Issue 17 — Summer 2014

Director's Introduction

Hilton Lewis, Interim Director, WMKO

Welcome to our Summer 2014 Newsletter for observers and prospective observers of the W. M. Keck Observatory (WMKO). Allow me to provide an overview of the main events and changes of the past quarter. More specific updates are to be found in the contributions that follow.

First I'd like to mark the transition of previous Director Dr. Taft Armandroff, who has left WMKO to become the Director of McDonald Observatory at the University of Texas, Austin. Taft departed in mid-May, and I have assumed the role of Interim Director until such time as a new director is in place. The WMKO Board is conducting an international search and intends to name the new director in September of this year. Fortunately we have a highly experienced and capable management team in place, able to provide full continuity of service in operations and in the development of new capabilities for the observatory. Users can continue to expect the same high level of performance and service to which they are accustomed.

We periodically hold a meeting to update the Scientific Strategic Plan of the observatory, with the last meeting being held in 2010. Since that time, there have been a number of significant developments, particularly in the advent of, or plans for, major new observational capabilities. It is both timely and necessary to update our Scientific Strategic Plan. We will conduct our next meeting on September 29–30 this year. The theme of the meeting is "Keck in the era of other facilities: GAIA, ALMA, JWST, LSST as well as highly specialized facilities such as Subaru". We will address the following broad themes:

- Surveys and time domain astronomy
- Synergy with current and future large telescopes
- Complementarity with future space missions, in particular JWST
- The future of adaptive optics at WMKO

It is clear that WMKO has become a national and to some extent international facility. Consequently we have invited a mix of community and representative external participants to the meeting. The meeting organizers are Shri Kulkarni (Caltech Optical Observatories Director), Claire Max (University of California Observatories Interim Director), and myself.

Immediately following the Strategic Planning meeting is the annual Keck Science Meeting, October 2–3. This year the meeting will be held at Caltech, and is being organized by Professor Chris Martin. The meeting will feature nine hours of science talks over one-and-a-half days. We also plan to hold a halfday Town Hall to summarize the results of the Strategic Planning Meeting and to provide an opportunity for additional community input. Details of the meeting and how to submit abstracts for talks and posters are available at: http://www.astro.caltech.edu/observatories/coo/cooEvents/2014KecSciMtg/KSM2014.html. We look forward to your active participation at what has always been an exciting and informative event!

There have been several important developments in major new capabilities at the observatory. Work has continued apace on two adaptive optics upgrades scheduled for shared risk science later this year: the Keck II Center Launch Telescope, and the Keck I near-IR Tip/Tilt Sensor system. The final commissioning of both systems has been delayed by poor winter weather, but we are confident that we are close to completion on both. We look forward to adding these long-awaited improvements to our observing capability.

In April this year we held a full management review of the critical primary mirror segment repair project. The panel of external experts concluded that the project was appropriately planned and managed, and gave the green light to proceed. An important aspect of the plan is to minimize the impact on routine observing. We may slightly alter the cadence of segment exchange to keep the repair pipeline proceeding optimally, but this should not result in any additional lost observing time. We are now focused on preparing the lab areas, tooling and metrology for the program. All the hardware and repair processes will be evaluated on a fully sized test blank, prior to running a first 'pathfinder' segment through the full process. Stay tuned for future reports on this crucial project.

Two new capabilities, KCWI-Blue and the upgraded replacement laser for Keck II, are both proceeding well. KCWI-Blue is an optical integral-field spectrograph being developed at Caltech; first light is slated for August 2015.

Our advanced fiber laser system for Keck II is being developed by Toptica in Germany, in a joint procurement between ESO and WMKO. The first of the fiber laser systems has been delivered to ESO headquarters for testing. We expect ours to be delivered to the observatory in October this year, with first scheduled science use in semester 2016A. This is paced by the need to not interrupt key science programs in 2015.

Work has begun in earnest on the development of the Keck I deployable tertiary at UC Santa Cruz, and a preliminary design review is planned for later this year. The deployable tertiary will give us the capability to rapidly switch at night between instruments at the Nasmyth foci (OSIRIS and HIRES) and Cassegrain (LRIS or MOSFIRE, depending on which is installed), significantly increasing our flexibility. Discussions on the effective and efficient use of this capability will be held at the aforementioned Keck Science Meeting in October.

