

KPNO/KITTPeAK

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

WTTM Completes Commissioning

Steve Howell, Charles Corson & Chuck Claver

The WIYN Tip-Tilt Module (WTTM) is an optical and near-infrared reimaging system that utilizes fast tip-tilt, or image motion, compensation. It performs rapid sampling (typically 100 hertz or more) of a reference star and, by rapidly steering the mirror at the same rate, produces corrected images that are generally 15 percent or more improved over natural seeing at WIYN.

WTTM commissioning was completed this fall. “In dome” and on-sky calibration and testing were performed and we highlight some results below. A “quick start” guide is provided with a simple to follow, easy procedure to use WTTM and obtain 90 percent or more of its potential benefit without being an experienced user.

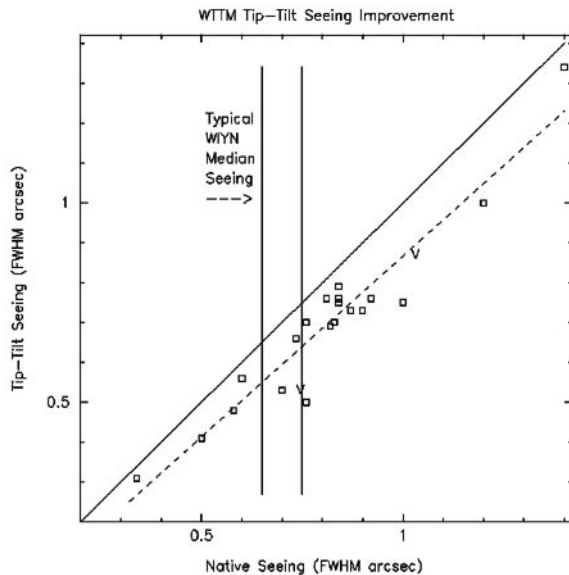


Figure 1. Performance gains when using WTTM tip-tilt correction.

WTTM has a 4-arcmin circular field of view within which the object of interest and a reference (guide) star (R=8–14) must be located. The reference star may be located anywhere within the 4-arcmin field of view and may be the same as the object of interest. The 4-arcmin field of view is optically split by a beam splitter, allowing a small fraction of the light to be passed to an error sensor mounted on an x/y stage for acquisition. Currently, two beam splitters are available, one (the 85/15 beam splitter) that passes approximately 90 percent of the light to the science detector and approximately 10 percent to the error sensor, and another (the

95/5 beam splitter) that passes about 95 percent of the light to the science detector.

WTTM uses a standard NOAO dewar and a 2K×4K CCD as the imager. A variety of 2-inch broadband filters that are matched specifically to WTTM are available. Other 2-inch filters are also available from the KPNO filter list, but these may not be optimal for WTTM.

Figure 1 shows a performance plot for WTTM. The plot shows the general 15 percent improvement to seeing, typically obtained in R band with a few “V” points shown as well. Median natural delivered image quality (DIQ) at WIYN is 0.65–0.75 arcsec and we have never experienced DIQ (natural or tip-tilt corrected) better than 0.29 arcsec for sustained (60 seconds or more) time periods.

A specific FWHM improvement is not guaranteed however. We have experienced nights and even a few hour periods within a night for which tip-tilt corrections provide zero improvement over standard imaging. It is likely these are times when upper atmosphere effects dominate the seeing and/or the seeing is simply too bad to be recovered. Ultimately though, WTTM offers users the best opportunity to maximize delivered image quality at WIYN.

Figure 2 shows a typical WTTM tip-tilt corrected image versus a natural seeing image. The figure allows a qualitative comparison of the improved image quality and encircled energy present within the tip-tilt corrected point source. Figure 3 illustrates the improvement obtainable with WTTM for an extended object.

continued

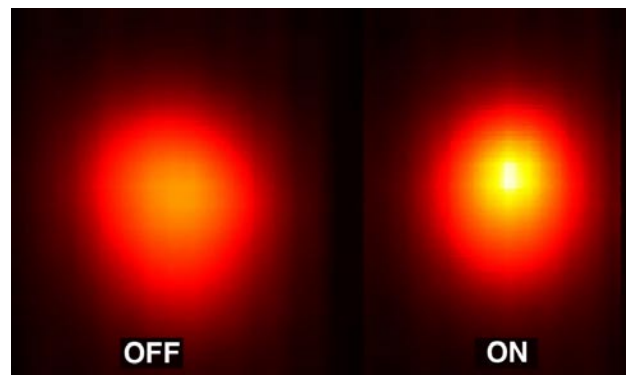
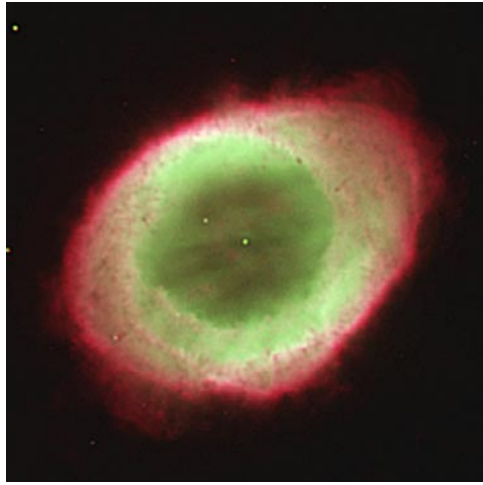


