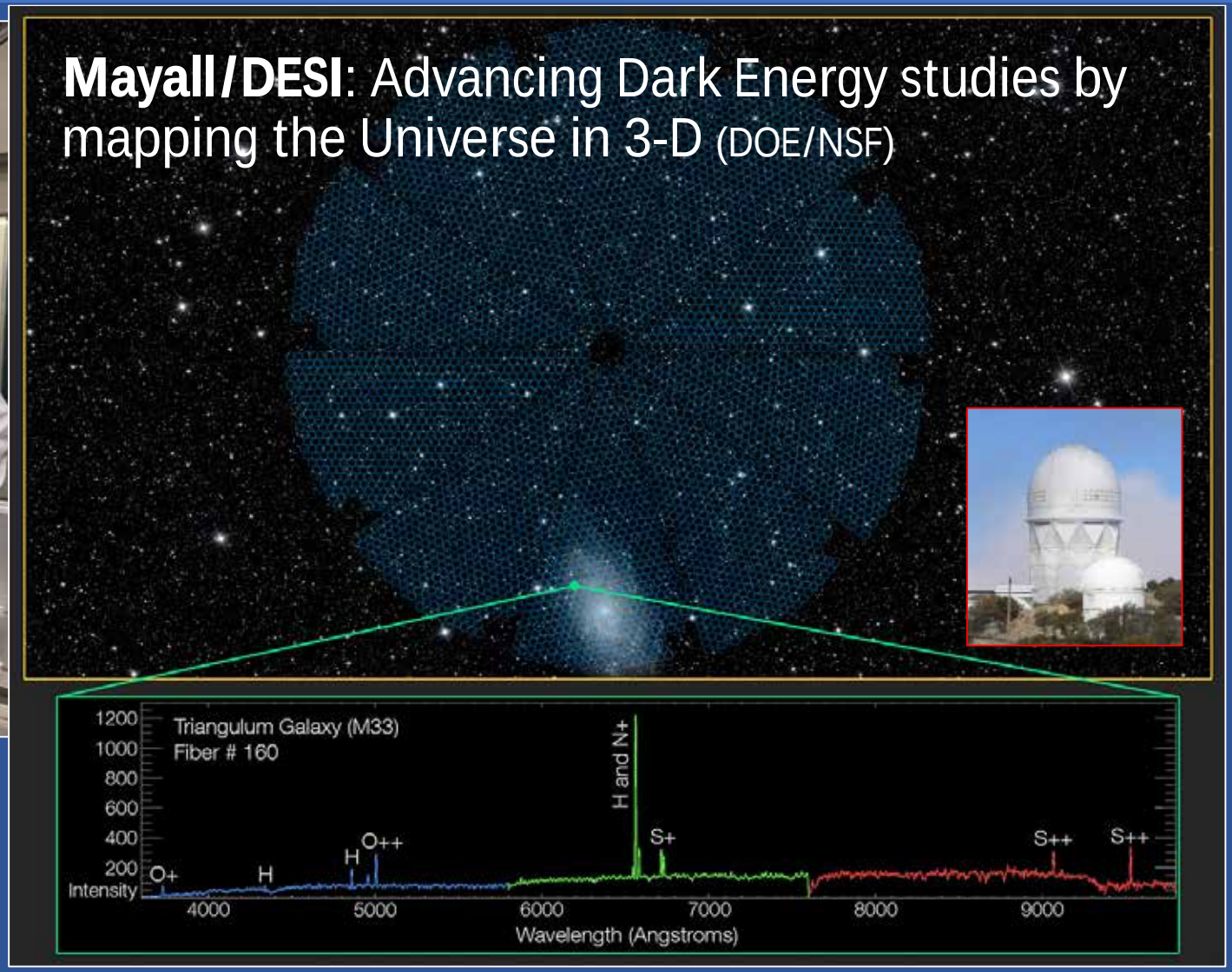
GEMINI OBSERVATORY

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.

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



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

CSDC
ANTARES
AEON

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

Gemini Board's *Strategic Vision* (Dec 2016) builds on existing strengths:

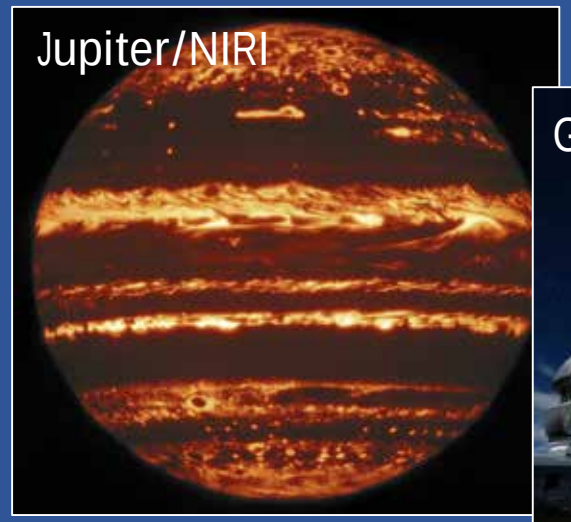
- Time Domain/MMA follow-up
- AO (GeMS and GNAO)
- Continue to support diverse scientific needs of its multi-national user communities

