WIYN's Major Advances in Upgrades and New Instrumentation

Richard Green & Patricia Knezek

The last year has seen a significant ramp-up in technical efforts devoted to WIYN instrumentation and telescope performance. This has led to the best image quality seen at WIYN. Typical rms wavefront errors delivered to the sensor are under 100 nanometers, leading to regular imaging performance with 0.3–0.4 arcsec FWHM.

A part of the improvement in image quality was the re-aluminization of all three mirrors during the month-long summer shutdown for the new Hydra positioner installation (see below). The tight schedule forced the issue of completing some long-needed improvements to the mirror-handling cart, including new drive screws with higher precision control that made the jacking motion much smoother. The entire operation went smoothly and with much less stress than in previous removals. Site Engineer Charles Corson also completed maintenance of the mirror support system that included identifying and replacing some misbehaving components. He then did a superb job of realigning the telescope optics, putting the finishing touches on the process of significantly improving the telescope performance.

During the past two years, a dedicated team led by Patricia Knezek has done an outstanding job on the design, fabrication, and integration of a replacement for the Hydra fiber positioner (see figure 1). Some key components of the original positioner could no longer be replaced, leading to the risk of catastrophic failure. In addition, several improvements made to the design when implementing Hydra II for CTIO were also desirable upgrades for WIYN performance. During the full month of WIYN shutdown in August, the old positioner was removed, its gripper mechanism was transferred to the new system, and the new positioner was installed with a precision realignment scheme on the telescope. In the course of testing and commissioning this new positioner, several aspects of the long-frozen software control were brought to full working order. The first scheduled shared-risk science run was a definite operational success. A few further improvements planned for fiscal year 2005 will increase performance beyond its predecessor, while providing a maintainable system for a further ten years of active use.

Good news for WIYN came in the form of a successful proposal for nearly $400,000 by Margaret Meixner to the Director's Discretionary Research Fund at Space Telescope Science Institute (STScI). She won support there for a project to build a near-infrared camera specifically for the WIYN tip-tilt module. Margaret is leading the instrument design effort to provide a 2K × 2K HgCdTe detector with a scale of 0.09 arcsec per pixel. As demonstrated by her traveling camera NIRIM, WIYN can frequently produce near-diffraction-limited images in the near-infrared, which will be reasonably matched to the adopted scale. KPNO will provide a Monsoon controller for compatibility with the mountain forward look. The WIYN High-resolution IR Camera (WHIRC) team, led by principal investigator Ed Churchwell (University of Wisconsin), and co-investigators Margaret Meixner and Don Figer (fSTScI), and Patricia Knezek (WIYN), is also submitting an ATI proposal to the National Science Foundation for the remaining funds. This project is off to a vigorous start, with a goal of two years to deployment.

Major progress was made in advancing the technology to produce wide-field CCD cameras with zonal fast guiding on-chip. George Jacoby leads WIYN in a collaboration with John Tonry and the PanSTARRS group at the University of Hawaii to develop

Figure 1. The WIYN Hydra team. Standing from left to right are George Jacoby, Gene McDougall, Dave Sawyer, Rich Gomez, Gary Muller, and Behzad Abareshi. Kneeling from left to right are Phil Massey, Charles Corson, and Dave Dryden. Missing from the photo are Di Harmer and Patricia Knezek.

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WIYN's Major Advances continued

orthogonal transfer array (OTA) CCDs. These 4K × 4K devices allow fast readout of individual ~500 × 500 pixel cells; the centroided position of a guide star can then be fed back to clock adjacent cells and move charge vertically or horizontally in either direction to achieve local fast guiding. WIYN is working with Dick Bredthauer of the commercial firm STA in close collaboration with PanSTARRS source Barry Burke at MIT Lincoln Laboratory (MITLL). Both groups staged initial foundry runs that were largely successful. The MITLL OTA has been demonstrated to image with its full format. The STA foundry devices will enter the testing phase before the end of 2004. The NSF ATI program granted WIYN the money to produce QUOTA, an 8K × 8K camera with OTA CCDs, planned for first light in 2006. All these steps are critical successes along the way to the production of a One-Degree Imager (32K × 32K) of OTA CCDs, planned for science operations in 2009. At its meeting in October, the WIYN Board reiterated its support for ODI development, and committed resources from the partner institutions for a strong effort in the current fiscal year.

