

## BIMONTHLY SUMMARY

March - April 2003



*Deep thanks and fond farewells to Craig Foltz and Steve West as they hunt for new challenges.*

## Personnel

Craig Foltz left the MMTO on March 14 to take on the role of Facilities Program Director at NSF Astronomy, Washington D.C. Craig served the Observatory for 18½ years as Staff Scientist, Deputy Director, and finally Director through the period of the 6.5m conversion project. His depth of understanding, leadership, and boisterous good humor are sorely missed. We express our deepest appreciation for Craig's many contributions to the MMT and wish him the best in this new phase of his life.

Gary Schmidt, professor of astronomy at UA, agreed to stand in as Interim Director, so there was no lapse in leadership during the hectic period surrounding the engineering and first light of the  $f/5$  secondary. Gary has a long affiliation with the MMT. As a research astronomer in the early 1980's Gary worked on the completion of the Blue Channel Spectrograph. Not long afterward, he supervised the design and construction of the Red Channel. He also served as Cognizant Scientist for the Steward 2.3-m telescope for 8 years and worked closely with Craig Foltz as a member of the MMT Council and Management Team. A search is being instituted by the MMT Council for a permanent director.

Steve West transferred from the MMTO in late March to work for the Steward 6.5-m LOTIS project. Steve's contributions were critical to the success of the baseline MMT, to the oversight of the technical staff, and most recently to the development of wavefront sensing and analysis tools to optimize the optical performance of the telescope. The silver lining in Steve's departure is that he will continue to work in Steward Observatory, where his deep knowledge of the inner workings of the MMT can be plumbed from time to time.

Following integration and transport of the  $f/5$  secondary mirror system to the mountain in mid-April, Instrument Maker/Designer Ron James retired from the MMTO. This completes a more than 30-year association with the University of Arizona, beginning with his helping to erect the 61-inch Kuiper telescope on Mt. Bigelow and ending with his key role with the 65-inch  $f/5$  secondary for the converted MMT. When one adds Ron's long term spent at Infrared Laboratories in Tucson, it is not an overstatement to say that his astronomical instruments and telescopes are scattered throughout the Universe. Ron's broad mechanical talents and vast experience will be missed. We wish him a long and very happy retirement.

Since transferring to the mountain staff in January, P. Spencer has become more involved with the everyday tasks of mountain operations: assisting with instrument changes and setups, working on equipment requiring immediate repair, general facilities maintenance, and assisting with observer support.

## Development

### $f/5$ Secondary

March and April saw a great deal of activity leading to the installation of the  $f/5$  secondary. Early in the period C. Chute, S. Bauman, and S. Callahan designed ventilation covers for the  $f/5$  cell. These panels provide extra rigidity for the cell and serve as a sturdy platform for new aluminum ventilation

nozzles. C. Wainwright and S. Callahan also designed new cooling lines to provide chilled methanol to the secondary hub. The lines will be routed in the shadows of two of the spider arms.

The  $f/5$  hexapod controller and its associated electronics, including the  $f/5$  mirror support board, completed their integration and testing at Sunnyside in March. The secondary mirror, cell, and hexapod were delivered to the mountain in early April, control electronics were installed, and the  $f/5$  wavefront sensor (WFS) and corrector optics were transported to the site.

During the April 10 M&E run, the  $f/5$  WFS was test-fitted and several minor modifications were made. PISCES was then mounted to the  $f/9$  topbox for the first time, allowing use with the resident WFS. The image improvement realized on the first night demonstrated the effectiveness of the system. D. McCarthy is planning to add an inclined dichroic to feed light to the topbox guide cameras to make full use of the configuration.

The commissioning run of April 16 - 21 began with a repeat measurement of the primary mirror optical axis, with results that support the earlier findings. The  $f/5$  secondary was installed on April 17 (Figure 1), culminating a 3-year effort that involved many people at SAO and SOML, and virtually everyone at MMT0. First light in the “naked”  $f/5$  configuration represented a very gratifying milestone that occurred early Saturday morning, April 18. The hexapod performed accurately and reliably, and early images with the  $f/5$  WFS science camera showed images smaller than  $0.7''$  on axis.

During the commissioning run, D. Fabricant reviewed the layout of the autofill dewar that is being installed in the 4<sup>th</sup> floor library. He agreed to relocate the dewar so that the library can continue to be used as a library and daytime office space.



