Smithsonian Institution &
The University of Arizona®

End of Quarter Summary

October - December 2013

MMT Observatory Activities

Our quarterly reports are organized using the same work breakdown structure (WBS) as used in the annual program plan. This WBS includes major categories with several subcategories. Specific activities might fall a tier or two below the subcategories. Since the WBS was recently established we expect that it will be modified to some extent in future program plans and reports.

Administrative

Program Management

The annual staff meeting and photo took place at the summit on November 5. Lunch was provided, followed by the "State of the MMTO" address by Director G. Williams. As a surprise, MMTO shirts were distributed to the staff at the end of the meeting.

Staffing

Will Goble started as Principal Engineer, Mechanical on November 1.

Tyler Barbaree resigned as Electronic Technician, Sr. on October 22. Recruitment for a replacement began in December.

Kevin Comisso's last day as temporary Office Assistant was December 20. He completed the tasks of inventorying and organizing mechanical drawings for the original and converted telescopes.

Strategic Planning

Weekly meetings continued in October with a survey distributed at the end of the month to the Arizona observatories consortium (Steward Obs. at UA, ASU, and NAU) and SAO/CfA communities. The survey asked for input on instrumentation and modes of observing to accomplish the most scientific return for the MMTO in the coming 5-10 years. A report on the input from the Strategic Planning committee is scheduled for completion in February 2014.

Reports and Publications

There were twenty-nine peer-reviewed MMT-related scientific publications and five non-MMT related staff publications during this time period. No technical memoranda or reports were generated. See the listing of publications in Appendix I, p. 20.

Presentations and Conferences

J. Hinz gave a talk entitled "The MMT Observatory: Current Capabilities and Plans through 2015" at the Arizona State University's School of Earth and Science Exploration on November 12. ASU is a full Arizona consortium partner, and she met with several research groups to obtain feedback from current MMTO users and to discuss improving communication.

G. Williams and J. Hinz attended the International Dark-Sky Association's annual meeting on November 15 in Tucson.

Safety

An oxygen sensor unit was purchased in December for use in confined spaces on the summit. The unit is located in the safety locker in the chamber.

Training

The following new videos were added to the Steward Observatory safety training website:

University of Arizona "Recognizing Chemical Hazards at Work" (5 videos)
Driving Mountain Roads: Slowing Down
Backing up on Forest Roads
Ladder Safety
Eye Protection

Six additional videos were also ordered by Steward to be added to the website.

Safety Inspections

Steward Safety and University of Arizona Risk Management performed an inspection of summit operations on October 24. Items of risk were identified and a list of recommendations made to improve the safety of personnel on the mountain. The complete list, entitled "Safety Inspection Write-Ups Oct 2013," can be found in the Documentation Database in the Safety folder. Many items have been corrected and work is in progress to address the remaining issues. Some items already corrected include:

- Electrical junction box covers were installed in various locations where they were found missing;
- Several power tools with damaged cords were replaced;
- All electrical panels were properly marked to prevent accidental blocking;
- Filters were ordered for the eyewash station in the summit shop.

Procedures and Protocols

All obsolete and expired chemicals from the MMT campus shops were picked up by Risk Management for disposal. On the mountain, a new chemical handling and storage procedure is being developed. Several issues are being addressed including tracking chemical expiration dates, documenting chemical removal from the summit, and checking chemical storage compatibilities.

New Lock Out/Tag Out procedures were developed for the mountain. All personnel now have, and are responsible for, their own locks for Lock Out.

A pre-use inspection form for the chamber manlift was developed. There are paper versions available as well as an online version (linked on the mountain iPad).

A new Fire Shutdown Procedure was finalized and Fire Shutdown Procedure decals were placed on equipment to draw the attention of the person performing the procedure.

A more permanent and secure mount was created and installed for the front shutter emergency air close cylinders.

D. Blanco circulated a draft safety credo for the MMTO that received comments and suggested revisions. A sign with the final consensus statement will be made and prominently displayed at the summit.

Miscellaneous

It was determined that a ringtail cat was getting into the control room via a 3-inch conduit running up the west side of the building. The conduit was sealed off, preventing the potential for unsanitary conditions and/or disease caused by animal droppings.

Primary Mirror

Coating & Aluminization

After critically reviewing the previous M1 mirror coatings, a project schedule was generated to describe and track the work necessary to successfully recoat M1 in the summer of 2014. All of the development tasks, as well as the actual coating tasks, have been included in this schedule. The work breakdown structure is:

1. Project Management
2. Cryopump Handling Improvements
3. Vacuum Membrane Protection
4. New Filament Characterization (in progress before schedule was completed)
5. Next Generation Filament Control (in progress before schedule was completed)
6. Data Handling Improvements (in progress before schedule was completed)
7. Minor Process Improvements
8. Equipment Checkout
9. Telescope Shutdown
10. Project Completion

As part of reviewing the previous M1 coatings, a number of issues and potential improvements were identified. The majority of the work in the upcoming quarter will focus on the vacuum membrane protection, new filament characterization, next generation filament control, and data handling improvements. In addition to providing a more reliable coating process, this work should lead to a successful recoating in 2014.

Regularly scheduled aluminization meetings have started in order to track project progress, to coordinate work between the teams, and to document the development work.

To ensure the vacuum membrane will be protected adequately during the coating process, a set of tests utilizing the Sunnyside vacuum testing facility's small coating chamber was initiated. These experiments are designed to evaluate various material configurations, and to identify a barrier for protecting the metallized Mylar vacuum membrane from molten aluminum droplets. Due to the location and the delicate nature of the vacuum membrane, the process of installing the membrane shield has been a driving factor for determining the material configurations tested. One round of testing was completed in this quarter.

An investigation was started to determine the feasibility of using the Sunnyside large coating chamber for testing a subset of the MMT filament control system, namely a two-welder forty-filament setup. Since a full scale test of the MMT M1 coating system is not practical, these subset tests will substitute. The goals of this testing will be to characterize the new filaments, to verify the operation of the next generation filament control, and to check out the improved data handling system from end-to-end. Early indications are that the Sunnyside large chamber can be configured for these tests without extensive fabrication or chamber modifications. Furthermore, these tests could possibly start as soon as February 2014.

A new chassis was built that provides galvanic isolation for 16 channels of analog input to replace the HP DAU (Data Acquisition Unit) used previously for collection of aluminization system data from the vacuum sensors and deposition monitors. The new isolation electronics allow for more channels to be connected to a PCI data acquisition board so all data can be collected from the aluminizing system at high rates during coating. To allow for software control of the welder setpoints for automatic coating, we designed a serial DAC (digital-to-analog converter) board that uses the PCI board digital I/O lines to add an analog output channel to the isolation chassis. D. Porter did the original driver coding for the data acquisition and DAC driver, and during this development, we found that the DAC serial control lines were corrupted by crosstalk that made the analog output voltage appear to have random fluctuations. Additional electronic filtering on the lines solved this problem.

A complete spare chassis for the isolation amplifiers is being built, along with the necessary cables to connect it to the aluminization control cabinet. The cabinet houses the signal conditioners and displays for the vacuum sensors and deposition monitors.