Rounding out the list of new developments is continued progress on the Telescope Control System Upgrade. The upgrade should be completed on Keck II in 2015A and on Keck I in 2015B. All aspects of the upgrade—the hardware, software and test procedures—have been carefully designed for minimal impact on observing. Indeed some of the first subsystems have already been tested at night during engineering time, with seamless reversion to the current systems.

I am very pleased to announce that the National Science Foundation's Major Research Instrumentation program has funded our proposal to add a red channel to the Keck Cosmic Web Imager (KCWI), currently under development at Caltech. The addition of the red channel restores the original concept of KCWI, and is a significant enhancement of capability. The project team plans to deliver KCWI-Blue to the observatory next year, and KCWI-Red in 2017.

Disappointingly, our proposal to the National Science Foundation's new Mid-Scale Instrumentation Program (MSIP) for funding of the Next Generation Adaptive Optics system (NGAO) for WMKO was unsuccessful. The proposal was highly rated, particularly on its science aspects, the technical approach and the experience of the team. However, the total funding available this year by the MSIP program would have been insufficient to fund NGAO. We are now examining the short term plans for future AO upgrades, and as noted earlier we will discuss at the Science Strategic Planning meeting our longer term plans to retain our leadership in adaptive optics.

Keck science productivity remains extraordinarily high. Recently published work by Dennis Crabtree, Acting Director of the Dominion Astrophysical Observatory, analyzing publications from 2008 to 2012 with citations updated in 2014, shows that on a per-telescope basis, Keck generates the highest number of papers, has the greatest impact (as measured by normalized citation rates) and has the highest percentage of high impact papers of all ground-based observatories worldwide. For full details of this interesting paper, I refer you to "A bibliometric analysis of observatory publications for the period 2008-2012", SPIE publication 9149-10, Observatory Operations, Astronomical Telescopes and Instrumentation 2014, which details the comparative study of all major observatories, along with details of trends with time.

We have augmented our collaborative time exchange agreement with the Australian National University (ANU) Research School of Astronomy and Astrophysics (RSAA) by exchanging an additional 20 nights spread evenly over 2016–2017. As with other exchanges, these nights are evenly distributed between the Keck I and Keck II telescopes and over lunar phases. We look forward to the added involvement of our Australian colleagues in the Keck Observatory.

The observatory has agreed to take over the responsibility for maintaining the slitmask design tools for LRIS (Autoslit), DEIMOS (DSimulator) and MOSFIRE (Magma), starting with Autoslit later this year. Our long term plan is to replace all three tools with a single, web-based tool. We are also evaluating the cost of maintenance and distribution of the instrument data pipelines.

We bid farewell to two colleagues at UC Santa Cruz who have contributed greatly to the success of the Keck Observatory. Sandra Faber, co-editor of the Keck "Blue Book" (the original specification for the telescopes), principal investigator for the DEIMOS instrument, Science Steering Committee member, WMKO Board member and former UCO Director has been a major contributor to the success of the observatory since inception in 1985. Harland Epps, instrument optical designer extraordinaire has been responsible for world-leading optical designs used in LRIS-red, LRIS-blue, HIRES, ESI, DEIMOS, MOSFIRE and our next instrument, KCWI. It is an achievement of extraordinary innovation, and has contributed mightily to the great success of our instrumentation suite. We thank both Sandy and Harland for their service to the observatory and wish them all the best in their future endeavors.

Finally, it is a pleasure to congratulate Erik Petigura, Andrew Howard, and Geoff Marcy as the winners of the 2013 Cozzarelli prize in Physical and Mathematical Sciences. The prize is awarded by the Proceedings of the National Academy of Sciences (PNAS) for a small number of papers that reflect scientific excellence and originality. The Cozzarelli Prize Web site includes the paper itself as well as an audio interview with Erik and Geoff. ✶

Keck I TBAD Completed

Paul Stomski, AO/Optics Engineer, WMKO
Randy Campbell, Support Astronomer, WMKO

As reported in the previous volume of this newsletter, the Transponder-Based Aircraft Detection system (TBAD) on Keck II was approved by the FAA for operation without the use of human safety spotters. Soon after the certification of Keck II's TBAD, a unit for Keck I was ordered from the original developers, Bill Coles and Tom Murphy of UCSD (Coles and Murphy, 2012). The new TBAD was installed into the secondary module of Keck I early in 2014. Basic functionality, testing, and performance evaluation occurred during the first half of the year. Although air traffic is sparse over Mauna Kea, enough data were acquired to confirm that the laser safety system (AIRSAFE) with TBAD as the aircraft detection device complies with the FAA adopted standard, SAE Aerospace Standard 6029A (see Stomski 2014). Consequently, both LGSAO systems are now approved by the FAA to operate their lasers without human aircraft spotters.

