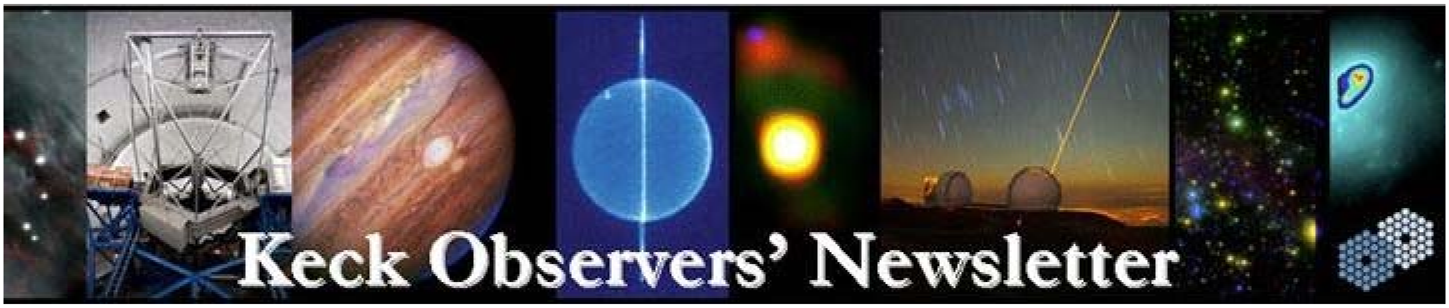


Director's Introduction

Taft Armandroff, Director, WMKO

Welcome to the Summer 2008 issue of the Keck Observatory Newsletter for observers. The release of our Newsletter is scheduled to help provide timely information for the proposal process for semester 2009A in the Keck Observatory community.

This issue of the Newsletter contains several articles that will help observers think about new observing opportunities planned for the future at Keck Observatory and how these relate to observers' scientific goals. The first of these articles describes the ASTRA project for the Keck Interferometer, which will result in substantial gains in spectral resolution, limiting magnitude, and astrometric accuracy. Another article announces improvements made to OSIRIS to ameliorate thermal background in the K band for its coarsest spatial scale. The third such article highlights opportunities that will result from enabling laser-guide-star adaptive optics on the Keck I telescope, in addition to Keck II. A more modest improvement is that LRIS has a new *I*-band filter. (This is an interference-type filter with a relatively square bandpass. Please see the LRIS filters on-line documentation to view the transmission curve.)

These and other areas of progress at the Observatory will be reviewed and discussed at the upcoming Keck Science Meeting, along with the latest exciting scientific results from Keck observations. The meeting will be held on Thursday, September 18, 2008, at U. C. Santa Cruz. We urge all Keck observers to attend and to submit recent Keck Observatory scientific results as talks and/or posters. Please note that the deadline to submit abstracts is August 31, 2008. The link above provides registration information and the capability to register and submit abstracts. The Keck Adaptive Optics workshop will be held September 16-17 in conjunction with the 2008 Keck Science Meeting.

As the U. S. astronomical community prepares for the upcoming Decadal Review, NOAO has formed the committee ALTAIR (Access to Large Telescopes for Astronomical Instruction and Research). This committee seeks to understand the needs and scientific opportunities facing the U. S. community related to ground-based optical/infrared telescopes in the 6.5- to 10-m aperture range. See the link above for a description of the ALTAIR committee, its charge, and activities.

Needless to say, Keck Observatory is a vital part of the U. S. optical/infrared observing system. A significant fraction of the scientific achievements that the American astronomical community has produced in the 6.5- to 10-m aperture range were the result of observations made at our two 10-m telescopes. Undoubtedly, Keck Observatory will continue to contribute to the U. S. astronomical community's scientific aspirations, particularly given the plans by the Observatory and its community to maintain the scientific vitality and competitiveness of the Keck instrumentation suite, adaptive optics systems, and interferometer. I urge all of our observers to complete the online survey distributed by ALTAIR in order to share your scientific aspirations and perspectives with this important and influential committee. (Please note that the deadline for completing the survey is August 15, 2008.) «

You've received this issue of the Keck

Keck Interferometer Adds New High-spectral-resolution Mode

Jorg-Uwe Pott, ASTRA Instrument Scientist, WMKO
Julien Woillez, ASTRA Project Manager / System Architect, WMKO
Peter Wizinowich, ASTRA Principal Investigator, WMKO
Rachel Akeson, Michelson Science Center, Caltech
Sam Ragland, Keck Interferometer Operations Manager, WMKO

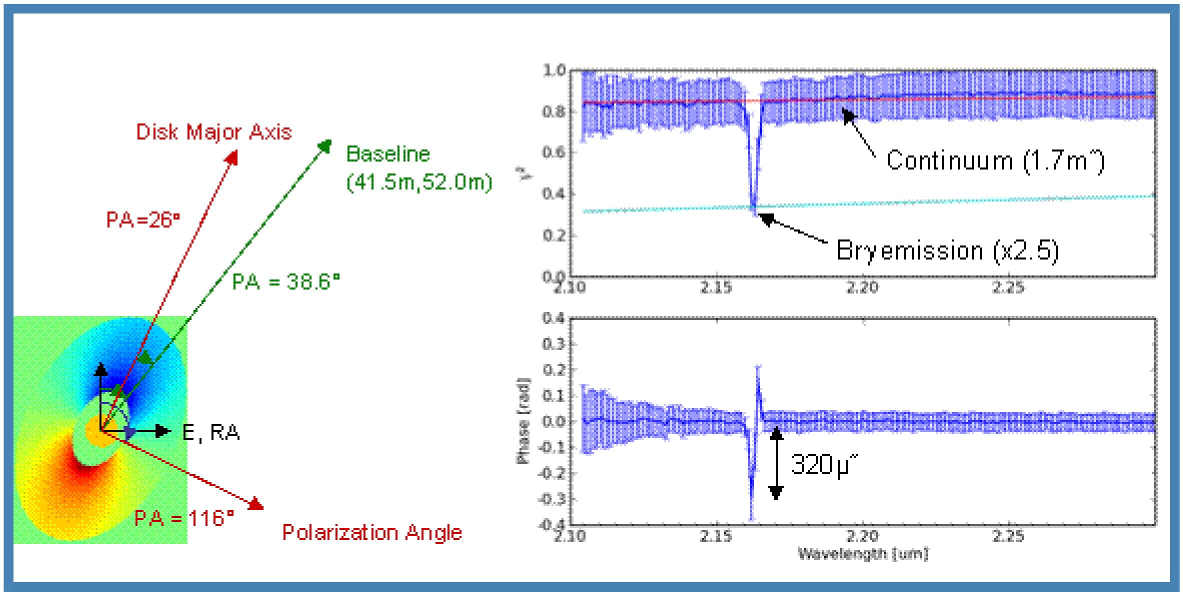
The Keck Interferometer (KI) combines the light from the two 10m Keck telescopes, offering a unique combination of near-infrared sensitivity and high angular resolution to the Keck science community. Funded by NASA and developed and operated by JPL, MSC and WMKO, KI has been utilized for a range of astrophysics, including disks around young stellar objects and the first infrared interferometry observations of an AGN. Recent developments include the addition of nulling interferometry and improved sensitivity. For more information about using KI, limiting magnitudes, and target requirements, please see the current call for proposals and the KI performance information at the MSC support page.

