NSF | NSO National Solar Observatory

AURA

FY2024 Annual Program Plan

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The National Solar Observatory is operated by the
Association of Universities for Research in Astronomy, Inc. (AURA) under
Cooperative Agreement with the National Science Foundation

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, by providing forefront observational opportunities to the research community. The NSO operates the world's most extensive collection of ground-based optical and infrared solar telescopes and auxiliary instrumentation, allowing solar physicists to probe all aspects of the Sun, from the deep solar interior, to the photosphere and chromosphere, to the outer corona and out into the interplanetary medium. These assets also provide data for heliospheric modeling, space weather forecasting, and stellar astrophysics research, putting our Sun in the context of other stars and their environs. NSO accomplishes this mission by:

- providing leadership for the development of new ground-based facilities that support the scientific objectives of the solar and space physics community;
- advancing solar instrumentation in collaboration with university researchers, industry, and other government laboratories;
- providing background synoptic observations that permit solar investigations from the ground and space to be placed in the context of the variable Sun;
- facilitating community understanding of the increasingly complex data produced by NSO's facilities;
- providing research opportunities for undergraduate and graduate students, helping develop classroom activities, working with teachers, mentoring high school students, and recruiting underrepresented groups;
- innovative staff research.

RESEARCH OBJECTIVES

The broad research goals of NSO are to:

- ***Understand the mechanisms generating solar cycles*** – Understand mechanisms driving the surface and interior dynamo and the creation and destruction of magnetic fields on both global and local scales.
- ***Understand the coupling between the interior and surface*** – Understand the coupling between surface and interior processes that lead to irradiance variations and the build-up of solar activity.
- ***Understand the coupling of the surface and the envelope: transient events*** – Understand the mechanisms of coronal heating, flares, and coronal mass ejections which lead to effects on space weather and the planet.
- ***Explore the unknown*** – Explore fundamental plasma and magnetic field processes on the Sun in both their astrophysical and laboratory context.

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1 EXECUTIVE SUMMARY

The National Solar Observatory (NSO) is the primary provider of key ground-based solar facilities to the US solar community. NSO makes available to the community a range of assets that allow solar astronomers to probe all aspects of the Sun, from the deep interior to the corona, the interface with the interplanetary medium or Heliosphere. As the Daniel K. Inouye Solar telescope (DKIST) continues its commissioning in FY 2024, NSO provides renewed scientific and instrumentation leadership in high-resolution studies of the solar atmosphere in the visible and infrared, and sustained synoptic observations of solar variability, and helioseismology.

Major components of the National Solar Observatory core planning include:

- Operating the National Science Foundation's (NSF) 4-meter DKIST on behalf of, and in collaboration with, the solar and astronomical community.
- Continuing DKIST technical improvements, including site and facility repairs and upgrades.
- Distributing calibrated DKIST data to the community of users.
- Operating the suite of instruments comprising the NSO Integrated Synoptic Program (NISP). This Program includes the Global Oscillation Network Group (GONG) and the Synoptic Optical Long-term Investigation of the Sun (SOLIS).
- Developing partnerships to establish a future network concept (next-generation GONG, ngGONG) that replaces GONG and SOLIS and provides ground-based solar data adapted to the research community's demands and the Space Weather operational stakeholders.

In parallel with these major components, NSO will continue to:

- Develop an orderly transition to a new NSO structure that efficiently operates DKIST and NISP and continues to advance the frontiers of solar physics. This structure establishes a matrix organization of the NSO that promotes a unified culture at the Observatory and optimizes resource allocations. The NSO's FY 2020–2024 Long Range Plan (LRP) describes the matrix structure. In FY 2024, NSO will consolidate the plans for a future NSO's Data Center.
- Expand interagency collaborations for NISP following the guidance in the newly released Implementation Plan for the National Space Weather Strategy[1] and in the Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (PROSWIFT) Act[2].
- Finalize the upgrade of the GONG network to adapt it to the Space Weather community's needs, ensuring its competitive continuation in solar Cycle 25.
- Develop Multi-Conjugate Adaptive Optics (MCAO) and other critical instrumental upgrades for the DKIST.
- Continue defining the transition of the Dunn Solar Telescope (DST) operations to a consortium led by New Mexico State University (NMSU). NSO will manage the Sacramento Peak site facilities in FY 2024.

[1] *https://www.whitehouse.gov/wp-content/uploads/2023/12/Implementation-Plan-for-National-Space-Weather-Strategy-12072023.pdf*

[2] *https://www.congress.gov/bill/116th-congress/senate-bill/881*

- Increase the diversity of the solar workforce. This FY 2024 APP summarizes activities at the Observatory to increase diversity within the NSO, its user community, and the undergraduate and graduate student populations, which include geographic, gender, ethnic, and racial metrics.

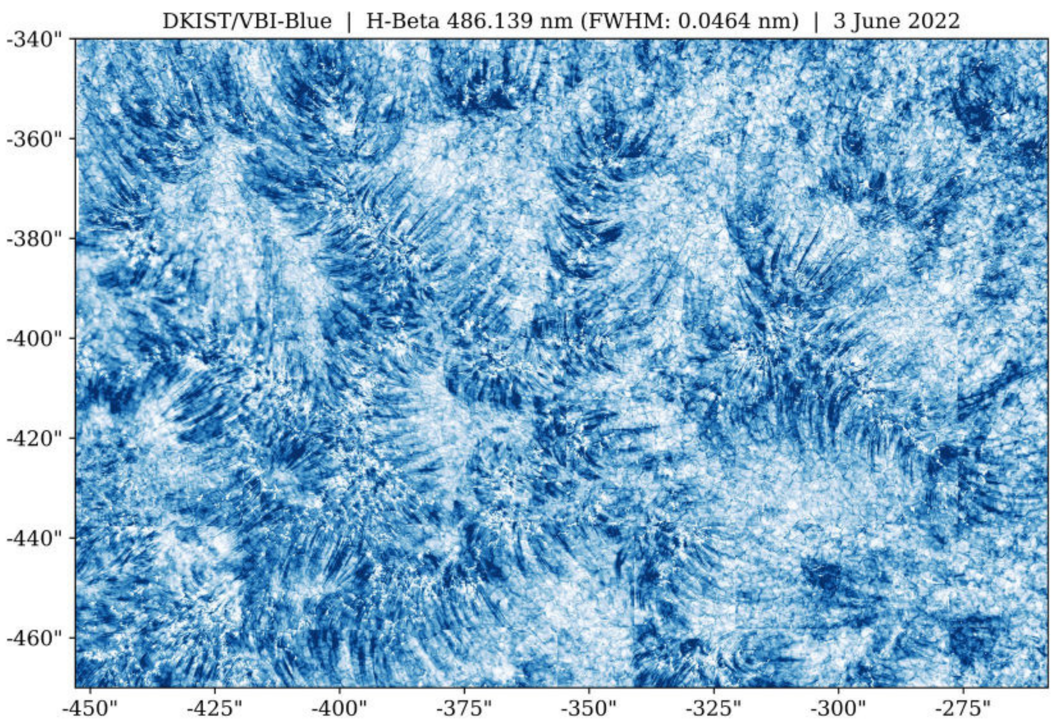

Figure 1.1. *An H-Beta image from Visible Broadband Imager of a plage region near the southeast limb of the sun obtained on June 3, 2022, during a coordinated campaign with Parker Solar Probe. This region was co-observed with the ViSP instrument that obtained photospheric and chromospheric spectropolarimetric data. The data was released on December 12, 2022.*

Some of the programmatic highlights of the NSO Program in FY 2024 include:

- Submit a 2-year extension of the current Cooperative Agreement between NSF and AURA for the operations of the NSO.
- Ending the second Operations Commissioning Phase (OCP2) of by executing as many observing proposals as possible following the priorities set by the DKIST Time Allocation Committee (TAC) for OCP2.
- Continuing commissioning the DKIST Data Center (DC) by receiving, processing, and delivering data obtained during OCP2.
- Planning for restarting operations of the SOLIS suite of instruments at Big Bear Solar Observatory (BBSO).
- Continuing the GONG refurbishment project deploying the newly acquired cameras.
- Furthering the science case and management aspects of the ngGONG project in conversations with the relevant Space Weather operational agencies and the research community.
- Testing the Level-2 pipelines with data from OCP as available.
- Advancing the definition of the interfaces between the DKIST Level-1 data and the Level-2 pipelines.
- Ensuring a prominent science-based and outreach program during the 2024 continental US total solar eclipse that combines DKIST coronal capabilities and observations from the totality path.

Additional actions to advance solar physics that NSO will undertake in FY 2024 include:

- Developing a response to the recommendations of the Solar and Space Physics (Heliophysics) 2024-2033 Decadal Survey.
- Implementing the DKIST Communications Plan to publicize the early science phase of the facility in close coordination with the NSF.
- Strengthening the connections between the in-situ and remote-sensing communities to fully realize the potential of multi-messenger solar and heliospheric physics by coordinated campaigns using Director's Discretionary Time (DDT) and through the activities included in the various Windows of the Universe Multi-Messenger Astronomy (WoU-MMA) Supplemental Funding Requestsd (SFR) received by the Observatory.

The following sections describe in detail the specific actions and milestones the NSO programs and functional units will develop in FY 2024 to achieve the above core plans and programmatic highlights.

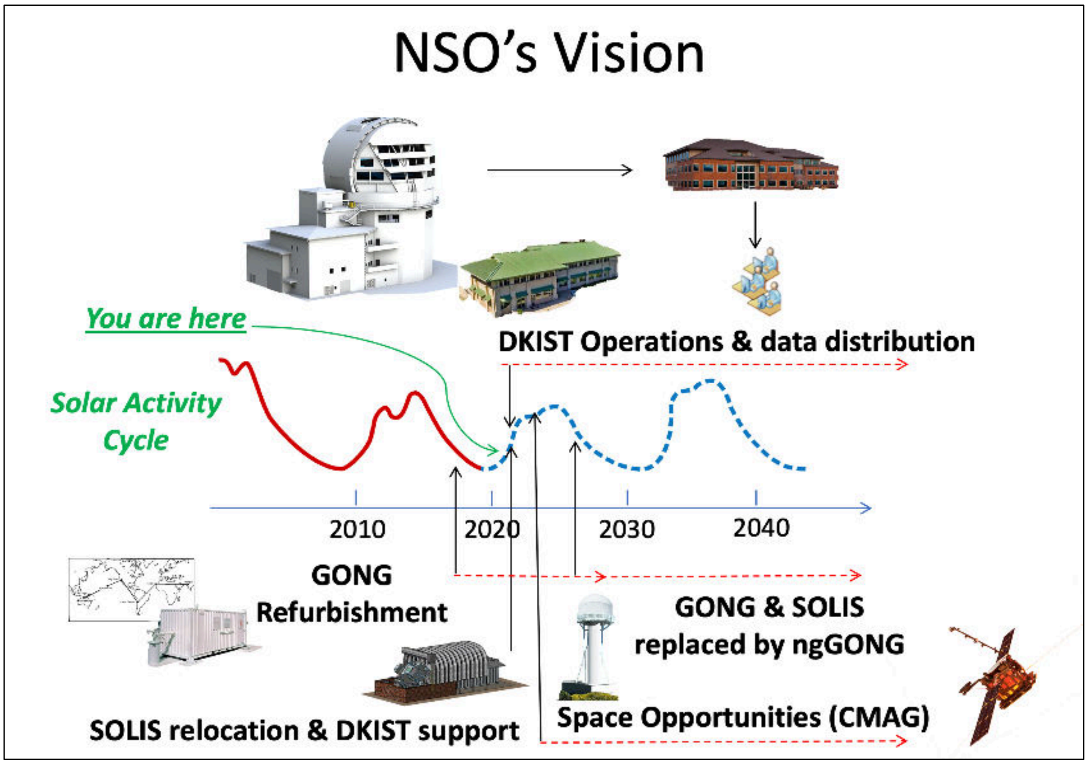

Figure 1.2. *The long-term vision of NSO over half the lifetime of DKIST.*

NSO FY 2024 Program

- **Daniel K. Inouye Solar Telescope (DKIST)**
  - Execute experiments from the second OCP call.
  - Prepare and execute 3rd OCP call.
  - Increase automation and available observing time.
  - VTF integration and commissioning.
  - Continue the DKIST Data Center implementation plan.
  - Continue developing Multi-Conjugate Adaptive Optics.
  - Continue the DKIST instrumental upgrades.
  - Elaborate the DKIST contribution to the 2-year Cooperative Agreement (CA) extension proposal.
- **NSO Integrated Synoptic Program (NISP)**
  - Operate the GONG network. Continue the network data distribution.
  - Complete the SOLIS site at Big Bear and start operations.
  - Continue refurbishing the GONG network, prioritizing new detectors deployment.
  - Engage stakeholders (DoC, DoD, international partners) in the ngGONG design phase.
  - Elaborate the NISP contribution to the 2-year CA extension proposal.
- **NSO Community Science Program (NCSP)**
  - Execute and test the DKIST Level-2 data products pipelines.
  - Start the implementation of the Level-1/Level-2 hardware interface.
  - Elaborate the NCSP contribution to the 2-year CA extension proposal.
- **Sacramento Peak Observatory**
  - Operate the site.
  - Define the transfer of additional operational responsibilities to NMSU.
- **NSO Directorate**
  - Lead the NSO proposal for the 2-year CA extension proposal.
  - Transition Leadership.
  - Support Observatory-wide efforts that promote existing and future facilities such as ngGONG.

2 DANIEL K. INOUYE SOLAR TELESCOPE (DKIST)

2.1 Introduction

The technical complexity of the Daniel K. Inouye Solar Telescope and its instrument systems make it the world's most advanced solar research facility. Operating such an advanced facility required a new paradigm for NSO with concepts such as service-mode observing and automated data processing and dissemination not available for the previous generation of National facilities. The previous generation of high-resolution ground-based facilities were operated in a Principal Investigator (PI) mode, where the PI was awarded a certain amount of observing time (typically 5-10 days) at the telescope and, to a large extent, was able to guide and direct the use of the observing time, including instrument and instrument-mode selection, real-time target selection, as well as definition and execution of calibration sequences. The raw data collected during an observing run, including all calibration data, were simply provided to the PI on hard disk or tape. It was the PI's responsibility to perform all necessary data processing, including calibrating the data. Due to the limited assistance that could be provided, every user essentially was required to become an expert user of the facility's complex instrumentation. Because of this PI-mode approach, science productivity was significantly limited due to the lack of any data handling support or any broader scheme to provide a unified and broadly accessible collection of the high-resolution data.

From a science productivity and general user perspective, DKIST Operations are much more efficient compared to the operations of the previous NSO or similar facilities. This statement applies to both the production of raw data at the DKIST facility as well as the processing and dissemination of calibrated data products. Observing modes such as service-mode observations will make more efficient use of the available observing time. These concepts build on the lessons learned from nighttime telescopes and radio facilities of similar size and complexity, such as Gemini Observatory, NRAO's Very Large Array, and even specific service-mode test campaigns at the Dunn Solar Telescope (DST). However, there are distinct and substantial differences in how solar and nighttime telescopes are operated. These differences are not only driven by the fact that solar telescopes (obviously) operate during the day but also by how solar instruments are designed (e.g., laboratory environment) and operated (multiple instruments sharing the light and running in parallel). Nevertheless, some operational concepts are similar and with some adaptation or modification can be transferred to some extent. The effort to design and implement the current DKIST operational concepts was substantial.

The previous NSO solar facilities, due to their limited time horizon and cost constraints, were operated with a minimalistic approach to maintenance. The facilities were able to accommodate a minimal set of maintenance activities during the day in parallel or interlaced with observing tasks. This approach was not viable for DKIST. A maintenance plan and strategies to ensure sustainable operations over at least two magnetic solar cycles are being developed. At large nighttime observatories, technical work, including regular maintenance, is performed during the daytime by a technical team. The night observations are performed by a relatively small science operations team. The inverse for various reasons is not practical for DKIST operations. Consequently, most technical and science operations activities must be performed in parallel during the daytime.

The scope of DKIST Operations also includes a sizable effort to develop and operate a Data Center that ingests, processes, stores, and distributes to the community an average of 3 PB per year of calibrated data.

The NSO Long Range Plan provides a summary overview of all DKIST Operations activities. The Annual Progress Report (APR) reports operations activities and accomplishments for the prior fiscal year. The Annual Program Plan (APP; this document) summarizes the operations activities and plans for the next fiscal year. During construction and operations ramp-up phase, operations concepts and procedures were developed and documented. In many cases, these documents were required to guide the development of subsystems but also contain valuable concepts and detailed information needed to plan and implement the DKIST Operations. For example, SPEC-0036, the Operations Concepts Definition document (OCD) is one of two Level-0 documents that describes how the observatory is meant to function post construction. Subsystems such as wavefront correction and instruments have developed their own subsystem-level OCDs that describe the user interactions with the subsystem and provide information for development of user manuals. Operations tools such as the proposal architect and the experiment architect are guided by OCDs and the Data Center has developed OCDs to guide hardware/software infrastructure and pipeline development, just to mention a few examples.

2.2 Management Structure and Staffing

Since the transition to operations, the DKIST organization has reached a quasi-steady state staffing condition. Figure 2.1 shows the top-level organizational chart (org-chart) for the DKIST Operations program. DKIST Operations is organized into several functional areas including:

- Directorate
- Science Operations
- Technical Operations
- Instrumentation Program
- Data Center
- Science Support and Research
- Safety

In addition to these functional groups, DKIST draws on NSO- and AURA-provided support for its Administration, Business, Human Resources, Education and Public Outreach, and IT needs. The funds for the corresponding FTEs for administrative and IT support are included in the DKIST Operations budget. As indicated in the org-chart, accountability of these services will be ensured via the Director's office.

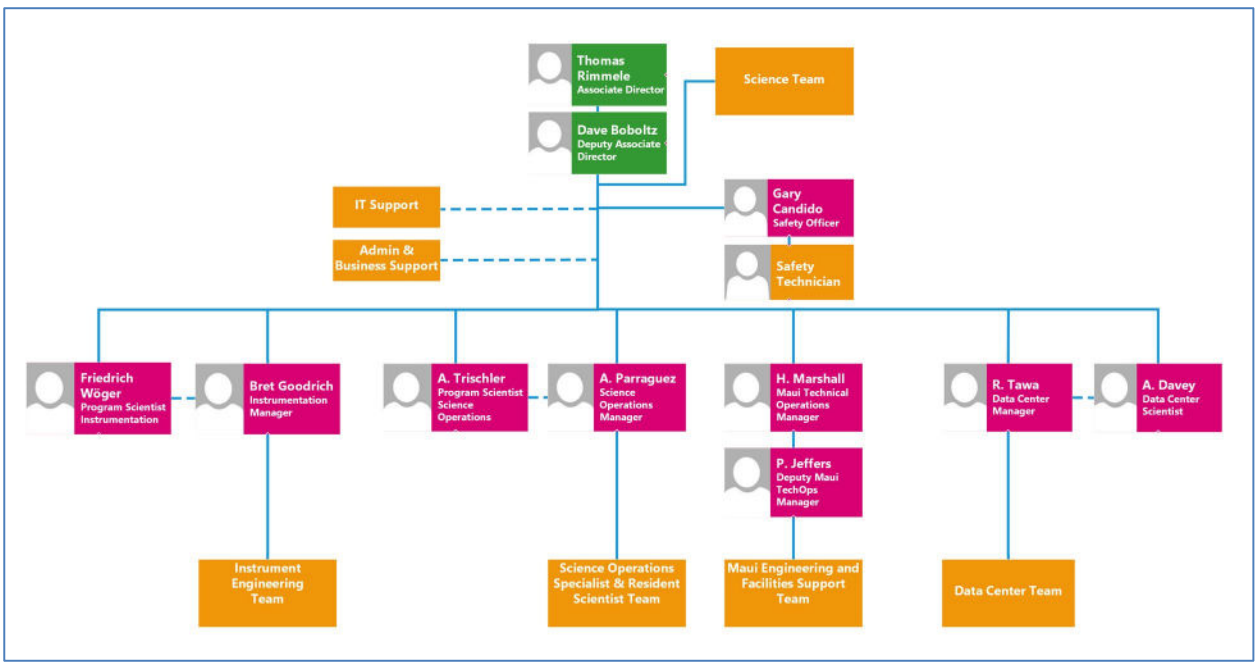

Figure 2.1. *DKIST top-level organizational chart.*

Key functional areas and management positions are defined as follows:

1. **Directorate**

   The **DKIST Associate Director**, is responsible for the overall scientific leadership and management of the observatory. The Associate Director is responsible for the planning and execution of regular operations of the DKIST facility and directly manages the Science Support and Research team. The position is currently located in Boulder and reports to the NSO Director.

   The **DKIST Deputy Associate Director** supports the DKIST Associate Director in the management of the observatory and the planning and execution of regular operations of the DKIST facility. The Deputy Associate Director oversees the DKIST Data Center as part of their responsibilities. The position is currently located in Boulder and reports to the DKIST Director.

2. **Science Operations**

   The DKIST **Program Scientist for Operations** is the Lead Scientist for development and implementation of DKIST Science Operations and provides scientific guidance to the **Science Operations Manager.** The Program Scientist for Operations interfaces and works with the community, including the NSO Science Team, to provide guidance on priorities of new developments. This position coordinates and guides the team of Resident Scientists. This position provides training to Science Operations Specialists. This position leads or guides the development of operations procedures and tools. This position works closely with and provides scientific guidance and direction to the Science Operations Manager. This position is located in Boulder.

   The DKIST **Science Operations Manager** supports the DKIST Director in the development and efficient operation of the DKIST facility. This position manages the development and execution of science operations plans, management of staff supporting the science operations, communication with the solar physics/astronomical community on DKIST capabilities and planning, and development and management of the telescope time allocation and user support programs. This position is responsible for developing and implementing work schedules for the SOS team including support of regular science observations, maintenance, and technical development activities. The Science Operations Manager works closely with the Program Scientist for Operations and the team of Resident Scientists. This position is located on Maui.

   The **Chief Science Operations Specialist** supervises the team of Science Operations Specialists (SOSs). This position is responsible for developing and implementing work schedules for the SOS team including support of regular science observations, maintenance, and technical development activities. As part of the telescope operations team, the Chief SOS performs regular observing support. The Chief SOS reports to the Science Operations Manager and works closely with the Operations Scientist and the team of Resident Astronomers.

   The **Science Operations Team**, which includes **Science Operations Specialists** and **Resident Scientists,** participates and support observing proposal evaluation, planning, and execution of daily observations. Resident Scientists are drawn from the pool of DKIST and potentially all NSO Scientists, including postdocs and students, scientists from partner institutes as feasible and community members. Coordination of science support resources the main challenge. Providing travel and other support to community members will be considered to incentivize broad participation in the Resident Scientist service. The Science Operations team is distributed between Boulder and Maui.

3. Technical Operations

The **Technical Operations Manager** supports the DKIST Director in the development and efficient site and technical operation of the DKIST facility. This position is responsible for the development and execution of technical, engineering, and maintenance operations plans, management of staff supporting the technical operations, communication with the observatory science and engineering community on DKIST capabilities and planning. Responsibility for management of summit facilities on Maui is included in this position.

The **Deputy Technical Operations Manager** coordinates and manages prioritized daily work schedule for technical staff and provides overall management of predictive, preventive, and corrective maintenance on telescope systems. The Deputy Technical Operations Manager coordinates with the Technical Operations Manager and Technical Engineering team to plan and schedule strategic projects, such as DKIST development activities, new instrument integration and commissioning, and Observatory upgrades plan and schedule supporting infrastructure and resources to current and future facility instruments. This position prepares Technical Operations staff shift patterns, coordinates with discipline leads to make assignments, and oversees technical staff training and development.

The **Engineering and Facilities Support Group** consists primarily of engineers and technicians. The group covers a broad skill set, required to support operations and maintenance of the complex DKIST facility. This group includes optical, mechanical, electrical engineering, systems engineering aspects and minimal facilities support personnel. This includes the Technical Operations management positions. Even though major new developments are planned to be pursued by the Boulder instrument development team using the Boulder facilities, the combined pool of Boulder and Maui engineering resources participates in new developments and upgrades to existing instrument and telescope systems, including software. The Engineering and Facilities Support Group is based on Maui.

4. Instrumentation

The **Program Scientist for Instrument Development** provides the scientific guidance and leadership for all new instrument development, upgrades to existing instruments, including current and future collaborations with instrument partners. The Program Scientist for Instrument Development interfaces and works with the community, including the NSO Science Team, to provide guidance on priorities of new developments. The Program Scientist works closely with the Instrumentation Program Manager and the leads of other operational components, including Science Operations, Technical Operations, and Data Center.

The **Instrument Program Manager** is responsible for managing scope, budget, and schedule of new development and upgrade efforts. In addition, the Instrument Program Manager is responsible for the management, operations, and maintenance of the current suite of DKIST instruments. The Instrument Program Manager takes scientific direction and guidance from the Program Scientist and coordinates closely with the leads of the other operational components.

The **Instrumentation Team** includes scientists and engineers dedicated to maintenance and upgrades for the current DKIST instruments (**Instrument Operations** and **High-Level Software**) and the development and implementation of new instrument concepts (**Instrument Development**). The Boulder Instrumentation team also contributes remotely and via campaigns to the operations and maintenance of summit systems. In particular, instrument systems such as Polarization Analysis and Calibration (PA&C) and Wavefront Correction (WFC), and software systems including the Camera software (CSS) that during construction were developed by the Boulder instrument team can be effectively supported with participation by Boulder-based instrumentation personnel. The Instrumentation team is distributed between Maui and Boulder.

5. **Data Center**

The DKIST **Data Scientist** provides the scientific guidance and leadership for the development and upgrades to existing Data Center infrastructure and calibration pipelines. The Data Scientist interfaces and works with the community, including the NSO Science Team, to provide guidance on priorities of new developments. The Data Scientist works closely with the Data Center Manager and the leads of other operational components, including Science Operations, Technical Operations, and Instrumentation.

The DKIST **Data Center Manager** is responsible for managing scope, budget, and schedule of new developments and upgrades to the Data Center. In addition, the Data Center Manager is responsible for the management, operations, and maintenance of Data Center hardware and software infrastructure and the instrument calibration pipelines. The Data Center Manager receives scientific guidance from the Data Scientist and coordinates closely with the leads of the other operational components.

6. **Science Support and Research**

The DKIST **Science Team** consists of scientists, post-doctoral researchers and students. The DKIST Science Team supports all areas of DKIST Operations, including service as Resident Scientists, leadership and support of new developments and instrument upgrades, EPO/C, data services, service on committees such as the TAC or SWG, and mentoring of students and post-docs. According to AURA policy, scientists have a fraction of their time available for personal research, which in many cases will be directly related to DKIST science objectives. The Science Team supports and collaborates with users of DKIST. The joint NSO/CU faculty positions engage in teaching, undergraduate, and graduate student training as well as research and support activities. The Science Team is distributed between Boulder and Maui.

7. **Safety**

The DKIST **Safety Program** team consists of the **Safety Officer** and the **Safety Technician** who are responsible for the continuation of the program elements into operations, evolving from the processes developed and implemented during the construction of DKIST. The Safety Officer reports directly to the DKIST Director and is located on Maui.

2.3 Program Goals and Milestones

Presented below are the FY 2024 Goals and Milestones of each of the major functional areas that comprise DKIST Operations.