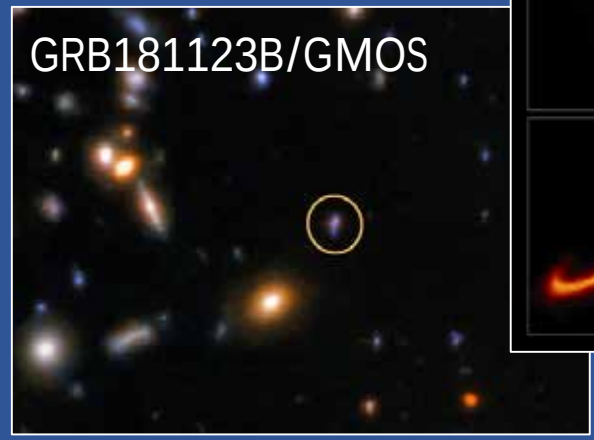
Aggressive instrument development program

- SCORPIO 8-beam OIR imager/spectrometer
- GHOST high-R optical spectrometer
- GNAO (AO development, part of GEMMA)
- GIRMOS (Canada), IGRINS-2 (Korea)

Popular Visiting Instrument program

- Maroon-X
- Alopeke/Zorro
- IGRINS…





Discovered ionized calcium with high-resolution spectra obtained with Gemini North on Hot Jupiter, WASP-76b

- Part of ExoGemS survey exploring diversity of planetary atmospheres

Gemini

The fiery exoplanet WASP-76b – a so-called hot Jupiter, where it rains iron – may be hotter than previously thought.

Credit: ESO/M. Kornmesser

Rubin: 10-year *Legacy Survey of Space & Time* (LSST) using 8.4-m telescope and world's largest digital camera

Dark Matter, Dark Energy

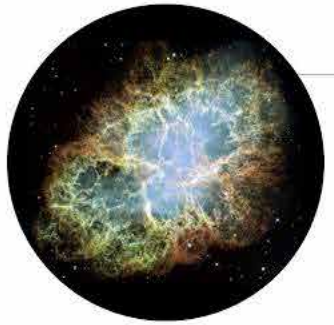
- Weak Lensing
- Baryon acoustic oscillations
- Supernovae, Quasars

Cataloging the Solar System

- Potentially Hazardous Asteroids
- Near Earth Objects
- Object inventory of the Solar System

Milky Way Structure & Formation

- Structure and evolutionary history
- Spatial maps of stellar characteristics
- Reach well into the halo



Exploring the Transient sky

- Variable stars, Supernovae
- Fill in the variability phase-space
- Discovery of new classes of transients

"From Science Drivers to Reference Design", Ivezić et al. (2008), arXiv:0805.2366

- Integration and launch of NOIRLab essentially completed in 2020
  - Transition funded through FY20-FY21, though some activities ongoing
  - Ramp up of operations and staffing for Rubin
- Renewal of funding for all NOIRLab programs, as a single, integrated organization, for five years starting in FY 2023
  - Three "linked" proposals plus Rubin ops plan to be reviewed in Jan 2022
  - Renewal of Gemini CSA, MSO/CSDC CSA, and start of Rubin Ops CSA in FY23

Funding timelines now aligned so NOIRLab can be viewed, reviewed, and ultimately recompeted as a single organization

- Gemini
  - Renewal of international agreement for 6 years before end of CY 2021
  - Various major instrument development milestones (GNAO, SCORPIO, etc.)
- Rubin
  - Completion of construction and commissioning; transition to operations
  - Data management (Interim data facility – US data facility [SLAC])
- US-Extremely Large Telescope (US-ELT)
  - Development of Program Office underway at NOIRLab
  - NOIRLab partnering with TMT and GMT; preparing for a positive outcome from *Astro2020*

- Rubin
- 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)

The Top-End Assembly for the Telescope Mount Assembly (TMA) was lifted by crane into the observatory dome an installed on the TMA on March 2, 2021. The task was completed successfully and was a highly celebrated milestone for Rubin Observatory. *Credit: Rubin Observatory/AURA/NSF.*

NSF's National Optical-Infrared Astronomy Research Laboratory NOIRLab
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Milestones, Opportunities, Challenges

1. Responding to Astro2020
   - NOIRLab's role in US-ELT
   - Responding to other recommendations in OIR astronomy
2. Rubin transition to operations
   - Further (COVID-related) delays to Rubin commissioning
3. Future of Kitt Peak
   - Neither WIYN (separate CSA) nor Mayall (DOE ops funding) part of renewal
4. Future of astronomy on Maunakea, Hawaii
   - Renewal of Master Lease and construction of TMT
5. Dark Skies and impact of Satellite Constellations on astronomy