The Keck Interferometer atop Mauna Kea.

The U. S. National Science Foundation funds our sensitivity and astrometry upgrade program called ASTRA via a Major Research Instrumentation (MRI) program. ASTRA is led by WMKO scientists Peter Wizinowich and Julien Woillez, and supported by the Keck science community, led by James Graham (UC Berkeley) as Project Scientist. Here we report on the first step of the project which aims at increasing the spectral resolution. This will be offered to the community in shared-risk mode starting with semester 2009A.

ASTRA stands for *AST*rometric and phase-*R*eferencing *A*stronomy with the Keck Interferometer. The technology of phase-referencing is similar to adaptive optics (AO) technology, routinely used at WMKO to correct images for the blur induced by the Earth's turbulent atmosphere. The interferometric counterpart, phase-referencing, stabilizes the optical path by balancing the continuously-changing atmospheric index of refraction with a respective move of the delay lines in the basement of the KI.

In the first phase of ASTRA we split the starlight, use one part of the light to stabilize the optical path (or to provide the phase-reference), and disperse the other part with a grism, increasing the spectral resolution of the KI by nearly an order of magnitude. Such a leap in resolution offers new science capabilities in many directions: resolving line emission regions in circumstellar shells and disks, or tracing spectral contributions of a companion to give some examples only. Results of the first light of this new technology, called self-phase-referencing (SPR), are shown in the figure below.



Proof of concept on a Be star, observed in the new ASTRA-SPR mode. **Left:** Sketch of a rotating disk, with indicated major axis as derived from single-telescope polarization observations, and the projected KI baselines used. **Upper right:** In comparison to the stellar continuum, the Br gamma emitting disk of the Be star is seen as an extended emission feature, shown in the square visibility drop at around 2.17 µm. **Lower right:** the Doppler broadening of the emission line results from the rotation of the emission disk and causes a photo-center displacement. The blue-shifted wing of the emission line is located on one side of the disk (negative fringe phase shift), while the red-shifted wing is on the other side (positive fringe phase shift).

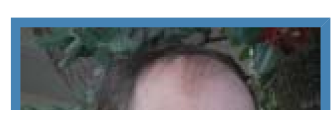
In the upcoming semester 2009A this new mode will be offered under shared-risk since it is still in development, but the first light on 2008 April 24 points to a promising future.

Josh Eisner, an assistant professor at the University of Arizona, is a regular WMKO observer who studies the innermost regions of protoplanetary disks. He is currently leading a program to observe gas and dust within one AU of young stars, with Keck time from both NASA and U. C. He comments that “The new spectral modes of the Keck Interferometer enable new probes of the dust and gas in protoplanetary disks that are fundamental to my research. And the speed and skill with which the team has added new capabilities allow a quick turnaround from initial ideas to published results.”

A growing number of traditional single telescope observers are acknowledging the efforts of the entire KI team to provide a sensitive interferometer to the community and use the KI to add crucial spatial constraints to the observer’s science. For instance, a team of UCLA observers, led by P.I. Andrea Ghez, has recently been awarded observing time to conduct a novel KI-V2 study of transition discs and their stellar origin. They are also investigating how their research around the massive black hole in the center of the Milky way can profit from the next phase of ASTRA, the so-called “off-axis phase-referencing,” where the atmosphere is stabilized by observing an off-axis guide star. This phase is planned to be implemented in 2009. «

New Support Astronomer Scott Dahm Joins Observing Support Group

Barbara Schaefer, Observing Support Coordinator, WMKO



After a successful search for the ideal candidate, the Observing Support group is pleased and excited to announce the addition of Scott Dahm as the eighth Support Astronomer.

Scott comes to us as a seasoned Keck observer having used NIRSPEC, LRIS, and HIRES in the past. He will initially concentrate primarily on NIRSPEC and HIRES in his support role at Keck. Scott comes to us from his most recent position as a National Science Foundation Astronomy and Astrophysics Postdoctoral Fellow at Caltech (September 2005 to June 2008). His postdoctoral research involved studies of circumstellar disk evolution using Keck and Spitzer Space Telescope observations of young stars in the Taurus-Auriga star forming region, the young cluster IC 348, and the 5 Myr old Upper Scorpius OB association. The objective of this research program was to constrain the timescale necessary for the dissipation of circumstellar disks and, by inference, for planetary systems to form around young, Sun-like stars.