2.3.1 Directorate

The DKIST Directorate consists of the Associate Director and the recently added Deputy Associate Director. The Directorate is responsible for leadership and management of the observatory, specifically its four operational components, namely Science Operations, Instrumentation, Technical Operations and the DKIST Data Center. In addition, the DKIST Associate Director manages the DKIST Science team. The DKIST Directorate interfaces with the NSO Directorate and various support services within NSO, i.e., Administrative Services, Information Technology, Education and Public Outreach, and the Business Office. The Directorate also works with and responds to requests from AURA Corporate and the National Science Foundation as required.

2.3.1.1 Directorate Goals for FY 2024

The DKIST Directorate has set the following goals for FY 2024:

Program Goal (Dir-1): Continue working with the DKIST senior management team to find new ways to improve operational efficiency and scientific output to keep DKIST on the leading edge of solar science.

Program Goal (Dir-2): Continue promoting the value and excitement of new DKIST science to the solar physics community, the broader astronomy community, funding agencies, and the general public.

Program Goal (Dir-3): Plan and prepare the DKIST portion of 2-year extension proposal (FY 2025-FY 2026) for submission to NSF.

Program Goal (Dir-4): Continue discussions with the NSF regarding the development of a DKIST Concept of Operations Plan.

Table 2.1. DKIST Directorate Goals for FY 2024

Program Goal	FY 2024 Time Interval
Dir-1	Q1 – Q4
Dir-2	Q1 – Q4
Dir-3	Q2 – Q3
Dir-4	Q3 – Q4

2.3.1.2 Directorate Goal Descriptions and Milestones

Leadership and Management Support (program goal Dir-1)

Throughout FY 2024, the DKIST Directorate will continue to support day-to-day operations of the facility providing leadership direction and management expertise to the four DKIST operational components and to the DKIST science staff. The goals will be to continue to improve the operation efficiency and scientific productivity of the DKIST facility. The Directorate will continue to communicate with the DKIST senior leadership team and solicit input on ways to achieve these goals. The DKIST Directorate continues to conduct quarterly prioritization meetings to keep the various operational components informed of each group's priorities and these will continue in FY 2024.

The DKIST Directorate regularly meets with staff from AURA Corporate and NSF-AST to keep each informed of the operational status and direction of the observatory. As part of leadership responsibilities, the DKIST Directorate will continue to provide briefings regarding the scientific achievements and operational status of DKIST to the following committees/councils:

- NSO Users Committee
- AURA Solar Observatory Council (SOC)
- AURA Board of Directors
- NSF leadership from the Astronomy Division, The Math and Physical Sciences Directorate, the Large Facilities Office, and the Division of Cooperative Support

Promoting DKIST and DKIST Science (program goal Dir-2)

As part of its leadership responsibilities, the DKIST Directorate is tasked with promoting the value and excitement of DKIST science to the solar physics community, the broader astronomy community, funding agencies, and the general public. Directorate personnel will continue to perform this task by attending and presenting at scientific and technical meetings, by encouraging scientific and technical staff to attend and present at meetings, and by working with NSO-EPO/C and AURA Corporate to get DKIST science results and technical highlights into various forms of media for consumption by the public.

Two-Year Extension Proposal (program goal Dir-3)

In September 2023, the DKIST AD met with NSF, AURA, and NSO management to discuss guidance regarding the renewal of the NSO Cooperative Agreement. The Associate Director provided input on appropriate time constraints and reasonableness of the proposed requirements and schedule. The three organizations have converged on a multi-step procedure that will begin with a two-year (FY 2025 – FY 2026) extension to the current Cooperative Agreement (CA) and Cooperative Support Agreement (CSA) for the management and operations of the NSO including DKIST. The current timeline shows this two-year extension proposal due to NSF in Q3 of FY 2024. During Q2 and Q3 of FY 2024, the DKIST Directorate will be heavily involved in planning, budgeting, and writing of this two-year extension proposal with input from the DKIST senior leadership team.

Concept of Operations Plan (program goal Dir-4)

The second step in the roadmap to a new 5-year CA involves an external Concept for Operations (ConOps) review, which would provide guidance to the NSF for the future CA renewal (FY 2027 through FY 2031). In FY 2024, the DKIST Directorate will be involved in the discussions that will help to define what this ConOps review will entail. Once a ConOps review Charge is in place, containing clear guidance from the NSF regarding scope, format, and schedule for the review, the DKIST Directorate, with input from the DKIST senior leadership, will put together the required ConOps plan and associated documentation in preparation for the external review panel.

2.3.2 DKIST Science Operations

The DKIST Science Operations (SciOps) team is responsible for the preparation, scheduling, and execution of DKIST science observations. They are the primary interface to the DKIST users as they prepare proposals and plan observations.

2.3.2.1 Science Operations Program Goals for FY 2024

The DKIST SciOps team has set the following goals for FY 2024:

Program Goal (SciOps-1): Preparation and release of the Cycle 3 Proposal Call.

Program Goal (SciOps-2): Support of the Cycle 3 proposal review process.

Program Goal (SciOps-3): Start generation and quality assurance of Cycle 3 experiments.

Program Goal: (SciOps-4): Continue Cycle 2 observing interlaced with DDT observing.

Table 2.2. Science Operations Goals for FY 2024	
Program Goal	**FY 2024 Time Interval**
SciOps-1	Q2 – Q3
SciOps-2	Q3 – Q4
SciOps-3	Q4 –
SciOps-4	Q2 – Q4

2.3.2.2 Science Operations Program Goal Descriptions and Milestones

Cycle 3 Proposal Call (program goal SciOps-1)

Each Proposal Cycle starts with the preparation, announcement, and release of a Proposal Call to solicit input from community members (Investigators, i.e. Principal Investigators and Co-Investigators) in the form of Proposals (i.e. observing requests). For a given Proposal Cycle, the Proposal Call announces the capabilities that will DKIST support. The Proposal Call preparation and release is a 3- to 4-month effort conducted by the Science Operations team. Proposals submitted in response to a Proposal Call will be accepted during a 1-month Proposal Submission Window after which no additional cycle proposals are accepted for a given Proposal Cycle. For Proposal Preparation and Submission, Investigators will use an integrated web-based Proposal Tool (called the Proposal Architect). Proposals are submitted by the Principal Investigator (PI). A Help Desk system (see below) will be used for questions and any issues that Investigators may encounter during the preparation and/or submission of Proposals.

Milestones to achieve this SciOps-1 goal are as follows:

- Develop the Proposal Cycle 3 timeline.
- Define the Proposal Call priorities.
- Define the capabilities offered by the instruments, telescope systems, and the observatory as a whole.
- Prepare the Proposal Tool (Proposal Architect) for the Proposal Call release.
- Update documents and webpages (if necessary) in preparation for the Proposal Call release.
- Draft the Proposal Call.
- Prepare and release Pre-Call Announcement.
- Achieve approval of the Proposal Call and produce final version of the Proposal Call.
- Announce the Proposal Call and its release through SolarNews, NSO Webpages, and email to registered users.
- Send out reminders of the proposal submission window deadline.
- Open and close the proposal submission window.
- Plan and prepare staff in support of the release of the Proposal Call, including support of the Help Desk with Help Desk agents during the proposal submission window.

Support of the Cycle 3 proposal review process (program goal SciOps-2)

All Proposals submitted in response to a Proposal Call are subsequently subjected to a competitive peer review during a 3- to 4-month Proposal Review Window. This proposal review window opens within a week after the proposal submission window has closed (i.e. no more proposals are accepted). During the proposal review process Cycle Proposals are evaluated considering technical feasibility, scientific merit, operational / scheduling / programmatic constraints, and policy guidelines. The technical evaluation is conducted by the members of the Technical Review Committee (TRC) led by the TRC Chair. The evaluation for scientific merit is conducted by the members of the Science Review Committee (SRC) led by the SRC Chair. The evaluation of relative merits of different proposals considering operational, scheduling, and programmatic priorities and policy guidelines is conducted by the members of the Time Allocation Committee (TAC) led by the TAC Chair. The outcome of the TAC review is a ranked list of prioritized proposals (a.k.a. Master Proposal List) that is sent for approval by the Director. After the Director's approval, the TAC notifies Proposal PI's of the results of the review process marking the closure of the proposal review window. The SciOps team will support the Cycle 3 review process in accordance with the DKIST process described above.

Generation and quality assurance of Cycle 3 experiments (program goal SciOps-3)

Immediately after PI's have been notified and with the closure of the proposal review window, the Experiment Generation Window opens. The length of the experiment generation window is variable depending on proposal pressure and available resources. On one side, this window is impacted by any inefficiencies in the proposal review process while on the other side it is constrained by a predefined point in time when Cycle specific observing is supposed to start. During this experiment generation window, Science Operations staff implements the accepted proposals using a web-based Experiment Generation Tool (called the Experiment Architect, part of the Operations Tools Suite). For each accepted proposal one experiment is created. An experiment includes one or more science observing programs and standard calibration observing programs. Part of experiment generation is a quality assurance process during which the created observing programs are validated (tested) on a system simulator. Experiment generation is a collaborative effort and is performed in communication with the proposal's PI. The PI communication during this process is facilitated through the Help Desk system (via proposal specific PI communication tickets). Once an experiment is validated, it is sent to the summit waiting for execution (once the experiment execution window opens). The goal is, and has been, to have all experiments created and validated prior to the opening of the experiment execution window. In this way, each experiment has the same chance of being executed (observed) irrespective of priority, target availability, observing conditions and perhaps additional constraints (e.g. technical guidance) impeding a specific observation. In reality, it has been challenging to achieve this goal due to resource limitations (i.e., a combination of FTE's and current capabilities of the operations tools). In case the execution window opens with a specific (starting) light distribution (out of multiple ones offered in the Proposal Call), the subgroup of the highest ranked experiments sharing this configuration of the telescope are prioritized, created, validated, and readied for observing at the summit.

Milestones to achieve this SciOps-3 goal are as follows:

- Train new team members on the usage of the Operations Tools (i.e. Experiment Architect, Operations Planning and Management Tool, End-to-End simulator) in preparation for the generation and validation of experiments.
- Update guidelines and other material necessary to provide guidance for the experiment generation and validation process.
- Prepare the Experiment Generation Tool (Experiment Architect) and other Operations Tools for usage during the experiment generation and validation process.
- Assign proposals to experiment generation team members.
- Facilitate and support the communication with PI's of accepted proposals during the experiment generation and validation phase.
- Inform PI's of accepted proposals that the experiment generation window has opened and what to expect.
- Manage and monitor the experiment generation and validation process.

Continue Cycle 2 observing interlaced with DDT observing (program goal SciOps-4)

Science Operations and any observing activities at the summit are planned on a long-term (six to twelve months), medium-term (one to three months) and short term (days to a week) basis. Long-term planning (LTP) is facilitated and governed by the solicitation Cycle. The medium-term planning (MTP) is mostly driven by Coudé Laboratory preparations (e.g., FIDO configuration changes), specific calibration planning, scheduled co-observing planning, and instrument and/or software updates/upgrades and their potential impact. The short-term planning (STP) is driven by the Sun (solar changes), weather/observing conditions, and the technical readiness of instruments and the Wave-Front Correction (WFC) system. Daily observing activities are conducted by Resident Scientists who direct the Science Operations Specialists (SOSs, a.k.a. Telescope Operators). Any performed science observation, its supporting calibration observations, related metadata and any auxiliary activity is monitored and tracked. Science Operations Specialists and Resident Scientists log information using respective Daily Log Tools tailored to the needs of science operations. At the end of an observing day, any proposal related data that has been obtained on that same day (by executing the respective observing programs) is transferred to the DKIST Data Center, subsequently correlated, and the PI is informed that data has been obtained.

Milestones to achieve this SciOps-4 goal are as follows:

- Schedule/manage Science Operations Specialists and Resident Scientists to support the observing process at the summit.
- Plan the general characteristics of OCP observing window(s) on a one- to three-month basis (mid-term plan, MTP).
- Send relevant experiments to the summit before an observing window opens.
- Execute those Cycle 2 experiments that have not been addressed yet or need repetition.
- Plan every week of observing with the Resident Scientists (short-term plan, STP) as practicable and feasible guided by weather, observing condition expectations, technical guidance, and solar target availability.
- Inform PI's of accepted proposals about the time frame of the next observing window and what to expect.
- Inform individual PI's of accepted proposals once an observation has been performed through the Help Desk system using the proposal specific PI communication ticket.
- Correlate science data with respective calibration data for the Data Center.
- Keep track of what observations have been performed.
- Support the 19th perihelion encounter of Parker Solar Probe through DDT observing with proposal development, generation and validation of a respective experiment and scheduled observing at a minimum on the day around the encounter on March 30, 2024.
- Support the solar eclipse through DDT observing with proposal development, generation and validation of a respective experiment and scheduled observing at a minimum on the day the continental total eclipse on April 8, 2024.
- Support Solar Orbiter during the early (March/April) and/or late (September/October) Remote Sensing Window through DDT observing with proposal development, generation and validation of a respective experiment and scheduled observing.

2.3.3 DKIST Technical Operations

The DKIST Technical Operations (TechOps) team comprises Maui-based management, engineers, and technicians. In essence, TechOps performs three main functions:

1. Support of On-Sun observing and proactively minimizing the loss of Science Operations time. Activities under this function are categorized as Availability.
2. The second is maintenance, which can be subdivided into planned (preventive) and unplanned (repair) maintenance, with further division of planned maintenance into activities that may be conducted concurrently with observing and activities incompatible with observing. These activities are categorized as Reliability.
3. The third category is upgrades to the facility and equipment. These upgrades are categorized under Capability Now for activities that are being implemented in the current period and Capability Future for activities that are in the design and planning stage in the current period.

2.3.3.1 Technical Operations Program Goals for FY 2024

The DKIST TechOps team has set the following goals for FY 2024:

Program Goal (TechOps-1): Provide technical support during Science Operations by maximizing staff efficiency and increasing automation to minimize downtime due to planned and unplanned technical outages (Availability).

Program Goal (TechOps-2): Continue a program of preventive maintenance to reduce technical downtime for the DKIST facility (Reliability).

Program Goal (TechOps-3): Continue to upgrade current capabilities of the facility to keep it on the leading edge of science (Capability Now).

Program Goal (TechOps-4): Continue to develop new upgrades to the facility to keep it on the leading edge of science (Capability Future).

Table 2.3. Technical Operations Goals for FY 2024

Program Goal	FY 2024 Time Interval
TechOps-1	Q1 – Q4
TechOps-2	Q1 – Q4
TechOps-3	Q1 – Q4
TechOps-4	Q1 – Q4

2.3.3.2 Technical Operations Program Goal Descriptions and Milestones

Availability (program goal TechOps-1)

In support of Program Goal TechOps-1, i.e., improving the available uptime of the DKIST facility, the TechOps team is planning the following activities: 1) coordinate cross-training of Science Operations Specialists (SOSs), 2) continue the process of thermal subsystem automation and user interface, and 3) improve subsystem fault/alarm identification, handling, and response, for convergence of observing support responsibilities to further reduce the quantity of TechOps staff scheduled onsite for on-sun operations.

Reliability (program goal TechOps-2)

In support of Program Goal TechOps-2, i.e., improving the reliability of the DKIST facility through preventive maintenance, the TechOps team is planning the following activities: 1) complete maintenance strategy status bottoms-up labor estimate for the technical operational work plan, demonstrating optimal utilization of this very unique DKIST facility, and 2) complete the re-alignment of the enclosure azimuth rail; implement improvements to the enclosure azimuth electro-mechanical system such as load-balancing, tuning for speed and acceleration efficiency, and increase safety integrity level.

Capability Now (program goal TechOps-3)

In support of Program Goal TechOps-3, i.e., improving the current capabilities of the DKIST facility, the TechOps team is planning the following activities: 1) complete the infrastructure remediation of the wastewater handling system, personnel lifts, and equipment lift, and 2) complete commissioning and balancing of the newly installed primary loop chillers (CH1, CH2).

Capability Future (program goal TechOps-4)

In support of Program Goal TechOps-4, i.e., developing new capabilities for the DKIST facility, the TechOps team is planning the following activities: 1) facilitate installation and commissioning of the VTF Instrument, 2) complete preparations for the potential exchange of the M3 mirror for its spare, 3) plan for the M1 mirror recoating operation for a future date yet to be determined, and 4) actively promote workforce development and inclusion through hosting Akamai Workforce Initiative engineering interns and a University of Hawaii Maui College technician intern.

2.3.4 DKIST Instrumentation

The DKIST Instrumentation program is a key component to keeping NSO/DKIST at the forefront of scientific discoveries and research in the field of high-resolution solar physics. At its first light, DKIST's instrumentation suite has already shown its vast potential, and recent discoveries with DKIST data have corroborated this fact.

To continue this success and ensure continued operation with minimal downtime, each DKIST instrument will be serviced throughout the year with a regular maintenance schedule. Additional servicing will be performed as needed or required. These activities include hardware and software upkeep, carried out in close collaboration with the Science Operations and Technical Operations teams, streamlining operator experience with the instruments based on the feedback received from team members, and furthermore, commissioning new instrument modes of operation.

In addition, the Instrumentation program team will continue to spearhead concepts of novel, state-of-the-art instrumentation, and technology where these opportunities arise, either through leveraging the vast knowledge of current internal and external resources and partners, or by building and fostering new national and international partnerships.

2.3.4.1 Instrumentation Program Goals for FY 2024

The DKIST Instrumentation team has set the following goals for FY 2024:

Program Goal (Inst-1): Continue and improve the program to maintain and upgrade the current DKIST instrument capabilities, including the installation of the Visible Tunable Filter (VTF).

Program Goal (Inst-2): Continue and improve the program to maintain and upgrade the current DKIST High-Level Software (HLS) capabilities.

Program Goal (Inst-3): Continue the development of future DKIST capabilities like the Multi-Conjugate Adaptive Optics (MCAO) and new infrared cameras.

Table 2.4. Instrumentation Goals for FY 2024

Program Goal	FY 2024 Time Interval
Inst-1	Q1 – Q4
Inst-2	Q1 – Q4
Inst-3	Q1 – Q4

Visible Broadband Imager (program goal Inst-1)

The Visible Broadband Imager (VBI) is a first light instrument for DKIST. It has been very successful in generating near-diffraction-limited data showing unprecedented details in the solar atmosphere that has generated excitement world-wide. The VBI was built at the National Solar Observatory and was the first DKIST instrument commissioned.

Due to its noise sensitive image reconstruction capabilities, the VBI is a major reason for the need of a visible camera upgrade. The current DKIST science cameras produce a stepped, multi-gain signal that is unfortunately apparent in speckle reconstructed data. The search for camera hardware solutions will continue throughout the fiscal year, with accompanying analysis of necessary modifications to the opto-mechanical setup of the instrument and control system changes. A design study to identify the impact of the VBI motor motion on other instrumentation will be performed in 2024 to inform an appropriate design that minimizes vibration induction. General maintenance work will consist of the upkeep of serviceable parts such as motorized stages, and verification of continued filter performance.

Visible Spectro-Polarimeter (program goal Inst-1)

With its high versatility and configurability, the Visible Spectro-Polarimeter (ViSP) instrument provides DKIST with opportunities for impactful discoveries using three standard- and new-wavelength diagnostics in unprecedented combinations. The ViSP was designed and built at the High-Altitude Observatory. It is utilized in the majority of all OCP Experiments and provides information on plasma flows and magnetic fields in the solar photosphere and chromosphere.

During 2024, 'ghost' images created by internal ViSP optics will be analyzed during a ghost mitigation study. These unwanted reflections can reduce the signal to noise ratio in the data and — more importantly — bias the polarimetric calibration, reducing the data's scientific value significantly.

A design study will be executed to investigate potential scan speed improvements of the slit to increase the output cadence of science data sets. Another design study will be used to determine an upgrade path for automating the ViSP M1 movement to adjust the slit focus.

To remove noise performance issues of the current science cameras and increase the accessible instrument field of view, an update to existing cameras will be considered through market research of viable visible light cameras and design studies for their integration.

ViSP general maintenance will consist of the servicing and performance verification of regularly moving parts that include motorized stages, gearboxes, rail systems, order sorting filters and their holders, and cameras.

Diffraction-Limited Near-Infrared Spectro-Polarimeter (program goal Inst-1)

The Diffraction-Limited Near-Infrared Spectro-Polarimeter (DL-NIRSP) is a state-of-the-art DKIST instrument acquiring unique and highly valuable science data for the DKIST community. The DL-NIRSP was designed and built at the University of Hawaii/Institute for Astronomy. The instrument will be undergoing important upgrades in FY 2024, as detailed below.

The Machined Image Slicer (MISI-36) upgrade for the DL-NIRSP will be installed during FY 2024. This new imaging system replaces the BiFOIS-36 optical fiber relay system and provides a more efficient and reliable mechanism for imaging the instrument slit-let arrays. The MISI-36 upgrade will occur during the first quarter of FY 2024, followed by on-sun site acceptance and science verification tests.

During 2024, the coronal image slicer MISI-116 hardware upgrade for the DL-NIRSP will be designed and constructed. This upgrade will include a motorized stage for a new slit mask, and other hardware needed to facilitate an efficient switch between the on-disk and coronal modes. The updated DL-NIRSP data calibration pipeline will be integrated into the DKIST Data Center, and all acquired science data will be automatically calibrated using this system. The MISI-116 hardware will be installed in FY 2025.

A design study will be performed to investigate potentially necessary opto-mechanical modifications to the visible light arm of the DL-NIRSP in order to accommodate an improved visible light camera system.

DL-NIRSP general maintenance will consist of the servicing and performance verification of regularly moving parts that include motorized stages, gearboxes, filters, and cameras. In addition, maintenance will occur on cryogenic pump, cold heads and other related systems.

Cryogenic Near-Infrared Spectro-Polarimeter (program goal Inst-1)

The Cryogenic Near-Infrared Spectro-Polarimeter (Cryo-NIRSP) instrument is designed to observe in infrared wavelength diagnostics with a focus on spectro-polarimetric coronal observations. Even though such observations have historically been very difficult, Cryo-NIRSP has demonstrated the ability to acquire coronal data on a regular basis, making it a vital contributor to the success of the DKIST project. The Cryo-NIRSP was built at the University of Hawaii/Institute for Astronomy.

During early FY 2024, a new warm filter mechanism will be designed, built, and installed. This new mechanism will provide more reliable motion control and position reporting. The effort to replace existing order sorting filters that have insufficient out-of-band blocking with improved filters will complete. A modulator optimized for operation at the wavelength of 1µm will be designed, manufactured and integrated into the Cryo-NIRSP. The cryogenic pump functionality will be maintained through a hardware upgrade and annual servicing.

A new beamsplitter between Cryo-NIRSP spectrograph and context imager will be explored to remove the current optic that only provides a limited usable field of view.

Cryo-NIRSP general maintenance will consist of the servicing and performance verification of regularly moving parts that include motorized stages, gearboxes, filters, and cameras. In addition, maintenance will occur on cryogenic pump, cold heads and other related systems.

Visible Tunable Filter (program goals Inst-1 and Inst-3)

The Visible Tunable Filter (VTF) is an imaging spectro-polarimeter, highly anticipated by the DKIST science community. It will deliver images at the diffraction limit of DKIST that encode scientifically the vectors of plasma velocity and magnetic fields. The VTF was built by the Leibniz Institut für Sonnenphysik (KIS).

In FY 2024, the VTF opto-mechanical, electrical, and software systems will be installed and integrated into the DKIST hardware and software infrastructure, with some acceptance testing performed throughout the year. During the second quarter of FY 2024, the VTF will be tested only in a visible broadband imager mode. During the final two quarters of FY 2024 the etalon will be installed into the instrument and tested. In summary, the VTF will still be in a commissioning phase throughout FY 2024, while the systems are verified, and potential issues addressed.

Simultaneously, during FY 2024, the second Fabry-Perot Etalon for the VTF will be under construction in Germany.

Mitigation of camera noise issues will be started by selecting and initially testing newly available, viable and affordable camera hardware solutions.

Optical Systems (program goal Inst-1)

The most important DKIST core capability is to efficiently capture the solar light and transfer it to each instrument, without compromising the beam quality by, e.g., introducing optical aberrations or polarization artifacts. This starts with the active primary mirror (M1), including control of its shape and coating performance, and continues to include each optical surface to the instrument camera. That is the reason why tight error budgets have driven, and continue to drive, the design and fabrication of each individual element in the optical train. Aside from controlling surface quality, a careful selection of the coating each optical surface in the beam path is subjected to is critical for throughput and polarimetric performance. As optical surfaces and coatings often degrade over time, it is a vital DKIST maintenance task to continuously verify and maintain the beam quality of DKIST while staying up to date with new technology and enhancing DKIST performance and capability where feasible.

Many other aspects impact the beam quality, such as vibrations or telescope internal seeing. Monitoring such effects with state-of-the-art tools allow identifying, diagnosing, and mitigating sources, thereby enhancing beam and science data quality.

Because of the ever-increasing demand to address additional science use cases, a further FIDO beam splitter option will be selected. The flexible combination of multiple instruments in different – or the same – wavelength interval is an important tool to gain insights into the physical parameters and their dynamics within the solar atmosphere, using a multi-diagnostic approach that probes the solar atmosphere with the advantage of each instrument's observational strength. For example, using the advantage of the large, one-dimensional field of the ViSP data in combination with the instantaneous two-dimensional, but small, field of the DL-

NIRSP allows analysis of one data set within the context of the other, leading to a more complete picture of the prevailing solar atmospheric parameters.

Using the existing tools, and potentially further tools, vibration measurement equipment will be deployed at different locations on the Coudé Lab floor and used in the mitigation of vibrations.

Since the previously procured “M9B” optic can be moved into and out of the optical beam path and exchanged with the current mirror optic (“M9A”) at that location, an opto-mechanical exchange mechanism will be designed.

Modern tools to measure parameters that impact the science optical beam, for example, non-common path aberrations (phase diversity sensor, see above) and the atmospheric turbulence height profile will be further investigated for use at the DKIST site.

Studies to stay at the forefront of the development of high-performance optical coatings will continue. With the modification of existing optical setups on the Coudé Lab floor to enhance instrument performance, the effort to mitigate stray light within the instruments will carry on.

To achieve the highest quality in DKIST polarimetric data, particularly in regard to their calibration, advances in optical elements and algorithms will be pursued with studies and verification tests.

Ongoing will be the modernization of laboratory equipment to continue to support acceptance testing of optical elements that are scheduled for use in the science optical beam path at the DKIST site.

High Level Software (program goal Inst-2)

A vital component of DKIST, the computer hardware and software, or “High Level Software system” allows telescope operators and engineers to control and otherwise interact with the DKIST telescope. In order to maintain the system and remain at the forefront of solar science and technology, both computer hardware and software need continuous attention to improve stability and performance.

During FY 2024 the Data Handling System will be upgraded to over 3 Petabytes of storage to allow for increased data storage throughput and capacity. This upgrade will enhance science capability by allowing operation of all instruments and cameras even in instrument modes that utilize the highest data acquisition rates. In addition, DHS processing will be enhanced to allow simultaneous read/write capability to store data, present ‘quick-look’ imaging capability, and process data for transfer to the DKIST Data Center.

The focus of the software updates for FY 2024 will be primarily on stabilization of existing telescope and instrument hardware and software systems, while simplifying operational processes where possible. Any significant telescope or instrument changes will require software support. New software work will include speckle processing pipeline development, instrument operational efficiency improvements, interfaces to telescope facility management, automated startup and shutdown procedures, and VTF software integration.

Maintenance of computer hardware and software will be performed, including replacement of older servers and operating systems upgrades; some software maintenance is supported by contractors.

With the help of instrument scientists, the operationally important Instrument Performance Calculators will be updated to better reflect the instrument capabilities. At the same time, the user interface for DKIST operators will be modernized and improved to simplify all processes where possible.

