End of Quarter Summary

January - March 2014

Testing at the Sunnyside aluminizing facility with the large vacuum chamber during March 2014. Shown left to right: W. Goble, D. Porter, and R. Ortiz, sitting (G. Rosenbaum is in the background). Two large monitors show two displays of the software user interfaces being developed for the aluminization effort. The main aluminization graphical user interface (GUI) is shown in front of R. Ortiz. A live video software GUI of the heating filaments is shown in the upper right of the photo. Control of the aluminization process is now automated.

MMT Observatory Activities

Our Quarterly Summary Reports are organized using the same work breakdown structure (WBS) as used in the annual program plan. This WBS includes a major category with several subcategories listed under it. In general, many specific activities might fall a tier or two below that. The WBS will be modified as needed in future reports and program plans.

Administrative

Staffing

Applications for the open Electronic Technician, Sr. position were reviewed.

K. Powell held a training session on March 10 for adaptive optics (AO) operators. We plan to train additional AO operators to further improve coverage.

Strategic Planning

Work continued this period on a draft report from the Strategic Planning committee using input received from a survey distributed late last year to the SAO and UAO communities regarding how best to accomplish the highest scientific return for the MMTO in the coming 5-10 years.

Reports and Publications

There were 23 peer-reviewed MMT-related publications and 5 non MMT-related publications during this time period. No technical memoranda or reports were generated. See the listing of publications in Appendix I, p. 18.

Presentations and Conferences

G. Williams attended the American Astronomical Society (AAS) meeting held January 5-9 in Washington, D.C.

Safety

Procedures and Protocols

Work continues on addressing chemical handling and storage procedures on the mountain. A new chemical storage locker was purchased and placed on the loading dock for storage of methanol. A second locker was identified as available for use and was moved to the pit for storage of chemicals and cleaning agents. A separate locker to store acids was purchased and an inventory of all acids was begun.

Work is ongoing and will continue into the next quarter, including:

1) Removal of unused or expired chemicals/acids from the summit through the University of Arizona Risk Management department.
2) Identification of proper chemical storage compatibilities; additional lockers will be ordered if necessary.
3) Labeling of all chemical and acid bottles per current OSHA standards.
4) Complete an updated chemical inventory, which will then become an annual procedure.

Primary Mirror

Moment-Z errors occurred when raising the primary mirror on February 20 and 25. We are mining past telescope operator logs for clues as to the cause. Despite this, there were no problems with the M1 cell this quarter.

Dust storms across Texas, New Mexico, and Arizona deposited a coating of dust on the primary mirror during the adaptive optics (AO) run in mid-March. This may have contributed to the contamination of the 40-micron gap that separated the shell from the backing body. This reinforces the need for both a closure policy against dust and for a reliable dust monitor. An earlier dust monitor (DustTrack) system installed ten years ago stopped working and has yet to be replaced. We are investigating a hand-held probe that the telescope operators could use to check the outside ambient for dust. A CO_2 cleaning will be scheduled in the next quarter.

Coating & Aluminization

In preparation for re-aluminization, T. Gerl led an effort to "reverse engineer" the Austin Scientific cryo-pump monitor circuit card. No drawings were provided with the original board when it was purchased. After closely inspecting the card, the board schematic was produced section by section. The schematic will assist in repackaging the electronics in the vacuum system rack to help eliminate wiring issues with the data acquisition system. The new board schematic will also aid with maintenance and repair.

The new 16-channel analog galvanic isolation chassis was completed, and the entire computer acquisition/control system was moved to the Sunnyside vacuum testing facility. During testing, several issues with the data acquisition electronics were fixed, ensuring that the vacuum system data inputs were calibrated and accurately converted to physical units.

D. Clark worked extensively on the aluminization data acquisition and control process software. Detailed testing of the automated deposition control software and data acquisition suite was performed in both the small 18" chamber with four filaments (two per welder circuit) and in the large 84" chamber with a full load of twenty filaments per welder, as in the actual MMT vacuum head. After many iterations of testing in the small chamber and three full tests in the large chamber, the coating process hardware and software are now able to produce acceptable coatings automatically, controlling the welder power supply and using the chamber deposition crystal sensors for feedback in the process control. We have begun exploring some contingencies in the software as well as designing safety checks that will alert the operators, or end the coating process, in case of catastrophic failure.

Figure 1 shows the current state diagram of the proposed software control for the aluminization software. Eight separate states have been defined, including the behavior within each state, and the transition criteria from one state to the next. These states and the associated state transitions are based on the physical processes involved in aluminum vaporization and empirical data that have been obtained at the Sunnyside test facility.

Two Linux system services, "alum-app" and "node-server," were created to provide system control of the aluminization software. The "alum-app" service is responsible for the hardware/software interface (i.e., data acquisition and hardware control) and process control. The "node-server" service provides the user interface, logging, data visualization, and image acquisition software functionality. These two services are integrated into the Linux "systemd" daemon. Both services boot at start time and remain running while the "aluminization" server is on.

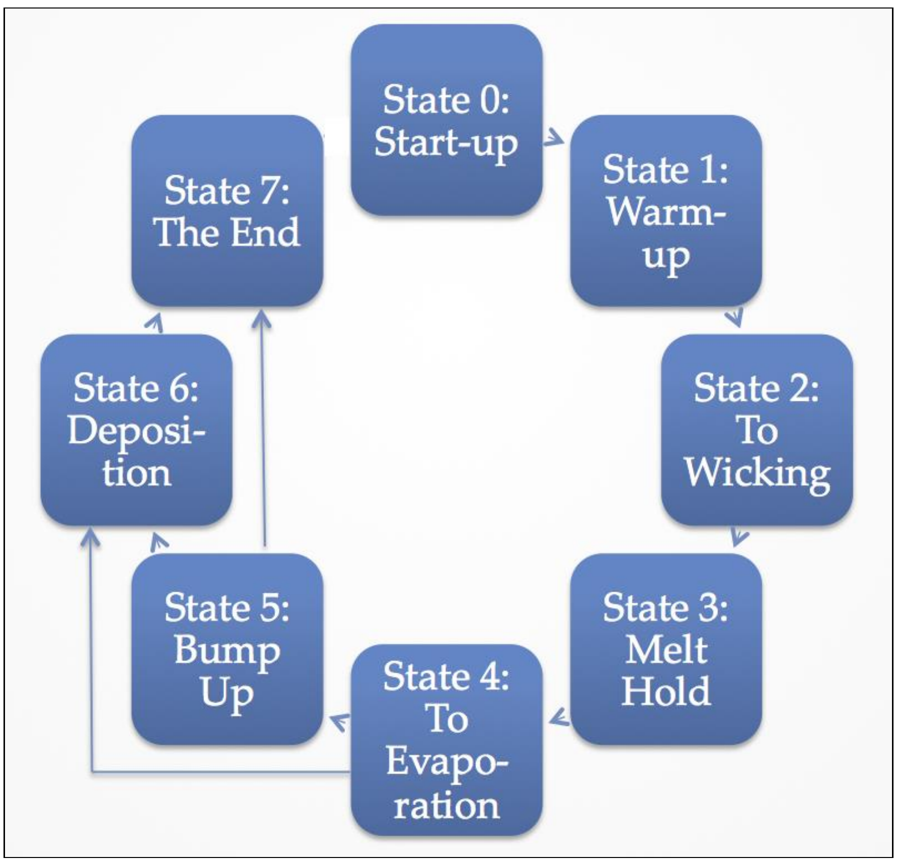

Figure 1. Proposed state diagram for automated control of the primary mirror re-aluminization.