Scott began his post-secondary school education in his home state at Louisiana State University, earning a Bachelor of Science degree in mathematics. From Louisiana he moved west, serving as a commissioned officer in the United State Navy onboard two ships home ported in San Diego. After resigning from his active duty commission, he resumed his education in astronomy, earning a Master of Science degree from San Diego State University in 1998. Moving even further west, Scott began his doctoral work under the direction of George Herbig at the Institute for Astronomy at the University of Hawaii. His doctoral work was interrupted for a year after 9/11 when he was mobilized to active duty, working in the anti-terrorism and force protection directorate of CINCPACFLT. Once demobilized, he returned to the IfA to complete his PhD (2005), with his research primarily focused upon the evolution of young galactic cluster populations from their emergence from molecular cloud cores to the zero age main sequence.

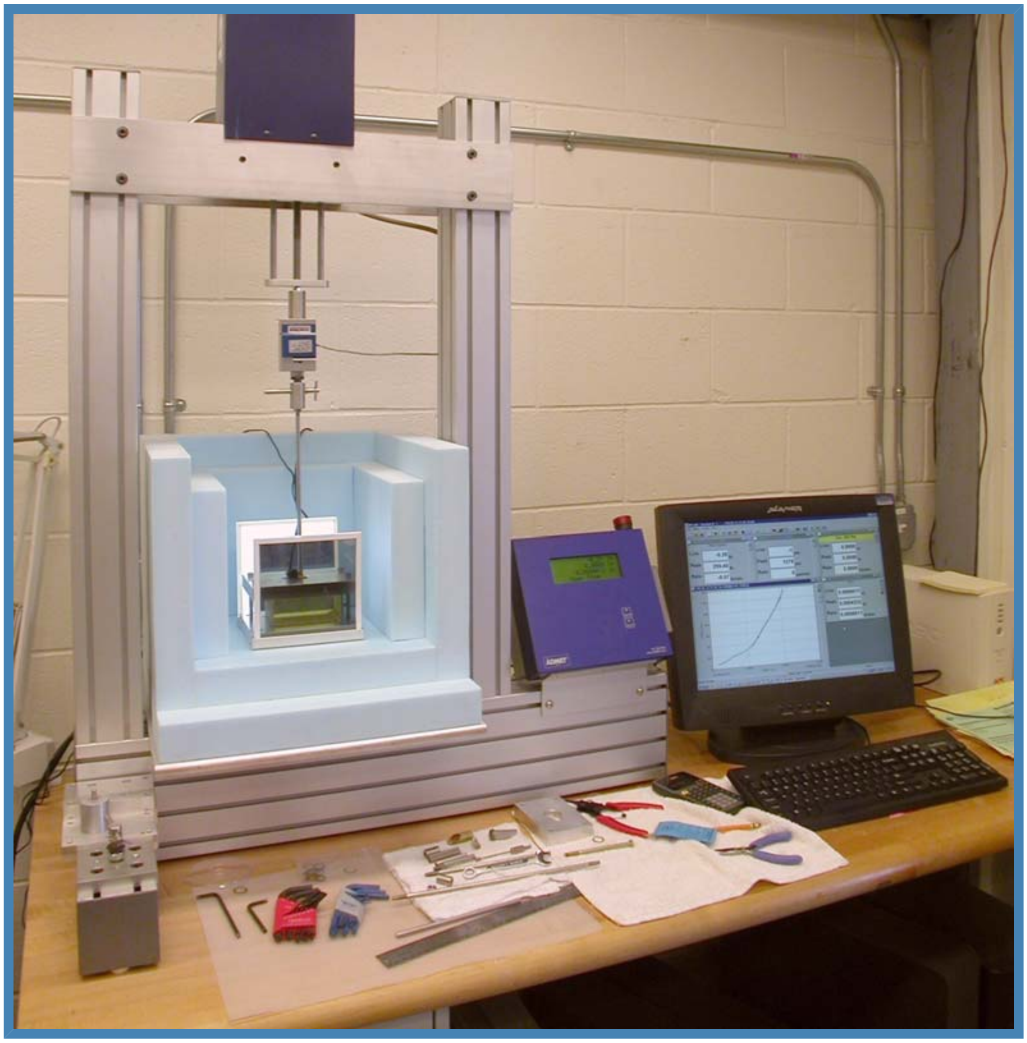
Returning to Hawaii is a move into familiar territory for Scott, because of his education and research here, and also for his wife Lisa whose family lives on Oahu. Their immediate family includes son John Paul and yet-to-be-named second child (appearing soon!). Scott remains an officer in the Navy Reserve and enjoys the outdoor activities of hiking, backpacking, and scuba diving. Please join us in welcoming Scott and his family to the Keck Ohana! «

The State of the Keck Mirror Segments

Taft Armandroff, Director, WMKO
Hilton Lewis, Deputy Director, WMKO
Dennis McBride, Facilities Manager, WMKO

Keck Observatory's primary mirror segments are one of the Observatory's most important assets. Beyond their role as a pioneering technology that has dramatically changed the state of the art in the design and construction of large telescopes, they are essential for the high performance achieved with the Keck telescopes and the wide variety of scientific programs that we support. Keck Observatory personnel regularly track all aspects of segment performance, including image quality, reflectivity, mechanical robustness, and related parameters.

A number of micro-fractures have been observed in the mirror segments. These are very small and are having no impact on the optical performance of the telescopes. There are two types of micro-fractures: those on radial pads that could propagate further into the glass, and a second variety, called "clamshell," that appear on the axial and radial pads and are considered less serious. There are about 10 segments (out of 84) with a micro-fracture that could be propagating.



Laboratory equipment used to test adhesives as part of the micro-fracture remediation efforts.
Image courtesy Dennis McBride (WMKO)

The root cause of the micro-fractures has been investigated internally at WMKO and discussed with Project Scientist Jerry Nelson and his original design team. In addition, outside experts have been consulted, including a valuable on-site visit by Schott engineers in May 2008. There are four factors believed to result in these micro-fractures:

1. prior to the original bonding of the support pads, subsurface damage due to glass machining was insufficiently ground out and etched for stress relief;
2. the bond adhesive was not optimal for minimizing differential stress;
3. handling loads were not considered sufficiently in segment design;
4. segments are prepared at room temperature but operate at cold temperatures under varying gravity loads.