*Figure 1: Shawn Callahan astride the new  $f/5$  secondary/hexapod.*

## **f/5 Instrumentation**

R. Eng (SAO) was at the observatory March 31 - April 4 to work on the light- and dust-tight tent for Hectospec and Hectochelle. Some structural additions and modifications were made to the aluminum tent frame. The black PVC tent material for the roof of the enclosure was measured, allowed to outgas at the FLWO Basecamp for 24 hours, and laid in place. The tent will be completed during a later visit.

T. Gauron (SAO) and G. Williams spent April 9 troubleshooting the Hectochelle order separating filter changer. The problem involved a shut-down of the filter pusher motor after the arm engaged and had begun to lift a filter from the bank. Initially thought to be due to crossed wiring in the electronic interlock, the problem was traced to the software interlock, and solved by M. Conroy (SAO).

The first test Hectospec spectrum through the iodine cell was obtained on April 22. Analysis of the data is underway.

## **Aluminizing**

The Steward LOTIS project plans to use the MMTO aluminizing vacuum head, associated pumps, and filament sources for coating their mirror, so an opportunity has arisen to continue development work on the filament power supply. Toward this end, a Simulink model has been developed to predict the behavior of a single aluminizing circuit (20 parallel filaments) during a coating run. While the model does not yet include the “wetting” period for the filaments, preliminary results suggest that the power required for heating an aluminizing circuit can be supplied by a commercially-available welding inverter. A candidate unit from Lincoln Electric has been identified and conversations with the Lincoln application engineers confirm that this is an appropriate application for this particular model.

A test run at the UA Sunnyside coating facility is planned using the small vacuum chamber and AC system to collect data on the time/power characteristics of filament heating and to verify the Simulink model. The test will then be repeated with a rental inverter. The Lincoln unit is available in the form of 6 units pre-wired in a portable rack, a very inviting method of replacing the automobile battery cages used in the past.

## **Encoders**

MMT autoguider data show a strong ( $\sim 0.25$  arcsec amplitude RMS) 1024-count error on the absolute encoders. This error term has traditionally arisen from a gain mismatch between the sine and cosine angle signals from the fine (Inductosyn) encoder. Several unsuccessful attempts have been made to identify and cure the mismatch. To better understand the low-level signal behavior of the encoder, a test tool has been built to measure the sine and cosine signals in parallel with the existing readout electronics. Using the test tool, we can measure the signal quality independently and make a determination as to the source of the error term. We expect to acquire this data soon and to move forward to a fix of the encoders during the next reporting period.

## Computers and Software

### *f*/5 Hexapod Software

The software engineering staff devoted a considerable fraction of their time to testing the *f*/5 secondary software/hardware interaction and to supporting first light at *f*/5. While the performance of all aspects of the *f*/5 control software (and electronics) at the mountain was entirely satisfactory, the project highlighted a need to reexamine the crate communication philosophy as well as the advantages of consolidating on one GUI for all foci.

VxWorks code developed by T. Trebisky now supports serial port communication with *f*/5 firmware. This code also implements an expanded “remote” socket protocol. VxWorks code was also written to support the SAO “MSG” protocol directly from the hexapod VME crate.

The VxWorks code for the *f*/5 also handles much of the functionality that is currently in the *f*/9-*f*/15 GUI. Platform-to-pod and pod-to-platform transformations are now performed within the crate, as are corrections for elevation and temperature changes. Additional options were added to allow for center-of-curvature and zero-point-coma tilts for the *f*/5, as well as for the existing *f*/9-*f*/15 hexapod GUIs. Direct socket communication between the hexapod crate and the mount and cell VME crates is also used for the new *f*/5.

The single, “universal” hexapod GUI is being developed in Ruby/GTK. This GUI will communicate with a single set of code within the hexapod VME crate. Further effort is needed to merge the *f*/5 code with existing and new *f*/9 and *f*/15 code.

### New Apogee CCD Software Interface

The Linux driver and interface for Apogee CCD cameras (such as those used by the interferometric and *f*/9 Shack-Hartmann WFS) that we have been using is no longer supported by the author, does not support newer revisions of the Linux kernel, and does not support newer PCI interface boards. A new, completely free driver and software development kit (available from <http://www.randomfactory.com/apogee-ifa.html>) has been developed by Dave Mills at NOAO/KPNO. It supports all current versions of Linux, all Apogee interfaces including parallel port and PCI, and provides source code to enable the development of custom interfaces. These distinct advantages compelled us to upgrade and port our software to use it.