Several optimizations for data transfer between software modules via the Redis server were implemented. The Redis server acts as a data bus or backbone for transfer of data between the various software modules. One optimization was the combination or encapsulation of many simple key:value data pairs into a single JSON (JavaScript Object Notation) string. For example, all welder-related data are now encapsulated into one JSON string: "welders." This JSON encapsulation of many small strings into a few larger strings greatly reduced the load levels on the aluminization server. Another optimization was the use of pipelining for setting values to the Redis server. Pipelining involves the execution of many small, related operations in a single transaction. A similar technique is being used for multiple inserts into the MySQL database.

Figure 2 below, as well as the cover photo, shows testing at the Sunnyside vacuum testing facility during this reporting period. Results from these tests have been used to better understand the aluminum vaporization process and redesigned filament characteristics. This understanding has been used to better design and constrain the state diagram shown in Figure 1 as well as the entire aluminization process. This understanding aids in the implementation of safety checks within the control software.

Figure 2. Testing with the small vacuum chamber at the Sunnyside test facility during March 2014. B. Comisso, W. Goble, and J. Di Miceli are shown, left to right. This small test chamber is used for coating small surfaces, such as test slides. Because of its rapid turn-around, 8-10 tests can be done in a single day.

The software group implemented a set of plotting tools useful for testing and monitoring of the aluminization activities at Sunnyside and for in-situ aluminization of the primary mirror. These plotting tools consist of 'live charts,' 'archive charts' and 'chart overlay' charts. One of these data visualization tools, the 'archive charts,' is shown in Figure 3. All charts use the Highcharts plotting JavaScript library, a plug-in for the jQuery JavaScript library. Data are loaded into the charts asynchronously using Node.js, Socket.io, and PHP. The following is a description of these plotting tools:

- 'Live charts' plots the real-time data from any sensor connected to the system, useful for monitoring parameters during the actual test.
- 'Archive charts' plots data from previous test sessions, used to examine data in detail after the test has been completed.
- 'Chart overlay' plots two different test sessions on separate charts, then superimposes both charts together to allow comparisons between the sessions.

Figure 3. A sample of aluminization data collected using the 'archive charts' plotting tool. Any of the tests performed can be selected from a relational database, and over 100 parameters related to each test can be plotted versus time. This GUI has been particularly useful as a "quick look" visualization tool during testing.

Camera video/image storage and camera control have also been integrated into the aluminization software. Camera recording can now be triggered and stopped via a button on the operator's GUI. A video stream at 30 frames per second (fps) is recorded from the camera to the onboard Security Digital (SD) card. Still images are recorded over the network on a dedicated Linux PC, "alum-data," at approximately 1 Hz. The 1 Hz images are used with the 'archive charts' GUI to show reference images while hovering over data points. Two different types of cameras are being evaluated for use with the aluminization process: AXIS P1343 Ethernet camera and a Nikon D90 DSLR.

Documentation of the testing process was done in preparation for an outside panel of experts who will conduct a readiness review in April. They will assess the process control system design, the plans for mitigating coating issues encountered in the 2010 primary mirror aluminization, and the overall readiness of the staff, software, and equipment for the planned re-aluminization during summer 2014.

Plans for the next quarter include completing the moving of all welder control electronics and data acquisition/display electronics into a single rack, upgrading the new rack's interior wiring, and simplifying the vacuum equipment cable connections for better long-term serviceability. Software development and testing will continue at the Sunnyside facility.

Hardpoints

A full night of maintenance and engineering (M&E) testing, including an elcoll run, was performed using significantly reduced breakaway pressure on the primary mirror hardpoints (34 psi compared to the typical 50 psi). The system performed well under this configuration, and deliberations are ongoing to determine if these lower breakaway pressures will be used in routine operations in the future.

Actuators

A simple Python GUI was created to allow staff to inject known wavefront aberrations into the primary mirror in order to test wavefront sensing software or hardware. This software will be tested fully and expanded to be compatible with both f/9 and f/5 secondary mirrors in the April-June quarter.

Secondary Mirrors

f/15

Work continues on the AO deformable mirror (DM) power supply upgrade. Initial testing of the system components revealed that minor rework or changes to the circuit cards are required. The chassis design is complete and installation of the components continues, including finalization of the firmware for driving the supply chassis LCD display that will show output currents and voltages. The final circuit card testing and assembly of the power supply is expected to take place in late May. This work has proceeded more slowly than originally planned, due to staff work on re-aluminization preparations.

Hexapods

Elcol measurements were taken for both f/9 and f/5 configurations. The slopes used to determine the nightly elcol corrections remain stable on year-long timescales.

f/9 and f/15 hexapod

Software development continued on a USB serial interface to the new signal conditioning cards for the hexapod strut transducers. These cards use a digitally-adjusted offset and gain circuit with low time and temperature drift. Upon completion of the USB-based hardware and software, the new boards can be adjusted for setup and maintenance.

Optics Support Structure (OSS)

Nothing to report.

Pointing and Tracking

Nothing to report.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on the MMT for 38% of the available nights from January 1 through March 31. Approximately 66% of those nights were scheduled with the Blue Channel Spectrograph and 34% with Red Channel. There were no SPOL observations this quarter. Of the total 433.8 hours allocated for f/9 observations, 190.1 hours (44%) were lost to winter storm weather conditions. Instrument, facility, and telescope problems accounted for 2.9% of lost time. Most of this was due to a building drive failure in January. Blue Channel lost 45% of its time to poor weather, with Red Channel losing 41%.

A new helium calibration lamp was ordered from Newport and arrived at the end of February. D. Clark provided a power supply for initial testing.

f/5 Instrumentation

The weather was relatively good this quarter. Only 75 hours were lost to weather: mostly clouds, some windy/dusty conditions, and one winter storm. This represented less than 20% of the allocated time.

