Issue 4

Winter 2008

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Director's Introduction

Taft Armandroff

At the W. M. Keck Observatory, our entire team is driven by the observing capabilities and services that we offer to our astronomy community and how these translate into frontline scientific research. At any time, the Observatory and our partners are working on a significant number of projects to enhance the Observatory, from new instruments and adaptive optics systems to updated software to new observing procedures. Informing our community of these new opportunities is important in order allow all to take scientific advantage of these in a timely manner.

Keck Observatory communicates with our community in a variety of ways, from our support astronomers discussing issues with observers in Waimea, to presentations at the Annual Keck Science Meeting, to colloquia at the partner campuses by Observatory staff, to e-mail announcements. One communications tool that has not been used recently is a Newsletter for Observers. With this issue, we are re-launching our Observers Newsletter and giving it renewed energy and purpose.

This re-launch issue contains what we view as important updates for our observing community, such as the recent commissioning of the next-generation wavefront controller for our adaptive optics systems and the much-anticipated atmospheric dispersion compensator for Keck I Cassegrain. We plan to continue with such relevant updates in future Newsletters. We expect to focus on updates of relevance to Keck observers and not to spend much or any space on scientific results, astropolitical developments, or public outreach. Our hypothesis is that by focusing on observers needs that we can make best use of the very limited resources that we have to devote to this Newsletter.

As is evident, the Newsletter is being distributed by e-mail and through the Keck Observatory web site. The Observatory does not have the funds for hardcopy distribution. This re-launch issue is being e-mailed to everyone who has observed at Keck that we have a valid e-mail address for. This includes all of the Keck Observatory communities: University of California, Caltech, NASA, University of Hawaii, TSIP/NOAO, and time exchanges with Gemini and Subaru.

You can easily forward this newsletter, add a subscriber, or delete yourself from the subscription list via the links at the bottom of this newsletter.

Because this is a Newsletter for our observer community, we would love to receive your feedback on whether this is helpful or not. We would also welcome suggestions for information that you would like to see featured. Please contact our crack newsletter editing staff at keck-newsletter@keck.hawaii.edu. «

Next Generation Wave Front Controller (NGWFC)

Randy Campbell

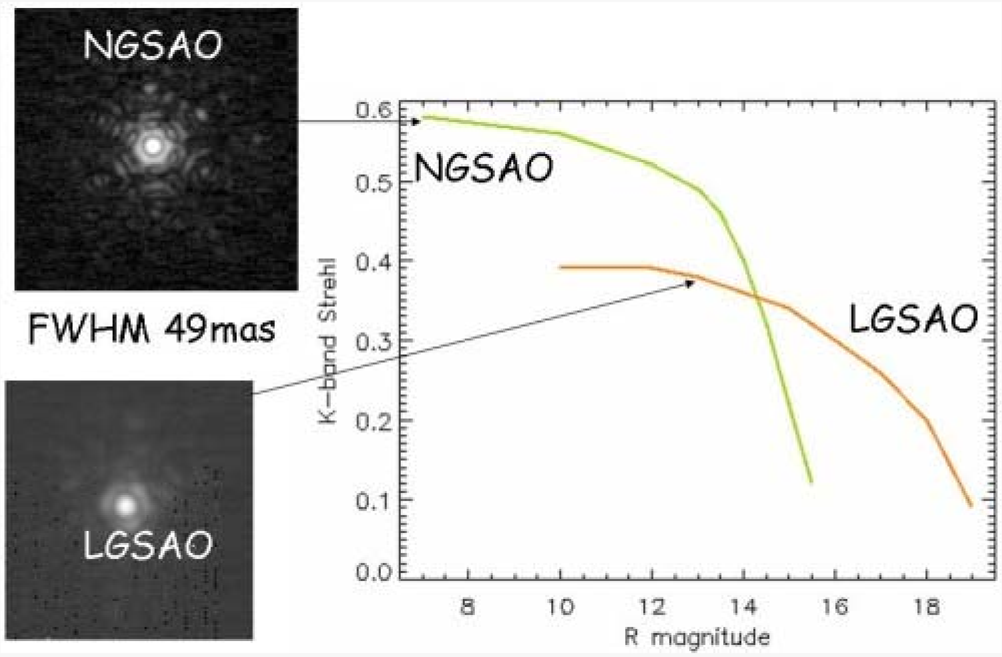
The WMKO AO development group recently completed an upgrade to the Keck AO system wavefront controller. The NGWFC project, which was funded by a Keck Foundation grant, has been very successful in meeting its performance goals and increasing the scientific capability of the Keck AO systems. The new controllers were installed on Keck I in late 2006 and Keck II in early 2007. After some teething pains, the systems are now reliable, efficient, and performing up to specification. The E2V CCD39 in the new SciMeasure wavefront sensor camera provides more sensitivity with lower read noise, dark current, and charge diffusion. The collaboration with Microgate to provide the real time control (RTC) systems worked out very well. The new RTC systems provide significantly more capability, allowing operation at up to 2 kHz. Furthermore, new wavefront sensor lenslets and reducer optics have improved the optical performance and throughput. Keck staff managed the project and developed much of the interface/control software. There was also a significant effort put towards integration, testing, characterizing, and preparing for science operations.

