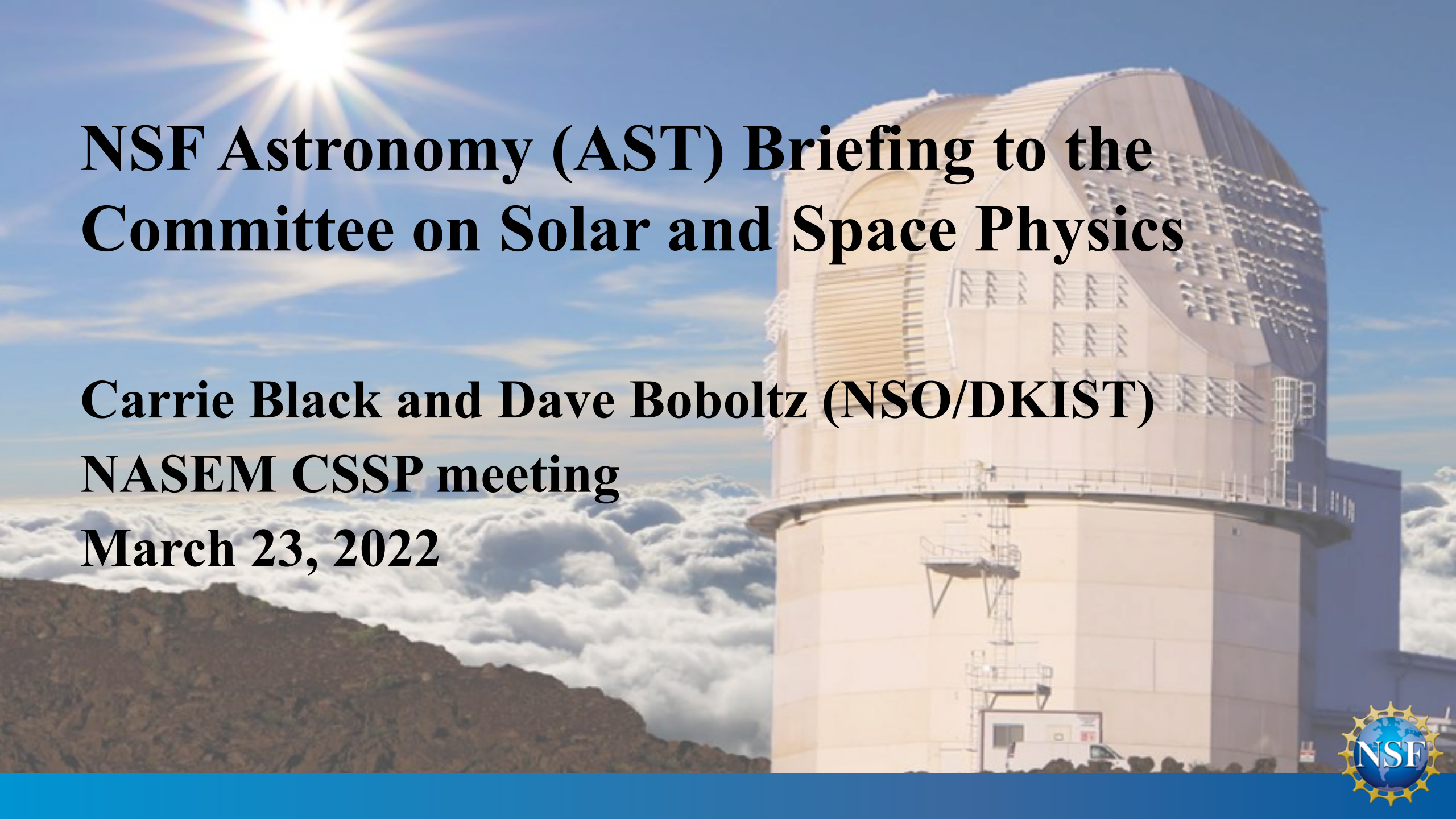




# **NSF Astronomy (AST) Briefing to the Committee on Solar and Space Physics**

**Carrie Black and Dave Boboltz (NSO/DKIST)**

**NASEM CSSP meeting**

**March 23, 2022**



# FY 2021 Appropriation and FY 2022 PBR

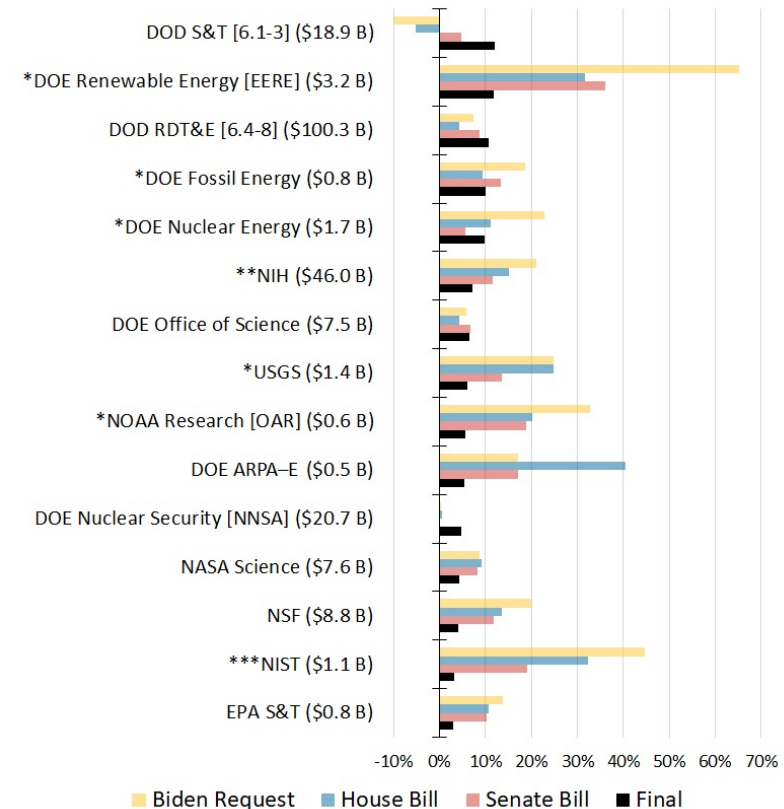
|           | FY21<br>Enacted | FY22<br>Request |
|-----------|-----------------|-----------------|
| NSF Total | \$8.48B         | \$10.3B         |

| AST<br>Budget | FY21<br>Estimate | FY22<br>Request |
|---------------|------------------|-----------------|
| AST Total     | \$277M           | \$294M          |
| Facilities    | \$219M           | \$216M          |
| Research      | \$53M            | \$73M           |
| Education     | \$5M             | \$5M            |

NSF topline \$8.838B  
4% increase, MREFC  
unchanged

AST PBR 6% increase

**FY22 Appropriations**  
% change from FY21 enacted  
\$ in ( ) are FY22 amounts



\* Excludes funds from the Infrastructure Investment and Jobs Act.  
 \*\* Includes funds for ARPA-H. The final bill provides \$1 billion for ARPA-H outside of NIH but allows for the money to be transferred to NIH.  
 \*\*\* Excludes earmarks.

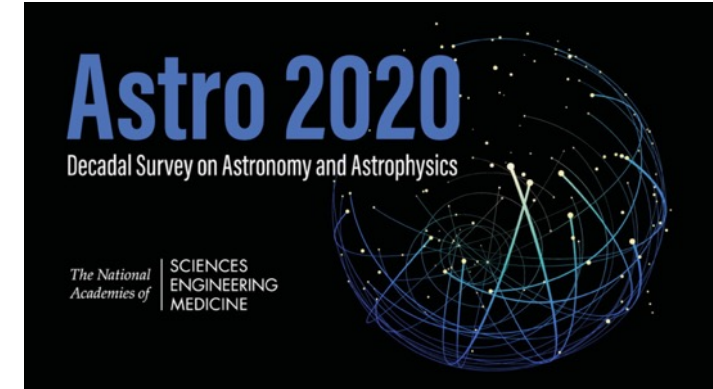


# Grants Programs

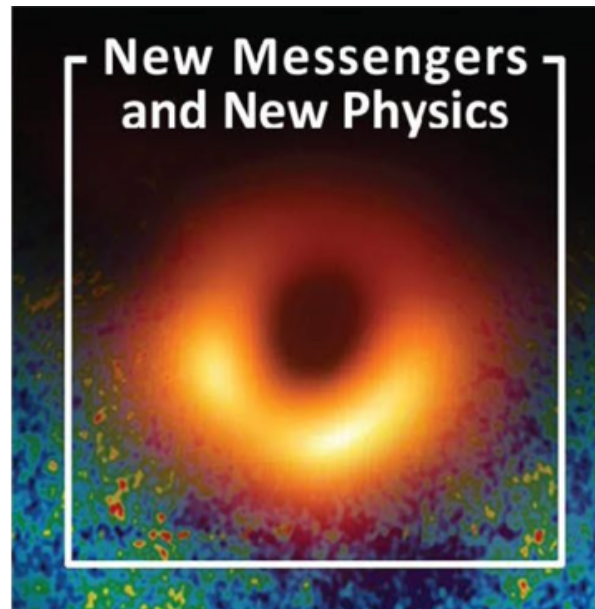
- Cover Solar Physics, Astrophysics and Planetary Science – including exoplanets
- Astronomy and Astrophysics Research Grants (AAG)
  - Solicitation: NSF 18-575
  - Deadline November 15
- Advanced Technologies and Instrumentation (ATI)
  - Solicitation: NSF 18-576
  - Deadline November 15
- All AST programs accept proposals for exoplanet research including the Astronomy and Astrophysics Postdoctoral Fellowship (AAPF).
  - CAREER
  - Graduate Research Fellowship Program (GRFP)