Solar

SOLIS

DKIST

EPO

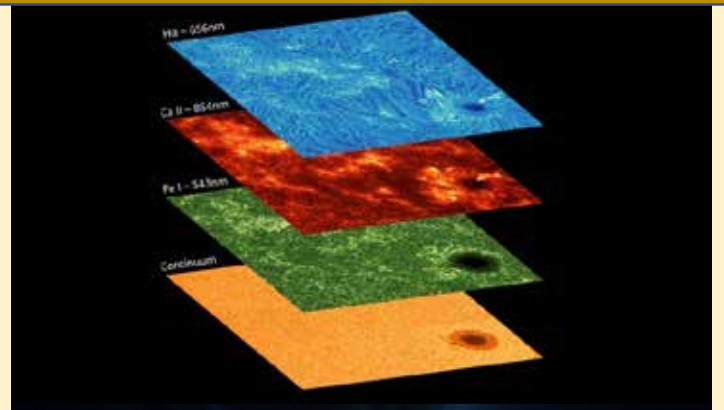
GONG – Cerro Tololo

Dunn Solar Telescope

GONG – Big Bear

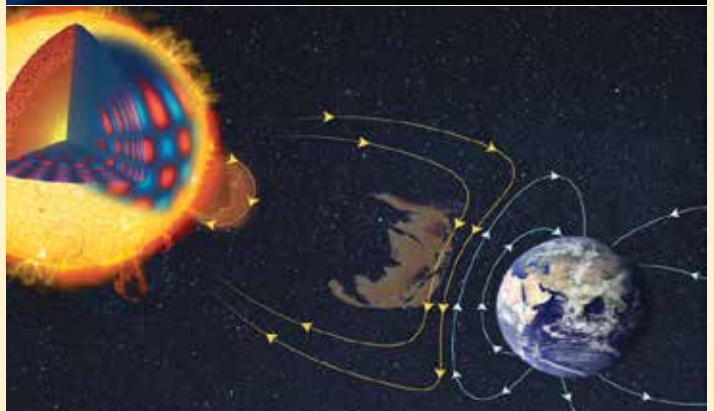
Mission: The mission of the NSO is to advance knowledge of the Sun, both as an astronomical object and as the dominant external influence on Earth.

Forefront Capabilities: NSO operates the world's most extensive collection of ground-based optical and infrared solar telescopes and instrumentation.