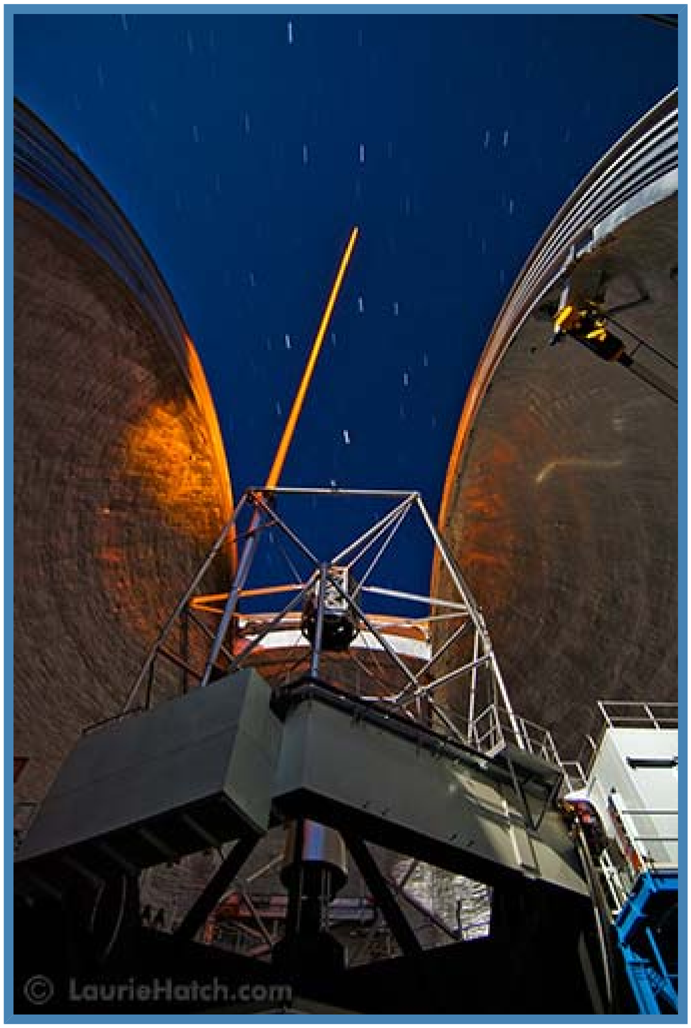
Currently the segment exchange and aluminization program is suspended, as we continue to investigate the issues surrounding the micro-fractures. We have increased the secondary/tertiary recoating frequency in order to help compensate for the resulting segment reflectivity losses.

The plan going forward is to reevaluate and revise mirror handling procedures, especially during segment exchanges, to evaluate adhesives and identify the best adhesive for repairs, and to develop a repair procedure for the radial pads. The Observatory is also instituting a detailed and systematic monitoring program of the mirror segments. Observatory personnel, led by Facilities Manager Dennis McBride, are proceeding forward with this work while continuing to collaborate with outside experts. A review by a panel of external experts will be conducted before any segment repairs are made. «

Keck I Telescope Prepares for Laser Deployment

Jason Chin, Keck I LGS-AO Project Manager, WMKO

With the Keck II Laser Guide Star (LGS) Adaptive Optics (AO) system now in routine operation and producing significant scientific output, the focus of the WMKO laser development team has turned to the deployment of the corresponding Keck I LGS AO system. In addition to providing a new capability to the Observatory, the Keck I LGS AO system will provide redundancy for the successful Keck II system and balance the observing load between the two telescopes. Keck II has operated at a maximum of 70 LGS AO nights per semester, and we hope to shift a significant fraction of that usage to Keck I via this laser development project.



The Keck II laser guider star system in operation.
Image courtesy of Laurie Hatch Photography. Please do not download or use without written permission from the photographer.

Building on our past success, the Keck I LGS AO project will incorporate designs and knowledge from the Keck II system to produce a second laser guide star for Keck on Mauna Kea. The project passed two significant milestones this fiscal year with the completion of the Preliminary Design Review in January 2008 and the Detailed Design Review in May 2008. Both reviews included internal reviewers as well as outside reviewers from Caltech, Gemini Observatory and Subaru Observatory. The project is now in the Full Scale Development Phase with fabrication of the subsystems.

The key aspects which the Keck I system will borrow from Keck II are parts of the design and control software for the optical bench. This is where the similarities end. The Keck I system will include a more robust state-of-the-art solid-state laser from Lockheed Martin Coherent Technologies to produce 20 W of 589 nm light. The laser will be housed on the Right Nasmyth Platform next to HIRES. From there, the laser beam will be injected into a fiber that will carry the beam from the platform to a projector behind the secondary mirror on the f/15 module. The centrally projected beam, along with the new laser pulse format, should produce significantly higher returns from the sodium layer while eliminating 80% of the spot elongation observed from the side-projecting laser on Keck II.

In addition to the design work, the project has completed installation of the laser service enclosure on the telescope and is in the process of upgrading the summit infrastructure for the laser, such as instrument cooling and electrical installation. The installation of the subsystems is expected to be completed by September 2009. From there, attention will be turned to moving OSIRIS from Keck II to Keck I to provide a science instrument capable of taking full advantage of the Keck I LGS AO System.

WMKO gratefully acknowledges the National Science Foundation for funding the Keck I laser and the Observatory's generous donors for supporting the Keck I laser guide star upgrade project. «

New Lasing Policy Improves Access to Targets

Randy Campbell, Support Astronomer/Adaptive Optics Operations Lead, WMKO

Telescopes on Mauna Kea are switching to a policy known as "First on Target" that will be used to arbitrate between lasing and non-lasing observatories in cases of beam interference. This policy makes non-lasing telescopes responsible for determining whether a laser beam is within their field of view in order to avoid possible data contamination. For example, when another telescope is lasing, the Keck I observer and the Observing Assistant (OA) need to use the available tools to check for possible laser collisions. At a minimum, the observer or OA should check prior to each new target. If an LGS telescope had achieved the tracking state prior to Keck I moving to the new object, then the lasing telescope would have priority and would be allowed to continue propagating its laser, which would not have been the case prior to this policy.