The NGWFC is providing better image quality overall for both LGSAO and NGSAO, although NGSAO is experiencing a larger margin of enhancement. New scientific capabilities include:

- NGSAO with fainter guide stars, an improvement of 1.5 mag. The crossover point at which NGSAO provides better correction then LGSAO has moved to

fainters stars. See the figure below for a comparison of NGS vs. LGS.
- Better performance in marginal seeing for both LGSAO and NGSAO; science is now being achieved on some nights that would have been washed out previously by poor seeing.
- Shorter IR wavelengths of *H* and *J* bands, and possibly *Y* (with the caveat that the *Y* passband may be affected by the cutoff of the dichroic) are now a more viable option for some programs; again true for both NGSAO and LGSAO.

The observatory's website has general information on LGS-AO and performance characteristics of the upgraded system. «



The trade between NGS and LGS has moved to fainter guide stars with the NGWFC. Some LGS programs may now be better with NGS, depending on the brightness and distance between the science target and the natural guide star. PSF examples from NIRC2 at 2.2 microns are included on the left using a 9th mag star for NGS and a 12th mag star for LGS.

Keck I Cassegrain ADC: Looking Sharp from Any Angle

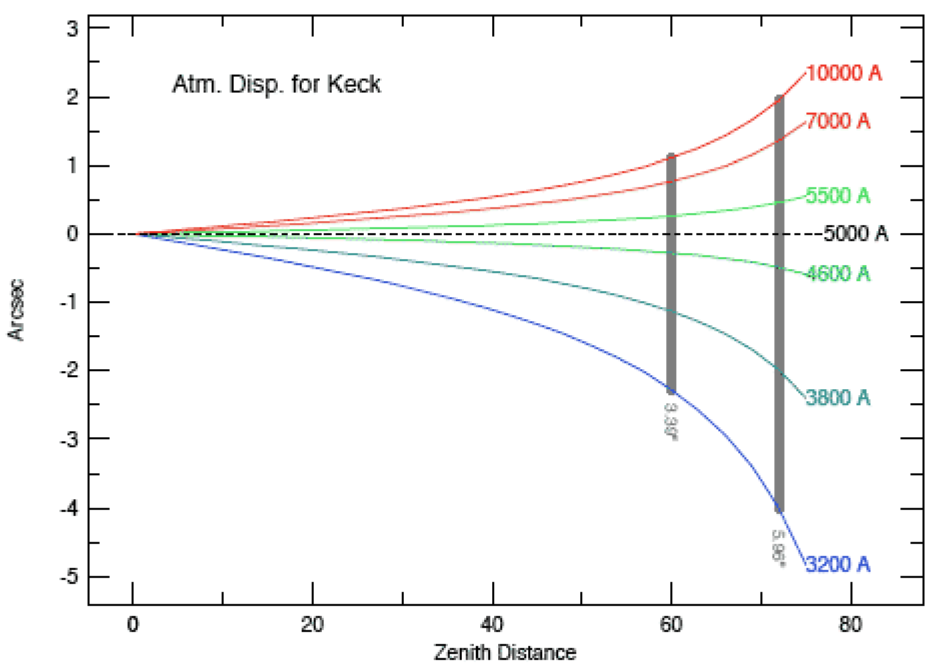
Gregory Wirth

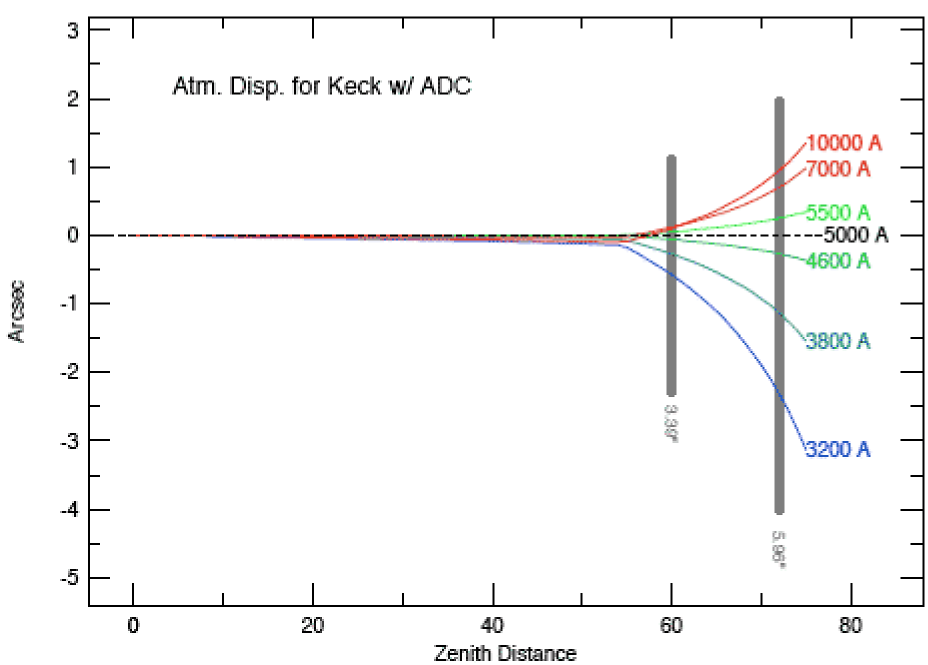
LRIS observers are now employing a new tool which enhances spectral throughput by 20% (on average) and frees them from the constraint of aligning slits to the vertical angle. The Keck I Cassegrain Atmospheric Dispersion Compensator (ADC) module was commissioned late in semester 2007A and is now deployed on nearly all LRIS science nights, providing significant benefits to LRIS observers.

The need for the ADC arises from basic optical principles and was foreseen early in the design of the Observatory. The Earth's atmosphere acts like a prism, refracting the light which passes through it and thus causing the apparent position of objects to deviate from their actual position. The amount of atmospheric refraction depends on two factors:

- Elevation: the dispersion is zero at the zenith but increases quickly at elevations close to the horizon.
- Wavelength: dispersion is small in the red but pronounced in the blue and ultraviolet.