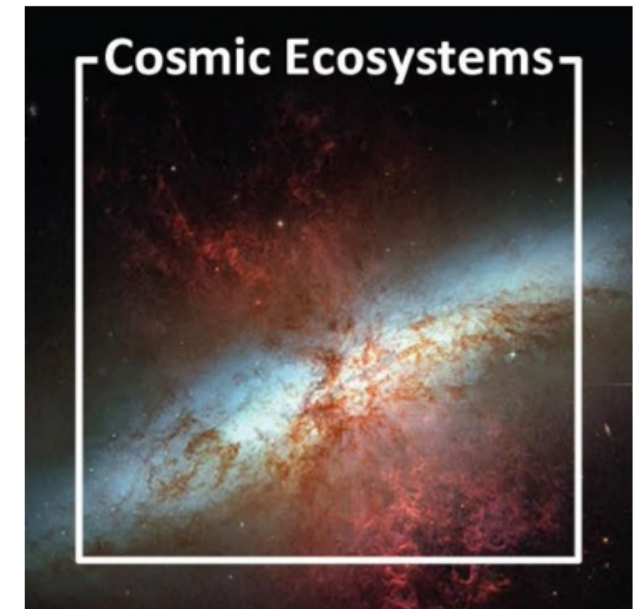
# Astro2020 Decadal Survey Science Themes



*Stars & Planets and the Search for Life Beyond the Solar System*  
Understanding star and planet formation and identifying earth-like extra-solar planets



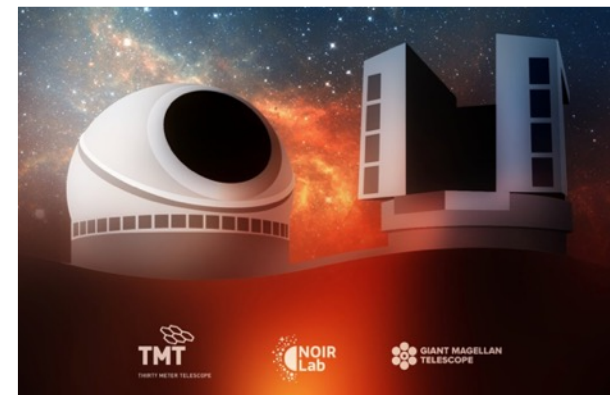
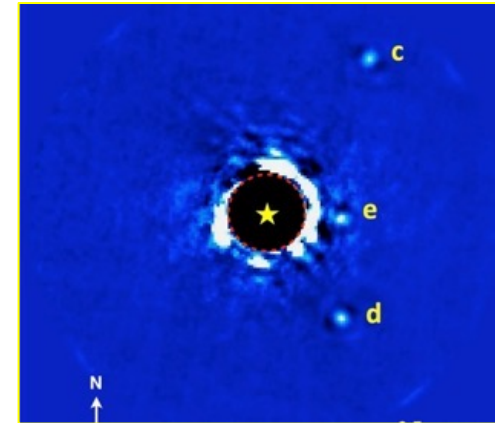
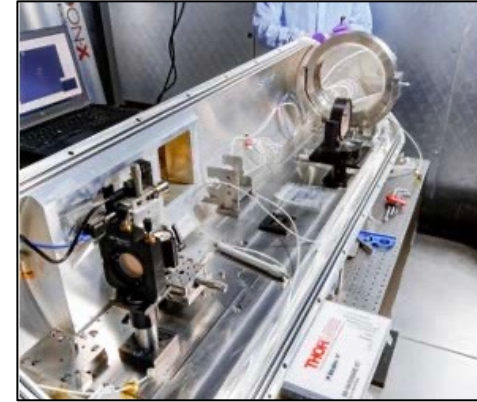
*Explosive Transients, New Messengers, Dark Energy*  
Combining time-resolved EM data with particles and GW to probe black holes, neutron stars, explosions and mergers.



*From Gas and Dust to Stars and Galaxies*  
Linking the cosmic web of gas and dust to the formation and evolution of galaxies.

# Exoplanet Research Support at AST Facilities

- Arecibo claimed the first discovery of an exoplanet in 1982.
- **\*All\*** NSF AST Major Facilities across the visible, IR, sub-mm, and radio are (or can be) employed in exoplanet discovery.
  - Optical (radial velocities): MAROON-X on Gemini North
  - IR: Gemini Planet Imager (GPI) on Gemini South
  - Sub-mm, Radio: ALMA, VLA
- Also support exoplanet research at observatories such as
  - Lowell Observatory, Whipple Observatory
- Recommendations from Astro2020 for future facilities
  - US-ELT
  - ngVLA



# NASA-NSF Exoplanet Exploration Program (NN-EXPLORE)

- Discovery and characterization of exoplanets
- NASA-NSF Partnered to develop **NEID**
  - A radial velocity instrument designed to measure the motion of nearby stars with extreme precision
  - Most promising current approach to eventually discover Earth analogs
- Mounted on the 3.5-meter WIYN Telescope at KPNO
- First Light in 2020
- Post development:
  - NSF provides the infrastructure,
  - NASA provides Guest Observer awards, tools, and archive.



- Two principal components shown here
- Port Adapter (U. Wisconsin-Madison)
  - Spectrograph (Penn State)

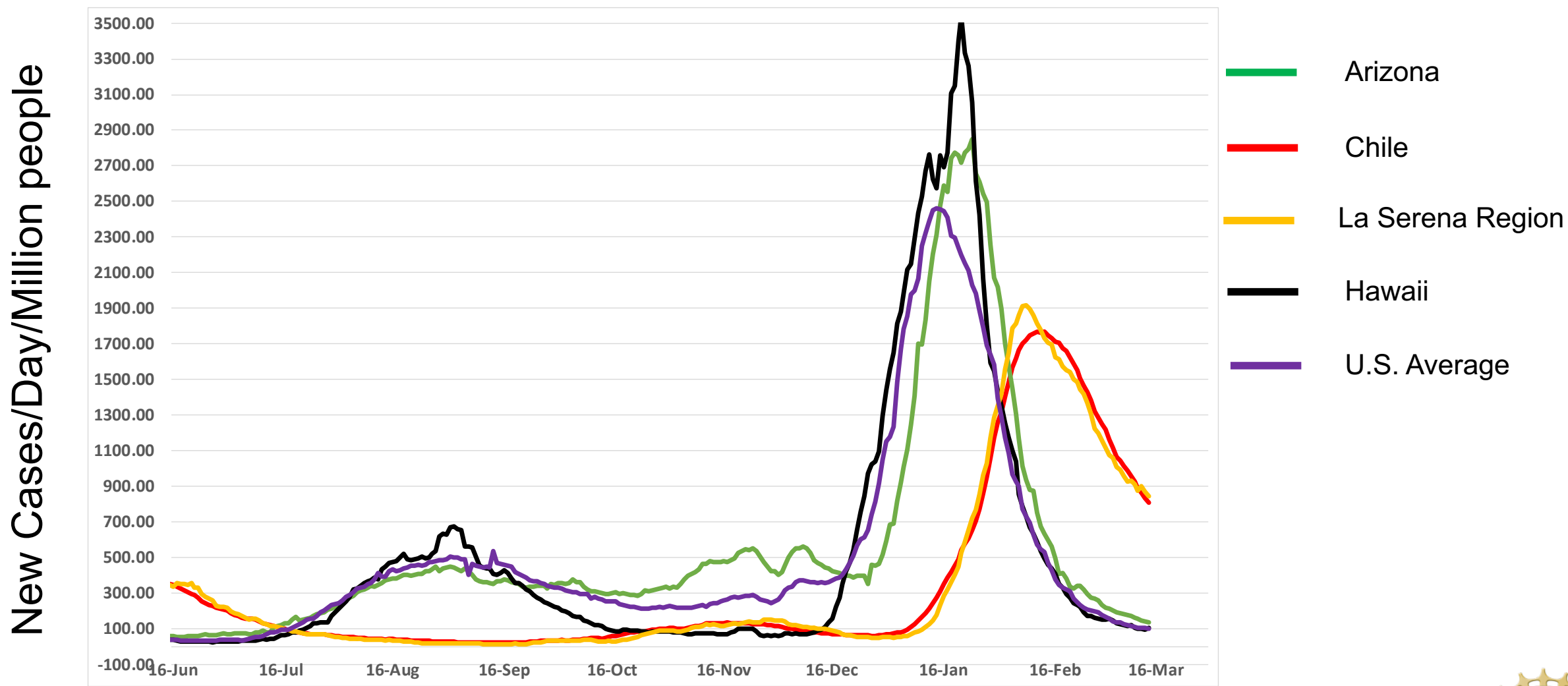


# Synoptic Optical Long-term Investigations of the Sun (SOLIS) for Exoplanets

- NSO's SOLIS has sun as a star capabilities
  - Combined use of the Vector Spectromagnetograph (VSM) and the Integrated Sunlight Spectrometer (ISS) can be used for exoplanet science
  - Can be used for modeling of the magnetic field influence on the spectrum. This provides insight into the environments to which exoplanets may be subject.