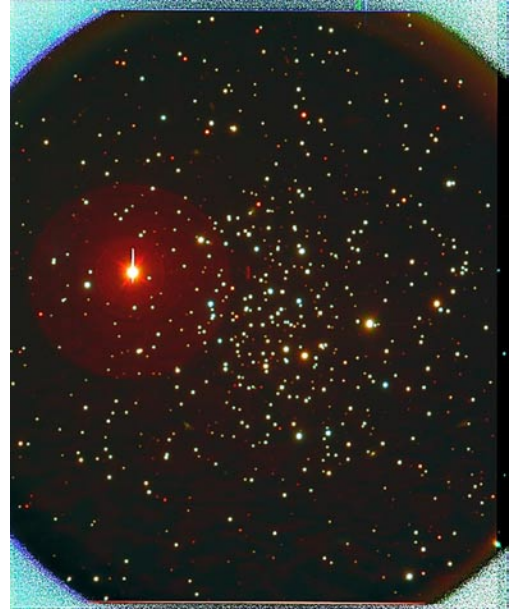
Figure 2. Two R-band images comparing the gain obtained with fast tip-tilt correction on and off: natural DIQ 0.57 arcsec, tip-tilt DIQ 0.42 arcsec, peak intensity improved by 45 percent.



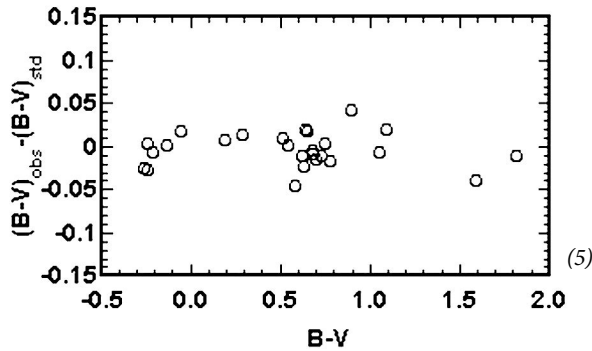
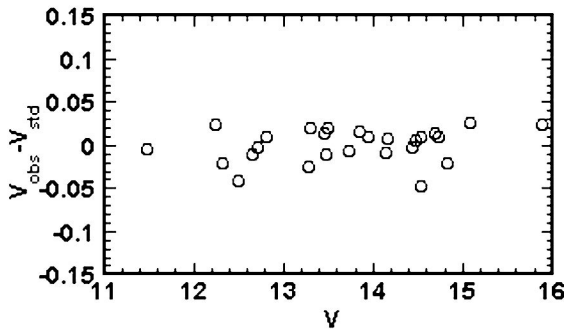
WTTM Completes Commissioning continued



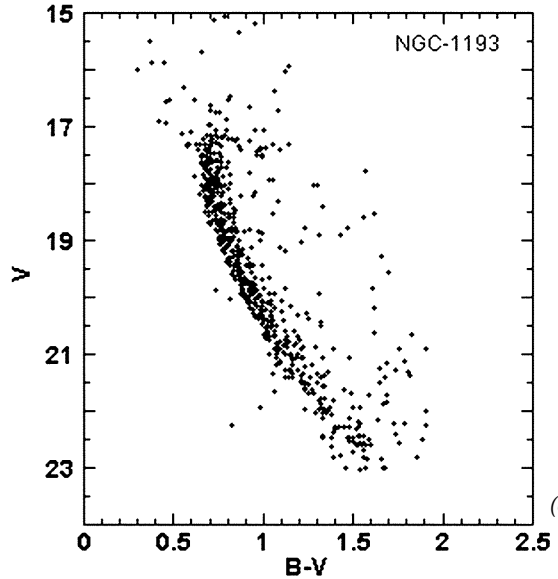
(3)



(4)



(5)



(6)

Figure 3. (Top left) Composite color image of the Ring Nebula made with WTTM. Two 3-minute exposures taken through H- α (the light of ionized hydrogen and nitrogen) and OIII narrowband filters were used to produce the color image. The tip-tilt corrected FWHM of the central star in this image is about 0.3 arcsec.