2.3.4.3 Instrumentation Development Program Goal Descriptions and Milestones

Multi-Conjugate Adaptive Optics (program goal Inst-3)

The DKIST project intends to remain at the forefront of scientific discoveries for the duration of its lifetime using state-of-the-art technology. An important requirement for meeting this goal is in facilitating data acquisition with the highest possible quality at all times given prevailing atmospheric conditions.

The initial High-Order Adaptive Optics (HOAO) system of DKIST is a classical adaptive optics system and is based upon well-established techniques and scaled-up technologies, such as the first and pioneering high-order system in solar adaptive optics developed at the Dunn Solar Telescope. As a single conjugate or classical system, the DKIST HOAO deploys one deformable mirror conjugate to the telescope aperture to correct the light path, and one unidirectional wavefront sensor to measure the adjustments needed. In such a system, the corrected field of view is typically limited to a patch on the order of 10 arcseconds in diameter around the viewing direction of the wavefront sensor. However, scientifically interesting regions can span dozens of arcseconds. Deployment of multiple deformable mirrors that are conjugate to different atmospheric altitudes in which strong turbulence occurs—the concept of a MCAO system—can widen the corrected field by several factors, providing a data set that is scientifically more useful.

For over a decade, NSO has been collaborating with the German Kiepenheuer Institut für Sonnenphysik (now Leibniz Institut für Sonnenphysik (KIS)) and the New Jersey Institute of Technology (NJIT) in the development of MCAO. Under the leadership of NSO and funded by NSF grants, the experimental solar MCAO pathfinder, called "Clear," was developed for NJIT's 1.6-meter Goode Solar Telescope (GST) located at the Big Bear Solar Observatory in Southern California.

Given the excellent progress made with Clear, DKIST has been pursuing the design and development of a much larger MCAO system for DKIST, with plans to correct atmospheric turbulence in three different layers (ground layer, four and eleven kilometers above the telescope).

In FY 2024 the Instrumentation Development team hopes to achieve the following milestones for MCAO:

- The phased design and fabrication of the majority of the optical and opto-mechanical components of the new MCAO system will be continued.
- The deformable mirror (DM) that is conjugated to an altitude of four kilometers above the telescope will be delivered and begin verification testing in the Boulder laboratory.
- The fabrication of the deformable mirror conjugated to eleven kilometers will be started.
- The necessary optical bench and opto-mechanical mounts will be designed, and manufactured. Installation will occur during the following fiscal year.
- The custom high-speed cameras will be delivered and verified, and will be integrated into the laboratory opto-mechanical wavefront sensor assembly.

Infrared Cameras (program goal Inst-3)

The DKIST Infrared (IR) Camera program began in 2020 with a request for proposal, development, and acquisition of four 4k x 4k digital science-grade infrared sensors. The IR cameras are designed for use in the DL-NIRSP and Cryo-NIRSP instruments as long-term replacements for the existing 2k x 2k analog sensors. The upgrades to these instruments allow them to perform at a higher resolution, extended IR wavelength coverage, reduced noise, and increased efficiency. To ensure continued operation with minimal downtime, the IR cameras will be serviced and maintained throughout each year of usage.

In FY 2024 the Instrumentation Development team hopes to achieve the following milestones for the IR Camera system:

- The IR Camera Read-Out Integrated Circuits (ROICs) and Focal Plane Arrays (FPAs) will be delivered to the DKIST project.
- Two Short-Wave Infrared (SWIR) and two Mid-Wave Infrared (MWIR) sensors will be delivered.
- A digital camera controller specification will be developed and an appropriate manufacturer selected.
- Specifications for all instrument upgrades will be created, reviewed, and approved.
- Project management planning will be continuing to direct the program schedule and budget.

- The DKIST laboratory will be furnished for camera development, including a lab camera controller, cryostat, and test equipment. Using this equipment, performance testing and down-selection of the detectors will be started.
- A cryostat design study for the DL-NIRSP will begin, along with design requirements for integration into the Cryo-NIRSP cryostat.
- Initial control software will begin to control and read the laboratory sensor.
- Thermal analysis of all sensors and cold heads will be completed.

Maintenance of the IR Camera system will consist of compressor maintenance, cold head refurbishment, and absorber exchanges.

2.3.5 DKIST Data Center

The DKIST Data Center (DC) team is an integral part of DKIST Operations responsible for the ingestion, processing, distribution, and curation of all DKIST data.

2.3.5.1 Data Center Program Goals for FY 2024

The DKIST DC team has set the following goals for FY 2024:

Program Goal (DC-1): Complete and put into production the Cryo-NIRSP pipeline. Publish the backlog of Cryo-NIRSP Data previously taken.

Program Goal (DC-2): Complete and put into production the DL-NIRSP pipeline. Publish the backlog of DL-NIRSP Data previously taken.

Program Goal (DC-3): Integrate the Hardware bought in buys #4 and #5 into the data center as it gets delivered and racked.

Program Goal (DC-4): Implement and enhance cyber security measures into the Data Center with the goal of placing safeguards on the scientific data and creating multiple backups of other data in geographically and virtually distinct locations.

Table 2.5. Data Center Goals for FY 2024

Program Goal	FY 2024 Time Interval
DC-1	Q1 – Q2
DC-2	Q2 – Q4
DC-3	Q2 – Q4
DC-4	Q1 – Q4

2.3.5.2 Data Center Program Goal Descriptions and Milestones

Data Pipelines (program goals DC-1 and DC-2)

As of the beginning FY 2024, two pipelines are in the process of being constructed. They are the Cryo-NIRSP and DL-NIRSP pipelines. The Cryo-NIRSP is further along in its development as the Cryo-NIRSP instrument was brought online first. The Data Center expects to complete the Beta version of the pipeline early in FY 2024, with the acceptance phase following thereafter (DC-1).

The pipeline acceptance phase is essentially an iterative cycle consisting of – 1) the DC produces data with the pipeline, 2) DKIST scientists review the data, find and highlight possible issues in the data, 3) pipeline algorithms and implementations are adjusted to mitigate or eliminate the found issues – repeat until the pipeline and the data are considered science ready. At this point the pipeline is placed into production and all of the backlog of data produced to date by that instrument is run through the pipeline and released to the PI and subsequently the community.

As of the writing of this document, the Cryo-NIRSP pipeline Beta was completed and is currently in the acceptance phase. It expected that Version 1 of pipeline should be ready for release by the end of the 2nd quarter of FY 2024.

The DL- NIRSP pipeline (DC-2) is closer to the beginning stage of development, though as of this writing a fair amount of work has gone into it. A working prototype pipeline has been developed, and it has been used to calibrate data taken by the DL-NIRSP instrument in its first incarnation. Further development of the pipeline is awaiting the installation of new DL-NIRSP hardware, i.e., the Machined Image Slicer (MISI-36) in the 1st quarter of FY 2024, at which point new test data will be taken and further pipeline development can and will proceed. Barring unforeseen circumstances issues with the "new" DL-NIRSP and the data taken with it, it is plausible that the production pipeline can be completed by the end of the fiscal year, and that is the goal that the DC is planning for.

Data Center Infrastructure (program goals DC-3 and DC-4)

The Data Center Infrastructure, while completed and functioning, is in a continuous state of change as new requirements, new hardware, and updated software are brought into play. The Data Center plans these updates and changes as part of its operations during the year, prioritizing some over others as operational realities (e.g. small staff) are considered. The major focus this FY will be twofold:

- As much as possible, bring online the hardware from the last two purchases that were made to refresh and augment the DC (DC-3).
- Implement to the best extent possible cyber security protocol to enhance the safety of the data that the DC holds (DC-4).

Both of these efforts will continue throughout this FY.

As of this writing almost all of the equipment bought in hardware buys #4 and #5 have been delivered. Switches bought in buy #5 – due late in CY 2024 - have yet to arrive as they have become very long lead items since the pandemic. Their absence will make it impossible to integrate the entirety of the last 2 hardware buys. As such, the DC will integrate roughly 50 new servers across the infrastructure, and another 4PB of storage. The rest of the equipment - ~10 PB of storage will be brought online when the buy #5 switches are delivered and racked.

The other major effort that the DC infrastructure will undertake this year is a hardening of the cyber infrastructure. In light of the attacks on our sister observatories, the DC has decided to backup all of the data that it possibly can on a regular basis and in geographically disparate areas.

As of now, the DC backs up all of the level-0 data in Amazon Web Services (AWS) Glacier, and backs up databases to local backups on a regular basis. The FY 2024 effort will focus on "locking" the local level-and level-1 data buckets, such that they cannot be modified or deleted, and backing up all of the other data that the DC produces (e.g., inventories, movies, secrets, scripts, etc.) both locally and off site (AWS) in immutable storage and with different security credentials. The idea is that if any data is compromised, the 2 disparate backups would be unlikely to be compromised as well by the time the intrusion is detected. While cyber security will be an ongoing operational concern for the rest of the project lifetime, the framework of the security posture including policies and procedures will be implement this fiscal year.

2.3.6 DKIST Science Support and Research

The DKIST Science team consists of a group of dedicated DKIST science staff who serve in a variety of roles from supporting instruments (instrument scientists) to supporting observations (resident scientists) to scrutinizing data products developing and improving calibration pipelines (data/calibration scientists), development of new instrument capabilities, supporting the community, EPO/C and DEI efforts. The Science team is also tasked with publishing DKIST science results, promoting DKIST science at meetings and conferences, and training new DKIST users. Individual scientists often perform multiple of the support functions listed above.

2.3.6.1 Science Support and Research Program Goals for FY 2024

The DKIST Science team has set the following goals for FY 2024:

Program Goal (Science-1): Provide scientific support during the planning, execution, calibration, and analysis of DKIST science observations.

Program Goal (Science-2): Promote DKIST through the generation and dissemination of DKIST scientific research results.

Program Goal (Science-3): Participate in the training of current and next generation of DKIST users.

Table 2.6. Science Goals for FY 2024

Program Goal	FY 2024 Time Interval
Science-1	Q1 – Q4
Science-2	Q1 – Q4
Science-3	Q1 – Q4

2.3.6.2 Science Support and Research Program Goal Descriptions and Milestones

Science Support (program goal Science-1)

The DKIST Science team will continue to provide support in areas of instrumentation, science operations, post-observation analysis in FY 2024. In the area of Instrumentation, DKIST instrument scientists will continue to support operations by assisting the Instrumentation Operations group in keeping the instruments running at an optimal state and introducing new modes of operation. The instrument scientists will also continue to help debug hardware and software problems and provided fixes to improve data quality. Some of the instrumentation related issues that DKIST scientists will support in FY 2024 include:

- Investigation and mitigation of vibrations, stray-light, and ghost images within the ViSP and VBI instruments (program goal Inst-1).
- Assist the Instrumentation team with the commissioning of the newly installed MISI-36 image slicer in the DL-NISRP instrument (program goal Inst-1).
- Assist the Instrumentation team with testing the newly installed warm filter and other upgrades to the Cryo-NISRP instrument (program goal Inst-1).
- Assist the Instrumentation team with the installation and integration of the VTF instrument (program goal Inst-1).

DKIST scientists will also continue to provide input to the Instrumentation Development group on potential new capabilities like the development of the MCAO system and the IR Cameras. Typically, the lead scientist of an instrumentation program is providing detailed guidance and direction for the program and performs technical work.

The DKIST Science team will continue to support the SciOps team in the planning, evaluation, scheduling, and execution of the DKIST science observations in FY 2024. The Science team will support the SciOps team in planning for the upcoming Cycle 3 call for proposals (program goal SciOps-1). DKIST scientists play will an integral role in the proposal evaluation process by providing the technical review of DKIST proposals through the Technical Review Committee (TRC) (program goal SciOps-2). The TRC is formed by DKIST Science team staff. In addition to providing technical expertise, some DKIST scientists participate in the scientific review of DKIST proposals through the Scientific Review Committee (SRC). DKIST scientists will continue to assist PIs and SciOps staff in the experiment generation process for Cycle-2 and Cycle 3 proposals using the Experiment Architect. They will continue to participate in the QA process using the End-to-End Simulator to test experiment execution procedures. As noted above in the Science Operations section, DKIST Science team members participate in the actual execution of the Cycle-2 experiments by serving as Resident Scientists on a rotating basis and will continue to do so in FY 2024 (program goal SciOps-3 and SciOps-4).

Finally, the DKIST Science team will continue to support the post-observation efforts of the DKIST Data Center and DKIST Data Scientist with regards to calibration and analysis of the data. DKIST scientists work with the Data Center to improve calibration pipelines. In FY 2024, this effort will focus on the Cryo-NIRSP and DL-NIRSP pre-production pipelines through an iterative process of analyzing calibrated data, developing calibration algorithms/code, working with the DC to implement production code, and scrutinizing reprocessed data (program goals DC-1 and DC-2). DKIST scientists will continue to respond to Help Desk tickets generated by users regarding DKIST data and work to find solutions and resolve issues.

Science Research (program goal Science-2)

In addition to their scientific support duties, the DKIST Science team are encouraged to generate and disseminate DKIST science results. In FY 2024, DKIST scientists will continue to be active researchers that apply for DKIST time as PIs or co-PIs, design observations, analyze data, and publish DKIST results. They will attend meetings and conferences presenting their results to the rest of the solar physics community. Several DKIST scientists are engaged in the planning of a joint DKIST, NASA Parker Solar Probe, and ESA Solar Orbiter meeting that will take place in San Antonio, TX the week of the total solar eclipse on April 8, 2024. DKIST scientists will also be attending the American Astronomical Society (AAS) Solar Physics Division (SPD) meeting in Dallas, TX also on the week of the total solar eclipse. This SPD meeting is also joint with the AGU's Triennial Earth Sun Summit (TESS) meeting.

Science Training (program goal Science-3)

As part of their duties, the DKIST Science team also participates in training the current and next generation of DKIST users through community workshops and mentorship programs. The DKIST Science team will continue to hold community workshops/training presentations in FY 2024.

DKIST scientists will continue to participate in training through mentorship programs like the Boulder Solar Alliance's Research Experiences for Undergraduates (REU) program, the DKIST Ambassador program, and the Hale Fellowship program shared between NSO and the University of Colorado, Boulder (CU). NSO is one of six institutions that participate in the Boulder Solar Alliance REU program, which is led by CU's Laboratory for Atmospheric and Space Physics. DKIST scientists will continue to mentor REU students in the summer of 2024. The DKIST Ambassador program provides financial support for graduate students and/or postdoctoral researchers at U.S. universities for up to two years. Ambassadors work with advisors at their home institutions and DKIST scientists on DKIST-related solar research. A new cadre of DKIST ambassadors recently started the 2-year program in in late FY 2023 – early FY 2024. In FY 2024, there will be 10 DKIST Ambassadors from universities spread across the U.S. working with DKIST scientists. Finally, NSO shares the Hale Fellowship program with CU. The program supports faculty, postdocs, and graduate students that work jointly with NSO and CU scientists. In FY 2024, DKIST researchers will continue to work with Hale fellows on research topics relevant to DKIST.

2.3.7 DKIST Safety

The DKIST Safety team consists of the Safety Officer and the Safety Technician who are responsible for the continuation of the Safety program elements into operations, evolving from the processes developed and implemented during the construction of DKIST. As in construction, safety, health, and environmental management continues to be an integral part of our work during DKIST operations. Management is responsible and held accountable for incorporating safety, health, and environmental policies, standards, rules, and principles into their work. The Safety team ensures adequate protection for our workers, the public, our equipment, and the environment. Safety management extends to the DKIST Director, engineers, managers, and supervisors. The Safety team will continue to work closely with supervisors to ensure the Safety Program requirements are met, providing Supervisors with appropriate OSHA Supervisor training to better understand their roles in the Safety Program. Although the Safety team consists of only two staff members, it provides continuous safety coverage with at least one safety team member on site, during both on-Sun science operations and periods of engineering/technical downtime.

2.3.7.1 Safety Program Goals for FY 2024

The DKIST Safety team has set the following goals for FY 2024:

Program Goal (Safety-1): Continuously monitor and support all safety-related aspects of DKIST operations.

Program Goal (Safety-2): Promote a safe work environment for DKIST operations by establishing a culture of prevention and response preparedness through training.

Table 2.7. Science Goals for FY 2024

Program Goal	FY 2024 Time Interval
Safety-1	Q1 – Q4
Safety-2	Q1 – Q4

2.3.7.2 Safety Program Goal Descriptions and Milestones

Safety Monitoring and Support (program goal Safety-1)

The Safety team supports DKIST with an almost continuous daily presence, ensuring the health and safety of all staff, visitors and contractors, while ensuring we stay compliant with OSHA and other agencies requirements. Various task directly related to Safety, Health and Environmental protection include daily site safety inspections, continuous real-time employee support and consultation regarding fall protection, Lock Out Tag Out (LOTO), confined space as well as other processes that require input so employees can safely perform their work. The team communicates with supervisors regarding any safety related issues, unsafe acts, conditions, or behaviors so we can realize and remedy the issue quickly and efficiently. The team completes daily logs documenting all of our inspections findings as well as weekly and monthly safety reports that are sent to DKIST Management and Supervisors. The Safety team provides a higher level of emergency response and first aid with both the Safety Officer and Technician trained as Emergency Medical Responders. The team has also been adapting, expanding and maintaining the Emergency Response Program including creating pre-incident plans for various scenarios including hazardous weather, fire, earthquakes as well as technical rescue and injury management. The Safety Officer investigates, documents, and offers actions in the event of injuries, accidents, equipment damage, near hits and near misses. We report and handle any workman's compensation claims. The Safety team also participates in the Hazardous Analysis Team, reviewing hazards with input from engineers and technicians, assigning a hazard level and creating appropriate Job Hazard Analysis documentation that employees utilize while performing various tasks to ensure safety. In support of Program

Goal Safety-1, i.e., monitoring and supporting all safety related aspects of the DKIST facility, the Safety team is planning the following activities:

- The Safety team will continue to make updates to the safety program for operations including updating our Electric Safety Program to allow non-qualified electrical workers the ability to switch off power to pumps for servicing.
- By the end of 2024, the team will have an outside contractor perform a DKIST Safety Program review, ensuring we are meeting the highest standards as possible.
- By the end of 2024k, DKIST will have the Emergency Response Team (ERT) in place. The ERT will consist of DKIST employees who will receive a more advance level of training in emergency medicine and response including high performance CPR, Emergency Medical Response, patient packaging and transport as well as assisting with basic rescues.

Safety Training (program goal Safety-2)

The DKIST Safety team provides on-site training in various processes including a new employee's Safety, Environmental, Cultural training and their first day site safety orientation. We provide ongoing training in LOTO, fall protection, confined space, electrics safety, respiratory protection, emergency response, on-site training for forklifts and aerial lifts as well as various other topics. We also make sure all site contractors, guests and visitors are appropriately trained in Safety, Environmental and Cultural requirements. We manage and update the training data base making sure everyone is current with required trainings and scheduling and administering updates and retraining's as needed. We conduct monthly, quarterly and yearly inspections of fall protection equipment, fire extinguishers, AED/First Aid and rescue equipment and vehicles. In support of Program Goal Safety-2, i.e., establishing a culture of prevention and response preparedness through training, the Safety team is planning the following activities:

- The Safety Officer became a Red Cross certified Adult CPR/First Aid/AED instructor. He has begun and will continue employee training.
- A Supervisor/Site lead/Duty Engineer Tactical Safety Training was recently created. In 2024 we will provide this training to our team leads giving them a better understanding of their response in the event of an emergency.
- Safety is working on finalizing the Supervisor Training which will be given to all leads and supervisors by the end of 2024. This training explains a supervisor's role in safety at DKIST.
- The Safety team will continue to update various training programs to allow for employee refresher's including Fall Protection, Fire Extinguisher and Fire Prevention.

3 NSO INTEGRATED SYNOPTIC PROGRAM (NISP)

3.1 Introduction

Providing the background synoptic[3] observations to characterize the variable solar activity and operating/developing ground-based facilities to enable such long-term observations are two key aspects of NSO's mission, which are entrusted to the NSO Integrated Synoptic Program (NISP). The program operates two facilities (Figure 3.1): Global Oscillation Network Group (GONG) and Synoptic Optical Long-term Investigations of the Sun (SOLIS). NISP engineering team provides technical support to NISP facilities (including two engineering GONG sites in Boulder, CO). The team is led by NISP Engineering Manager, Mr. Greg Card. Data from GONG and SOLIS facilities are processed and disseminated to research and space operation communities via NISP Data Center, coordinated by Dr. Olga Burtseva. The data center is also involved in curation of historical NSO data and some non-NSO observations. Research and Development (R&D) activities are conducted by NISP scientific personnel, with Dr. Kiran Jain serving as the Lead Scientist for farside imaging, Dr. Luca Bertello serving as the Lead for Solar Atmosphere Section, and Dr. Sushant Tripathy serving as the Lead for Solar Interior Section of NISP. The Leads work with the engineering and data center teams to provide/coordinate science support to assure the quality of observational data and development of new data products. Dr. Sanjay Gosain, Observatory Scientist, provides support for NISP instrumentation and new instrument development. Dr. Gordon Petrie plays a role in monitoring the zero point in GONG magnetograms, pole filling and monitoring the production of PFSS data products. Dr. Shukur Kholikov supports data quality analysis and testing of helioseismology data including new cameras, and Dr. Rudi Komm participates in the data quality analysis.

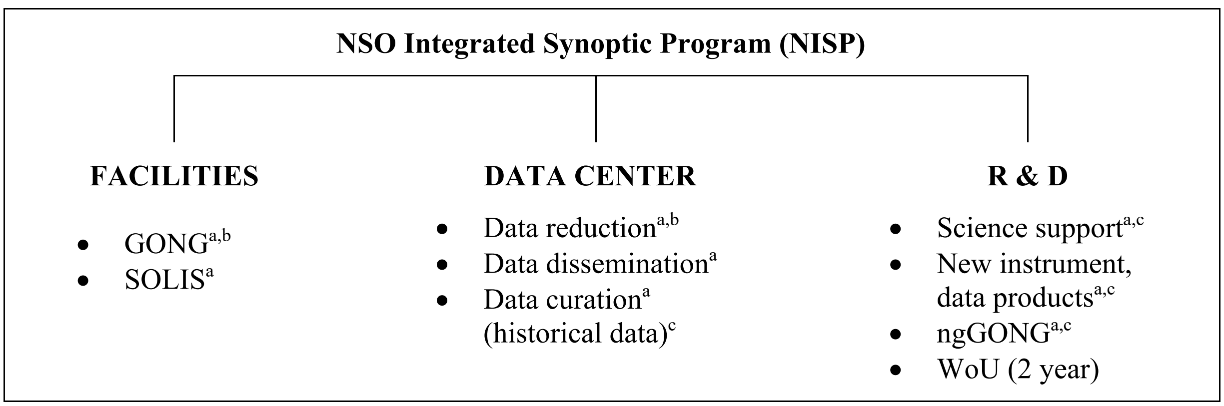

Figure 3.1. *NISP organizational structure with funding sources as the following: (a) NSF-base (ops, refurbishment, R&D); (b) NOAA funding (GONG operations. Current NSF-NOAA IAA was signed in CY 2021; FY 2022-2026.); (c) External grants funding.*

The majority of NISP scientists are funded by individual research grants by NSF or NASA, and thus, their service responsibilities are prorated according to their NISP funding allocation. In FY 2024, the NISP scientific team includes a visiting scientist, Prof. Kalevi Mursula (University of Oulu, Finland) and one postdoctoral researcher, Dr. Amr Hamada. In FY 2022, the program also received a limited time (2-year) funding from NSF's Windows on the Universe: The Era of Multi-Messenger Astrophysics (WoU-MMA) program to improve the application of NISP data products to modeling of space weather. This funding will end in FY 2024. NISP Associate Director, Dr. Alexei Pevtsov provides overall leadership to the Program. He interfaces

[3] By synoptic, we mean large-scale (full-disk), long-term (solar cycle and longer) observations.

with the NSO Directorate and NSO's Administrative Services, Information Technology, Education and Public Outreach, and the Business Office. He also works with and responds to requests from AURA Corporate and the National Science Foundation as required.

3.2 NISP GONG Component

GONG is a six-site network, located in California, Hawai'i, Australia, India, Spain, and Chile, of automated telescopes circling the world to provide continuous observations of the Sun (Hill, 2018). GONG data are extensively used by research and the operational space weather communities. GONG (near) real-time data are provided to NOAA's Space Weather Prediction Center (SWPC), the US Air Force 557th Weather Wing, AFRL, the United Kingdom Meteorological Bureau, and Japan's Space Weather Forecast Center for the operational space weather forecast.

3.2.1 GONG Goals

- Operate the GONG network for research and space weather operations. Continue timely distribution of data.
- Continue refurbishing the GONG network, prioritizing new detectors deployment.

3.2.2 GONG FY 2024 Objectives and milestones

To achieve GONG goals, FY 2024 has the following objectives (see, Table 3.1):

Program Objectives (NISP-1): Operate GONG network at the duty cycle as of the beginning of FY 2024 or better.

Program Objectives (NISP-2): Timely disseminate data from all NISP instruments.

Program Objectives (NISP-3): Make major advancement in GONG refurbishment.

Table 3.1. GONG Objectives for FY 2024

Program Objective	FY 2024 Time Interval
NISP-1	Q1 – Q4
NISP-2	Q1 – Q4
NISP-3	Q1 – Q4

3.2.3 Description of GONG FY 2024 Objectives

NISP-1 objective includes conducting routine operations, working with the site supporting personnel on required maintenance and troubleshooting, conducting scheduled site PM (preventive maintenance) trips, monitoring quality of data and taking corrective measures (e.g., remote tuning voltages to LCVRs, cleaning/replacing affected hardware), ensuring on-site (quick reduce) data processing and timely data transfer. NISP-1 also includes adding UV blockers to the LCVRs and activities for bringing GONG/ML site back to operation.

NISP-2 includes data quality assurance, working with NOAA/SWPC and other external users, operating and maintaining GONG pipelines, processing, and releasing data on a specified schedule, assisting the user community with the access to NISP current and historical data, routine maintenance, and replacement of the data center hardware. This includes running the Air Force Data Assimilative Photospheric Flux Transport (ADAPT) and providing the results to the users.

NISP-3 includes developing, testing, and deploying a new Camera-Data Acquisition System (DAS) to three (3) network site, completing the modification of GONG pipelines to accommodate the new data, and data merging into network data products. It is anticipated that the camera-DAS deployments will start in the Spring of 2024 (first deployment is planned for March 2024. The deployments would be separated by at least a 2-month intervals). Other tasks under GONG refurbishment include replacement of GPS units (to be completed in FY 2024), replacement of protective windows, and HVAC system upgrades (FY 2024-2025).

3.3 NISP SOLIS Component

SOLIS has three main instruments: a Vector Spectro-Magnetograph (VSM) capable of observing full-disk vector and line-of-sight magnetograms in the photosphere and chromosphere; a Full-Disk Patrol (FDP) imager; and an Integrated Sunlight Spectrometer (ISS) for observing high-resolution spectra of the Sun-as-a-star. The VSM produces 2K × 2K longitudinal and vector magnetograms constructed from full Stokes polarization spectra at a resolution of 200,000 in the Ca II 854.2 nm line and the Fe I 630.15/630.25 nm line pair. The FDP can take observations with a temporal cadence as short as 10 seconds in several spectral lines including Hα, Ca II K, He I 1083.0 nm, continuum (white light), and photospheric lines. The ISS observations are taken in nine spectral bands centered at the CN band 388.4 nm, Ca II H (396.8 nm), Ca II K (393.4 nm), C I 538.0 nm, Mn I 539.4 nm, Hα 656.3 nm, Ca II 854.2 nm, He I 1083.0 nm, and Na I 589.6 nm (D line) with a resolution of 300,000. SOLIS was relocated to Big Bear Solar observatory and is currently under construction.

