

KPNO OPERATIONS

K I T T P E A K N A T I O N A L O B S E R V A T O R Y

WIYN Tip-Tilt Module Available for General Use

Chuck Claver & Abi Saha

Beginning in semester 2003A, investigators will have access to “tip-tilt” wavefront correction for imaging at the WIYN 3.5-meter telescope. The WIYN Tip-Tilt Module (WTTM) has successfully completed an extensive phase of testing and commissioning from its first light run in February 2002, through June 2002. The WTTM is an addition to the WIYN Instrument Adapter System (IAS), providing a second image port alongside the existing MiniMosaic imager (MIMO).

Figure 1 shows the newly reconfigured IAS with the MiniMosaic dewar (left) and the WTTM dewar (right). The WTTM is accessed via a movable pickoff mirror in the IAS. Observers will be able to choose between using the 9.6-arcmin-square field of MIMO or a tip-tilt-corrected field nearly 4 arcmin on a side imaged via a CCD on the WTTM. It will also be possible to go back and forth from one instrument to the other by moving a feed mirror in the instrument adapter. The configuration change takes only a few minutes.

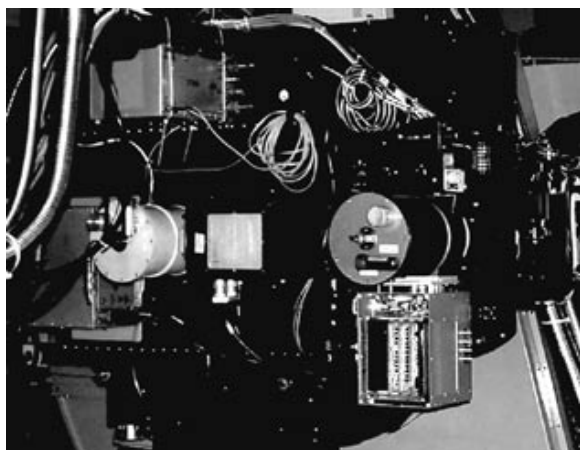


Figure 1

The WTTM not only provides tip-tilt correction of the wavefront with update rates as fast as 1000 hertz, but it also senses drifts in focus and sends corrective signals to the telescope secondary-mirror control. The exact update rates depend on the guide star brightness, where 500 hertz can be achieved with a $V = 15.5$ magnitude star. Early commissioning results for the WTTM were presented in the June 2002 *Newsletter*, where we reported seeing impressive gains in image quality. Since then, in the best conditions we have had during testing, R and I band images with FWHM as small as 0.25 arcsec have been obtained on exposures that are several minutes in duration.

In the control room, the additional workstation, Navajo, provides control to the HARCON CCD system. This data acquisition system is very similar to the one used on Sand for the MiniMosaic. Thus, users of MiniMosaic will be familiar with the control and command syntax for the WTTM CCD. Currently the instrument is being run with an EEV-80 CCD with 2430×2048 13.5-micron square pixels that project to 0.11 arcsec on the sky, providing an approximately 4.6×3.8 arcmin field. Our measured performance shows that the EEV-80 has readout noise of 4.5 electrons at a gain of 1.33 electrons per data number. The measured quantum efficiency of this device is shown in figure 2. The full well of this device is 84,000 electrons at $<0.1\%$ nonlinearity.

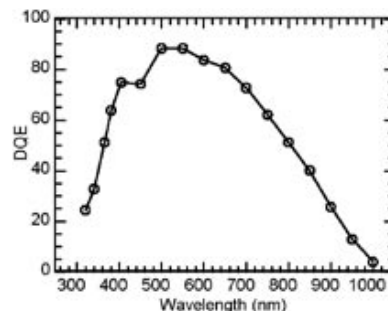


Figure 2

We have verified that aperture photometry can be done to better than 1% accuracy with this setup while imaging through the WTTM. Due to the five extra reflections in the light path and the losses from the beam splitter that sends a portion of the light to the wavefront sensors, it is expected that the WTTM imager will have a lower overall throughput than the MIMO. At present WTTM loses 0.26 magnitude in V, 0.56 magnitude in I, and 0.40 magnitude in B and R in comparison compared to MIMO.

A substantial part of this inefficiency is due to the WTTM's lossy beam splitter, which passes approximately 20% of the light to the error sensor and 60% to the science CCD, while 20% is lost in the metallic coating. We are in the process of acquiring a set of beam splitters and a notch filter that are optimized for a host of applications. We also plan to upgrade to a Lincoln Labs CCD that will have an imaging area of 2048×2048 with 15-micron pixels (0.125 arcsec). The Lincoln Labs device uses high-resistivity silicon, which has an enhanced red response that is 2 to 5 times better than the EEV device between 850 and 1000 nanometers. This will dramatically improve I and z band performance.