The scarcity of flights in the vicinity of Mauna Kea presented a challenge for testing TBAD. To help supplement the sparse air traffic, whenever possible the dome was opened in the evening with the telescope pointed at the horizon towards Hilo to detect flights on approach or takeoff at Hilo airport. Additionally, we tested both TBAD units by chartering an aircraft to fly precise passes during daytime (Figure 1). The aircraft was equipped with a logging GPS unit so the data could be analyzed later to characterize the performance of the detection system. Having data from both the normally occurring air traffic and the daytime chartered flights enabled many performance criteria to be measured precisely. These include parameters like the detection range, the detection angle from laser bore-sight, the reaction time, etc. These tests were done over a wide range of conditions and in all cases TBAD showed excellent performance, establishing full compliance with the SAE standard.

Figure 1. Flight tests were accomplished using a chartered aircraft (upper left of the photo) flying multiple precise passes in front of the observatory.

In addition to two operational TBAD units (with spares) UCSD also supplied Keck with a device called the Transponder-SIMulator—TSIM—to be used for periodic test and maintenance. TSIM creates a very low power (~ 5 mW) radio signal at 1090 MHz that mimics a distant aircraft's transponder signal. A single patch antenna mounted on the inside dome wall transmits the signal (Figure 2). This is the same kind of patch antenna that TBAD uses as a receiver. With TSIM, the operations team can check that TBAD is working without having to rely on the occasional sporadic detection of an aircraft. Such tests are done periodically and are included in the operations plan as part of the compliance with AS-6029A. Isaac Lum of UH Manoa, a summer intern sponsored by the Akamai Workforce Initiative, performed the TSIM baseline measurements and helped develop the test protocol with a TSIM prototype in the summer of 2013.

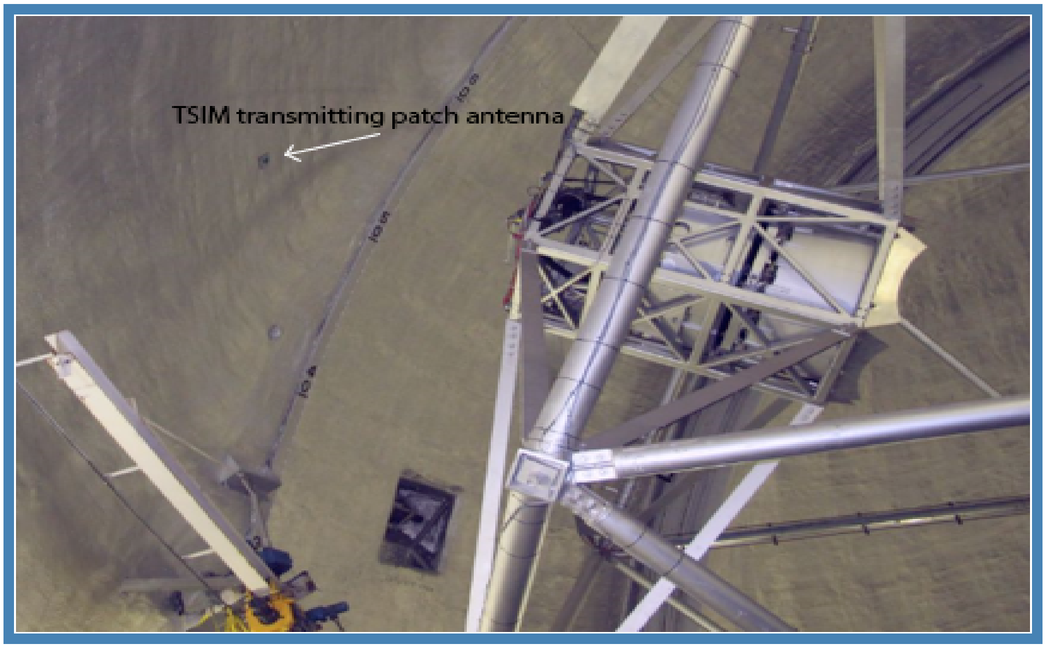

Figure 2. The Keck II telescope pointed towards a device on the dome called the Transponder-SIMulator, TSIM, that is used for periodic test and maintenance of TBAD. TBAD itself is mounted on the top end of the secondary module.

