MMT Observatory
Smithsonian Institution &
The University of Arizona®

End of Quarter Summary

October - December 2014

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.

Administrative

Program Management

The annual staff meeting and photo took place at the summit on October 28. Lunch was provided, followed by the "State of the MMTO" address by Director G. Williams, and the staff photo.

Staffing

Ricardo Ortiz officially assumed the role of Mountain Operations Manager in November. Dan Blanco, previously Chief Engineer/Mountain Operations Manager, transferred to the campus staff and will continue to serve as Chief Engineer.

Strategic Planning

A review of five-year plans for Smithsonian Institution (SI)-funded projects was held on December 10. Several long-range projects were identified including repainting the MMT enclosure, installing an exterior lift for transporting instruments to and from the observing chamber, renovating the aging summit septic system, converting part of the Instrument Repair Facility (IRF) to offices (continuing our efforts to reduce the occupied, heated spaces within the enclosure), and making further upgrades to the summit HVAC systems. MMTO staff has since identified other projects that will be added to the list in the future.

Reports and Publications

There were 26 peer-reviewed publications and one non MMT-related publication during this reporting period. No technical memoranda or reports were generated. See the listing of publications in Appendix I, p. 18.

Presentations and Conferences

J. Hinz gave a talk entitled "The MMT Observatory: Current Capabilities and Plans through 2015" at Northern Arizona University's (NAU) Department of Physics and Astronomy on October 20. NAU is a full Arizona consortium partner. She met with members of the faculty at NAU and Lowell Observatory. She also gave a short presentation to NAU students taking an astronomy course taught by P. Massey, who has been a frequent observer at the MMTO.

Safety

Training

All staff completed the OSHA-required Hazard Communication Standards (HAZCOM) training during this reporting period. This training covers classifying and labeling hazardous chemicals.

Safety Inspections

In December, MMTO Safety Officer T. Gerl instituted monthly safety inspections at the mountain site. Responsibility for specific areas was chosen by various staff who will perform walk-through inspections looking for safety hazards and general tidiness.

Primary Mirror

The primary mirror was CO_2 cleaned on December 15.

Coating & Aluminization

Additional testing on the latest design length of the proposed aluminum-cored filaments was performed at the Sunnyside testing facility to evaluate the performance of a shorter filament with a lower overall aluminum load. This type of filament is less likely to form large drops that could turn into drips. To aid in avoiding drips, minor tweaks to the control software were implemented and tested to shorten the time period between melting and the onset of deposition. The deposition control algorithm remains very robust to changes in the filament load.

A number of filament lengths were tested, all shorter than the ones used in the past. We found that a limiting factor on the filament length was that the considerably lower load resistance could potentially trip the Miller welders' output current protection circuit at roughly 990 A peak current. When the protection circuit trips, it requires a power cycle on the welder to reset. A slightly longer filament was selected as the final candidate for full-scale testing since an overcurrent event would cause a coating-cycle failure. The peak current seen with the selected filaments is of order 820 A, which is within the welders' short-time output rating without overheating.

Electronic design work began for updating the welder control boards. The ground loops encountered during testing at the Sunnyside facility will be fixed. The ability to individually enable the welder units will also be added, as well as cleaning up other electrical issues.

The new welder board test box was completed, and all the welder boxes in hand were tested and fully checked out.

Utilizing the Sunnyside large coating chamber, three tests were performed with 13H filaments on October 2, 7, and 9, respectively. As in the previous large chamber testing, two arrays with twenty filaments each were used to approximate the conditions in the MMTO bell jar. When compared to an array of 23H filaments tested in the same manner, the 13H filaments provide a higher maximum deposition rate and a more rapid increase in deposition rate, as seen in figure 1 below. The coating thickness for each of these tests was 965 Å, 1010 Å and 1020 Å. In all three tests, an average of 0.21 grams of aluminum was evaporated per filament. Even with minor tweaks made to the process between each of the 13H filament tests, the filament control system is providing remarkably consistent coatings.

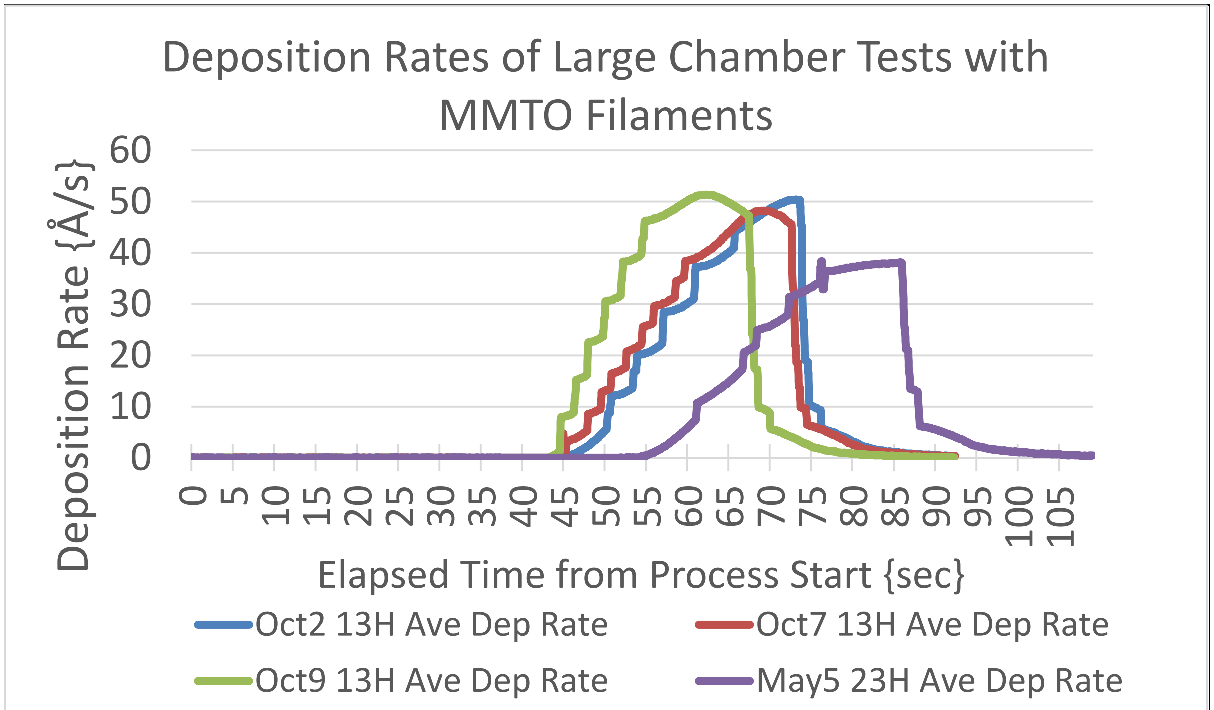

Figure 1. Deposition rates of the MMTO Sunnyside large chamber tests.