As part of the upgrade, a new computer was purchased to replace the old WFS computer (the old computer will still be used with the interferometric WFS). The new machine is a small form-factor Pentium 4-based Shuttle SS51G and is equipped with a new PCI Apogee controller. It is configured to run without a keyboard or monitor, and its GUI is designed to be accessed over the network using the VNC protocol (the default session is accessible at *wavefront.mmt0.arizona.edu:1*). The small form factor proved to be valuable when the long cable to the east Nasmyth platform did not work properly with the PCI controller. As a workaround, we were able to install the computer on the east side of the *f*/9 topbox and use a short cable. The WFS computer will eventually find a permanent home on the east drive arc and use a 30-foot cable (known to work with the PCI controller) to the CCD.

Some modifications to the Mills driver and libraries were required to run it under Red Hat 8.0 and integrate it with our WFS software. The FITS image handling routines needed more significant modification to handle extra header information that the WFS software will require, such as rotator angle. This turned out to be the cause of the problems S. West originally had in building custom scripts using the Mills code. Once these modifications were made, it became very easy to pull in telescope information via the MSG protocol and insert it automatically into each FITS image.

A simple TCL-based GUI was then written to interface to the new Apogee driver (see Figure 2 for a screenshot). This provides basic image acquisition capabilities with the option of inserting telescope information into the image headers. It will also automatically number the images to help avoid accidental overwrites. Upon acquiring a frame, the most recent image is displayed in a DS9 window.



*Figure 2: Screenshot of the new Apogee CCD image acquisition GUI. Acquired images are automatically displayed in a DS9 window (not shown).*

### ***f/9 Shack-Hartmann WFS Software***

Following S. West's departure, T. Pickering assumed responsibility for the *f/9* WFS software. The main feature that has been added is the ability to display the image being analyzed together with the fitted centroids in a DS9 window. Some other relatively minor revisions were made, such as removing the actuator force graphical display, which was too small and hard to read to be useful (the forces are still provided in text format). The WFS software is now run on *wavefront* via VNC along with the new Apogee CCD interface. A screenshot of a typical session is shown in Figure 3.