Sun as an Astronomical Laboratory

From the solar interior to the outer corona

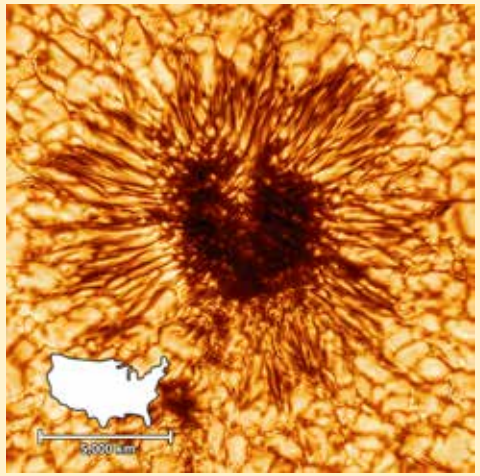


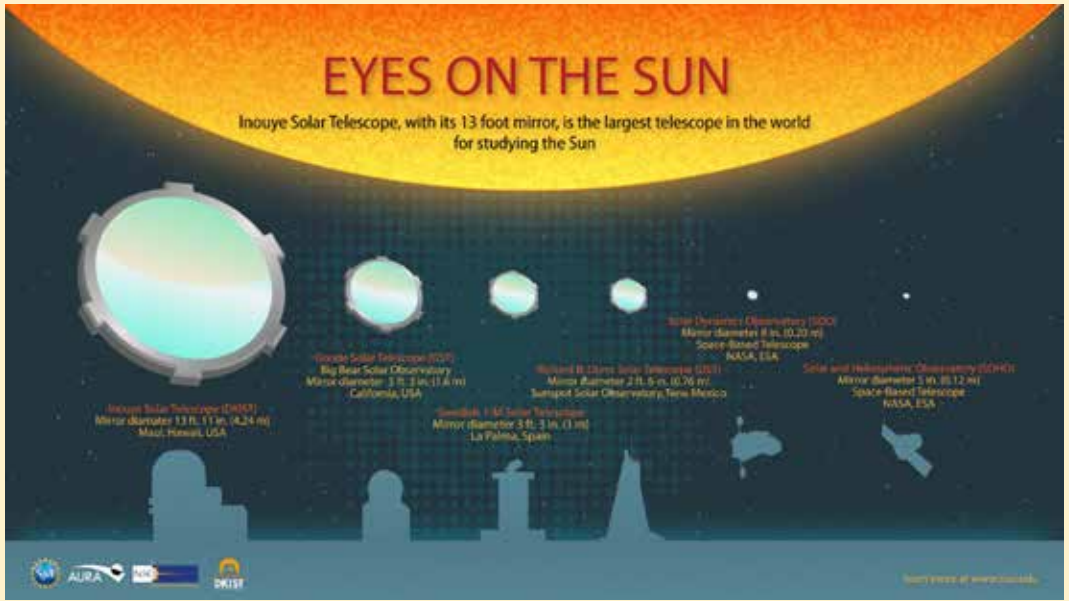
Earth-Sun Interactions

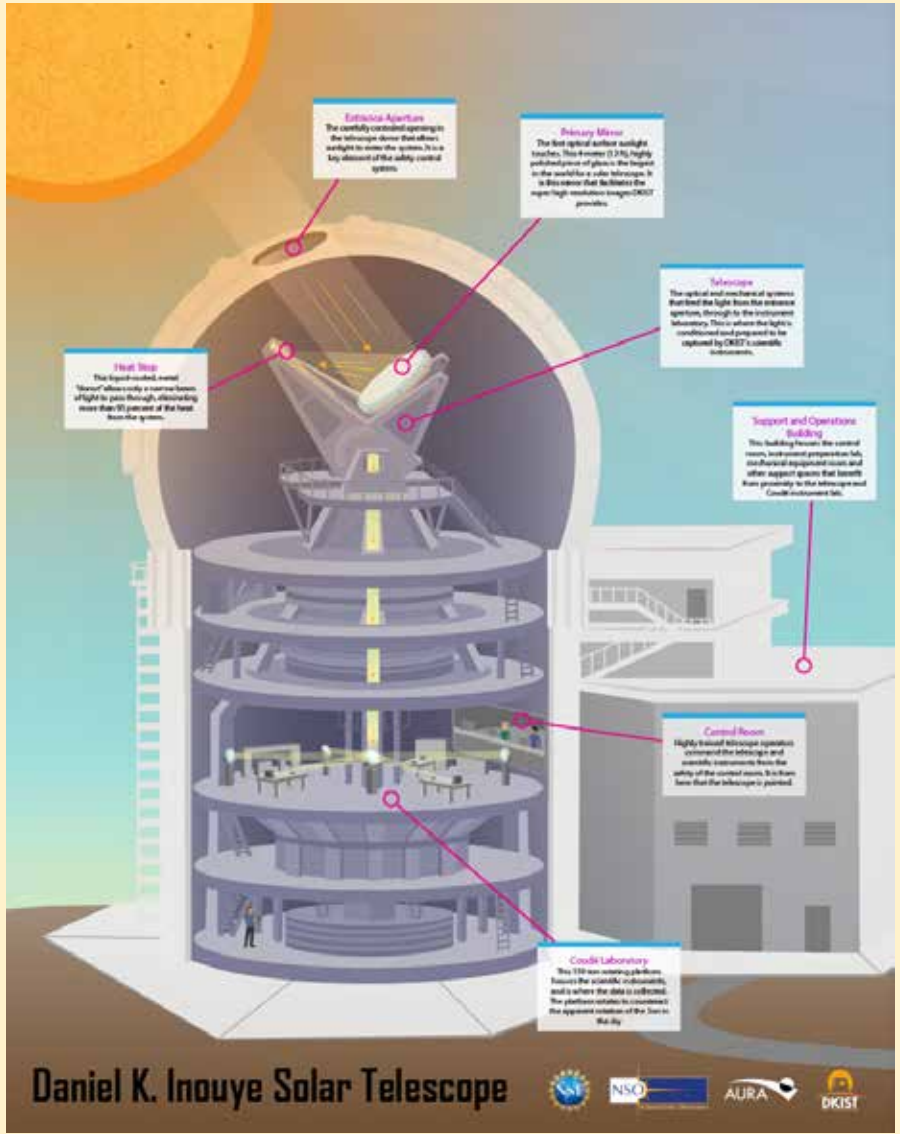
Space Weather

DKIST

- Will focus 12kW of solar power on the 4m mirror
  - Observe all day, make ice all night
- DKIST will resolve to 25km
  - Plasma kinetic scales, small scale vector magnetic fields