Unfortunately, a single aluminum drip was observed during each of the last two tests in the large chamber. The first test was not instrumented properly, so there may have been a drip from that test as well. After an extensive investigation of the test data, it was determined that these drips are likely due to the duration of time in which molten aluminum is present on the filaments when the filament lacks the energy to start evaporating the aluminum. The filament heating profile used with the 13H filament was the same as used with the more massive 23H filament (12 grams compared to 20 grams), and this profile does not account for the faster temperature rise of the 13H filament. Using the data from the October tests as a basis, the process will be tweaked to reduce the duration in which molten aluminum is present on the filaments. To ensure the process changes do not have any unforeseen consequences, another round of testing using the Sunnyside large coating chamber is planned for spring 2015.

An overall project schedule for the work required to be properly prepared for the primary mirror coating in the summer of 2015 has been developed and presented to the MMTO staff. The largest task in this schedule is the full system testing planned at basecamp utilizing the equipment acquired in 2008 from the LOTIS project. At least one full coating system test is planned to be completed before June 2015.

A preliminary layout and assembly plan for the bell jar, bell jar extension (from LOTIS), and the rear bell jar (from LOTIS) was created. Since these items will be located in the open space just south of the MMTO warehouse at basecamp, bearing pads are required under the equipment to prevent excessive soil movement due to the large component weights involved. A conceptual design for the bearing pads has been completed, and the final design and drawing package will be ready to circulate for vendor quotes in early January. Three local vendors that have capabilities to complete this work have been identified.

Additionally, the basecamp coating assembly plan has been used to start an extensive reorganization of the equipment in front of and in the MMTO warehouse. This has been necessary to free up space in which to efficiently work with these large components.

Static Supports

On October 21, ten of the primary mirror static support shoulder bolts were removed from the mirror cell and inspected for evidence of binding during the process of raising or lowering the primary mirror. None of the removed shoulder bolts or the corresponding Teflon sleeves showed any signs of binding or excessive wear. The shoulder bolts and sleeves were reinstalled, and the inspection was terminated due to the lack of any noticeable issues.

Several glitches in the mirror cell occurred during this period; excessive moments were recorded on October 14 and 19. An inspection of the primary mirror cell revealed three thermocouple cable bundles had, over time, become wedged between the edge of the primary mirror and the wall of the cell. These were moved to a better location. This work did not eliminate instances of bad-raises and excessive moments, but hopefully will help to reduce them.

Mirror Support

The primary mirror support VME crate power supply failed and was replaced with a spare. During troubleshooting, it was discovered that the 5V VME logic power supply output is only 4.8V. This low voltage, close to the TTL logic supply minimum level of 4.75V, may be causing brownouts of the cell crate reset circuit, which may be related to the cell CPU booting issue when the supply is first turned on. A complete new spare unit will be built with a unified supply design that integrates the 4.8V lockout and the required VME and DAC board supply outputs. This will improve the robustness of the supply unit as well as the electronics packaging.

Hardpoints

Intermittent instability in the primary defining hardpoints caused some minor lost time on October 15 and 18, November 16-17, and December 3. These were traced to a noisy LVDT power supply.

Secondary Mirrors

f/15

Both new adaptive optics power supply chassis are now completed and undergoing bench testing. They have run at nominal load current as well as the peak output currents as listed in the Microgate acceptance documentation. A quick temperature reading of inlet air versus exhaust showed a change of +25°C. More testing of the power supplies under load, including taking thermal images, is planned to fully characterize and assess them.

We found that the current sensor boards were not performing as expected. Each board performs well if no other power supply in the chassis is running. However, when the other outputs are enabled, the sensor outputs are disturbed by the adjacent magnetic fields in the wiring, causing the displayed current to be inaccurate. This could not be fixed by changing the firmware due to the ever-changing load currents and magnetic field strengths. It was decided that new sensors made by the same company should be tested as an alternative.

The required smart card interface is in the design pipeline for next quarter. When completed, we will prepare to deploy the new deformable mirror (DM) power supply.

Mount Servos

An old Shuttle box was set up in the lab with CentOS 7 installed, and a limited set of EtherCAT terminals was used as a vehicle to begin the testing and development of a new Linux-based mount control computer. S. Schaller installed the EtherCAT master stack and the Linux RT-Preempt kernel on the base system, but before serious testing could begin, the computer power supply failed.

A new Shuttle DS81 computer was assembled and preliminary software and hardware testing is planned during the next quarter. Rather than experimenting more with CentOS, we installed a low-latency RT-Preempt Fedora 20 distribution from Stanford's Planet CCRMA Project as the base OS for testing. Other details regarding this can be found on p.14, in the "Computer and Information Technology" section.

Hexapods

Nothing to report.

Optics Support Structure (OSS)

Nothing to report.

Pointing and Tracking

Nothing to report.

Science Instruments

f/9 Instrumentation

A bare-bones web interface for the Red and Blue Channel Spectrographs exposure time calculators was implemented as a testing prototype. Work continues on polishing the interface and in preparing a user-friendly version, potentially in time for the next call for proposals.

The f/9 instruments were on the MMT for 42% of the available nights from October 1 through December 31. Approximately 71% of those nights were scheduled with the Blue Channel Spectrograph, 24% with Red Channel, and 5% with SPOL. Half a night was scheduled for M&E. Of the 437.9 total hours allocated for f/9 observations, 210.9 hours (48%) were lost to weather conditions. Instrument, facility, and telescope problems accounted for less than 1% of lost time. Blue Channel lost 48% of its time to poor weather, with Red Channel losing 48%, and SPOL losing 50%.

f/5 Instrumentation

A number of tests of the Hectospec throughput measurements based on single star observations (usually taken as a standard routine as part of a queue run on the instrument) were completed to determine how well the relative throughput of the instrument is characterized. The majority of users do not observe flux "standards" (such as F stars) on the same configuration as their science objects, so knowing how well the relative fluxing can be completed from the more traditional flux standards can be helpful. We found that the relative flux errors (characterized by a synthesized g-r color difference) was small, <8%. The absolute flux calibration is much more condition dependent (from slit losses and clouds), but the relative fluxing based on non-simultaneous measurements is quite robust.

During this quarter, 339 observing hours were scheduled for SAO f/5 instrumentation with 138 of those hours, nearly 41%, lost mostly due to weather. Only two hours were lost to non-weather causes: a half hour to an elephant hose failure; a half hour spent verifying that a reported "gripper not closed" error from the positioner software was not due to a significant problem in the instrument; a quarter hour lost to oscillations of the telescope mount while gathering data with SWIRC; and a little over a half hour lost due to the degradation of the fiber connection for the SWIRC instrument, causing intermittent data dropouts and resulting in the loss of several short exposures. Fog, clouds, high winds, and a dripping building contributed to the hours lost to weather. The positioner gathered 378 science exposures along with more than twice that many calibration images (bias, flat, comp, dark, and sky). Over the 26 scheduled nights, 112 fields were observed, with the weather so poor on seven nights that we did not even configure for a field.

