MMT Observatory
Smithsonian Institution &
The University of Arizona

End of Trimester Summary

January - April 2009

MMT Staff Scientist, Grant Williams (center), along with MMT Telescope Operator, John McAfee (left), and observer, Peter Challis (right) from the Harvard-Smithsonian Center for Astrophysics, are shown being interviewed for the International Year of Astronomy project "Around the World in 80 Telescopes", organized by the European Southern Observatory in Germany. The 24-hour live video webcast held April 3-4, 2009, featured 80 of the most advanced telescopes on and off Earth. The MMT was featured on April 3, at 11:52 p.m. and can be viewed by clicking on the link below:

http://www.ustream.tv/recorded/1340447

Personnel

Bryan Cardwell was hired on March 23 as an electrical engineering student.

Ben Kunk was hired on April 6 as Mechanician, Sr.

Tom Oldham was hired on April 20 as Mechanician, Sr.

William Stangret retired on April 23 after 7 years working with the MMTO mountain operations.

Talks and Conferences

External Presentations

M. Hastie gave the following talks:

-"Stellar Dermatology", Public Talk, Green Valley, AZ, 2/14/09
-"The MMT's Instrument Suite", Invited Talk, Univ. of Minnesota, Minneapolis, MN, 3/13/09
-"The MMT's Instrument Suite", Invited Talk, Center for Astrophysics, SAO, Cambridge, MA, 3/17/09

On February 5, F. Vilas gave a talk about the MESSENGER mission to Mercury at Academy Village, a community of retired university and other professionals, in Tucson.

On March 9, F. Vilas and G. Williams attended a town council meeting at Rancho Sahuarita, a community located north of Mt. Hopkins, where dark sky issues were discussed. Both gave short presentations to the town council.

On April 24, Grant Williams gave a talk at the NOAO Friday Lunch Astronomy Seminar Hour (FLASH) entitled "Nearby Gamma-Ray Burst Progenitors: A Spectropolarimetric Survey of Wolf-Rayet Stars in the Local Group".

RELATED NOTE: Please see p. 22 for *MMT in the Media*.

Meetings/Conferences

M. Hastie gave a poster presentation at the American Astronomical Society Meeting held January 4-8 in Long Beach, CA entitled: "A Novel Approach to Quantifying Chromospheric Activity in T Tauri Stars" (M. Hastie, M. M. Casali, M. Ashley, M. Hidas; #213, #414.11; Bulletin of the American Astronomical Society, Vol. 41, p. 225).

On April 2, M. Hastie attended the UK E-ELT Science Workshop, Exo-planets and Proto-stars with the European ELT, held in Edinburgh, Scotland, where she gave a presentation entitled "Imaging planets with the MMT AO system".

On March 23-25, D. Smith attended a safety audit held at Apache Point Observatory in New Mexico. Safety-related issues were discussed. He also observed the installation of instruments, the night telescope operators, and general observatory operations.

On April 14-15, C. Knop attended a NSF Large Facilities & AST Safety Workshop held at NOAO.

F. Vilas attended the following meetings:

-Chaired the inaugural meeting of the NASA Small Bodies Assessment Group on January 12-13 in College Park, MD.
-Served on the Lunar and Planetary Science Conference Program Committee, January 20-24.
-Chaired the first meeting of the Survey and Detection Panel of the National Academies Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies on January 28-30 in Washington, DC.
-Attended a MESSENGER MASCS team meeting on March 11-12 in Tucson, AZ.
-Attended the Lunar and Planetary Science Conference on March 23-27 at The Woodlands, TX.
-Attended the meeting of the National Academies Committee to Review Near-Earth Object Surveys and Hazard Mitigation Strategies on April 27-May 1 in Maui, Hawaii.

Primary Mirror Systems

Primary Mirror Support

Actuator #147 continued to show warnings during operations. Inspection revealed that the unit installed in place of the original failed unit (which was blowing the 48V supply fuse on the sector distribution card) was a low-force unit intended for service in the mirror edge position(s). This explains why the unit could never achieve the 300lbf command; the edge units have a maximum available force of ~240lbf. It is unclear why the improper model actuator was installed.

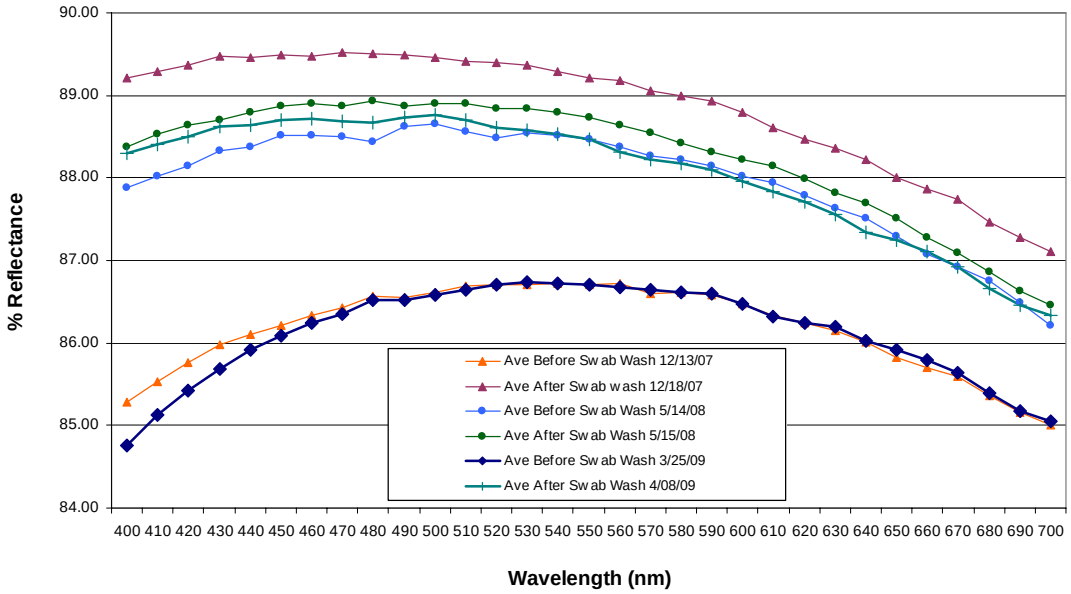
The original #147 unit's card was repaired and the complete actuator was tested on the test stand; it passed. This unit was then re-installed in the cell. Individually bump testing passes, global bump testing passes, and the mirror was successfully raised without force warnings on #147 at zenith (~300lbf).

