

BIMONTHLY SUMMARY

January - February 2003



The image above shows the secondary cell and hexapod assembly on the test platform. This platform, affectionately known as the "Iron Maiden," allowed 180 degree rotation of the assembly as well as precise adjustment of the mirror support system and calibration of the hexapod support electronics. Image by S. Callahan.

Personnel

In early January, UA undergrad Ryan Hawke was hired to work on miscellaneous wavefront activities.

Mechanical engineer Clede O'Neal left the MMTO in late January.

Development

Primary Mirror Aluminizing

A primary mirror central plug for cleaning/aluminizing has been fabricated and anodized. Experiments are underway to determine which protective coating provides the best combination of chemical resistance and low outgassing. A Teflon coating, similar to the nonstick stuff on your frying pan, looks promising.

The belljar has finally been depopulated. On 10 February under B. Kindred's direction, R. Ortiz, P. Ritz, D. Blanco, and R. Harris (FLWO) removed the two cryopumps and the 3.5-ton gate valve from the bell jar at the summit support building, and relocated them to the FLWO basecamp warehouse. It was decided that the valve was in need of a major overhaul/upgrade and it was returned to GNB in Sacramento. The pumps will be sent to the manufacturer for refurbishment.

A second large gate valve (for our second cryopump) has been ordered. This is to be funded by the LOTIS project, which also will use the MMT belljar.

Primary Mirror Thermal System

MMT Technical Memo #03-7, *Evaluation of Thermal Performance for the MMT Primary Mirror During January 2003*, was written and published. This memo evaluates thermal data from January 2003 against thermal performance criteria as found in *Optical Specifications for the MMT Conversion* (Fabricant et al. 1996, http://cfa-www.harvard.edu/cfa/oir/MMT/mmt/foltz/mmt_conv5/mmt_conv5.html). In all, over 150,000 temperature measurements were summarized and analyzed in the memo.

A visualization tool using animated GIF images was created to animate spatial and temporal thermal variations for the 6.5m primary. This tool allows rapid assessment of changing thermal conditions for the primary mirror.

f/5 Secondary Mirror System

Throughout January and February the main focus of the engineering teams was the integration and testing of the f/5 secondary mirror support and control systems at Steward's Sunnyside vacuum facility. First, the mirror was installed into its cell and all actuators were installed. R. James designed new hardpoint cell attachments with push-pull capability that allowed precise positioning of the mirror in the mirror cell. With support from the electronics group, S. Bauman designed a new electronic card retainer. This retainer supports the cell electronics and seals the ventilation system.

Testing and debugging the f/5 mirror support electronics and hexapod control concentrated on providing robust, low-noise data samples over the serial links from the mirror support board to the operator GUI and the hexapod control firmware. A number of bugs in the printed-circuit layout and wiring errors in the serial link cabling were fixed by C. Knop and B. Comisso. Several firmware and hardware changes were also required to provide the necessary signal isolation and filtering before digitization. A software median filter has been provided for all the link data channels (hexapod LVDTs, support forces, etc.).

Once the operation of the support servo was verified, we moved on to evaluating the performance of the hexapod control (the hexapod controller depends upon LVDT sampling provided by the mirror support board). To aid the initial testing of the hexapod control system, a matrix was formulated to transform Cartesian coordinates of the mobile plate into strut length changes. The tilts are arbitrarily set about the plane of actuator intersections just below the mobile plate. These will be changed after the hexapod passes its initial testing phase. An Internal Tech Memo (#03-3) was written on the general aspects of Stewart platform transformations for the MMT.

Test procedures included measuring the positional uncertainty of the servo, noise on the LVDT samples, repeatability of positioning on individual struts, and global behavior vis-à-vis platform commands from the control GUI. We found that while the analog servo loop developed for controlling the strut lengths worked well at some positions, it fell short of the goals whenever the position demand was inside the static-friction zone of the roller nut. (This can be thought of as a dead zone.) It was felt that increasing the servo integrator gain to restore this lost motion would not result in stable behavior, so the decision was made to abandon the analog servo in favor of closing the position loop in the controller firmware.