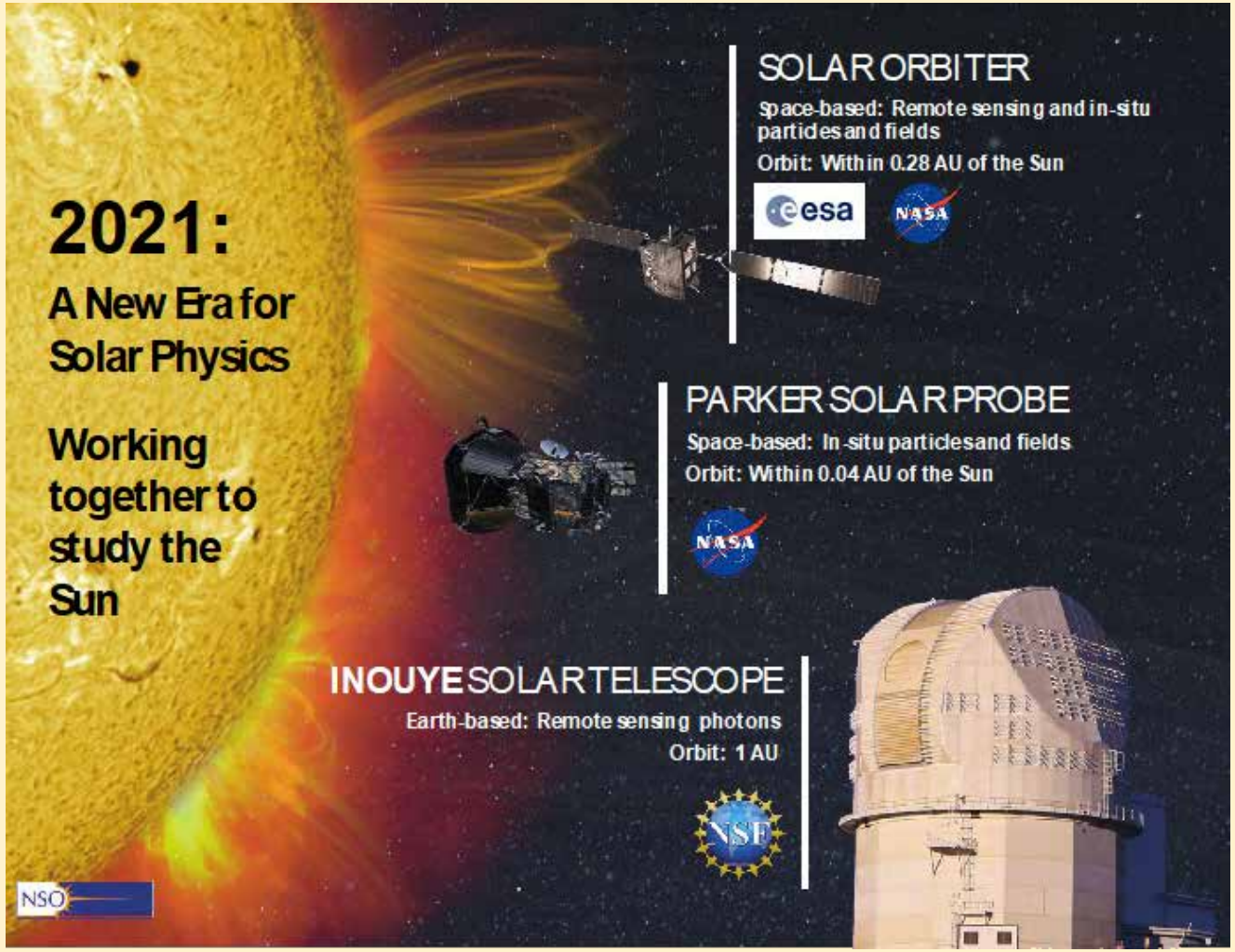






DKIST

- on schedule for transition to operations early Dec 2021
  - All four instruments have completed site acceptance tests, and two have completed Science Verification (SV) and other two have collected on-sky SV data



1. First Science at DKIST to begin December 6, 2021
   - future DKIST ops funding
2. GONG and Dunn Solar Telescope are continuing to operate
   - GONG is renewing an IAA with NOAA/SWPC
3. Solar and Space Physics decadal survey and ngGONG
4. Eclipses 2023 and 2024
   - Citizen CATE/ SuperCATE (Continental America Telescopic Eclipse)
   - support of small science grants
   - multi-agency cobranded safety materials