Optics

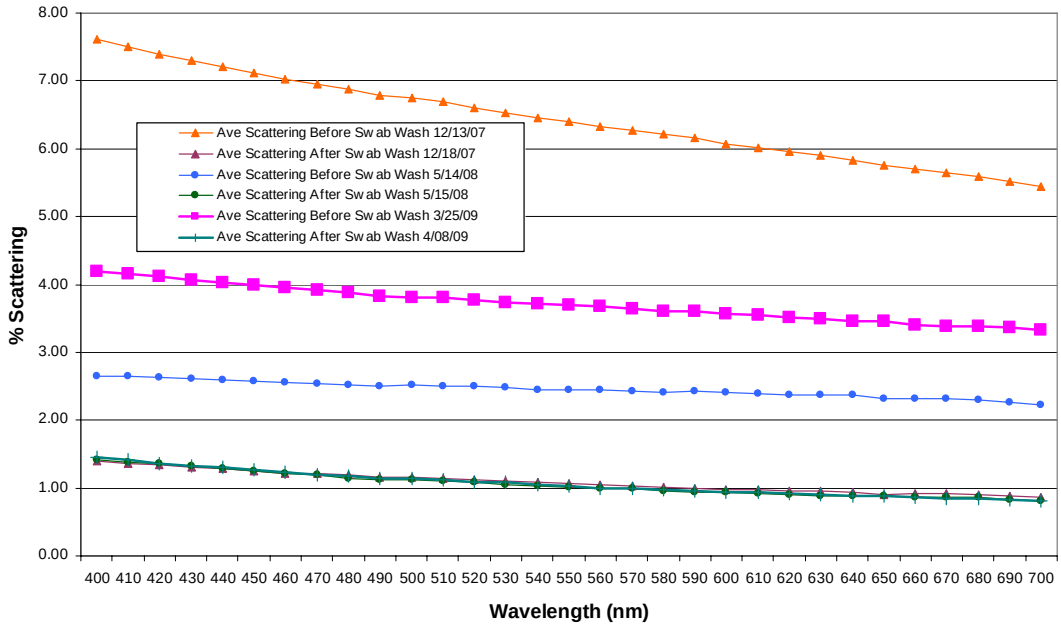
The M1 mirror was washed successfully April 6-8. The reflectance and scattering measurement results were excellent, enabling aluminization to be deferred until 2010. Below are plots showing the reflectance and scattering measurements compared with previous measurements.

Images of the M1 preparation and mirror wash were captured. Preliminary movies have also been made of these images. Further work is needed to edit the movie and to add narrative. Still images are also available showing mirror characteristics before and after the wash.

Swab Wash Reflectance Comparison Dec07 & May08 & April09



Swab Wash Scattering Comparison Dec07 & May08 & April09



Thermal System

The new Type T thermal system was installed on the telescope in late April. The electronics enclosure was installed in the northeast quadrant for preliminary testing. At this time, absolute temperatures are only available for the faceplate and in one location on the backplate. (There is only one thermocouple on the backplate.) Differential temperatures are available across the frontplate. An additional absolute card was added to monitor the chamber temperature, enclosure temperature, and the IJB block used for the differential card.

Aluminizing

The addition of a breakout panel to the aluminization monitoring box will soon be completed. All parts were received; however, we did not have the correct crimping tool for one of the RG-174 cable connectors. The tool is now in hand and the job is estimated to be completed by the end of May.

The rebuild of the glow-discharge power supply was completed, and it was successfully tested in the lab with a light-bulb dummy load. This dummy load and all the new cables are now stored with the unit for future use.

Optics Support Structure (OSS)

Secondary Hub

A broken return "up" spring was replaced on the 10,000-lb Hydra-Set after it suffered a failure. The oil was also drained and refilled at the same time and the Set is now working properly. This unit is used to position the secondary mirror on the hub and is capable of raising and lowering in .001-inch increments for precise positioning.

Secondary Mirror Systems

f/5 Secondary Support

In late 2008, the f/5 mirror support system started to intermittently fail to display support data on the graphic user interface (gui). The mirror appeared to be supported properly but the location and forces were not being recorded. Testing revealed that the Lantronix unit was the problem. Since its replacement, the system has been operational. Some of the secondary support software has been modified to improve robustness. The new code works well with the f/5 mirror but has a glitch that prevents it from working properly with the f/9 secondary support system. Testing and evaluation will continue when the f/9 is installed.

Telescope Tracking and Pointing

Mount Pointing and Tracking

The tracking performance for the final trimester of 2008 for the elevation axis was evaluated and reported in MMTO Internal Technical Memorandum #09-2. The median elevation tracking reported was 0.072" RMS. This report is available at the URL:

http://www.mmto.org/MMTpapers/pdfs/itm/itm09-2.pdf.

A follow-up report for the azimuth tracking for the same period is planned.

The mount computer experienced a puzzling failure during the reporting period. For a still-unknown reason, the PC BIOS experienced an upset that changed the PCI-bus system settings. At boot time, the BIOS assigned PCI bus addresses that were different than those before. The VxWorks PCI support library (created by MMTO to allow us to use the PC486 version of VxWorks (5.3.1) didn't scan for these new addresses, so the PCI I/O hardware within the mount computer's infrastructure became unavailable to the software. The problem also revealed that the spare IP (IndustryPack) module carrier was not working, while the one that was in use was still functional. To overcome this issue, the PCI support code was rewritten to scan the bus for all possible hardware. The broken IP-carrier was sent to GE Fanuc for repair, and a spare was ordered.

Work has begun to calculate all coordinates at the same rate as the servo update rate (currently 1000 Hz). This will yield a smoother servo command stream while the telescope is tracking.

Encoders

Fabrication of a new test box for checking the alignment of the instrument rotator heads began in late April. This new tool will provide an independent method of checking the counting and index-mark output from the tape heads. Since we depend on robust detection of the index marks on the rotator tape for calculating the rotator position, this tool will make it possible to verify that the heads are indeed outputting the index mark pulse at each index position. We plan to use this tool with the newest iteration of the head mounting bracket reported in the last trimester report to confirm the performance of the head alignment.

Assessing Mount and Hexapod Pointing Performance

After the mirror wash, we had one on-sky Maintenance & Engineering (M&E) night with f/5 installed on April 8-9. The time was used to fix f/5 Wavefront Sensor (WFS) issues pertaining to newer versions of Tcl/Tk, to obtain pointing data, and to obtain elcoll data.

The f/5 WFS software issues stemmed from a Tcl/Tk script, originally written by SAO, which was used to perform most stage motion and image acquisition tasks. It was written in a way that works with Tcl/Tk 8.4 or earlier, but doesn't work with Tcl/Tk 8.5. It would have taken significant rewriting and refactoring to make it compatible, so it was easier and ultimately cleaner to simply replace it. Where motion control commands are sent, the code was changed to send network commands directly to the 'waveserv' motion control server. The image acquisition commands are

now carried out by executing a simple, 8-line shell script that takes an exposure time in seconds and a filename as arguments.

Other WFS software changes were made to fix various issues with deploying the WFS off-axis. These were tested and off-axis WFS data was acquired. No obvious signs of M1-M2 misalignment were found in these data, though the poor weather conditions probably prevented us from getting data that were stable and consistent enough to test that adequately.