We found that D. Porter's original prototype C code for data acquisition on the aluminization PC, and the associated redis updates to connect the data-collection process with other software (e.g., web pages), was using large amounts of CPU time - the system load often going over 100%. The software was rewritten by D. Clark to speed up the data acquisition and to add the welder-control C code generated from the Simulink-based system design to lower the overall CPU load. Several suggestions from D. Gibson for pipelining operations and adding more efficient JSON stringify operations for the redis data updates were implemented as well.

Initial testing in the lab with a single welder and resistive test load bank were done as proof-of-concept that the generated code would run correctly in the system, and that the proposed power-control loop and transition logic work. Several stability issues were discovered in this testing and it appears that nonlinearities, sample lag, and noise will have to be handled by the control system to produce smooth and predictable welder-control outputs. A new set of control algorithms to handle these issues is in the process of being tested in the lab before the computer and hardware are taken to the Sunnyside facility for testing on actual filament loads.

A significant effort was put into the software framework for the in-situ re-aluminization of the primary mirror. This framework includes: 1) a centralized key-value store (Redis) for data exchange, 2) newly developed hardware-software interface software for faster data sampling and better hardware control, 3) automated control software based upon state diagrams, 4) redundant relational databases and log files, and 5) re-engineered user interfaces using current web-based technologies.

Work continues on new data acquisition and control software that interacts with the ten welders that supply power during aluminization, and with the various pressure and deposition rate monitors within the vacuum chamber. The main aluminization computer has been upgraded to more current hardware and to a recent version of the Fedora (Linux) operating system (OS), replacing the previous Windows XP OS. Three PCI boards are installed in this computer for data acquisition. Two of the boards have been used in prior aluminization efforts for welder data acquisition and control. The third board has been added to replace a HP-DAU for vacuum and aluminization deposition data. Data acquisition software is now reading raw values from these PCI cards and converting these values to physical parameters, such as vacuum pressure and voltage. Live video streams, taken through portals into the aluminization vacuum chamber, are being integrated into graphical user interfaces (GUIs) and recorded for later analysis. D. Clark continues to refine a state-diagram control algorithm that is based upon empirical testing and modeling of physical processes. States within this state diagram include the heating, melting, vaporization, and deposition of aluminum during the event. Code generated from the Simulink control model is integrated into the rest of the software framework. This automated control is critical for providing consistency for an optimal final aluminum coating on the mirror. New schema were defined for relational databases that maximize performance and allow for rapid (e.g., 50-100 Hz) logging of data. New user interfaces are being developed that employ current web technologies, including Hypertext Markup Language 5 (HTML5), websockets, and node.js. These new web technologies allow continuous connections between servers and web browser clients, and for synchronous updating of multiple web clients for a consistent user experience. They also allow more sophisticated data presentation and visualization. Performance of the software framework, including data acquisition and logging, hardware control, the Redis key-value store, and the websocket telemetry, is being assessed and tested. Use of a robust, automated software framework helps ensure the success of the full-scale re-aluminization of the MMTO primary mirror.

Actuators

Primary mirror support actuator #52 was exhibiting intermittent bump test and operational force-output failures. Extensive troubleshooting was performed to determine the source of the intermittent problem, including swapping #52 with its mirror-image unit from the cell, #103, to ascertain if the issue was the actuator or the cell control system electronics. The actuator swap showed that the problem followed the actuator, so we tested it on the actuator test stand. No problems were detected. Since the issue remained when the actuator was installed in the cell, we made some electronic cables and tools to measure all the actuator signals in place in the cell.

With in-cell testing, we found that the problem actuator was inconsistently failing bump tests with good mirror cell control signals on the input side, while the monitor force signal fed back to the cell was not meeting requirements. We removed the actuator and carefully re-inspected all the hardware.

We determined the issue was a faulty seal on the air cylinder that produced, in certain shaft positions, enough of a leak to prevent the actuator from producing the full force demanded by the mirror support servo.

In the course of checking out #52, more primary mirror actuator circuit cards were tested and added to the spares storage inventory. Several cards are still in need of additional repair/testing to return them to a serviceable condition.

After major service to the mirror supports last August, we continued to see intermittent problems with the primary mirror hanging in mid-raise until aborted by a "panic" (emergency lower). Tracing back through the telescope operator logs pinpointed the date these problems started. It coincided with a modification of the control code written to include individual actuator calibration data. In early December, T. Trebisky applied a fix to change the effective weight of the mirror to make it heavier by 0.4%, which solved the problem.

Miscellaneous

The mirror cover hoisting system was inspected and preventative maintenance was performed to ensure its safety. A slightly modified design was discussed and will be put into place in early 2014.

Secondary Mirrors

Power, fiber, and video coax cables were run to the secondary hub to prepare for a future prime-focus alignment project.

f/15

A new cooling fan and cover were installed in the existing deformable mirror (DM) power supply to increase airflow and better cool the equipment in the supply enclosure.

Work continues on the DM power supply upgrade. The SolidWorks drawings are nearly complete for the panel layouts and bottom plate-hole patterns for mounting the electronics in the power supply chassis. The front and rear panels for the power supplies were milled and are ready for installation. Minor changes, consisting of filing the opening as well as filing the tabs off the display unit, were made to the front panel to accommodate the display assembly. Testing of the circuit cards, as well as final assembly of the initial test power supply, will be done in early January 2014.

Hexapods

f/9 and f/15 hexapod

New signal conditioning cards for the hexapod strut transducers were populated during this quarter. These cards use a digitally-adjusted offset and gain circuit with low time and temperature drift.

USB-based hardware and software will be developed, enabling the new boards to be adjusted for setup and maintenance.

Optical Support Structure

Nothing to report.

Pointing and Tracking

Nothing to report.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on the MMT for 41% of the available nights from October 1 through December 31. Approximately 76% of those nights were scheduled with the Blue Channel Spectrograph and 16% with Red Channel. SPOL was scheduled for only 3 nights. Of the total 430 hours allocated for f/9 observations, 158.2 hours (37%) were lost to weather conditions, mostly during an early December snowstorm. Instrument, facility, and telescope problems accounted for only 0.3% of lost time. Blue Channel lost 39% of its time to poor weather, with Red Channel losing 20% and SPOL 45%.

The new argon pen-ray calibration lamp was tested with the Blue Channel spectrograph on November 11 by D. Smith and J. Hinz. For testing, the lamp was first placed on the left side of the calibration cabinet. Even with a non-optimal test setup (no focusing optics), the argon throughput from the calibration cabinet via one fiber seemed equal to or better than the currently used HeAr lamp (see Figure 1). The Ar lamp was also tested on the right hand side of the cabinet with better focusing optics along with two fibers usually used with the current Ne lamp (but with no neutral density filters).