The success of the pioneering Keck/UCSD collaboration in winning the approval of TBAD for use instead of human spotters has motivated other observatories operating lasers to follow suit. Both Subaru and Gemini supported the Keck development and are currently procuring their own units. These efforts are coordinated through meetings of the Mauna Kea Laser Operations Group (MLOG). Each observatory will need to go through a similar process of testing their entire safety system that includes TBAD to show compliance with AS-6029A. Observatories beyond Mauna Kea are also interested in using TBAD and each of these sites will need to show that TBAD is effective for their particular air traffic situation, which may be quite different from the traffic over Mauna Kea. ✶

DEIMOS Grating, Computer Upgrades Aim To Improve Performance And Reliability

Greg Wirth, Support Astronomer, WMKO

The Keck Observatory is partnering with the technical staff at the University of California Observatories (UCO) to address several longstanding problems affecting DEIMOS operations. By repairing the grating system, upgrading the computer system, and troubleshooting the rotator system, we hope to restore Keck II's most-used instrument to working as well as or better than it ever has in its 12 years of service to the Keck observing community.

When we assess instrument performance a key metric is the fraction of usable sky time that is lost to instrument faults; our goal is to limit such time loss to 3% or less. With a typical time loss of 1%–2% over the last several years, DEIMOS has generally performed well by this standard. However, in 2013 instrument problem rose to 2.5% and prompted us to take a closer look at the causes of the time loss and possible solutions.

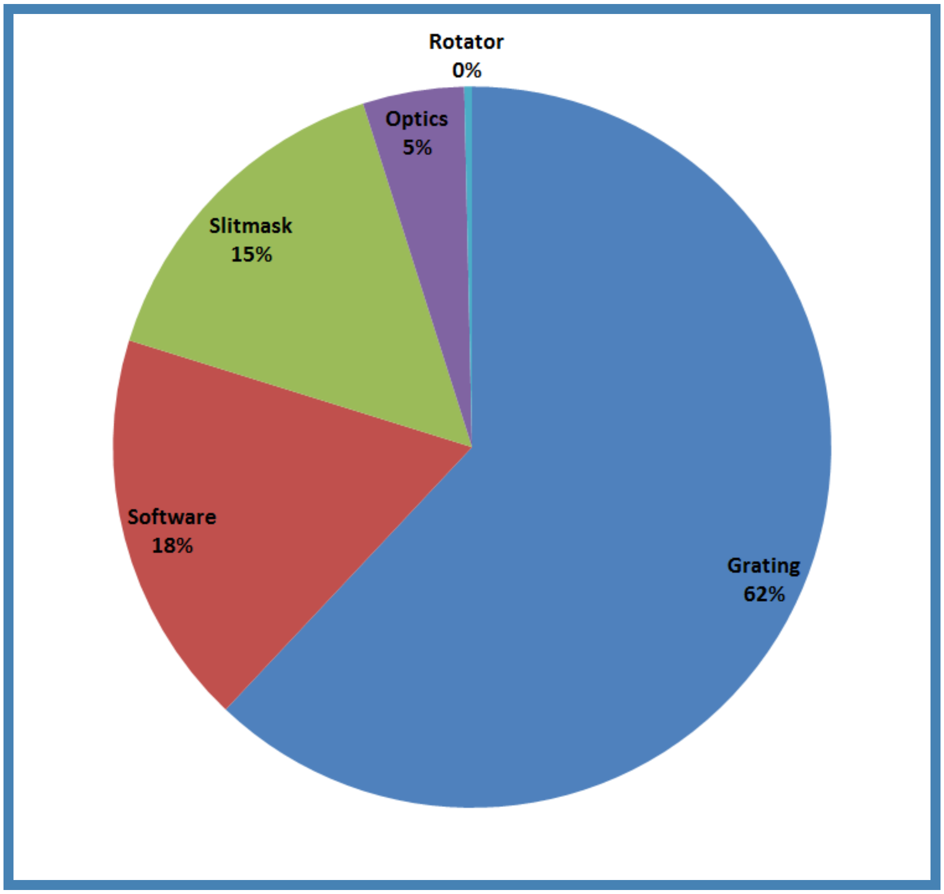

Figure 3. Fraction of usable time lost to instrument faults during DEIMOS nights in 2013.