# COVID Trends at AST Facility Sites



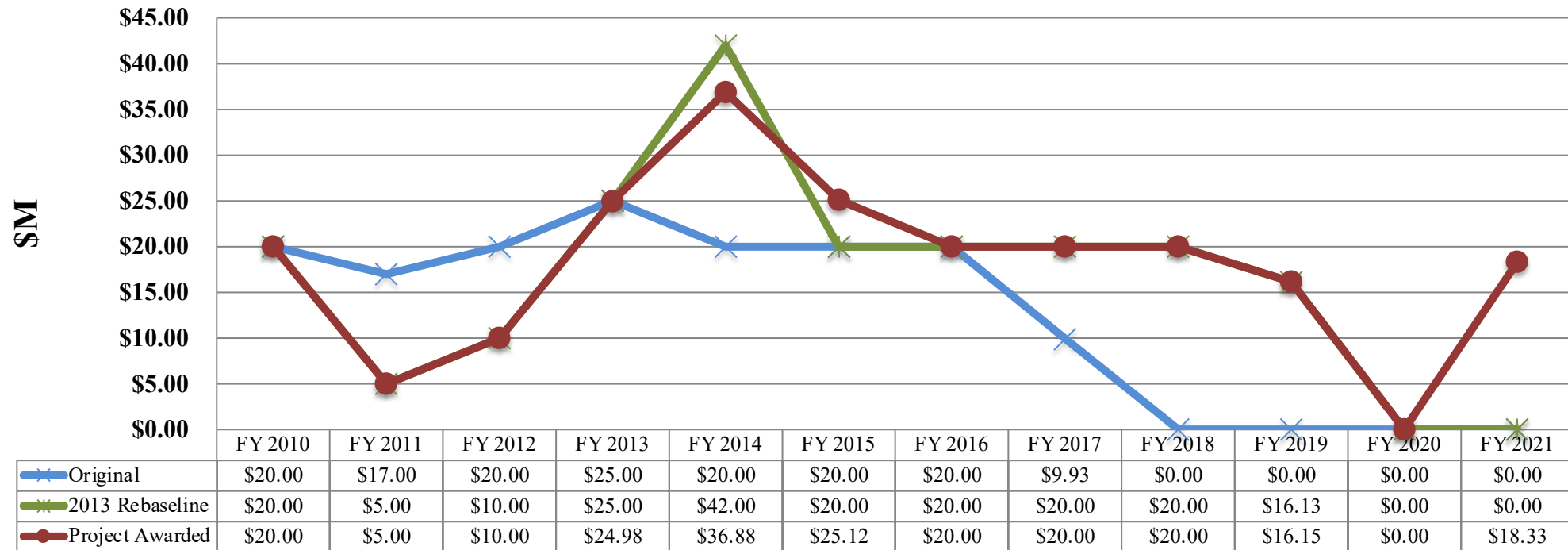
# Impacts of COVID-19 on DKIST Construction

- **March 17, 2020:** DKIST site construction halted and access to the DSSC offices closed to all non-essential personnel.
- **May 29, 2020:** Restart review held. DKIST site construction approved for Phase I restart
- **June 4, 2020:** DKIST site construction restarted
- **June 22, 2020:** NSF Acting Director **authorized Management Reserve** up to \$9.4M
  - COVID-19 impact is an **unforeseeable (NSF-held) risk** that was realized
- **July 6, 2020:** Project transitioned to a modified Phase 1 (Phase 1b) return-to-work
- **Nov. 2020 – March 2021:** Large COVID-19 spike in the U.S.
- **Feb. 24, 2021:** The **NSB authorized the NSF Director** to award **additional Management Reserve** up to \$9.5M



# DKIST MREFC Funding Profile

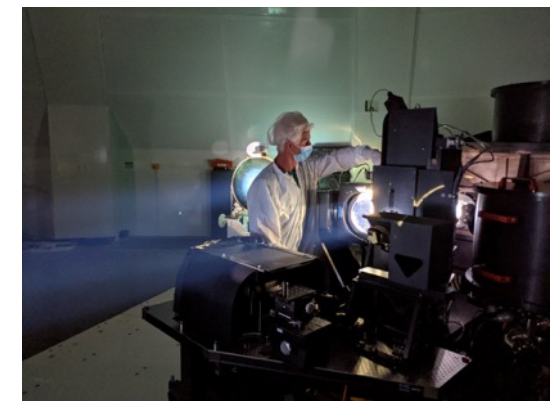
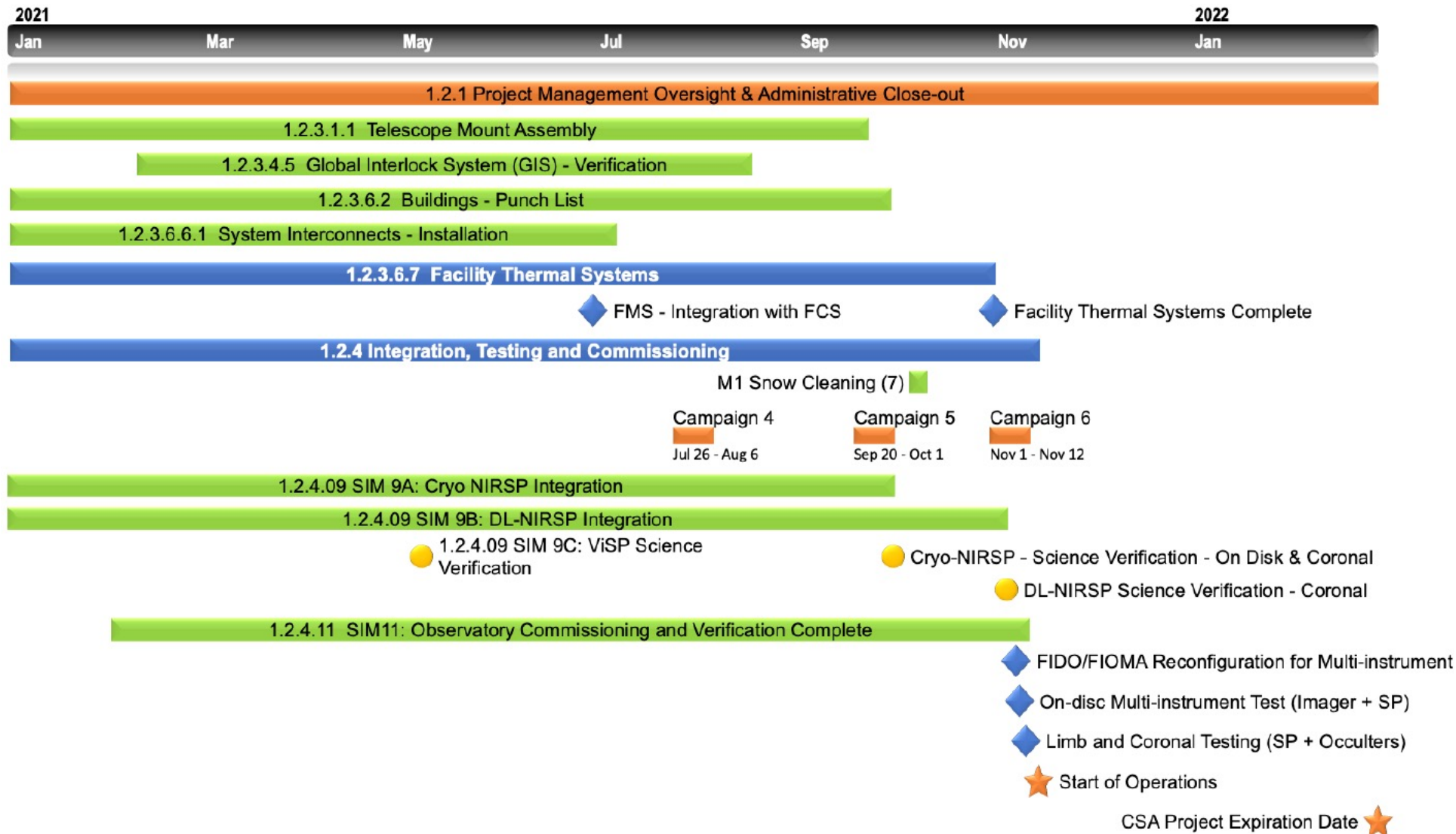
MREFC Funding Profile for DKIST