3.3.1 SOLIS Goals

- Complete the SOLIS construction at Big Bear and start operations.

3.3.2 SOLIS FY 2024 Objectives and milestones

To achieve SOLIS goals, FY 2024 has the following objectives (see, Table 3.2):

Program Objectives (NISP-4): Achieve first light with SOLIS VSM and ISS instruments.

Program Objectives (NISP-5): Restart regular operations of SOLIS/VSM and ISS instruments

Table 3.2. SOLIS Objectives for FY 2024

Program Objective	FY 2024 Time Interval
NISP-4	Q2 – Q3
NISP-5	Q3 -- Q4

3.3.3 Description of SOLIS FY 2024 Objectives

NISP-4 includes installation of all remaining equipment (chiller), installing VSM and FDP on SOLIS mount, alignment of the mount, and taking first-light observations with VSM early-Summer (current target date is May 2024), and restarting all associated data processing pipelines. After VSM first light, work on ISS first light would start.

NISP-5: After achieving the NISP-4 objective, the teams will work on restarting regular operations by two SOLIS instruments (VSM and ISS). This includes finalizing the work on mount alignment, electronics and instrument testing/repairs, data processing, daily monitoring of SOLIS instrumentation, and science verification of data quality. It is anticipated that by the end of FY 2024, VSM and ISS would be in full operations, while work on FDP may continue in FY 2025. The current target date for VSM restart is September 2024.

3.4 NISP Data Center Component

The data acquired by NISP-operated instruments are transmitted to the NISP Data Center located on the first floor of the SPSC Building. Those observations are processed, for both scientific research and space weather applications, through various pipelines, resulting in more than a hundred derived data products (including intermediate ones that are primarily for internal purposes), or 5.5–7.4 TB of total data per month. About 50% of those files are publicly available within a minute of the observation being acquired, another 10% within 15 minutes, and 10% more within an hour. The remaining 30% are based on one to several months of observations and are provided accordingly. The NISP Data Center currently uses 8 personnel, with two working remotely from Tucson. One of DC personnel is supported by NISP base at 50%, and two are funded by Windows-on-the-Universe budget supplement.

3.4.1 DC Goals

NISP Data Center goals are included with GONG and SOLIS goals specifically to:

- Continue timely distribution of data, and
- Complete modification of GONG pipelines to accommodate data from new GONG cameras.

3.4.2 DC FY 2024 Objectives and milestones

To achieve DC goals, FY 2024 has the following objectives, which are included with:

Program Objectives (NISP-6): Timely disseminate data from all NISP instruments.

Program Objectives (NISP-7): Make major advancement in GONG refurbishment.

3.4.3 Description of DC FY 2024 Objectives

NISP-6 and NISP-7 are described in detail in Section 3.2.3.

3.5 Other NISP Goals

- Engage stakeholders (DoC, DoD, international partners) in the ngGONG design phase.
- Elaborate the NISP contribution to the 2-year CA extension proposal.
- Promote the value of long-term synoptic science to funding agencies, research community, and the public.
- Develop a path forward to maintain a healthy and productive program in the current environment of limited funding.

3.5.1 Other NISP FY 2024 Objectives and milestones

To achieve these goals the following objectives have been set for FY 2024 (see, Table 3.3):

Program Objectives (NISP-8): Plan and prepare the NISP portion of NSO's 2-year extension proposal (FY 2025-2026) for submission to NSF.

Program Objectives (NISP-9): Continue promoting the value of long-term synoptic science to the solar physics community, the broader astronomy community, funding agencies, and the public.

Program Objectives (NISP-10): Continue working with domestic and international partners and funding agencies regarding the development of ngGONG.

Program Objectives (NISP-11): Develop a long-range plan for maintaining a healthy and productive program.

Table 3.3. NISP Objectives for FY 2024	
Program Objectives	**FY 2024 Time Interval**
NISP-8	Q1 – Q4
NISP-9	Q1 – Q4
NISP-10	Q1 – Q4
NISP-11	Q1 – Q4

3.5.2 Description of other NISP FY 2024 Objectives

NISP-8 includes developing NISP portion of proposal to NSF for NSO's two-year extension of the Cooperative Agreement.

NISP-9 includes active collaboration with NSO public outreach office, news media, public organizations about recent discoveries, publications, public lectures, opinion articles emphasizing the need and value of long-term investigations of the Sun and the NISP role.

NISP-10 includes regular communications with all stakeholders in respect to future ngGONG as a replacement to aging GONG network. It includes exploration of new funding sources and establishing new partnerships.

NISP-11 includes investigating various funding opportunities to maintain a healthy synoptic program at NSO. Proposals to major NSF and NASA initiatives would be prepared and submitted (e.g., NSF's AI Institute, NASA's heliophysics missions, NASA-NOAA R2O-O2R program, NASA instrument development program etc.) This goal also includes development of training and succession plans for anticipated future retirements. The program will continue accumulating funds for future NISP DC Hardware replacement/upgrade. It is anticipated that such an upgrade would occur in Q3-Q4 FY25 at the earliest. As a separate development, NISP will explore the option of establishing its role as a National Center for Historical Data in Solar Astronomy. Additional funding will be thought from the funding agencies for this initiative.

3.6 Team roles for achieving Program Objectives

As NISP AD, Dr. Pevtsov is responsible for achieving all program goals. Roles of the teams for each NISP goal are summarized in Table 3.4. NISP scientific staff will continue providing support for all program goals as assigned. NISP personnel will continue participating in NSO-wide activities e.g., REU, DEI, EPO/C.

Table 3.4. NISP Teams role for FY 2024 Objectives		
Program Objective	**Primary Team**	**Supporting Team**
NISP-1	NISP AD and Engineering	DC and NISP scientists
NISP-2	NISP AD and DC	Scientists and engineering
NISP-3	NISP AD, Engineering, and DC	Scientists
NISP-4	NISP AD, Engineering, and DC	Scientists
NISP-5	NISP AD, engineering, and DC	Scientists
NISP-6	NISP AD and Scientists	DC
NISP-7	NISP AD	NISP management team
NISP-8	NISP AD, scientists	NISP management team
NISP-9	NISP AD	NISP management team
NISP-10	NISP AD	NISP management team
NISP-11	NISP AD	NISP management team

4 NSO COMMUNITY SCIENCE PROGRAM (NCSP)

Traditionally, the NSO program has been conducted in two almost separate branches, with the synoptic part centered around GONG and SOLIS in NISP, and the high-resolution efforts centered initially around the DST, and now DKIST. With the move of NSO Headquarters to Boulder, the opportunity arose to foster a closer cooperation between the two branches. With this goal in mind, the NSO has created a new program: the NSO Community Science Program (NCSP). It leverages opportunities (funded via specific SFRs) to facilitate the use of our data by the solar community. These strategic initiatives ideally integrate scientists from both NISP and DKIST sides, enhance the value of data produced by NSO facilities, and have a well-defined scope and time frame. These opportunities support NSO's overall mission in facilitating community understanding of the increasingly complex data produced by our facilities.

The first SFR under NCSP focused on the development of pipelines to generate DKIST Level-2 data (physical quantities in the solar atmosphere) from the observations. Given the relevance of this data for the community, the program now uses base funding to ensure its regular creation and distribution.

Since FY 2022, NCSP also uses funding from a WoU-MMA SFR related to the generation of data products relevant to the 2024 total solar eclipse.

4.1 DKIST Level-2 Pipeline Science Goals

NCSP original objective is to carry out the development of the software pipelines to process telescope and instrument-calibrated DKIST spectro-polarimetric Level-1 observations into Level-2 data. This process is called spectro-polarimetric inversion and requires numerically demanding algorithms. The work on this effort is two-fold. First, it requires the development and implementation of the algorithm to identify suitable Level-1 data from the DKIST Data Center for inversion and, second, flowing inversion results back into the Data Center. After assigning the corresponding Level-2 metadata, the DKIST Data Center will distribute the results t the solar community using the same infrastructure as the Level-1 data.

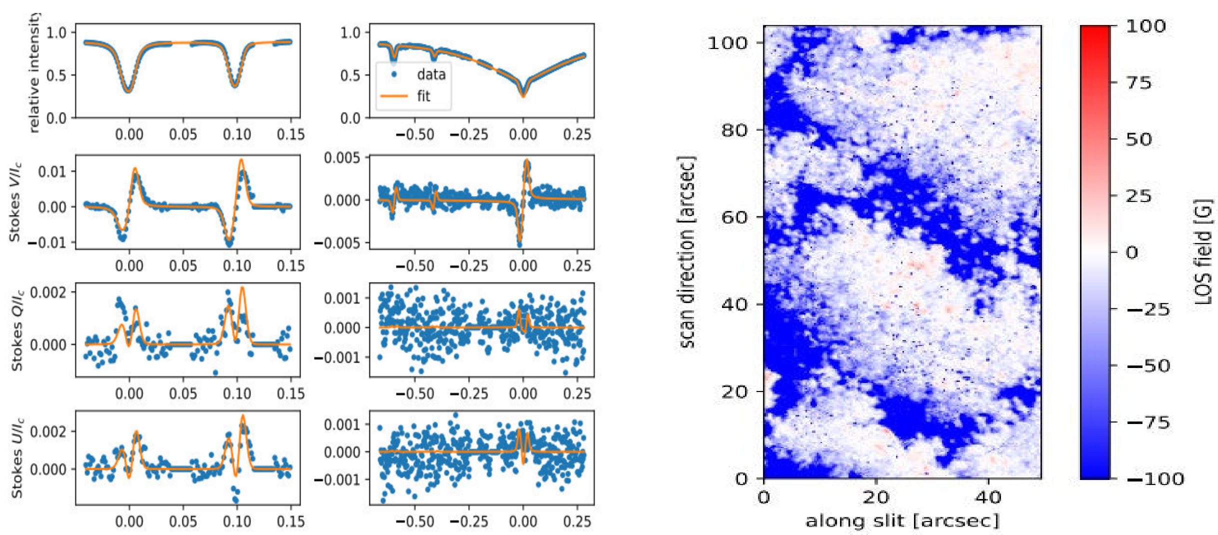

Figure 4.1. *Example of spectral inversion of one pixel in a scan of the solar surface (left panel), and the measured magnetic field strength map, derived from such line fits in all pixels (* $\log \tau_{500} = -2$*).*

In FY 2023, NCSP has developed software for the ViSP Level-2 pipeline. The pipeline includes all the necessary steps required for preprocessing the data, wavelength calibration, co-alignment of the FeI 630.2 nm and CaII 854.2 nm arms of the spectrograph, additional polarization calibration, and correction for center-to-limb variation. These steps are necessary for a physically meaningful inversion with the DeSIRe numerical code. Figure 4.1 is an example of the output produced by the pre-processing pipelines and the inversion code.

The left panel shows the fit between the line profiles derived by the inversion code (orange) and the observed line profiles (blue) of the FeI 630.2 nm (left column) and CaII 854.2 nm channels (middle column). The two spectral regions have been inverted simultaneously. The right panel shows, as an example, the derived magnetic field strength from a slit scan of the solar surface.

For FY 2024, NCSP goals in the Level-2 science efforts are:

Program Goal (L2Science-1): Identification of inversion candidates in the DKIST observations, automated ingestion of candidates into the inversion hardware (Blanca cluster).

Program Goal (L2Science-2): Create a coherent software package combining all pre-processing steps, wavelength and additional polarization calibration, co-alignment, and heliocentric angle correction. Finally, the package will also reformat the data in a manner suitable for DeSIRe ingestion.

Program Goal (L2Science-3): Implement additional physics in the DeSIRe inversion code, for more realistic inversion of lines with Partial frequency ReDistribution (PRD).

Program Goal (L2Science-4): Create a coherent software package that combines all post-processing steps, reformat inversion output into FITS files suitable for distribution to the community and consistent with Data Center Level-1 data. Reformatting implies carrying over relevant FITS header keywords from the originating Level-1 data and introduction of relevant metadata for the inverted products.

Program Goal (L2Science-5): Integrate goals L2Science-1 – 4 into an automated pipeline that runs mostly autonomously in the inversion hardware.

Table 4.1. Level-2 Science Goals for FY 2024

Program Goal	FY 2024 Time Interval
L2Science-1	Q2
L2Science-2	Q2-Q3
L2Science-3	Q2
L2Science-4	Q4
L2Science-5	Q1-Q4

4.2 DKIST Level-2 Pipeline Data Center Goals

A software engineer integrated in the DKIST Data Center team is in charge to create the infrastructure to identify and move the data to the scientific inversion core and back to the Data Center. The overarching goal for FY 2024 is to create the Level-2 processing system prototype: a program that accomplishes the core tasks manually and helps us discover potential missing requirements and design challenges. The system will be rewritten and demand time-consuming improvements before it is fully operational. We anticipate roughly twice the amount of development time for the full system than for the prototype. Figure 4.2 describes the interfaces at the Data Center between the Level-2 and the Leve-1 hardware, including the scientific core (L2 High Compute) of the infrastructure.

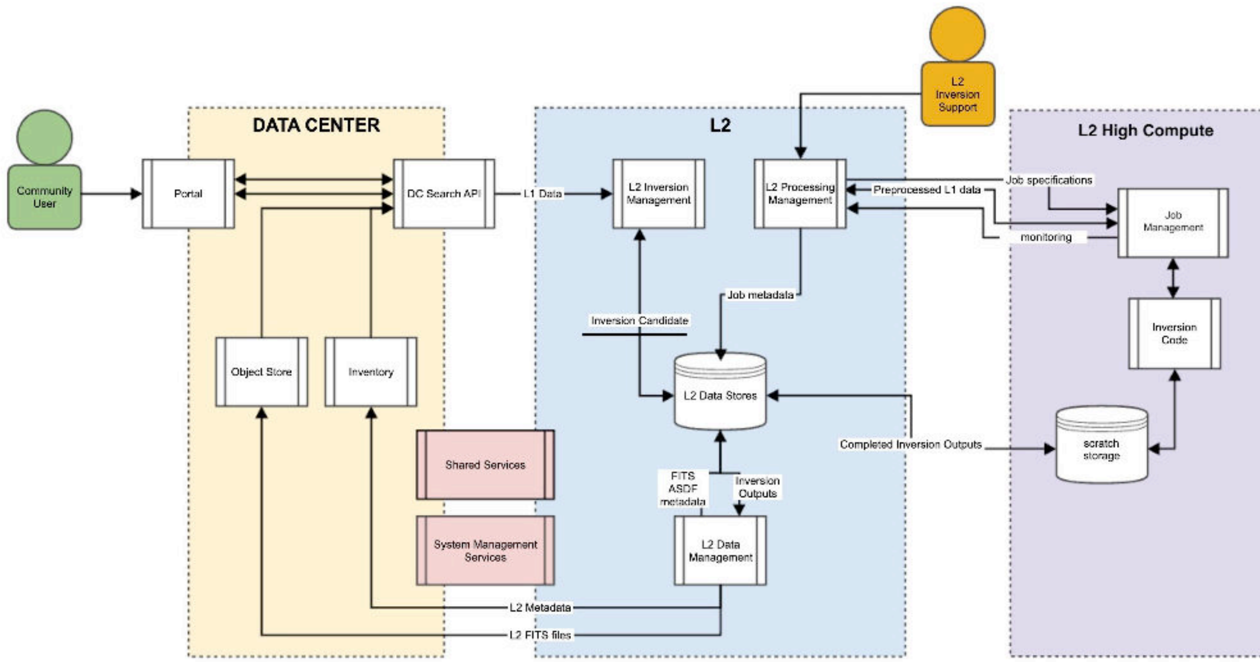

Figure 4.2. *Updated architectural Level-2 diagram.*

The specific Level-2 Data Center goals for FY 2024 to complete a functional prototype are:

Program Goal (L2SDC-1): Candidate Evaluation - screening for qualified VISP data.

Program Goal (L2SDC-2): Testing bidirectional transfer to the scientific pipeline.

Program Goal (L2SDC-3): Post-processing Metadata - create a header specification for FITS output and update inverted data that matches Level-1 and Level-2 data sets.

Table 4.2. Level-2 Data Center Goals for FY 2024

Program Goal	FY 2024 Time Interval
L2DC-1	Q2
L2DC-2	Q3-Q4
L2DC-3	Q4

4.3 WoU-MMA Eclipse Goals

The NCSP WoU-MMA SFR targets maximizing the scientific output from NSO facilities during the quadrature configuration Solar Orbiter and PSP will have as seen from Earth (DKIST) during the 2024 total solar eclipse. One important component of this maximization is to understand the prediction of the solar wind conditions heliospheric models will predict at the time of the eclipse. Traditionally this is done using synoptic maps such as those regularly provided by the GONG. In the WoU-MMA SFR we included the possibility to use a more updated synoptic map to predict heliosphere conditions by using the combination of GONG and Solar Orbiter PHI (Polarimetric and Helioseismic Imager; SOPHI) data after carefully intercalibrating the two instruments.

The SOPHI/GONG scaling factor shows some variability with time that needs to be fully addressed. Once the scaling is established it will be applied to the full-disk SOPHI line-of-sight magnetogram to create a homogeneous dataset that is compatible with the GONG magnetograms. These two datasets will then be merged to create a composite synoptic map. Although the procedure to create a synoptic map is quite standard, in this case one needs to account for the different line-of-sights between GONG and SOPHI and the difference in the time of observations. This requires some additional modification of the current code, including a different weighting function to be applied to the magnetograms. After the SOPHI/GONG composite map is produced, we are going to run our local version of the Wang-Sheeley-Arge (WSA) solar wind model and compare the results to those using the corresponding GONG-only synoptic map. These tests will use the heliospheric Community Coordinated Modeling Center. As in FY 2023, we expect to collaborate quite closely with the PI institutions of SOPHI in Germany and Spain.

Program Goal (WoU-MMA-1): Final validation of the SOPHI/GONG scaling factor.

Program Goal (WoU-MMA-2): Generation of at least two SOPHI/GONG composite synoptic maps. One of them centered around the day of the 2024 total solar eclipse.

Program Goal (WoU-MMA-3): Comparison of inferred solar wind properties using WSA model driven by GONG and SOPHI/GONG synoptic maps for the same Carrington rotations.

Table 4.3. NCSP WoU-MMA Goals for FY 2024

Program Goal	FY 2024 Time Interval
WoU-MMA -1	Q2
WoU-MMA -2	Q3-Q4
WoU-MMA -3	Q4

5 EDUCATION, PUBLIC OUTREACH & COMMUNICATIONS (EPO/C)

The Education, Public Outreach & Communications (EPO/C) department works diligently, in collaborations with other NSO departments, to tell our story to the world by getting the public excited about discoveries of our home star, and our scientists' results amplified to broader audiences to encourage a broad understanding of solar physics by a diverse population of scientists, policy-makers, educators, and the public—with a special interest in reaching underrepresented groups, including women, minorities, Indigenous peoples, persons with disabilities, and veterans.

The Head of Education and Outreach, recruited in June 2023, is based in Boulder, and responsible for the overall implementation of all EPO/C programming, as well as representing the interests and mission of NSO nationwide. NSO's Education and Community Liaison Officer is located in Hawaiʻi and is chiefly responsible for NSO's formal education (K-12) programming, in addition to developing and nurturing relationships with educators, community members, and stakeholders in Maui, and across the State of Hawaiʻi. NSO's Communications Specialist, also located in Hawai'i, is responsible for developing and implementing a diverse media engagement strategy for NSO, and projects therein, as well as sourcing stories from within NSO and the NSO user community.

EPO/C's work is broadly grouped as educative, both formally and informally, from middle school to college, and with a focus on teachers; engaging, with a focus on indigenous communities; and communicative, while leveraging appropriate channels to share information according to the needs and interests of our various audiences—including both traditional and social media. Alternatively, we would like to consider updating EPO/C's name to Communications, Education & Engagement (CEE) in line with other similar centers.

5.1 NSO's EPO/C Priorities

The overarching EPO/C goals for the next five years are listed below.

- NSO remains a nationally recognized center of education and outreach excellence—qualitatively and quantitatively—and first-rate on everything Sun.
- NSO fosters committed in-person relationships, driven by best practices in education and outreach, and a focus on equity, within the communities it serves—especially in Hawai'i, and those in which it is based.
- NSO celebrates true collaborative partnerships with parties whose missions align for the production or coproduction of education and outreach products with a positive measurable impact.

In particular, the specific goals for 2024 are listed below:

Program Goal (EPO/C-1): Ideate, develop, and implement a series of education and public outreach programs in Southwest Texas to support eclipse activities. (EPO/C-1)

Program Goal (EPO/C-2): Ideate, develop, and implement, in collaboration with NSF—and other NSF centers—an ambitious live stream of the total eclipse.

Program Goal (EPO/C-3): Redesign and revitalize the NSO brand.

Program Goal (EPO/C-4): Hire a Graphic Designer to assist in all visual and identity aspects of our education, public outreach, and communications efforts.

Program Goal (EPO/C-5): Update NSO's website to the new brand, once approved, and improved its user experience.

Program Goal (EPO/C-6): Implement a new communications plan with a focus both in traditional and social media.

Table 5.1. EPO/C Goals for FY 2024	
Program Goal	**FY 2024 Time Interval**
EPO/C-1	Q1-Q2
EPO/C-2	Q1-Q2
EPO/C-3	Q1-Q4
EPO/C-4	Q3
EPO/C-5	Q4
EPO/C-6	Q2-Q3

5.1.1 The Case for Additional EPO/C Staff

Relative to the other AURA-run centers, NSO severely lags behind in terms of EPO/C staff, relative to center size. AURA-run centers have an average of around 5% EPO/C staff by FTE, while NSO is at around 2% (3.5 EPO/C for about 150 FTEs). Getting NSO to par with the other NSF-funded centers would require the NSO EPO/C staff to increase to up to eight FTEs.

With the enormity of the scale of work facing the EPO/C team in Boulder and Maui, from building goodwill amongst the community, to engaging with cultural leaders, building education programs, providing academic support, and participating in national and international conferences, we would like to request the following:

1. Increasing a current Boulder-based 0.5 FTE position to 1 FTE as a Graphic Designer (or adding a full position for a total of 1.5 FTEs);
2. The addition of 2 FTEs as Education and Public Outreach Specialists in an entry level assistant role in Maui and Boulder (for a total of two educators in Maui, and one in Boulder); and
3. The addition of 1 FTE as a Communications Specialist in an entry level assistant role (for a total of two).

This would allow for, as structured today, four Maui-based members and three Boulder-base members.

The vision for the Educator Specialist in Maui is to support the Maui-based Education and Public Outreach Officer, by conducting low-level engagement, outreach and other activities that occur on a near-constant basis. In particular, we will require someone who will be responsible for conducting tours of DKIST once it is operational in order to minimize the impact on the DKIST operations team—we envision this being, once all their intended responsibilities are considered, one full time person. This will not only provide a boost of support if need be—e.g., for a large outreach event where more than one extra person would be valuable—but provide an excellent way to further engage the local DKIST community on Maui. The Educator Specialist in Boulder will support the Boulder team similarly.

The vision for the Communications Specialist is to support the Communications and Public Information Specialist, by expanding our science writing capabilities to traditional and innovative formats.

The vision for the Graphic Designer is to support the EPO/C team with a series of key creative skills that are crucial today when deploying education and public outreach programs, as well as communicating with diverse audiences through media channels beyond the traditional ones, including social media—e.g., videography, photography, graphic design, storytelling, etc. Furthermore, this role will be crucial to our rebranding as detailed below.

At present, these positions are unfunded, and its support would require additional funding from NSF. However, we are allocating $100,000 from our carryover budget to cover the first year of the Graphic Designer—pending NSO leadership committing to make this a permanent position.

5.1.2 The Case for NSO Rebranding

Our brand is our heart and soul; it is responsible for uniting a diverse spectrum of audiences—ranging from scientists to the general public—around our mission and vision by building trust. It embodies the collective perception and impression that defines us. Presently, the NSO brand falls short of its potential—especially when compared to some counterparts.

Branding is the art of molding this perception, a vital endeavor in a crowded landscape where we aim to distinguish ourselves and transcend our current fragmented and disjointed state. A comprehensive rebranding encompasses not only a fresh logo but also an updated visual language (i.e., color palette, font palette, etc.), and extends beyond these elements as it translates into a welcoming and reliable voice that stands for scientific excellence.

Elevating Brand Presence

The primary objective of our rebranding initiative is to elevate NSO's brand presence among the scientific community and the general public. We aspire to create a brand that is unmistakable and unforgettable, and effectively conveys NSO's mission and importance as a leading solar physics research center.

Revitalizing Our Image

The rebranding endeavor strives to rejuvenate NSO's image, rendering it contemporary and appealing to a 21st-century audience, while still respecting its historical roots. This entails crafting a fresh, dynamic visual identity that mirrors NSO's visionary quest to unravel the enigmas of our home star.

Ensuring NSF Adherence

Given our status as an NSF-funded institution, it is paramount to guarantee that our rebrand aligns seamlessly with NSF's stringent guidelines and regulations.

Enhanced Public Engagement

The rebranding project aims to amplify NSO's capacity to engage with the public, extending an invitation to a broader audience. This encompasses developing a brand that makes scientific knowledge more accessible and engaging through educational materials, interactive content, and outreach initiatives.

Fortified Collaborations

Our rebranding strategy should bolster NSO's ability to foster partnerships with peers in the scientific realm, both nationally and internationally. This may involve establishing a brand identity that champions collaboration, spotlights shared goals, and stimulates opportunities for cooperation with other research institutions.

We will be working on our rebranding throughout 2024. A soft-launch will happen by the end of the year, with an official launch happening in 2025 coinciding with the 25-year anniversary of NSO as an independent center.

5.2 Education, Public Outreach and Communications

5.2.1 Eclipses

Given the number of accessible eclipses both home and abroad, it is an optimal time to leverage the power of eclipses to share NSO's mission and vision with broader audiences while they have their attention on the Sun.

5.2.1.1 Continental Annular Eclipse (2023)

An annular eclipse on Saturday, October 14, 2023, crossed North, Central, and South America. The annular eclipse began in the United States, traveling from the coast of Oregon to the Texas Gulf Coast, and was visible in Oregon, Nevada, Utah, New Mexico, and Texas, as well as some parts of California, Idaho, Colorado, and

Arizona. The path of annularity continued on to Central America, passing over Mexico, Belize, Honduras, and Panama; and South America, where it will travel through Colombia before ending off the coast of Natal, Brazil, in the Atlantic Ocean.

We observed the annular eclipse from Uvalde, TX with a team led by Professor Maria Kazachenko and Dr. Jorge Perez-Gallego—including Dr. Ryan French and Marcel Corchado-Albelo from Dr. Kazachenko's research team, and John Williams, Tishanna Ben, and Evan Pascual from our EPO/C team. The program—partially funded by Dr. Kazachenko's NSF CAREER Award—run in a location which greatly benefitted from such a scientific outreach effort, and in collaboration with a local team from Southwest Texas Junior College and Sul Ross State University—including fifteen students. Additionally, we leveraged our presence there to do a trial run of our total eclipse broadcast, as described below.

5.2.1.2 Continental Total Eclipse ('24)

On Monday, April 8, 2024, a total solar eclipse will cross North America—including Mexico, the United States, and Canada. The path of the total solar eclipse will begin over the South Pacific Ocean and enter continental North American through Mexico's Pacific coast at around 11:07a PDT. A partial eclipse will be seen from the Inouye Solar Telescope for 1 hour and 25 minutes starting at 6:31a local time.