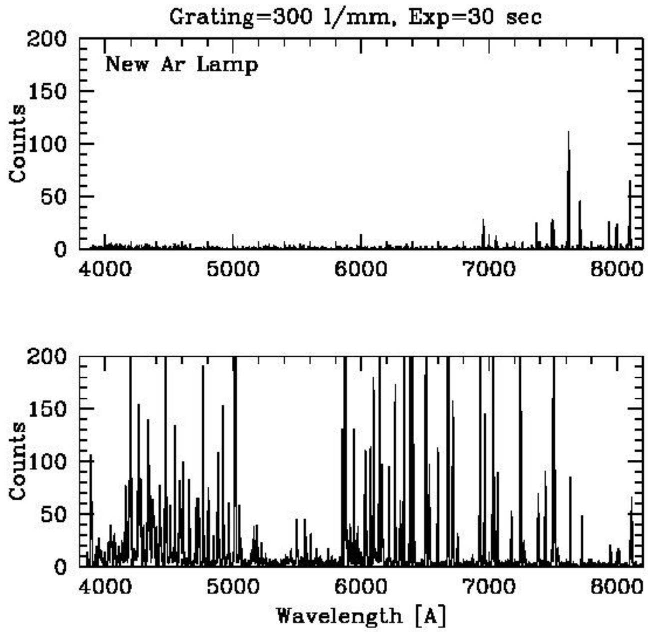

Figure 1. *Top:* The new Ar lamp spectrum taken with the 300 l/mm grating at a central wavelength of 6240A with an exposure time of 30 seconds. *Bottom:* A spectrum of the currently used HeAr lamp with same settings.

The exposure time calculator for the Blue and Red Channel Spectrographs has moved through its first major milestone (software development and calibration) and is currently being converted to interact smoothly with the PHP interface previously designed, with only minor modifications. Once these changes are complete, our host of archival data will be used to double-check the output of the new calculator. Final additions such as filter selection and blaze functions of gratings will be added.

f/5 Instrumentation

Poor weather resulted in the loss of a little over half the allocated time for Hecto and SWIRC on 39 nights this quarter. 406 exposures were obtained on 114 fields with the Hecto instruments. There were also almost 1700 calibration exposures for bias, flat, comparison lamp, dark, and sky. The three nights of scheduled SWIRC observations were totally clouded out, and no sky exposures were obtained.

There were a couple of issues with the wavefront sensor (WFS) this quarter. The SBIG camera server failed to start when powered up in mid-November for the SWIRC run. After consultation with D. Porter, the server was started using the command line without rebooting the WFS computer and the camera worked properly from then on. In late November, the telescope operator left the WFS stage on-axis at the end of a mostly cloudy night. That situation was not realized by the robot operator when he began calibration exposures the next day. The stage was blocking about half the fibers and, by chance, the separation of exposed and blocked fibers was near the boundaries of the chip amplifiers (2 chips with 2 amplifiers each). It appeared as if two amplifiers had failed. N. Caldwell was the first to realize that the problem was a deployed WFS stage. The Hecto software generates a pop-up to notify the observer that the stage is deployed, but for some time it had been registering many false reports of a deployed stage when the stage was parked. The software is now more robust, and the SPICE GUI continually reports the status/location of the WFS stage. Both of the robot operators, M. Calkins and P. Berlind, have also been trained and authorized to park the WFS if this happens again. The problem was corrected well before sunset and no sky time was lost.

The MMTCam software interface was modified to allow the user to stop ADC tracking and set the prisms to zero. The atmospheric dispersion correction is not needed for the filtered exposures.

A replacement hardware VME CPU board has been acquired and tested. This unit has battery-backed memory on board and will be swapped in if the external battery-backed memory card fails. The latter card is out of production, and no additional replacements could be found.

The positioner has behaved well through this reporting period with the exception of the Robot 2 P axis, which has been acting up since March. The reported values of the home and limits sometimes change unpredictably when the axes are homed. The limit values are carefully examined each time the axes are homed, and the home offset value is adjusted to properly center the gimbal stage.

The electronics processing (EP) box on the positioner was not reporting an error condition and would not power up the acquisition and guide cameras one day in mid-October. In addition to the camera control and interlock circuitry, this box has the gimbal axis signal conditioning circuits and the temperature AD circuit along with analog multiplexers to monitor numerous temperature sensors within the positioner. After several server resets failed to correct the problem, we power cycled the EP box and that corrected the problem. The EP box had some problems again about 6 weeks later, but this time the situation was corrected with server restarts.

The ThAr lamps for Chelle were not working reliably. They would sometimes fail to come on late last quarter and early in this quarter. Testing of the 18 individual lamps revealed two that required excessive voltage to light. The required voltage was also a function of how much the lamp had been on recently, which confused the issue. Those two lamps were replaced and additional lamps have been ordered. During the testing, a diagnostic of imminent failure was found. If the voltage required to maintain the lamp's nominal current rises after the lamps are lit, it suggests that one of the lamps in the series is approaching failure. The power supply for Lamp Series 3 has a voltage test point and a voltmeter to monitor this. The high voltage connectors for Lamp Series 1 and Lamp Series 2 can temporarily be plugged into the Lamp Series 3 power supply to perform the test. The operating current for the lamps was reduced from about 15 milliamps to about 12 milliamps to prolong the life of the lamps. No complaints have been received regarding a change in brightness from the change in current.

New filter spacers were designed for the MMTCam. They were fabricated at the University Research and Instrumentation Center. Once anodized, they will be installed in the instrument.

f/15 Instrumentation

There were two adaptive optics (AO) observing runs during this reporting period: October 17-23 and December 9-12. The seven-night October run consisted of three Maintenance & Engineering (M&E) nights and four science observing nights. The four-night December run consisted of one M&E night and three science nights. 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. However, problems continue with the WFS camera and with the DM power supply. Also, 60 and 120 Hz noise issues were seen intermittently. Overall, the Natural Guide System (NGS) has long periods of excellent performance interspersed with periods where the system is less robust and more inefficient.

The auto-rastering routine developed by the MMT software group worked quite well and made a significant difference in the time required to align the system on the first night of operation. Work was also done on the NGS topbox to clean the optical components as well as the interior of the topbox. A cover was purchased to reduce the amount of dust entering the instrument. Also, protective plastic bags are now placed over the optical elements, where possible, to prevent accumulation of dust.

The first night of the October run was designated as M&E. However, the following two science nights of operation were reassigned to M&E due to issues with the installation of the long wavelength detector for ARIES. The first f/15 M&E night included general checkout of the f/15 operation on-sky. The auto-rastering routine was used to align the system on the first target and greatly reduced the amount of time for acquisition. A number of different tests were performed including testing new synthetic reconstructors, taking data on faint targets, troubleshooting alignment laser stage issues, and putting numerous actuators back in service. Overall, it was a successful night of setup and testing.

During the following two M&E nights, we continued to perform system checkout, as well as testing new capabilities to improve the system performance. Some issues with high currents on the DM were traced to issues with the WFS camera focus. It appeared that the WFS camera focus stage was not homing properly, sometimes leading to a large focus error. Other things that were tested included non-sidereal tracking, and closing the loop on non-point source objects such as moons and comets.

In general, the AO system performed well during the following four science nights with the MMTPol instrument. Time was lost during the first two nights due to poor seeing. WFS camera freezing issues continued to occur. Though infrequent, when the WFS camera does freeze, it can be very time consuming to restart.

The final night of AO operations saw difficulty with keeping the loop closed during certain periods due to high currents on the DM. This appears to have been related to a 60 and 120 Hz noise issue that corrupted the slopes data to the PCR, ultimately giving bogus commands to the mirror. The noise occurred intermittently and infrequently but, when present, was very large.