The software changes were also tested by performing a long elcoll run. The results of this are shown below in Figure 1. The systems were out of thermal equilibrium after being closed up and worked on for more than two days and then closed for most of the first half of the night due to clouds. This is likely the cause for most of the scatter seen in the results, especially for focus (Z motion). However, it's clear that there are significant zero-point offsets compared to the previous results (red lines). There may be slight changes in the elevation-dependent terms, but they are not significant given the scatter in the data. It's also clear that the significant transverse terms (X and Ty) that we've been observing are still there. The hexapod open-loop parameters were updated to use these new results, except for focus where only the zero-point was updated.

After the elcoll run was completed, we took a set of pointing data. The conditions were a bit poor and the automatic selection of reference stars was not as efficient as we would have liked, so not as much data were obtained as intended. It was clear while taking the data, however, that the combination of updated elcoll and existing pointing models yielded very good results. Even long slews usually brought stars within 1-2" of the center of rotation. We saw some slight signs of systematic behavior as a function of position on the sky. Due to wind, though, the data were too sparse and noisy to provide a significant improvement over what we had.

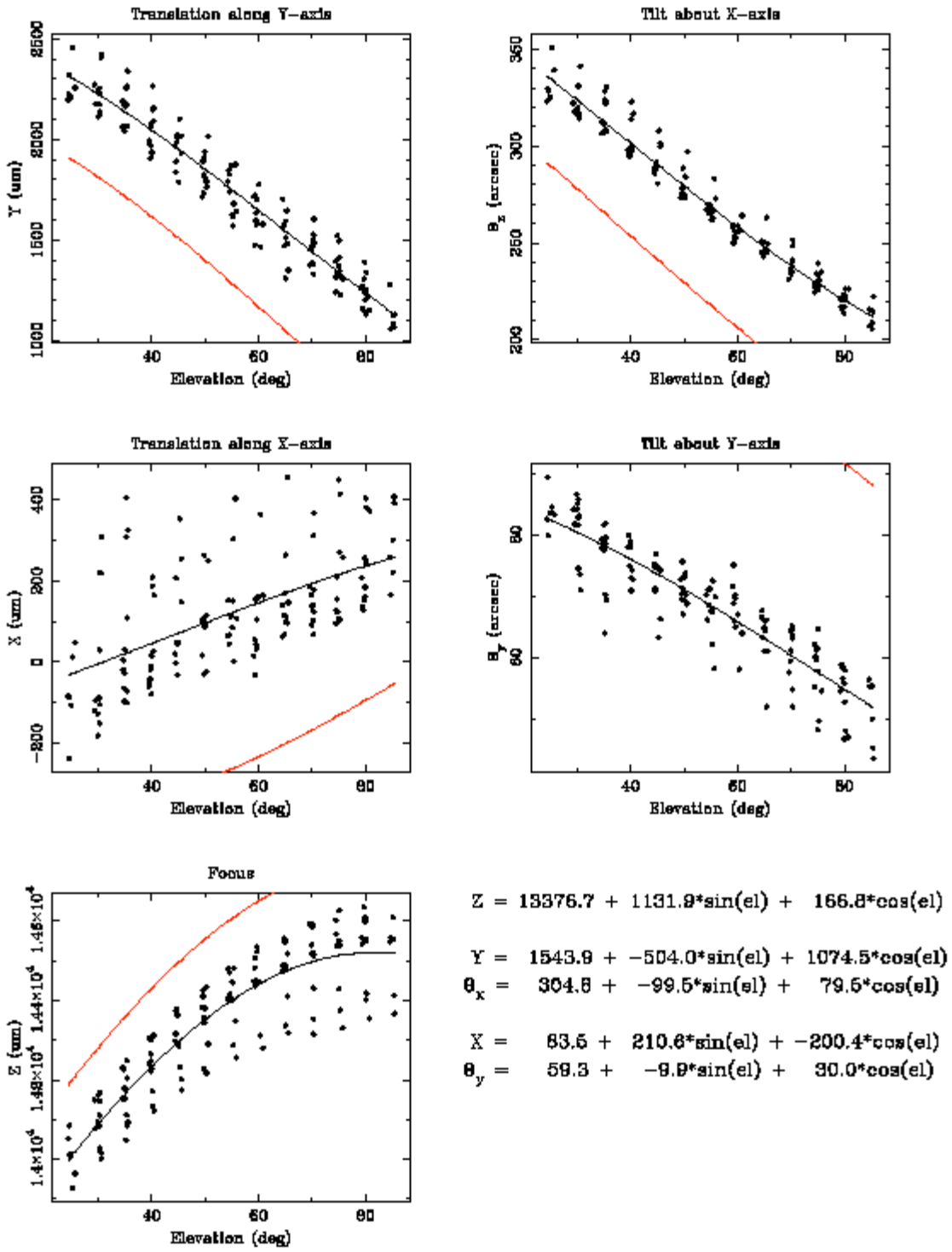


Figure 1. Results of the elcoll data obtained during the night of April 8-9. The best fits to the current data and to previous data are shown as black and red lines respectively.

Computers and Software

M1 Mirror Ventilation System

The automated control of the M1 ventilation system, "vent_auto", was revised and includes use of a new high-capacity dataserver (described in more detail in the next section). A new vent_auto MySQL background log was created that can be used to monitor and assess performance for the vent_auto algorithms under various operational and environmental conditions, such as high outside dewpoints and warm M1 glass temperatures.

Miniserver Improvements

The implementation of a unified approach to miniserver design and programming continued. This unified approach is currently used in several dozen miniservers involved in data telemetry and logging for subsystems at the MMT. The unified approach combines two existing processes for each miniserver into one process, making use of common code for most miniserver functionality. It also makes extensive use of configuration tables. Configuration data have been incorporated for approximately 1840 miniserver parameters. These configuration data contain information related to measurement units, descriptions, expected values, miniserver associations, and MySQL and RRDTool logging details. Related MySQL configuration tables contain information on general miniserver information, such as update interval and log file locations. Work continues on migration of new and existing miniservers into this unified approach.

A single, high-capacity dataserver was developed as part of the unified miniserver implementation. All of the 1840+ miniserver parameters as well as additional derived or composite parameters are available from this dataserver. In addition, the web-based MySQL background log "data dumper" was updated to use the unified miniserver configuration information.

A new Python/matplotlib, web-based plotting application for logged MMT miniserver data was implemented. This plotting application allows up to eight parameters to be plotted on the same graph to facilitate data analysis and comparison. The application accesses several gigabytes of logged MMT telemetry data. This code was originally written using mod_python. However, mod_python was found to use excessive memory with larger database queries. Use of CherryPy was also investigated and may be used if the user load increases for this and related applications. Currently, the plotting application is being run as a CGI script.