During the recent commissioning period, we have been characterizing the image improvement in different observing conditions. In the best conditions so far (“native” seeing of 0.5 arcsec), WTTM has

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WIYN Tip-Tilt continued

delivered images with FWHM as good as 0.25 arcsec. Even in less than average seeing (1 to 1.2 arcsec), WTTM produces better images, varying from only marginally better to a very noticeable 0.7 arcsec. Figure 3 shows what can be achieved with the WTTM in moderately good conditions. These histograms of FWHM are from 45 image pairs taken by alternating 10-second exposures between closed-loop and open-loop control.

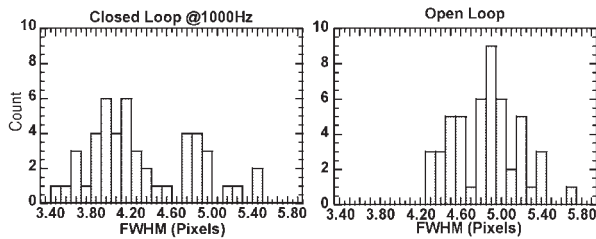


Figure 3

Due to coherence length limitations, tip-tilt correction is best very near the star that is used for deriving the wavefront correction, and the improvement diminishes as one moves away—if sufficiently far away, the wavefront corrections become uncorrelated and actually start to degrade the image. Thus far, we have seen only improvement within the 4 arcmin field of view of the WTTM, and never any degradation. The rate at which the degree of improvement falls off with distance from the reference star varies from night to night. Presumably when it changes slowly, the disturbing region in the atmosphere is relatively low, and when it changes quickly, the disturbances are farther aloft.

In most instances, this variation in PSF is subtle and can only be detected under the best of conditions (see figure 4).

An observing manual is being compiled and written. Substantial contribution to this effort is coming from Dipankar Maitra (a graduate student at Yale, one of the WIYN partner institutions), who is already using WTTM on a shared-risk basis. While the operation of this instrument is not trivial, it should be well within one's grasp after a careful reading of the manual. We shall be posting progressively improved versions of the manual at www.noao.edu/wiyn/wttm_usr_man.html.

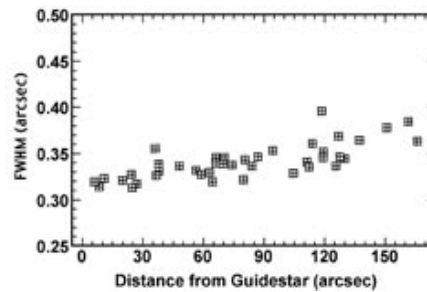


Figure 4

We hope that you will help make the effort of developing and deploying this instrument worthwhile by proposing to use it in semester 2003A. There is a huge gap between the 0.7- to 1-arcsec images typical of good ground-based telescopes and the 0.1-arcsec images from HST. We think that WTTM will fill this niche.

Summer Upgrades

Richard Green

One visible aspect of the new operating mode for Kitt Peak is a reduced scope of activities during summer shutdown. Nevertheless, both WIYN and the 4-meter received significant attention during the summer monsoon.

The major activity at WIYN was realuminizing the primary and tertiary mirrors. This project marked the first use of the new aluminizing arrangement in the 4-meter building. The chamber is now located in a partial enclosure on the opposite (west) side of the large ground-floor area. That location is away from the giant truck-loading door and should offer considerable advantages for cleanliness, particularly during the critical stage from washing to sealing the chamber. The facility improvement was made possible in part through the

revenues provided by the other observatories that make use of the KPNO aluminizing capability. The realignment of the WIYN primary in its cell and to the telescope requires a concerted effort, along with the generation of new lookup tables for the pointing and active optics systems. Minor repairs to the primary mirror support system led to the best active optics system performance yet recorded. Some facility work was planned for this two-week interval as well, particularly improvements to the computer room hardware configuration.

In the subsequent two weeks, attention turned to the 4-meter. The two major efforts there were a brake job for the 4-meter declination drive, and installation of the wavefront camera in the guider-rotator. The telescope was officially shut down

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Summer Upgrades continued

only when it was not usable, which was a five-day interval while the declination brake work was completed and the wavefront camera was physically installed. The next work week was planned for wiring and testing of operability for the wavefront camera assembly. The successful completion of that project will allow for tuning of the 4-meter active optics system without mounting a direct camera at the Cassegrain focus. That capability was designed into WIYN, and has proven very effective for nightly zero-pointing of the active optics settings.

The 2.1-meter was not slated for any major maintenance this summer, but was instead scheduled for special observing programs and instrument testing. Teachers with the NOAO Teacher Leaders in Research Based Science Education (TLRBSE) program used it for three nights in mid-July, and the Research Experiences for Undergraduates (REU) students enjoyed two weeks of scheduled time with SQUIID and then Goldcam. Two weeks in early August were given to Jian Ge and his team from Penn State for Test and Engineering time. They produced a novel fiber-fed bench spectrograph, which includes a Michelson interferometer and iodine reference cell. The goal is to achieve radial velocity measurement stability of better than 10 meters per second, and to offer that capability to users.