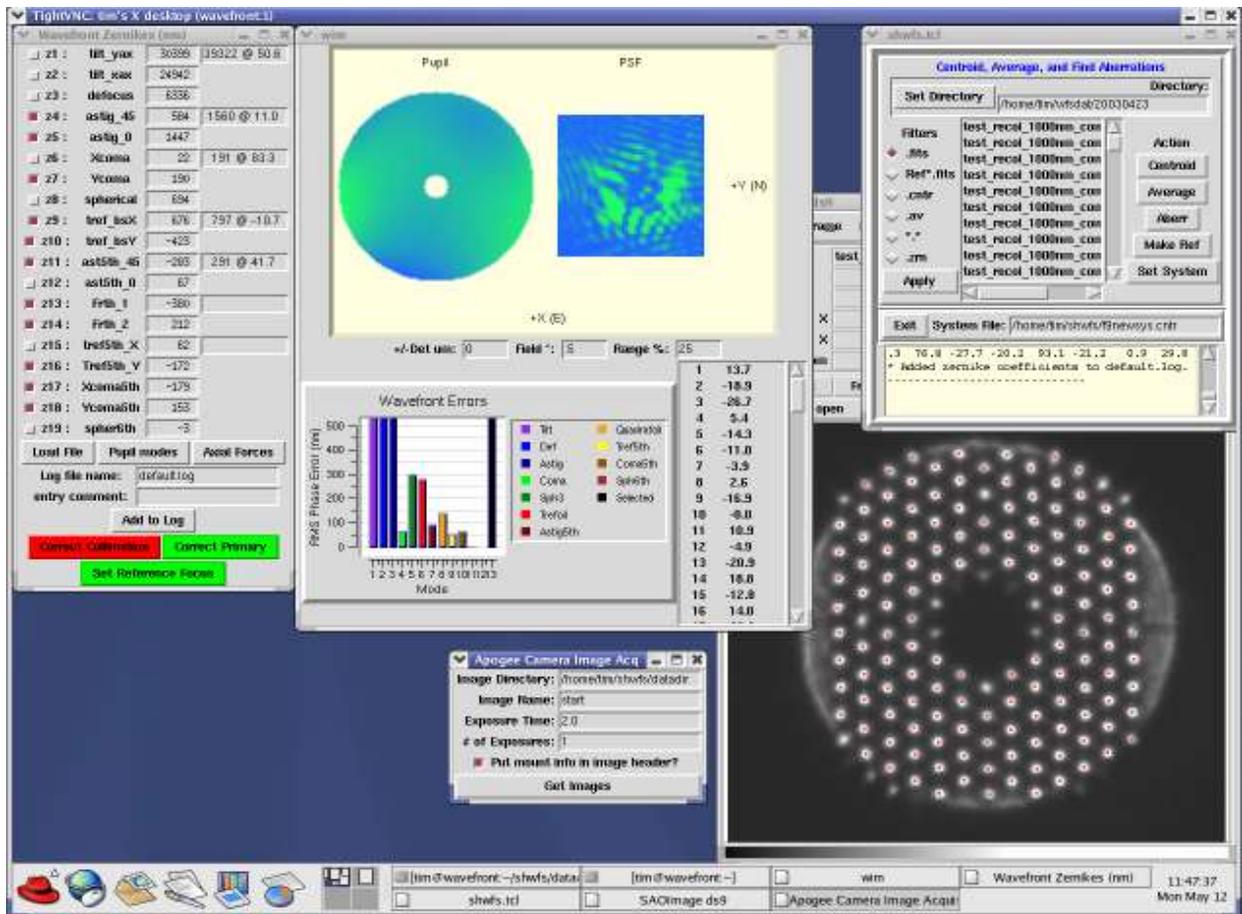


Figure 3: Screenshot of a typical  $f/9$  WFS analysis VNC session. Running the GUIs in a VNC session greatly simplifies setup and allows them to continue running from night to night. This permits the reference focus from one night to carry forward to the next. It also allows the session to be accessed from multiple computers simultaneously, which greatly aids engineering and debugging.

Some internal changes were made as to how the WFS software handles certain modes and corrections. Coma corrections are now handled solely by movements of the secondary about its center of curvature, as opposed to the previous method of secondary vertex tilts plus telescope repointings. Corrections for spherical aberration, as well as any other mode with amplitude  $<100$  nm, are turned off by default in the analysis GUI. They can be re-enabled if desired, but spherical aberration is frequently due to thermal problems, and is often best left to sort itself out since large bending forces can be required to correct it. Likewise, relatively small amounts of high-order modes can involve relatively large correction forces, and are often best ignored unless the conditions are exceptional.

It has been found that if the integrated force correction becomes too great, the `rcell` interface to the cell crate will silently ignore any further corrections. The standard procedure for now should be to clear all forces and then reload the default `startForces` before doing any primary mirror correction with a WFS system. Generally 2-3 iterations are sufficient to obtain a good figure if the

conditions and data warrant. If that is not the case, one should probably return to `startForces` and start over. Obviously, more work and experience are needed to fully quantify these procedures.

A test was performed where the same star was observed repeatedly over the course of 15 minutes and each image analyzed separately. The results for each mode were then detrended and the RMS calculated from the residuals. The results are:

| <u>MODE</u> | <u>RMS (nm)</u> | <u>MODE</u> | <u>RMS (nm)</u> |
|-------------|-----------------|-------------|-----------------|
| tilt_yax    | 5360.7          | ast5th_45   | 98.0            |
| tilt_xax    | 1850.1          | ast5th_0    | 88.5            |
| defocus     | 339.8           | Frth_1      | 98.9            |
| astig_45    | 275.4           | Frth_2      | 103.8           |
| astig_0     | 289.3           | tref5th_X   | 72.1            |
| Xcoma       | 124.7           | Tref5th_Y   | 66.2            |
| Ycoma       | 158.8           | Xcoma5th    | 55.7            |
| spherical   | 71.8            | Ycoma5th    | 68.0            |
| tref_bsX    | 185.3           | spher6th    | 35.7            |
| tref_bsY    | 175.2           |             |                 |

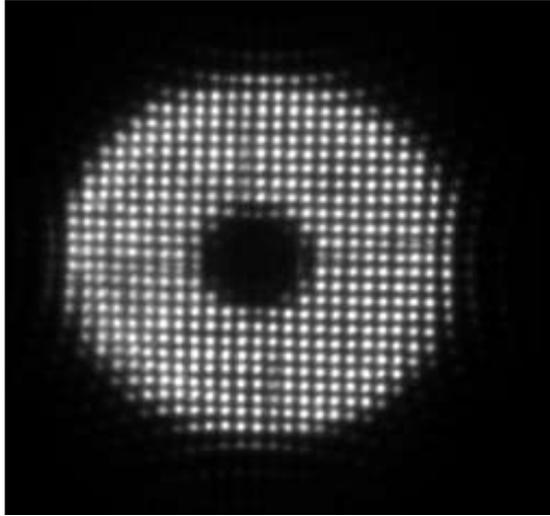
Thus the 100 nm cutoff is reasonable, indeed conservative, especially if multiple images are averaged together and analyzed.