A new miniserver and related logging for the T-series thermocouple temperatures for the primary mirror NE cell quadrant was set up. Work began on combining code for the loft and pit Neslab miniservers into a single Perl module that can be shared by these two miniservers.

Astronomers' Log

For several years our telescope operators have been using a web-based logging tool. Throughout the night, they make entries in this log, which can immediately be viewed by anyone on staff. More commonly the day staff checks this log the next morning as they begin their day. This log complements the "SR system" that is used to submit and track trouble reports.

It was felt that making a facility like this available to the observers would be beneficial in many ways, and so an "Astronomers' Log" was implemented. Like the operators' log, this allows observers to report problems or comment on situations in real time, rather than waiting until the end of their run to submit a comprehensive report. Details can be recorded immediately instead of observers relying on their recollections of what happened days before. This facility seems useful as it stands and we hope to improve and enhance it as we gain experience and receive feedback. As a result of some feedback, we have developed an improved log viewer that provides both the operators' and astronomers' logs. Also, both logs are now distributed by automated daily email to the day staff, providing easy access of nightly operations and observations.

Non Sidereal Tracking

For some time, the MMT mount computer has supported the tracking of non-sidereal objects. The upcoming LCROSS (Lunar CRater Observation and Sensing Satellite) mission will culminate in the LCROSS satellite impacting on the lunar surface. The MMT is among the observatories that will be observing this event. Tracking specific points on the lunar surface presents new challenges. The MMT will rely on ephemerides obtained from the JPL Horizons system. We already have a tool that fetches ephemerides from JPL Horizons using their web based interface. Unfortunately, the web interface does not give access to coordinates requested in the form of lunar latitude and longitude, and it was necessary to develop a second tool to obtain these from their telnet interface. This tool was written (in the ruby language) as a command line script that can fetch emphemerides and immediately command the mount to acquire an object. Alternately, the ephemerides can be fetched in advance for a specified time and target and saved as a disk file. Such files can be loaded into the mount computer when they are needed, eliminating any real-time dependence on a network connection to the server at JPL.

Servo performance tools

In support of the ongoing effort to improve the azimuth servos, our servo performance data collection and analysis facility was extended and improved. At this point we are using it to collect data to characterize the existing azimuth servo. These data will be a baseline to which we will be able to compare data collected from improved servo controllers.

Crate console logger

We have found it useful to capture and log all console output from each of our VxWorks computers. The VME bus based crates send console output to serial ports, and we have used Lantronix serial-to-network converters to capture the output. Our x86 based mount crate does not have a serial console. We have developed an application that establishes a network connection via telnet (intercepting the console stream) and logs this to a file. This will provide a console log for the mount crate, but will be equally useful for the cell crate and other VME VxWorks computers, allowing us to have a console log without having to use a Lantronix unit (and allowing the Lantronix currently in such use to be released to some other purpose).

Windows Software Updates

Windows Active Directory and Windows Server 2003 administration continued, including:

a) replaced defective USB drive for vault.mmto.arizona.edu, the /MMTWindows Active Directory domain server,
b) set up additional user and administrator Active Directory accounts for MMT personnel,
c) installed additional software on vault to ease system administration,
d) scheduled weekly backups of Windows Active Directory users files from vault,
e) began compiling results of a survey of current Windows usage in the MMT department.

Replacement of Windows Server 2003 and Active Directory for MMT staff was investigated, with the possible use of existing LDAP authentication as is used by MMT Linux users. Installation of pGina with Windows XP was done on three MMT Windows machines with LDAP authentication to the MMT LDAP servers. A description of Windows XP installation, using pGina and LDAP authentication, was written for the MMT Dokuwiki.

Miscellaneous Software Topics

Software staff worked on a replacement for the "mmtservice" script. The new script, "mmtserv", uses DNS SRV records for host and port information for network services. This puts all host and port information in one place, making changes much easier, and aids in moving quickly to a backup server in the event hacksaw suffers a long outage. Timing adjustments and a few other bugs were fixed, and a web page was built to show the status of all services. The mmtserv script controls approximately 65 separate processes on hacksaw and other MMT machines. These processes are running continuously and perform a wide array of functions for the MMT, including the data telemetry.

With the SRV database fully deployed, modifications were made to the client side of the software that runs the saoguider, ccdacq, the blue/red spectrograph guis, the primary mirror support guis, the high speed data gathering for the hexapod, and the NGS AO guis and related software.

The NGS AO data, topbox, and science servers were also modified so that they are now managed by mmtserv, and a generic log tailing server was written for them. More information was added to the ao_gui tss tab, and code was installed to open the loop if the tss goes into safe mode, and warn the telescope operator.

The telescope balancing graphical user interface (gui), "balancer", was updated to add data for the MMIRS instrument and to remove seldom-used interfaces to observed and calculated telescope balance data. The code was also converted to use a Make file and the mxmlc compiler directly, rather than require the Eclipse-based Flex Builder integrated development environment for compilation of code.

Applications on the MMT computers, including the MMT operators' computer, that are menu-accessed and web-based, were updated to take advantage of new features of Firefox 3.0. The use of individual profiles for each web-based application was removed. Firefox 3 allows quick recovery of windows and tabs on restart. This rapid recovery requirement for the telescope operators was a main reason in running each web-based application as its own process and with its own Firefox profile.

The MMT Operators' and Astronomers' logs were set up to be distributed by automated daily email. This provides timely feedback of nightly operations and observations to the day staff.

A secure blog for the MMT electronics staff use was set up to assist them in documentation of their activities.

Mountain linux machines were upgraded to the Fedora 10 operating system.

Instruments

In order to improve support for all instruments, a roster was created assigning a lead person for each instrument or system.

f/15 Instrumentation

Natural Guide Star (NGS)

The f/15 DM system was used on the telescope twice during the 2009a trimester: 14 nights in NGS mode in January and 4 nights each of NGS and LGS time in March. The first four nights of the January run were lost due to a winter storm, and portions of several other nights were also lost due to poor conditions. The March run was also plagued by poor weather, with three nights lost entirely and most other nights losing at least a few hours to conditions.

For the most part, the DM and NGS systems performed well. There was a gap contamination event on the night of January 8 that was severe enough that the last three hours of the night were lost. The "push-n-wiggle" routine was applied to the DM the following day and that reduced the effect of the contamination enough to get the system working properly. The maximum gap when the DM was pulled against the reference body was still 40-43 microns and remained that way for the remainder of the January and March runs. This didn't appear to affect the efficiency of operations for NGS, but may have done so for LGS. It's also not very desirable to stress the mirror by operating with that much contamination. On April 16 a crew of MMTO staff, assisted by M. Montoya and R. Sosa (SO/LBTO), removed the DM's shell for cleaning. The process went very smoothly and helped acquaint several new MMTO staff members with the required procedures. Although removing the shell elevates the risk, the contamination was again safely removed without incident.