The new laser projection policy was adopted with the intent of balancing laser collision arbitration. Prior to this change, the laser traffic control system (LTCS) would automatically shutter a laser when the sodium layer star or the Rayleigh scatter beacon of the laser was within the field of view of any other telescope actively participating in the system. Under the old policy, non-lasing telescopes always had priority over laser facilities. The new policy will allow laser propagation to continue in the case of the laser guide star observation having started tracking on the object before the non lasing telescope.

The First-on-Target policy is being phased in on Mauna Kea with Keck I, Keck II and Gemini currently using the new system. Since this requires updating, installing, and testing the updated software, each observatory will be included over a period of time. Doug Summers, Keck's laser software engineer, is leading the effort to implement the new LTCS system.

To ease the operation and help make Keck I and Keck II observers aware of possible laser collisions, the new MAGIQ guider software includes features to help query the LTCS system. Observers should plan to coordinate with Observing Assistants and Support Astronomers on laser issues. MAGIQ automatically queries LTCS when the telescope begins moving to a new object and the destination coordinates are set. If there are no collisions predicted at the time the coordinates are set, then the priority is established and the observations will be protected from laser interference in most cases. Note that offsetting the telescope for a sky observation can cause the telescope to lose priority if a new destination is selected. MAGIQ, which we envision to be the primary tool for non-lasing operations at Keck, will also query for collisions when the "preview" feature is used. Observers can use this for occasional queries to check the next target or to update the status when waiting out a collision before moving to the next target. When in a collision state, MAGIQ will automatically query repetitively until a "no collision" state is returned. The software then reports the interfering telescope, the start time, and the end time of the predicted collision. Of course, the query will not provide actual coordinates or any information on the expected duration of the planned observation. Observers may need to coordinate with the lasing telescope to help plan possible actions. The WMKO observing support staff greatly appreciates observers' patience and cooperation as the new policy is phased in.

For more information, please see Observing With Laser Emissions on Mauna Kea and The WMKO "First-on-Target" Laser Policy. «

Observers' Newsletter because of your previous professional contact with the W. M. Keck Observatory. You may choose to unsubscribe

Space Command Changes Impact Keck Lasing

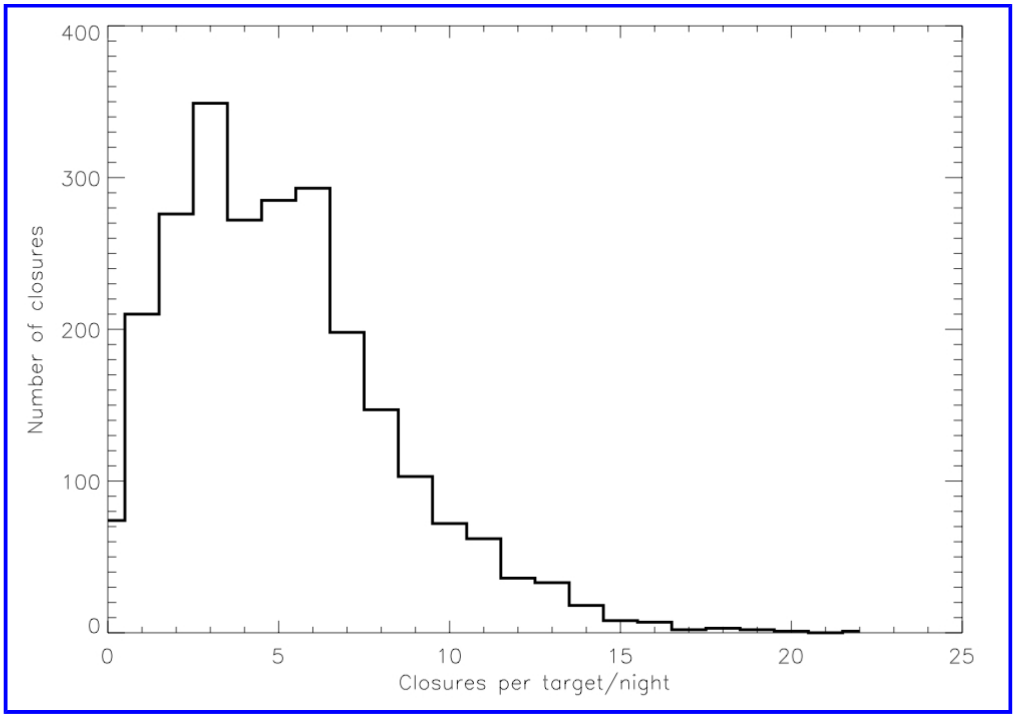
Randy Campbell, Support Astronomer/Adaptive Optics Operations Lead, WMKO
David Le Mignant, Adaptive Optics Instrument Scientist, WMKO