During the December run, the auto-rastering routine again greatly reduced the time needed to acquire the first target during setup. The topbox optics needed to be re-aligned after the optical elements had been cleaned between runs. A number of tests were run on the December 9 M&E night, including testing the ability to put in slope biases to the PCR and debugging the AO seeing monitor.

Time was lost due to communications issues with *ao-pcr* during the December 10-12 science nights. It was unclear whether these issues were related to network problems or other computer issues. In addition, clouds and bad weather contributed to a loss of time on-sky. The final night was dedicated to testing of the non-linear curvature WFS (nlCWFS), which was installed while the topbox was on the telescope. A marathon effort to align the optics ensued, but was only partially successful due to the inherent inflexibility of the instrument's design. Some image data were obtained and certain components were checked out, such as the WFS camera and software, but we were not able to acquire simultaneous Shack-Hartmann/nlCWFS data due to the alignment issues.

During the December ARIES run, the group from Arizona State University continued to obtain data on low-mass companions to nearby stars, with objects observed on two nights of the run, although some time was lost due to weather.

Work is in progress by J. Stone on the ARIES calibration unit. A ThAr and a Photron lamp have been obtained and are working, contained in a prototype enclosure.

Topboxes and Wavefront Sensors (WFS)

f/9 Topbox

Software has been developed to interface the existing WFS correction code with the new network-interface f/9 WFS camera. In addition, work is ongoing to convert the current WFS pipeline code to function properly when the new camera is in place. We expect two long f/5 and f/15 runs in spring 2014, opportune times for engineering activities with the new camera. We hope to be able to test on-sky performance of the new system during the April 2014 engineering run. Transitioning to this new camera not only removes one computer that requires maintenance, *f9wfs*, but also removes a possible single point failure from our f/9 operations: the PCI board used to interface the current f/9 WFS camera to *f9wfs* is no longer produced and we have no replacements. Should that board fail, we would be left without WFS capabilities when using the f/9 secondary.

Work is also ongoing with the WFS spot finding algorithms to more robustly treat spots that may not be completely distinct in the images. During soft (>1.5") seeing, WFS often fails due to insufficient spots found; investigations have shown this is due to spots that overlap, even only slightly, that are counted as a single spot using the current algorithm. An algorithm has been written that solves these issues quickly and is being converted to Python code to fit more seamlessly into the current WFS code framework.

Natural Guide Star (NGS) Topbox

During an AO run, the NGS top box alignment laser stage was found to be inoperative. The stepper motor driver was identified as the cause. An attempt to swap in a motor driver borrowed from the LGS top box was unsuccessful, as that unit was also not working. A new unit was purchased, programmed with the code from the prior unit, and installed. Testing with the new driver was successful and the alignment stage was declared operational. During a subsequent run, use of the laser was possible to check optical alignment of the top box and ARIES optics.

At the same time that the bad motor driver was discovered, a visual inspection was performed of the wiring of the topbox. The inspection revealed that the connectors to all of the driver stages needed repair, e.g., connector pins had been poked into their matching connector without the necessary housing for proper mating. Those and additional repairs will be done to bring the entire NGS top box equipment and wiring up to industry standards.

The MMTPol cooler control cable can now be connected in either the storage area on the 2nd floor east for staging, or on the elevation drive arc during observing.

Facilities

Main Enclosure

A new Honeywell fire alarm system was installed at all of the facilities on Mt. Hopkins during this quarter. The system is active, although the internet interface is not yet in service. When complete, the system will automatically send email notifications to a TBD distribution. Other enhancements are scheduled to be done in the near future.

GLHN, a consulting firm, began studying the HVAC system used to control temperatures of the telescope, primary mirror, and facility. Their task is to recommend improvements to the system regarding performance, maintainability, and efficiency.

Progress was made towards a new roof for the MMTO. One goal is to reduce the emissivity of the roof, currently about 0.8 for a membrane roof, to about 0.1 or less. Plans are to lay a standing seam metal roof over the existing membrane and replace or re-attach the snow melt resistance cable. One failing of the membrane is that it does not conduct heat from the cables, so the snow does not melt evenly. A standing seam metal roof will provide better heat distribution.

Two low-emissivity roofing materials have been identified: Galvalume® and Galvalume Plus®. These are common roofing materials that have excellent corrosion resistance and are widely available. Bare Galvalume has a pearl white finish. Galvalume Plus adds a clear plastic overcoat that prolongs the low emissivity.

It was discovered that the first bank of roof heaters on the west shutter were not operating. The problem, an open neutral wire, was fixed.

A survey was undertaken of the building and chamber for possible thermal issues that might degrade seeing. Current measurements were taken on all equipment that might produce heat and are also in the path of the telescope. A portable handheld IR camera was purchased to aid in the search and was used to check electrical cabinets and equipment.

The chamber instrument lift limit switches had new brackets designed and fabricated to prevent early shut off of the hydraulic pump. Intermittent issues relating to the remote not operating were due to loose connections on the contactor, presumably associated with vibration. The connections were tightened to the manufacturer's recommended torque value.

To reduce congestion in the control room, the computer UPS units were relocated to the drive room and new grey receptacles were installed in the control room. The video distribution amplifier box was moved to 3rd floor east. The wireless access point near the Hecto robot operator's station was moved to free up space and to prevent interference with work activities in the area.

Several UPS units were repaired and had new batteries installed. The new batteries were labeled with the date of installation.

The fluorescent light under the telescope was repaired.

A protective cover was installed over the main entrance keypad to prevent ice buildup.

The telescope operator's CRT monitor was inspected and cleaned.

Instrument Repair Facility (IRF)

Service was completed on the Bridgeport mill to correct increasing backlash and to replace worn parts. A new roller nut assembly was installed for both x and y table axes. Backlash and alignment was reset at manufacturer specifications.

Common Building

A lightning strike took out one phase of electrical service to the Common Building during this reporting period. The road was cut and trenched to bury a new service line to the building.

Exterior work on the Common Building began this quarter. Exterior gutters and eaves around the deck were repaired. Contractors took advantage of the balmy weather to paint the new steel work. Old drywall and insulation were removed from the basement's west wing and will be replaced after all leaks are repaired.

Computers and Information Technology

Computers and Storage

A new Synology network-attached storage (NAS) device was purchased and configured for use by the MMTO adaptive optics (AO) effort. This NAS box, named *ao-nas*, will contain archival data and software related to MMTO AO activities. The NAS box is equipped with four 3-terabyte (3 TB) hard drives, for a total of 12 TB unformatted storage space. The drives were configured to the Synology Hybrid Raid format, which is a variation of the RAID5 disk array configuration. The final RAID disk array has 8.1 TB of available storage space with one-disk redundancy in case of a disk failure. The *ao-nas* NAS box is primarily maintained by K. Powell. It is located with other MMT campus server hardware in the 3rd floor Steward Observatory server room.

During this reporting period, over 3 TB of AO archival data and software were transferred to *ao-nas* from other MMT NAS boxes and external USB drives, freeing up space on those storage devices. A software backup of *ao-pcr* software was performed in October 2013. Approximately 5 TB of storage space are available for future AO data storage needs. The MMTO AO effort will benefit greatly from having a dedicated storage facility for archiving data and software.