Radio

NSF's Radio Facilities
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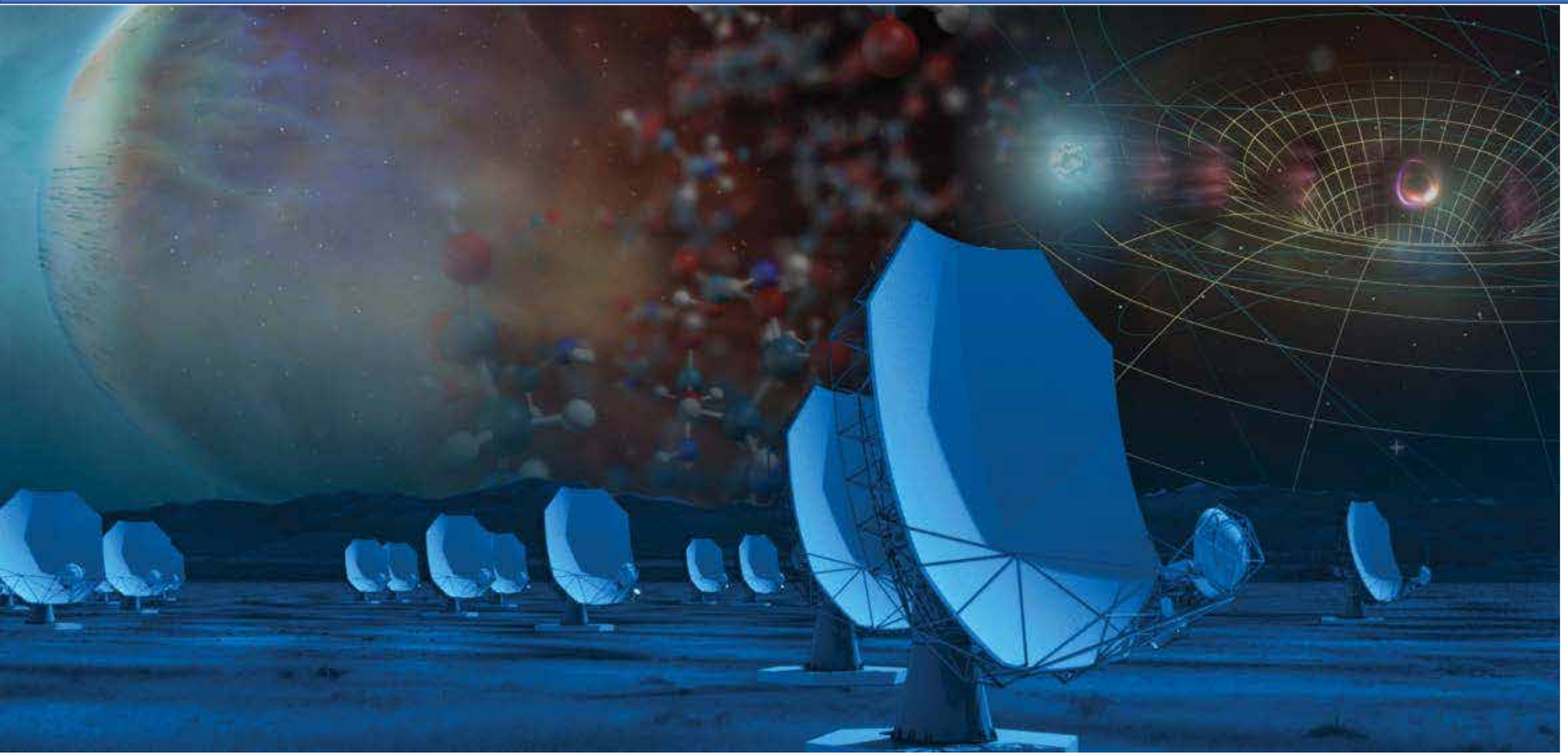
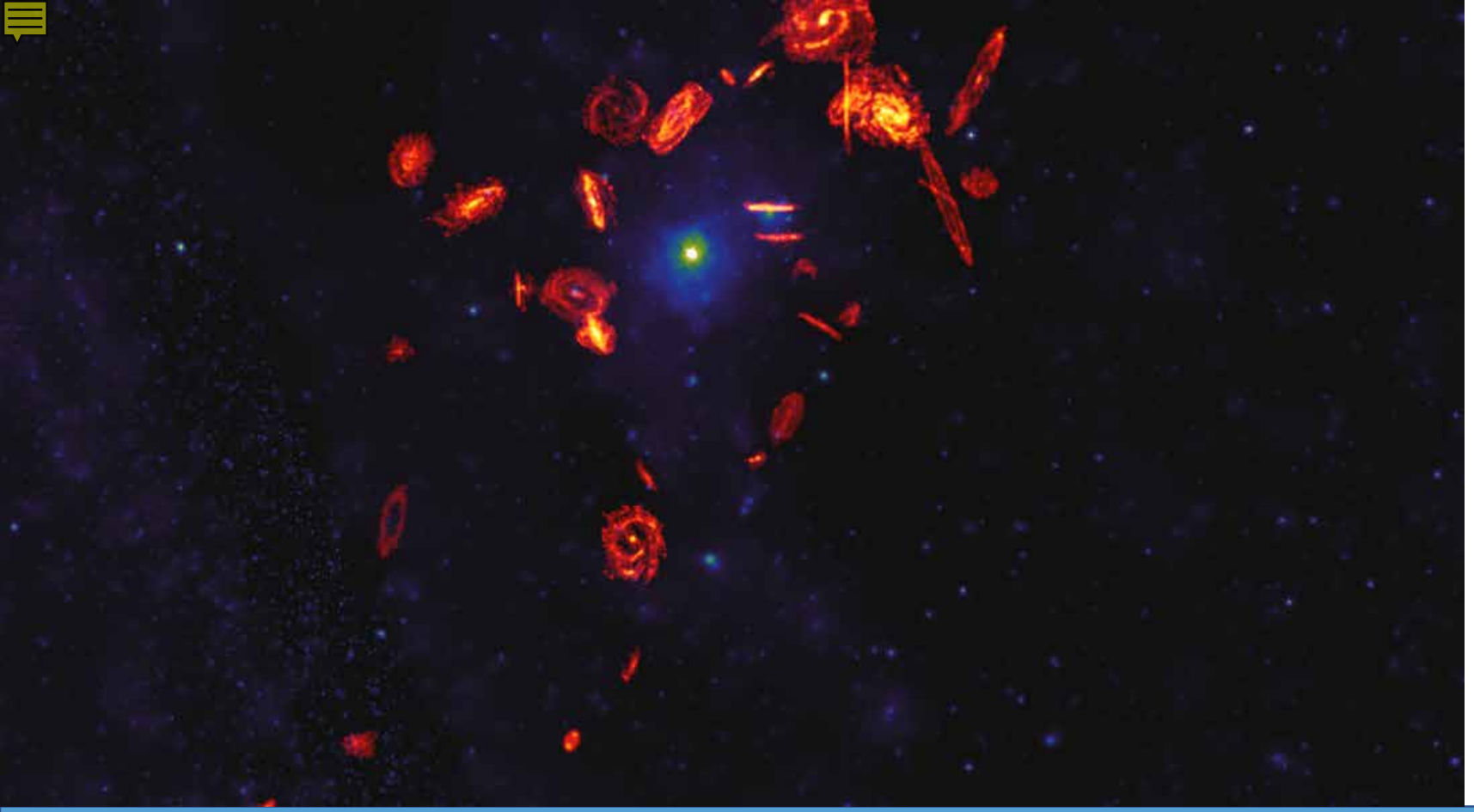




Currently operating as usual

- o VLA, ALMA and VLBA fully operational
- o NRAO management devised Covid-19-safe practices for maintenance and operations



Completed largest high-resolution survey of star-forming fuel ever conducted in galaxy clusters