This analysis (Figure 3) shows that nearly all of the time loss could be attributed to three sources: the grating system, slitmask system, and DEIMOS instrument software. The slitmask system problems had already been addressed—and essentially eliminated—through intensive troubleshooting by our summit instrument staff during 2013. This left the grating and software systems as the principal sources of lost time.

The DEIMOS grating system exhibits two primary symptoms. First, the grating system has unacceptably large flexure when the grating is clamped up at certain instrument rotator positions. The cause of this flexure is unclear, but could result from screws and bolts deep within the grating mechanisms having loosened over time. Our present workaround requires the observer to rotate DEIMOS to specific rotator positions whenever changing gratings. Although effective, this results in several minutes of lost time for each grating change.

The second problem is that the grating tilt mechanism will sometimes fail to move to the demanded position, putting the spectrum or image at the incorrect location. This generally causes the Flexure Compensation System software to fail, since the size of the offset (often hundreds of pixels) generally exceeds the capture range of the software (currently limited to 100 pixels). We have deployed tools and procedures that allow observers to correct the grating position within a few minutes, but lost time still results.

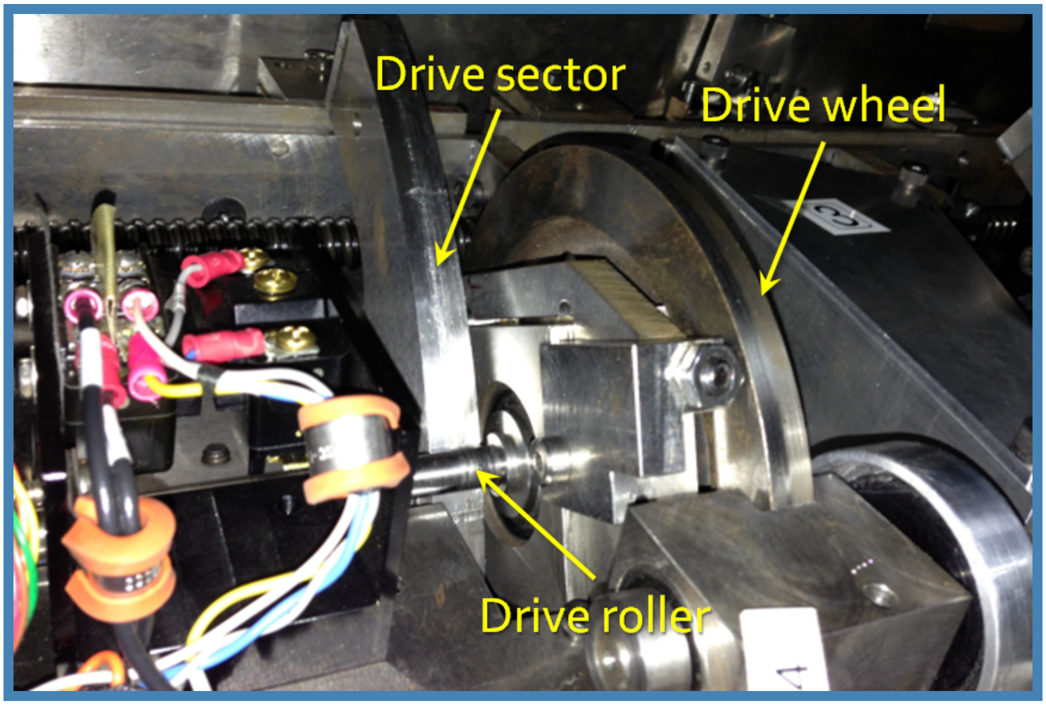

Figure 4. Close-up view of the grating tilt mechanism. The metal-on-metal contacts between the drive roller and drive sector show significant signs of wear, as does the drive wheel.