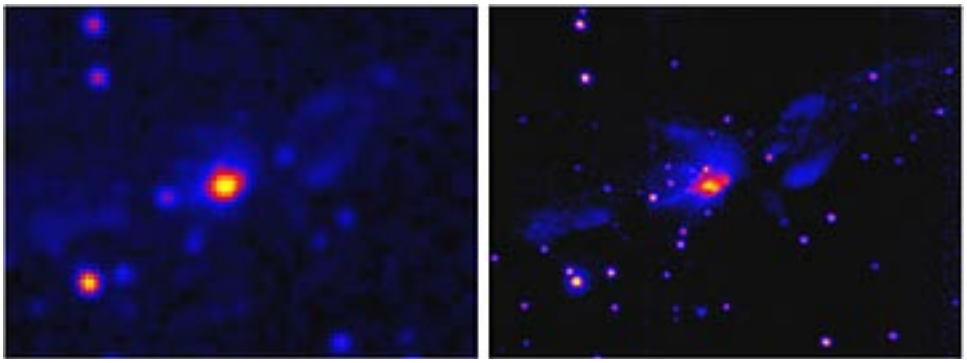


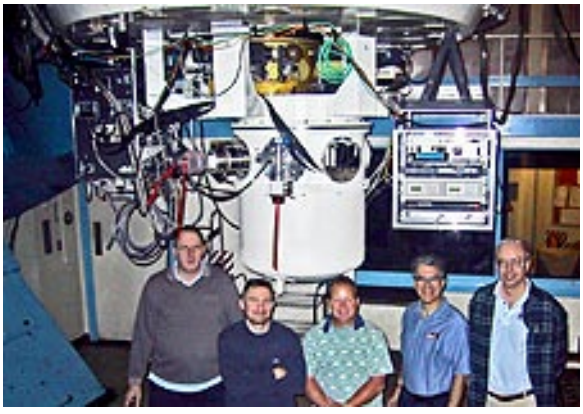
Figure 2. A comparison of the 2MASS (left) and WIYN/NIRIM (right) K_s images of the massive star-forming region G192.2.

First-Light Run for IRMOS a Major Success

Richard Green & John MacKenty

The long-time partnership of the Space Telescope Science Institute (STScI), Goddard Space Flight Center (GSFC), and Kitt Peak National Observatory (KPNO) was rewarded in September with a highly successful first-light run of the Infrared Multi-Object Spectrograph (IRMOS) on the Kitt Peak 2.1-meter telescope. This instrument uses a cold micromirror array as a programmable multislit mask. Principal investigator John MacKenty and his commissioning team were on the sky on the first night. The initial run allowed data acquisition to test throughput in all the bands with images and spectra (it is hot in z as well as K!), to map the geometry of the projection optics, and to test some designer slit configurations.

The GSFC team went above and beyond to produce a state-of-the-art instrument. Ray Ohl has served as the technical team lead, pulling the project successfully through several challenging situations. Savoring the success of the development through participating in the



IRMOS on its first-light run. Left to right: Knute Ray, Ray Ohl, Tim Madison, Richard Green, John MacKenty (principal investigator).

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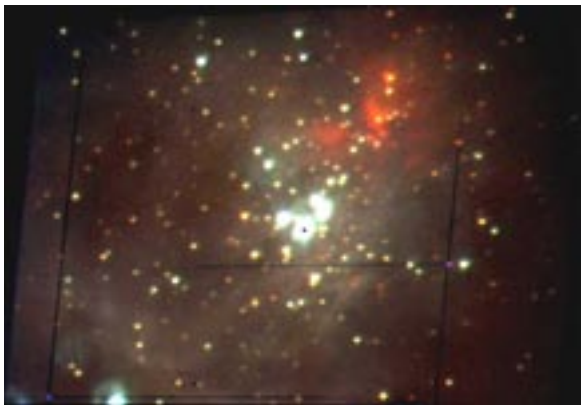
First-Light Run for IRMOS continued

first-light run were engineers Joe Connelly and Knute Ray, technical support person Tim Madison, and project manager Leroy Sparr. Matt Greenhouse is the project co-investigator, supporting IRMOS technology development in the interests of the James Webb Space Telescope (JWST) program at GSFC.

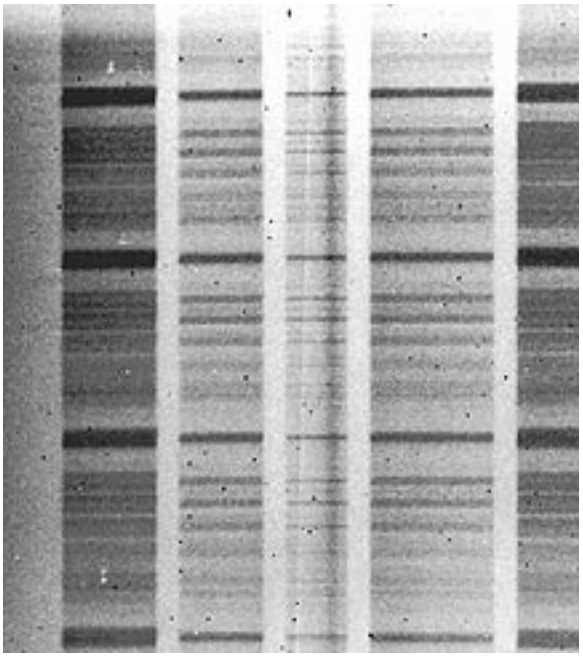


JHK composite of Orion. Some artifacts of the micromirror array are visible in this undithered image.