Early efforts with the digital servo proved frustrating. There were problems in the non-ANSI compliant C compiler used to generate the firmware for the Microchip PIC microprocessors. In addition, several subtle issues came to the fore about variable declarations, loop counters, and 32-bit/16-bit math operations. Eventually, T. Trebisky and D. Clark were able to overcome these and write some good, working code!

The new code has more robust communications to the VME crate, and runs a digital position loop on all six hexapod struts whenever a new position is demanded by the VME. Interestingly, the servo algorithm is not the standard PID, but instead is a variable-proportional gain algorithm that steadily increases the position loop gain as the position error gets smaller. This defeats the dead zone behavior. Early results suggest that the positional standard deviation with this setup is about equal to the noise from the LVDTs, 3 microns rms.

f/5 and f/15 Temperature Control

C. Wainwright, R. James, and S. Callahan began detailing a new means to deliver coolant to the secondary fixed hub. These cooling lines will deliver chilled methanol to the f/5 and f/15 secondaries from a Neslab chiller located in the west loft.

f/5 Instrumentation

The motors that drive the translation stage and the pusher arm for the Hectochelle order-separating filters were checked out. We found that the interlock switches that prevent the stage from moving when a filter is deployed were not working properly. They were stopping the motion of the filter holder arms during deployment, i.e., they were locking out the wrong motor. This problem will be fixed soon. After bypassing the interlocks, we performed a preliminary alignment between the filter pusher arm and each of the cam followers on the filter holders. The resulting positions were added to the filter position look-up table.

During light-leak tests in the spectrograph room, we found that AndyCam was not operating properly with the Hectochelle camera electronics. J. Geary visited during the week of February 3rd

to troubleshoot the camera/controller interface. After a thorough inspection, he found that the uploaded signal voltages and clock rates in the Hectochelle controller were being reinitialized to their default values just prior to image. The problem was most likely occurring with the Hectochelle camera also, but the default controller values were those of the Hectochelle CCDs.

A. Szentgyorgyi and G. Williams worked during the weeks of January 27th and February 10th to complete the optical alignment of Hectochelle.

R. Eng and N. Caldwell were on-site to install the aluminum frame for the light- and dust-tight tent for both Hectospec and Hectochelle during the week of February 17th.

f/9 Secondary Mirror System

A Tech Memo (#03-4) was written summarizing the support system modifications made during the past year.

f/9 Topbox Shack-Hartmann Wavefront Sensor

In January, the Shack-Hartmann optical system was realigned to the topbox mechanical axis. This activity was required because sometime in late 2002 the wavefront sensor beam became misaligned for an unknown reason. It was discovered that the misalignment was due to the spectrograph comparison source jumping off its kinematic mount (the wavefront sensor pickoff mirror is stacked on top of this assembly).

The system was retested twice prior to the Flamingos run without incident. However, when Flamingos arrived, it was discovered that the wavefront sensor beam had once again become misaligned. Brackets were installed on the pickoff mirror assembly that inhibit misalignments due to shock when the slide assembly hits its limits. Unfortunately, inclement weather during the Flamingos run limited time on-sky, and the wavefront sensor was not retested.

Interested parties should take note of two technical memos on this subject. The first (#03-1) summarizes the optical performance of the MMT as analyzed by this wavefront sensor, while the second (#03-6) describes the practical aspects of the wavefront sensor design, implementation, and alignment.

The other significant topbox modification is replacement of the sapphire beam splitter with a pellicle in the alignment fixture. An adapter should be completed in early March, with installation and alignment planned for the next time the topbox is off for an extended period.

f/9 Instrumentation

Great news! Thanks to the hard work of Mike Lesser and the UA ITL group, we now have a new detector for the Blue Channel. D. Smith, T. Pickering, and C. Foltz installed the dewar on the spectrograph on February 25 and did some initial alignment and performance checks.