Close inspection of the slitmask system revealed evidence of significant wear on several of the parts involved in the grating tilt mechanism (Figure 4). After consultation with UCO staff, we decided that a major disassembly of both DEIMOS grating stations to replace these worn parts and tighten all connectors was in the best long-term interest of the instrument. Replacing these components involves dismantling and rebuilding the grating system, a task that requires time, care, and the assistance of the lone remaining member of the original instrument development team. We will remove DEIMOS from service for one lunation to provide up to six weeks for these repairs choosing a time when DEIMOS typically has low science demand. The servicing mission will begin in early January 2015, with a goal of returning it to service for the dark run beginning in mid-February 2015. This major servicing mission should significantly reduce the excessive flexure in the grating system and help the grating tilt to position reliably. As a bonus, we will receive spares for the worn parts that can be used in a future servicing mission, if needed.

DEIMOS computer systems and software are the second area we hope to address this year. Aging computer hardware gets expensive to maintain, and upgrading the hardware is an opportunity to ensure that all software is properly maintained and can be rebuilt. As a first step toward replacement of the two computers that control DEIMOS, we will partner with UCO's Scientific Programming Group to review the existing DEIMOS software codebase on the primary instrument host computer, ensure that all components are properly checked into a version control system, and then rebuild the software from the repository onto a new host computer that will replace the aging system currently in use. Future work will involve replacing the DEIMOS secondary host and the rotator control computer to eliminate those obsolete components.

The DEIMOS rotator system represents a third area of concern which currently is not contributing to nighttime faults. The rotator system has been experiencing regular daytime software crashes when the summit staff members rotate DEIMOS via its on-board controls rather than under computer control. Replacing the rotator's computer has not solved the problem, so we are continuing to investigate other components in the control loop to identify the source of the problem.

These servicing efforts, the first major repairs on DEIMOS since it entered service in 2002, should allow DEIMOS to continue to serve the Keck observing community reliably for another decade or more. ✶

All Eyes on the Galactic Center

Greg Doppmann, Support Astronomer, WMKO

Last spring the night sky over Mauna Kea displayed a breathtaking view of multiple laser beams all pointing toward the center of the Milky Way (Fig. 5). Dual sodium laser beams at 589 nanometers propagating from the twin Keck domes on May 20th were joined by ones from Gemini and Subaru. This event marked the first time that all four of Mauna Kea's laser guide star-equipped telescopes were operating their lasers simultaneously as they studied the exotic environment of our Galactic Center.

Figure 5. Keck II, Keck I, and Subaru (left to right) and Gemini (off the image to the left of Keck II) pointing their lasers at the Galactic Center. Photo Credit: Jason Chu, Institute for Astronomy, University of Hawaii.

Using OSIRIS on Keck I and NIRC2 on Keck II, a team of UCLA astronomers led by Andrea Ghez has been carefully measuring the motions of the central stars and gas that are hurling around the Galaxy's supermassive black hole residing at its center. Keck's dual LGS systems have enabled this groundbreaking research to characterize the properties of the nearest supermassive black hole and test general relativity in a previously unexplored regime. ✶

Aloha Barbara Schaefer!

Jim Lyke, Support Astronomer, WMKO

Figure 6. Barbara Schaefer celebrates the successful completion of another semester's schedule.

As many now know, Keck's Observing Support Coordinator, Barbara Schaefer, is retiring in August. Observers are familiar with Barbara's work: scheduling the telescopes, championing the needs of observers, and supervising the Observing Assistants. She is an expert at segment exchange recovery, which returns the mirror segments to proper alignment and phasing after replacing some of them with freshly coated segments. Her contributions to what was initially called the Ten Meter Telescope started long before there was a Keck Observatory.

As a Large Telescope Operator at Kitt Peak in 1977, Barbara first heard about the ten meter telescope when operating for Jerry Nelson and his graduate student, Gary Chanan. Barbara always wanted to learn more about the telescopes she operated. She moved to the NASA IRTF about a month before science operations began at that telescope. There she learned more about telescopes and, more importantly, about the wonders of Hawaii. All along, she kept in touch with the original TMT project. In 1982, she convinced Jerry Nelson and Terry Mast to hire her. Now in Berkeley, she became the Jill-of-all-trades and learned even more about telescopes. At the start, Barbara answered phones, typeset papers, drew diagrams, kept the notes of the Tuesday meetings, and designed the first TMT T-shirt. Soon she was doing quality assurance testing with the mirror glass and testing prototypes: for polishing segment blanks, for cutting off the blank's ears to make the hexagons, for edge sensors, for actuators, etc. Barbara asserts that she could assemble actuators in her sleep and had a few nightmares doing that!