The MMTO has three similar, but slightly larger (15 TB), NAS boxes (*nas1, nas2*, and *nas3*) that are used for data storage and archiving. One of these NAS boxes, *nas1*, had a disk failure on disk #4 during the reporting period. Because the NAS boxes are RAID5 arrays with one disk redundancy, there was no RAID array failure with the failure of this disk. Although the NAS box continued to operate, the failure of this single disk caused high load levels on *nas1* and on *hacksaw*, the primary server at the telescope. The network file system (NFS) mounts of the /mmt directory from Linux computers at the observatory, such as *hacksaw*, were moved from *nas1* to *nas2* because of the disk failure. Although data are regularly synchronized between the NAS boxes, a small amount of data was lost during this re-mounting of the /mmt directory. Two new replacement hard drives were purchased for *nas1*: one to replace the back drive and one as a spare. The RAID array on *nas1* was repaired without incident. The /mmt NFS mount remains to *nas2* through the end of the reporting period.

Several incidents of random kernel failures occurred on *hacksaw* and, less frequently, on the *mmt* virtual machines (VMs) during the reporting period. These kernel failures were related to "out of memory" issues apparently associated with a recent release of the open-source VirtualBox software, used by the MMTO for server virtualization. Various measures were taken to reduce the load and the memory requirements for these servers, including deploying caching name servers, reducing the maximum number of allowed Apache web server processes, modifying MySQL re-indexing parameters, and identifying and fixing a memory leak in the VentAuto.pl script.

Work continued on the telescope status displays and computers for the control room. An additional MacMini computer and a new 40-inch Samsung High Definition (HD) TV/monitor were purchased. Although this computer and monitor will be used in the control room, they are currently being used as part of the aluminization effort at the Sunnyside facility and at the campus electronic shop. Work continues on refining the content of the telstat displays, with the addition of more "widgets" that contain telescope status information. This work focuses on optimizing the content for the HDTV monitors, including ergonomic and ease-of-use factors.

Network

Work continued with Smithsonian Institution personnel on network issues. These issues included:

- 'broken pipes' or network socket connections during long network operations
- configuring an installed NAT router for wireless network traffic
- configuration of computers that were using DHCP that should not be using this service
- proper configuration of the 'summit-data' wireless access points
- activation of a redundant fiber link between two switches at the summit
- compromised MMT and non-MMT computers that were on the MMT mountain subnet

S. Schaller was heavily involved in this work and wrote several software tools to query the network switches to aid in this debugging.

An Airport Extreme wireless base station was purchased and installed near the campus SAO suite of offices next door to the MMTO offices on the 4th floor of Steward Observatory. This wireless access point is being used by W. Goble (whose office is temporarily in the SAO suite) and by other MMT staff when direct-wired connection to the MMT subnet is not possible.

All OS X machines were updated to the Maverick (10.9) operating system. This upgrade did bring some challenges, but all have been addressed; all instruments that utilize the computer, *pixel,* to make observations have done so successfully during their run. Due to schedule issues, ARIES has not been fully tested with *pixel*, but we hope to accomplish that during the next f/15 run in order to permanently retire the old observer computer *alewife*.

Hardware/Software Interfaces

Several changes in the AO software were made. These included: increased server button size in the GUI, setting default values for the camera rate and biases, camera initialization for NGS, and duplicate PCR and WFSC server/power buttons on the camera tab. A bug in the test stand code that was abnormally terminating an actuator test was also fixed.

Numerous issues were addressed related to the primary mirror support system and cell crate. The MMTO software staff provided extensive support for tasks reported elsewhere under Hardpoints and Actuators sections. The effective weight of the MMT primary mirror changed because of the re-calibration of the cell support system actuators during the summer of 2013. This change in the apparent weight of the primary mirror caused frequent "panics" of the mirror. Software code changes made in December 2013 remedied this. In addition, a cold spot in the primary mirror glass temperatures was investigated. This apparent cold spot includes E-series thermocouples TC16-TC18.

The hexapod removal/installation issues continued to be investigated. These issues are most apparent with the f/15 configuration. A script, paddle_raster.pl, was created and revised that automates "clicking" the mount paddle in a spiraling raster pattern. This script allows the size of the raster pattern and the time between moves to be varied. It has been used on each AO run and has greatly reduced the time required to acquire the first object after remounting the f/15 secondary. Eventually, more consistent remounting of secondary mirrors, including the f/15, will remove the need for this rastering script.

Support was provided for the MMTPol instrument, including installation of the most recent Java on *pixel* and setting the macports version of Python as the default. "Astropy" was installed on *pixel*.

A new version of the telescope operator's paddle is under development using a Beaglebone Black. The original Arduino-based hardware was repackaged with a new case and wiring for eventual deployment.

Telemetry, Logging, and Database Management

The MMT autologger software moved into testing with observers. This software allows observers to quickly add comments to an automatically-generated (PDF) log of the data acquired, eliminating the need for handwritten logs, which can be more easily lost than electronic logs, and which can be stored with the data. Initial tests with observers have produced several small bugs that are currently being investigated. All are minor and do not impact the fidelity of the logged information.

Annunciator

Issues related to annunciator alerts were addressed. The heavy load on *hacksaw/nas1/nas2* during weekly backups of data on these machines slowed down other processes, triggering annunciator alerts.

Weather and Environmental Monitoring

All Sky Camera and Web Cameras

The all-sky camera server software is being rewritten using Python (the previous version is written in Perl). The new server script will be completely self-contained and will no longer call external executables to determine sunrise and sunset times, build FITS images, and to insert database records. Python has some very useful libraries that do all of these features natively, making the code much easier to maintain. A new procedure for storing the archive images and serving images to the public is being discussed. Where the new server script will run (either a Mac or Linux machine) is still being determined.

Seeing

Figure 2 shows combined f/5 and f/9 WFS seeing values, corrected to zenith, plotted against time from October 1, 2013 to January 1, 2014. Figure 3 presents the same seeing data as a histogram with 0.1 arcsec bins.

Median f/5 WFS seeing for the three-month period was 0.95 arcsec with a mean value of 0.99 arcsec. Median f/9 WFS seeing for the same period was 0.94 arcsec with a mean value of 0.94 arcsec. The f/5 data set includes 1160 samples while 817 samples are in the f/9 data set. The combined f/5 and f/9 WFS median seeing for this period was 0.94 arcsec with 1977 samples.