### ***f*/9 Elevation-Dependent Collimation**

The elevation-dependent components of defocus and decollimation can be corrected using a simple TCL script called `elcoll.tcl`. This script applies relative tilt and focus corrections to the secondary that are derived from 2<sup>nd</sup>-order polynomial fits to focus and coma versus elevation. Previously employing vertex tilts of the secondary plus telescope repointings, the script has also been modified to make coma corrections solely with hexapod movements by moving the secondary about its center of curvature. This has the benefit of not affecting the mount's pointing model, and should do a better job of maintaining the alignment of the optical system. The ability to make motions about the center of curvature (and the zero-coma point as well) were also added to the operator's hexapod GUI by D. Gibson, making initial setup and collimation much more straightforward.

### ***f*/5 Shack-Hartmann WFS Software**

A version of the *f*/9 WFS analysis was forked off and modified to work with the *f*/5 optical setup. Most of the initial changes involved optical parameters that differ due to the different telescope and WFS focal lengths. Data were taken with the *f*/5 WFS system during the commissioning run in April, but analysis of that data achieved only partial success. The two main problems plaguing the analysis were the unknown rotation of the WFS system with respect to the optical system, and the inability of the *f*/9 spot association routines to robustly deal with the much finer grid of spots produced by the *f*/5 WFS (see Figure 4 for a representative image). There is also a minor problem with a 1.27 degree misalignment between the CCD camera and lenslet array, but that can be dealt with by rotating each image before the centroiding and analysis are done.



*Figure 4: Representative data obtained with the f/5 WFS during the April commissioning run.*

Several attempts to massage the  $f/9$  spot association algorithms to work with the  $f/5$  setup failed to yield reliable performance. The fine spacing and relatively large distortions near the edges (which were exacerbated by an optical problem that failed to locate the lenslet array at the pupil) made it very difficult to reliably associate spots with their reference apertures in an automatic way. More sophisticated algorithms, such as Bayesian pattern matching, are being researched as a way around this. In the meantime, S. West's interactive aperture overlay script is being resurrected as a way to do the initial association manually. This will also be back-ported to the  $f/9$  package as a fall-back should its automatic method fail (e.g., if the seeing is bad or the image is under or overexposed). A coarser 13x13 lenslet array may also be tested.

### **Miscellaneous**

At the request of (and with the support of) the LBTO, a report describing the internal operation of the primary mirror support software is being developed. The software used at the MMT is also used in the Magellan telescope, and will form the basis for the software to be used at the LBT. This technical report will benefit all of the parties involved.

### **General Facility**

The March 15 - 21 engineering run was devoted to preparatory work for the installation of the  $f/5$  secondary system. P. Spencer, K. Van Horn, B. Comisso, and C. Knop moved the primary mirror cell cable bundle into the new elevation cable carrier and a tie-off point was added to the building. This change is a marked improvement to the cable management of the telescope. R. James and S. Callahan located, drilled, and tapped holes in the secondary hub. A junction box was installed and Minicam cables were rerouted through the energy chain into the spectrograph lab; the additional cables and fibers for Megacam remain to be rerouted.

D. Smith installed the  $f/5$  100 psi clean-air line to the secondary lab for lab testing, and the main line to the secondary hub.

The layout of the east drive arc PI interface panel has been completed by the mechanical engineering group and sent out for fabrication. K. Van Horn will now move on to designing the panel for the control room.

The elevation stow pin configuration has been changed to place it at the top of the safety chain. This allows the “IN” signal to be recognized by the software after the telescope has gone below final limit at horizon. The stow pin is now fully functional at 0.3 degrees. The mechanical assembly of the stow pin actuator still must be recalibrated during summer shutdown, but the software change to a 6-second time limit on power application should eliminate safety concerns.

The RUPS unit has had the “ON BATTERY” signal added to the TOOLS GUI to provide the operator with that information. This modification eliminated the old cabling into the control room and the Sonalert on the bookcase. This information is now run over a fiber from the RUPS room.

Cyrus Jones (UA Atmospheric Sciences) completed hardware installation of a GPS-based Precipitable Water Vapor (PWV) detection system at the summit support building. Work continues on establishing network communications.