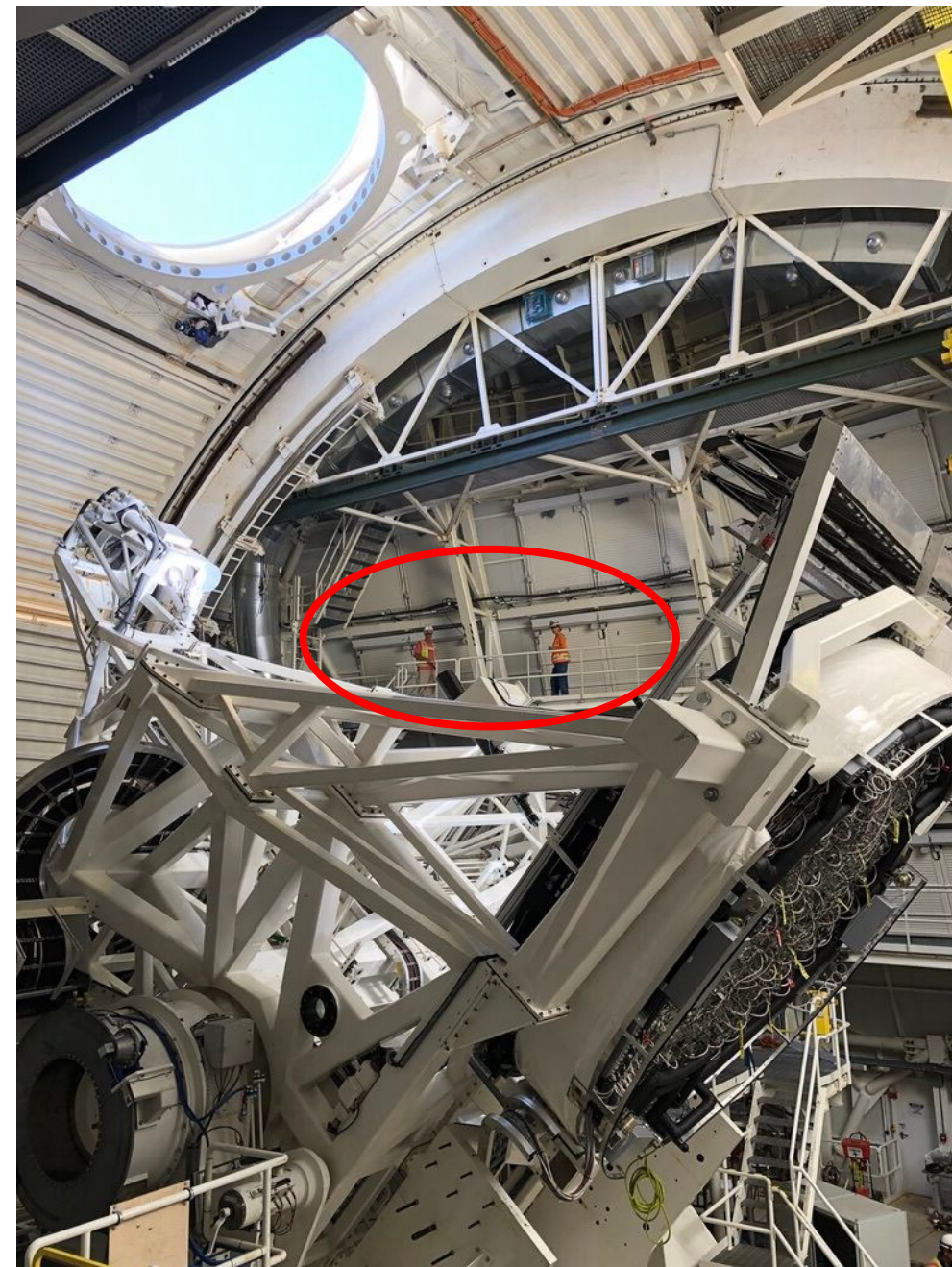
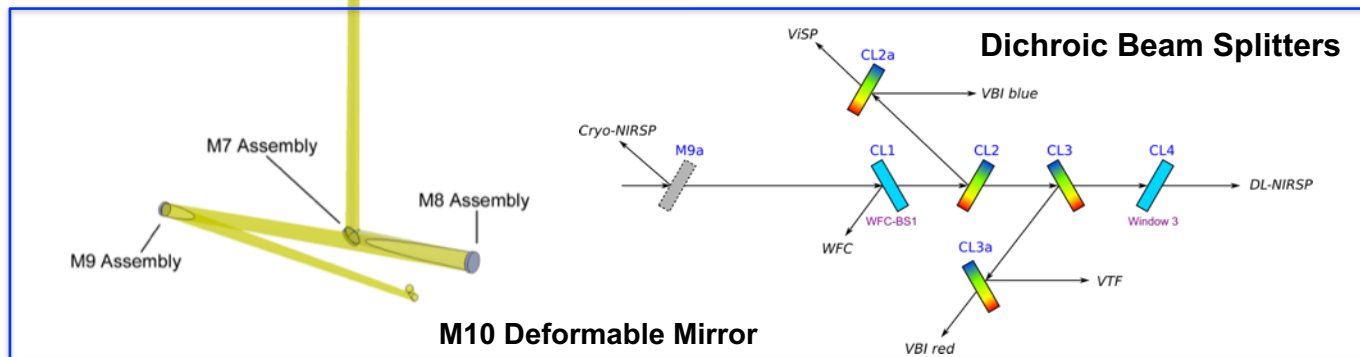
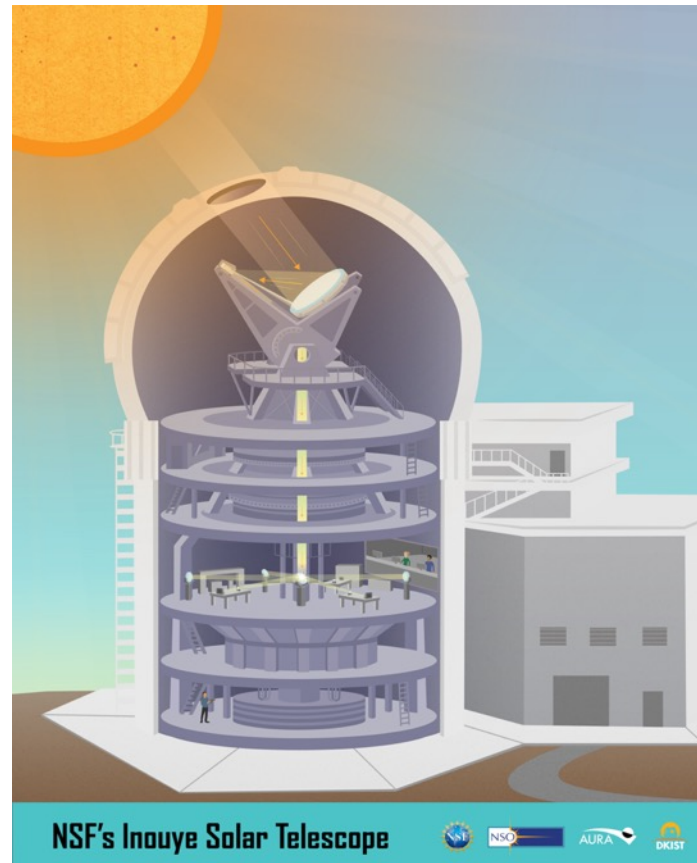
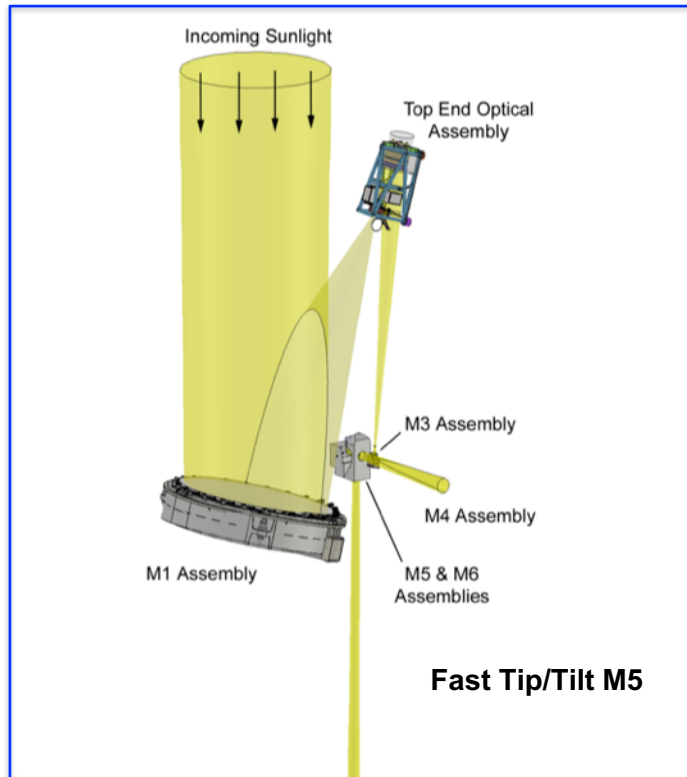
- Additional **\$18.33M** in Management Reserve Authorized by NSF for mitigation of **14 months of schedule delay** due to COVID-19
- DKIST Total Project Cost = \$344.13M + \$18.33M = **\$362.46**