We had 306 hours on sky for observing with HectoSpec, HectoChelle, and MMTCam. We obtained 601 exposures with Hecto on 200 fields over the 37 scheduled nights. In addition to the science data, over 2000 bias, flat, and comparison frames were taken to calibrate the science data. We also used some to the cloudy time to obtain about 30 "dark" exposures to map the low level red light leak that originates in limit sensors on the robots.

MMTCam took almost 500 exposures of 16 science targets on 6 nights when it shared time with the Hectospec or Hectochelle instrument. Approximately 500 exposures for bias, dark, and flat calibrations were also taken. To improve efficiency and evaluate the instrument stability, calibration data were sometimes taken on days other than the science data days, usually before or after the Hecto calibration data were obtained and while waiting for the sky to be sufficiently dark to begin science observations.
A new filter has been added to Chelle to select the wavelengths around 626 nm. A few of the hollow cathode lamps for calibration (HeNeAr and ThAr) failed and new ones were installed. While the dome-boxes were open, new continuum lamps were installed. The RAID arrays for data on the *clark* and *lewis* servers were reporting as degraded. A disk drive on each system was replaced and the array was rebuilt.

The wavefront had a series of failures and issues at the start of a hecto run on February 5. Initially we did not have communication with the wavefront sensor (WFS) after it was installed. We discovered that the optical fiber at the media converter in the WFS was broken. A new fiber was connected to continue the debugging process. Next, we discovered that the fiber-to-copper media converter in the SAO computer rack had failed during the six-week interim since the previous hecto run in December. A new unit was swapped in and communication was restored. Then, a series of software issues appeared: failure to connect to the PMAC card, a need for reloading of the device driver for the SBIG camera, and additional steps to massage the code. During the software work, some print statements were added to the system initialization code to monitor the process. Work on these issues continued into the next morning, with most of the software work being done by J. Roll. The WFS was ready for operation the following afternoon and was mounted along with hecto, with one night having been lost.

A number of issues appeared late in the quarter with the WFS and the positioner. The WFS stage had an issue with motion and failed to reach its destination, costing a half-hour of observing time to evaluate and recover. A note was put in the service log suggesting how to recover from similar incidents should they recur. The X-axis servo amplifier on Robot 1 of the positioner reported a fault early in a configuration for morning calibration. The situation was discussed with D. Fabricant and J. Roll and operation continued, after a few test moves, with the parking of fibers. Morning calibrations were postponed to the afternoon. During one move, the gripper on Robot 1 reported a failure to close. One hour of observing time was lost while the situation was evaluated. The target button for the move was eventually parked and marked "do not use" until it could be examined. No actual problem was found in these situations. The gripper and servo amplifier worked fine after the incidents. They will be looked at during the upcoming service mission before the next hecto observing run.

f/15 Instrumentation

There were two adaptive optics (AO) observing runs during this reporting period: January 10-16 and March 10-16. The January run consisted of one M&E night, three science nights with

NGS/ARIES, and three science/engineering nights with MMTPol. The March run included one M&E night, one engineering night with the new nonlinear curvature wavefront sensor (nlCWFS), and five science nights with NGS/ARIES. The adaptive secondary mirror continued to perform well, and there were no major issues related to the deformable mirror (DM) electronics, actuators, or software used to raise, flatten, and control the mirror. There was one incident of contamination in the gap but this resulted in no loss of science time, nor did it affect the overall operation of the DM. The details of the incident are discussed below.

In general, the AO runs were successful, and considerable science and engineering data were collected during each run. However, problems persisted with the WFS camera hardware/software and power supply. A new issue of extremely slow computer and control GUI responses caused considerable problems in operating the system on several nights. An approximate half hour was lost to large oscillations in the telescope azimuth axis, preventing the AO loop from staying closed. In addition, approximately 1.5 nights were lost to poor seeing and winds.

The first night of the January run saw the initial signs of the issues with computer slowness. The extremely slow GUI response times made it very difficult to set up the AO system and to keep the loop closed. Another software issue was with the rotator tracking-enabled button on ao-gui. There have been several instances where rotator tracking is enabled but is clearly not tracking, resulting in the typical "flower petal" pattern building up on the DM. It is unclear why the software does not see that rotator tracking is enabled, but the fix seems to be to cycle telescope rotator tracking off/on until both the telescope and ao-gui see that rotator tracking is enabled.

Troubles also persisted with both the WFS camera and the DM336 power supply. The DM336 failed to come up properly during the first M&E night so this did not result in any lost observing time. The issue again appeared to be an under-voltage on the VCCA power unit. Once the voltage was adjusted, the power supply worked well throughout the remainder of the run. The WFS camera continued to have issues with the camera freezing up, corrupting WFS images. During the run, a number of hardware components were checked to see if they were causing the WFS camera problems, but no hardware-related problems were found.

The initial M&E night in March proved useful in solving a number of issues prior to science observations. Problems with locating the first target of the run re-occurred with a pointing error just over three arc-minutes. Not even the auto-rastering routine helped much for this large an offset. The DM336 power supply failed again and required a spare for the VCCA Lambda unit to be swapped out. The unit was also pulled out of the rack and a fan placed over it to help with cooling issues. As work was being performed on the DM336, TSS was lost on the mirror, and the shell fell on the clips for about fifteen minutes. During this time, contamination was able to enter the DM gap. The contamination required some massaging of the shell to reduce the gap height, but ultimately did not interfere with the operation of the system.

Computer slowness was extremely bad during portions of the March run. The software group was unable to diagnose the cause of the problem. Throughout the remainder of the run, WFS camera issues were the dominant source of lost time. The SCSI cable was checked and replaced by a spare, but this did not fix the WFS camera from freezing.

Significant science and engineering data were collected during both AO runs. The nonlinear curvature WFS was able to align and collect useful data throughout its engineering night. Significant data were also collected during the NGS/ARIES and MMTPol nights.

Topboxes and Wavefront Sensors (WFS)

f/9 Topbox

A mounting system for the new f/9 WFS camera was designed and tested. This new mounting bracket allows for a relatively quick change between the new SBIG camera and the established Apogee camera. Cabling and baffling of several LEDs was completed on the new camera in the f/9 topbox. Testing of the camera and integration into the WFS software will continue into the next quarter.

Natural Guide Star (NGS) Topbox

After detailed planning, work has begun on improvements to the NGS top box interior wiring to clean up problems with missing strain reliefs and other issues. The improvements will increase the NGS system reliability.

Facilities

A facilities site visit by Smithsonian personnel was conducted February 18-21. Various MMTO facilities issues were discussed including the new fire alarm system, a new HVAC design, plans for a heated roof, and road improvements.