The fiber positioner had a minor glitch in November when an error message indicated that the gripper had not closed properly. This halted the positioning sequence. The state of the instrument was checked and operation of the gripper was tested, both empty and on a few buttons, to verify that it was operating properly. The same error had occurred earlier in the year with no apparent cause. The gripper and the wires had been inspected during the summer service mission and everything appeared nominal. After the gripper was found to be working normally, the remaining deployed fibers were parked without incident. The event occurred late in the night and there was insufficient time to get additional exposures.

MMTCam gathered 169 exposures on twelve objects over ten nights. A little more than 300 exposures were obtained for dark, bias, flat, focus, and engineering data.

SWIRC was scheduled for three nights but gathered science data only one night due to poor weather. The instrument gathered 494 object exposures on 89 targets. A dozen exposures were taken to adjust focus. Another 60 exposures were gathered for dark calibration. The observer was able to get an additional 60 dark exposures the next afternoon to improve the dark calibration. There were 83 engineering darks taken the next day to troubleshoot the image dropout problem and to verify that cleaning and reseating the optical fibers at three locations corrected the problem. No exposures were lost during test exposures performed during initial checkout and subsequent additional test exposures after the instrument had been mounted.

Preparations are underway for the return of the MMIRS instrument from the Magellan telescope at Las Campanas Observatory in Chile to the MMTO next spring. Plans are in place for reassembly, testing, and incorporation of new control computers. Options for slit mask manufacturing are still being explored to ensure that the best product is available in the best time. Staff will be trained in the several hours-long process of slit mask exchange, which involves warming up a portion of the instrument, changing the masks, and re-cooling the instrument before the night's observations begin.

Off-axis guiding was fully implemented during a MAESTRO run in early September. A procedure to acquire a guide star and position the MAESTRO slit on a target, even a faint target, was implemented (though in the case of a faint object, the procedure is time-intensive). Work continues on the future goal of continuous off-axis wavefront sensing.

Lab equipment and documentation for the MAESTRO instrument was moved in December from the Steward Observatory building on campus to the lower warehouse at the FLWO Administration Complex (basecamp) for storage.

f/15 Instrumentation

There were two adaptive optics (AO) observing runs during this reporting period. An October run consisted of one Maintenance and Engineering (M&E) night and ten science nights. A November run consisted of 1.5 M&E nights and 5.5 science nights. Overall, the AO system performed very well and the two runs were extremely productive, although hardware failures did occur on the first night of each run. We were able, however, to recover with little on-sky time lost.

<u>October 2-13</u>

The first night of the October AO run was an M&E night intended to set up the system for the following science nights as well as implement both software and hardware improvements to the system. A serious problem was immediately found with the WFS camera's linear and rotational stages. Both stages were intermittently losing power as well as homing incorrectly. The problem was traced to bad solder joints in the 24V power supply cable to the topbox. Fortunately, there was sufficient extra cable length to remove the bad section without having to repair and replace it. This allowed us to get on sky afterwards to test the system and verify that the stages moved and homed correctly. This particular faulty cable was the source of numerous failures during the past several runs by preventing the focus and rotation angle from being set correctly. Unfortunately, intermittent electrical problems are notoriously difficult to track down, and it took a major failure of the 24V power supply before we were able to locate where the problem was occurring.

Once the power cable was fixed, the AO system performed extremely well for the remainder of the run including all of the science nights. A total of three nights were lost to weather.

November 3-9

The November run also had a major hardware failure on the first night of the run. At 4:10 a.m., the real time control computer, *ao-pcr*, had a disk failure in the RAID array. Unfortunately, it was found that the RAID array had been configured as striped and not mirrored, which means that there was no redundancy. When the first disk failed, it brought down the entire RAID array. Because of this the entire RAID array on *ao-pcr* had to be reconstructed, including installation of the Fedora operating system. Due to the team's hard work throughout the day and evening this was accomplished approximately halfway through the second night, with only five hours total lost on-sky. Once the RAID array on *ao-pcr* had been repaired, the AO system again performed extremely well and the overall run was very productive.

Training of additional AO operators began during the October and November runs and will continue in future AO runs.

Topboxes and Wavefront Sensors (WFS)

f/5 WFS

Work continued on a new wavefront sensing suite of software. The current software spans many software languages and is difficult to modify for future instrumentation. During this quarter, significant progress was made on a new spot finding algorithm as well as on many prototypes for the various subroutines used in our current WFS software. Example images and the correct "solution" were also obtained in order to create the routines needed for wavefront sensing with MMIRS, an instrument returning to the MMTO early next year.

Facilities

General Infrastructure

The following progress was made on these SI-funded projects:

MMT Roof: This is a project to cover the existing membrane roof with a standing seam metal roof with low-emissivity coating (Galvalume®), and fitted with an embedded heating system for melting snow. A 2 x 4 ft working model of the proposed roofing system was built and cold-tested in a walk-in refrigerator/freezer. The heated mockup, inclined at the same angle as the MMT roof, was tested under severe conditions. The test demonstrated the system's ability to melt accumulated ice. A report is available in the Documentation Database under Administration/SI Projects/1383801 MMT Heated Roof.

HVAC Upgrades: This project includes upgrades to aging HVAC equipment at the MMTO. A kick-off meeting with contractors was held on December 9. The "new" chiller, the former "Carrier on the Rock," has been tested and will become the primary chiller for the summit while the existing chiller will be kept as a back-up. A platform was built around the new chiller to provide safety when accessing it, and footings were laid to support the glycol runs and electrical conduits needed to put the unit into operation. Detailed plans were prepared for installation of new glycol pumps and make-up unit to regulate the level of coolant in the plumbing runs to the building. Specific equipment was identified and approved for purchase, including a new 1200 Amp service panel that will be fed from the existing 500 kVA main power transformer, and new fan-coil units (FCUs) for the control room, second floor west, and third floor east.

Fire Alarm: The fire alarm system is nearly complete; we await a final check and approval by SI. Inspection and final acceptance of the system has been delayed.

Repairs to Heated Road at Summit: The final report and bid documents were completed and will be released for competitive bid early in 2015. The report briefly studied the possibility of using IR lamps to heat the road. Unfortunately, the study was based on an arbitrary manufacturer's recommendation to power the lamps with three times more power than is presently available from the road heaters; consequently, the study concluded that IR heating would not be feasible. The present documents provide for a major reworking of the road, stripping all asphalt from the summit road, re-capping with a two-inch layer of concrete, and topping with four inches of asphalt. The plans include a new cable barrier on the outer edge of the road and a handrail along the inner edge. However, there is no current provision for heating the road. The goal is to complete this work by June 1 so as not to compromise re-aluminization of the primary mirror during summer shutdown that begins in July. The report and bid documents are posted in the Documentation Database under Administration/SI Projects/MMT Heated Road/Submissions.