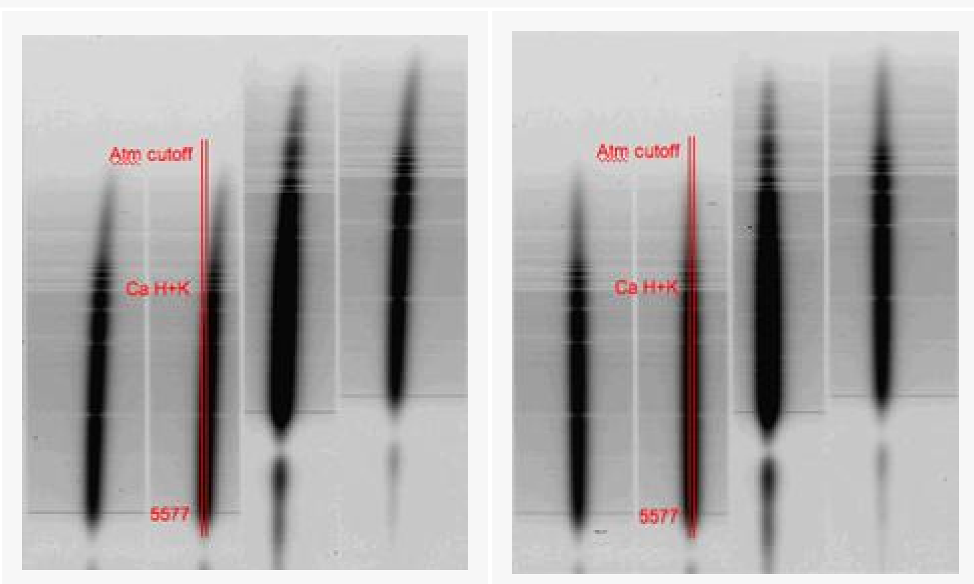
Thus, light from a point source is dispersed into a vertical spectrum. This dispersion is not a significant problem when observing near the zenith or covering only a narrow wavelength range. However, when observing away from zenith and either imaging with broadband filters or acquiring spectra over a broad wavelength range, the effect of differential atmospheric refraction—the difference between the apparent position of the bluest and reddest light being observed—can exceed 3 arcsec, enough to seriously compromise observations. Without correction, images will suffer from poor image quality due to the extended apparent shape of the target, and spectra may lose a substantial amount of light (varying with wavelength) if care is not taken to align the slit with the elevation axis and thus capture all of the light. For this reason, LRIS observers have long been required to plan their observations such that slits, whether longslits or slitlets on masks, are roughly aligned with the parallactic angle, thus placing the slit along the "spectrum" produced by the atmosphere in order to optimize throughput.


Atm. Disp. for Keck
10000 A
7000 A
5500 A
5000 A
4600 A
3800 A
3200 A
Arcsec
Zenith Distance


Atm. Disp. for Keck w/ ADC
10000 A
7000 A
5500 A
5000 A
4600 A
3800 A
3200 A
Arcsec
Zenith Distance

The top panel shows the differential atmospheric dispersion of various wavelengths (relative to 5000 Å) vs. distance from the zenith. The lower panel shows how well the ADC corrects that dispersion. (Graphics courtesy of A. C. Phillips, UCO/Lick Observatory.)

To improve the spectroscopic throughput and imaging performance, particularly in the blue and ultraviolet spectral regimes where LRIS is considered the world's leading spectrograph, a team at UCO/Lick Observatory in Santa Cruz developed the concept for the Keck I ADC module. Under the direction of Principal Investigator J. S. Miller, Project Scientist A. C. Phillips, and Project Manager D. Cowley, the ADC team designed and constructed a module which would provide correction over the entire field of view accessible to LRIS; their work is described in an SPIE paper. The completed module was delivered in January 2007 and consists of two 40-inch-diameter circular prisms with adjustable separation. A dedicated computer reads the telescope elevation and continuously adjusts the prism separation to undo the refraction induced by the atmosphere. A key challenge for the ADC project was devising anti-reflection coatings which would perform well over the entire LRIS wavelength range and applying them to the two large prisms. To accomplish this, the team developed a sophisticated sol-gel spin-deposition technique that gives them a capability unique in the realm of astronomical coatings.



The left panel shows spectra curved with wavelength by wavelength-dependent atmospheric refraction. (Elevation runs left-to-right in these frames.) With the ADC in operation, the spectra are straightened out. If you imagine a slit placed vertically in the images above (like the two red lines), you can see that in the blue much of the spectrum misses the slit without the ADC (left panel), but the spectrum closely follows the slit with the ADC in use (right panel). (Graphics courtesy of A. C. Phillips, UCO/Lick Observatory.)

Since almost all LRIS observations are improved by using the ADC module, and since removing and installing the module is a difficult task, WMKO now encourages all LRIS observers to use the ADC; in fact, LRIS observers who want to observe without the ADC must specifically justify their request and accept that their observations may be scheduled at the start or end of the LRIS observing block to accommodate the required changeover. Recent engineering tests with the polarimeter also indicate that the ADC does not significantly change the measured polarization of incoming light, although teams requiring the highest-precision polarimetry measurements might choose to observe without the ADC. Interested observers should consult the detailed report by WMKO's Bob Goodrich for further guidance on using the ADC with the LRIS polarimeter.