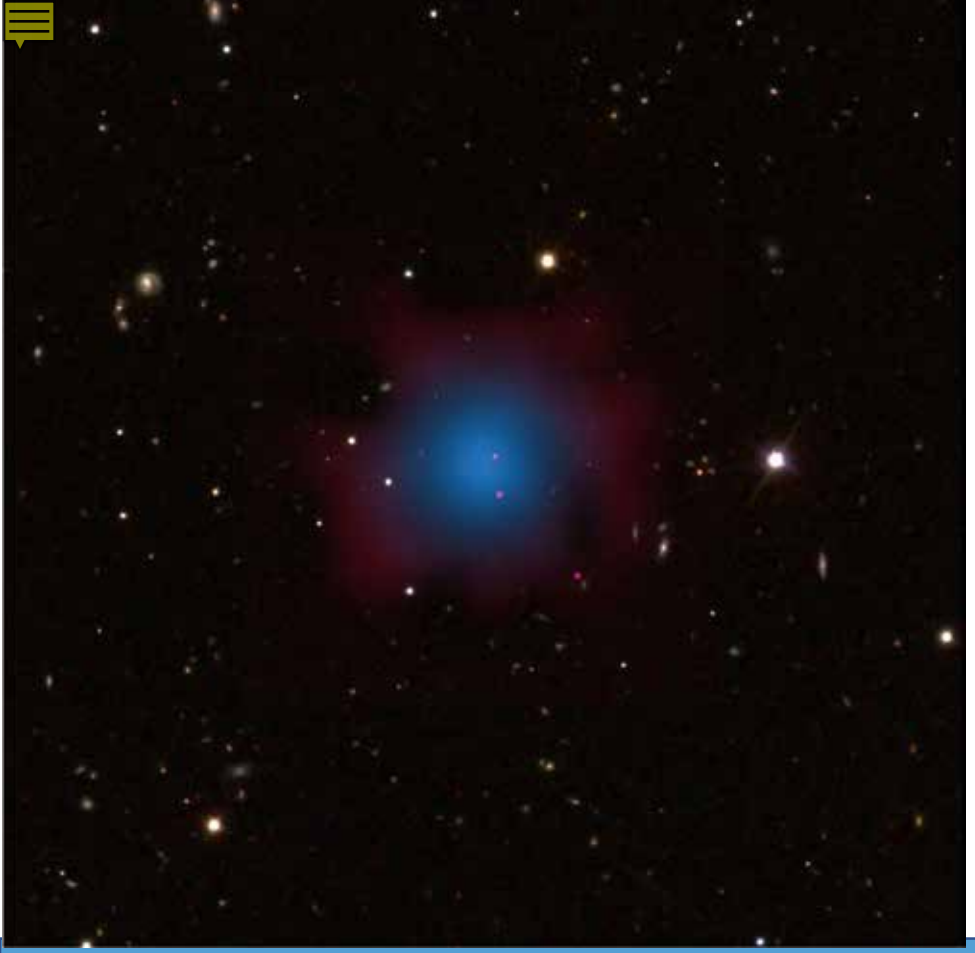
- 51 galaxies in Virgo cluster
- Brown et al. (2021); ApJSS

ALMA also detected water in most massive galaxy in early Universe (12.88 billion light years) and a galactic wind driven by supermassive black hole 13.1 billion light years away

ALMA

The VERTICO—Virgo Environment Traced in Carbon Monoxide—Survey observed the gas reservoirs in 51 galaxies in the nearby Virgo Cluster and found that the extreme environment in the cluster was killing galaxies by robbing them of their star-forming fuel. In this composite image, ALMA's radio wavelength observations of the VERTICO galaxies' molecular gas disks are magnified by a factor of 20. They are overlaid on the X-ray image of the hot plasma within the Virgo Cluster.

Credit: ALMA (ESO/NAOJ/NRAO)/S. Dagnello (NRAO)/Böhringer et al. (ROSAT All-Sky Survey)



Massive galaxy cluster (z=1.75) close to the epoch when it began to emerge from cosmic web

- Combined effort with Green Bank Telescope (MUSTANG-2), Chandra, and SDSS data; Mustang-2 is a 223-feedhorn bolometer camera with fastest mapping speed for continuum observations at 90 GHz (June 2021 publication)

Radar transmitter capabilities demonstrated with images of Tycho crater on the Moon (September 2021)

Green Bank Observatory

Composite image using MUSTANG-2, Chandra, and SDSS data. The faint red glow shows the hot gas at large radii. galaxies present in MUSTANG-2 and Chandra appear as point sources (in magenta) and density of the comparatively cool gas (in blue); galaxies in optical (SDSS) data are in the foreground.

Credit: Phillip Cigan/Stefano Andreon/Charles Romero

Arecibo

- Safety consistently prioritized
- Emergency cleanup expected to be complete by early December, 2021
  - Damage assessment
  - Debris cleanup
  - Environmental – No hazardous materials released as a result of the collapse; sampling analysis of groundwater and surface water; soil sampling and soil removal where hydraulic oil had been released

Silt fences installed for pollution prevention
Photo taken during NSF's site visit

Intact dish components and tops of towers are being stabilized

Historic Buildings being retained and repaired.

ALFA Receiver

Reflector Panels

Cable Car House (Building 5) and Cable Car

Salvage Survey Committee

- Ø Advisory Committee established jointly by NSF and UCF includes Arecibo Observatory staff, historians and curation experts
- Ø Identify objects of potential scientific, cultural, or historic value to be preserved for potential display at the site or other museum
- Ø Longer-term curation agreement under development

- Ø NSF sponsored a workshop in June (see NSF 21-055)
- https://arecibo.hub.ki/
- Initial informational talks given April 2, 2021; recording is available at link
- More than 100 participants
- Ø **NSF will carefully consider input from**
  - June workshop
  - Scientists via established decadal planning processes
  - Merit-review of submitted proposals
  - Environmental/historical considerations

Workshop's goal was to facilitate ideas for

- next generation science in astronomy, atmospheric and geospace sciences, planetary radar or related fields
- inclusive educational and cultural programs
- robust radio science programs, including engineering, instrumentation and radio frequency interference (RFI) mitigation

1. Responding to Astro2020
   - NRAO role in ngVLA
   - New MSIP FY2021 to prototype ngVLA antenna
2. Maintenance / Development for ALMA - possible partnership redefinitions in future (increased costs for O&M)
3. Spectrum management – constellation satellites
4. NRAO lost about 30 people implementing vaccine mandate; NRAO is now ~30% teleworking.