Tucson Building and Remodeling (TBR) has been awarded a contract for site work that includes:

1. Summit Support building modifications
2. Bell jar support modifications
3. Enclose the Common Building basement
4. Add an extension to IOTA
5. Upgrade the MMT fire alarm system
6. Make minor modifications to other mountain fire alarm systems
7. Replacement of RUPS (pending funding)

Except for items 5 and 6, work will be delayed until the end of the owl breeding season. Accompanied by T. Welsh, TBR representative Larry Kappler and several subcontractors' representatives visited the mountain on April 3 to assess the work.

## **Maintenance and Repair**

### **Optics**

R. Ortiz and D. Blanco designed and built a special fixture called the Rotator Alignment Tool (RAT). This was installed during the March M&E run and used to survey the location of the primary mirror mechanical axis and the secondary fixed hub with respect to the instrument rotator axis, which has been adopted as the master reference axis for collimating the telescope. B. McLeod and S. Callahan joined in the survey. Using a K&E alignment telescope fitted with a video camera, the primary mirror axis can be located from the center of the coma pattern. Tests will be continued on future nights devoted to telescope engineering.

CO<sub>2</sub> cleaning of the primary mirror is now being done on a regular monthly schedule. Cleanings were performed the first weeks of March and April.

### **Facility Power**

Several power outages occurred during the months of March and April. They were traced to changes in the line made by Citizens Power (now a division of Tucson Electric Power). The branch power to the mountain leaves the main trunk at a substation by Amado; however, a fuse box was recently added near the Agua Caliente Ranch. Recent power outages are associated with this fuse station and have resulted in the loss of one or two phases. This was compounded by a failure of phase detection cutoff switches at the Ridge generator, which resulted in loss of phase at the summit. This was further compounded by the erratic behavior of the summit RUPS, which failed to re-synch, and led to a complete loss of quiet power during an observation.

K. Van Horn measured the frequency of the power produced by the Ridge generator and found a slightly high value – on the edge of the acceptance range of the summit RUPS. This explains the erratic behavior of RUPS when the mountain is on the Ridge generator; it sometimes failed to re-synch, resulting in a failure of quiet power on the summit.

Acting on notification from S. Criswell that federal money was available for the purpose, K. Van Horn, D. Clark, D. Blanco, and J.T. Williams generated a proposal to replace the RUPS with a new solid-state UPS. The new UPS would be located in the ring pit to provide better isolation against lightning strikes. We plan to route the UPS within the building to the front and rear shutters so that these can be closed under power. S. Criswell informs us that the proposal has a good chance of being funded.

### **Building Drive**

Several building drive events occurred during this reporting period. On March 19, while working on the building drives, K. Van Horn noticed a grating sound coming from the SE building drive wheel. Upon closer inspection he and P. Ritz found that the wheel bearing retainer had broken and that the bearing was slowly backing out of its housing. C. Foltz decided to halt operations until the problem was fixed. As a result of round-the-clock efforts by the mountain support staff, the mechanical engineering group, J.T. Williams, and the Steward Machine Shop, the problem was fixed by midnight the following night.

Over the next week, the operations staff replaced the keeper in the NW wheel as a preventive measure. This operation had been performed on the NE and SW idler wheels in August '94 when a similar failure occurred; however, the drive wheels were not modified at that time because the drive transmissions prevent access. Modifications have now been made to all four units to allow access to the keepers.

Early in the evening of April 24, A. Milone reported a gravelly noise emanating from the NW drive wheel. After some phone consultation, D. Blanco decided to shut down the telescope for the night. Upon investigation the next day, the operations staff found that one of the building drive transmissions had become misaligned by about 0.5 degrees relative to the drive motor shaft. The crew realigned the motor and restored operations by evening. During the course of this work, it was

found that several of the assembly bolts in the transmission had come loose. These were re-torqued on both transmissions.

The investigation of other building anomalies by K. Van Horn and P. Spencer, using a Data Acquisition Unit (DAU), noted episodes where exceptionally high building drive currents led to a shutdown of the drives. The problem was traced to a misalignment of the inner bearing race on the #1 motor drive wheel. The bearing was regreased and its retaining rings replaced with more serviceable types that allow for systematic maintenance.

These two failure modes may be incited by rapid temperature variations causing differential expansion between the building and rail, and they highlight the need for more frequent inspections and preventive maintenance of the building drive system.

A further building drive failure mode was discovered while the facility was running on the Ridge generator. This mode manifests itself as a rapid dropout of the building drive and results in a collision with the telescope. A possible failure mechanism could be the dropping of a phase or out-of-range phase voltages – the 480 3-phase voltages are monitored at the building drive disconnect switch by a Tyco 253-pvmu 3-phase protector relay. This device continuously monitors the voltage amplitude of each of the incoming phases, and interrupts the incoming voltages if any of the amplitudes are above or below a set-point threshold, and/or a set difference in voltage between any of the phases is detected. The relay will automatically re-engage when all levels return to normal. The intermittent characteristic of this type of building collision is consistent with power interruptions to the building drive.