A number of AO software tasks were worked on during this time; however, the lack of on-sky engineering time due to weather prevented most of them from getting sufficient testing to allow them to be fully deployed. The two most important features that require more testing are PID servo control of the DM and porting of the ability to enable/disable the DM's real-time loop mode directly from the PC reconstructor (PCR). Currently, starting and stopping the AO loop requires extra mouse-clicks to do before or after RT loop from the DM control gui in addition to clicking close or open AO loop. We hope to get these capabilities fully tested and deployed during the 2009b trimester.

Laser Guide Star (LGS)

To support data-acquisition operations on the DM accelerometers, the previous AO LGS accelerometer interface electronics were documented, removed, and replaced with a better designed electronics box that packages the power supply, wiring, and connectors in a 19" rack mounted

enclosure. The new box also supports additional connections for acquisition of the accelerometer data.

Work continued on the west drive arc panel for AO LGS. The BNC and fiber connectors were installed. One fiber has been run from the yoke room to the new panel.

f/9 Instrumentation

Blue Channel and Red Channel Spectrographs

Following the instrument change on Saturday, January 17th, a problem was discovered with the Red Channel deep depletion CCD during check out. The images had the appearance of window shades which were not regular or straight. In an attempt to clear the problem, the power to the camera was cycled and the Windows computer that runs the detector server was rebooted. The problem persisted and therefore Dave Baxter of ITL was contacted. He suggested disconnecting the power from the power supply for a few minutes. None of the attempts fixed the problem and so the Cassegrain was reconfigured to use Blue Channel for the night. Red Channel was sent to ITL for troubleshooting and repair. Unfortunately, the diagnosis was that the detector had failed. It will be replaced with a similar device and sent back for testing and use in the second trimester.

f/5 Instrumentation

MMIRS

There has been a great deal of preparatory work done this trimester in anticipation of the arrival of MMIRS (MMT and Magellan InfraRed Spectrograph) and its first commissioning run in May. Power and communications were routed per SAO specifications; noisy and quiet power with 30 amp service was provided to the east and west instrument storage rooms as well as to the drive arc. Optical fibers were run from the yoke room to the east and west instrument rooms; we are currently awaiting delivery of the last set of fibers to run from the yoke room to the drive arcs for the on-instrument guiders. The MMTO assisted the MMIRS team in the design of the cable drape to support the cables from the drive arcs to the instrument. A preliminary drape design was fabricated and tested prior to the arrival of the MMIRS instrument.

In addition to preparing the telescope, a significant effort was afforded to preparations for transport of the instrument from Cambridge, MA to the summit of Mt. Hopkins as safely as possible. Solutions for gentle transport of the instrument up the mountain road were scoped and agreed on, as were the procedures for unloading the instrument into the observatory building. A major decision to invest in air casters for handling MMIRS, and subsequently other instruments, was agreed on and the equipment procured. A report on the commissioning will appear in the next trimester summary.

Hectospec

A January servicing mission was undertaken by an SAO crew to address a problem that developed in December 2008 with gripper 2 in the fiber positioner. The team found that the opto-interrupter sensor was set too close to the operating position of the actuator. The margin was only a couple thousandths of an inch and was corrected to be the same as that of gripper 1, about 13 thousandths.

The Hecto spectrographs gathered many spectra over the 60 days the positioner was on the telescope this trimester. There were only a couple of minor issues with operations, resulting in minimal time lost due to instrument problems. A guide rail was installed in January to help guide the positioner during installation and removal to avoid sideloads on the fiber chain. One of the calibration lamps was replaced; another set of lamps has shown reduced intensity, which will require additional investigation. The dark current on Chelle was monitored extensively and was reduced with improved baffling.

Megacam

Megacam was on the telescope on January 1 to start the year and then for another six days in April. There were some software issues that surfaced during this run but it was successful overall. Megacam is scheduled to be moved to the Las Campanas Observatory in Chile later this year for use on the Magellan Clay Telescope.

Seeing

The overall seeing during the 2009a trimester was markedly worse than what we enjoyed last fall. The median jumped from 0.68" to 0.88", the mean from 0.73" to 0.97", and the mode from 0.58" to 0.73". The histogram of seeing data for the entire trimester is shown in Figure 3.

The change in seeing conditions is largely due to the weather, which became a lot more unsettled starting in late December. Breaking the data out into individual months (Figure 4) reveals that February and April were significantly more unsettled on average than January and March. April, in particular, was marked by a steady procession of strong frontal systems passing through every few days that, while dry, brought along plenty of wind and cooler temperatures.

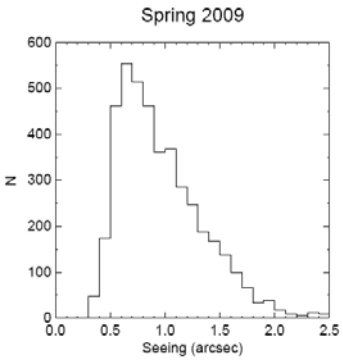


Figure 3. Histogram of Spring 2009 seeing data (corrected to zenith).
Data were acquired using the f/5 and f/9 Shack-Hartmann wavefront sensors.