Compressed Air System

On December 8, check valves were added to the compressed air system to properly set up the piping for parallel compressor operation. To ensure this work would be completed with minimal downtime, the compressor isolation valves were also replaced as part of this upgrade.

Computers and Information Technology

Work continued on a scheduling and program management system for the MMTO. This work is described in a SPIE paper by D. Porter *et al.*, 2012, entitled "An Integrated Scheduling and Program Management System."

Goals of the new scheduler system include:

- Centralized data storage for MMTO science programs, observing runs, telescope configuration, operating conditions, and system downtime statistics
- Use of this centralized data storage to pre-fill web interfaces such as the operator's log, and for queries from other MMT software on current scheduling and telescope configuration information
- Reduction in work for the MMTO administrative staff, including automated webpage generation of scheduling information, and automated email notifications to observers
- Simplification of the MMT management process of scheduling observing programs and individual runs, including software checks for scheduling conflicts
- Providing a simple web interface for observers to input information, including contact information, dorm reservations, and other observing requirements
- Providing a staff portal homepage with an upcoming nightly summary, including science program, instrument, secondary, operator, observer, etc.
- Generation of nightly through yearly reports with tables and charts of reported lost time and reasons for that lost time
- Use of current web technologies for design and aesthetics of user interfaces

Toward these goals, a "scheduler" MySQL database was created on *nas1*, the MySQL master. This database is replicated on the *ops* and *nas3* MySQL slaves. Web interfaces will be hosted on *ops*, with *nas3* as a possible backup. The MySQL database currently contains around forty separate tables for scheduling and program management at the MMT. The specific details of the tables and their internal fields will be modified, as needed, as work continues on the system. At the moment, software development is focusing on defining the "Programs," "ObservingRuns," and related tables.

A Representational State Transfer (REST)-based or "RESTful" application programming interface (API) is being developed for the scheduler. An object-oriented programming approach is being taken with implementation in the PHP programming language. A set of API endpoints allows access to the scheduler database from "Asynchronous Javascript and XML" (AJAX) "POST" requests. New values to be inserted into the database are passed as POST parameters. This API will be used by all web interfaces to the scheduler system.

Work is continuing on the web-based front-end for the new scheduling database. The main interface will include a calendar creator for use in generating the schedule. The calendar interface will feature drag-and-drop events and alerts for various conflict conditions. All changes to the schedule via the calendar are immediately updated in the database using AJAX POSTS. The Bootstrap framework is being used for layout and components for a seamless UI design. Modal dialogs will allow for form input that will submit data to the server with AJAX POSTS without page reloads. Current MMTO static pages such as the HTML schedule will be replaced by dynamic schedule pages that will update automatically as the schedule is changed with the calendar editor. This will ultimately reduce the amount of manual edits required by administrative staff.

Computers and Storage

The following Linux and Mac system administration tasks were done:

- A new hard drive was installed on the "aluminization" server. Fedora 20 was installed on the computer as well as aluminization software, including the data acquisition, hardware control, user interface, and logging software.
- All OS X machines, with the exception of *pixel* and *gilead*, were updated to OS X Yosemite. These two observer computers have not been updated to ensure the updates will have no impact on operations.
- "Fail2ban" was installed on several Linux and Mac computers to increase security. Fail2ban scans the computer for malicious signs such as too many password failures, seeking for exploits, etc. It then updates firewall rules to reject the IP addresses for a specified amount of time.
- Routine updates were made to the Linux servers, virtual machine hoses, telescope operator computers, and network-attached storage (NAS) devices.
- New hard drives were installed in *ao-pcr* and *chisel* because of disk failures. Adaptive optics (AO) software was successfully re-installed on *ao-pcr*. *Chisel* was configured as the primary telescope operator computer.
- A new motherboard was installed in *pipewrench*, the backup telescope operator computer, because of various hardware failure issues. The onboard network interface had failed several months ago on the old motherboard, requiring a USB-to-ethernet dongle. The new motherboard allows the onboard network interface to be used.

Mount software upgrade

Discussion continues among staff on the mount software upgrade. One approach to modularizing the mount software was presented by D. Clark. Discussion and evaluation of various options continues on this topic.

Operating System Evaluation and Testing

CentOS 7, an open-source derivative of the production version RedHat Enterprise Linux 7, was evaluated as a possible operating system for our Linux computers. CentOS has a support life-time of ten years and a release cycle of three years as opposed to the one-year support life-time and six-month release cycle for Fedora. The MMT Linux system administrators plan to continue to use Fedora, the development version of RedHat Linux. Because of this, use of CentOS would not benefit the MMT at this time. Work would be required to ensure that all MMT user interfaces would run on CentOS.

A servo test computer, *sarntal*, was configured for testing real-time operating systems and ethercat technology. A standard installation of CentOS 7 was re-configured for low latency by applying the RT-Preempt kernel patch. The RT-Preempt patch converts Linux into a fully pre-emptible kernel. A signed ethercat driver was also installed on *sarntal*, and a low level ethercat application interface was written for ethercat testing under real-time conditions. Work was initiated on evaluating the POSIX realtime API and writing test programs to measure real-world latencies. Results from these tests will be available in early 2015.

PyEphem

PyEphem, (http://rhodesmill.org/pyephem/), a partial implementation of the popular Xephem astronomy software in Python, was used to rewrite the "edb_gui" user interface completely within

Python. This user interface allows catalog entries for sidereal and non-sidereal objects, including earth-orbiting satellites, to be sent directly to the mount crate. Software using PyEphem was also written to provide almanac information for the MMTO, including sunrise and sunset times and moon phase. This information is available via a web interface and has been used to fill the "almanac" table within the MySQL scheduler database with thirty years of values.

Network

A new Axis M7001 video encoder, Videoserver3 (videoserver3.mmto.arizona.edu), was added to the network and opened through the campus firewall. This new encoder displays the same video as videoserver1.mmto.arizona.edu, but is dedicated to graphical user interfaces (GUIs) and remote observers. Previously the GUIs and remote observers were using videoserver1.mmto.arizona.edu, which was originally deployed for guider image acquisition. Issues have arisen in the past where too many connections to the encoder caused the guider to fail to acquire images. With this new encoder, external clients will no longer interrupt the guider acquisition. The new remote viewer for the acquisition camera can be found on the mmto.org website under "Observer's Tools"-> "Video Frame Grabber."

Telemetry, Logging and Database Management

Inventory Database

T. Gerl and D. Porter continued work on a QR code-driven inventory database. The database is in MySQL and contains an inventory of all critical parts at the MMTO. Each component will be labeled with a QR code that can be scanned by any mobile device (Android or iOS) and will immediately display a web page documenting the component, details about spares, and any other useful information. A prototype of the system has been developed to prove the concept. Work is underway finalizing the database schema and creating the web front-end.