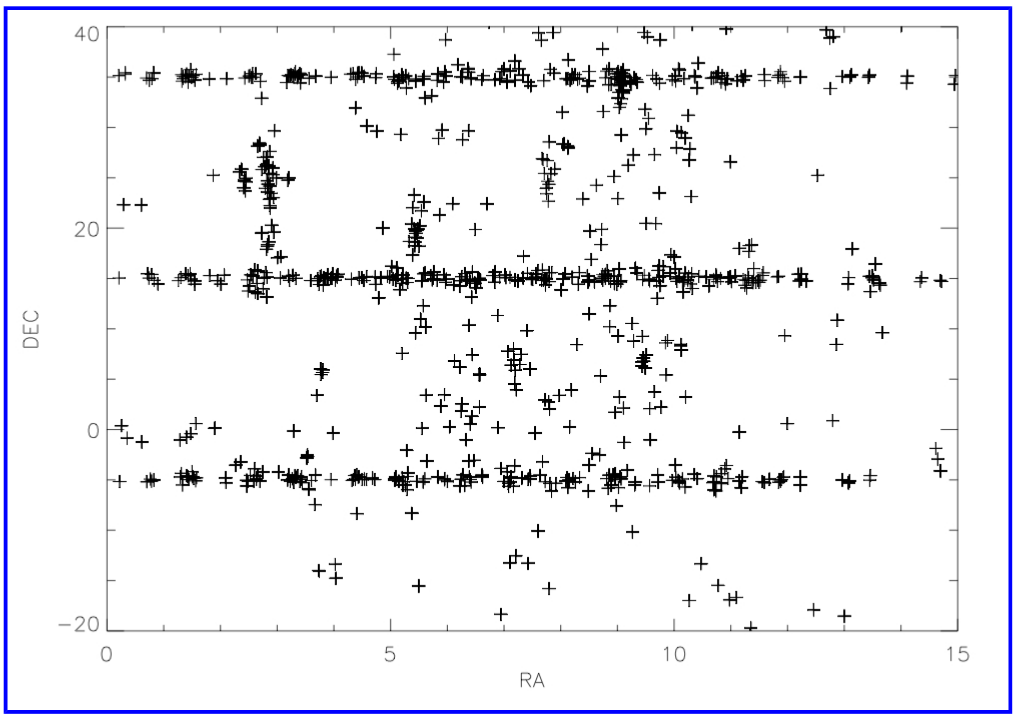
In November of 2007, The Keck LGS AO operation was significantly effected by a change at U. S. Space Command, which modernized their satellite avoidance system to what is known as “Spiral 3”. With the old system, we rarely had a closure but the new Laser Clearing House (LCH) Spiral 3 now produces many closures per target on every night. The WMKO LGS AO runs in late November - early December 2007 would have been severely impacted by the new system (if the weather had been acceptable), rendering many objects unobservable. Keck submitted the LCH Information Sheet on 30 Nov. 2007 to register the laser in the new Spiral 3 system for the predictive avoidance computation. This form allowed LCH to work with Air Force Research Labs/Satellite Assessment Center to “normalize” the laser parameters for use with satellite susceptibility data. This process decreased the number of satellites that the predictive avoidance runs protect, creating what is known as a unique projection list (UPL). Also, the LCH reduced the avoidance half angle to 1.5°.

The combination of the UPL and the reduction in the avoidance half angle has reduced the closures in number and duration. The statistics show that the reduction in number of closures was on the order of 40% and that the closure duration decreased by about 60% for a typical object.

As of June 2008, we estimate an average of 15 minutes lost science time per night, including start/stop overheads, when compared to the no-closure condition under which we operated for four years. Some science programs will be unaffected when there are many targets to choose from and thorough “open window” planning is performed. We’ve found that in some cases the lost time is negligible. However, for programs with few targets or a single high priority target the science time losses could be much more.

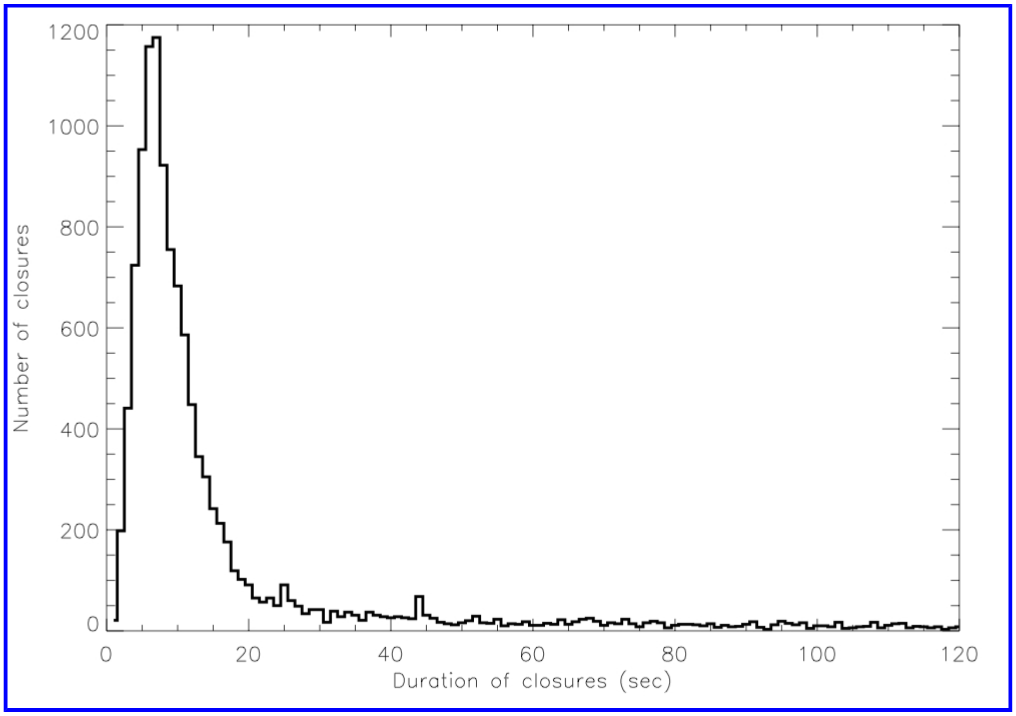
A more detailed analysis on the Laser Clearinghouse closures and their impact on LGS observations was recently completed. We compiled the data for the LCH closures for 34 nights between January 1, 2008 and May 24, 2008, which is a representative period when coordination of operations ran smoothly between Keck and LCH. The AO Operations Group submitted the coordinates for 2452 astronomical targets to the LCH during that period, which represents 72 targets on average per LGS observing night. The total number of closures over that period was 14,926. The median number of closures per target per night is 6.0 with a standard deviation of 3.0. The histogram of the number of closures per target per night is presented in the top of the diagram below. The maximum number of closures for a target was 23 for a given night. Only 3% of the sample targets did not have any closures and 14% of the sample targets had 9 or more closures per observing night. On the bottom of the diagram, we show the spatial distribution of the sample targets. The three lines at constant Dec. are the result of selecting a sample of engineering stars for each science night (used to check out the system) in a systematic manner (nearly constant Dec. but varying RA).