The first part of a new comprehensive Honeywell fire alarm system was installed at all of the facilities on Mt. Hopkins. Early on, a false alarm was triggered at the MMTO by a smoke detector located directly above the 200 liter dewar in the bench spectrograph alcove. The smoke detector was replaced with a heat detector and there have been no further problems. The system appears to be in good working order and will be inspected in early May.

The second part of the fire alarm system has been more problematic. The Keltron box is a second party add-on that monitors the Honeywell system. It has internet connectivity and can broadcast an alarm and send text messages over the mountain radio. Interruption of the internet triggers an alarm in these units. Recently, there have been frequent internet interruptions on the mountain, and the incessant Keltron alarms have caused a number of complaints. In addition, the Keltron unit that was delivered had a faulty power supply and had to be returned. The first replacement unit had to be rejected because of its obsolete XP operating system; a second replacement is expected soon. The contractor, TBR, and Firetrol, the fire alarm system subcontractor, are working on solutions to the problem of internet interruptions triggering the alarm.

General Infrastructure

On January 9, the telescope operator reported noise from air leaks in the pit. Inspection found that a ladder had fallen onto the pit Neslab chiller. The ladder had been used to install a smoke detector by the fire alarm contractors. It was left standing in the pit and was overlooked during the operator's routine inspection before observing. When the building turned, the ladder wedged against the rotary plenum box that feeds the east elephant trunk that feeds pressurized air into the primary mirror cell. The ladder punched the sheet metal out of the bottom of the plenum box and broke several spot welds. B. Kunk and C. Chang repaired the break using pop rivets and inspection of the plenum found no further damage at that time.

Smithsonian Institution (SI)-contracted architects have been working on the design of a new standing seam metal roof to cover the membrane roof installed in 2008. The new roof will be made of low-emissivity materials to reduce radiative cooling to the night sky. This has been a problem, as condensate collects on the roof and can blow into the chamber. The new metal roof will incorporate a new snow-melt system to replace the one installed in 2008 that has not performed well. The design is being done by subcontract with minimal input from MMTO.

A separate SI-funded project for HVAC upgrades was initiated in February. GLHN, a local engineering firm, was contracted to assess the facility HVAC equipment and generate a list of recommendations. A construction bid package is being prepared and we expect to implement several of their recommendations in the fall. The package includes an early test of the spare Carrier chiller ("the Carrier on the Rock") to assess if it is operable. The Carrier was set on a rock east of the IRF ten years ago but was not put into service. If the unit is operable we plan to integrate it as a spare chiller for MMTO operations.

In early 2007 an infrared camera, borrowed from Kitt Peak National Obs., was used to take thermal images of every room inside the MMT building and images of the outside perimeter of the building both during the day and at night to observe the flow of heat and/or heat sources. During this reporting period the 200 images taken in 2007 were extracted from the archive, changed to jpeg format, and put into a document to make the results more accessible. The MMTO has since acquired a new handheld thermal camera to survey electrical equipment and the general facility environment, and soon we expect to produce some comparison images using the new camera.

Computers and Information Technology

Network

During this quarter, thirteen Linux machines were upgraded to Fedora 20, and five Mac computers were upgraded to Mac OS 10.9 (Mavericks).

The yearly offload of historical data was completed, transferring data from the network-file-system (NFS) mounted "/mmt" directory to external USB drives. This transfer took longer than usual due to a bad external USB drive and a continuing problem with broken network connections between the mountain and campus offices, discussed in more detail below. The usual backups and reboots of

Linux and Mac systems were also completed. Problems continue with several older Linux machines, which are soon to be retired. A prelink problem on the semi-retired observers' Linux computer, *alewife*, was particularly difficult to solve.

IRAF software was updated to version 2.16.1. A minor problem was fixed with the login daemon on mmto.org. A new printer, an HP LaserJet Pro 400 color Printer M451dn, was purchased and located in the MMT control room as the default printer for the Linux and Mac control room machines. The printer is also available for other mountain Mac and Windows observers and staff users. Issues regarding the lack of updates for our Fedora mirror were debugged. A large number of machines were reconfigured so that their clocks would not drift after University Information Technology Services (UITS), for security purposes, blocked the network time protocol (NTP) service from passing through their firewall. This prevented the use of external NTP servers. UITS NTP servers are now being used throughout the MMT. Other network problems were addressed after a new network address translation (NAT) gateway was configured by Jun Wu (Smithsonian Institution/Washington) to handle mountain wireless traffic. Several user computers were identified that were either misconfigured and/or had computer viruses. This NAT gateway has greatly lightened the NAT load on *hacksaw*, our main mountain server. MMT staff also worked with Jun to get a wireless access point (AP) functional on the fourth floor of the MMT. Activation of this AP completes the currently planned wireless coverage for the MMT building.

Disk 4 failed on the network-attached storage (NAS) computer, *nas1*, on January 2. This NAS has a 5-disk RAID disk array. Although the NAS computer continued to operate, its ability to write to disk was severely impacted, and its ability to handle the network file system (NFS) traffic from *hacksaw* and other computers was significantly compromised. The NFS mounting of the /mmt directory on all Linux computers was moved from *nas1* to *nas2*. A replacement hard drive was installed in *nas1*, and its RAID array repaired without incident. The NFS mounting of the /mmt directory remains on *nas2*. Automated email notifications from the NAS computers to software staff have been configured to provide more detailed status information.

Several web server security issues were identified on the main MMT summit computer server, *hacksaw,* by UITS. A QualysGuard Enterprise Security account was obtained by MMT staff through the site-wide UITS license. This account is being used for scanning MMT web sites for security vulnerabilities. The MMT websites on mmto.org and hacskaw.mmto.org were scanned. The mmto.org website had no security issues, but a few security issues were found on the hacksaw.mmto.org website. The higher security vulnerability issues on this site have been addressed, but additional work is still needed.

Various issues have arisen with the UITS network switches. Of particular concern has been the inability to transfer (i.e., via the "rsync" Linux utility) large files from the mountain to campus. Broken pipe errors routinely occur, making routine transfer of files very difficult to complete. A trouble report has been started with UITS. One issue that was identified while working on this trouble report is that all network traffic between the two MMT subnets (128.196.100/24 at the mountain and 199.104.150/23 on campus) was traversing the Steward firewall twice. The Steward firewall has been reconfigured by UITS so that there are no firewall restrictions between these two subnets.

Other network issues are apparently affecting all of Steward Observatory, including the MMT. UITS has done various software and hardware upgrades of network equipment to address these issues. Work continues with UITS on improving overall network robustness.