Weather and Environmental Monitoring

All Sky Camera and Web Cameras

The skycam server software was ported from Perl to Python and deployed on the new *ops* server. The previous version of the software ran on *yggdrasil* (the old operator computer). The skycam.mmto.arizona.edu website has been moved from the server *hacksaw* to *ops*.

We are still investigating possible future camera replacements for the StellaCam.

Seeing

Figures 2 and 3 present apparent seeing values, corrected to zenith, for the period of October 1, 2014, to January 1, 2015. These values are derived from measurements made by the f/5 and f/9 wavefront sensors (WFSs).

Figure 2 shows the time-series seeing data for October through December 2014. Seeing measurements for the f/5 WFS are shown in blue circles; f/9 WFS seeing measurements are represented by green triangles. Data points alternate through time between these two WFS systems as the telescope configuration and observing programs change. No data were collected during f/15 configurations.

Overall seeing trends for the two WFS systems are similar, although the median f/9 seeing value is slightly lower than the median f/5 value as seen in Figure 3. The median f/5 seeing value is 0.84 arcsec while the median f/9 seeing value is 0.73 arcsec. The combined median seeing for the two WFS systems is 0.78 arcsec. Both the f/5 and f/9 data sets are approximately the same size, 1319 points for f/5 versus 1350 points for f/9, for a total of 2669 data points.

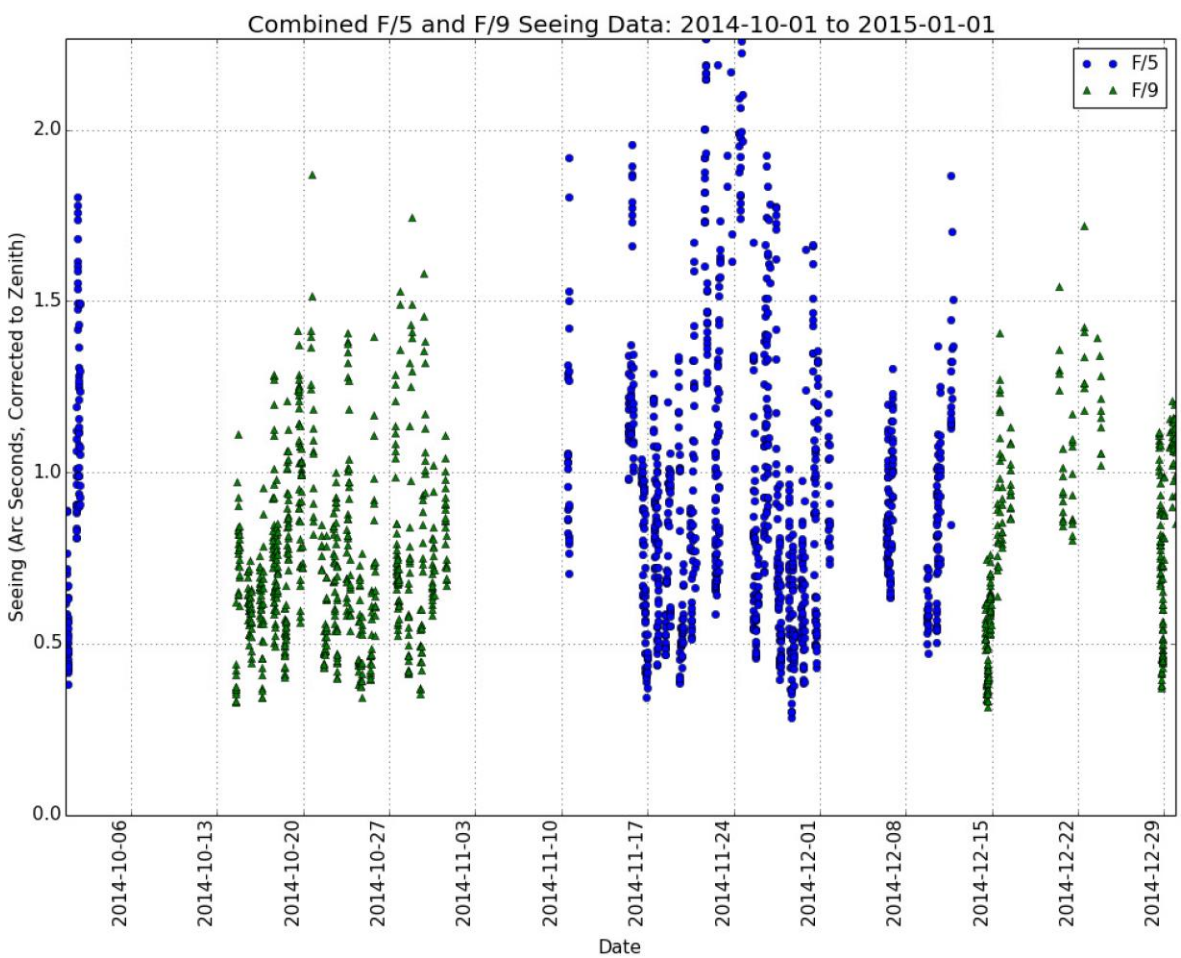

Figure 2. Derived seeing for the f/5 and f/9 WFSs from October through December 2014. Seeing values are corrected to zenith. f/5 seeing values are shown in blue, while f/9 values are in green. An overall median seeing of 0.78 arcsec is found for the 2669 combined (f/5 and f/9) WFS measurements made during this period.