# Project Completion – Nov. 19, 2021



# DKIST Optics



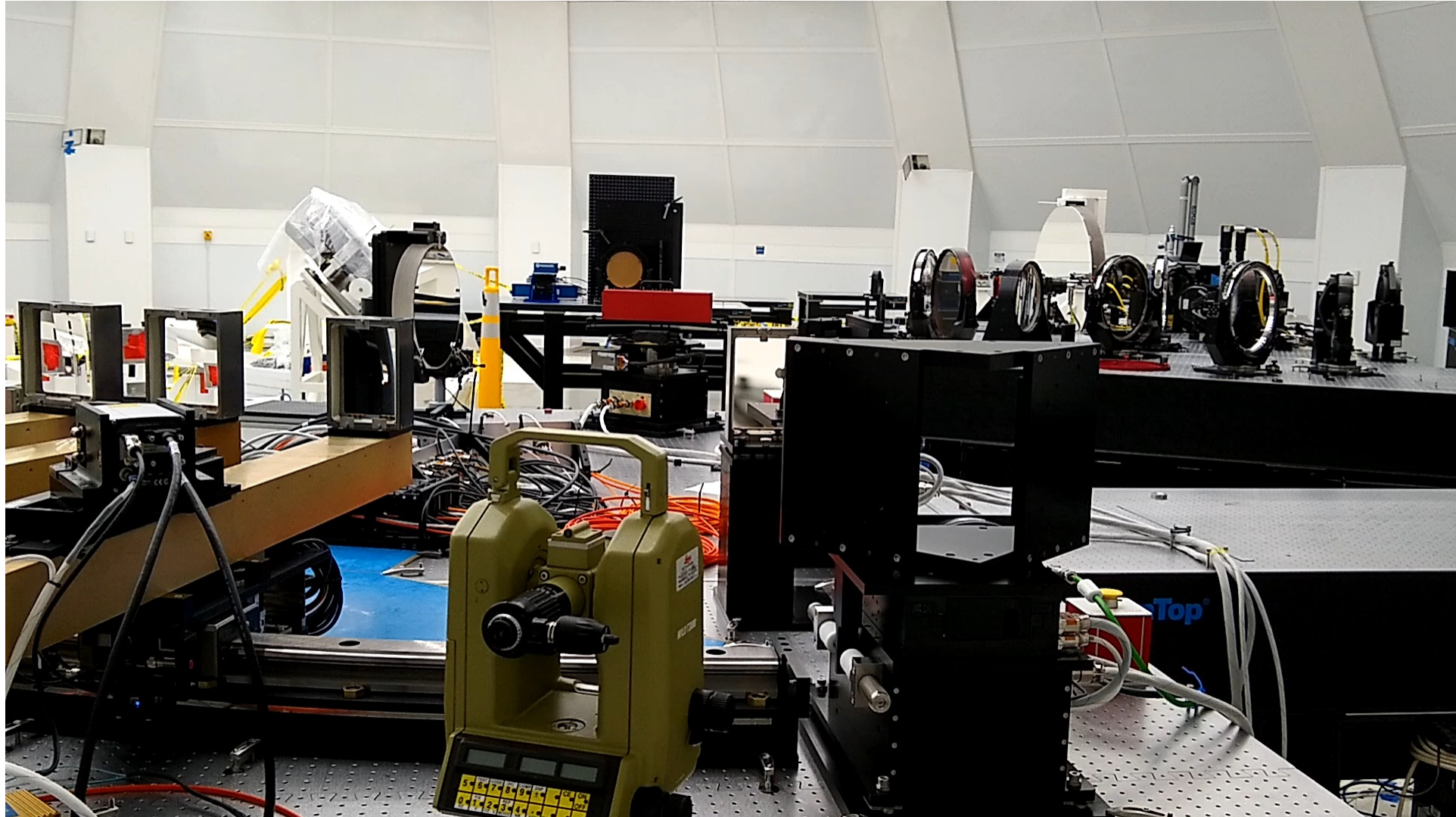
# IT&C Instrument Status – December 2021



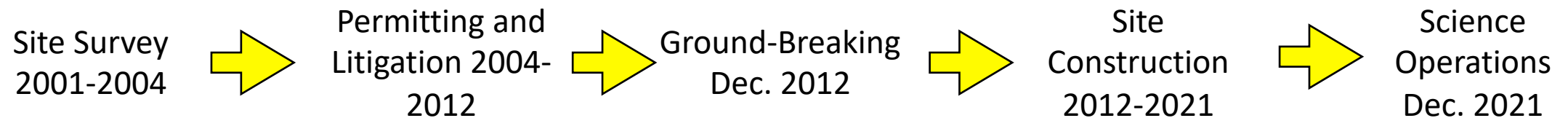
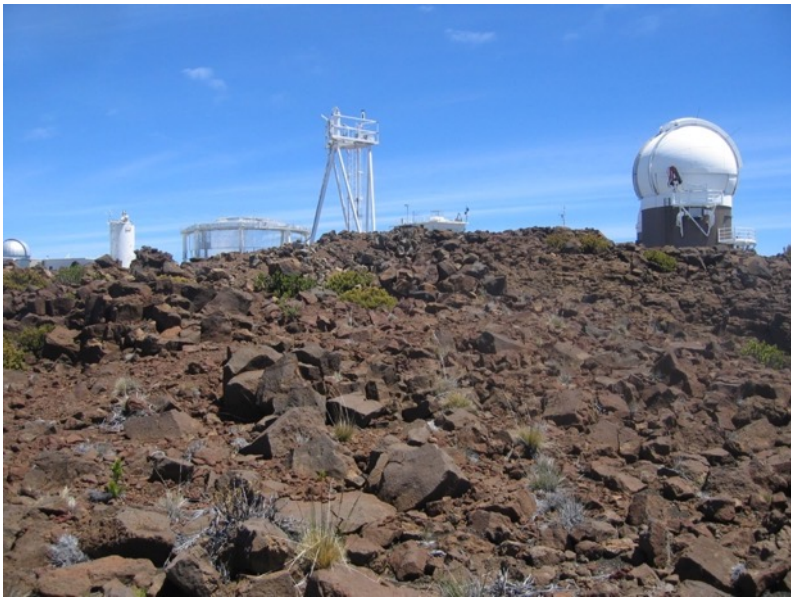
| Instrument                                                | Procurement & Fabrication | Lab Assembly | Lab Acceptance Test Plan (LAT-P) | Lab Acceptance Test (LAT) | Delivery to Summit | Site Integration, Test & Commissioning (IT&C) | Site Acceptance Test Plan (SAT-P) | Site Acceptance Test (SAT) | Science Verification Plan (SV-P) | Science Verification (SV) |
|-----------------------------------------------------------|---------------------------|--------------|----------------------------------|---------------------------|--------------------|-----------------------------------------------|-----------------------------------|----------------------------|----------------------------------|---------------------------|
| Visible Broadband Imager (VBI)                            | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | Complete                         | Complete                  |
| Cryogenic Near-IR Spectropolarimeter (Cryo-NIRSP)         | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | Complete                         | Complete                  |
| Diffraction Limited Near-IR Spectropolarimeter (DL-NIRSP) | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | Complete                         | Complete                  |
| Visible Spectropolarimeter (ViSP)                         | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | Complete                         | Complete                  |
| Wavefront Correction System (WFC)                         | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | n/a                              | n/a                       |
| Polarization, Analysis & Calibration System (PA&C)        | Complete                  | Complete     | Complete                         | Complete                  | Complete           | Complete                                      | Complete                          | Complete                   | n/a                              | n/a                       |



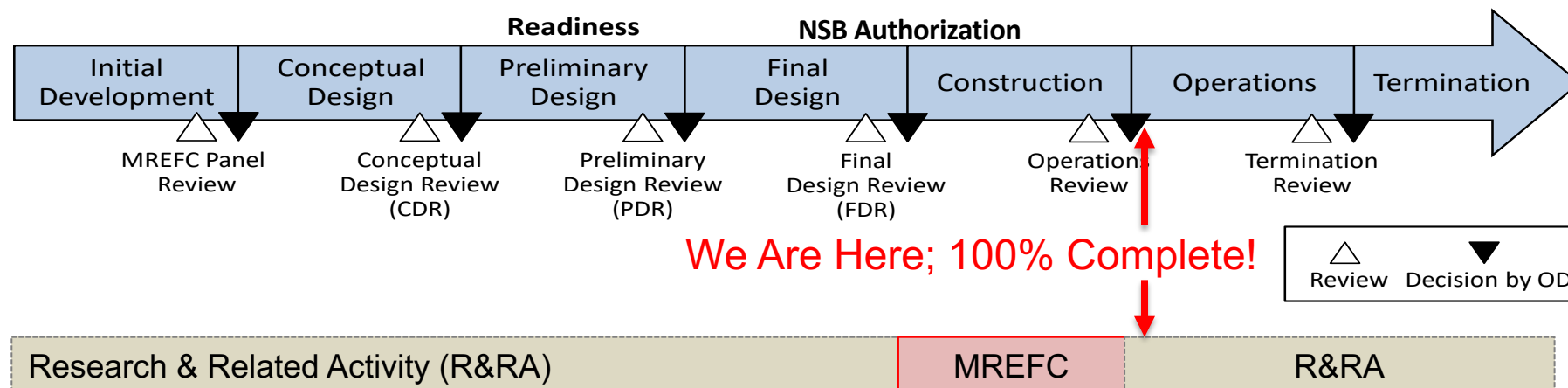
# Coudé Lab with all Instrumentation Operational