Rob Seaman, Mike Fitzpatrick, and colleagues led the charge for a mountainwide upgrade of IRAF and ICE. Bob Marshall



WIYN 3.5-meter mirror being inspected prior to stripping and washing in the upgraded aluminizing area. Note the new location for the vacuum chamber.

upgraded the data acquisition computers for Mosaic, while the IRAF group worked on integrating a new fast LINUX box for data reduction.

As a KPNO user myself, I appreciate an occasional reminder of the amount of effort required from a highly skilled staff to maintain the competitive level of performance of our telescopes. My thanks to all those involved.

Staff Changes

Richard Green

Since the release of the last issue of the *Newsletter*, we have bid farewell to several KPNO staff members and welcomed back an old friend.

John Hoey left KPNO after 32 years with the observatory. It was clear from the discussions over cake and punch at his farewell party in the Drafting Room that John is widely respected for his skills in mechanical design, his experience, and for passing the most stringent test of all: designs that have seen long and trouble-free service at the telescope. We wish him all the best in retirement.

Andrew Allday ended his service as WIYN Observing Assistant to return to Hawaii. Andrew's warm cheerfulness and observatory experience were qualities we greatly valued during his time at Kitt Peak.

Mike Brotherton completed his term as Postdoctoral Research Associate to take up a tenure-track faculty position at the University of Wyoming. Mike worked with me on analysis of FUSE spectra of Active Galactic Nuclei (AGN) to study energetic outflows and the mechanism of far-ultraviolet continuum emission. He is looking forward to joining a department

that is in the midst of a renewed commitment to astronomy, as well as continuing a vigorous research program on AGN.

George Will returned to the mountain in July as an Observing Assistant (OA). George was a telescope operator for KPNO from 1980-1991, preceded by a stint as an operator at Steward Observatory. We're delighted to add an experienced, top-tier OA to the group, and look forward to gaining the benefit of his experience in the telecommunications industry to assist with the challenges of our pending mountain telephone switch and its support of the impending data flood.

High-Risk Wildfire Season

Richard Green

From the headlines all summer, it was easy to tell that the Western United States was in grave danger from wildfires. Southern Arizona and Kitt Peak were no exceptions. By the end of May, the measured moisture content of plants was significantly below the lowest value ever recorded, and there had been essentially no winter rain. A small fire in two-foot-high grass on the reservation below Kitt Peak produced eight-foot-high flames. On Mt. Lemmon, a huge national crew of firefighters worked for more than a week to contain the massive Bullock fire. The concern for Kitt Peak was the possibility of an extended period of dry lightning preceding any significant monsoon rains. In unfavorable circumstances, the brush-filled canyons on the mountainside could act as chimneys to transporting a wildfire to the summit within a half-hour of ignition.

KPNO therefore took a number of precautions to reduce the risk of fire damage to the observatory. We had meetings on the mountain and excellent support from Guy Acuña, the Division Chief of the Wildlands Fire Division of the Tohono O’odham Department of Public Safety. His crews worked with the observatory facilities crew and our summer interns from the Nation to clear brush from critical areas. Two high-priority places were the steeply wooded slopes below the WIYN telescope and below the power station and water pumps in the maintenance area. Mike Hawes and his facilities team enabled the power foaming unit, which has the potential to protect all the structures of the observatory for at least 12 hours. The mountain evacuation plan was updated and distributed. The picnic grounds were closed and afternoon public visiting hours were curtailed during the period of highest thunderstorm risk. In addition, tenant observatories reduced the brush in their areas. With these precautions in place, scheduled observing was not curtailed.

Fortunately, the monsoon season commenced with little lightning and immediate soaking rains. Although the rains were not anticipated to make up the deficit of the drought condition, they were sufficient for sharply reducing the immediate fire risk. The picnic grounds were reopened and normal visiting hours restored on August 1.

This was one year where July observers’ disappointment in getting rained out was more than matched by the staff’s relief in seeing storm clouds roll in and let loose.



KPNO staff and summer students Steve Preciado, Cooney Lejero, Steve Fredericks, and Juan White (working for Mountain Facilities) help clear away brush and cut trees.



KPNO facilities crew tests foaming pump for fire protection.

WIYN Strategic Planning Needs You!

There will be a planning meeting of all partners on September 13–14 to discuss and decide strategic directions for the WIYN Consortium, including upgrades and new instrumentation on the WIYN 3.5-meter telescope. See www.noao.edu/wiyn for information on the current state of WIYN.

Your thoughts and suggestions for strategic planning are valuable. Please assist us by passing on your views to Abi Saha at saha@noao.edu, or by phone at (520) 318-8288.