The path of totality continues from Mexico to the United States—i.e., traveling through Texas, Oklahoma, Arkansas, Missouri, Illinois, Kentucky, Indiana, Ohio, Pennsylvania, New York, Vermont, New Hampshire, and Maine.

The path of the total solar eclipse will exit continental North America in Newfoundland, Canada at 5:16p NDT—after traveling through Canada's Southern Ontario, Quebec, New Brunswick, Prince Edward Island, and Cape Breton.

NSF's NSO, with invaluable support from NSF personnel, will host a live broadcast of the eclipse rooted on three observing programs that ensures reaching a diverse audience—including the scientific community, citizen scientists, and the general public. The three complementary observing programs are run by (A) the Inouye Solar Telescope; (B) SuperCATE; and (C) CATE 2024. The three locations are (i) Maui, Hawai'i (DKIST); (ii) Mazatlán, Mexico (SuperCATE); and (iii) Eagle Pass, TX (SuperCATE & CATE 2024). The scientific components of each program are listed below.

1. Inouye Solar Telescope: Maps ionic density and temperatures—that can be compared with SuperCATE 2024—and the coronal magnetic field; furthermore, measurements can be compared to those in-situ of the Solar Orbiter and PSP—i.e., Windows on the Universe - Multi-Messenger Astrophysics.
2. SuperCATE: Spectroscopy and high-resolution imager providing estimates of the coronal temperatures.
3. CATE 2024: Measures linear polarization and electron density.

Furthermore, the production will potentially leverage content from other NSF centers, such as NCAR—e.g., the Airborne Coronal Emission Surveyor (ACES).

The broadcast will be hosted by Dr. Ryan French and Dr. Jorge Perez-Gallego and produced by NSF's Video Production Team. The broadcast, while covering the usual eclipse content, will connect—before (~ 75 minutes) and after (~ 15 minutes) the eclipse at their site—with experts to discuss the scientific significance of all scientific programs, and with citizen scientists and the public at the hosting location to discuss the broader impacts of the eclipse.

Dr. Sanjay Gosain will be leading our SuperCATE 2024 effort in Mexico, and Dr. Kevin Reardon will be leading our SuperCATE effort in Texas.

Additionally, we will once again be running a series of public programs in Eagle Pass, TX—and the surrounding areas—with Dr. Kazachenko's team.

5.2.1.3 International Eclipses as Outreach Avenues

After this year's annular eclipse and next year's total, the next continental American eclipse is not until 2044 and 2045; with a total and an annular over Alaska in 2033 and 2039 respectively, and an annular over Hawaiʻi in 2046.

Many of the invaluable lessons learned on how to engage the general public in these events can be used to establish meaningful partnerships with international agencies in the path of eclipses— starting with, for example, Spain in 2026 and 2027. These may support both research and education in multiple ways.

5.2.2 Journey to the Sun & Journey through the Universe

The Journey to the Sun (JTTS) educator program is hosted by the National Solar Observatory, which built and manages the Daniel K. Inouye Solar Telescope on Maui. The program focuses on supporting middle and high school educators in teaching science content through the lens of solar astronomy. At the workshop, participants will gain a deeper understanding of solar astronomy in terms of both scientific discoveries and its impact on Maui's STEM industry. Participants will also receive resources and activities for teaching their students about various topics within solar astronomy.

Journey through the Universe (JTTU) Maui is a relatively new expansion of NOIRLab's highly successful JTTU program on Hawai'i Island but focused on Maui-based schools and astronomy facilities. JTTU promotes science education at Hawai'i Island school districts and inspires students to explore STEM fields by developing literacy in science. JTTU endeavors to foster curiosity and wonder about our Universe, and the cutting-edge research and technology that is allowing us to understand our place in the cosmos like never before.

We are in the process of merging both Maui initiatives for a greater Journey effort that will also include community events, and thus having a positive impact on K-12 students, educators, and families.

5.2.3 Higher Education

5.2.3.1 University of Colorado Boulder Hale Program

The George Ellery Hale (GEH) Fellowships include a 2-year Postdoctoral Fellowship, offered each year to a postdoctoral scientist; and a 3-year Graduate Fellowship, offered each year to two students. Additionally, this program also appoints a 3-year visiting faculty.

The GEH Graduate Fellowship is designed to give students the freedom to explore a variety of solar physics research paths. The award supports students through the early years of their graduate education—i.e., years 1–3—at which point they should explore other funding options with their thesis advisor. Because of this, they are generally offered to incoming students, but those more advanced in their education may also be eligible.

To create an environment within which GEH graduate fellows can thrive, they are encouraged to pursue research with multiple mentors before deciding on a thesis project. A research rotation element consisting of half a semester research project mentored by CU and/or NSO scientists, allows students to work on four different projects during their first year. Upon project completion—i.e., twice a semester—students give a short half an hour lunch talk on their work to their cohort of fellows, mentors, and interested scientists. This approach gives students an opportunity to explore research possibilities, take full advantage of the self-defining aspects of the research opportunity, and broaden their exposure to topical solar and space physics.

Currently—as of Fall 2023—the program appoints one visiting faculty, two postdoctoral fellows, and seven graduate fellows. Going back to Fall 2020, it has positively impacted the careers of two visiting faculty, five postdoctoral fellows, and twelve graduate fellows.

5.3 Communications

NSO approaches diversity in storytelling as a tool for communications and content dissemination: diversity in the stories we tell; diversity in the ingredients which make those up; diversity on how they are best told; and, most importantly, diversity in both the voices telling them, and the ears they reach. By doing so, all people feel welcome and supported.

5.3.1 Social Media Engagement and Plan

NSO is working to increases its production—or co-production— of weblog posts to two each month to become a reliable source. These will include popular stories on research, facilities, education, outreach, and staff.

Increasing our presence on social media is key to reaching audiences of today—with that in mind, all traditional media pieces will be interpreted for social media. NSO seeks to increase its social media presence while acknowledging different social media platforms are best suited for different content formats and audiences. An initial goal is to match our NSF counterparts where we fall behind—as listed on the table below.

Table 5.2. Social Media Followers* per Platform

**as of 1.21.24*	**Facebook**	**Instagram**	**X**	**LinkedIn**
NSO	10K	3.2K	6.6K	2K
Gemini	14K	4.8K	13.4K	3K
Rubin	9.3K	4.3K	15.7K	2K
NOIRLab*	4.1K	3.9K	5.4K	2K
NRAO	78K	13.7K	44.9K	14K

Our goal is to be present on social media on an almost daily basis—whether one or another platform—with recurrent posts—e.g., Sun Trivia Tuesday, Space Weather Wednesday, Fun Sun Fact Friday, etc. A second—happening-based—layer of social media engagements may be triggered by press releases, scientific conferences, staff recognitions, etc.

5.3.2 DKIST Communications Plan

While all stories rooted on NSO will be fueling our communications, it is important to focus on increasing the presence of the Daniel K. Inouye Solar Telescope (DKIST) in all media. The DKIST Communications Plan is designed to increase public awareness of our newest facility during the next five years.

The first light images of DKIST, released in January 2020, demonstrated how wide-reaching the impact of NSF's new solar facility can be. From the front page of the New York Times to late night talk shows, the detail and structure captured by the Inouye Solar Telescope inspired awe and wonder worldwide.

NSO has an obligation to communicate Inouye's new discoveries, and demonstrate their value for the scientific community, NSF, the federal government, and the general public—we understand science communication as a foundational component of a national observatory. In particular, translating and interpreting scientific ideas for broader audiences—typically at 8th grade reading level—is critical to fully convey the importance of the Inouye Solar Telescope's science—if specialized knowledge cannot be explained to a non-expert audience, the impact of this knowledge is minimized.

Our communication strategy is rooted in the generation of quality owned media, the cornerstone of which are both images and scientific results from the Inouye Solar Telescope. Furthermore, leveraging the unique assets produced by it, gives us an invaluable platform to generate extensive earned media—as demonstrated by the first light images' impact.

DKIST-specific messages used to guide DKIST-specific communications in any media are rooted on NSO's mission, and are outlined here:

- "The Inouye Solar Telescope is the most powerful solar telescope in the world."
- "The Inouye Solar Telescope produces the highest resolution observations of the Sun's surface ever taken.
- "The Inouye Solar Telescope ushers in a new era of solar science, poised to revolutionize our understanding of the Sun and its impacts on Earth."
- "Hailed as the NSF's "crowning achievement" for ground-based solar astronomy, the Inouye Solar Telescope utilizes the next generation of solar observing technology capable of capturing images of the Sun in unprecedented detail."
- "The Inouye Solar Telescope opens a new window into solar observations, serving as a pathfinder to the Sun with the ability to reveal features three times smaller than anything we can see on the Sun today, and does so multiple times a second."
- "The Inouye Solar Telescope fosters a diverse, equal, and inclusive work environment that is collaborative and welcoming to team members."

In order to create the products outlined in this plan, both the outreach team and the DKIST team need a designated point of contact within the DKIST team to support its efforts and facilitate the flow of information. To facilitate the effort this scope is to be fulfilled by two individuals—i.e., the Science Communications Liaison (DKIST-SCL) and the Operations Communications Liaison (DKIST-OCL). Collectively, they are (i) well versed in the goings-on at the summit; (ii) able to interpret the scientific and engineering goals and achievements of the telescope; (iii) familiar with the diverse on-site expertise; (iv) interested in supporting the communications efforts of the telescope; and (v) able to accommodate their schedule to work closely with the outreach team as needed to push the DKIST Communications Plan as part of NSO's overall communications goals.

The DKIST-OCL role includes the following responsibilities:

1. Meeting on a monthly basis with the EPO/C team.
    a. To provide a regular high-level summary of telescope "happenings," including, but not limited to, on-sun campaigns targets; this also includes a recap of the previous month, and a strategic discussion of upcoming possibilities—while understanding some may be more likely than others.
    b. To discuss monthly foci in terms of relevant stories so assets can be directly or tangentially identified to complement these throughout the month—e.g., stories tied to cultural annual observances such as Women in Science Day, Sun Day, or Astronomy Day (the EPO/C team will share an ongoing calendar of these opportunities as far in advance as possible).
2. Coordinating interactions between the EPO/C team and relevant scientists and/or engineers if/when needed—e.g., interviews to further contextualize a result highlighted in a press release, and/or discuss its human factor.
    a. Helping coordinate, as needed, with all participating partners—e.g., AURA, NSF, and others.

3. Acting as an intermediary between the EPO/C team and scientists and/or engineers when the EPO/C team gets, for example, media requests, remote or in person speaking opportunities, career panels, etc.; so, in collaboration with DKIST leadership, they can direct these requests to the appropriate individuals—based on expertise and availability.
    a. Keeping a record of the time DKIST team members spend fulfilling EPO/C efforts—to (i) make sure we focus on quality and efficiency; and (ii) to properly credit and highlight everyone's involvement both internally and publicly as needed—e.g., EPO/C award.
    b. Making all DKIST team members feel welcome when assisting with EPO/C efforts to expand and diversify those participating in them—and make sure that everyone who wants, can as long as their responsibilities allow.
    c. Acting also as an intermediary between scientists and/or engineers and the EPO/C team by welcoming ideas and/or requests from them.

The DKIST-SCL role includes the following responsibilities:

1. Meeting on a monthly basis with the EPO/C team.
    a. To provide a regular high-level summary of telescope "happenings," including, but not limited to, on-sun campaigns targets; this also includes a recap of the previous month, and a strategic discussion of upcoming possibilities—while understanding some may be more likely than others.
    b. To discuss monthly foci in terms of relevant stories so assets can be directly or tangentially identified to complement these throughout the month—e.g., stories tied to cultural annual observances such as Women in Science Day, Sun Day, or Astronomy Day (the EPO/C team will share an ongoing calendar of these opportunities as far in advance as possible).
2. Participating in story development in different capacities such as the ones described below—after identifying story-worthy scientific results from DKIST, and sharing them with the EPO/C team for potential dissemination.
    a. Reviewing stories for scientific accuracy.
    b. Both generating and assisting in the generation of high-quality multimedia content from telescope data, as needed.
3. Requesting Director's Discretionary Time (or other) on the telescope for education and outreach activities—in collaboration with the EPO/C team.
4. Working with the EPO/C team to identify images taken by DKIST to be used for public outreach—and leading their processing and delivery to the EPO/C team with the available metadata.

The mission of these roles is to perform a major part of the workload needed for the NSO's EPO/C team to carry out the tasks described in the following sections, minimizing the impact on the rest of the DKIST staff. These responsibilities will be included in the Job Description of both the DKIST-OCL and the DKIST-SCL. Currently, Dr. Catherine Fischer officially serves as DKIST-SCL, while Heather Marshall, serves as DKIST-OCL.

Our DKIST Communications Plan has been developed by the EPO/C team in collaboration with the DKIST leadership team, and will be evaluated based on the following desired outcomes:

1. MEDIA AWARENESS: "Increase awareness of Inouye Solar Telescope's first three years of operations, positioning Inouye Solar Telescope as the revolutionary world leader in ground-based solar observatories"
2. GENERAL PUBLIC AWARENESS: "Inspire and captivate public interest with Inouye Solar Telescope audiences through multimedia stories that highlight Inouye Solar Telescope's strengths in science, people, and technology."
3. SCIENCE ENGAGEMENT: "Attract researchers, students, and inspire the next generation of solar scientists. Disseminate breakthrough research results from peer reviewed journals."
4. STAKEHOLDER ENGAGEMENT: "Demonstrate the scientific value of the Inouye Solar Telescope in order to secure future funding and confidence in Inouye Solar Telescope operations."
5. BROADER IMPACT AWARENESS: "Genuinely and authentically communicate stories in which diversity, equity, and inclusion are integrated into Inouye Solar Telescope's operations."

6 DIVERSITY AND INCLUSION

This section describes the NSO's ongoing broadening participation efforts and goals in FY 2024.

NSO has two Diversity Advocates, each with a focus that prioritizes, but not limited to, diversity issues at their sites: Stacey Sueoka (DKIST, located in Maui) and Sanjay Gosain (NISP, Boulder-based). Both DAs are members of AURA's Equity and Inclusion Council (EIC). The DAs regularly meet with the NSO Director to discuss diversity and inclusion activities and concerns. In addition to their regular duties, the DAs work part-time (10%, under the NSO Director) to support diversity and inclusion activities across the Observatory. There is a general expectation that DAs will serve for approximately two years.

In 2020, the NSO DAs started an NSO broad discussion forum, the Diversity, Equity, and Inclusion Working Group (DE&I-WG). This forum provides an opportunity for all staff to meet and discuss informally any Diversity, Equity, and Inclusion topics, often dominated by workplace environment issues. Because of the nature of the discussions, the DE&I-WG has split into three subgroups with a location focus: a Maui-specific WG, a Boulder WG, and a joint DE&I-WG encompassing all-NSO. The three WGs meet in alternating months. These WGs have proven to be an effective method of communication among staff and management for issues around diversity and the workplace environment at NSO.

As explained above, NSO regularly organizes multiple internal discussions on DEI topics. There is an interest in clarifying how staff should charge for time spent on DE&I. This issue was brought to the Solar Observing Council (SOC) in the fall of 2022, as some staff had expressed concerns about how such activities should be charged. The SOC, in its recommendations, concluded that NSO should establish a robust process for charging time to DEI activities that are reflected on the Observatory Work Breakdown Structure (WBS) system and that is communicated to the staff. Setting up new WBS accounts will be part of the CA extension.

6.1 DEI in the REU & Akamai Programs

As in previous years, NSO will participate in the Boulder-wide, LASP/CU-Boulder-led REU program, in 2024.

The program starts with a week-long summer school in solar and space physics and continues with seminars and discussions while the students work at one of the participating institutions, providing peer collaboration opportunities. At the end of the summer, the students present the research findings. NSO usually has 3-5 REU students with mentors, sometimes located in Maui. This year, NSO will offer several REU opportunities that use data from the 2024 total solar eclipse. The process for selecting applicants includes DEI considerations. Historically, the percentages of both female and Hispanic accepted participants are larger than the corresponding applicant numbers. American Indian and African Americans unfortunately show the opposite trend. To reverse this trend, the program is reaching out to Historically Black Colleges and Minority Serving Institutes.

The goal of the Akamai Workforce Initiative program is to develop a workforce that reflects the diverse population of the state of Hawai'i. Therefore, there is an emphasis on broadening participation to include more Native Hawaiians, women, and other groups underrepresented in STEM. Traditionally, DKIST has supported several interns, offering the opportunity to work remotely with mentors. The COVID-19 pandemic severely impacted or even canceled previous editions of Akamai, resulting in a poor record for placing women and Native Hawaiians. In 2023, the Akamai Program was affected by the wildfires on the island of Maui. The 2024 edition is ongoing. The program is run by UC Santa Cruz’s Institute for Scientist and Engineer Educators (ISEE) and provides an 8 weeklong internship at observatories and technical companies on Maui and Hawai’i Island for STEM undergraduates with ties to Hawai’i. Last year four more interns were placed at the Inouye Solar Telescope, two of whom were born and raised on Maui, and the other two attend the University of Hawaii. For the 2024 cohort we expect a similar number of interns to be mentored at DKIST, as well as instructor support from DKIST staff for the program as a whole.

6.2 Hawai'i community Engagement

Efforts in community engagement are beginning to have more focus as the DKIST transitions from construction to operations. We would like to establish a strong relationship between our organization and the local community, as there are personal relationships that exist but not much of an organizational connection just yet. NSO as an organization can define who we are as a "work community", and how we are seen by our "local community". One aspect of this is intertwined with programs run by the EPO/C team. Several programs are underway such as the Journey through the Universe (JTTU), a week-long event where observatory staff volunteer to visit Maui K-12 classrooms and provide activities or presentations to the students. JTTU is a program adopted from our Mauna Kea observatory counterparts, where they have been running for twenty years on Hawai'i Island.

There are other aspects of community engagement beyond EPO/C that can help group our relationship with the "local community". Services for and with the community can forge new relationships, we can also learn from the Mauna Kea observatories as they have been actively doing so. Observatory staff volunteer to plant native trees and plants on the mountain, and volunteer at local events and celebrations.

6.3 Promoting DEI during the 2024 Total Solar Eclipse

A Total Solar Eclipse (TSE) event is very good opportunity for EPO/C activities, as was demonstrated during the Great American Eclipse of 2017 where a plethora of citizen science experiments were conducted during totality all along the eclipse path. Luckily, another TSE event will happen on the April 8th, 2024, which will trace its path across the continental United States, starting from the western coast of Mexico to North-Eastern US. This TSE event presents us with another great opportunity for outreach activities that promote diversity aspects and indeed several scientific and public events are planned across the country. As explained in section 5.2.1, NSO is involved in many such activities:

1. **Citizen CATE 2024**: Like 2017 CATE experiment but with upgraded polarization-sensitive cameras and telescopes. Forty sites along the path of totality run by volunteer citizens.
2. **SuperCATE 2024**: A two site network with large aperture telescopes to obtain emission spectrum of the corona and study its temperature with radial density. Led by NSO scientists with a team of undergrad and grad students.
3. **Public talks** by NSO scientists at various locations along the eclipse path and online during the NSO-led broadcasts from Eagle Pass (TX).

The goal of the NSO Diversity Advocacy group is to make sure that the planned EPO/C activities keep DEI principles in mind while reaching out to the volunteers and participants, such as by including students and teachers from schools in the underserved areas and encourage participation by the communities that are traditionally underrepresented in the STEM fields.

A TSE event in Australia and an annular eclipse in the USA during 2023 gave eclipse teams an opportunity to prepare for the big event of this year. Teams from NSO, together with partner institutes NCAR and SWRI, made trips with a first batch of volunteer trainees to observe these events. During the annular eclipse NSO team reached out to communities in Uvalde (TX) and interacted with them with variety of activities. The NSO outreach webpages related to eclipse events are also revamped with a lot of educational material and presentations related to the Eclipse.[4]

[4] *https://nso.edu/for-public/exciting-events/*

Several DEI discussions took place while developing the hiring process for the team members for CATE 2024 and SuperCATE 2024. More are planned for FY 2024. They include developing strategies to reach out to diverse communities, public libraries, indigenous, amateur photographers and astronomers, educators in the path of totality to make the CATE team members and the public aware and appreciative of DEI principles.

7 FY 2024 SPENDING PLAN

The NSO CSA AST-1400450 spending plan is based on receiving in FY 2024 $25.46M for NSO as described in the President's Budget Request (PBR) (see Table 7.1), excluding the Special Projects (see below). The FY2024 PBR includes $19.58M for DKIST operations and $5.88M for other NSO infrastructure operations and maintenance. The NSO's Program allocations presented here follow the guidelines in Table 10.4-2 of the Cooperative Agreement proposal submitted by AURA in October 2013 an updated in Section 10 of the FY 2020 – FY 2024 Long Range Plan (LRP). This update is based on current estimates of actual costs of operating the DKIST facility obtained during the commissioning phase.

Table 7.1. FY 2024 President's Budget Request

Total Obligations for NSO
(Dollars in Millions)

	FY 2022 Actual	FY 2023 Estimate Base	FY 2024 Request	ESTIMATES[1] FY 2025	FY 2026	FY 2027	FY 2028	FY 2029
NSO	$6.96	$5.88	$6.24	$5.88	$5.88	$5.88	$5.88	$5.88
Operations & Maintenance	*5.88*	*5.88*	*5.88*	*5.88*	*5.88*	*5.88*	*5.88*	*5.88*
Special Projects [2,3]	*1.08*	-	*0.36*	-	-	-	-	-
DKIST Operations	19.58	20.68	21.43	21.43	21.43	21.43	21.43	21.43
Operations & Maintenance	*19.58*	*19.58*	*19.58*	*21.43*	*21.43*	*21.43*	*21.43*	*21.43*
Special Projects [3,4]	-	*1.10*	*1.85*	-	-	-	-	-
TOTAL	**$26.54**	**$26.56**	**$27.67**	**$27.31**	**$27.31**	**$27.31**	**$27.31**	**$27.31**

[1] Outyear estimates are for planning purposes only. The current cooperative agreement ends in September 30, 2024.
[2] NSO Special Projects reflects transition activities at Scramento Peak Observatory.
[3] Funding in FY 2023 and FY 2024 does not include potential additional funding that may be provided by MPS' Office of Strategic Initiatives (formerly Office of Multidisciplinary Activities) for deferred maintenance projects.
[4] DKIST Special Projects reflects additional funding for research infrastructure to optimize community access.

The $25.46M allocation is the same as received in FY 2022 and FY 2023, effectively making the Observatory's budget flat for a third year. The Special Projects are a new category that appeared for the first time in the FY2023 PBR for Sunspot (Sacramento Peak) and DKIST infrastructure and community access. Site activities in Sunspot are budgeted in section 7.2.5 following the Supplement Funding Request (SFR) NSO submitted in FY 2023. NSO has not yet received guidance to solicit the funds for the DKIST related $1.85M Special Project.

All NSO programs and subdivisions use a 3% escalation for payroll and non-payroll in their budgets. The payroll escalation follows a market analysis by AURA HR presented for approval to the AURA's SOC. The analysis includes compensation data from similar research and academic institutions in the geographical locations where NSO is present.

The spending plan presented here is structured in five subdivisions: The Director's Office (HQ), which includes the EPO/C Program; the DKIST Program; NISP; NSO Community Science Program (NCSP); and Sunspot. Figure 7.1 describes the organizational structure of the Observatory and includes all cost-account managers with financial responsibilities.

In FY 2021, NSO started using the Deltek platform for all business and accounting practices. The NSO business team and AURA/CAS has uploaded the final FY 2024 budget following the guidance from the subdivision leaders described in the following sections. The final budgets for CSAs AST-1400450 and AST-1023439 in the system will be available at the end of Q2 FY 2024.

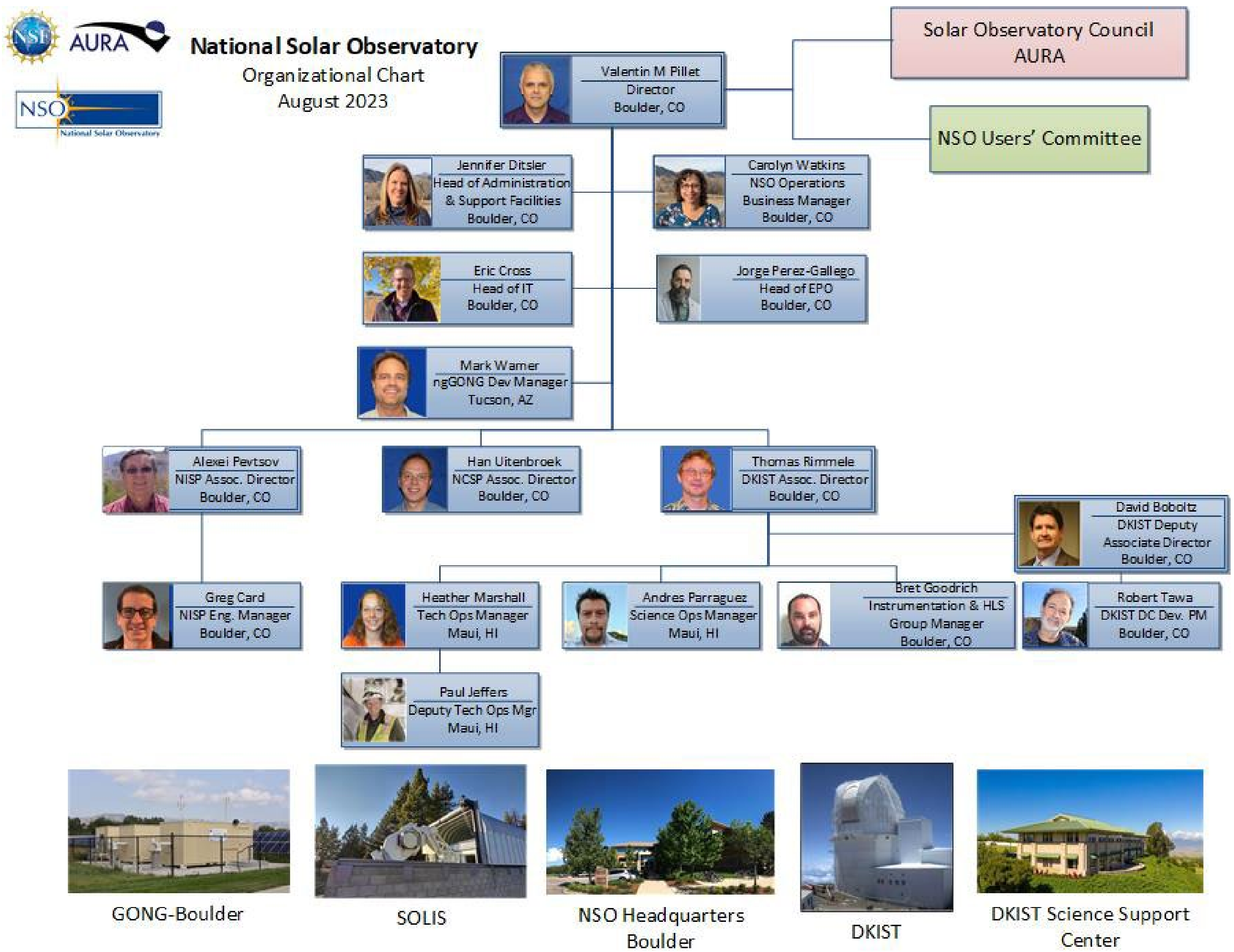

Figure 7.1. *Top-level organizational structure of the National Solar Observatory.*

7.1 FY 2024 Budgetary Assumptions: NSF New Funds, Carry Forward, and Non-NSF Funds

Table 7.2 summarizes the funding that NSO expects to receive as new NSF funding (Base Funding from the AST division, Special Projects, and Supplement Funding Requests) and anticipated non-NSF (NOAA) support for operations in FY 2024. The NSO Spending Plan in FY 2024 was developed based on receiving $25.46M of NSF funding for the regular base operations. For Sunspot operations and transition activities, an SFR that includes multiple deferred site maintenance elements was submitted jointly by NSO (lead institution) and NMSU (subaward). Budgetary pressures are forcing a renegotiation of this SFR, which might see decreased support for deferred maintenance. Table 7.2 also includes the third year of the FY 2021-awarded WoU-MMA SFR ($676K) allocated to NCSP and the second year of the FY 2022-awarded WoU-MMA SFR ($1,005K) given to NISP. The funding received from NOAA in FY 2024 for GONG operations is $1.09M and is budgeted by the NISP program following the original guidance submitted to NOAA/SWPC. These funds are not discussed in this section.