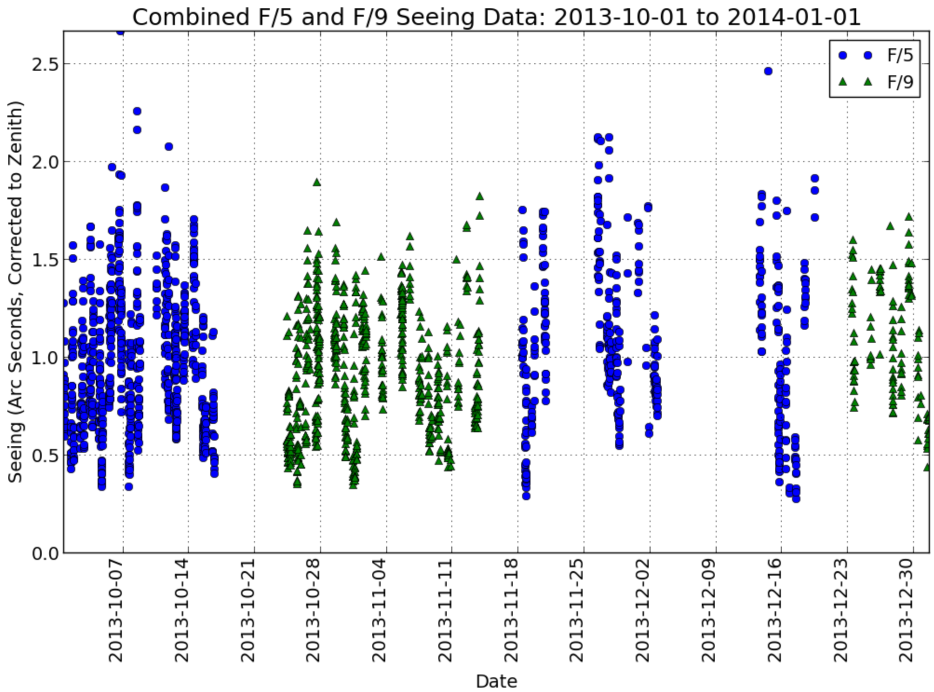

Figure 2. Time-series plot of f/5, f/9 and combined f/5 and f/9 WFS-derived calculated seeing values for October through December 2013. No WFS data are available when observing is not possible or when the f/15 secondary is on the telescope.

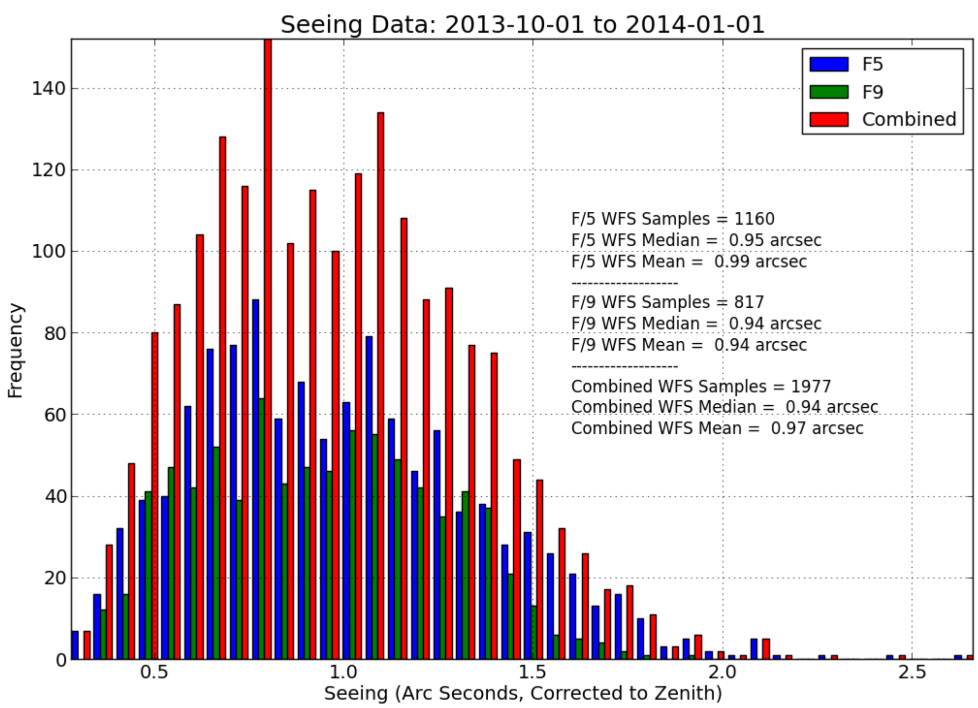

Figure 3. Histograms of f/5, f/9 and combined f/5 and f/9 WFS-derived calculated seeing values for October through December 2013. The median f/5 seeing is 0.95 arcsec while the f/9 median seeing is 0.94 arcsec. Data are grouped into 0.10 arcsec bins.

User Support

Remote Observing

The MMTO supported a total of 13.63 nights of remote observing this quarter. Four nights were for UA observers, with 9.63 nights for CfA. Due to safety concerns, a simple warning image was created and placed on the *pixel* computer desktop. Staff will click this image while working so that remote observers do not attempt to reconfigure the spectrograph while instrument specialists are still changing the gratings or performing maintenance. All Blue and Red Channel Spectrograph users allocated time for spring 2014 were emailed in December regarding remote capabilities.

Documentation

Procedures

The new maintenance program for the electronics group was implemented and is working well. Several new Maintenance Requirement Cards (MRCs) have been created as new items for inspection arise. Current items inspected with MRCs include: building drive motors, blower controller, MGE Comet UPS, AED, elevator flashlight, emergency flood lights, emergency eyewash station, Yankee humidity sensor, and the azimuth amplifiers.

Public Relations and Outreach

Visitors and Tours

11/8/13 - Judy Huret (Smithsonian Institution Board Member), her husband Robert Huret, along with their guests, Carol and Charles Sumner, were given a tour of the MMTO by Grant Williams. Following their tour, a dinner was hosted for them at the FLWO Administration Complex where discussions continued.

10/2013 - Inga Spence, a professional photographer, visited the MMTO to take pictures for a textbook. She granted us permission to use one of her images for our 2013 Christmas card.

MMTO in the Media

On December 10, a very bright meteor crossed southern Arizona. An image of the meteor, captured by the MMT's all-sky camera, was used in an *Arizona Daily Star* December 11 article entitled "Tucson is epicenter of meteorite strike, rock hunt."

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)

13-72 The *Spitzer* Mid-infrared Active Galactic Nucleus Survey. I. Optical and Near-infrared Spectroscopy of Obscured Candidates and Normal Active Galactic Nuclei Selected in the Mid-infrared
M. Lacy, et al.
ApJ Supp, **208**, 24

13-73 A New Hα Emission-like Survey in the Orion Nebula Cluster
E. Szegedi-Elek, et al.
ApJ Supp, **208**, 28

13-74 LoCuSS: The Steady Decline and Slow Quenching of Star Formation in Cluster Galaxies Over the Last Four Billion Years
C.P. Haines, et al.
ApJ, **775**, 126

13-75 New Radial Abundance Gradients for NGC 628 and NGC 2403
D.A. Berg, et al.
ApJ, **775**, 128

13-76 Star Clusters in M31. V. Evidence for Self-enrichment in Old M31 Clusters from Integrated Spectroscopy
R.P. Schiavon, et al.
ApJ Lett, **776**, L7

13-77 The Contribution of Halos with Different Mass Ratios to the Overall Growth of Cluster-sized Halos
D. Lemze, et al.
ApJ, **776**, 91

13-78 A Reverse Shock in GRB 130427A
T. Laskar, et al.
ApJ, **776**, 119

13-79 Discovery of Four High Proper Motion L Dwarfs, Including a 10 pc L Dwarf at the L/T Transition
P.J. Castro, et al.
ApJ, **776**, 126