The ADC has two key implications for LRIS slitmask observers. The first is that the effective pixel scale at the telescope focal plane is changed by a small amount. This means that observers must use the revised version 3.09 of Judy Cohen's AUTOSLIT slitmask design software for LRIS to design their masks, and also that observers should redesign rather than re-use old (non-ADC) masks. The second is that LRIS slitmasks do not need to be designed for use at the parallactic angle any longer; observers are free to orient their masks at whatever angle optimizes the scientific return, as long as observations are made at moderate airmass (<2). For longslit observers, using the ADC requires no special considerations in planning the observing program; they may position the longslit at any orientation regardless of the parallactic angle.

Operationally, the ADC is essentially invisible to the observer. The only difference to the operating environment is the presence of a small GUI indicating the status of the module. This GUI allows the observer to define the wavelength range being observed, and adjusts the positioning of the ADC prisms to optimize image quality over that range; otherwise, no controls are accessible to the observer. In practice, the module has been virtually trouble-free, befitting a component with only one moving stage!

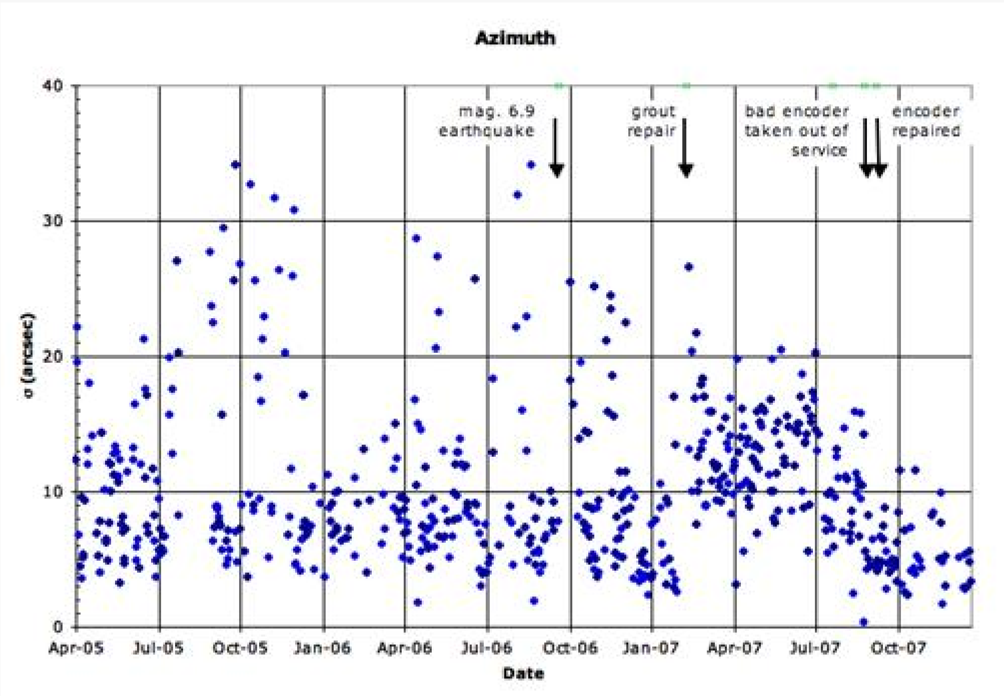
Further information on the design, performance, and operation of the Keck I Cassegrain ADC module is available on the WMKO website. «

Keck I Pointing Issues

Bob Goodrich

On 15 October 2006, a pair of major earthquakes hit Hawaii, and the Keck telescopes were offline for a period of time while repairs were made. Some of the problems caused by the earthquakes manifested themselves as decreased pointing accuracy. Another effect was the partial collapse of grout supporting the Keck I azimuth ring.

After the grout repair in early March 2007, Keck I observers suffered from particularly poor pointing (standard deviation 20 arcsec in azimuth). Resolving this problem became a top priority at the Observatory, and a tiger team was assembled to diagnose and repair the gross problems. The team's initial goal was to fix the worst problems, and return pointing accuracy and slew speeds to a tolerable level.