MMT Critical Computer System Robustness

A significant amount of work was done to understand and, hopefully, improve the performance of *hacksaw*, the NAS computers, and other machines so that they can maintain near real-time response for observing even when occasional, heavily resource intensive, non-observing demands are placed on them. Two software meetings were held on this topic with productive discussions. The consensus is that most of the webserver and database tasks that currently run on *hacksaw/nas2* should be moved elsewhere. Specifications for a possible computer for "non-critical" MMT software have been defined and are being evaluated for purchase. Additional system services, such as NAT translation for the internal MMT IP, are also being addressed with work on a new hardware NAT router.

Two of the most computationally intensive activities for the MMTO are: 1) complex database queries for data analysis and visualization, and 2) video processing for skycam movies. These complex database queries can be triggered by users via secure web pages. These queries are currently occurring on *hacksaw/nas2*. Video processing is currently being done on the Linux computer *yggdrasil*, which is retired except for this video processing. In addition, most of the web pages currently on *hacksaw* need to be migrated to a non-critical computer. This migration of web pages, databases, and video movies and images off the mission-critical computer *hacksaw* will require resources. Addressing the issues of *hacksaw/nas* robustness is ongoing.

Telemetry, Logging and Database Management

Users have begun testing the automatic logging software for the Blue and Red Channel Spectrographs. A few changes were made to the software, based upon feedback from several astronomers. After completion of a listing of its features, the software will be ready for full deployment and expansion to ARIES and SPOL.

Miscellaneous

An abstract entitled "Software framework for the 2014 MMT Observatory primary mirror re-aluminization," co-authored by J Duane Gibson, Dusty Clark, and Dallan Porter was accepted for the SPIE Astronomical Telescopes + Instrumentation conference in Montreal, Canada, in late June.

Seeing

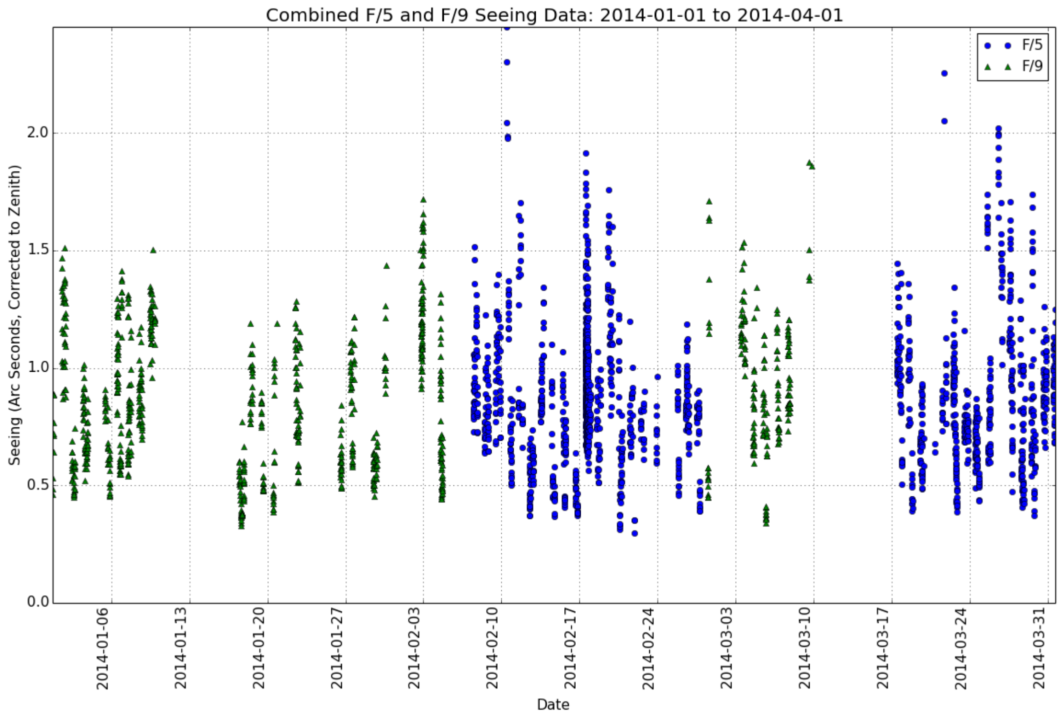

Figure 4 shows the seeing data from both the f/5 (blue) and f/9 (green) WFS datasets as a function of time during this quarter. Seeing measurements between the two configurations are consistent. The gaps in data in mid-January and mid-March are due to f/15 observing runs where no WFS seeing data are logged.

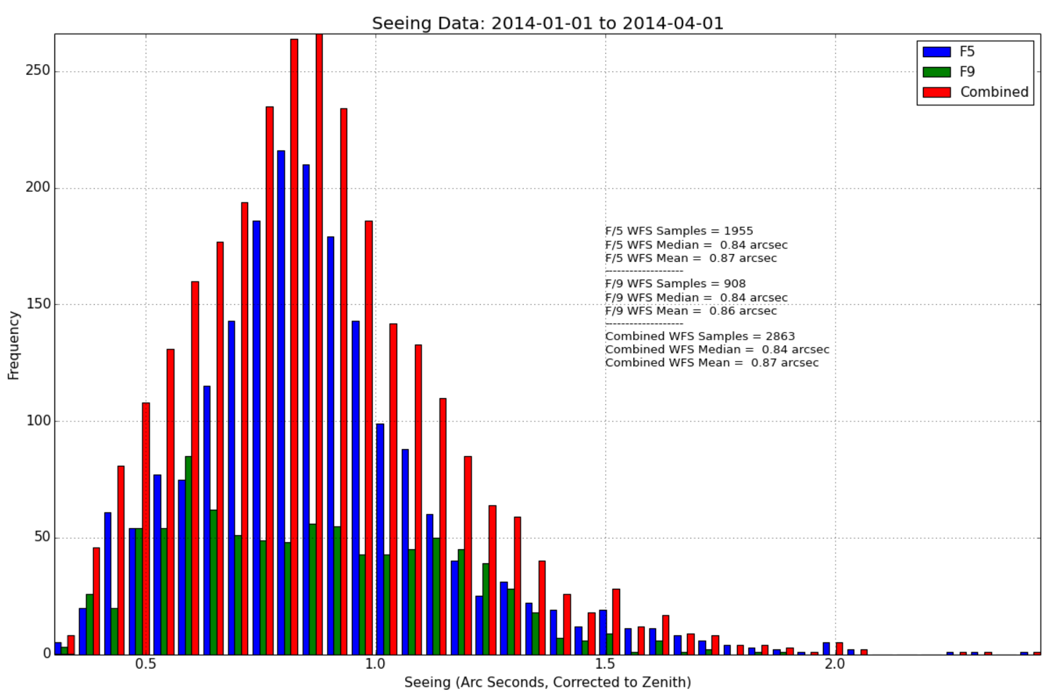

Figure 5 shows the histograms of seeing values for f/5 (blue), f/9 (green), and the combined dataset (red). The median seeing for both f/5 and f/9 was 0.84" during this quarter, again reiterating the self-consistency between the seeing measurements with the two different WFS systems. These median seeing values are consistent with past trends.