13-80 A Determination of the Space Density and Birth Rate of Hydrogen-line (DA) White Dwarfs in the Galactic Plane, based on the UVEX Survey
K. Verbeek, et al.
MNRAS, **434**, 2727

13-81 A Search for Boron in Damped Lyα Systems
T.A.M. Berg, S.L. Ellison, K.A. Venn, and J.X. Prochaska
MNRAS, **434**, 2892

13-82 The Lack of Star Formation Gradients in Galaxy Groups up to $z \sim 1.6$
F. Ziparo, et al.
MNRAS, **434**, 3089

13-83 A Quasar-Galaxy Mixing Diagram: Quasar Spectral Energy Distribution Shapes in the Optical to Near-Infrared
H. Hao, et al.
MNRAS, **434**, 3104

13-84 The Low-Mass Stellar Population in the Young Cluster Tr 37. Disk Evolution, Accretion, and Environment
A. Sicilia-Aguilar, et al.
A&A, **559**, 3

13-85 On-sky characterization of the VISTA NB118 Narrow-band Filters at 1.19 μm
B. Milvang-Jensen, et al.
A&A, **560**, 94

13-86 High-Velocity Line Forming Regions in the Type Ia Supernova 2009ig
G.H. Marion, et al.
ApJ, **777**, 40

13-87 Connecting Transitions in Galaxy Properties to Refueling
S.J. Kannappan, et al.
ApJ, **777**, 42

13-88 Dual Supermassive Black Hole Candidates in the AGN and Galaxy Evolution Survey
J.M. Comerford, K. Schluns, J.E. Greene, and R.J. Cool
ApJ, **777**, 64

13-89 The Obscured Fraction of Active Galactic Nuclei in the XMM-COSMOS Survey: A Spectral Energy Distribution Perspective
E. Lusso, et al.
ApJ, **777**, 86

13-90 The Pattern of CN, O, and Na Inhomogencities on the Red Giant Branch of Messier 5
G.H. Smith, P.N. Modi, and K. Hamren
PASP, **125**, 1287

13-91 Measuring Galaxy Velocity Dispersions with Hectospec
D. Fabricant, et al.
PASP, **125**, 1362

13-92 The Runaway Binary LP 400–22 is Leaving the Galaxy
M. Kilic, et al.
MNRAS, **434**, 3582

13-93 Evidence of Increased UV Fe II Emission in Quasars in Candidate Overdense Regions
K.A. Harris, et al.
MNRAS, **435**, 3125

13-94 Candidate Type II Quasars at $2 < z < 4.3$ in the Sloan Digital Sky Survey III
R. Alexandroff, et al.
MNRAS, **435**, 3306

13-95 The CASSOWARY Spectroscopy Survey: A New Sample of Gravitationally Lensed Galaxies in SDSS
D.P. Stark, et al.
MNRAS, **436**, 1040

13-96 A New Class of Pulsating White Dwarf of Extremely Low Mass: The Fourth and Fifth Members
J.J. Hermes, et al.
MNRAS, **436**, 3573

13-97 Orbital Parameters for the Two Young Binaries VSB 111 and VSB 126
N. Karnath, et al.
AJ, **146**, 149

13-98 Microlensing of Quasar Ultraviolet Iron Emission
E. Guerras, et al.
ApJ, **778**, 123

13-99 Gravitational Lens Models Based on Submillimeter Array Imaging of *Herschel*-selected Strongly Lensed Submillimeter Galaxies at $z > 1.5$
R.S. Bussmann, et al.
ApJ, **779**, 25

13-100 A Deep Search for Faint Galaxies Associated with Very Low-Redshift C IV Absorbers: A Case with Cold-Accretion Characteristics
J.N. Burchett, et al.
ApJ Lett, **779**, L17

Non-MMT Related Staff Publications

X-Ray Nuclear Activity in S4G Barred Galaxies: No Link between Bar Strength and Co-occurrent Supermassive Black Hole Fueling
Cisternas, M., Gadotti, D. A., Knapen, J. H., et al., (J. Hinz)
ApJ, **776**, 50

The CO-to-H2 Conversion Factor and Dust-to-gas Ratio on Kiloparsec Scales in Nearby Galaxies
Sandstrom, K. M., Leroy, A. K., Walter, F., et al., (J. Hinz)
ApJ, **777**, 5

Toward a Removal of Temperature Dependencies from Abundance Determinations: NGC 628
Croxall, K. V., Smith, J. D., Brandl, B. R., et al., (J. Hinz)
ApJ, **777**, 96

Investigating the Presence of 500um Submillimeter Excess Emission in Local Star Forming Galaxies
Kirkpatrick, A., Calzetti, D., Galametz, M., et al., (J. Hinz)
ApJ, **778**, 51

GRB 091024A and the Nature of Ultra-Long Gamma-Ray Bursts
Virgili, F.J., Mundell, C.G., Pal'Shin, V., et al., (G. Williams)
ApJ, **778**, 54

Appendix II - Service Request (SR) and Response Summary: October – December 2013

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 a new SR has been created, one or more responses are created by staff members to address and, eventually, to close the SR. These SRs and associated responses are logged into a relational database for later reference.

Figure 4 presents the distribution of responses by priority during the period of October through December 2013. As seen in the figure, the highest percentage (72%) of responses were "Important" priority, 13% were "Low" priority, 8% were "Near-Critical" priority, and 7% were "Information Only." There were no "Critical" SRs during this period. "Critical" SRs address issues that are preventing telescope operation while "Near-Critical" relate to concerns that pose an imminent threat to continued telescope operation. There were a total of 61 responses during this three-month reporting period.

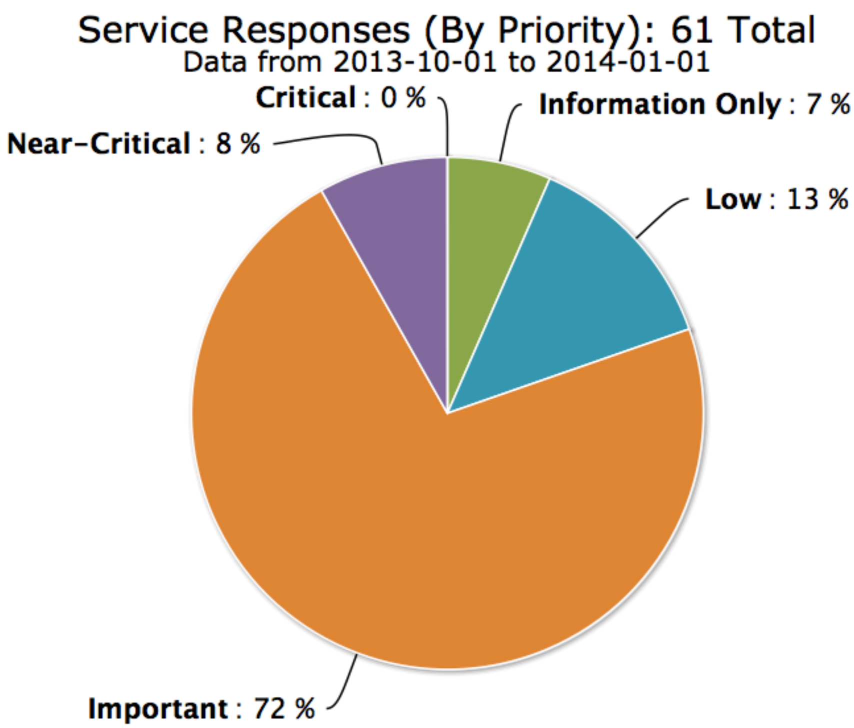

Figure 4. Service Request responses by priority during September through December 2013. The majority (72%) of the responses are related to SRs of the "Important" priority, while "Low" and "Near-Critical" priority responses are 13% and 8%, respectively, of all responses.