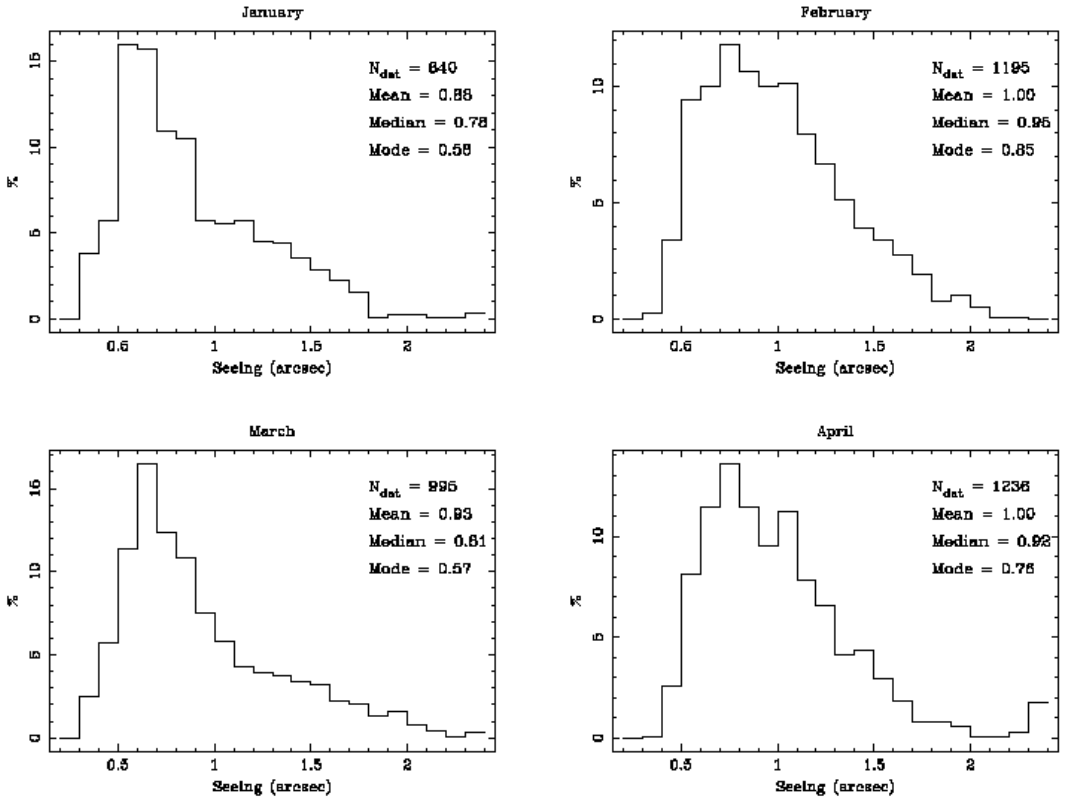


Figure 4. Spring 2009 seeing data broken down by month.

Documentation

The MMT drive room consists of equipment required to physically move the telescope structure in both azimuth and elevation, along with some miscellaneous sub-systems. The majority of the equipment used for azimuth and elevation control was locally designed and fabricated, so there are no commercial off the shelf (COTS) manuals or web sites that provide documentation on the system. The MMT is working to develop its own documentation (schematics, troubleshooting procedures, preventive maintenance requirements, illustrated parts breakdowns) to be kept in a central location so it can be easily found if maintenance is required. A document is being created that will display the layout of the drive room racks. By clicking on a particular device in the rack, a folder will pop up with all the documentation associated with that device. A separate folder was created for each device installed in the drive room rack, and that folder was hyper-linked to the name of the device located in drive room layout document. This folder is in the process of being reviewed and finalized. When complete, it will be relocated for ease of access for all maintenance personnel. A hard copy of this document will also be kept in the electronics lab at the MMT.

General Facility

Building Drive

In early January, we had reports of the building drive intermittently shutting down during operations. Both DC and Normal red lights would illuminate on the amps. All the fuses in the building drive, the DC bus, motor field, and power supply bus voltages were checked and found to be good. The individual amplifier output current/voltage were also checked. There was some imbalance in the anti-backlash output currents with significant drift. After leaving the building drive powered on ~45 minutes, no anomalies were noted in the drive's operation. A subsequent inspection after another failure revealed loose high voltage input lugs on #2 amp. They were tightened, as well as the 480V lug connections. Data were grabbed using the Fluke power analyzer meter. The system has worked flawlessly since this repair.

Circuit card schematic reviews for both the building drive fault card and servo cards was completed, mostly for identification purposes to identify which signals are inputs, outputs, and their locations. This will aid with design and fabrication of test tools that might be needed to get data for troubleshooting if there are any future intermittent building drive failures.

Weather and Environmental Monitoring

The WXT-520 (Vaisala 4) located on the west side of the MMT structure was removed, repaired by the factory, and reinstalled. The Vaisala 4 and the R.M. Young anemometer both display near identical wind information for the west side of the building. Vaisala 3, a WXT-520 installed on the east side, is also operational. A new gui displays all the wind data from these three instruments as well as the wind sensors on the summit.

Additional spare items for the R.M. Young anemometer were ordered and have been received.

A replaceable lightning suppression box was designed and built for the west flag pole electronics. The plan is to have one of these boxes at the top and bottom of each flag pole to prevent damage to weather equipment. All of these boxes will be identical, with two spares built up for ease of replacement.

A Temptrax environmental monitoring unit was installed to monitor the temperature of a small test area on the MMTO building roof. An area of the new white roof had a probe attached directly to it as well as another one mounted approximately three inches above it. A similar setup was used on a test section of roof covered in aluminum tape. Test data are being recorded and will be analyzed to determine the effect of the new roof on the overall thermo dynamics.

An inventory was completed of all the weather-monitoring equipment and their capital costs, along with a summary of the repair and maintenance costs for the equipment. This will be used as a tool to determine what weather equipment is required for operations, and the cost, in order to make more informed management decisions.

AO Electronics Rack

The AO electronics rack, which is essential to the operation of the AO subsystem, must accompany the AO secondary mirror wherever it goes. This is a difficult process, with several obstacles to overcome.

First, the AO electronics rack was designed to operate with 120V 3-phase power, which is readily available at the MMT. In the AO maintenance room in the Common Building basement, only 120 single phase was available. This required adjustment to the DM power supply to increase the current output to safely operate the AO mirror when located in the Common Building. Not only was it extremely tedious to get to the potentiometer to adjust this, it was also unsafe to operate the equipment with two different power sources. A new 3-phase power outlet was added to the AO maintenance room to remedy this problem.

To simplify handling the cables (we have to disconnect and re-connect every time we move the electronics rack), a quick-disconnect panel was manufactured and attached to the rear of the AO electronics rack. This clearly identifies which cables need to be disconnected to transport the unit, and centralizes all the connections required to operate the electronics rack, which makes running the AO system simpler and safer.

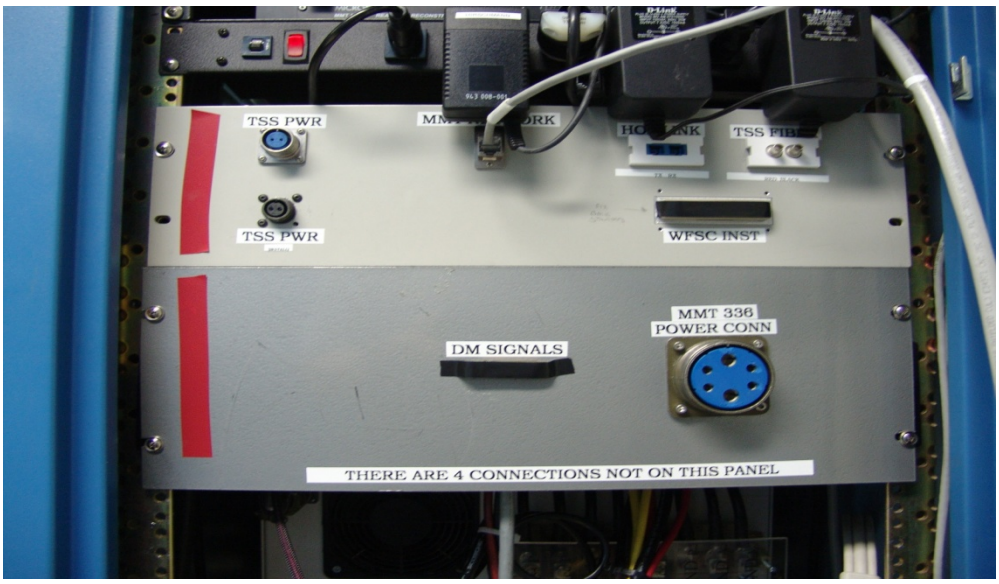


Figure 2. AO Electronics Rack

Common Building

An ongoing task of clearing up the lower floor of the common building took a big step forward this trimester. The main room and a number of the side rooms have been cleared and cleaned with the intention of using this space as overspill for instrument storage from the summit. Many items have been organized and labeled to keep the space better arranged. Work continued on cleaning out the

AO DM test stand room and to consolidate equipment. The metal-working machines will be removed shortly so that we can keep this area as clean as possible. Additional storage shelves and safety equipment will be sourced in the coming weeks.