User Support

Remote Observing

The MMTO supported a total of eleven nights of remote observing this quarter. Eight nights were for UA/ASU observers, with three nights for CfA.

Several changes were made on the observer computer, *pixel*, when connecting through Screen Sharing (VNC) that will make connections between Linux and Windows machines to the remote observing computer more robust.

Data Quality Assessment

Prototype routines in IDL were developed and can be run on any Blue or Red Channel images to quickly compare the current bias level, lamp count rates, and throughput to an archival "historical" value, and issue a report of any red flags. Work is ongoing to transition this code to Python, and deploy it in such a way that these reports are both automated and robust.

Data Archive

The data archive from Blue and Red Channel was requested by astronomers on three occasions during this quarter due to unforeseen issues with data transfer and/or a failed hard drive. In all cases, the data from the archive fully replaced the missing data, leading to no loss of telescope scientific efficiency.

Documentation

Nothing to report.

Public Relations and Outreach

Visitors and Tours

2/19/14 - J. Hinz gave a refresher course on the MMTO to the F.L. Whipple Observatory (FLWO) volunteer tour guides at the Visitors Center before public tours resumed in March.

2/24/14 – G. Williams gave a tour of the MMTO to a group of 10 UA optical science graduate students, arranged by MMTO graduate research assistant, X. Zhu, also an optical science graduate student.

2/26/14 – E. Falco gave a tour of the FLWO facilities and the MMTO to a group of 12 students and 2 professors from Wales.

2/27/14 – G. Williams gave a tour of the MMTO to 4 graduate students from Arizona State University (ASU). Their tour was coordinated to take place on a night that an ASU faculty member was observing at the MMT.

3/14/14 – G. Williams gave a tour of the MMTO to the Huachuca (AZ) Astronomy Club.

3/15/14 – D. McCarthy (astronomer and ARIES instrument PI) and E. Olszewski (professor and frequent observer at the MMT) gave a tour of the MMTO to 8 prospective UA astronomy graduate students.

Public Presentations

1/14/14 - J. Hinz gave a talk to the Sonora Astronomical Society in Green Valley entitled "Spinning Disks: The Dynamics of Galaxies."

1/29/14 - J. Hinz gave the presentation "Spinning Disks: The Dynamics of Galaxies" as part of the Smithsonian Lectures on Astronomy in Green Valley, AZ.

2/12/14 - G. Williams gave a presentation entitled "Supernovae in Any Way, Shape or Form," as part of the Smithsonian Lectures on Astronomy in Green Valley, AZ.

MMTO in the Media

2/12/14 - *Astronomy* Magazine editor, David Eicher, posted a blog detailing his visit to the MMTO and F.L. Whipple Observatory. Included were photos of the MMT, telescope enclosure, and surroundings.

Site Protection

One meeting of a site protection action committee, of which MMTO is a member, was held in February to discuss concerns and strategies.

G. Williams or J. Hinz represented the MMTO at five meetings during this quarter regarding county and city outdoor lighting codes. County and city meetings included a Cochise County Outdoor Lighting Code committee meeting, a Cochise county public hearing held in Bisbee, AZ, and Sierra Vista, AZ city council and planning and zoning committee meetings.

Appendix I - Publications

MMT Related Scientific Publications
(An online publication list can be found in the MMTO ADS library at http://www.mmto.org/node/244)

14-01 A Panchromatic View of the Restless SN 2009ip Reveals the Explosive Ejection of a Massive Star Envelope
R. Margutti, D. Milisavljevic, A.M. Soderberg, et al.
ApJ, **780**, 21

14-02 The Ultraviolet-bright, Slowly Declining Transient PS1-11af as a Partial Tidal Disruption Event
R. Chornock, E. S. Gezari, et al.
ApJ, **780**, 44

14-03 Short GRB 130603B: Discovery of a Jet Break in the Optical and Radio Afterglows, and a Mysterious Late-time X-Ray Excess
W. Fong, E. Berger, B.D. Metzger, et al.
ApJ, **780**, 118

14-04 "Direct" Gas-phase Metallicities, Stellar Properties, and Local Environments of Emission-line Galaxies at Redshifts below 0.90
C. Ly, M.A. Malkan, T. Nagao, et al.
ApJ, **780**, 122

14-05 How Good a Clock is Rotation? The Stellar Rotation-Mass-Age Relationship for Old Field Stars
C.R. Epstein and M.H. Pinsonneault
ApJ, **780**, 159

14-06 A Merger Shock in A2034
M.S. Owers, P.E.J. Nulsen, W.J. Couch, et al.
ApJ, **780**, 163

14-07 Mapping Compound Cosmic Telescopes Containing Multiple Projected Cluster-scale Halos
S.M. Ammons, K.C. Wong, A.I. Zabludoff, et al.
ApJ, **781**, 2

14-08 A New Population of Ultra-long Duration Gamma-Ray Bursts
A.J. Levan, N.R. Tanvir, R.L.C. Starling, et al.
ApJ, **781**, 13

14-09 SDSS J074511.56+194926.5: Discovery of a Metal-rich and Tidally Distorted Extremely Low Mass White Dwarf
A. Gianninas, J.J. Hermes, W.R. Brown, et al.
ApJ, **781**, 104

14-10 Chandra and MMT Observations of Low-mass Black Hole Active Galactic Nuclei Accreting at Low Rates in Dwarf Galaxies
W. Yuan, H. Zhou, L. Dou, et al.
ApJ, **782**, 55

14-11 Interaction between the Broad-lined Type Ic Supernova 2012ap and Carriers of Diffuse Interstellar Bands
D. Milisavljevic, R. Margutti, K.N. Crabtree, et al.
ApJ Lett., **782**, L5

14-12 The Wind of Variable C in M33
R.M. Humphreys, K. Davidson, M.S. Gordon, et al.
ApJ Lett., **782**, L21

14-13 CLASH: Photometric Redshifts with 16 HST Bands in Galaxy Cluster Fields
S. Jouvel, O. Host, O. Lahav, et al.
A&A, **562**, 86

14-14 The Wolf-Rayet Stars in M 31. I. Analysis of the Late-type WN Stars
A. Sander, H. Todt, R. Hainich, W.-R. Hamann
A&A, **563**, 89

14-15 Masses, Radii, and Orbits of Small Kepler Planets: The Transition from Gaseous to Rocky Planets
G.W. Marcy, H. Isaacson, A.W. Howard, et al.
ApJ Supp., **210**, 20