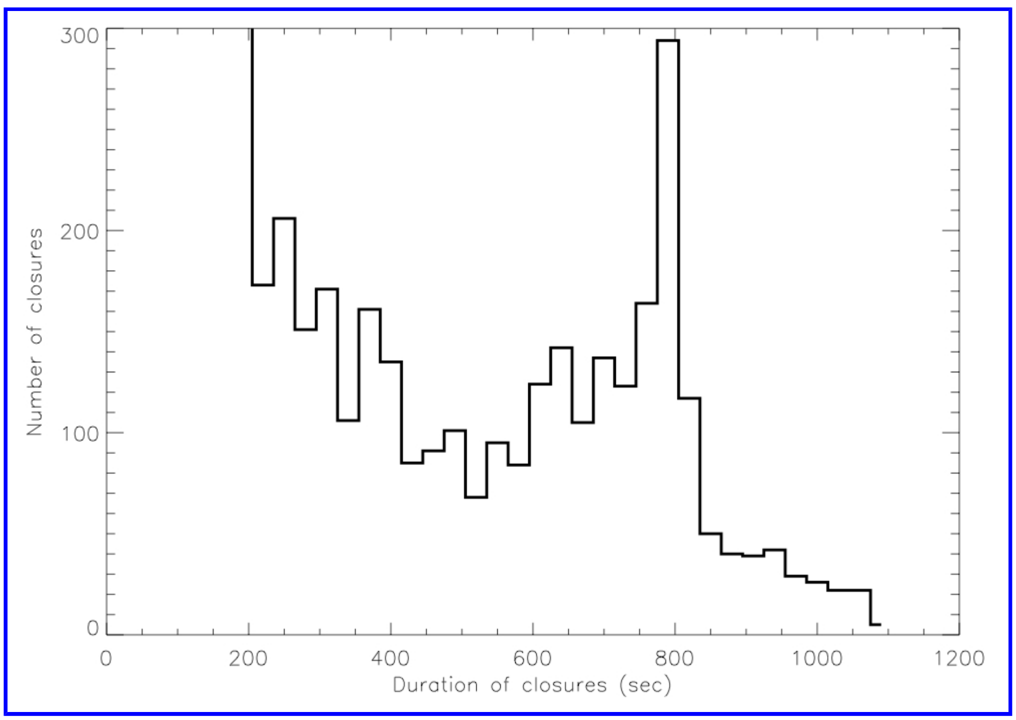




Top: Histogram of the number of closures per target per night. **Bottom:** Spatial distribution of the sample targets. The density increase along the horizontal lines is due to a target selection bias.

We investigated the distribution for the duration of the closures for the sample targets. The results are presented in the figure below. The vast majority (65%) of the durations are shorter than 20 seconds, 13.5% between 20 sec and 2 min, 6.5% between 2 min and 5 min, and 15.5% longer than 5 min. The longest durations are for about 1,000 sec with a few rare instances longer than 1,200 sec (20 min). One closure lasted 46 min! The figure shows the histograms of the closure durations respectively for short and long period closures.





Histograms for the closure durations. **Top:** short duration (bin of 1 sec). **Bottom:** longer durations (bin size of 30 sec).

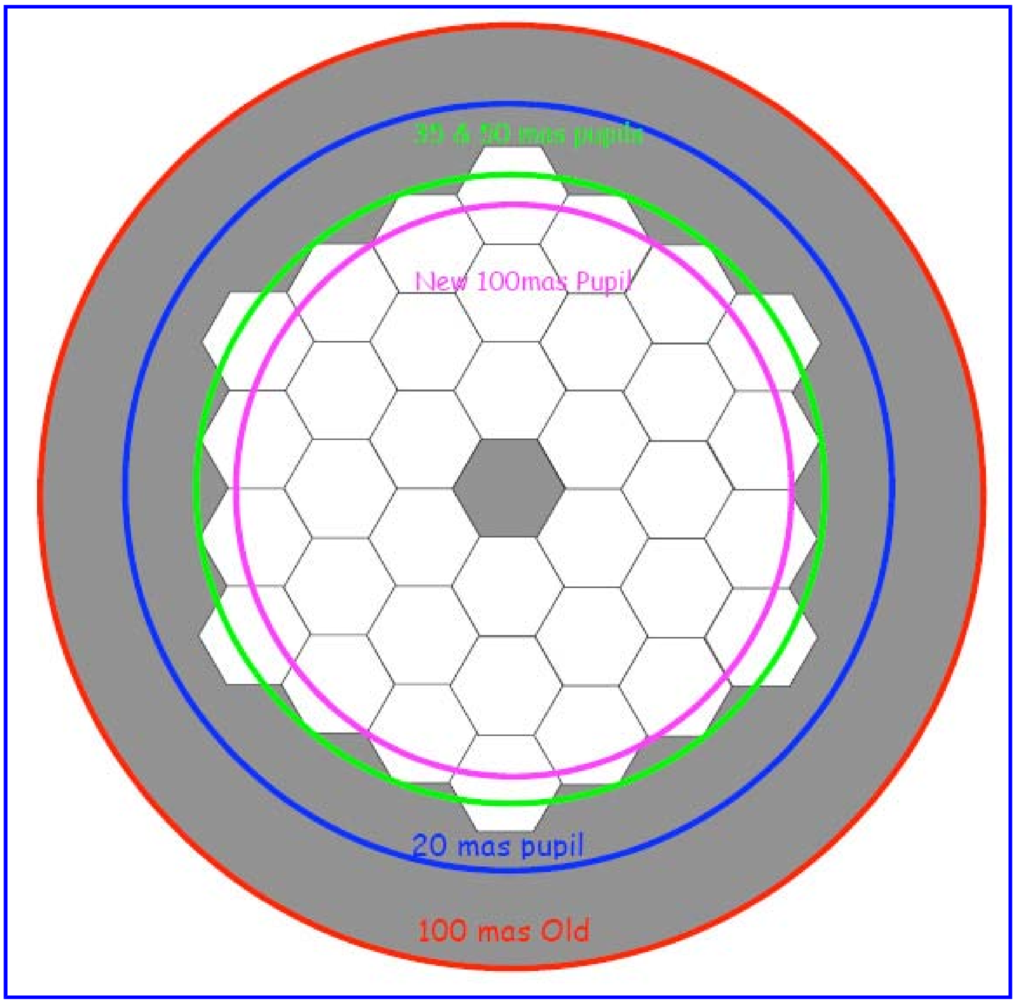
The histogram for the short duration closures shows a distribution peak with a half-maximum width between 3 and 12 sec. The histogram for the longer durations shows a fairly constant decrease after 200 sec, yet with a remarkable factor 2 to 3 increase of closures between 600 and 850 sec. The high number of short duration closures indicates that these closures are likely due to satellites with high angular velocity at relatively low altitude, likely on polar orbits. If the closure lasts less than 3 seconds, it is likely that the laser beam intersects a smaller area of the avoidance impact cone with lower probability of impact with the satellite, and we hope to be able to discuss with the LCH new procedures for these type of closures presenting lower likelihood of impact.