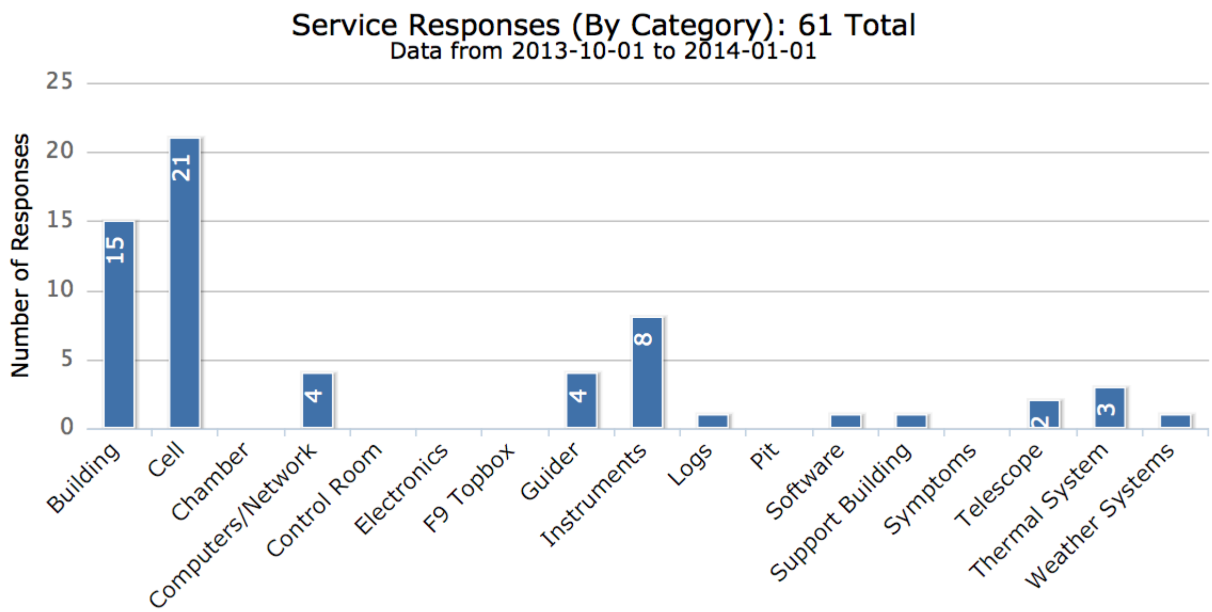

Figure 5. Service Request responses by category during September through December 2013. The majority of responses were within the "Cell" category, followed by the "Building" and "Instrument" categories.

Figure 5 presents the same 61 Service Request responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues within the database. The majority of the responses from October through December were related to the "Cell" category, followed by "Building" and "Instruments."

During this reporting period, there was no "Critical" priority activity. "Near-Critical" SRs were related to the ice blocking access to the front-door keypad (SR #992 -> Building -> "front-door keypad") and excessive noise from the loading dock Neslab chiller (SR # 1052 -> Building -> "load-dock Neslab"). The front-door keypad is now enclosed in a new weatherproof enclosure. Noise issues related to the loading dock Neslab chiller have also been addressed.

There were many "Important" priority SR entries related to the primary mirror support system and cell crate that were addressed over this quarter. These mirror support and cell crate issues included: 1) identifying a slow clock on the CPU board within the cell crate; 2) adjustment in the total primary mirror weight, resulting from recalibrating actuators, that affected proper lifting and lowering of the primary mirror; 3) issues with several individual actuator positions failing bump tests (e.g., actuator position #52); 4) uneven cooling of the primary mirror, especially around E-series thermocouple #16; 5) cell crate booting issues, including failing to boot after several power cycles; and 6) an excessive number of mirror panics during normal operations. A large amount of staff time was spent addressing these issues. The complexity and number of issues required several months to be fully addressed.

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

October 2013

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	4.00	44.70	6.00	0.00	0.00	0.00	0.00	6.00
PI Instr	24.00	258.90	69.50	0.00	3.25	0.00	0.00	72.75
Engr	3.00	32.80	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**	**336.40**	**75.50**	**0.00**	**3.25**	**0.00**	**0.00**	**78.75**

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	22.4
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	1.0
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	23.4

** Breakdown of hours lost to telescope

0.75 Raising M1 required rebooting
1.00 AO system unable to keep loop closed
0.50 PCR/camera freeze; high current regions
1.00 High current issues breaking AO loop

November 2013

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	15.00	172.00	37.30	0.00	0.50	0.00	0.00	37.80
PI Instr	15.00	176.60	127.05	0.00	0.00	0.00	0.00	127.05
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	**30.00**	**348.60**	**164.35**	**0.00**	**0.50**	**0.00**	**0.00**	**164.85**

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	47.1
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.1
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	47.3

** Breakdown of hours lost to telescope

0.50 WFS issue, possible power supply problem

Year to Date November 2013

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	107.00	1075.70	341.20	7.16	19.65	8.00	0.00	376.01
PI Instr	180.00	1761.20	658.85	6.15	53.60	15.25	6.20	740.05
Engr	19.00	188.20	67.90	0.00	0.00	0.00	0.00	67.90
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**306.00**	**3025.10**	**1067.95**	**13.31**	**73.25**	**23.25**	**6.20**	**1183.96**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	93.8
Percentage of time scheduled for engineering	6.2
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	35.3
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	2.4
Percentage of time lost to general facility	0.8
Percentage of time lost to environment (non-weather)	0.2
Percentage of time lost	39.1

December 2013

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	14.00	167.70	99.70	0.00	0.00	0.00	0.00	99.70
PI Instr	15.00	179.60	85.15	0.00	2.00	0.00	0.00	87.15
Engr	1.00	12.00	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	**30.00**	**359.30**	**184.85**	**0.00**	**2.00**	**0.00**	**0.00**	**186.85**

Time Summary Exclusive of Shutdown

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	51.4
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.6
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	52.0

** Breakdown of hours lost to telescope

2.00 AO PCR

Year to Date December 2013

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	121.00	1243.40	440.90	7.16	19.65	8.00	0.00	475.71
PI Instr	195.00	1940.80	744.00	6.15	55.60	15.25	6.20	827.20
Engr	20.00	200.20	67.90	0.00	0.00	0.00	0.00	67.90
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**336.00**	**3384.40**	**1252.80**	**13.31**	**75.25**	**23.25**	**6.20**	**1370.81**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	94.1
Percentage of time scheduled for engineering	5.9
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	37.0
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	2.2
Percentage of time lost to general facility	0.7
Percentage of time lost to environment	0.2
Percentage of time lost	40.5