14-16 The Superluminous Supernova PS1-11ap: Bridging the Gap between Low and High Redshift
M. McCrum, S.J. Smartt, R. Kotak et al.
MNRAS, **437**, 656

14-17 Ultraviolet-Excess Sources with a Red/Infrared Counterpart: Low-mass Companions, Debris Discs and QSO Selection
K. Verbeek, P.J. Groot, S. Scaringi, et al.
MNRAS, **438**, 2

14-18 The Production of Strong, Broad He II Emission After the Tidal Disruption of a Main-sequence Star by a Supermassive Black Hole
C.M. Gaskell and P.A. Rojas Lobos
MNRAS, **438**, 36

14-19 SN 2009ip and SN 2010mc: Core-collapse Type IIn Supernovae Arising from Blue Supergiants
N. Smith, J.C. Mauerhan, J.L. Prieto
MNRAS, **438**, 1191

14-20 Galactic Winds and Stellar Populations in Lyman α Emitting Galaxies at z~3.1
E.M. McLinden, J.E. Rhoads, S. Malhotra, et al.
MNRAS, **439**, 446

14-21 PS1-10jh: The Disruption of a Main-sequence Star of Near-solar Composition
J. Guillochon, H. Manukian, E. Ramiriz-Ruiz
ApJ, **783**, 23

14-22 Line-of-sight Structure toward Strong Lensing Galaxy Clusters
M.B. Bayliss, T. Johnson, M.D. Gladders, et al.
ApJ, **783**, 41

14-23 A Redshift Survey of the Strong-lensing Cluster Abell 383
M.J. Geller, H.S. Hwang, A. Diaferio, et al.
ApJ, **783**, 52

Non-MMT Related Staff Publications

Embedded Star Formation in S^4G Galaxy Dust Lanes
Elmegreen, D. M., Elmegreen, B. G., Erroz-Ferrer, S., et al., (J. Hinz)
ApJ, **780**, 32

Morphological Parameters of a Spitzer Survey of Stellar Structure in Galaxies
Holwerda, B. W., Munoz-Mateos, J.-C., Comeron, S., et al., (J. Hinz)
ApJ, **781**, 12

ARRAKIS: Atlas of Resonance Rings as Known in the S^4G
Comeron, S., Salo, H., Laurikainen, E., et al., (J. Hinz)
A&A, **562**, 121

Unveiling the Structure of Barred Galaxies at 3.6μm with the Spitzer Survey of Stellar Structure in Galaxies (S^4G). I. Disk Breaks
Kim, T., Gadotti, D. A., Sheth, K., et al., (J. Hinz)
ApJ, **782**, 64

Dissecting the Origin of the Submillimetre Emission in Nearby Galaxies with Herschel and LABOCA
Galametz, M., Albrecht, M., Kennicutt, R., et al., (J. Hinz)
MNRAS, **439**, 2542

Appendix II - Service Request (SR) and Response Summary: January - March, 2014

The MMT Service Request (SR) system is an online tool to track ongoing issues that arise primarily during telescope operations, although the system can be used throughout the day and night by the entire staff. Once an SR has been created, one or more responses are created by staff members to address and eventually close the SR. These SRs and associated responses are logged into a relational database for later reference.

Figure 6 presents the distribution of SR responses by priority during the period of January through March 2014. As seen in the figure, the highest percentage (57%) of responses were "Important" priority, 28% were "Critical," while 10% were "Low." The remaining are "Information Only" (5%) or "Near-Critical" (0%). "Critical" SRs address issues that are preventing telescope operation, while "Near-Critical" SRs relate to concerns that pose an imminent threat to continued telescope operation. There were a total of 40 responses during this three-month period. This number averages approximately one response per two days by the MMT staff during the period, including weekends.

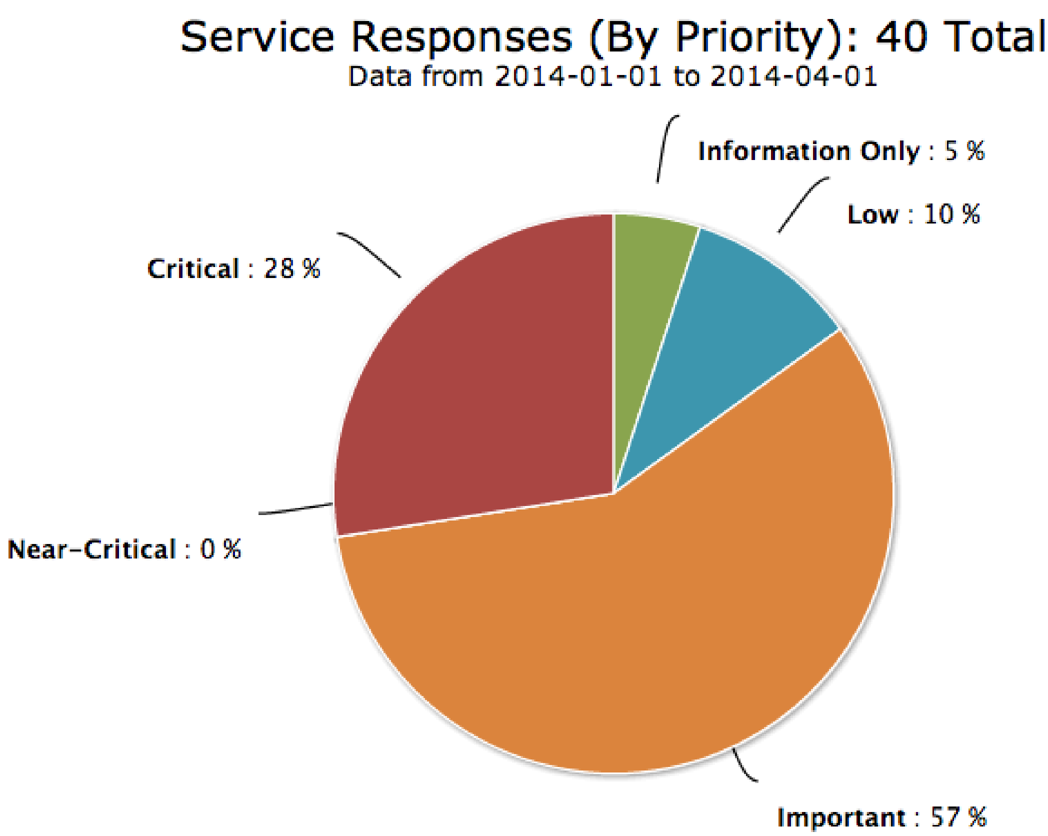

Figure 6. Service Request responses by priority during January through March 2014. The majority (57%) of the responses are related to SRs of "Important" priority, while "Critical" and "Low" priority responses are 28% and 10%, respectively, of all responses.