# 20 years: From Site Survey to Completed Construction



# DKIST in the NSF Facility Lifecycle



# Operations: All Hands on Deck

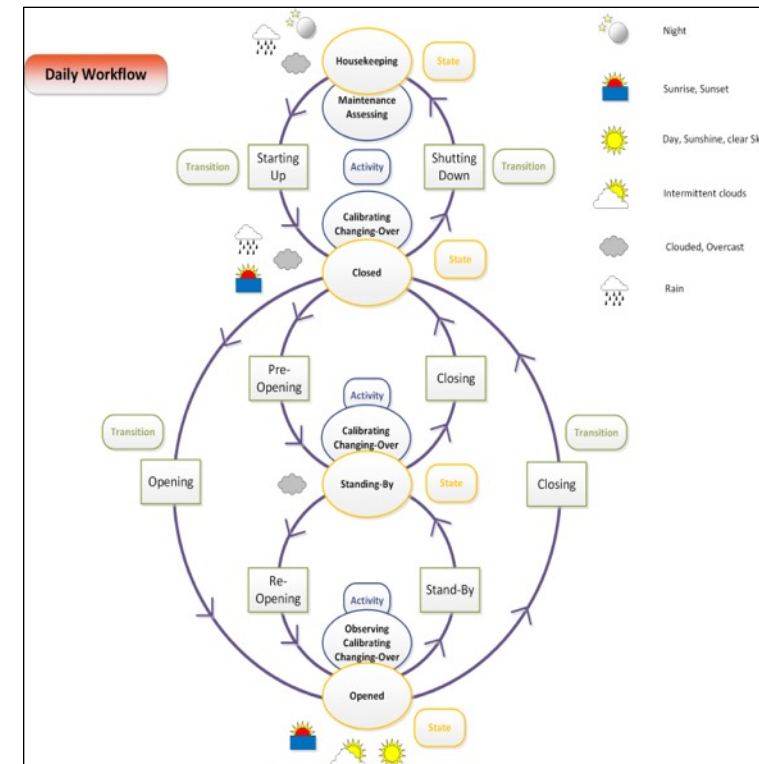
- Start of Operations Commissioning Phase (OCP) – Dec. 6, 2021
- Poor weather in Dec. followed by Close-out Activities Jan. – mid Feb.



DKIST Control Room just outside the Coudé lab during science verification

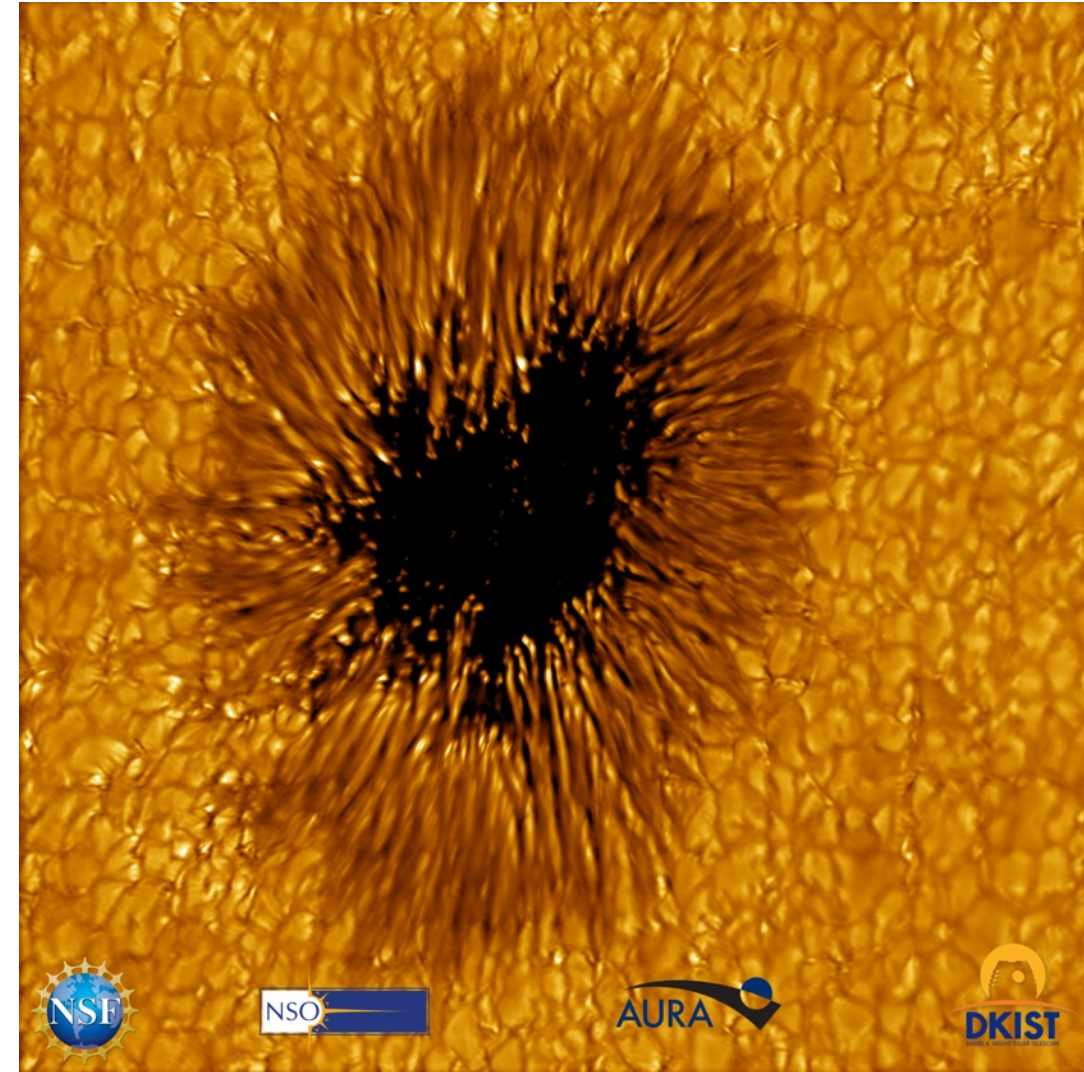
# DKIST Operations Concept

- End-to-end Support: Community researchers supported from proposal to calibrated data
- Service Mode Operations: DKIST team conducts observations on behalf of proposal PI team
- Dynamic Scheduling: Daily selection of the proposal(s) that best match target availability and atmospheric conditions