Individual Investigator Programs

1. AST grants are being submitted now (CAREER, AST)
2. A new program: Partnerships in Astronomy & Astrophysics Research and Education (PAARE) was just approved. Will be announced in a couple of days. We will continue to sustain well-developed partnerships, extend the range of eligible institutions, and provide shorter-term support to develop new partnerships. We will arrange a webinar and provide more information at the AAS meeting.

FY 2022 Programs and Deadlines

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

* NSF-wide solicitations

COVID Summary

- 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
- 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

- 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 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.

Constellation Satellites

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Satellite Constellations

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)

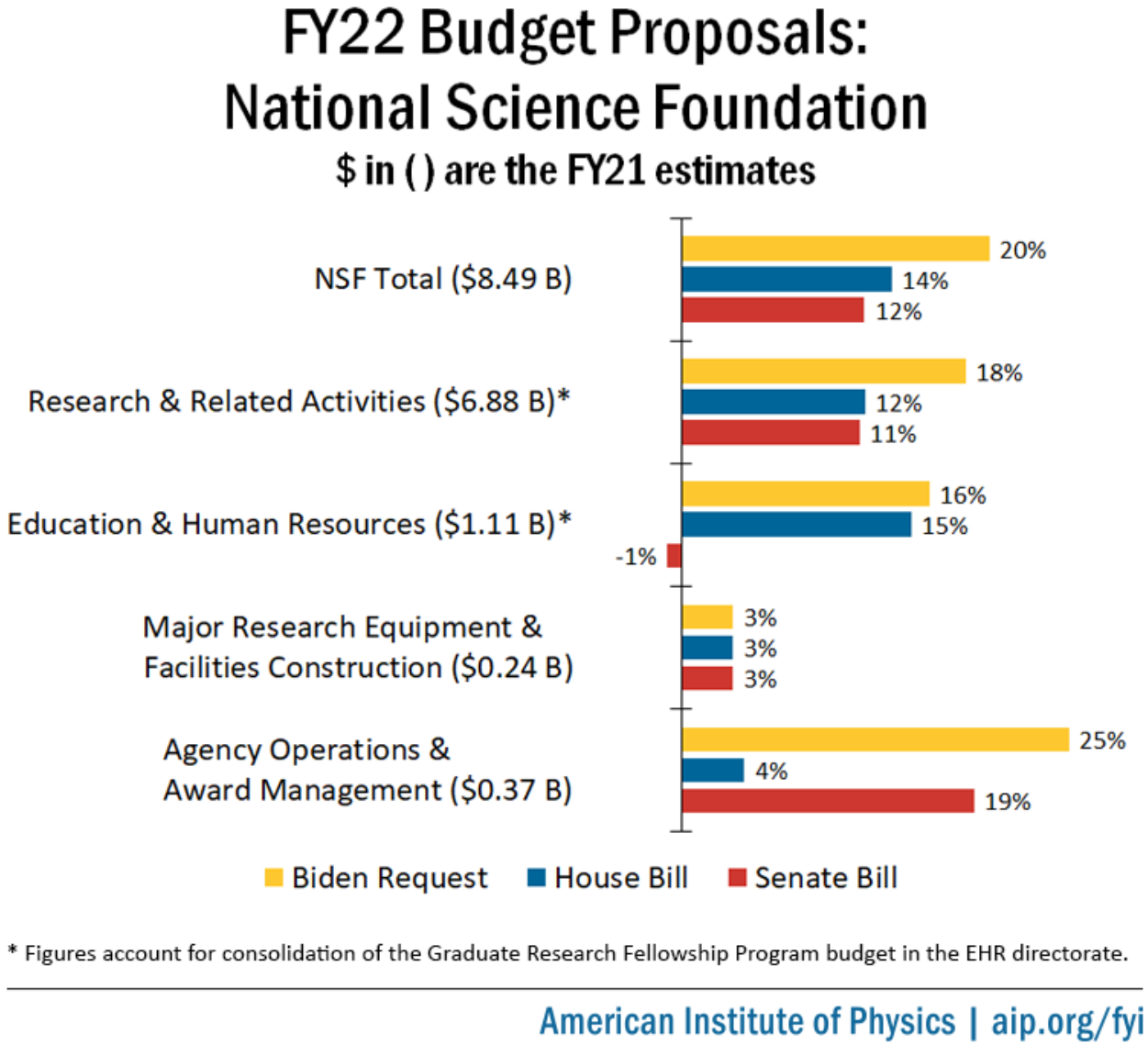
Radio Frequency

- 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's Spectrum Innovation Initiative
  - NSF's 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/

Preparations for Astro 2020



Proposed FY22 budget. MREFC line reflects current, closing projects and not necessarily a future commitment.

- We are pleased with the vision and opportunities for inter-agency synergies. We plan to work within fiscal constraints of the NSF AST budget to implement as much of that vision as possible.
- Good news: recommendations for transparency, workforce development, DEI all align with NSF priorities and we can build on this (e.g., PAARE program).
- Caution: potential increases in NSF's budget tend to be tagged to innovation and competition, and not just for fundamental research such as astronomy. Thus, if NSF's total budget goes up by some percentage, that does not necessarily mean that the budget for fundamental research will go up by the same percentage.
- Note: the recommended Decision Rules for the US ELT, and specifically the Astro2020 recommendation for an external programmatic review of the viability of both projects in 2023 is quite good advice. This would come after the FY 2024 budget request has gone to Congress, so the earliest possible construction funding request for a US ELT is FY 2025.

Questions/Discussion?