Figure 4. (Top right) Composite color image of the old open cluster NGC 1193 obtained with WTTM. This image was produced using B, V, and I band images of integration times 4 \times 450, 4 \times 300, and 9 \times 180 seconds. The mean FWHM of the images is 0.5 arcsec.

Figure 5. (Bottom left) Photometric fits for V and B-V observations. The fits end near V=16 as these are the faintest Landolt standards available. Formal RMS residuals to the fits (1σ) are 0.018 (B) and 0.02 (V).

Figure 6. (Bottom right) Color magnitude diagram for NGC 1193 derived from the WTTM images used to produce figure 4. Note the main sequence turn-off and giant branch.

continued



WTTM Completes Commissioning continued

For those of you familiar with MiniMosaic at WIYN, the throughput of WTTM is about 30 percent less across the optical, but this factor is generally compensated for by improved DIQ if signal-to-noise (i.e., encircled energy) is your major concern. Thus, the choice to use WTTM for your science program (instead of MiniMosaic) will be almost exclusively based on the need for high-resolution imaging.

As an example of science that can be performed with WTTM, we illustrate some recent results obtained by Chuck Claver in December 2003. Figure 4 shows a WTTM image of the old open cluster NGC 1193. This cluster is 7–8 billion years old and lies at a distance of 4300 parsecs. NGC 1193 has $[Fe/H]=-0.29$ and $E(B-V)=0.12$. The color image was produced from Harris *B*, *V*, and *I* images and the observations used the 85/15 WTTM beam splitter.

Figure 5 shows the results of photometric fits based on Landolt standard star fields observed before and after NGC 1193. One result from these observations is the production of a new color-magnitude diagram (see figure 6) that extends over three magnitudes deeper than previously available. The color magnitude diagram shows the main sequence turn-off and giant branches as well as a few apparent blue stragglers.

The new WTTM user manual is available at www.noao.edu/kpno/manuals/WTTM/WTTM.html, and WTTM can be proposed for as an NOAO facility instrument in semester 2004B (proposals due 31 March 2004). Any scientific or technical questions related to WTTM can be directed to the WIYN instrument scientist at howell@noao.edu.

Proposing for an Upgraded Hydra on WIYN

Pat Knezek

WIYN Observatory is working with NOAO to upgrade Hydra, the multifiber spectrograph on WIYN's 3.5-meter telescope. The main goal of this upgrade is to ensure that Hydra remains competitive for the next ten years, and it primarily involves replacing aging parts and upgrading the software. An additional goal of the upgrade is to decrease the fiber configuration time by about a factor of two, allowing a full configuration to take approximately 10 minutes.

Linux versions of the setup and simulator software have already been released, and can be downloaded from

<ftp://noao.edu/kpno/hydra/linux> via anonymous ftp. The upgrade installation on the telescope will take place in August 2004. As a result of this and other shutdown activities, the WIYN 3.5-meter will not be available for science for the entire month of August. Furthermore, Hydra will be unavailable for September 2004, while instrument commissioning is completed. We will be scheduling Hydra in October 2004 in a shared-risk mode. Proposers who are awarded early Hydra time in the fall of 2004 are encouraged to prepare a back-up observing plan using one of the imagers or integral field spectrographs, and include that as a part of their Observing Run Preparation (ORP).

Multi-Object Spectroscopy with FLAMINGOS

During the 2003B semester, we successfully supported two multi-object spectroscopy runs from the visitor community on the University of Florida instrument FLAMINGOS. The masks were designed in-house from astrometric coordinates provided by the investigators, and were fabricated by the same local vendor who provides the masks for RCSP and MARS multi-object spectroscopy. This article is a reminder that KPNO will support community proposals for MOS with FLAMINGOS, but only on the Mayall 4-meter telescope.

Those who wish to propose for this mode should familiarize themselves with the instrument performance and MOS field (roughly 3×9.5 arcmin) by referring to the FLAMINGOS manuals, available at flamingos.astro.ufl.edu/Manuals.

There are a couple of points to keep in mind. First, we are able to generate masks only from astrometric coordinates; we do not have the ability to support the FLAMINGOS mosplate generation pipeline, which utilizes FLAMINGOS images of the target field. The 4-meter rotator can position the long axis of the mask at any position angle, but we do

not have a program for optimizing the mask layout; this must be carried out manually by the proposer. Secondly, to properly align the mask at the telescope, each mosplate field must have at least two, and preferably three, moderately bright stars ($K<14$) well-distributed along the long axis of the mask. The alignment star holes are typically 8 arcsec square, and this real estate is naturally unavailable for target slits.

Anyone considering a MOS proposal with FLAMINGOS should feel free to consult with Dick Joyce (rjoyce@noao.edu) or Ron Probst (rprobst@noao.edu).