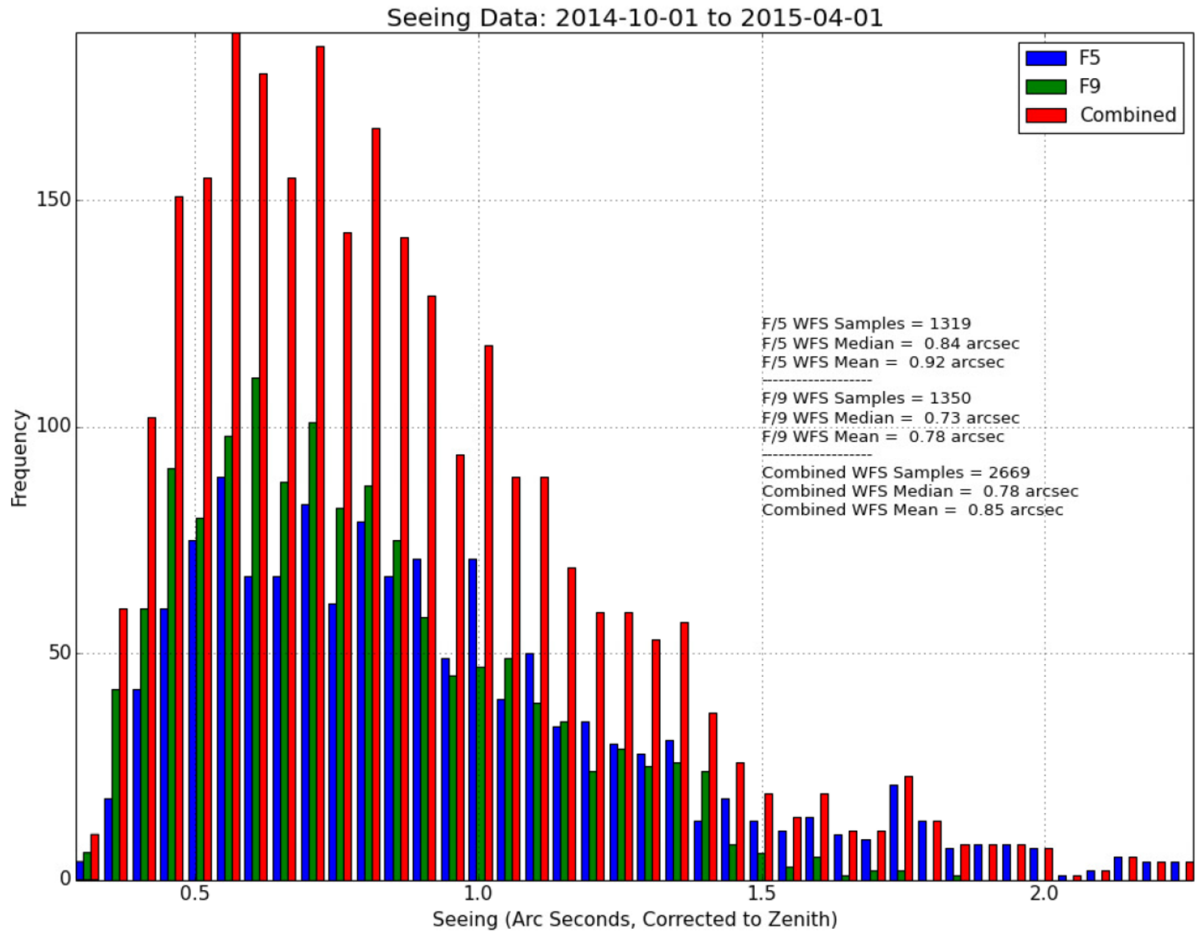

Figure 3. Histogram (with 0.1 arcsec bins) of derived seeing values for the f/5 and f/9 WFSs from October through December 2014. Seeing values are corrected to zenith. Median f/5 seeing is 0.84 arcsec while the median f/9 seeing is 0.73 arcsec. A combined (f/5+f/9) median seeing value of 0.78 arcsec is found for the 2669 WFS measurements made during this period.

User Support

Remote Observing

A total of 10.5 nights of remote observing was supported this quarter. Four nights were for CfA and 6.5 nights were for UA/ASU observers. Two hours of observing were lost on October 15 due to a CfA observer having difficulty with the remote connection. This was the first time lost to any problems during remote observing. We believe the issue was caused by the type of VNC client the observer was using (Chicken of the VNC versus the default ScreenSharing for Macs). Investigation of the incident is ongoing, but several alternatives have been made available.

Although remote observing greatly reduces travel time and costs for observers, it also adds to IT complexity with a wide variety of computers connecting to MMTO computers via SSH, VPN, and VNC. Individual settings on the remote observers' computer, such as color depth for a VNC session, need to be correct. These issues are addressed as they arise. Because of the many benefits, the trend for increased remote observing is expected to continue.

Documentation

Procedures

J. Hinz worked with C. Kulesa to produce a dewar filling procedure for ARIES. The procedure was added to the Documentation Database.

Public Relations and Outreach

Visitors and Tours

10/10/14 – Mt. Graham Intl Obs. docents visited the MMTO and Ridge telescopes, accompanied by C. Nance, director of MGIO. In appreciation for their work, the docents are taken each year on a field trip to neighboring observatories. This year the MMTO and FLWO observatories were chosen.

10/24/14 - C. O'Leary, visiting researcher from UCLA Science/Art Research Center, visited VERITAS for a photography and video project about astronomy. He also visited MMTO and took photos for his project.

11/20/14 – G. Williams led a tour of the MMTO for 21 FLWO docents and volunteers, and six FLWO staff members on Volunteer Appreciation Night. Following a dinner, the group arrived at the MMTO at sunset for the tour. B. Weiner, UA astronomer and observer for that night, also spoke briefly to the group about his research.

Public Presentations

J. Hinz organized speakers for the 45th Smithsonian Lectures on Astronomy, and created flyers to advertise the series, which begins in January 2015.

On December 4, E. Martin and M. Guengerich participated in STEAM (Science, Technology, Engineering, Arts, & Math) Night at Sonoran Science Academy, a local Tucson middle/high school. Students and parents picked up informational handouts, examined a piece of mirror glass, and viewed videos depicting a primary mirror wash and an instrument change at the MMTO.

Figure 4. MMTO Telescope Operator, E. Martin, answers questions from a middle school student regarding a video showing a primary mirror wash at the MMTO.

MMTO in the Media

G. Williams was interviewed for an October 30 *Sierra Vista Herald* article, written by Amanda Baillie, entitled "Code Changes Put County Ahead on Protecting Dark Skies," regarding the recent changes to the Cochise County Lighting Code.

G. Williams was quoted in an October 1 *Arizona Sonora News Service* article, written by Brian Valencia, entitled "Light Pollution from Phoenix Threatens Astronomy Industry."

Site Protection

J. Hinz attended a teleconference on November 12 that was a follow-up meeting to the August "Blinded by the Light" conference held in Flagstaff, Arizona that was attended by J. Hinz, G. Williams, and D. Blanco.

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)

14-66 Rapidly Evolving and Luminous Transients from Pan-STARRS1
M.R. Drout, et al.
ApJ, **794**, 23

14-67 Star Formation Trends in the Unrelaxed, Post-merger Cluster A2255
K.D. Tyler, L. Bai, and G. H. Rieke
ApJ, **794**, 31

14-68 A Spectroscopic Census in Young Stellar Regions: The σ Orionis Cluster
J. Hernández, et al.
ApJ, **794**, 36

14-69 Precise Atmospheric Parameters for the Shortest-period Binary White Dwarfs: Gravitational Waves, Metals, and Pulsations
A. Gianninas, et al.
ApJ, **794**, 35

14-70 X-Ray-selected Galaxy Groups in Boötes
B. Vajgel, et al.
ApJ, **794**, 88

14-71 *Kepler* Detection of a New Extreme Planetary System Orbiting the Subdwarf-B Pulsator KIC 10001893
R. Silvotti, et al.
A&A, **570**, 130

14-72 LoCuSS: The Near-infrared Luminosity and Weak-lensing Mass Scaling Relation of Galaxy Clusters
S.L. Mulroy, et al.
MNRAS, **443**, 3309