Table 7.2 Expected NSO FY 2024 Funding	
(Dollars in Thousands)	
NSF Astronomy Division Funding	$25,460
Special Projects (transition activities Sunspot)	$1,602
SFR WoU-MMA NCSP (Year 3)	$676
SFR WoU-MMA NISP (Year 2)	$1,005
Subtotal NSF Astronomy Division Funding	$28,743
FY 2024 NOAA Support	$1,094
Total NSO Funding	**$29,837**

Table 7.3 shows the six subdivisions and the corresponding FY 2024 NSF new funds allocations for NSO Headquarters (NSO HQ, also referred as Director's Office); DKIST Operations; NISP; Sunspot Operations (NSO SP), and NCSP. The funds include base funding and SFRs when applicable. There is a reduction in the allocations for NSO HQ, DKIST, and NISP that corresponds to their portions of the NSO Fee (last row). These contributions to the NSO Fee were negotiated with the NSF in FY 2017. NSO intends to submit a new Fee proposal in FY 2024 to adjust the use of the funds following the end of the DKIST construction project and the unique circumstances created by the COVID-19 post-pandemic.

Table 7.3. NSO Allocations of NSF Funds

Fiscal Year: 2024

Funding Source: New Funds

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.1	NSO Directors Office	8.90	1,507,923	957,546	2,465,469	0	2,465,469
CS006.2	NSO NISP	16.11	2,529,459	1,416,757	3,946,217	0	3,946,217
CS006.3	NSO Sunspot	3.50	350,288	1,240,499	1,590,787	0	1,590,787
CS006.4	NSO NCSP	6.95	892,856	244,708	1,137,564	0	1,137,564
CS006.5	NSO DKIST Ops	67.53	11,011,044	8,502,258	19,513,302	0	19,513,302
CS006.9	NSO AURA Management Fee	0.00	0	69,012	69,012	0	69,012
Overall - Total		**102.99**	**16,291,570**	**12,430,781**	**28,722,351**	**0**	**28,722,351**

Table 7.4 provides the distribution of carry-forward funds for each program. The Director's Office (NSO HQ) carryforward is of $1.52M includes a credit from the rate reconciliations corresponding to the years FY 2021 and FY 2022. For NISP, the $1.56M balance results mostly from unused GONG refurbishment and SOLIS relocation funds, Data Center hardware upgrades, and the first year of the FY 2022-awarded WoU-MMA SFR. Two components contribute to the NCSP carry forward, the remaining funds from the Level-2 SFR and the two first years of the FY 2021-awarded WoU-MMA SFR. Table 7.4 includes $86K carry forward in the NSO Fee account, reflecting the reduced use of these funds primarily due to the COVID-19 pandemic restrictions. The DKIST carryforward in FY 2024 budgets for $18.84M but we note that the actual cash available to the

Program is considerably smaller as the corresponding NSF obligations were of only $4.9M in FY 2023. Section 7.2.2 presents the reprofiled DKIST budget for FY 2024.

Table 7.4. NSO Carryforward

Fiscal Year: 2024

Funding Source: Carryover

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.1	NSO Directors Office	1.43	348,689	1,174,979	1,523,668	0	1,523,668
CS006.2	NSO NISP	2.25	273,226	1,284,357	1,557,583	0	1,557,583
CS006.3	NSO Sunspot	0.00	0	550,130	550,130	0	550,130
CS006.4	NSO NCSP	6.50	721,160	1,509,808	2,230,968	0	2,230,968
CS006.5	NSO DKIST Ops	29.43	5,356,054	13,476,424	18,832,478	0	18,832,478
CS006.9	NSO AURA Management Fee	0.00	0	86,279	86,279	0	86,279
Overall - Total		**40**	**6,699,129**	**18,081,977**	**24,781,106**	**0**	**24,781,106**

We list next the budgetary assumptions used to create the NSO’s FY 2024 Spending Plan. The fringe benefits and indirect rates were applied based on the FY 2023 approved Provisional Indirect Rate Agreement letter from the NSF, dated December 1, 2021. The spending plan used escalation on payroll per the Cost Model Proposal submitted to the NSF on December 14, 2018, at a rate of 3%.

Post-Retirement Benefits costs were based on FY 2023, escalated by 3%, and allocated to the sub-divisions based on payroll distribution. Historical Unfunded Liabilities were budgeted as described in AURA's Cost Rate Proposal dated October 11, 2018 ($50K/year), allocated to the subdivisions based on projected payroll distribution per year.

The University of Colorado Lease Office Space costs were based on FY 2023, escalated by 3%, and allocated to subdivisions based on projected square-foot usage, including allocated common space.

The University of Colorado IT connectivity costs were based on FY 2023, escalated by 3%, and allocated to subdivisions based on projected headcount. AURA/CAS Human Resources software application (Ultipro) costs were based on FY 2023, escalated by 3%, and allocated to subdivisions based on projected headcount. Insurance costs were based on FY 2023, escalated by 3%, and assigned to subdivisions based on headcount, vehicle location, and direct usage as applicable.

The NSO Fee is assumed at the current negotiated amount ($69K/year) per Cooperative Support Agreement Amendment #14. These funds are used for allowable expenditures that are not part of the scope of the Cooperative Agreement. The corresponding budget has been subtracted from the programs using it (HQ, DKIST, and NISP).

7.2 Subdivisions Breakout

This section presents an overview of the most significant expenses projected for each subdivision (or program) and the changes concerning the original CA proposal and the LRP document. The tables in this section show the major functional areas' spending plan in more detail, breaking out payroll (FTEs) and non-payroll. The budget tables are provided as separate line items for two different funding sources: NSF FY 2024 new funds and carry forward. Work package disclosure is available on the Deltek platform.

The corresponding subsections below detail the spending plan using the targets provided in Tables 7.3 and 7.4. These spending plans include all AURA's indirect rates.

7.2.1 Director’s Office (NSO HQ)

The NSF base funding allocation for the Director´s Office in FY 2024 is $2.46M (Table 7.3), and the program carryforward in FY 2024 (Table 7.4) totals $1,53M. Table 7.5 presents the FY 2024 NSF spending plan for the Director’s Office. Staff included in the Director’s Office budget are the Director, the NSO Director’s

Office Executive Administrator, the NSO Business Manager and a Budget Specialist, a combination of several fractional FTEs from various administrative positions and IT personnel, including the lead IT manager, and the entire NSO EPO/C group. Non-payroll expenses account for AURA's oversight committee and obligations, supplies and materials, and other miscellaneous costs incurred by the Director. The Director's Office supports two NSO Diversity Advocates with base funding. A significant fraction of the non-payroll budget ($350K) pays for about a third of the lease of the 3rd floor at the CU Boulder HQ, including all common areas.

Table 7.5. NSO Headquarters

Fiscal Year: 2024

NSO Director's Office

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.1	New Funds NSO Directors Office	8.90	1,507,923	957,546	2,465,469	0	2,465,469
CS006.1	Carryover Directors Office	1.43	348,689	1,174,979	1,523,668	0	1,523,668
Overall - Total		**10.33**	**1,856,612**	**2,132,525**	**3,989,137**	**0**	**3,989,137**

The NSO EPO/C program, under the Director's Office, consists of 3.5 FTEs. The EPO/C officer is located at NSO HQ (currently in Florida relocating in CY 2024), and the communications specialist resides in Maui. On the island, an EPO/C assistant promotes solar physics within the local community, particularly with local K-12 students and teachers. The late hires for the EPO/C team in FY 2016-2017 and the recent replacement for the Head of the EPO/C in FY 2023 created carryforward funds ($122K) budgeted primarily to increase the visibility of NSO including participating at conferences such as the AGU, SPD/AAS, etc. The EPO/C team uses an SFR ($65K) to do a live broadcast of the 2024 total solar eclipse from Eagle Pass (TX) connecting to the DKIST operation room and amateur telescopes along the totality path (the CATE Program).

In FY 2024, the new Head of EPO/C, Dr. Jorge Perez Gallego, is starting a major rebranding exercise for the NSO, including the Observatory's website using an external contractor. The Director's office is budgeting $50K from the carryforward funds to cover the costs of the corresponding subaward.

Since FY 2022, NSO has consolidated all IT services into a unified program. This functional unit is the second component of the matrix structure for the Observatory (the first being the administrative services). The Head of the IT service, rEPO/Crting to the NSO Director, allocates IT resources across all subdivisions each year and in consultation with the respective program's Directors. The Director's Office allocates a non-payroll budget of $25K for hardware replacements. In FY2023 NSO budgeted for a major refurbishment of the main meeting room in Boulder W312 that is still pending. The corresponding funds ($75K) are in the IT carryforward account.

During FY24 at the NSO will be striving to improve its cybersecurity practices by completing the following set of tasks. We will implement cloud-based immutable backups for the IT infrastructure by March 2024, aiming to enhance data protection and recovery capabilities. To fortify DKIST's resilience in the face of potential cyber incidents, a disaster recovery plan will be developed and tested by June. This plan will serve as a strategic framework to mitigate risks and ensure the continuity of operations. Additionally, cybersecurity policies are being updated to align with Trusted CI's Framework Implementation Guide, enhancing the overall security posture of the NSO and will be completed by September. To bolster password security across the NSO enterprise, a password management tool will be deployed. This initiative aims to enhance access control and protect sensitive information from unauthorized access and will be completed by March 2024. Simultaneously, a comprehensive cybersecurity training program for end-users is being launched. This includes instructional videos and the implementation of an email phishing campaign. The goal is to empower users with the knowledge and skills needed to identify and thwart potential scam attempts, thereby contributing to a more secure digital environment for the NSO. This training program will be fully implemented by March 2024.

Other relevant items covered in the Director's office carryforward are:

1. The dedication in FY 2024 of Mark Warner (50% level) to the ngGONG project. This allocation helps disseminate the MREFC Project Management expertise and lessons learned from the DKIST Construction effort to the ngGONG project and other areas of the NSO.
2. Additional science support at around $150K. These funds support a broad spectrum of scientific activites not directly included in the programs, such as payroll for cross-calibrations of GONG and spacecraft data, computers, and page charges for publications by NSO's scientists and emeritus.
3. Equipment moves to Boulder and Maui that have not occurred yet because of the postponed divestiture of the DST. The carryforward funds are $141K for these pending transition activities.
4. Additional travel expenses ($30K) that occur in FY 2024 to support attendance by NSO scientists and collaborators to meetings (TESS/SPD, AGU). A similar amount is allocated to kick off the ngGONG Science Working Group which will meet at least once in FY 2024.
5. Miscellaneous expenditures such as vehicles ($30K).
6. Funds for leadership transition, including payroll ($107K) and additional travel and relocation funds ($56K). These funds are part of the rate reconciliation received by the Director's office. Of these funds, $200K remains unbudgeted and will be returned to the Programs once the expenditures to cover the leadership transition are understood.
7. The SFR for the broadcats of the 2024 eclipse from Eagle Pass.

7.2.2 DKIST Operations Program

The DKIST Operations Program is under the direction of Thomas Rimmele as DKIST Associate Director. In FY 2024, the DKIST Operations Program, with approximately 97 FTEs, is the largest program at the NSO. The 97 FTEs reflect full year of operations staffing. Hiring challenges in technical areas on Maui continue and may prevent us from reaching full staffing levels in FY 2024. The DKIST new funds for FY 2024 are $19.527M; the program's carry forward is $18.84M (Table 7.6). This includes $150k of supplemental funding for E/V vehicles and infrastructure received at the very end of FY 2023. Approximately $17M of carry forward funds are budgeted in FY 2024 to fund the basic operations of DKIST, and investments in instrumentation upgrades and data systems. These investments involve contracts with industry. Developing and placing contracts is typically taking many months. It is therefore possible that not all anticipated contracts can be implemented in FY 2024, i.e., may slip into FY 2025. In fact, several instrumentation contracts that were planned to be led in FY 2023 have slipped into FY 2024 (e.g., coronal image slicer contract with UH). The remaining balance of carry forward of about $1.85M will be required to fund the DKIST Community Support (Ambassador Program, Community Workshops) in FY 2025 and FY 2026 and the impact of escalation in FY 2026 (NSF guidance is for a flat funding profile at $28M for FY 2025-2026). This section explains in detail how the program is budgeting these carry-forward funds to operate DKIST.

Table 7.6. NSO DKIST Operations

Fiscal Year: 2024
NSO DKIST Operations

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.5	New Funds NSO DKIST Ops	67.53	11,011,044	8,502,258	19,513,302	0	19,513,302
CS006.5	Carryover NSO DKIST Ops	29.43	5,356,054	13,476,424	18,832,478	0	18,832,478
Overall - Total		**96.96**	**16,367,098**	**21,978,682**	**38,345,781**	**0**	**38,345,781**

The DKIST operations staffing plan was presented in the FY 2020 – FY 2024 LRP. Since submission of the LRP in 2019, the budget estimates for DKIST operations were updated following the delays of the start of operations due to COVID-19 but also a more substantiated understanding of the cost of science and technical operations.

The AURA Solar Observatory Council recently issued several recommendations, including one to develop a staffing plan with a "realistic cost profile for the number of staff required to achieve strategic and tactical objectives safely, efficiently, and without team burnout." This recommendation was given consideration while updating staffing and non-payroll budget estimates. An AURA organized DKIST operations budget review was held in September 2022 with presence of NSF Program Officers. We note that the estimate for the total staffing number of about 100 FTE has been stable since the time of LRP submission and review. This was discussed with NSF at a meeting in Boulder in August of 2023. Progress continues to be made with refining and updating of resource requirements for DKIST operations using actual expenditures and refined planning of resource requirement for maintenance and upkeep of the complex summit facility. The resource estimates summarized below are based on our best understanding of what it will take to operate DKIST.

In FY 2022 and FY 2023 we gained experience from operating this unique, one-of-a-kind telescope facility in OCP mode. The current budget estimates are now informed by actual expenditures and encumbrances over approximately two years, as well as updated program plans in the instrumentation development WBS. Estimates for non-payroll expenses such as electricity have been refined based on actual expenses.

The Data Center realized the risk associated with calibration engineer staffing. The data center staffing plan was updated accordingly.

We expect the OCP2 to conclude in fall of CY 2024. The proposal calls for OCP3 will be released in April 2023. The proposal review process and experiment generation will occur in the second and third quarters of FY 2024. The support provided to the community during the proposal process continues to be taxing on the Science team. As expected, the level of required science support increased significantly during the proposal preparation and execution phase, when selected proposals must be converted to executable experiments, tested, and executed in service mode.

In FY 2024, we plan to hire one additional science position for Maui to support the operations and optimization of the wavefront correction systems. A science liaison to EPO/C has been appointed.

The Operations Management budget (WBS CS006.5.P1.OM.01) of $2.79M (Figure 7.3) funds the payroll expenses for DKIST Associate Director (AD), Deputy AD; the management function of the Head of Instrumentation and Head of Science Operations; payroll for Administrative Support; and payroll for the Safety Program ($1.53M, Figure 7.4). The non-payroll expenses ($1.261M, Figure 7.5) include quality control, unfunded liabilities, UltiPro, Insurance, post-retirement benefits, professional development for DKIST staff, nonpayroll expenses for admin and safety and travel.

The DKIST Scientists' support for DKIST operations (WBS CS006.5.P1.OM.02) is budgeted (19.2 FTE payroll, non-payroll, and travel) at $4.23M for FY 2024 (Figure 7.3). The budget funds the service and personal research function of NSO scientists. Most of the science support budget are payroll expenses ($3.4M, Figure 7.4). The $274k budgeted in the equivalent carry forward account (WBS CS006.5.P1.CO.02 – Science) funds the 50% joint faculty positions with CU.

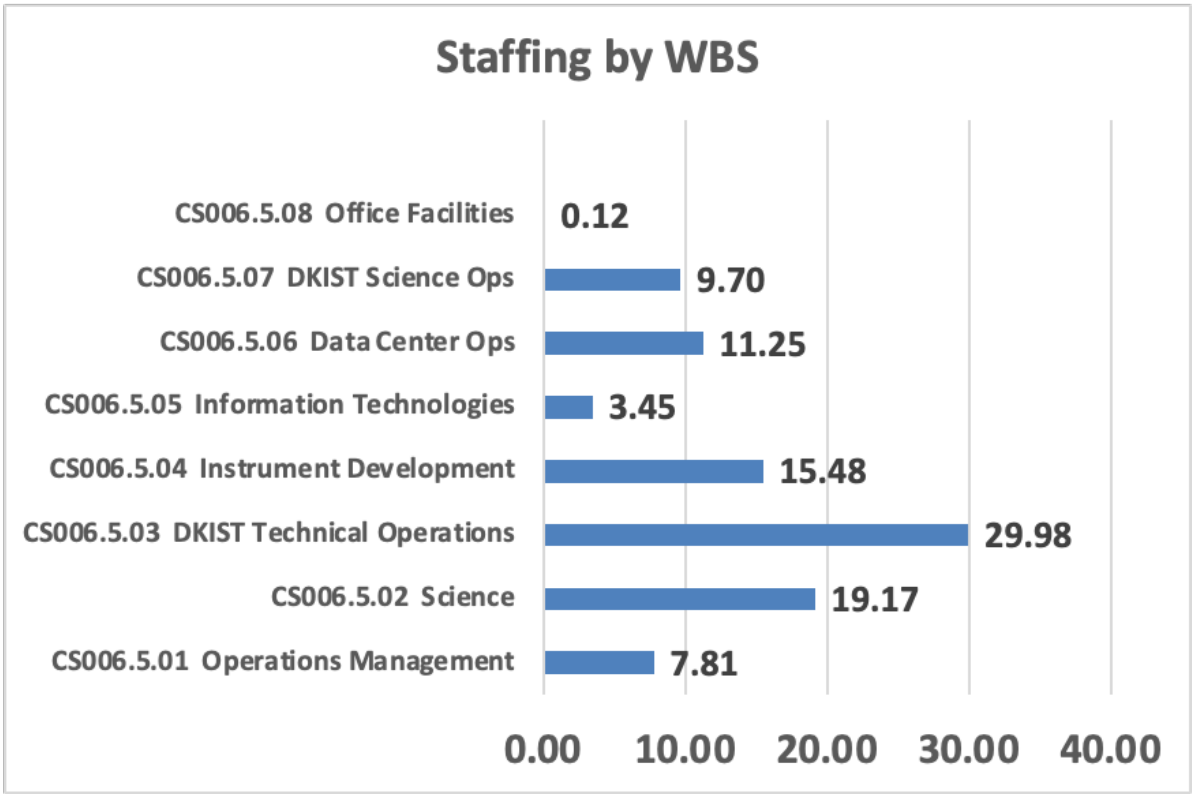

Figure 7.2. *FTE by WBS for FY 2024. CS006.5.04 Instrument Development includes the R&M of the complex set of first-generation instruments, as well as major upgrades (e.g. IR detectors) and developments (e.g. MCAO).*

The Technical Operations budget (WBS CS006.5.P1.OM.03) funds payroll ($5.36M) and non-payroll ($3.64M) expenses in support of technical summit operations (support facilities, observing support, maintenance and upkeep, upgrades). The payroll budget supports ~30 FTE of engineering and management staff. The non-payroll budget includes cost of electricity, supplies and materials, replacements (e.g. chiller, optical elements, computers, vehicles), maintenance and support contracts, machine shop and travel.

The Instrumentation program (WBS CS006.5.P1.CO.04) is funded entirely with carry-forward funds ($10.7M). The payroll expenses for 15.5 FTE are $3.17M. The non-payroll budget ($7.55M) includes the MCAO development, the IR detector/camera replacement, image slicer upgrade for DL-NIRSP, replacements and upgrades for all instruments (motors, filters, modulators), additional optical elements for the light distribution system, software, various support contracts and travel.

The IT support budget (WBS CS006.5.P1.OM.05) totals $1.23M and is split between labor ($0.645M, 3.5 FTE) and non-labor ($0.589M).

Development and operations of the Data Center (WBS CS006.5.P1.CO.06) are funded by carry-forward. The payroll budget of $2.16M supports 11.3 FTE. Non-payroll expenses for data storage and processing hardware replacement and expansion, software, support contracts, supplies and materials and travel amount to $2.72M.

The budget of $1.77M for summit science operations and operations tools is split between new funds (WBS CS006.5.P1.OM.07) and carry forward funds (WBS CS006.5.P1.CO.07). The "OM" account primarily funds the labor cost for Science Operations Specialists, including the management function ($1.1M). The "CO" account primarily funds the labor for the development and maintenance of operations tools.

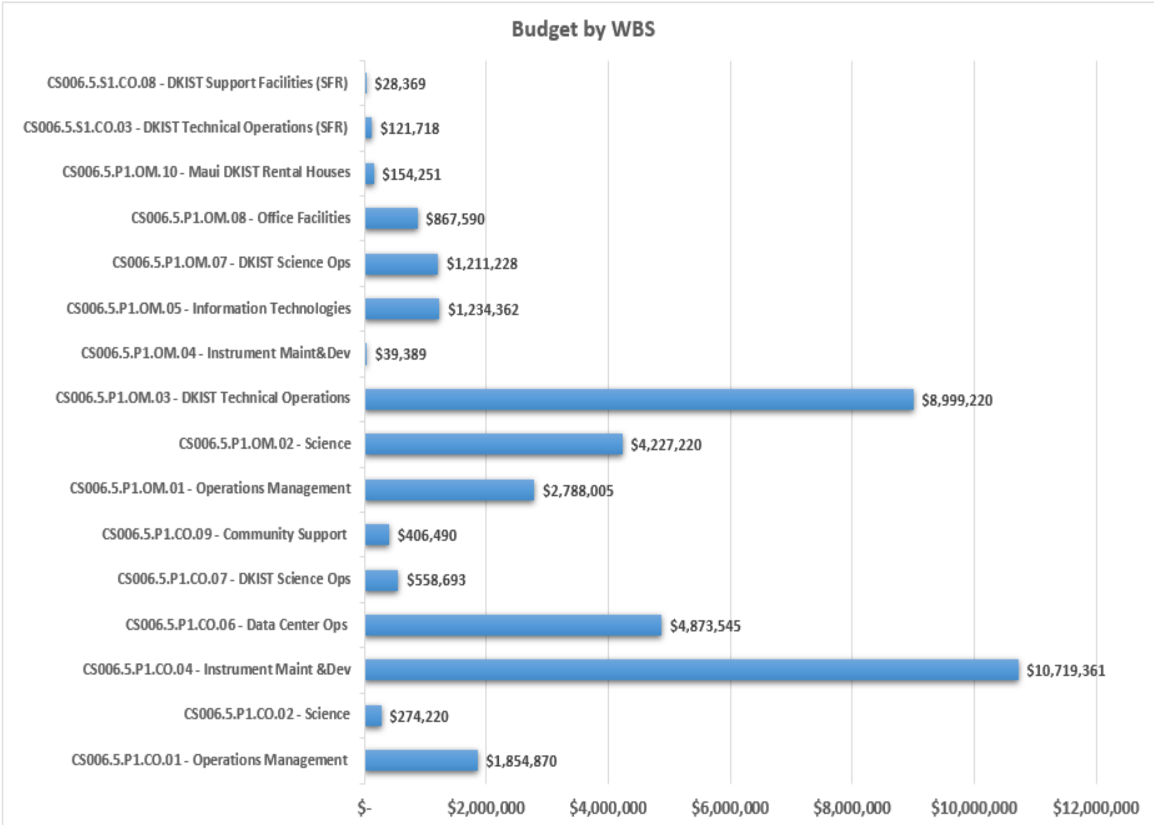

Figure 7.3 *Total cost by WBS for FY 2024. New funds are budgeted in accounts tagged as "OM" WBS items funded with carry-forward funds are tagged as "CO".*

The lease and operations expenses for the office facility in Boulder and the DSSC on Maui (WBS CS006.5.P1.OM.08) amount to $0.86M.

Community support, which includes the Ambassador Program, is funded from carry-forward ($0.41M; WBS CS006.5.P1.CO.09).

Non-Payroll estimates (see Figure 7.5) have undergone several update cycles since the LRP budget estimates were performed. More recent actuals are now available for a significant number of equipment and supplies items. Firm vendor quotes for equipment have been received where previously only ROM pricing and/or scaling from previous similar items was available, leading to an increase of the annual non-payroll expenses in the areas of Maui Technical and Facilities operations and new instrumentation development. For example, firm contract pricing for the development and fabrication of IR detectors has resulted from a formal and competitive RFP process and implementing a contract. The cost of new and much more capable IR detector technology that within approximately three years will replace the aging, limited performance H2RG detector technology, is significantly higher than previously estimated. Similarly, a firm price contracts for the procurement of an image slicer device and the MCAO deformable mirror conjugate to 11km conjugate and slated to replace M7 are now in place. A formal quote for the coronal image slicer for DL-NIRSP has been requested. We estimate the cost of this contract to be very similar to the recent on-disk image slicer contract.

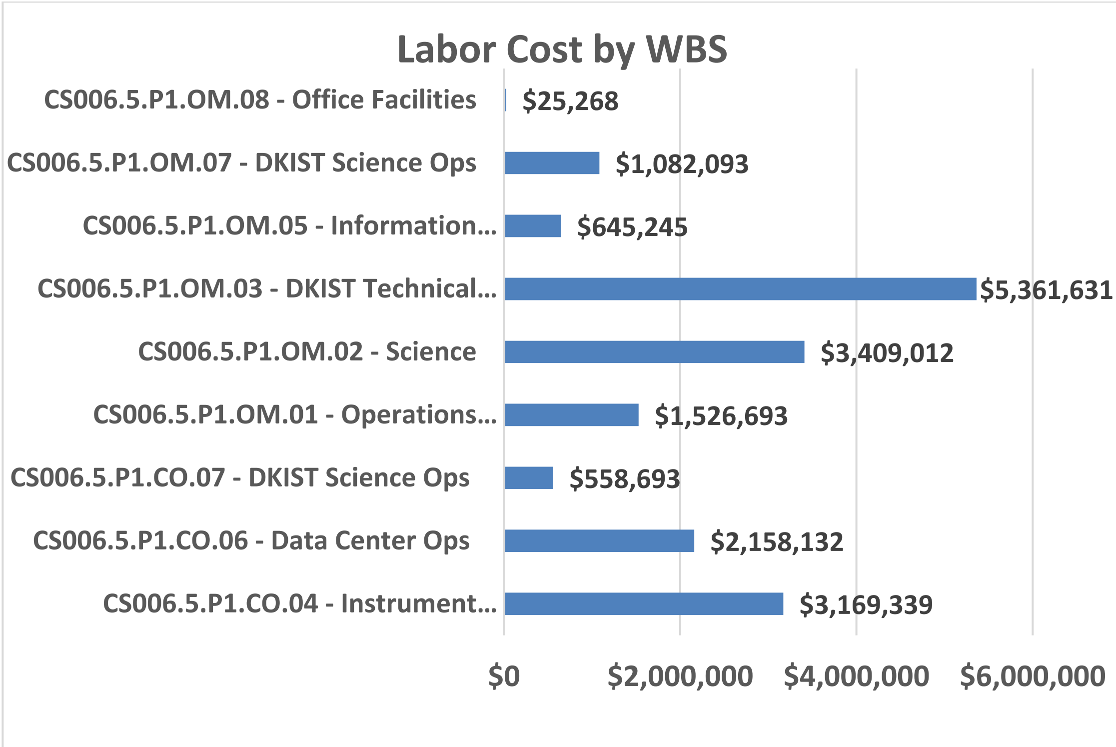

Figure 7.4. *Payroll by WBS for FY 2024.*

The instrumentation program includes sustained support and maintenance of the current suite of instruments, major upgrades, and improvements to existing instrumentation, MCAO development, and the integration of a dual etalon VTF delivered by the German partners. We note that some large contracts, including the custom-built coronal image slicer, visible camera upgrades and replacements and optical components that were originally planned for FY 2022 have slipped to FY 2023 and are contributing to the carry forward. The deferred spending also explains the increased FY 2024 budget ($33.5M) as compared to the annual budget projection for FY 2023 ($30.1M) presented in the previous APRPP. System integration and testing in the lab and some summit integration activities will commence in FY 2023-2024. Summit integration and acceptance testing will continue within the scope of the 2-year CSA extension (expected duration: FY 2025 – FY 2026).