Standard deviation of pointing residuals in azimuth. Vertical arrows show (left to right): (1) the October 2006 earthquake; (2) the grout repair in March 2007; (3) removal of the bad encoder; and (4) replacement of the repaired encoder. Each point represents a night with more than 8 pointing checks. High values of the standard deviation could be due to particularly uncertain coordinates for some programs, or small number statistics for the night, etc.

The emergency workaround implemented was to decrease the azimuth slew speed of the telescope. This mitigated the problem somewhat, but also assured that we did no further damage to the system by driving it at unusually high currents. By September 2007 the team had identified and repaired a number of other problems. These included:

- Repair of an intermittent ground short on the azimuth encoder #1 mount. The intermittent short was traced to compromised encoder mount insulation which is believed to be caused by the October 2006 earthquake.
- Replacement of the azimuth encoder #1 capstan assembly to match the diameter and crown radius of encoder #2.
- Mitigating oil and debris on the azimuth encoder and drive contact surfaces through hydraulic system maintenance.

This work helped restore the pointing performance close to pre-earthquake levels (standard deviation < 10 arcsec in azimuth), and allowed us to increase the slew speed to normal levels. Work continues as part of the "Telescope Drive System (TDS) Restoration" project. Goals of this project include returning the slew speeds and pointing accuracy on both telescopes to pre-earthquake levels:

- Slew speed restoration:
  - Elevation (note that elevation slew speeds had been reduced prior to the 2006 earthquake due to unrelated problems)
    - K1: increase from 0.8 to 1.0°/sec (descoped from project)
    - K2: increase from 0.5 to 1.0°/sec (dependent on success of Keck II Elevation Drive Preload Redesign project)
  - Azimuth
    - K1: increase from 1.0 to 1.3°/sec
    - K2: maintain at 1.3°/sec
- Increase robustness of TDS in maintaining peak performance
- Delivery of a comprehensive TDS manual

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The MAGIQ Guider System

Jim Lyke

MAGIQ, which stands for Multi-function Acquisition, Guiding, and Image Quality monitoring system, is a WMKO project to implement new acquisition and guiding software, and replace the existing guide cameras as well as provide a standard guide camera for future instruments. The new software will provide users with improved tools and will be used with both existing and "legacy" guiding systems and the new guide cameras. The new software will be gradually released for routine use with all of the instruments, while guide camera upgrades will be performed on one instrument at a time.

The MAGIQ software is intended as a replacement for Xguide and will includes a keyword interface like that used on the science instruments. During implementation, certain features of SKY have also been included. Beyond the required functions of acquiring objects and guiding the telescope, the MAGIQ software, in combination with the new guide cameras, will include the ability to keep the telescope in focus throughout the night and also provides new features that will improve communication between observers and observing assistants (OAs). For instruments with MAGIQ hardware upgrades, we will measure telescope focus and send secondary mirror corrections without interrupting observations. Within MAGIQ, the observer and OA will share the starlist. Observers will be able to highlight the next target in their GUI and the highlight will appear on the OA's GUI. Additionally, starlists will be automatically indexed, allowing observers to request "star #22 on the list," for example.

NIRSPEC was chosen as the first instrument to receive a MAGIQ hardware upgrade. January 2008 marked the beginning of the integration pathfinder on NIRSPEC. The PXL hardware and optics were removed from NIRSPEC and the MAGIQ system was installed to test fit and function. Additional improvements and clearances were defined and the MAGIQ system was tested briefly on sky on January 17; weather reduced on-sky time to two hours. However, in that time we obtained excellent image quality (FWHM of 0.56 arcseconds), showed that focus was flat across the field, and remotely adjusted the camera focus. These final two points are significant improvements over the old system. After the engineering night, the MAGIQ system was removed and the PXL system was replaced and recalibrated. NIRSPEC resumed science operations on January 22 with guiding from the MAGIQ software. The MAGIQ system will be installed permanently onto NIRSPEC in March 2008.