The new detector is called "ccd35." This should be entered in detpars as the detector name (detname). The new chip is smaller than the old: 2688 x 512 x 15 micron pixels vs. 3072 x 1024 x

15. This is really not much of a problem since the old detector was under-filled spatially and vignetted in both the red and blue.

The chip has wonderful characteristics: read noise is measured at 2.5 electrons rms; full well is 140,000 electrons; cosmetics are nearly perfect; and the QE is superb ($\sim 65\%$ at 3200 Å, $>90\%$ at 4000 Å and $\sim 65\%$ at 8000 Å). For details, go to <http://www.itl.arizona.edu/UAO/FacilityCCDs.htm> and click on the links for ccd35.

This completes the upgrade of the detectors on the MMT Spectrograph. Both channels now have detectors with read noise more than a factor of two smaller than their predecessors. Thanks again to Mike Lesser and the ITL miracle workers.

Computers and Software

Computer and Network Security Upgrades

While the programmers downtown had all upgraded their desktop machines to Red Hat 8.0 over the course of last fall, the mountain machines (hacksaw, hoseclamp, alewife) lagged behind due to issues relating to the kernel drivers used for the framegrabber cards. T. Pickering finally managed to sort that out, which cleared the path for upgrading the mountain. So far it seems to have been successful, though we're hopeful the next release will clear up some niggling usability issues such as the ability to make a root-level MMT desktop menu.

The wireless access point in the control room that had become very unreliable and weak was replaced with a new one. At the same time, an access point was installed in the main office downtown. Because of the greater security concerns within the campus environment, users will need to consult with T. Pickering to enable access for their wireless device.

To add an extra level of network security, we have had CCIT implement access control lists on their core routers for the MMT network. These effectively work very much like a firewall but do not require any extra hardware. The current configuration blocks all access for network devices such as switches and wireless access points, allows full access for some server machines that can implement their own internal security, and allows a limited number of well-used ports for everything else with some exceptions for special cases.

Tracking Performance Statistics Page

The guider logs are now automatically parsed every morning and the summary page of results updated accordingly. This page can be found at <http://www.mmt.org/tracking/>. Figure 1 shows representative results for a recent calm night. Under such conditions, the tracking performance is quite good with tracking errors of less than 0.1" a majority of the time. Figure 2 shows a worst case scenario where the wind was 30 mph or more most of the night. The current guider and mount servo systems can't keep up with that much buffeting. The guide star FWHM measurements should in principle provide a good indicator of seeing, but f/9 topbox optics and the limited dynamic range of the framegrabber output limit this for the video-based guider used for Blue and Red Channel as well as Flamingos. The guider system for Minicam uses its own direct-imaging guide CCD chip and should provide much better seeing determinations.