Thanks to careful prep work by Tony Abraham, Khairy Abdel-Ghawad, Will Goble (project lead), and Scott Bulau in Kitt Peak Engineering; Skip Andree, Bill Binkert, Mike Hawes, and the facilities crew; and Jim Hutchinson, Steve Lane, and Bill McCollam of Mountain Electronic Maintenance, the pre-observing support, setup, and alignment was very straightforward. As our instrument scientist, Dick Joyce had been running interference for months, and Bill Ditsler had made a special trip to GSFC to work on the instrument during assembly. Bill also made sure the flex rig facility was ready to receive the instrument and team on arrival. Hal Halbedel managed to create a new cadre of 2.1-meter telescope operators. We're also grateful to Paul Schmitt and the Major Instrumentation group for the loan of some critical vacuum equipment, and for the support of Central Facilities for careful handling.

At the 2.1-meter telescope, each micromirror in the 848 × 600 array subtends approximately 0.4 arcsec on the sky. Observers will be able to take an infrared image, then interactively design a custom slit mask from the image, and immediately begin taking multiple object spectra. Each of the J, H, and K bands is covered with a choice of gratings offering resolutions of approximately 300, 1000, and 3000. The initial measurement of the contrast ratio exceeded expectations.

The instrument has been scheduled for additional testing and engineering runs on the 4-meter and 2.1-meter telescopes in November. Future work will include reduction of background, and major improvements in user-interface software. Should progress continue at the current pace, the call for shared-risk proposals could come for 2005B.



Custom multislit H-band spectra of M31. The nucleus is visible in the central slit; galaxy signal is present in all slits. The slit widths were varied to compensate for the changing light profile of the galaxy, with the central width of 3 pixels = 1.1 arcsec, flanking slits of 7 pixels = 2.7 arcsec, and outer slits of 15 pixels = 5.3 arcsec. The (central) spectrum has R~1000; this is a single raw frame of a 100-second exposure.

KPNO and the University of Maryland— An Effective Partnership

Richard Green & Lee Mundy

As reported in the March 2002 *NOAO-NSO Newsletter*, Kitt Peak National Observatory (KPNO) solicited partnerships to maintain a vital flow of new instrumentation for the 4-meter telescope. After a series of reviews, a partnership was established between KPNO and the Astronomy Department at the University of Maryland. The department brought established expertise in astronomical software, particularly through their technical support of BIMA and CARMA, along with financial resources for critical instrument hardware purchases. In exchange for providing skilled personnel and much-needed financing, the department's 19 professorial faculty, some 40 research faculty, and large graduate student population were allocated 20 percent of the 4-meter nights scheduled for scientific observations. At the recommendation of the review panel, some of those nights can be exchanged for time on WIYN or the 2.1-meter telescope. Dedicated Maryland observing time began in Semester 2003B.

The initial focus of the partnership has been on the production of the NOAO Extremely Wide-Field Infrared Imager (NEWFIRM) as a scientific system. The NEWFIRM program will produce the camera hardware, the data acquisition hardware and software, and the data pipeline to go from raw data to calibrated images. Maryland resources have supported the purchases of large optics for the camera and augmentation of fabrication efforts, and will allow the acquisition of a suite of narrowband filters that were not in the baseline budget. Maryland personnel Rob Swaters and Brian Thomas are fully integrated into the NOAO pipeline development team; their participation has made the critical difference for meeting the delivery schedule. Sylvain Veilleux was the lead on the department's proposal, and provides oversight of Maryland personnel as well as coordination of the Maryland Time Allocation Committee (TAC) process. Sylvain also serves on the NEWFIRM science advisory committee, advancing a full intellectual partnership.

Oversight of the partnership is provided by the Committee on Maryland and NOAO Development (COMAND). Three members of this Board are provided by each institution. The current COMANDos are Lee Mundy, Sylvain Veilleux, and Stacy McGaugh of Maryland, and John Glaspey, Richard Green, and Dick Shaw of NOAO. The Board reviews and approves each year's operation plan and has developed a set of metrics to gauge the success of partnership efforts. The department has goals of enhanced scientific visibility and excellence in graduate training. KPNO must demonstrate valuable return to observers in terms of new capability. Given the burgeoning number of observational thesis projects and the demonstrable progress on the NEWFIRM pipeline, the Board members are confident that the success criteria will be well met.

Instrument shop supervisor Roger Repp with the NEWFIRM dewar shell delivered by the vendor.