14-73 A New Gravitational Wave Verification Source
M. Kilic, et al.
MNRAS Lett., **444**, 1

14-74 First Detection and Characterization of Symbiotic Stars in M31
J. Mikolajewska, N. Caldwell, and M.M. Shara
MNRAS, **444**, 586

14-75 The Low-mass Star and Sub-stellar Populations of the 25 Orionis Group
J.J. Downes, et al.
MNRAS, **444**, 1793

14-76 Close Companions to Two High-redshift Quasars
I.D. McGreer, et al.
AJ, **148**, 73

14-77 Adaptive Optics Images. III. 87 *Kepler* Objects of Interest
C.D. Dressing, et al.
AJ, **148**, 78

14-78 Cosmological Constraints from Measurements of Type Ia Supernovae Discovered during the First 1.5 yr of the Pan-STARRS1 Survey
A. Rest, et al.
ApJ, **795**, 44

14-79 Systematic Uncertainties Associated with the Cosmological Analysis of the First Pan-STARRS1 Type Ia Supernova Sample
D. Scolnic, et al.
ApJ, **795**, 45

14-80 The SAGES Legacy Unifying Globulars and GalaxieS Survey (SLUGGS): Sample Definition, Methods, and Initial Results
J.P. Brodie, et al.
ApJ, **796**, 52

14-81 A Deep *Spitzer* Survey of Circumstellar Disks in the Young Double Cluster, h and χ Persei
R. Cloutier, et al.
ApJ, **796**, 127

14-82 Strong Chromatic Microlensing in HE0047-1756 and SDSS1155+6346
K. Rojas, et al.
ApJ, **797**, 61

14-83 The Next Generation Virgo Cluster Survey. XV. The Photometric Redshift Estimation for Background Sources
A. Raichoor, et al.
ApJ, **797**, 102

14-84 Comparing Dense Galaxy Cluster Redshift Surveys with Weak-lensing Maps
H.S. Hwang, et al.
ApJ, **797**, 106

14-85 High-density Circumstellar Interaction in the Luminous Type IIn SN 2010jl: The First 1100 Days
C. Fransson, et al.
ApJ, **797**, 118

14-86 SDSS1133: An Unusually Persistent Transient in a Nearby Dwarf Galaxy
M. Koss, et al.
MNRAS, **445**, 515

14-87 The VAST Survey – IV. A Wide Brown Dwarf Companion to the A3V Star ζ Delphini
R.J. De Rosa, et al.
MNRAS, **445**, 3694

14-88 Spectral Analysis and Abundances of the Post-HB Star HD 76431
V. Khalack, et al.
MNRAS, **445**, 4086

14-89 On the Automated and Objective Detection of Emission Lines in Faint-Object Spectroscopy
S. Hong, A. Dey, M.K.M. Prescott
PASP, **126**, 1048

14-90 Mining the Gap: Evolution of the Magnitude Gap in X-ray Galaxy Groups from the 3-Square-Degree XMM Coverage of CFHTLS
G. Gozaliasl, et al.
A&A, **566**, 140

14-91 Software Framework for the Upcoming MMT Observatory Primary Mirror Re-Aluminization
J.D. Gibson, D. Clark, and D. Porter
SPIE, **9152**, 1

MMT Technical Memoranda / Reports

None

Non-MMT Related Staff Publications

Spitzer/Infrared Array Camera Near-Infrared Features in the Outer Parts of S4G Galaxies
Laine, S., Knapen, J. H., Munnoz-Mateos, J.-C., et al., (J. Hinz)
MNRAS, **444**, 3015

Appendix II - Service Request (SR) and Response Summary: October - December 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 5 presents the distribution of SR responses by priority during the period of October through December 2014. As seen in the figure, the highest percentage (44%) of responses were of the "Important" priority. "Critical" and "Near Critical" responses were 26% and 27% of the total number of SRs, respectively. "Information Only" SRs were the remaining 3%. There were no "Low" priority responses.

"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 62 SRs during this three-month period, up from 32 SRs during the previous three-month reporting period, although the previous period included summer shutdown.

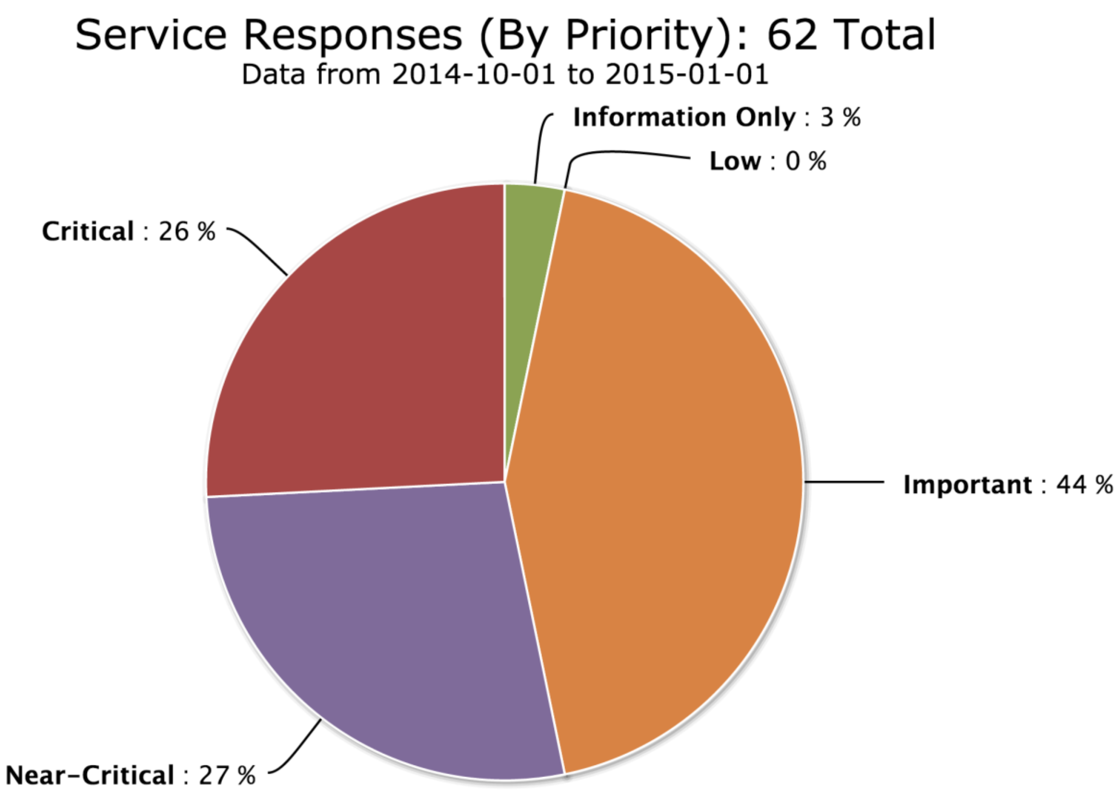

Figure 5. Service Request responses by priority during October through December 2014. The majority (44%) of the responses are related to SRs of "Important" priority, while 26% were "Critical," 27% were "Near-Critical," and 3% were "Information Only."