When the project moved to Hawaii for final assembly, Barbara moved too and made Hawaii her home once again. By 1991, as Keck's Lead Observing Assistant, Barbara rotated weekend shifts to test the telescope. The engineers worked all week; Barbara (with Julia Simmons and Teresa Chelmeniak) tested all weekend. After demonstrating control of nine segments, the Keck I telescope officially became the largest telescope in the world.

Barbara has been in her current position since shortly after Keck II began regular operations in 1996, ensuring observers get the high quality of customer service for which Keck is known. She revels in the great discoveries coming out of Keck, and has enjoyed developing relationships with astronomers, watching them ply their craft on the telescopes. Barbara says it best, "The science is amazing, but the people are memorable." ✶

A Message from Barbara

Barbara Schaefer, Observing Support Coordinator, WMKO

Dear Colleagues,

It is with very mixed emotions that I say goodbye to my job here at Keck Observatory. It's been over 32 years since I walked into the Science Office in Berkeley and began working with Jerry Nelson and Terry Mast (and the cast of hundreds) on the design and development of what was to become a truly revolutionary set of telescopes and instruments. Wow! What a journey and what a learning experience!

The best parts of the past few years have definitely been hanging out in the evenings with all of you and the Observing Support crew, watching the photons collecting on the detectors and chatting about the science coming from those photons. Amazing, mind-boggling discoveries—or more mysteries—are the reasons I became interested in following an astronomical career in the first place. The science is fantastic, yes, but so also are the friendships many of you have offered through the years, from my days at Kitt Peak, then the IRTF, and finally Keck. Thank you all for the great science and the wonderful friendships.

Please do keep in touch—I'll be just down the road from the Keck Headquarters, still following the discoveries, interested to hear what answers you find or to just catch up on the latest astro gossip. My new gmail address is BASchaeferPhoto. Let's have coffee or "do lunch" when you are in town! Mahalo for many fantastic years!

A hui hou, malama pono, 'til we meet again, take best care, and sending you much aloha,
Barbara Schaefer ✶

Observing Tips

Terry Stickel, Observing Assistant, WMKO

At W. M. Keck Observatory, Observing Assistants (OAs) and observers all make use of the Multi-function Acquisition Guiding, and Image Quality-monitoring system (MAGIQ) to select targets and identify fields. While both the "OA UI" and the "Observer UI" are clients of the MAGIQ server, the observer's MAGIQ UI contains only a subset of the functionality available from the OA's MAGIQ UI. The MAGIQ home page contains a brief synopsis of useful features, while a 38-page MAGIQ Observer UI Guide contains more detailed information . There are two useful features not mentioned in the online synopsis: the DSS image display and the dropdown magnifier tool (Fig. 6).

MAGIQ's DSS image pane tab is to the immediate right of the camera image tab near the top of the observer's MAGIQ UI. This pane is started by default when the observer's UI is started. The image is loaded when a starlist item is selected with the left mouse button. By default the source of the images is the 2nd Digitized Sky Survey (Red), or DSSR2 (pixel scale 1 arcsec, 422–564 nm bandpass). Using MAGIQ's DSS image has several advantages over DSS images printed on paper, or standalone images displayed on a computer screen.