Figure 7 presents the same 40 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. The majority of the responses from January through March were related to the "Telescope" category. An approximately equal number of responses occurred for "Computers/Network," "Building" and "Pit" (the enclosed, below-ground area beneath the rotating telescope building).

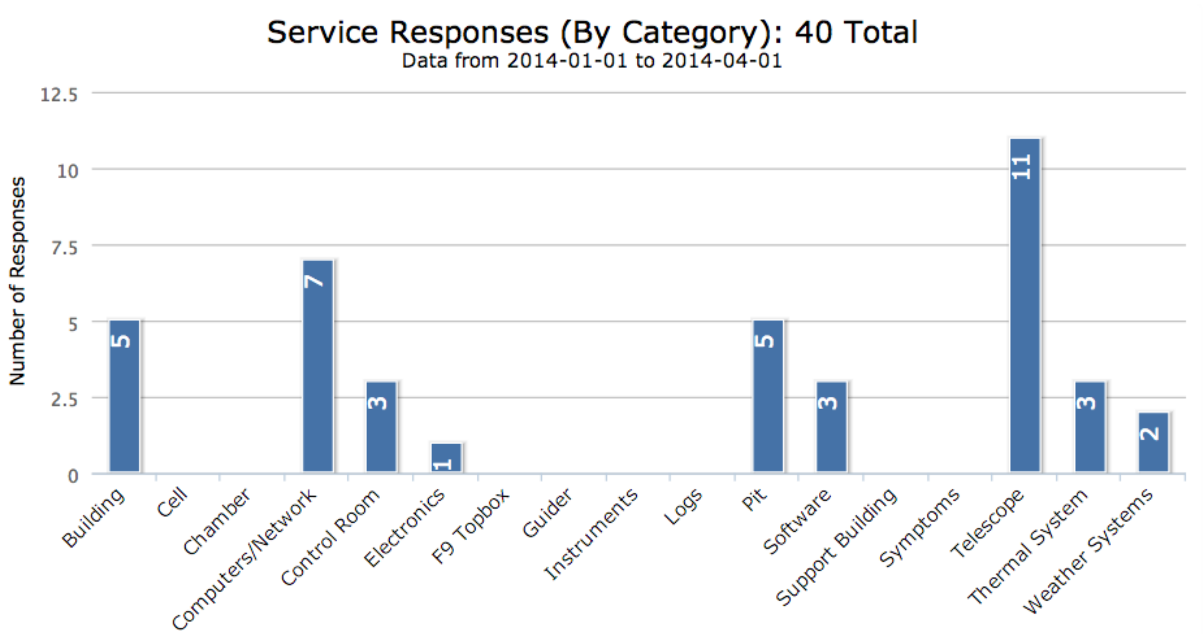

Figure 7. Service Request responses by category during January through March 2014. The majority of responses were within the "Telescope" category.

Appendix III - Observing Statistics

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.

Use of MMT Scientific Observing Time

January 2014

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	270.20	91.50	0.50	0.00	12.50	0.00	104.50
PI Instr	5.00	59.00	17.80	0.00	5.50	0.00	0.00	23.30
Engr	3.00	35.80	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**	**365.00**	**109.30**	**0.50**	**5.50**	**12.50**	**0.00**	**127.80**

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	29.9
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	1.5
Percentage of time lost to general facility	3.4
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	35.0

* Breakdown of hours lost to instrument
- 0.50 Grating not zeroed

** Breakdown of hours lost to telescope
- 3.50 WFS camera issues
- 1.00 DM & rotator issues
- 1.00 AO camera and oscillation issues

*** Breakdown of hours lost to facility
- 1.00 Hacksaw server slowness issues
- 11.50 Building drive failure

February 2014

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	5.00	57.20	43.90	0.00	0.16	0.00	0.00	44.06
PI Instr	22.00	243.90	53.15	0.25	11.65	0.00	0.00	65.05
Engr	1.00	11.10	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	**28.00**	**312.20**	**97.05**	**0.25**	**11.81**	**0.00**	**0.00**	**109.11**

Time Summary

Percentage of time scheduled for observing	96.4
Percentage of time scheduled for engineering	3.6
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	31.1
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	3.8
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	34.9

* Breakdown of hours lost to instrument
- 0.25 Hecto guide camera

** Breakdown of hours lost to telescope
- 0.16 M1 mirror panic
- 11.40 f/5 WFS communication issues
- 0.25 Hexapod issue

Year to Date February 2014

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	28.00	327.40	135.40	0.50	0.16	12.50	0.00	148.56
PI Instr	27.00	302.90	70.95	0.25	17.15	0.00	0.00	88.35
Engr	4.00	46.90	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	**59.00**	**677.20**	**206.35**	**0.75**	**17.31**	**12.50**	**0.00**	**236.91**

Time Summary

Percentage of time scheduled for observing	93.1
Percentage of time scheduled for engineering	6.9
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	30.5
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	2.6
Percentage of time lost to general facility	1.8
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	35.0

March 2014

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	106.40	54.70	0.25	0.00	0.00	0.00	54.95
PI Instr	20.00	201.70	32.70	1.50	8.50	0.00	0.00	42.70
Engr	1.00	10.40	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	**31.00**	**318.50**	**87.40**	**1.75**	**8.50**	**0.00**	**0.00**	**97.65**

Time Summary

Percentage of time scheduled for observing	96.7
Percentage of time scheduled for engineering	3.3
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	27.4
Percentage of time lost to instrument	0.5
Percentage of time lost to telescope	2.7
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	30.7

* Breakdown of hours lost to instrument

0.25 CCD power had to be recycled
0.50 Hecto ADC server hung up
1.00 Failed sequence errors with hecto robots

** Breakdown of hours lost to telescope

0.50 AO camera reboot
4.50 AO camera freeze, gap contamination, problems with actuator and flattening mirror
1.50 Unable to close AO loop; AO camera issues
1.50 AO camera freezing, AO GUI sluggish
0.50 WFS stage hung up

Year to Date March 2014

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	38.00	433.80	190.10	0.75	0.16	12.50	0.00	203.51
PI Instr	47.00	504.60	103.65	1.75	25.65	0.00	0.00	131.05
Engr	5.00	57.30	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	**90.00**	**995.70**	**293.75**	**2.50**	**25.81**	**12.50**	**0.00**	**334.56**

Time Summary

Percentage of time scheduled for observing	94.2
Percentage of time scheduled for engineering	5.8
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	29.5
Percentage of time lost to instrument	0.3
Percentage of time lost to telescope	2.6
Percentage of time lost to general facility	1.3
Percentage of time lost to environment	0.0
Percentage of time lost	33.6