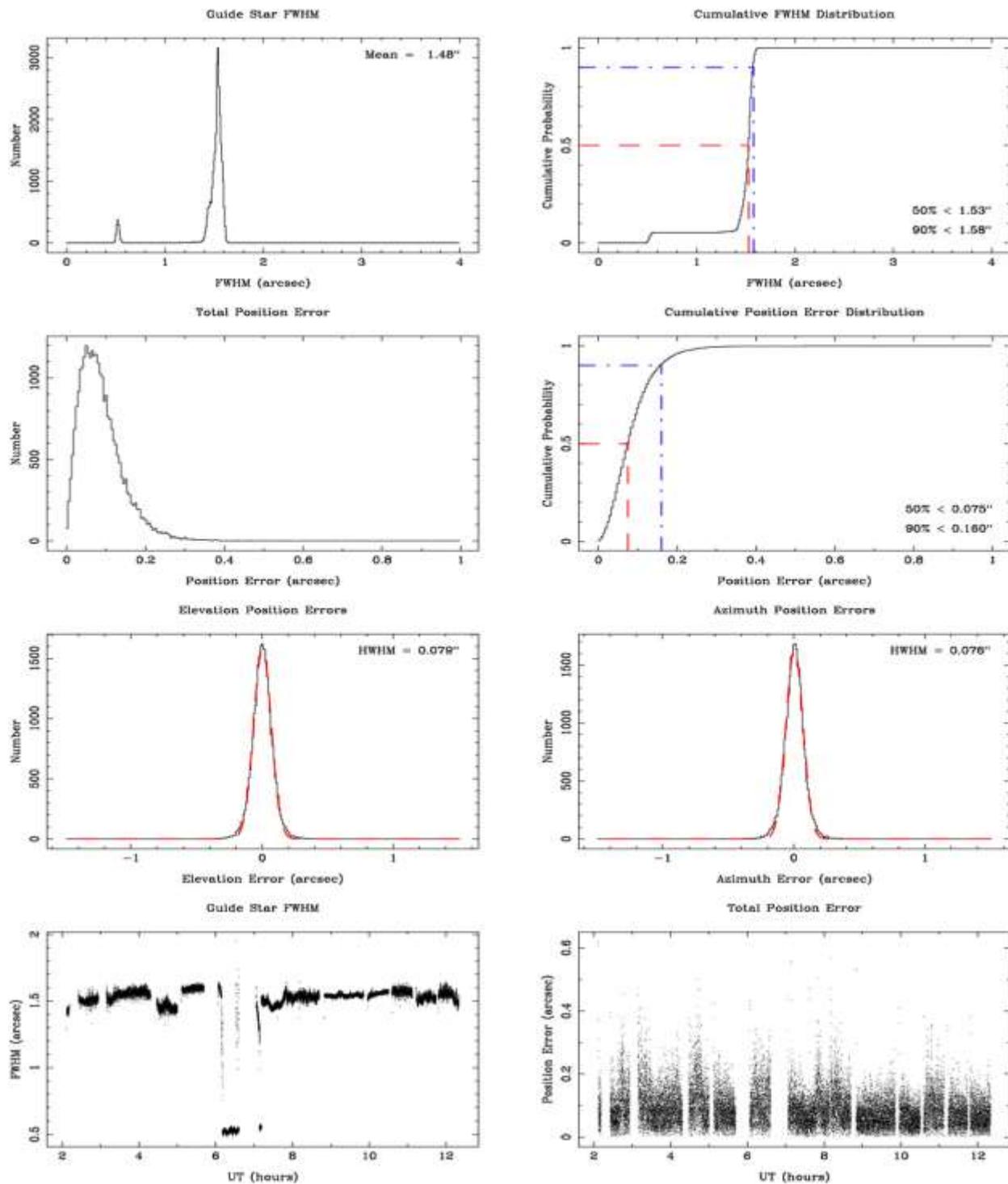


Figure 1: Representative results for a recent calm night. Tracking performance is quite good with tracking errors of less than 0.1" a majority of the time.