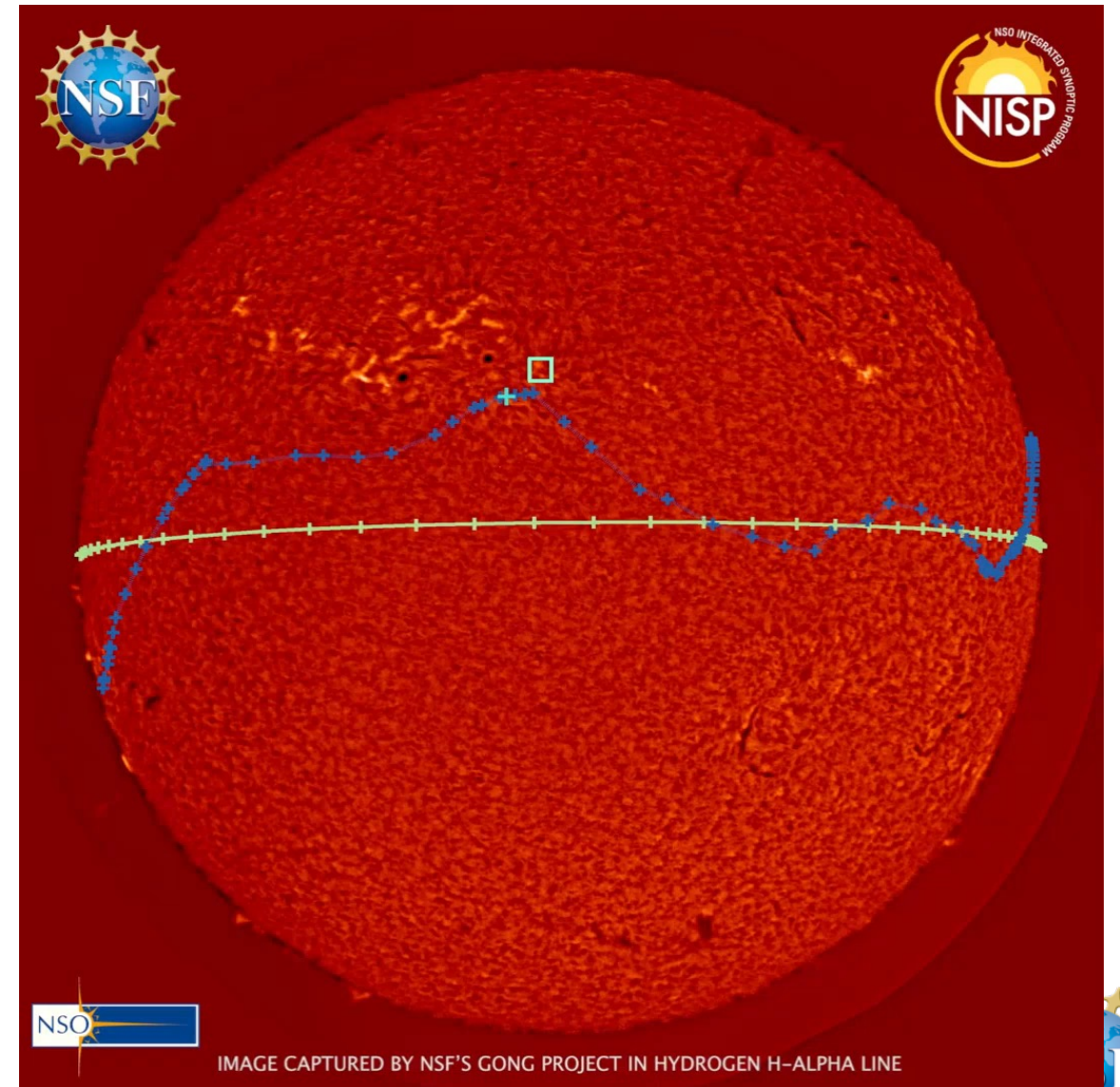
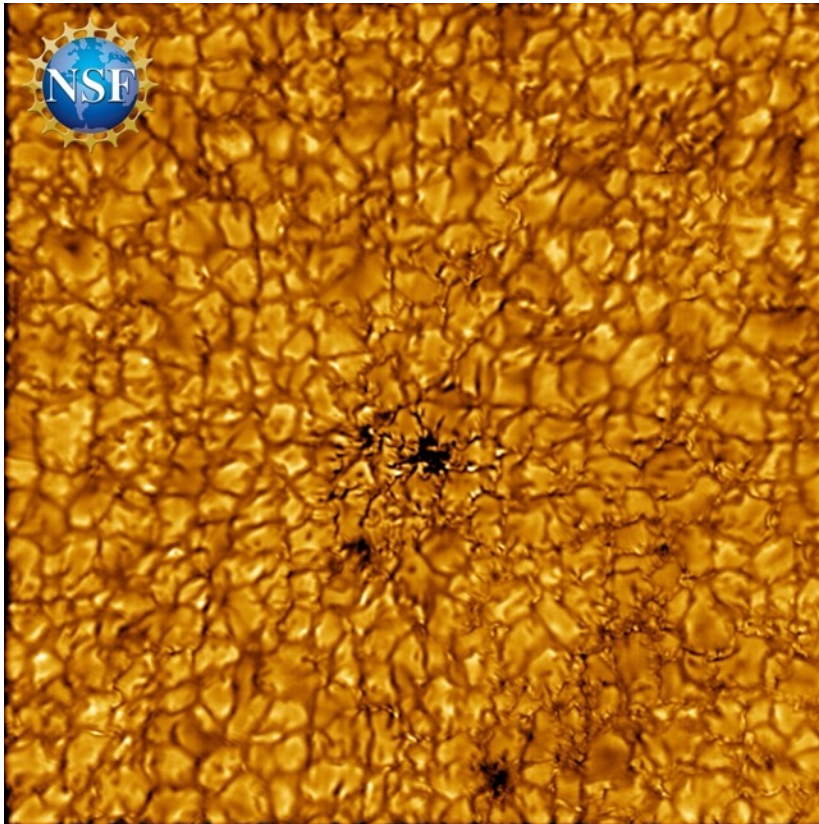
# DKIST First Science Observations – Feb. 23, 2022

- “Electric Field Associated with Magnetic Reconnection Driving a Jet in the Chromosphere”
- led by Dr. Tetsu Anan from National Solar Observatory with 11 co-PIs from the U.S. and Japan
- Observed with the VBI and the ViSP instruments
- Image is with the VBI blue channel at  $\sim 450$  nm

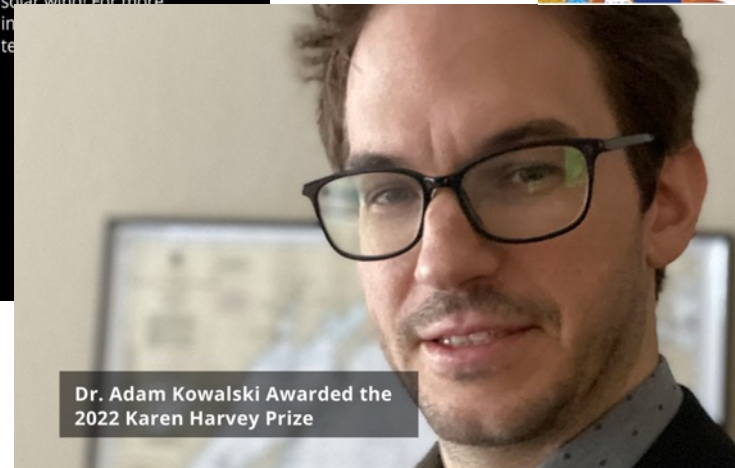
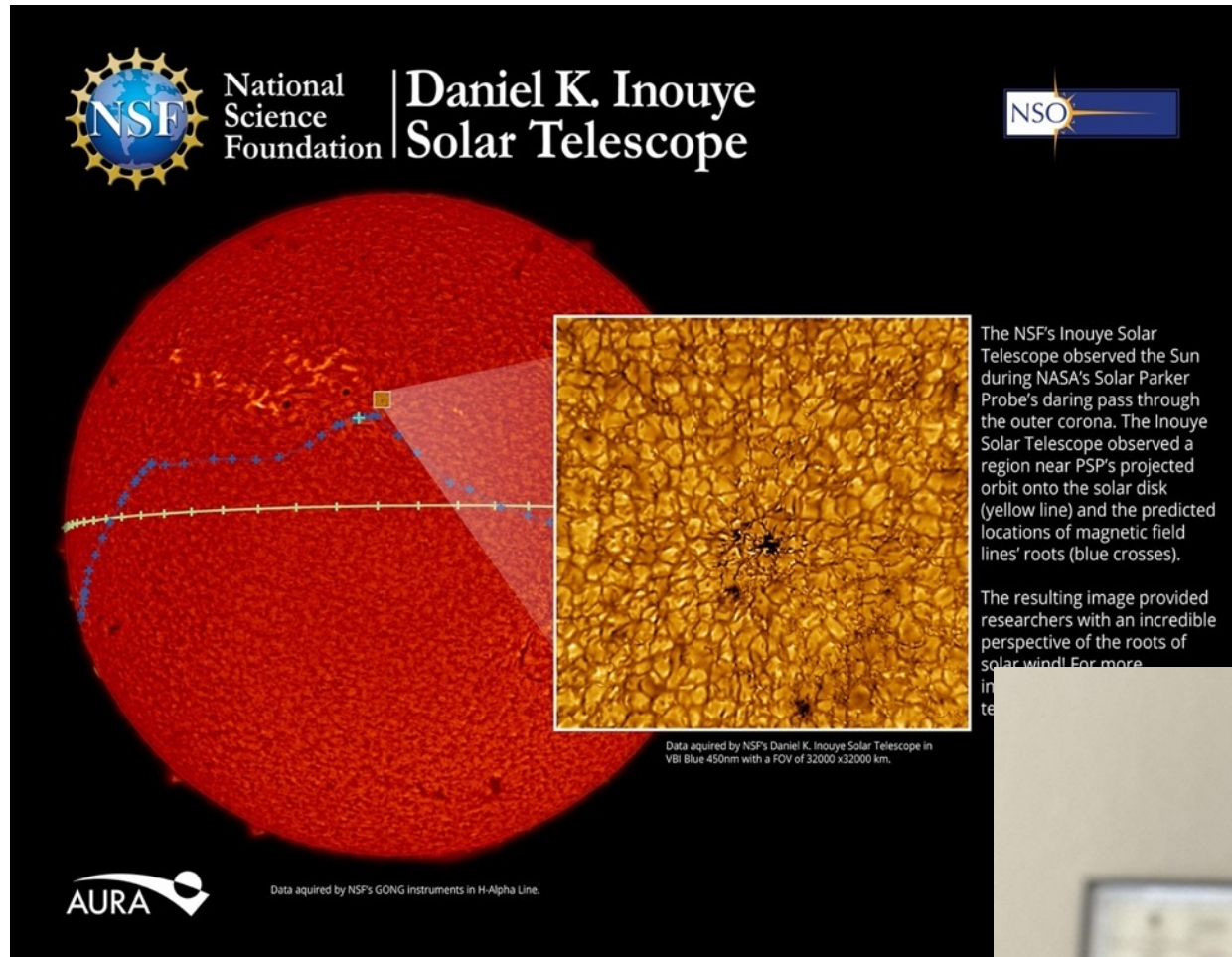