Other Facility Improvements and Repairs

Sayco Heating & Air Conditioning made repairs to the building refrigeration system.

SM&R contractors added a new section of guardrail along the dangerous section of the access road from 3.0 km to 3.5 km.

Two pull boxes damaged by recent heavy equipment were repaired on the summit road by SM&R. During this effort, it was found that the redundant 4160V line to the summit was not switched properly. An electrician from Sabino Electric was hired to activate this circuit.

A pneumatic system was designed to provide high volume air lines throughout the chamber for the use of air casters.

TBR Construction and Engineering was awarded the contract to add a new second floor loading dock, a large rolling door to the second floor east lab, and make all of the structural reinforcements to remove the structural column at the back of the chamber.

A cam follower was reinstalled after a noise coming from the rear shutters was investigated. It was discovered the cam follower had come loose and was trapped at the east end of the rail. Additional cam followers were found to be loose and were also tightened. While the louver was off for these repairs, the wheels were also greased.

An electromagnetic valve in the vacuum pumping station was replaced. The old valve was cleaned and will be kept as a spare for future use.

The second section of flexible duct in the pit was replaced by new metal ducting. Part of the first section was also reworked to improve sealing joints. The ventilation system in the pit now consists of metal and PVC sections, improving its reliability.

The fire procedure for this year was updated in March. It is posted on the MMT website as well as printed copies posted on the mountain and in the MMTO campus office. Several items were changed for better preparedness.

The MMT Cat6 Ethernet backbone and Cat5 drops were completely documented and all the cables were labeled. C. Knop is the contact person if new network connections are made or more Ethernet drops are required, so that network documentation can be kept up to date.

The defective control room telestat monitor, still under warranty, was replaced with a new monitor.

MMT Council Meeting

An MMT Council Meeting was held on February 18. F. Vilas responded to Council findings from the September 2008 meeting. D. Clark gave a presentation on MMT telescope elevation tracking.

Visitors

March 14 – Afternoon visit by high school student hosted by former employee, K. Van Horn.

March 14 – Evening tour for 2 teachers and 1 student from Phillips Andover Academy hosted by F. Vilas.

April 22 – visit by National Academy of Science/National Research Council committee members hosted by F. Vilas. A tour of the MMT was provided by S. Callahan.

Publications

MMTO Internal Technical Memoranda

ITM09-1: Elevation Servo Review Committee Report, T.E. Pickering, P. Cheimets, S. Schaller, J. Hagen, D. Harvey, January 2009, (http://www.mmto.org/MMTpapers/pdfs/itm/itm09-1.pdf)

ITM09-2: Elevation Tracking for the 3rd Trimester of 2008, D. Clark, T. Trebisky, T. Pickering, March 2009, (http://www.mmto.org/MMTpapers/pdfs/itm/itm09-2.pdf)

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

09-01 The Anisotropic Spatial Distribution of Hypervelocity Stars
W. R. Brown, M.J. Geller, S.J. Kenyon, B.C. Bromley
ApJ, **690**, L69

09-02 Luminous Blue Variable Stars in the Two Extremely Metal-Deficient Blue Compact Dwarf Galaxies DDO 68 and PHL 293B
Y.I. Izotov and T.X. Thuan
ApJ, **690**, 1797

09-03 MMT Hypervelocity Star Survey
W.R. Brown, M.J. Geller, S.J. Kenyon
ApJ, **690**, 1639

09-04 Deep MMT Transit Survey of the Open Cluster M37. III. Stellar Rotation at 550 Myr
J.D. Hartman, et al.
ApJ, **691**, 342

09-05 Active Galactic Nucleus Host Galaxy Morphologies in COSMOS
J.M. Gabor, et al.
ApJ, **691**, 705

09-06 Star Clusters in M31. I. A Catalog and a Study of the Young Clusters
N. Caldwell, et al.
AJ, **137**, 94

09-07 The X-Ray Environment during the Epoch of Terrestrial Planet Formation: *Chandra* Observations of h Persei
T. Currie, et al.
AJ, **137**, 3210

09-08 Digging into the Surface of the Icy Dwarf Planet Eris
M.R. Abernathy, et al.
Icarus, **199**, 520

09-09 An Alternative Origin for Hypervelocity Stars
M.G. Abadi, J.F. Navarro, M. Steinmetz
ApJ, **691**, L63

09-10 The Evolution of Late-Time Optical Emission from SN 1979C
D. Milisavljevic, R.A. Fesen, R.P. Kirshner, P. Challis
ApJ, **692**, 839

09-11 Abell1201: The Anatomy of a Cold Front Cluster from Combined Optical and X-Ray Data
M.S. Owers, et al.
ApJ, **692**, 702

09-12 The Spectral Energy Distributions of Red Two Micron All Sky Survey Active Galactic Nuclei
J. Kuraszkiewicz, et al.
ApJ, **692**, 1143

09-13 *Spitzer* Observations of Extended Lyman-α Clouds in the SSA22 Field
T.M.A. Webb, et al.
ApJ, **692**, 1561

09-14 High-Redshift Quasars in the Cosmos Survey: The Space Density of z > 3 X-Ray Selected QSOs
M. Brusa, et al.
ApJ, **693**, 8

09-15 The Origin of the 24 μm Excess in Red Galaxies
K. Brand, et al.
ApJ, **693**, 340

09-16 Observations of Main-Sequence Stars and Limits on Exozodical Dust with Nulling Interferomtry
W.M. Liu, et al.
ApJ, **693**, 1500

09-17 Extended Lyα Nebulae at z ~ 2.3: An Extremely Rare and Strongly Clustered Population?
Y. Yang, et al.
ApJ, **693**, 1579

09-18 On-Sky Wide-Field Adaptive Optics Correction Using Multiple Laser Guide Stars at the MMT
C. Baranec, et al.
ApJ, **693**, 1814

09-19 Spectroscopy of High-Redshift Supernovae from the ESSENCE Project: The First Four Years
R.J. Foley, et al.
AJ, **137**, 3731