### **Blue and Red Channel Spectrograph**

A problem with rotation of the Blue Channel Spectrograph aperture wheel was investigated by D. Smith and P. Spencer. In cold conditions, the wheel would stick at position 4 (slit of 2.0 arcsec width). The sticking would either cause the wheel to fail for slits beyond position 3 (3.5 arcsec, 5.0 arcsec, and the magnetic plate), or the software would become confused and improperly index some of the positions. After changing some software settings and lubricating the gears, bearings, and stepper motors with synthetic watch oil, the wheel now seems to work even when the ambient temperature drops below 32F.

### **ARIES**

Inadvertently omitted from the last Bimonthly Summary was a two-night commissioning run with ARIES and the  $f/15$  adaptive optics system in January. While diagnosing excess astigmatism observed in the AO top box optics, the entrance vacuum window was inadvertently cracked, ending initial tests before closed-loop operation was optimized. The astigmatism was created both by the tilted vacuum window and also by the top box optics. First-light results show that the ARIES optics work nominally, that ARIES has minimal flexure on the telescope, and that pupil images of the secondary can be used for precise alignment and are diagnostic of surface errors in the secondary mirror.

## **Miscellaneous**

The R. M. Young weather monitor broke due to ice buildup and has been repaired; additional spare parts have been procured. K. Van Horn moved slightly the location of the Rainwise weather receiver in the RUPS room, and has heard of no problems since doing so. Please advise him if problems are still occurring.

The gate on the building roof was replaced per SI safety request. The old unit was left in an open state and subsequently ripped off by the roof shutters.

A proposal has been generated and submitted to replace the MMT phone system with one that is more capable and reliable.

## **Operations**

The MMTO maintains a database containing relevant information pertaining to the operation of the telescope and facility instruments, and the weather. Details are given in the June 1985 monthly summary. The data attached to the back of this report are taken from that database.

## **Visitors**

March 29: Dan Brocius and Nelson Caldwell hosted a large group from the Max-Planck Institute, including Hans-Walter Rix (Director, Max-Planck-Institut für Astronomie). A group from Space Telescope Science Institute also visited, accompanied by Melanie Freed of Steward Observatory.

April 19: Dr. Michael Meyer and teaching assistant Abby Hedden accompanied their Astronomy 250 class to the MMT. The group was also accompanied by FLWO docents Jim Trexler, Dick Bruns, John Amirault, and Tom Saville.

## **Publications**

### **MMTO Internal Technical Memoranda**

None

### **MMTO Technical Memoranda**

None

### **MMTO Technical Reports**

None

## Scientific Publications

- 03-5 Optical Spectropolarimetry of Quasi-Stellar Objects Discovered by the Two-Micron All Sky Survey  
Smith, P. S., Schmidt, G. D., Hines, D. C., Foltz, C. B.  
Accepted by *ApJ*
- 03-6 Spectroscopic Discovery of the Supernova 2003dh Associated with GRB 030329  
Stanek, K. Z., Matheson, T., Garnavich, P. M., Martini, P., Berlind, P., Caldwell, N., Challis, P., Brown, W. R., Schild, R., Krisciunas, K., Calkins, M. L., Lee, J. C., Hathi, N., Jansen, R. A., Windhorst, R., Echevarria, L., Eisenstein, D. J., Pindor, B., Olszewski, E. W., Harding, P., Holland, S. T., Bersier, D.  
Accepted by *ApJ Letters*

## Observing Reports

Copies of these publications are available from the MMTO office. We remind MMT observers to submit observers' reports, as well as preprints of publications based on MMT research, to the MMTO office. Such publications should have the standard MMTO credit line: "Observations reported here were obtained at the MMT Observatory, a facility operated jointly by the University of Arizona and the Smithsonian Institution."