The WMKO AO Operations team continues to work to minimize any potential lost science time with planning and operating tools. In addition, we continue to work with the LCH and with other laser facilities in the astronomy community with the hope of making improvements in the closure statistics. However, we realize this is the new reality of operating lasers and an issue that we'll likely need to deal with for the foreseeable future. «

March 2008 OSIRIS Service: You Asked for It, You Got It!

James E. Lyke, Support Astronomer, WMKO

As originally designed, the OSIRIS pupil for the coarse, 100 mas scale was oversized. This caused high thermal background levels in the long end of *K*-band. To compensate, we added four new *K*-band filters to OSIRIS with built-in pupils for the 100 mas scale. These new filters are called *Kcb*, *Kc3*, *Kc4*, and *Kc5* (where the "*c*" means coarse) and they are identical to the *Kbb*, *Kn3*, *Kn4*, and *Kn5* filters respectively. Both sets of *K*-band filters are in the instrument. To make room for these new filters, we removed the *Open*, *Zn2*, *Zn3*, and *Zn5* filters. The new *KcX* filters are meant to be used only with the 100 mas plate scale. For all other plate scales, please continue to use the original *K*-band filters. We expect the 2.20 µm background to improve from 10.6 mag/sq" to 11.9 mag/sq". Our engineering time in June to compare the on-sky performance was weathered out, but we hope to get numbers on the new filters soon. We thank James Larkin and Shelley Wright at UCLA for their leadership in this retrofit.



The sizes of the OSIRIS pupil masks projected onto the 10 m mirror. Note that while the old pupil mask for the 100 mas scale was much larger than the primary mirror, the new one inscribes the mirror. The new pupil mask should decrease the thermal background.

During this service, we also corrected a mechanical issue with the OSIRIS handling cart that prevented the instrument from defining in the proper location. Since the mission, we can now measure the focus offset among the four SPEC plate scales and the Imager. Furthermore, any focus difference among scales is removed automatically by the AO system. Additional details are available on the OSIRIS News Page. «

newsletter using the links below. We will not share your e-mail address with any third parties.

Metrics: Number of Targets

Bob Goodrich, Observing Support Manager, WMKO

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

As discussed last issue, an "efficient" observing night sometimes is measured by a maximum of the night spent collecting science photons. But of course there are other metrics. Another metric, perhaps more appropriate to surveys, is the number of targets observed in one night, or per hour. The "targets per hour" metric has the advantage of not penalizing summer programs for the shorter nights. Below we multiply the number of targets per hour by 10 hours, what might be considered an average night on Mauna Kea.

Instrument	Date	Targets / 10 hrs	Observers	Observing Assistant
HIRES	2005-12-12	221.1	Cochran, Endl, Wittenmeyer	G. Puniwai
NIRC2	2007-06-06	120.7	Ireland, Kraus	T. Stickel
NIRSPEC	2008-06-24	84.2	B. Davies, Goto, Asami	H. Hershley
NIRC	2004-09-04	78.4	Ireland, Tuthill, Monnier, Danchi, Rajagopal	M. Reed
LWS (ret.)	2004-09-01	68.8	Ireland, Tuthill, Monnier, Rajagopal	G. Puniwai
LRIS	2004-10-21	63.3	Gal-Yam, Kneib	J. Rivera
OSIRIS	2006-04-20	31.7	Stark, Bouchez, Ellis	C. Wilburn
ESI	2005-05-17	29.4	Barth, J. Greene, Ho	T. Stickel
DEIMOS	2004-07-05	25.7	Kirkpatrick, Lowrance	T. Stickel

Maximum rate of targets for each instrument, converted into an "average" 10 hour night. The recent NIRC2 night highlighted in blue is the only "record breaker" within the past year.

Unfortunately, in the metrics database science targets are not distinguished from calibration (standard) stars, or even from pointing stars. An inspection of the above dates indicates that these effects do not seriously alter the statistics on the tabulated nights. Nor does the tabulation above distinguish between unique targets or a handful of targets observed multiple times.

Summer months still receive a slight hit in target rate due to the overhead of getting started each night, but this seems to be a minor effect; NIRC2, NIRSPEC, OSIRIS, ESI, and DEIMOS all show records during the time of year with the shortest nights. «

Back Issues

Please see the Keck Observers' Newsletter Archive.

If you have any questions, comments, or concerns to share with us, please contact keck-newsletter@keck.hawaii.edu

Copyright © 2008 W. M. Keck Observatory, 65-1120 Mamalahoa Hwy, Kamuela HI 96743, USA