The MAGIQ software interface is currently available for all instruments. Ask your support astronomer to give you a tour of MAGIQ. Observers may start the MAGIQ software from the same pull-down menu from which they started the guider eavesdrop. Instructions are available on the Web. This page will be updated with software guides and screenshots as they become available. «

Observer Homepages at Keck

Barbara Schaefer, Jeff Mader, Marc Kassis

During the proposal process for 2008A, we introduced a login webpage for all Keck users submitting observing proposal cover sheets. There were several reasons for this addition, including:

- giving PIs a unique home page listing their upcoming observing time and submitted observing proposal cover sheets;
- giving Co-Investigators the ability to submit cover sheets for their PI, and have their own home page listing those that they submitted (the PI will see these proposals as well);
- allowing users to copy a previous semester’s cover sheet to the current semester;
- allowing users to update cover sheets after they have been submitted; and
- allowing users to update their contact information.

All Keck observers that were in our observer database in August 2007 should have received an email with their login username and password. The web pages also allow new users to submit a request to have an account created. An account is necessary in order to submit an observing proposal. The figure below shows a sample home page from one of our most eminent observers.

The login page is a secure method for storing confidential proposal information. It is located at https://www2.keck.hawaii.edu/inst/PILogin/login.php.

The following upgrades are planned for the future:

- a password reminder will be implemented, and
- LRIS and DEIMOS configuration form information will be accessed through

the observer home pages.

The coversheet form for observing semester 2008B will be available in early February for you "early birds"! «

Top Performers

Bob Goodrich

Warning! The following is to be considered as entertainment only!

As many of you know, WMKO tracks the "duty cycle metrics" of each observing night. The science time is considered to be the amount of time between 12° twilights that is spent with the science shutter open and the science detector collecting photons from the sky. From the metrics data we can find the nights that show the highest fraction of science time. The list, up to date as of the end of calendar year 2007, is shown below, listing the highest science fraction achieved for each instrument. LWS is listed, even though it has been decommissioned. That's one record which will stand forever!

Note that as we gather more data, it becomes less and less likely that records will be broken. Even so, a number of records were broken in 2007. Of course, it's not surprising that the relatively new OSIRIS should have broken a record. The top three OSIRIS nights all were above 80% efficiency. Continual improvements in AO operations help for OSIRIS, as it does for NIRC2, which broke the 70% efficiency threshold for the first time in August. Both the OSIRIS and NIRC2 records were achieved on LGS-AO nights.

LRIS set a new high-water mark last February, coming within a minute of breaking 90% efficiency, on a polarimeter night. A new DEIMOS standard was set in January, pushing above 90% efficiency. In fact, that observing team holds the top three DEIMOS slots, the fifth, and the ninth! The most recently broken mark was on NIRSPEC, which topped 90% (and more than 10 hours of science!) for the first time in November.

Top performers for each WMKO instrument
Blue background indicates records that were set in 2007.

Instr	Date	% science	Observers	Observing Assistant
HIRES	2005-11-25	96.24	Crystal Martin	J. Rivera
ESI	2005-11-29	92.21	Crystal Martin	G. Puniwai

NIRSPEC	2007-11-20	92.01	Rauch, W. Sargent, G. Becker	C. Parker
LRIS	2007-02-15	89.86	Tran	C. Parker
DEIMOS	2007-01-15	90.62	Capak, Szokoly, M. Sargent, Kartaltepe	T. Stickel
NIRC	2006-01-08	84.25	Capak	C. Sorenson
OSIRIS	2007-05-04	83.51	Menendez-Delmestre, Blain	C. Parker
NIRC2	2007-08-22	73.23	Stockton	J. McIlroy
LWS (ret.)	2003-03-16	48.62	Whysong	J. Rivera

What contributes to a "top performer?" Clearly the science program is crucial; the highest duty cycles are achieved with very few targets in the night. Looking at the list of observers, one can believe that WMKO observing experience also makes for efficient observing. Finally, a clear, fault-free night is crucial. «

Back Issues

Please see the Keck Observers' Newsletter Archive.

If you have any questions or concerns, please contact keck-newsletter@keck.hawaii.edu.