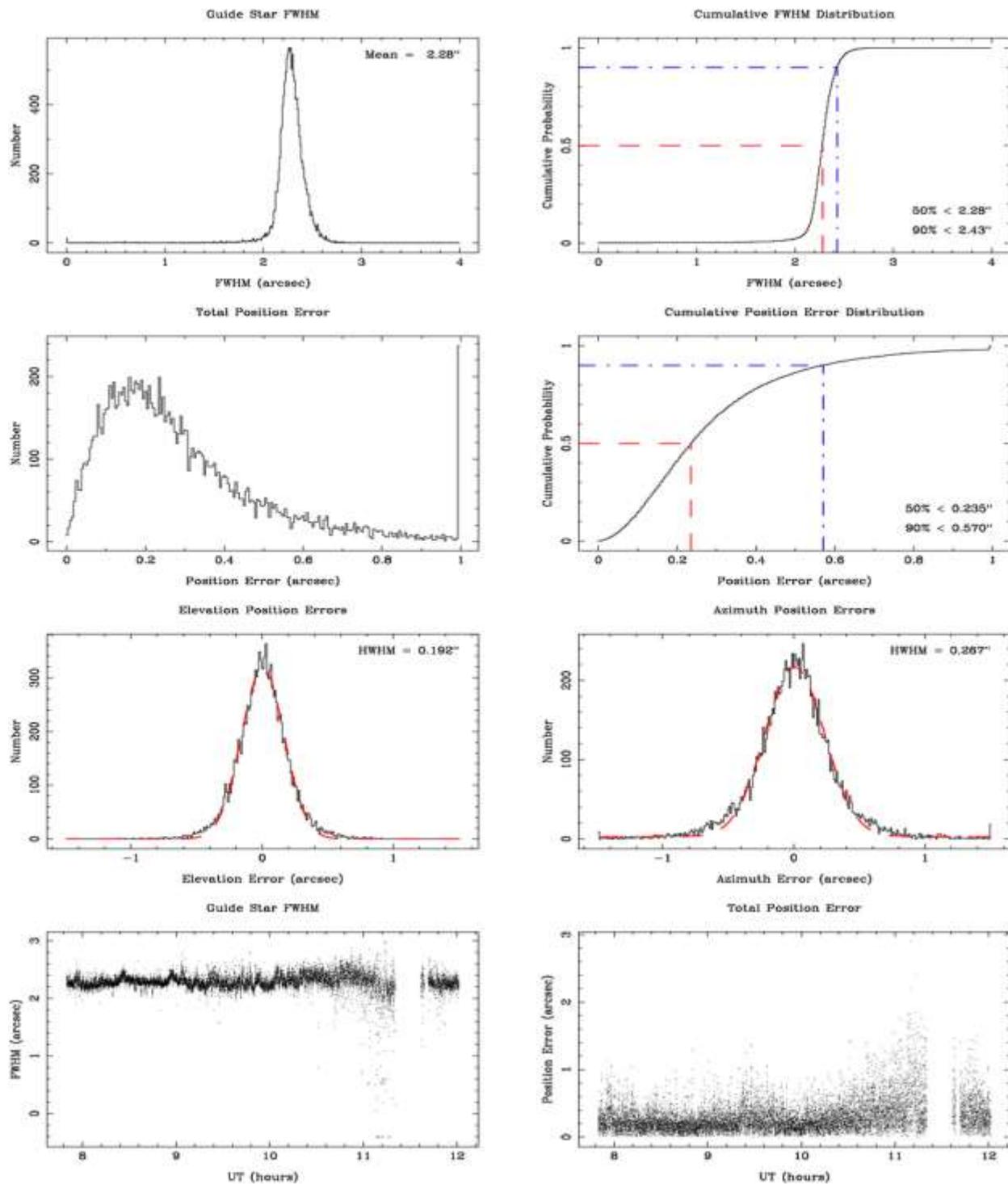


Figure 2: Worst case scenario with wind 30 mph or more most of the night.

f/5 Hexapod Software

Software to control the f/5 hexapod continues to be the focus for much of the software group. The software consists of three components: the user interface, the real-time control software, and firmware in the cell and pod controllers.

A prototype GUI written in Perl/Tk was created and tested for the new f/5 secondary. Along with pod positioning, it allows the monitoring of the support cell and the thermal control subsystem, where applicable. The f/5 prototype GUI has now been rewritten using the newly available Glade-2 and Ruby-Gnome2 programming tools. This GUI has a more modern look-and-feel than can be achieved with the Tk widgets. It is anticipated that most future GUIs will be created using these programming tools, including a single user interface that is intended to handle the entire secondary subsystem for all configurations (f/5, f/9, and f/15)

The real-time software runs under VxWorks in the usual VME chassis with a MC68040 CPU. We considered abandoning this component for f/5, since the control electronics has a serial interface, but there are many advantages for retaining this configuration. In particular, this allows us to support f/9 and f/15 from the same “box” that runs f/5. This box presents a unified interface to the network, and commands such as focus changes can be requested via an identical message regardless of which secondary is mounted. (Retrofitting the current f/9 software to this model is a task we hope to tackle in the months to come.) The current f/9 architecture requires sending such commands to the operator interface, since up to now the real-time crate has only handled pod motions; the platform transforms are done in the GUI.