Figure 6 presents the same 62 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. The majority of the responses from October through December were related to the "Cell" and "Telescope" categories with 20 and 15 responses, respectively. Responses also occurred in the "Building," "Computers/Network," "Support Building," "Thermal System," and "Weather Systems" categories.

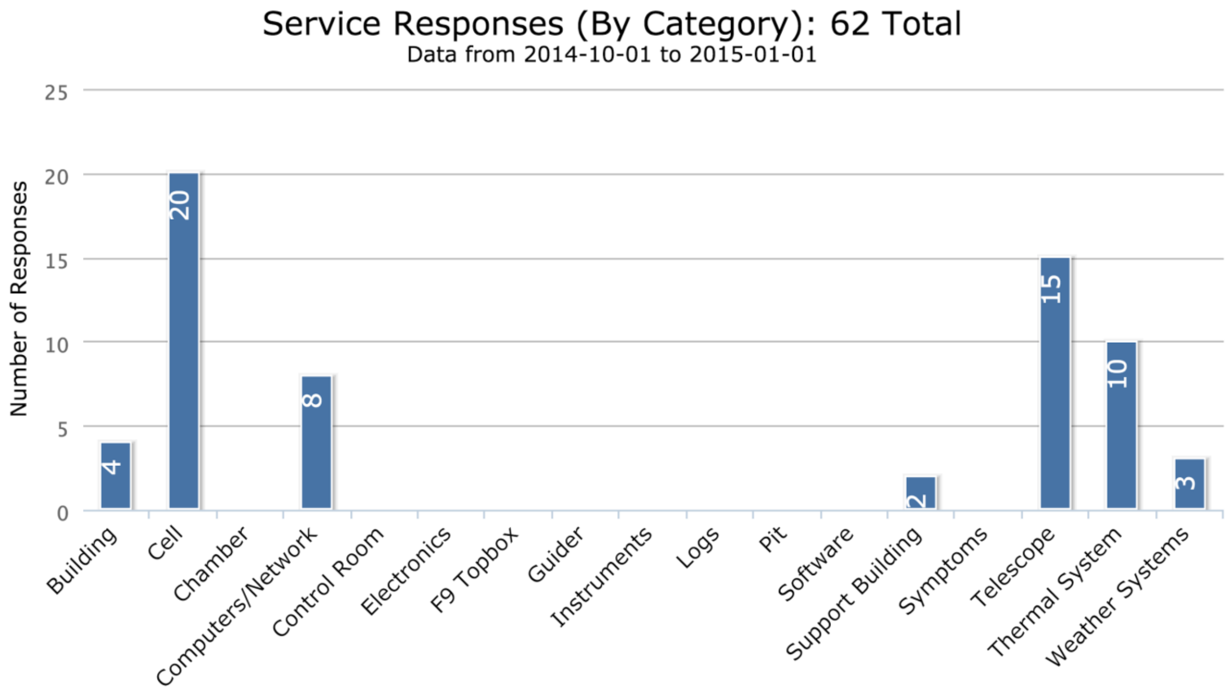

Figure 6. Service Request responses by category during October through December 2014. The majority of responses were within the "Cell" and "Telescope" categories.

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 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	17.00	187.90	29.70	2.00	1.00	0.00	0.00	32.70
PI Instr	13.00	138.00	48.90	0.00	0.00	0.50	0.00	49.40
Engr	1.00	10.50	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**	**78.60**	**2.00**	**1.00**	**0.50**	**0.00**	**82.10**

Time Summary

Percentage of time scheduled for observing	96.9
Percentage of time scheduled for engineering	3.1
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	23.4
Percentage of time lost to instrument	0.6
Percentage of time lost to telescope	0.3
Percentage of time lost to general facility	0.1
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	24.4

* Breakdown of hours lost to instrument
2.00 VNC remote observing issues

** Breakdown of hours lost to telescope
0.75 Primary mirror panics
0.25 Az amp shut off

*** Breakdown of hours lost to facility
0.50 Elephant hose broke off

November 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	3.00	34.00	28.20	0.00	0.00	0.00	0.00	28.20
PI Instr	24.00	280.30	86.40	1.50	6.70	0.00	0.00	94.60
Engr	3.00	34.30	13.75	0.00	1.50	0.00	0.00	15.25
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**30.00**	**348.60**	**128.35**	**1.50**	**8.20**	**0.00**	**0.00**	**138.05**

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	36.8
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	2.4
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	39.6

* Breakdown of hours lost to instrument
1.00 Issue with ARIES
0.50 Hecto sequence error

** Breakdown of hours lost to telescope
1.50 AO-PCR would not boot up
5.70 AO-PCR problems
1.00 East elephant hose broke

Year to Date November 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	109.00	1090.10	456.90	3.50	2.16	13.00	0.00	475.56
PI Instr	170.00	1675.10	453.95	8.75	34.10	5.00	0.00	501.80
Engr	20.00	204.40	65.10	0.00	3.50	0.00	0.00	68.60
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**299.00**	**2969.60**	**975.95**	**12.25**	**39.76**	**18.00**	**0.00**	**1045.96**

Time Summary Exclusive of Shutdown

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	32.9
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	1.3
Percentage of time lost to general facility	0.6
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	35.2

December 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	15.00	180.00	129.00	0.50	0.00	0.00	0.00	129.50
PI Instr	12.00	143.30	91.85	0.75	0.25	0.00	0.00	92.85
Engr	3.00	36.00	15.00	0.00	0.00	0.00	0.00	15.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**30.00**	**359.30**	**235.85**	**1.25**	**0.25**	**0.00**	**0.00**	**237.35**

Time Summary

Percentage of time scheduled for observing	90.0
Percentage of time scheduled for engineering	10.0
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	65.6
Percentage of time lost to instrument	0.3
Percentage of time lost to telescope	0.1
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	66.1

* Breakdown of hours lost to instrument

0.75 Issue with SWIRC

0.50 Blue Channel remote connection problem

** Breakdown of hours lost to telescope

0.25 Oscillation

Year to Date December 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	124.00	1270.10	585.90	4.00	2.16	13.00	0.00	605.06
PI Instr	182.00	1818.40	545.80	9.50	34.35	5.00	0.00	594.65
Engr	23.00	240.40	80.10	0.00	3.50	0.00	0.00	83.60
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**329.00**	**3328.90**	**1211.80**	**13.50**	**40.01**	**18.00**	**0.00**	**1283.31**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	92.8
Percentage of time scheduled for engineering	7.2
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	36.4
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	1.2
Percentage of time lost to general facility	0.5
Percentage of time lost to environment	0.0
Percentage of time lost	38.6