# GONG and DKIST a Powerful Combination

- GONG and DKIST were both observing during the Parker perihelion on Feb. 25, 2022



# NSO Press



# NSO Reviews

- FY21-FY22 APRPP Preliminary Draft received and approved
- Expecting external review of APRPP, spring FY22
- AURA's current award for NSO Management and Operations expires in 2024
- NSF is investigating the need for an open competition of NSO M&O as per the Major Facilities Working Guide
  - Meetings to be held in Q1.
  - A solicitation would need to be well underway or out by summer 2022



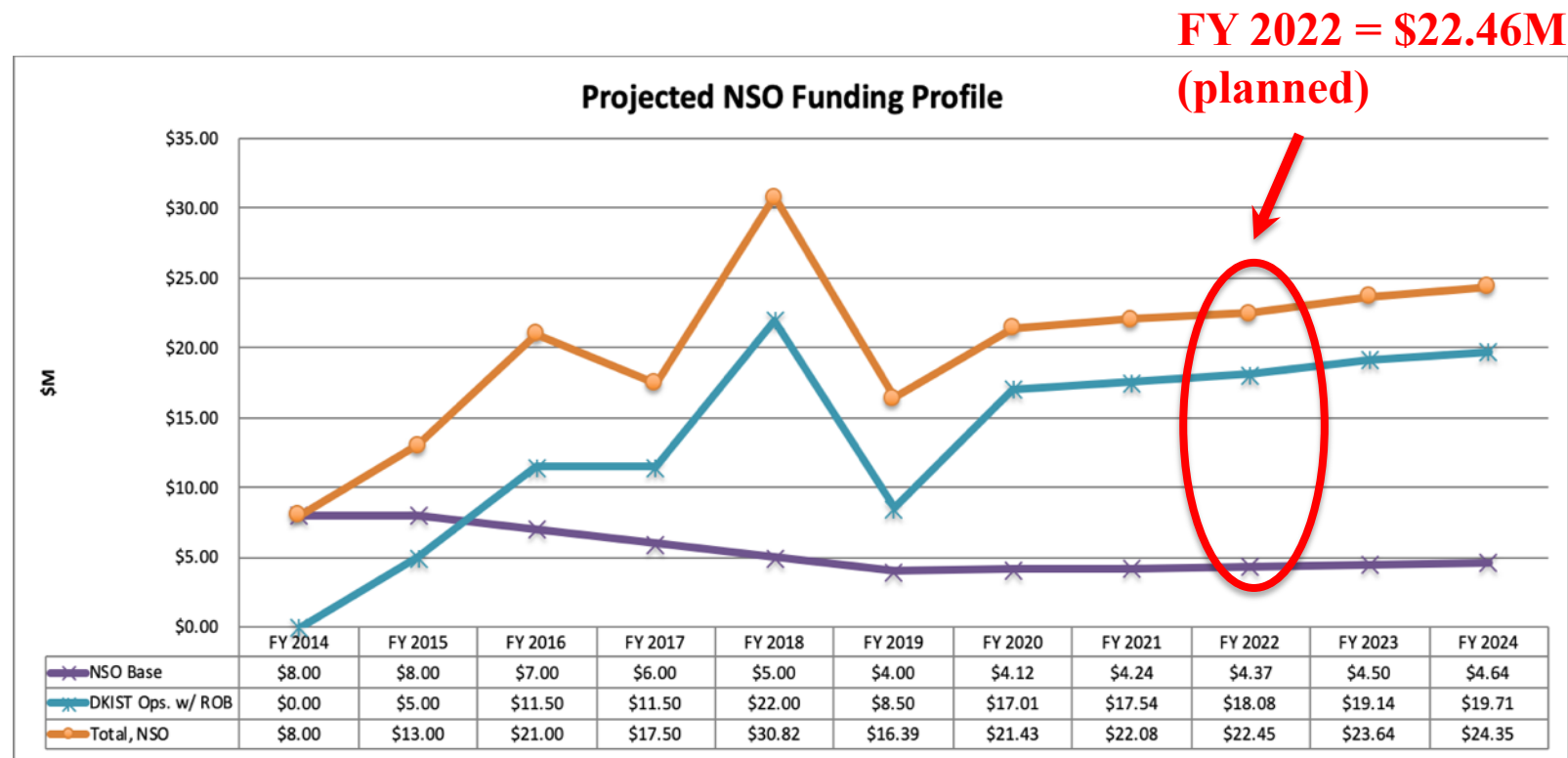
# NSO Proposals and Awards (FY22 to date)

- Supplements made in FY22:
  - NMSU-NSO transition of Sac Peak and site restoration
- GONG IAA
  - 5 year award signed by NSF and NOAA in May 2021
  - Transitioned processing of observations to NOAA
- Mid-Scale Research Infrastructure 1 for ngGONG
  - Declined



# NSO Operations & Maintenance

- FY 2020 (Actual) = \$21.49M
  - Sac Peak ops = \$300K (Incl)
  - Relocatable houses = \$350K
  - WoU-MMA = \$480K
- FY 2021 (Est.) = \$22.09M
  - Sac Peak ops = \$300K (Incl)
  - WoU-MMA = \$2M
- FY2022 (Req.) = \$25.46M
  - Sac Peak ops = \$1M (\$300K Incl)
  - DKIST Ops = \$1.5M (Incl)
  - Level 2 Data Products = \$1M (Incl)



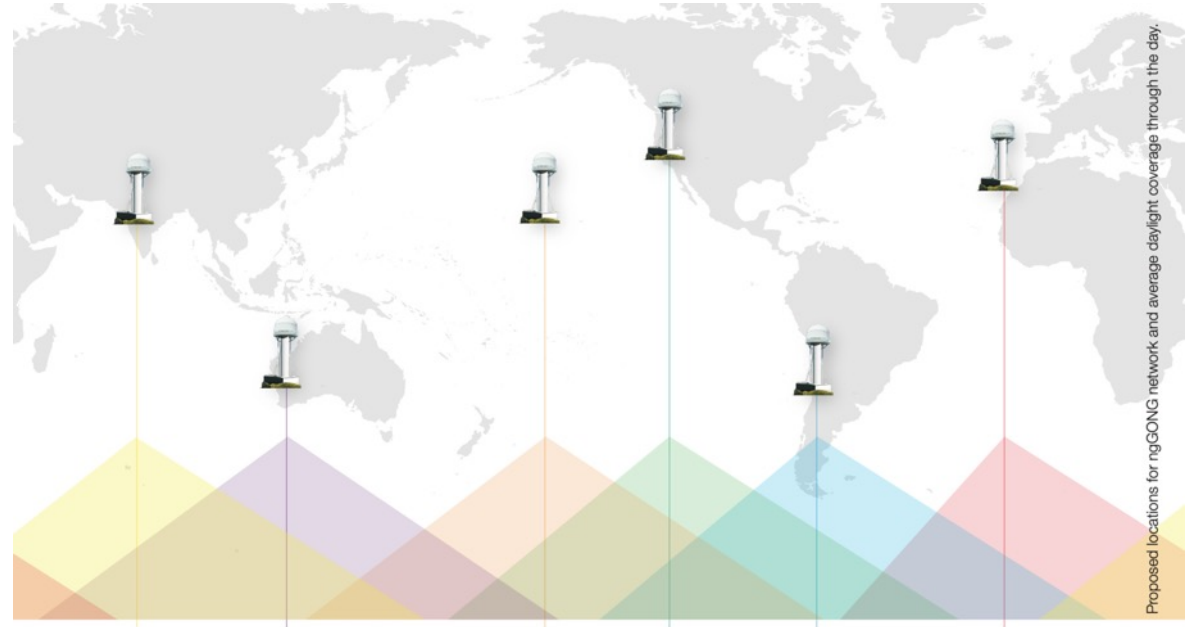
# Solar and Space Physics Decadal Survey

- ASTRO2020

“...an appropriate role for astronomy and astrophysics decadal surveys is to comment on the value of ground-based solar physics projects for astronomy and astrophysics priorities, **with the solar and space physics decadal survey being the more appropriate body to prioritize and rank ground-based solar physics projects within the context of the full range of multi-agency activities in solar physics.**”
- MREFC and MSRI both rely on community documents that prioritize and rank projects



# ngGONG: A Potential Future Recommendation?



- Current GONG data products used for Space Weather prediction, however, it was not designed for operations and is starting to show its age
- ngGONG will be a ground-up design to satisfy Space Weather research and operations requirements (R2O – O2R)
- NSO/NSF seeking operations-focused partners for design support



# Questions?