An “msg” server was written in C that can be integrated into the VxWorks code for the hexapod crate. This msg server will allow new and current SAO equipment to communicate with the new f/5 secondary, using existing network protocols.

General Facility

The new 25 hp Gardner Denver air compressor was installed, retiring the old 15 hp Mattei which will be used for shop air. The new unit is now our main air source, and increases the capacity of the air pressure system to the primary mirror support. Thanks go to T. Welsh (FLWO) and P. Ritz for help with installation and checkout.

Cyrus Jones from UA Atmospheric Sciences started installation of a GPS based Precipitable Water Vapor (PWV) detection system at the summit support building. Mt. Hopkins will soon be added to a nationwide network as part of this innovative weather monitoring system. More information is available at www.suominet.ucar.edu.

On 3 and 4 February the adaptive optics group moved their power bus bars from the lower to the upper spider vane to clear the path for f/5 cable runs. A second cable tray up the northeast corner of the OSS (in addition to the one already installed at the southeast corner) was installed, and the AO cables were moved to this location. K. Van Horn, C. Knop, and B. Comisso rerouted the cables that were housed in a gray plastic tube called the “elephant trunk.” This has been an awkward cable path that required special attention from the operations staff. We are happy to bid it farewell.

K. Van Horn ordered and installed three new 12.5 A UPSs in the servo rack, M1 cell rack, and the M2 rack. These proved their effectiveness during several power outages toward the end of February. A fourth 12.5 A UPS was purchased as a spare, but has been put into service for instrument use. It is located on the east side of the third floor. In order to make room for these changes, the Stentofon was disconnected and its life support removed.

The actuator test stand and spare actuators were moved from the fourth floor to the east side of the third floor. This area will most likely become a test and repair area for mirror cell hardware.

R. Ortiz and P. Ritz installed a new cable chain on 27 February (see picture below). This will be populated with cables for SAO instruments. We also plan to reroute the primary mirror cell cable bundle to this chain. After evaluating a test cable set in late February, we expect to populate the chain in March.



Phil Ritz stands by the new elevation energy chain. In the foreground is the primary mirror cable bundle that will be rerouted through the chain.

Maintenance and Repair

Optics

On 29 January B. Kindred, P. Ritz, and R. Ortiz did a CO₂ cleaning of the primary mirror. We expect to repeat this periodically starting monthly and working up to a bi-weekly schedule.

Building Drive

In February we experienced a recurrence of building drive failures coinciding with the arrival of a cold front. The failures occur during slews, so they have not interrupted observations. The intrepid operators have been able to recover quickly with minimal loss of time. In working on the problem, P. Spencer and K. Van Horn identified several sources that are likely contributing to the failures. First, some of the supply voltages in the building servo rack had drifted, affecting both logic and servo performance. In addition, inspection of electrical components on the servo board revealed a poorly connected integrator resistor. This has been repaired, and power supplies have been repaired and/or ordered for replacement. Since these fixes, intermittent building drive failures have not recurred.

Miscellaneous

Blown circuit breakers for the incandescent lights in the chamber were repaired by replacing one of the toggle switches at the southeast corner of the chamber.

Testing of the drive room 3COM switch has revealed that some ports will not operate with a VME crate but work fine with a Windows machine. Attempts to reconfigure these ports have not solved the problem, and testing continues.

The casters on the topbox cart were replaced. The replacements are pneumatic so we expect to minimize jostling the topbox optics, thus saving time realigning them.

Visitors

In February we had a visit from Tom Hoffman, who was the lead mechanical engineer for the original MMT and a key consultant for the 6.5m conversion. Tom shared several stories of the construction and installation of the original MMT, and engaged in informal technical discussions with the staff.

February 19: Gay Wray, accompanied by Grant Williams, Craig Foltz, and Irwin Shapiro.

Publications

The tech memos listed below are available on-line at URL <http://www.mmt.org/MMTpapers/indexes.html>.