In summary: FY 2024, carry forward in the amount of about $17M is used to fund the Instrument program, the Data Center, Science Operations and Community Support. Carry forward in the amount of $1.85M will be needed in FY 2025/2026 to fund Community Support and the impact of escalation in the anticipated flat funding scenario. As is the case for all budget figures presented in this section, escalation of 3% is included.

Our strategy has been to acquire complex and costly, often custom-built hardware items during the current CSA. These are typically long-lead items, which require multi-year development contracts with vendors. Our approach is motivated by budget realities and projections, but also takes into account the significant delays of scheduled development milestones we continue to experience with vendors for custom built hardware. It is important to note that the FY 2025 budget estimate of $28.5M presented at the recent DKIST operations budget review with NSF assumes significantly reduced (compared to FY 2022-2024) non-payroll budgets for instrumentation, but also the Data Center, where additional significant hardware investements occur in FY 2024 (e.g. IR controllers, Coronal Image Slicer, and additional compute and storage nodes).

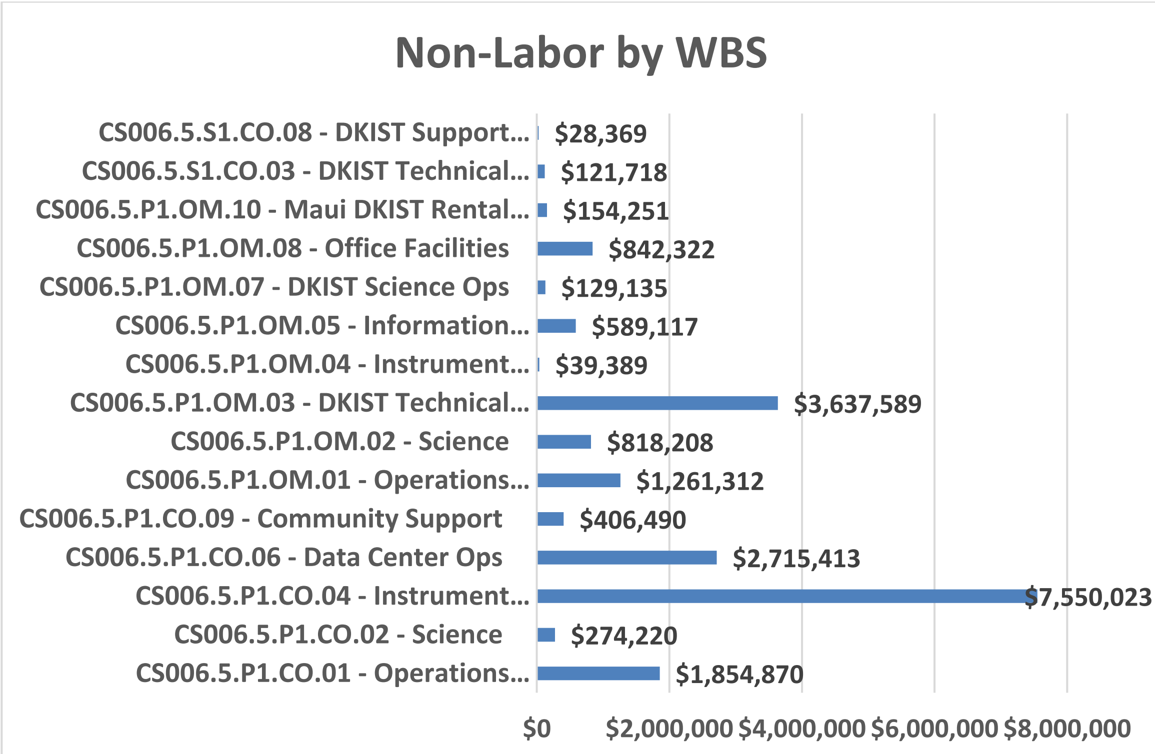

Figure 7.5. *WBS non-payroll cost for FY 2024.*

7.2.3 NSO Integrated Synoptic Program (NISP)

The NISP combines staff from SOLIS and GONG under Alexei Pevtsov as Associate Director. The Program also provides partial support to NSO Administrative and IT staff. In its funding philosophy, NISP continues to rely on a three-pronged approach: NSF base funding, NOAA support, and external grants. For future large-dollar amount items (i.e., new data center servers), the Program is following its previously established plan and allocates an annually prorated amount. The Program is on track to achieve this goal by the end of FY 2024.

Table 7.9. NSO NISP

Fiscal Year: 2024

NSO NISP

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.2	New Funds NSO NISP	16.11	2,529,459	1,416,757	3,946,217	0	3,946,217
CS006.2	Carryover NSO NISP	2.25	273,226	1,284,357	1,557,583	0	1,557,583
Overall - Total		**18.36**	**2,802,686**	**2,701,114**	**5,503,800**	**0**	**5,503,800**

The NSF base funding for NISP in FY 2024 corresponds to $3.94M, which is a combination of the $2.94M base funding contribution (same as in FY 2023) and $1M from the last year of the NISP's WoU-MMA SFR. NISP carryforward in FY 2024 (Table 7.9) totals $1,557M split into $1,072M from the NISP base and $485K from the WoU-MMA SFR. The increase in carryover from FY 2023 can be attributed to several factors. For the NISP’s WoU-MMA SFR, the hiring process took longer than expected resulting in about 5–6-month delays. In addition, due to some administrative issues, the Program was not able to hire one of three programmers budgeted for this project. Delay in SOLIS first light and a late start of NISP visiting scientist pushed the funding allocated for these activities to FY 2024. NSF base funding supports research with GONG and network operations deficit as needed. The carryover portion of NISP base includes unspent portion of GONG refurbishment, SOLIS construction funding, and NISP data storage reserved for a future purchase. The WoU-MMA carryover is budgeted for two postdocs, one software engineer (programmer), a desktop computer, travel for the NSO team with partners at CUA/GMU (one trip), software licenses (IDL, Matlab), and CU Office space.

In addition, the non-NSF funding available for GONG operations, about $1M (see Table 7.2), corresponds to the third year of the renewed IAA between NOAA/SWPC and the NSF (CSA AST-1023439). The updated budget considers revised costs for operating the network, reflecting scalability and new site fees at various locations, and runs until FY 2026.

As in previous years, the NISP budget is alleviated by a series of non-NSF grants and subcontracts. The downside of this is that the NISP science workforce focuses efforts on the scope of the grants but reduces support to the Program's main scientific areas represented by GONG and SOLIS. To alleviate this issue, in FY 2024, one scientist (Dr. S. Kholikov) was allocated 50% of his time to NISP support role. This has had a beneficial effect on the level of scientific support of NISP operations including new camera development (part of GONG refurbishment) and GONG operations. The approach would be continued in FY 2024 and FY 2025 subject of funding situation at NISP. Similar to FY 2023, in a search for external support, emphasis will be made on projects closely align with NISP priorities. This will help mitigate a negative impact of external funding while still benefiting from its positive aspects. NSF's WoU-MMA SFR (WBS CS006.2.S1.OM.06.01) is one example of this approach.

Currently, NISP has a total of approximately 20 FTEs. The NSF base funding covers about 16 FTEs (including 2 FTE for scientific programmer staff funded by NISP's WoU-MMA SFR). GONG operations (engineering and Data Center groups) use 3.62 FTEs funded from the NOAA/SWPC contribution.

NISP comprises an Atmospheric Section and an Interior Section, each led by a project scientist/project lead who reports to the NISP Associate Director. As the rest of the scientific staff, both project leads are only partially supported by NSF base funding. The engineering support staff, supervised by the NISP Engineering Manager, supports SOLIS and GONG operations and instrument upgrades. The base-funded fraction of scientific staff supports the development of various NISP data products, monitoring the data quality, addressing routine/emergency issues related to data processing, and responding to the community's need for data access. NISP scientific staff are also supervise REU students and involved in other NSO-broad EPO/C activities.

The Program continues to use the FY 2016 one-time contribution for GONG refurbishment, and the remaining funds are part of the Program's FY 2024 carry-forward (Table 7.9, WBS CS006.2.S1.OM.04.08 and CS006.2.S1.OM.04.10). Specifically, about $131K is budgeted to ensure completion of GONG refurbishment, which scope is summarized in the FY 2021-2022 APRPP. A small change to this plan was made in FY 2023, and it is described in NSO FY 2023 Annual Progress Report. Due to a failure of an old unit, a new window-type unit was installed at GONG/BBSO. Given the lifetime of these units, their cost as compared with the cost of converting GONG/BBSO to a split-unit HVAC, it was decided to continue with the window-type air conditioning units at that GONG location.

NISP base funding in FY 2024 uses $183K from the program's carryforward (WBS CS006.2.S1,CO.04.09) to cover the final phases of SOLIS construction and a restart of its operations. It is now expected that the first light of SOLIS VSM will be achieved in May 2024, and the operations will restart in September 2024. GONG data used for the operational space weather forecast are analyzed at SWPC/NOAA using the data reduction pipelines maintained by NISP. The more research-oriented aspects of GONG data are reduced by the NISP Data Center. The NISP Data Center is currently operating under a Block Publishing Schedule for our DMAC data pipelines. The processing schedule is available at GONG web page, and it is promptly updated. This is a

3-month-block schedule, which results in final data products being output alternately every 2 and 3 GONG-months (1 GONG-month is 36 days). All quick reduced data (most relevant to the operational space weather) continue to be provided in near real time. All datasets are collected by the NISP Data Center and made available for downloading by the solar community.

In FY 2024, NISP allocates $941K base funding for the Data Center (WBS CS006.2.S1.OM.03.18) and $461K as part of the program's carryforward for Data Center equipment upgrades (WBS CS006.2.S1.CO.03.21). In respect to this WBS, the program will achieve its stated goals and would be ready to acquire new hardware later in FY 2025.

In FY 2024 the Program will see a modest expansion via hiring supporting personnel including one engineering technician. Two scientific programmers hired in FY 2023 will continue working throughout FY 2024 under WBS CS006.2.S1.OM.06.01. Most likely, the positions will continue into FY 2025 until all remaining funds are exhausted. As part of the strategic development, the Program will strengthen its scientific group by hiring at least one postdoctoral fellow. In addition, in FY24 the Program will provide partial support for one current postdoc, (Dr. A. Hamada), at the level of 0.25FTE.

To enhance scientific collaboration, the Program allocated a modest amount of funding ($60K) to support long-term visitors to NISP. Prof. K. Mursula was selected as the first visitor to NISP. Due to late start, this position will be funded via carryover funding (WBS CS006.2.P1.CO.01.01).

7.2.4 NSO Community Science Program (NCSP)

The LRP document described a new synergistic program, the NSO Community Science Program, aimed at scientific activities that benefit from the combined expertise of DKIST and NISP. NCSP uses supplemental funding from initiatives that have a research impact extending to both programs. The first such initiative was the DKIST Level-2 data project aimed at producing physical quantities derived from the observables produced by the spectropolarimeters of DKIST. Starting in FY 2022, NCSP also receives base funding to secure long-term distribution of Level-2 data products. More recently, we have added to the program funding from a three-year SFR that integrates DKIST and GONG data products to improve coronal modeling in preparation for the 2024 total solar eclipse. FY 2024 is the last year of this SFR.

The NSF new funds for NCSP in FY 2024 corresponds to $1.14M (Table 7.3), which is a combination of the $465K from the base augmentation (same as in FY 2023) to continue the DKIST Level-2 effort and $676K from the third year of the NCSP's WoU-MMA SFR (Table 7.2). NCSP carryforward in FY 2024 (Table 7.4) totals $2.23M, which is equally split in the Level-2 SFR remanent ($1.77M) and the WoU-MMA unspent funds ($462K). The NCSP will use a significant fraction of the Level-2 carryforward funds in FY 2024, including the expenditures needed for the Level-1 to Level-2 hardware interface ($960K). Table 7.10 shows the program's spending plan for the new funds and carry forward.

Table 7.10. NSO NCSP

Fiscal Year: 2024
NSO NCSP

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.4	New Funds NSO NCSP	6.95	892,856	244,708	1,137,564	0	1,137,564
CS006.4	Carryover NSO NCSP	6.50	721,160	1,509,808	2,230,968	0	2,230,968
Overall - Total		**13.45**	**1,614,016**	**1,754,516**	**3,368,532**	**0**	**3,368,532**

The program's primary mission is the development of DKIST Level-2 data products. Testing for creating these data products started following the availability of the first DKIST Level-1 data public release as part of the

DDT coordinated observations with Parker Solar Probe. Another collaborative opportunity this year is the third flight of the Artic Sunrise balloon program. Using DDT, DKIST and Sunrise will co-observe regions of the Sun and produce unique full Stokes spectro-polarimetric data sets from photospheric and chromospheric lines whose interpretation need of the complex inversion codes used by NCSP. To better integrate our team in the Sunrise collaboration, the program has allocated funding to travel to the US PI institution (JH/APL) and the launch site (Kiruna, Sweden).

The spending plan for the WoU-MMA follows the original scope of the SFR. The FTE allocation within the program (Table 7.10) corresponds to four graduate students recruited in FY 2023 and 2024. Some of these students participated in the 2023 (Australia) total solar eclipse and will continue being part of the continental US 2024 eclipse activities. NSO plans two primary campaigns, one in Eagle Pass (TX) and a smaller group in Mazatlán (Mexico) that corresponds to the first contact point with the ground of the totality path. Travel to these campaigns is included in the NCSP non-staff cost. The team in Texas will consist of graduate students, EPO/C personnel, and NSO scientists. In Mexico, an expert team formed by NSO scientists and technicians will perform spectroscopic observations in coordination with DKIST.

The SFR proposal also included a new data product combining the Solar Orbiter mission and GONG magnetograms. The recent release of full disk magnetograms from the PHI instrument will accelerate this activity in FY2024 and require travel to the collaborating partner institutions.

The program is considering using a subaward with LASP/CU ($145K) to establish a collaboration involving CU/NSO shared faculty appointee Dr. Adam Kowalski to study chromospheric emission during solar flares and its extension to coronal lines. The model that this collaboration will produce would supply important constraints on the properties of flare plasmas and involves observations with DKIST/ViSP with strong connections with current student projects at NSO.

7.2.5 Sacramento Peak (Sunspot)

As in previous years, the NSO plans to continue operating the Sunspot site using a dedicated SFR. This SFR contemplates one year of continued support to consolidate the ongoing implementation of Alternative 2 from the Final Environmental Impact Study and lays out the foundations for a transfer of the site's management to NMSU. The SFR request is for a total of about $1.6M, which is above the PBR allocation.

Table 7.11 provides the spending plan for the requested funding. The SFR (submitted in FY 2023) includes a subaward to NMSU of $543K. As in FY 2023, the NSO leads the SFR, and all NMSU activities are included in the subaward. This model consolidates all utility payments at the NSO, simplifying the administrative processes between the NMSU and AURA.

Table 7-11 NSO Sunspot

Fiscal Year: 2024

NSO Sunspot

Project ID	Project Name	FTEs	Staff Cost	Non-Staff Cost	Spend Plan	Other Revenue	NSF Base Revenue
CS006.3	New Funds NSO Sunspot	3.50	350,288	1,240,499	1,590,787	0	1,590,787
CS006.3	Carryover NSO Sunspot	0.00	0	550,130	550,130	0	550,130
Overall - Total		**3.50**	**350,288**	**1,790,629**	**2,140,917**	**0**	**2,140,917**

The FY 2024's SFR considers, as in previous years, several deferred maintenance aspects (totaling $432K):

1. Skid Steer rental
2. VOQ cleaning and boler heat replacement
3. Removal of the relocatable housing grounds
4. Sanitary sewer system pump
5. Painitng of the DST

The program has a carryforward of $550K generated by the late invoicing of the NMSU costs in FY 2023 ($352K) and two years of housing revenue ($152K). NMSU has requested a 1-year extension on their subaward.

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8 APPENDIX A. SCIENTIFIC AND KEY MANAGEMENT STAFF

The NSO staff provide support to users including observational support, developing and supporting state-of-the-art instrumentation to ensure that users obtain the best data, and maintaining data archives and the means to accessing the data. Members of the scientific staff are defining how DKIST will be operated and how NSO will handle the data. In addition, both scientific and engineering staff serve as mentors for undergraduate and graduate students and postdoctoral fellows. They also organize community workshops on critical areas of solar research and planning. Staff science and instrument development allow NSO to stay at the forefront of solar physics and play a crucial role in fulfilling user support.

The current NSO scientific and management staff, as well as affiliated scientific staff, are listed below with their primary areas of expertise and key observatory responsibilities.

Scientific Staff

Tetsu Anan	Assistant Scientist: Solar electric fields; magnetic reconnections; solar chromospheric heating; high-energy non-thermal particles; integral-field-unit spectropolarimetry including instruments, data reduction, and data analysis.
Christian Beck	DKIST Resident Scientist. Post-focus instrumentation; data reduction pipelines; high-resolution spectroscopy and spectro-polarimetry of the photosphere and chromosphere; development of inversion tools for chromospheric spectral lines; DKIST instrumentation and data calibration approaches.
Luca Bertello	NISP Solar Atmosphere Program Scientist and SOLIS Data Scientist; solar variability at different temporal, spectral, and spatial scales; calibration of solar magnetic field data; solar-stellar research; space weather.
David A. Boboltz	NSO Deputy Associate Director for DKIST; Radio astronomy; Very Long Baseline Interferometry (VLBI); stellar evolution; late-type stars; circumstellar atmospheres; astrophysical masers; radio stars, e.g., RS CVn and Algol binaries; high-resolution imaging; spectro-polarimetry; instrumentation.
Gianna Cauzzi	High resolution imaging and spectroscopy of the lower solar atmosphere; chromospheric structure and dynamics, including wave dynamics and heating. Flare physics and lower atmospheric signatures. Chair of the Science Review Committee for the DKIST OCP. Head of the DKIST Ambassador Program. Member of the Panel on Sun and Heliosphere for the NAS Decadal Survey 2024-2033.
Serena Criscuoli	High-spatial resolution spectroscopy and spectropolarimetry of the photosphere and chromosphere; radiative transfer; solar and stellar spectral variability; DKIST Resident Astronomer.

Alisdair Davey	CMEs and associated phenomena; acceleration and heliospheric propagation of SEPs during solar flares and CMEs; use of computer vision/AI in identifying solar features and events; development of the VSO and the heliospheric data environment, including integration of data and modeling efforts.
Andre Fehlmann	DKIST infrared instrumentation specialist; IR instrumentation; precision spectro-polarimetry; coronal magnetic fields; student engagement and community outreach.
Catherine Fischer	Data reduction pipelines, high-resolution imaging, spectroscopy, and spectropolarimetry, solar small-scale magnetic field evolution.
Sanjay Gosain	Observatory Scientist, NISP Instrument scientist; optical design and calibration of the instruments for polarimetry and spectroscopy, instrument modeling; study of solar flares, eruptive phenomena; chromospheric magnetism; magnetic helicity, Public outreach: Training Citizen Scientists for Experiments during Eclipse, Diversity Advocate (Boulder).
David Harrington	DKIST polarimetry scientist; instrumentation; spectropolarimetry, adaptive optics, novel optical systems, detector systems, applied research, community workforce development.
Sarah A. Jaeggli	3D structure of sunspot magnetic fields; atomic and molecular physics of the photosphere and chromosphere; radiative transfer modeling and spectral synthesis; instrumentation for spectroscopy and spectropolarimetry, including DKIST facility instrument development; engaging the community to perform multi-facility observations.
Kiran Jain	Scientist; Farside Project Lead Scientist; Helioseismology – global and local; farside acoustic imaging of the Sun; multi-wavelength helioseismology; acoustic oscillation mode characteristics; time-series analysis; solar variability; solar interior structure and dynamics; subsurface flows; active regions and solar magnetism; space weather; Sun-Earth connection.
Maria Kazachenko	Inversion techniques to derive the electric fields and Poynting fluxes on the surface of the Sun using magnetic field measurements; data-driven simulations of the solar coronal magnetic fields; statistical properties of solar flares.
Rudolf W. Komm	Helioseismology; dynamics of the solar convection zone; solar activity and variability.
Adam Kowalski	Flare observations and radiative-hydrodynamic modeling; white-light flare radiation and continuum properties; connection between magnetic activity and flares on the Sun and younger M dwarf stars; teaching physics of stellar atmosphere modeling and observational astronomy and spectroscopic analysis; student mentor.

Maxim Kramar	Physics of the solar corona. Particularly, developing techniques for the inferring coronal plasma properties such as density, temperature, and magnetic field and its application to study various coronal phenomena such as Coronal Mass Ejections (CME), solar wind, space weather.
David Kuridze	Plasma diagnostics in the solar atmosphere; high-resolution spectroscopy and spectropolarimetry; Chromospheric and coronal magnetic field measurements; chromospheric fine-structures and flares.
Gordon J. D. Petrie	NISP; solar magnetism; GONG magnetogram zero-point analysis; the Sun's polar magnetic fields and their responses to activity cycles, comparing high-resolution and full-disk magnetogram data; coronal magnetometry in support of heliospheric modeling for solar encounter missions and other applications; end-to-end calibrations of magnetogram observations.
Alexei A. Pevtsov	NSO Associate Director for NISP; solar magnetic fields; corona; sunspots; chromosphere; solar-stellar research; space weather and space climate.
Valentín M. Pillet	NSO Director; solar activity; Sun-heliosphere connectivity; magnetic field measurements; spectroscopy; polarimetry; astronomical instrumentation with an emphasis on spectropolarimetry.
Kevin P. Reardon	Dynamics and structure of the solar photosphere, chromosphere, and corona; implementation of modern techniques for data archiving, processing, and discovery; application of imaging spectroscopy techniques; post-focus instrumentation development; spectropolarimetry of the solar atmosphere; transit studies of inner planets; history of solar astronomy.
Thomas R. Rimmele	NSO Associate Director for DKIST; DKIST Construction Project Director; sunspots; small-scale magnetic surface fields; active region dynamics; flares; acoustics waves; weak fields; adaptive optics; multi-conjugate adaptive optics; instrumentation.
Thomas Schad	Chromospheric and coronal magnetic field diagnostics; precision spectro-polarimetry; DKIST Operations, DKIST Instrumentation; DKIST Technical TAC chair; student engagement and community outreach
Dirk Schmidt	DKIST adaptive optics, high spatio-temporal resolution observation techniques; development of adaptive optics systems, in particular multi-conjugate adaptive optics systems.
Lucas A. Tarr	Observational, theoretical, and numerical investigations of the low solar atmosphere; active region evolution; development of 3D MHD data driven simulations; MHD wave propagation; DKIST operations; student mentorship; public outreach.
Sushanta Tripathy	NISP Interior Program Lead Scientist; magnetoseismology of active regions; global and local helioseismology; solar activity cycle; ring-diagram analysis, sub-surface flows, cross-spectral analysis of oscillation time series.

Alexandra Tritschler	Senior Scientist; DKIST Operations Scientist; DKIST operations development; DKIST Observatory Control System Scientist; DKIST Target Acquisition System Scientist; DKIST Visible Broadband Imager; solar fine structure; magnetism; Stokes polarimetry.
Han Uitenbroek	Associate Director for NSO Community Science Program; atmospheric structure and dynamics; radiative transfer modeling of the solar atmosphere; Development of the DeSIRe inversion code; Development of the Level 2 pipelines for spectropolarimetric data from DKIST.
Friedrich Wöger	Senior Scientist; DKIST Instruments Project Scientist. Image reconstruction techniques; adaptive optics; two-dimensional spec-troscopy, and spectro-polarimetry; DKIST instrumentation, in particular the visible broadband imager; DKIST wavefront correction system; DKIST data handling system.

Grant-Supported Scientific Staff

Shukirjon S. Kholikov	Helioseismology; data analysis techniques; time-distance methods.

Postdoctoral Fellows

Andrei Afanasev**	Data-driven MHD modeling of solar active regions.
Joao da Silva Santos	Solar magnetism and atmospheric heating.
Ryan French	Coronal and chromospheric observations of solar flares.
Amr Hamada	Machine Learning application on GONG dataset and solar flare forecasting.
Alin R. Paraschiv	Inversion problems, data calibrations, and data interpretation of the Solar Corona.
Yuta Notsu	Stellar magnetic activity and flares.

**DKIST Ambassador

Key Management Staff

David Boboltz	DKIST Deputy Associate Director.
Gregory Card	NISP Engineering & Technical Manager.
Eric Cross	Head of Information Technology.
Jennifer L. Ditsler	Head of Administration & Support Facilities.
Bret D. Goodrich	DKIST Instrumentation Manager.
Heather K. Marshall	DKIST Technical Operations Manager.
Jorge Perez Gallego	Head of Education & Public Outreach
Robert E. Tawa	DKIST Data Center Project Manager.
Mark Warner	DKIST Program Manager.

Carolyn Watkins	NSO Business Operations Manager.

Graduate Students

Abdhullah Alshaffi	University of Colorado	MHD simulations of eruptive events on the Sun.
Sarah Bruce	University of Colorado	Solar eclipse research.
Marcel Corchado-Albelo**	University of Colorado	Flare current sheet properties.
James Crowley	University of Colorado	Spectral inversions and photospheric structure.
Caroline Evans	University of Colorado	Solar surface magnetism.
Ryan Hofmann	University of Colorado	Solar chromospheric thermodynamics with ALMA.
John Stauffer**	University of Colorado	Molecular and millimeter temperature diagnostics.
Cole Tamburri**	University of Colorado	Chromospheric flare dynamics.
Dennis Tilipman	University of Colorado	Energy transfer in the quiet Sun.
Isaiah Tristan	University of Colorado	Stellar flares.
Ayla Weitz	University of Colorado	Chromospheric and coronal connections.
Amanda White	University of Colorado	Optical element polarization characterization.
Leah Zuckerman	University of Colorado	Machine learning applications in solar physics.

**DKIST Ambassador

DKIST Ambassadors

Shah Bahauddin	University of Colorado	Magneto-convection; acoustic source.
Melissa Bierschenk	George Mason University	Magnetic activity; solar eruptions.
Yingjie Zhu	University of Michigan	CME diagnostics in the inner corona.