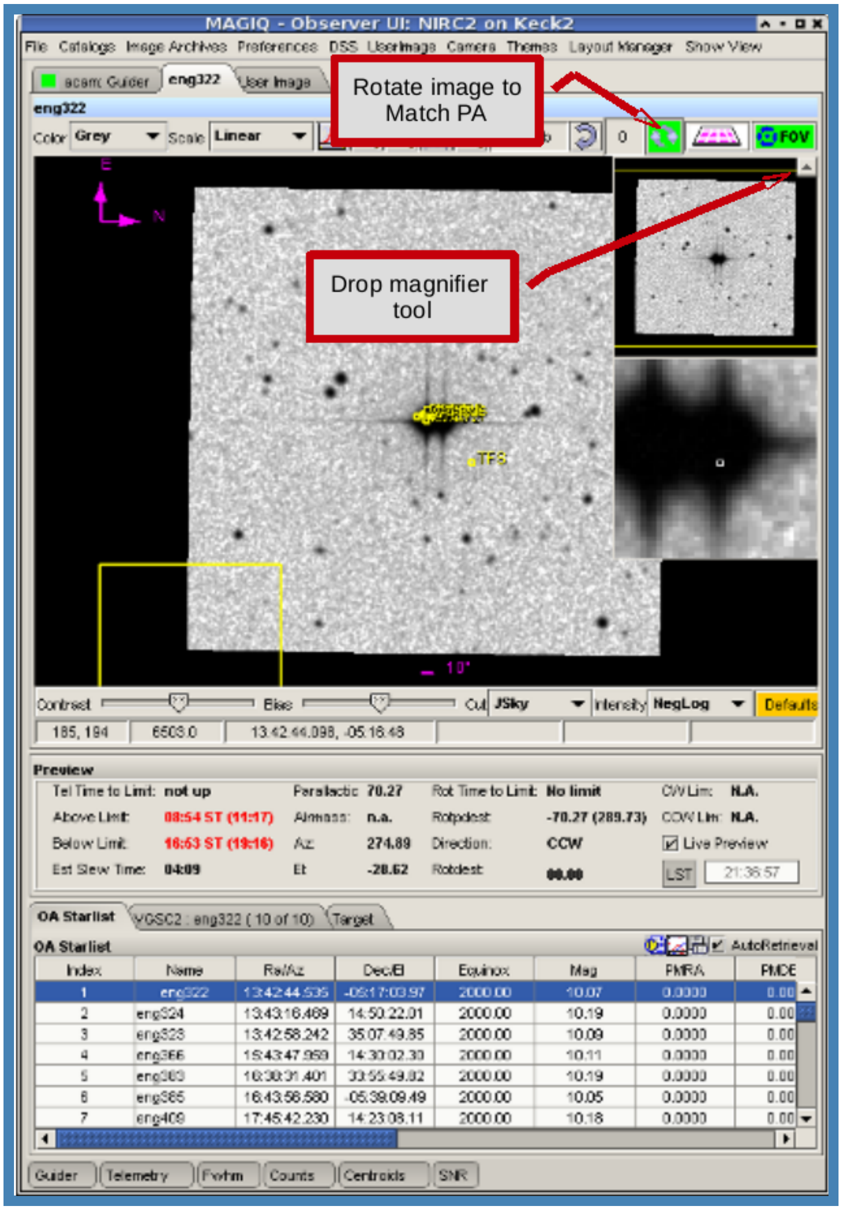

Figure 6. The MAGIQ guider interface, showing how to use DSS images together with guider images to rapidly identify your field.

By left-clicking the FOV button above and to the far right of MAGIQ's DSS image display, small yellow dots on the image will mark the position of the pointing origins for the current instrument (Figure 6). The compass rose to the upper left of the DSS image is available to orient the image with respect to the guider image, and, by left clicking the third button from the right above the image, the DSS image can be rotated to match the current guide camera orientation.

The small magnifying glass icon can be clicked on the guider display and DSS display until their scales match. On a 1280 x 1024 monitor, the image display in the observer UI is a bit over 350 pixels on each side. This significantly undersamples a MAGIQ camera resolution of 1024 x 1024 pixels. The dropdown magnifier tool is available if the precise location of a pixel in the image needs to be determined, or when an observer would like a closer look at a specific region: to check the position of a target on a slit, for example. The "magnify region" tool is accessed by left clicking the down arrow in the small box at the upper right corner of the guider camera image display. When the tool is activated, moving the mouse across the image will display a 4X zoomed region of the image in the lower of the two drop down windows. As long as the mouse is within the image boundaries, the zoomed area will be centered on the mouse pointer and will move with the mouse pointer. It is not possible to lock the zoomed area of the image in place. ✶

Hurricane Iselle Hits The Big Island

Bob Goodrich, Observing Support Manager, WMKO

Hurricane Iselle made landfall on the Big Island on Thursday, August 14. The windward side of the island absorbed the brunt of the storm, with many power lines and large trees downed. The Observatory and its Waimea headquarters fared well, though. We did have some problems, mostly related to electricity, however. We proactively canceled observing Thursday night. On Friday, we lost a Keck I dome motor, probably damaged by unstable power as the power utility struggled with downed systems. While we observed through a fixed dome azimuth on Keck I on Friday, on Saturday night power instability likely triggered a failure of a circuit breaker, costing the entire night on both telescopes.

The Keck staff responded admirably to the challenges, and our observers remained patient as we worked through the problems. Mahalo to everyone involved. ✶

Back Issues

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