09-20 First "Winged" and X-Shaped Radio Source Candidates. II. New Redshifts
C.C. Cheung, et al.
ApJ Supp, **181**, 548

09-21 LeoV: Spectroscopy of a Distant and Disturbed Satellite
M.G. Walker, et al.
ApJ, **694**, L144

09-22 The Runaway White Dwarf LP400-22 has a Companion
M. Kilic, et al.
ApJ, **695**, L92

09-23 Deep MMT Transit Survey of the Open Cluster M37 IV: Limit on the Fraction of Stars with Planets as Small as $0.3R_J$
J.D. Hartman, et al.
ApJ, **695**, 336

09-24 Clustering of Red Galaxies Around the $z = 1.53$ Quasar 3C 270.1
M. Haas, et al.
ApJ, **695**, 724

Copies of publications are available from the MMTO office. We remind MMT observers to submit 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 *mguengerich@mmto.org* or to the following address:

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

Non-MMT Scientific Publications by MMT Staff

The MESSENGER Mission to Mercury: New Insights into Geological Processes and Evolution from the First Two Encounters
Head, J. W. III, et al., F. Vilas
LPSC XL (2009), abstract #2198

MMTO in the Media

2/6/09 – Univ. of Arizona website "UA in the News", article on the LCROSS (Lunar CRater Observation and Sensing Satellite) mission and F. Vilas, project team leader. This mission will send a small rocket into a lunar crater in search for frozen water. Read the article at: http://uanews.org/node/23929

2/17/09 – *Daily Wildcat,* Univ. of Arizona campus newspaper, article and interview with F. Vilas about the LCROSS mission. http://media.wildcat.arizona.edu/media/storage/paper997/news/2009/02/17/News/Water.On.The.Moon-3633668.shtml

4/3/09 - Live video webcast – The MMT was one of 80 telescopes featured in the Intl Year of Astronomy project, "Around the World in 80 Telescope". This video can be viewed at: http://www.ustream.tv/recorded/1340447

4/27/09 –*Arizona Daily Star* newspaper, Tucson, article and interview with F. Vilas about the LCROSS mission.

MMTO Home Page

The MMTO maintains a web site (*http://www.mmto.org*) that includes a diverse set of information about the MMT and its use. Documents that are linked to include:

- MMT Latest News and Blog.

- General information about the MMT and Mt. Hopkins.
- Telescope schedule and observing program titles.
- User documentation, including instrument manuals, detector specifications, and observer's almanac.
- Scientific and technical publications.
- A photo gallery of the Conversion Project as well as specifications related to the Conversion.
- Information for visiting astronomers, including maps to the site.
- The MMTO staff directory.

NOTE: A major effort is ongoing to redesign the MMT website; this will be a complete overhaul of the website. We hope to complete it by fall 2009.

Observing Database

The MMTO maintains a database containing relevant information pertaining to the operation of the telescope, 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.

NOTE: Beginning January 2005, the formula for accounting lost time on the telescope has been changed. Previously, time lost to weather was deducted from the total observing time before calculating time lost to instrument, telescope, and facility from the remaining balance. From now on, the time lost to each source is computed as a fraction of the total scheduled time.

And beginning June 2005, a new category, environment, was added to account for time lost to natural, uncontrollable, non-weather events such as flying insects melting in laser beams and forest fires.

Use of MMT Scientific Observing Time

January 2009

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	*Lost to Telescope	Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	10.00	116.70	63.50	0.00	0.25	0.00	0.00	63.75
PI Instr	18.00	212.70	80.00	2.00	10.00	0.00	0.00	92.00
Engr	3.00	35.60	21.00	0.00	0.00	0.00	0.00	21.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**31.00**	**365.00**	**164.50**	**2.00**	**10.25**	**0.00**	**0.00**	**176.75**

Time Summary

Percentage of time scheduled for observing	90.2
Percentage of time scheduled for engineering	9.8
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	45.1
Percentage of time lost to instrument	0.5
Percentage of time lost to telescope	2.8
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	48.4

* Breakdown of hours lost to telescope

3.0 Secondary (F15) problem
3.5 Pointing/Computer problems w/AO, PCR server, wfs camera
2.5 AO
0.25 Primary panic
1.0 Computer

February 2009

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	* Lost to Telescope	**Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI Instr	28.00	312.20	121.15	0.50	1.00	0.50	0.00	123.15
Engr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**28.00**	**312.20**	**121.15**	**0.50**	**1.00**	**0.50**	**0.00**	**123.15**

Time Summary

Percentage of time scheduled for observing	100.0
Percentage of time scheduled for engineering	0.0
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	38.8
Percentage of time lost to instrument	0.2
Percentage of time lost to telescope	0.3
Percentage of time lost to general facility	0.2
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	39.4

* Breakdown of hours lost to telescope

0.5 Broken mount miniserver
0.5 Hacksaw crash

** Breakdown of hours lost to facility

0.5 Reboot hoseclamp

Use of MMT Scientific Observing Time

March 2009

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	*Lost to Telescope	Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	6.00	59.10	16.00	0.00	9.90	0.00	0.00	25.90
PI Instr	23.00	238.30	69.35	0.50	0.80	0.00	0.00	70.65
Engr	2.00	21.10	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**31.00**	**318.50**	**85.35**	**0.50**	**10.70**	**0.00**	**0.00**	**96.55**

Time Summary

Percentage of time scheduled for observing	93.4
Percentage of time scheduled for engineering	6.6
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	26.8
Percentage of time lost to instrument	0.2
Percentage of time lost to telescope	3.4
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	30.3

* Breakdown of hours lost to telescope
0.8 wfs
9.9 mount/encoders

April 2009

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	* Lost to Telescope	Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	7.00	65.00	13.35	0.00	0.00	0.00	0.00	13.35
PI Instr	20.00	183.20	56.95	0.00	0.50	0.00	0.00	57.45
Engr	3.00	28.40	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**30.00**	**276.60**	**70.30**	**0.00**	**0.50**	**0.00**	**0.00**	**70.80**

Time Summary

Percentage of time scheduled for observing	89.7
Percentage of time scheduled for engineering	10.3
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	25.4
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.2
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	25.6

* Breakdown of hours lost to telescope
.5 mount computer

Year to Date April 2009

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	Lost to Telescope	Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	23.00	240.80	92.85	0.00	10.15	0.00	0.00	103.00
PI Instr	89.00	946.40	327.45	3.00	12.30	0.50	0.00	343.25
Engr	8.00	85.10	21.00	0.00	0.00	0.00	0.00	21.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**120.00**	**1272.30**	**441.30**	**3.00**	**22.45**	**0.50**	**0.00**	**467.25**

Time Summary

Percentage of time scheduled for observing	93.3
Percentage of time scheduled for engineering	6.7
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	34.7
Percentage of time lost to instrument	0.2
Percentage of time lost to telescope	1.8
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	36.7