9 APPENDIX B. ACRONYM GLOSSARY

A&E	Architecture and Engineering
AAAC	Astronomy and Astrophysics Advisory Committee (NSF)
AAG	Astronomy and Astrophysics Research Grants (NSF)
AAS	American Astronomical Society
ACE	Advanced Composition Explorer (NASA)
ACP	Algorithm Change Proposal
ADAPT	Air Force Data Assimilative Photospheric flux Transport
AD	Associate Director (NSO)
AF	Air Force (US)
AFRL	Air Force Research Laboratory
AFWA	Air Force Weather Agency
AGS	Atmospheric and Geospace Sciences Division (NSF)
AGU	American Geophysical Union
AIA	Atmospheric Imaging Assembly (SDO)
aka	Also Known As
ALMA	Atacama Large Millimeter Array
AMO	Access-Mode Observing (DKIST)
AMOS	Advanced Maui Optical and Space Surveillance Technologies (MEDB)
aO	Active Optics
AO	Adaptive Optics
AOX	Adaptive Optics Associates – Xinetics Inc.
APRPP	Annual Progress Report and Program Plan (NSF)
APL/JHU	Applied Physics Laboratory, Johns Hopkins University

APS	Astronomy and Planetary Science (University of Colorado, Boulder Department)
AR	Active Region
ARRA	American Recovery and Reinvestment Act
ASP	Advanced Stokes Polarimeter
APDA	Astronomical Photographic Data Archives (PARI)
ATI	Advanced Technology Instrumentation (NSF)
ATM	Atmospheric Sciences (Division of NSF)
ATRC	Advanced Technology Research Center (University of Hawai‘i)
ATST	Advanced Technology Solar Telescope (NSO)
AU	Astronomical Unit
AURA	Association of Universities for Research in Astronomy, Inc.
AWI	Akamai Workforce Initiative (Hawai‘i)
AWS	Amazon Web Services
BE2E	Boulder End-to-End (DKIST)
BiFOIS	Birefringent Fiber-Optic Image Slicer
BLNR	Board of Land and Natural Resources (State of Hawai‘i)
BB	Big Bear (GONG site)
BBSO	Big Bear Solar Observatory (California)
BOE	Basis of Estimate
BO/ITL	Biological Opinion/Incidental Take License (U.S. Fish & Wildlife Service)
BSA	Boulder Solar Alliance
CA	Cooperative Agreement
CAS	Central Administrative Services (AURA)
CATE	Citizen Continental America Telescopic Eclipse (NSO Project)
CAM	Cost Account Manager (DKIST)

CCD	Charge Coupled Device
CCMC	Community Coordinated Modeling Center
CDAW	Coordinated Data Analysis Workshop
CDM	Compact Doppler Magnetograph (SWRI)
CDN	Content Delivery Network (NSO EPO/C)
CDO	Chief Diversity Officer (AURA)
CD-ROM	Compact Disk – Read Only Memory
CDR	Critical Design Review
CDUP	Conservation District User Permit
CEPP	Coronavirus Exposure Prevention Plan (AURA)
CES	Coudé Environmental System
CfA	Center for Astrophysics (Harvard Smithsonian)
CfAO	Center for Adaptive Optics (University of California, Santa Cruz)
CGEM	Coronal Global Evolutionary Model
CGEP	Collaborative Graduate Education Program (University of Colorado, Boulder)
CHU	Critical Hardware Upgrade
CHW	Chilled Water primary coolant loop (DKIST)
CISM	Center for Integrated Space Weather Modeling
CJS	Commerce, Justice, Science (Subcommittee, US House Appropriations Committee)
CLEA	Contemporary Laboratory Exercises in Astronomy
CMAG	Compact Magnetograph (NISP)
CMEs	Coronal Mass Ejections
CMMS	Computerized Maintenance Management System
CNC	Computer Numerical Controlled
CNSF	Coalition for National Science Funding

CoDR	Conceptual Design Review
COLLAGE	COLLAborative Graduate Education (University of Colorado, Boulder)
ConOps	Concept for Operations (DKIST)
COS	College of Optical Sciences (University of Arizona)
CoRoT	COnvection ROtation and planetary Transits (French Space Agency CNES)
CoSEC	Collaborative Sun-Earth Connection
COSI	Code for Solar Irradiance
COSPAR	Committee on Space Research
COTS	Commercial Off-the-Shelf
CPR	Cost Performance Report (DKIST)
CR	Carrington Rotation
CRIM	Coudé Rotator Mechanical Interface
Cryo-NIRSP	Cryogenic Near-Infrared Spectropolarimeter (DKIST)
CS	Center Services (NSO)
CSA	Cooperative Support Agreement
CSAP	Center Services Action Plan (NSO)
CSF	Common Services Framework
CSIC	Consejo Superior de Investigaciones Cientificas (Spain)
CSM	Cryo-NIRSP Steering Mirror
CSP	Critical Science Plan
CSS	Camera Software
CSSS	Current Sheet Source Surface
CT	Cerro Tololo (GONG site)
CTL	Center-to-Limb
CU Boulder	University of Colorado, Boulder

CYRA	Cryogenic Infrared Spectrograph (NJIT, Big Bear Solar Observatory)
DA	Diversity Advocate
DAD	Deputy Associate Director
DAG	Directed Acyclic Graphs
DAS	Data Acquisition System
DB-P	Dual-beam Polarizer (McMath-Pierce Telescope)
DC	Data Center (DKIST)
DD	Diverse Discussions (NSO)
DDT	Director's Discretionary Time
D&D	Design & Development
DASL	Data and Activities for Solar Learning
DC	Data Center
DCAP	Data Center Action Plan (NSO)
DE&I	Diversity, Equity, and Inclusion
DE&I-WG	Diversity, Equity, and Inclusion Working Group (NSO)
DEIS	Draft Environmental Impact Statement
DEM	Differential Emission Measure
DHS	Data Handling System
DIL	"Day in the Life" (DKIST)
DKIST	Daniel K. Inouye Solar Telescope (formerly ATST)
DL-NIRSP	Diffraction-Limited Near-Infrared Spectropolarimeter (DKIST)
DLNR	Department of Land and Natural Resources (State of Hawai'i)
DLSP	Diffraction-Limited Spectropolarimeter
DLT	Digital Linear Tape
DM	Deformable Mirror

DMAC	Data Management and Analysis Center (GONG)
DoC	Department of Commerce
DoD	Department of Defense
DOE	Department of Energy
DRD	Design Requirements Document
DRMS	Decision, Risk and Management Sciences (NSF)
DSF	Disappearing Solar Filament
DSPAC	DKIST Science Policy Advisory Committee
DSSC	DKIST Science Support Center (Maui, Hawaiʻi)
DST	Dunn Solar Telescope
DWDM	Dense Wavelength Division and Multiplexing
EA	Environmental Assessment
EA	Experiment Architect
EAST	European Association for Solar Telescopes
EF	Evershed Flow
EGSO	European Grid of Solar Observations
EGU	European Geosciences Union
EIC	Equity and Inclusion Council (AURA)
EIS	Extreme-ultraviolet Imaging Spectrometer (*Hinode*, NASA)
EIS	Environmental Impact Statement
EIT	Extreme ultraviolet Imaging Telescope (SOHO)
EMR	Experience Modifier Rate (OSHA)
EPA	Environmental Protection Agency
EPD	Energetic Particle Detector
EPO/C	Education, Public Outreach & Communication (NSO)

ESA	European Space Agency
ESF	Evans Solar Facility
ESO	European Southern Observatory
EST	European Solar Telescope
EU	European Union
EUI	Extreme Ultraviolet Imager (Solar Orbiter)
EUV	Extreme Ultraviolet
EVMS	Earned Value Management System (DKIST)
FAA	Federal Aviation Administration
FAT	Factory Acceptance Test
FCR	Final Construction Review
FDP	Full-Disk Patrol (SOLIS)
FDR	Final Design Review
FEIS	Final Environmental Impact Statement
FIDO	Facility Instrument Distribution Optics (DKIST)
FIP	First Ionization Potential
FIRS	Facility Infrared Spectropolarimeter
FMS	Flexible Manufacturing System
FLC	Ferroelectric Liquid Crystal
FLI	First Light Initiative
FOCS	Feed Optics Control Software
FOV	Field of View
FPGA	Field Programmable Gate Array
FSR	Free Spectral Range
FTE	Flux Tube Expansion

FTEs	Full Time Equivalents
FTS	Facility Thermal Systems (DKIST)
FTS	Fourier Transform Spectrometer (McMP)
FY	Fiscal Year
GAM	Gravity Assist Maneuvers
GB	Giga Bytes
GBPs	G-band Bright Points
GBSON	Ground-Based Solar Observing Network
GEH	George Ellery Hale (University of Colorado, Boulder)
GIS	Global Interlock System
GISS	Global Interlock System Software
GNAT	Global Network of Astronomical Telescopes, Inc. (Tucson, Arizona)
GOES	Geostationary Operational Environmental Satellites (NASA and NOAA)
GOME-2	Global Ozone Monitoring Experiment–2
GONG	Global Oscillation Network Group
GOS	Gregorian Optical System (DKIST)
GPS	Global Positioning System
GRIS	GREGOR Infrared Spectrograph (GREGOR Telescope)
GSFC	Goddard Space Flight Center (NASA)
GST	Goode Solar Telescope (Big Bear Solar Observatory, California)
GUI	Graphical User Interface
HAO	High Altitude Observatory
HASO	Historical Archive of Sunspot Observations
HAZEL	HAnle and ZEeman Light
HCP	Habitat Conservation Plan (Hawai‘i State Division of Forestry & Wildlife)

HCS	Heliospheric Current Sheet
HIDEE	Heliophysics Infrastructure and Data Environment Enhancements (NASA)
HIPPO	CMMS Software (DKIST)
HIS	Heavy Ion Sensor
HLS	High-Level Software
HMI	Helioseismic and Magnetic Imager
HNP	Haleakalā National Park (Hawai‘i)
HO	Haleakalā Observatory (Hawai‘i)
HOAO	High-Order Adaptive Optics
HPCF	High Performance Computing Facility (University of Colorado, Boulder)
HQ	Headquarters
HR	Human Resources
HSG	Horizontal Spectrograph
HST	Hubble Space Telescope
HXR	Hard X-Ray
IAA	Instituto de Astrofísica de Andalucía (Spain)
IAA	Interagency Agreement (US Government)
IAC	Instituto de Astrofísica de Canarias (Spain)
IAU	International Astronomical Union
IBIS	Interferometric BIdimensional Spectrometer (Arcetri Observatory)
ICD	Interface Control Document
ICM	Inversion by Central Moments
ICME	Interplanetary Coronal Mass Ejections
ICS	Instrument Control System
IDF	Intermediate Distribution Frame

IDL	Interactive Data Language
IEF	Inverse Evershed Flow
IfA	Institute for Astronomy (University of Hawai‘i)
IFU	Integrated Field Unit (McMath-Pierce Solar Telescope Facility)
IGNITION	Human-Machine Interface (DKIST)
IHY	International Heliophysical Year
IMAP	Interstellar Mapping and Acceleration Probe (NASA)
IMaX	Imaging Magnetograph eXperiment (SUNRISE)
IMF	Interplanetary Mean Field
INAF	Istituto Nazionale di Astrofisica (National Institute for Astrophysics, Italy)
IPC	Integration Progression Criteria (DKIST)
IPS	Integrated Project Schedule (DKIST)
IR	Infrared
IRES	International Research Experience for Students (NSF)
IRIS	Interface Region Imaging Spectrograph
IRIS SMEX	Interface Region Imaging Spectrograph Small Explorer Mission (NASA)
ISEE	Institute for Scientist and Engineer Educators (UCSC)
ISIS	Integrated Science Investigation of the Sun (Parker Solar Probe)
ISOON	Improved Solar Observing Optical Network
ISP	Integrated Synoptic Program (NSO)
ISRD	Instrument Science Requirement Document
ISS	Integrated Sunlight Spectrometer (SOLIS)
ISWAT	International Space Weather Action Teams (COSPAR)
IT	Information Technology
ITAR	International Traffic in Arms Regulations

ITF	Infrared Tunable Filter
ITAR	International Traffic in Arms Regulations
IT&C	Integration, Testing, & Commissioning
IWS	Individual Wastewater System (DKIST)
JCI	Johnson Controls
JPL	Jet Propulsion Laboratory (NASA)
JSOC	Joint Science Operations Center (SDO)
JTTS	Journey to the Sun (NSO Teacher Workshop and Telescope Program)
KAOS	Kiepenheuer Adaptive Optics System
KCE	KC Environmental (Maui, Hawai‘i)
KIS	Kiepenheuer Institute for Solar Physics (Freiburg, Germany)
KPI	Key Performance Indicators (DKIST)
KPNO	Kitt Peak National Observatory
KPVC	Kitt Peak Visitor Center
KPVT	Kitt Peak Vacuum Telescope
KS	Kamehameha Schools (Maui, Hawai‘i)
KTH	KTH Royal Institute of Technology, Stockholm, Sweden
LAPLACE	Life and PLAnets Center (University of Arizona)
LASCO	Large Angle and Spectrometric Coronagraph (NASA/ESA SOHO)
LASP	Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)
LAT	Lab Acceptance Test
LCROSS	Lunar CRater Observation and Sensing Satellite
LCVR	Liquid-Crystal Variable Retarder
LE	Learmonth (GONG site) VIC, Australia
LESIA	Laboratoire d'études patiales et d'instrumentation en astrophysique (Paris Observatory)

LFM	Large Facilities Manual (NSF)
LIC	Local Interlock Controller
LMSAL	Lockheed Martin Solar and Astrophysics Laboratory
LoHCo	Local Helioseismolgy Comparison Group
Loki	End to End Simulator System (NSO)
LOS	Line Of Sight
LOTO	Lock-out Tag-out
LRP	Long-Range Plan
LTE	Local Thermodynamic Equilibrium
LWS	Living With a Star
M1CA	Primary Mirror Cell Assembly (DKIST)
MAG	Magnetometer
MagEX	Magnetic Explorer (LASP CU-Boulder Mission)
MBP	Magnetic Bright Point
McMP	McMath-Pierce
MCAO	Multi-Conjugate Adaptive Optics
MCC	Maui Community College (Hawai‘i)
MDI	Michelson Doppler Imager (SOHO)
ME	Milne-Eddington
MEDB	Maui Economic Development Board
METIS	Coronagraph (onboard Solar Orbiter)
MF	Management Fee
MHD	Magnetohydrodynamic
MKAOC	Mauna Kea Astronomy Outreach Committee (Hawai‘i)
MKIR	Mauna Kea Infrared

ML	Mauna Loa (GONG site) (Hawai‘i)
MOU	Memorandum of Understanding
MLSO	Mauna Loa Solar Observatory (HAO) (Hawai‘i)
MOI	Memorandum of Intent
MPI	Message Passing Interface
MPR	Midterm Progress Review
MPW	Manual Processing Worker
MR	Management Reserve
MREFC	Major Research Equipment Facilities Construction (NSF)
MRI	Major Research Instrumentation (NSF)
MSAC	Math and Science Advisory Council (State of New Mexico)
MSFC	Marshall Space Flight Center (NASA)
MSIP	Mid-Scale Instrumentation Program (NSF)
MSRI-1	Mid-Scale Research Infrastructure-1 (NSF)
MWIR	Mid-Wave Infrared
MWO	Mt. Wilson Observatory (California)
NAC	NSO Array Camera
NAI	NASA Astrobiology Institute
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NASM	National Air and Space Museum
NCAR	National Center for Atmospheric Research
NCOA	National Center for Optical-Infrared Astronomy
NPR	National Public Radio
NPS	National Park Service

NCSP	NSO Community Science Program
NCSP	NSO Coudé Spectro-Polarimeter (DKIST)
NDSC	Network for the Detection of Stratospheric Change
ngGONG	Next Generation Global Oscillation Network Group
NHPA	National Historic Preservation Act
NHWG	Native Hawaiian Working Group
NIR	Near Infrared
NISP	NSO Integrated Synoptic Program
NJIT	New Jersey Institute of Technology
NLFFF	Non-Linear Force-Free Field
NLTE	Non-Local Thermodynamic Equilibrium
NMDOT	New Mexico Department of Transportation
NMSU	New Mexico State University
NOAA	National Oceanic and Atmospheric Administration
NOAO	National Optical Astronomy Observatory
NOIRLab	National Optical-Infrared Astronomy Research Laboratory
NPDES	National Pollutant Discharge Elimination System (EPA/HI Dept of Health)
NPFC	Non-Potential Field Calculation
NPR	National Public Radio
NPS	National Park Service
NRAO	National Radio Astronomy Observatory
NRC	National Research Council
NREL	National Renewable Energy Laboratory
NSBP	National Society of Black Physicists
NSF	National Science Foundation

NSF/AST	National Science Foundation, Division of Astronomical Sciences
NSF/ATM	National Science Foundation, Division of Atmospheric Sciences
NSHP	National Society of Hispanic Physicsts
NSO	National Solar Observatory
NSOC	NMSU Sunspot Observatory Committee
NSO/SP	National Solar Observatory Sacramento Peak (New Mexico)
NSO/T	National Solar Observatory Tucson (Arizona)
NSSL	Near-Surface Shear Layer
NST	New Solar Telescope (NJIT Big Bear Solar Observatory)
NSTC	National Science Technology Council
NTT	New Technology Telescope (ESO)
NWNH	New World New Horizons (Astro2010: Astronomy & Astrophysics Decadal Survey)
NWRA/CoRA	NorthWest Research Associates/Colorado Research Associates
O&M	Operations and Maintenance
OCD	Operational Concepts Definition (DKIST)
OCC	Operations Commissioning Call (DKIST)
OCM	Operations Commissioning Module
OCP	Operations Commissioning Phase (DKIST)
OCP1	Phase 1 - Operations Commissioning Phase (DKIST)
OCP1	Phase 2 - Operations Commissioning Phase (DKIST)
OCS	Observatory Control System (DKIST)
OEO	Office of Education and Outreach (NSO)
OFCM	Office of the Federal Coordinator for Meteorology
OLPA	Office of Legislative & Public Affairs (NSF)
OMI	Ozone Monitoring Instrument

OMB	Office of Management and Budget
OP	Observing Program
OPMT	Operations Planning & Monitoring Tool
OSHA	Occupational Safety and Health Administration
OSIRIS	Observing System Including PolaRisation in the Solar Infrared Spectrum
O-SPAN	Optical Solar Patrol Network (formerly ISOON)
OSTP	Office of Science and Technology Policy (US Office of the President)
PA	Programmatic Agreement (State Historic Preservation Office/Federal Historic Preservation Office)
PA	Proposal Architect
PAARE	Partnerships in Astronomy & Astrophysics Research & Education (NSF)
PA&C	Polarization Analysis & Calibration
PAEO	Public Affairs and Educational Outreach (NOAO)
PB	Peta Bytes
PBR	President's Budget Request
PARI	Pisgah Astronomical Research Institute
PCA	Principal Component Analysis
PDR	Preliminary Design Review
PEP	Project Execution Plan
PFSS	Potential Field Source Surface
PhET	Physics Education Technology (University of Colorado, Boulder)
PHI	Polarimetric and Helioseismic Imager (Solar Orbiter)
PI	Principal Investigator
PLA	Project Labor Agreements
PLC	Programmable Logic Controller

PM	Project (or Program) Manager (NSO)
PM	Preventive Maintenance
PM	Planned Maintenance
PMCS	Project Management Control System
PRC	Portfolio Review Committee (NSF)
PRD	Partial Frequency Redistribution
PRI	Public Radio International
ProMag	PROminence Magnetometer (HAO)
PROSWIFT	Promoting Research and Observations of Space Weather to Improve the Forecasting of Tomorrow (US Senate Act S881)
PSP	Parker Solar Probe
PSPT	Precision Solar Photometric Telescope
QA/QC	Quality Assurance/Quality Control
QAS	Quality Assurance System
QBP	Quasi-Biennial Periodicity
QL	Quick-Look
QSA	Quasi-Static Alignment
QU	Queen’s University (Belfast, Ireland, UK)
QWIP	Quantum Well Infrared Photodetector
RA	Resident Astronomer
RASL	Research in Active Solar Longitudes
RDSA	Reference Design Studies and Analyses
RET	Research Experiences for Teachers
REU	Research Experiences for Undergraduates
RFP	Request for Proposal

RHESSI	Reuven *Ramaty High Energy Solar Spectroscopic Imager (NASA)*
RIG	Research Infrastructure Guide
RISE/PSPT	Radiative Inputs from Sun to Earth/Precision Solar Photometric Telescope
rMHD	Radioactive Magnetohydrodynamic
RMS	Root-Mean-Square
ROB	Remote Office Building
ROD	Record of Decision
ROI	Region of Interest
ROIC	Return on Investment Capital
ROSA	Rapid Oscillations in the Solar Atmosphere
RPW	Radio and Plasma Wave
RTC	Real-Time Control (DKIST)
SACNAS	Society for the Advancement of Chicanos and Native Americans in Science
SAMNet	Solar Activity Monitor Network
SAN	Storage Area Network
SASSA	Spatially Averaged Signed Shear Angle
SAT	Sight Acceptance Testing
SCB	Sequential Chromospheric Brightening
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Chartography
SciOps	Science Operations (DKIST)
SCM	Small Complete Mission (NASA)
SCOPE	Southwest Consortium of Observatories for Public Education
SDO	Solar Dynamics Observatory (NASA)
SDR	Solar Differential Rotation
SED	Stellar Energy Distribution

SSERVI	Solar System Exploration Research Virtual Institute (NASA)
SFC	Space Flight Center (NASA)
SFR	Supplemental Funding Request
SFT	Surface Flux Transport
SH	Spherical Harmonic
SI	Strategic Initiative
SIM	System Integration Module (DKIST)
SM	Service Manager (NSO Data Center)
SMEX	Small Explorer (IRIS)
SMO	Service-Mode Observing (DKIST)
SNA	Surface Normal Actuator
SNR	Signal-to-Noise Ratio
S&O	Support and Operations (DKIST)
SOA	Service Oriented Architecture
SOC	Solar Observatory Council (AURA)
SOHO	Solar and Heliospheric Observatory
SOI	Solar Oscillations Investigations (SOHO)
SOLARC	Scatter-free Observatory for Limb Active Regions and Coronae (Univ of Hawai‘i)
SOLIS	Synoptic Optical Long-term Investigations of the Sun
SONG	Stellar Oscillation Network Group
SOP	Science Operations
SORCE	Solar Radiation and Climate Experiment
SOS	Science Operations Specialist (DKIST)
SOT	Solar Optical Telescope
SOT/SP	Solar Optical Telescope Spectro-Polarimeter (*Hinode*, NASA)

SOW	Statement of Work
SPA	Surface Parallel Actuator
SPC	Scientific Personnel Committee (NSO)
SPD	Solar Physics Division (AAS)
SPEs	Solar Proton Events
SPICE	Spectral Imager of the Coronal Environment (Solar Orbiter)
SPIES	SpectroPolarimetric Imager for the Energetic Sun (Dunn Solar Telescope)
SPINOR	Spectro-Polarimeter for Infrared and Optical Regions
SPRING	Solar Physics Research Integrated Network Group (European Union)
SPSC	Space Science Center (University of Colorado, Boulder)
SRA	Summer Research Assistant
SRC	Science Review Committee
SRD	Science Requirements Document
SREC	Southern Rockies Education Centers
SSA SWE	Space Situational Awareness – Space Weather Segment (European Space Agency)
SSEB	Source Selection Evaluation Board (Federal Government)
SSL	Space Sciences Laboratory (University of California, Berkeley)
SSOC	Sunspot Solar Observatory Consortium
SSP	Source Selection Plan (DKIST)
SST	Swedish Solar Telescope
SSWG	Site Survey Working Group (DKIST)
STARA	Sunspot Tracking and Recognition Algorithm
STEAM	Science, Technology, Education, Arts, and Mathematics
STEM	Science, Technology, Engineering and Mathematics
STEP	Summer Teacher Enrichment Program

STEREO	Solar TErrestrial RElations Observatory (NASA Mission)
STIC	Stockholm *Inversion* Code
STS	Science for a Technological Society (2013 Solar and Space Science Decadal Survey)
SUC	Science Use Case
SUCR	Summit Control Room (DKIST)
SUMI	Solar Ultraviolet Magnetograph Investigation (NASA, MSFC)
SUP	Special Use Permit
SuperCATE	Spectrograph experiment (NSO)
SV	Science Verification
SVP	Science Verification Phase
SW	Solar Wind
SWA	Solar Wind Analyzer
SWEAP	Solar Wind Electrons Alphas and Protons (Parker Solar Probe)
SWG	Science Working Group (DKIST)
SWIR	Short-wave Infrared
SWMF	Space Weather Modeling Framework
SWORM	Space Weather Operations, Research and Mitigation (NTSC)
SWPC	Space Weather Prediction Center (NOAA)
SwRI	Southwest Research Institute
SWx-*TREC*	*Space Weather* Technology, Research and Education Center (University of Colorado, Boulder)
SXR	Soft X-Ray
TAC	Telescope Time Allocation Committee
TB	Tera Bytes
TBD	To Be Determined

TCS	Telescope Control System
TD	El Teide (GONG site) (Canary Islands, Spain)
TechOps	Technical Operations (DKIST)
TED	Technology, Entertainment, Design (YouTube)
TEOA	Top End Optical Assembly (DKIST)
TI	Tenant Improvement
TMA	Telescope Mount Assembly
ToO	Target of Opportunity
TOP	Technical Operations
TPC	Total Project Cost
TRC	Technical Review Committee
TRACE	Transition Region and Coronal Explorer
TRC	Technical Review Committee
UA	University of Arizona
UC	User’s Committee (NSO)
UD	Udaipur (GONG site) (Rajasthan, India)
UH	University of Hawai‘i
UBF	Universal Birefringent Filter
UCSC	University of California, Santa Cruz
UK	United Kingdom
UPS	Uninterruptible Power Supply
UROP	Undergraduate Research Opportunities Program
USAF	United States Air Force
USF&WS	US Fish and Wildlife Service
USNO	United States Naval Observatory

UT	User's Tool
UV	UltraViolet
UVCS	UltraViolet Coronagraph Spectrometer (SOHO)
VBI	Visible-light Broadband Imager (DKIST)
VCCS	Virtual Camera Control System (Dunn Solar Telescope)
VFD	Variable Frequency Drive
VFISV	Very Fast Inversion of the Stokes Vector (Inversion Code, HMI)
ViSP	Visible Spectropolarimeter (DKIST)
VLA	Very Large Array
VSM	Vector SpectroMagnetograph (SOLIS)
VSO	Virtual Solar Observatory
VTF	Visible Tunable Filter (DKIST)
VTT	Vacuum Tower Telescope (Tenerife, Spain)
WBS	Work Breakdown Structure
WCCS	Wavefront Correction Control System
WDC	Workforce and Diversity Committee (AURA)
WFC	Wavefront Correction (DKIST)
WFS	Wavefront Sensor (DKIST)
WHI	Whole Heliospheric Interval
WHPI	Whole Heliosphere and Planetary Interactions
WISPR	Wide-Field Imager (Parker Solar Probe)
WIT	Women In Technology (MEDB)
WoU-MMA	Windows on the Universe Multi-Messenger Astrophysics (NSF Program)
WOW	World of Work (Patsy T. Mink Summit, Hawai‘i)
WSA	Wang-Sheeley-Arge (Solar Wind Model)

WSDL	Web Service Description Language
WSHFH	White Sands Habitat for Humanity
WWW	World Wide Web