Submit publication preprints to [bruss@mmt.o.org](mailto:bruss@mmt.o.org) or to the following address:

MMT Observatory  
P.O. Box 210065  
University of Arizona  
Tucson, AZ 85721-0065

## MMTO in the Media

The origin of  $\gamma$ -ray bursts has been an enigma since their discovery some four decades ago. In the late 1990's the intense bursts of high-energy light were linked to "afterglows" at lower energies that could be associated with generally distant galaxies. Theories for the eruptions have typically involved the collapse of a massive star to a neutron star or black hole, or the merger of neutron stars. However, the "smoking gun" wasn't found until the occurrence of an extremely bright  $\gamma$ -ray burst on March 29. The afterglow from that event was also extraordinarily bright and long-lived, allowing studies from large ground-based telescopes for more than a week following the burst. The MMT and Blue Channel spectrograph played a crucial role in that follow-up by providing a regular series of spectra of the fading light. A compilation of data from several observers (Figure 5) revealed for the first time the extraordinarily broad emission lines of elements manufactured during the detonation of a Type 1c supernova at a redshift of 0.17. The discovery has received considerable attention in the news media, and a partial list of links to web announcements is provided below.

- BBC - <http://news.bbc.co.uk/1/hi/sci/tech/2949735.stm>
- deseretnews.com - <http://deseretnews.com/dn/view/0,1249,490033314,00.html>
- Harvard-Smithsonian Center for Astrophysics - <http://www-cfa.harvard.edu/press/pr0311.html>

- NASA - [http://www.nasa.gov/home/HP\\_news\\_03135.html](http://www.nasa.gov/home/HP_news_03135.html)
- Science@Nasa - [http://science.msfc.nasa.gov/headlines/y2003/10apr\\_grb.btm](http://science.msfc.nasa.gov/headlines/y2003/10apr_grb.btm)
- Spaceflight Now - <http://spaceflightnow.com/news/n0303/11grb/>
- Toledo Blade - <http://www.toledoblade.com/apps/pbcs.dll/article?Date=20030410&Category=NEWS08&ArtNo=104100114&Ref=AR>
- UA News Services - <http://uanews.org/cgi-bin/WebObjects/UANews.woa/4/wa/SRStoryDetails?ArticleID=7206&wosid=tV8FqyiYxp7SmpdstpIVQg>

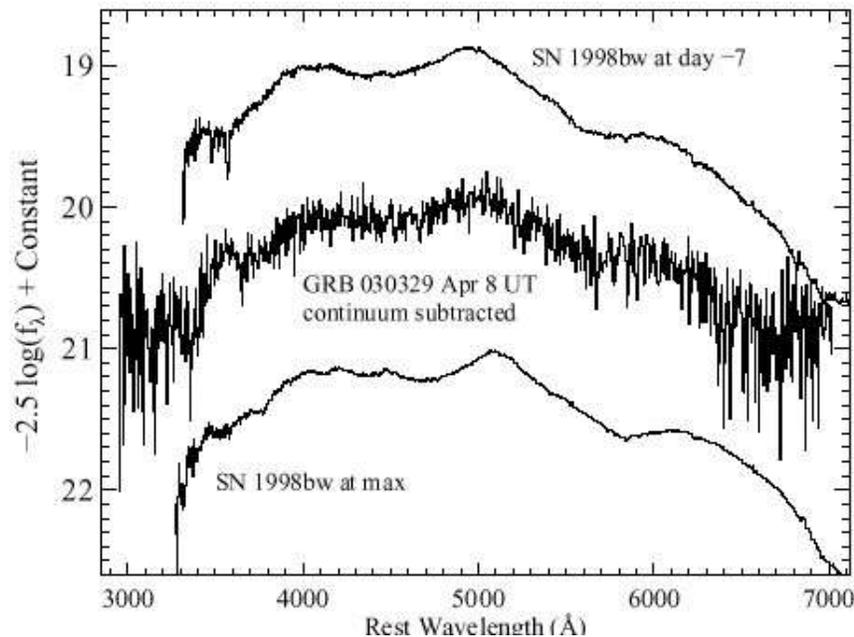


Figure 5: GRB spectra obtained with the MMT and Blue Channel Spectrograph. From “Spectroscopic Discovery of the Supernova 2003db Associated with GRB 030329,” Stanek et al. 2003, *ApJ Letters*, in press.

### **MMTO Home Page**

The MMTO maintains a World Wide Web site (the MMT Home Page) which includes a diverse set of information about the MMT and its use. Documents that are linked to include:

1. General information about the MMT and Mt. Hopkins.
2. Telescope schedule.
3. User documentation, including instrument manuals, detector specifications, and observer’s almanac.
4. A photo gallery of the Conversion Project as well as specifications and mechanical drawings related to the Conversion.

5. Information for visiting astronomers, including maps to the site and observing time request forms.
6. The MMTO staff directory.

The page can be accessed via URL *<http://www.mmt.org>*.