MMTO Internal Technical Memoranda

- 03-1 MMT F/5 Baffles and Double Reflections
N. Caldwell and B. McLeod
- 03-2 Aluminizing the MMT F/5 Secondary Mirror
B. Kindred
- 03-3 Stewart Platform Matrices for the 6.5m MMT
S. C. West

MMTO Technical Memoranda

- 03-1 Fall 2002 F/9 Optical Performance of the 6.5m MMT Analyzed with the Top Box Shack-Hartmann Wavefront Sensor
S. C. West
- 03-2 Test Report for MMT F/5 Secondary Mirror
Steward Observatory Mirror Lab
- 03-3 Status of Pointing of the 6.5 m MMT
T. Trebisky, C. Foltz, S. West
- 03-4 Modifications to the f/9 Secondary Mirror Hardpoints
S. C. West, S. P. Callahan, R. James, D. Clark, C. Wainwright, K. Van Horn
- 03-5 Segmented Zero-Deviation Cross-Dispersion Prisms for the Hectochelle Multiobject Spectrograph
D. G. Fabricant, A. Szentgyorgyi, H. W. Epps
- 03-6 F/9 Top-Box Shack-Hartmann: Practical Design and Implementation
S. C. West, S. P. Callahan, R. James, P. Spencer, H. Olson, B. Kindred, R. Ortiz, T. Pickering
- 03-7 Evaluation of Thermal Performance for the MMT Primary Mirror During January 2003
J. D. Gibson

MMTO Technical Reports

None

Scientific Publications

- 03-1 Two Rare Magnetic Cataclysmic Variables with Extreme Cyclotron Features Identified in the Sloan Digital Sky Survey
Szkody, P., Anderson, S. F., Schmidt, G., Hall, P. B., Margon, B., Miceli, A., SubbaRao, M., Frith, J., Harris, H., Hawley, S., Lawton, B., Covarrubias, R., Covey, K., Fan, X., Murphy, T., Narayanan, V., Raymond, S., Rest, A., Strauss, M. A., Stubbs, C., Turner, E., Voges, W., Bauer, A., Brinkmann, J., Knapp, G. R., Schneider, D. P.
ApJ, **583**, 902
- 03-2 The Strongly Polarized Afterglow of GRB 020405
Bersier, D., McLeod, B., Garnavich, P. M., Holman, M. J., Grav, T., Quinn, J., Kaluzny, J., Challis, P. M., Bower, R. G., Wilman, D. J., Heyl, J. S., Holland, S. T., Hradecky, V., Jha, S., Stanek, K. Z.
ApJ Letters, **583**, L63
- 03-3 The Blue Straggler RS Canum Venaticorum Star S1082 in M67: A Detailed Light Curve and the Possibility of a Triple
Sandquist, E. L., Latham, D. W., Shetrone, M. D., Milone, A. A. E.
AJ, **125**, 810
- 03-4 Radial Velocity Survey of Members and Candidate Members of the TW Hydrae Association
Torres, G., Guenther, E. W., Marschall, L. A., Neuhäuser, R., Latham, D. W., Stefanik, R. P.
AJ, **125**, 825

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 Smithsonian Institution and the University of Arizona."

Submit publication preprints to bruss@mmt.org or to the following address:

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

MMTO in the Media

Articles on adaptive optics at the MMT appear on the Astronomy.Com web site at URL <http://www.astronomy.com/Content/Dynamic/Articles/000/000/001/207xdebz.asp> and on the University of Arizona's UANews.org web site at URL <http://uanews.org/cgi-bin/WebObjects/UANews.woa/2/wa/SRStoryDetails?ArticleID=6807&nosid=ztljsGO2pXiPOFXrRqu601w>.

Two articles about the MMT also appeared in *Green Valley News*. “MMT telescope still making history after reconfiguration” appeared in the January 22 edition, and “New mirror takes twinkle out of starlight” appeared in the February 7 edition.

MMTO Home Page

Important Note: The MMTO web site has moved to <http://www.mmt.org>. Please update your links.

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>.