MMT Observatory
Smithsonian Institution &
The University of Arizona®

# End of Quarter Summary

## July - September 2013

## MMT Observatory Activities

Beginning with this quarterly report, our reports will be 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 has only recently been established, we expect that it will be modified to some extent in future program plans and reports.

## Administrative

### Program Management

The following meetings were held during this reporting period: two engineering, two software, two telescope operator, one servo, and one adaptive optics.

### Staffing

Four candidates for the Operations Manager/Chief Engineer position were selected to make site visits to the MMTO in July and August. Dan Blanco, who had previously worked for the MMTO as mechanical engineer and Mountain Operations Manager, accepted the position and started on September 30.

### Scheduling

Summer shutdown began on July 23 and went through August 19. An all-hands cleaning day of the observatory took place on the last day. The observatory reopened on August 20.

### Strategic Planning

Weekly strategic planning meetings were held in August and September. Along with G. Williams, attendees included members of the MMT Council and MMTO staff scientist J. Hinz. Discussions included MMT instrumentation and observing modes for the next 10 years. Plans were also discussed to prepare and distribute a survey to CfA and Arizona consortium astronomers to get their input and feedback on these issues. The survey will be distributed in the next reporting period.

## Reports and Publications

There were thirty peer-reviewed MMT-related scientific publications and two 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

D. Gibson attended the University of Arizona Information Technology Summit held on the UA campus on July 10.

## Safety

### Training

The MMTO staff safety video compliance for this reporting period is at 84.4%, up from 83.1%.

### Safety Inspections

Deficiencies were found in the chemical inventory during the September Smithsonian Institution METR inspection, i.e., several missing Material Safety Data Sheets (MSDS). Efforts are underway to correct these.

### Procedures and Protocols

Work was started to convert the old MSDS to the new Safety Data Sheet (SDS) format. An internal chemical storage/handling/disposal policy was drafted. Disposal of outdated and obsolete chemicals is in progress, and inventories are being completed for all hazardous chemical storage lockers. A new "Right to Know Center" was ordered to hold two new SDS binders.

Tags were ordered to assist with fire/lightning shutdown procedures. To save time, these tags will be located next to equipment that must be shut down during an evacuation. The tags were recently received and will be installed during the next reporting period.

### Miscellaneous

The broken lock on the MMT's fire alarm panel was fixed.

## Primary Mirror

### Coating & Aluminization

The serial DAC (Digital-to-Analog Converter) prototype to support computer-controlled welder setpoint output for mirror coating was converted to a printed circuit. It was then sent to OSH Park for fabrication. Testing and integration of the DAC boards into the analog-signal data acquisition chassis will be completed after summer shutdown. We anticipate that future new electronics for MMTO will go directly from prototype testing to surface-mount printed circuits for deployment.

The vendor, OSH Park, was identified for printed circuit board (PCB) manufacturing. This vendor accepts direct input of board files electronically, and the PCB production is much cheaper than the historical method of using wire-wrapped or hand-wired boards.

The electronics group is supporting the development of interface software to the data-interchange software proposed by the software group. Redis (http://redis.io/), a lightweight C-based key:value data server, is being used to integrate the Simulink-based deposition controller with the realuminization software infrastructure.

Additional information on interface software for the primary mirror realuminization can be found in the Computers and Information Technology section, Hardware/Software Interfaces on p. 15.

**Ventilation and Thermal Systems**

The HP data acquisition unit (DAU) input cards, used for reading the various thermocouples in the ventilation system heat exchangers and ducting, were modified with sockets to accept replacement relays on the input cards. Replacement of the read relays in the DAUs is necessary after several months of continuous operation, which results in sufficient wearing that degrades the signal measurements and produces inaccurate temperature readings.

A voltage protection circuit was installed for the Carrier AC unit to safely shut down the system if the input power is interrupted. This will help to protect the system during a brown-out or phase loss condition. If the system trips, the telescope operator will need to manually reset it.

A cover for the air-control NEMA box at the cell computer was installed.

**Actuators**

During summer shutdown, all of the primary mirror support actuators were removed, rebuilt, re-calibrated, tested, and re-installed. Water contamination in December left the mirror-support system with intermittent problems, and the reliability of the air transducers in the actuators had become questionable.

Using a detailed procedure developed at the campus electronic shop, all of the actuator air transducers were removed and disassembled for inspection. Approximately two dozen actuators had obvious signs of water damage to the transducer interiors. In many cases this was correlated with some sort of blockage of the fine orifice inside the transducers; we found others with remnant Teflon pipe sealant debris as well. A detailed report listing each actuator condition and the needed repairs was produced and made available in the Documentation Database.

All of the mirror actuators were serviced and replaced, and all available spares were brought into working order. We also produced more actuator cards from stored unpopulated printed-circuit boards. All spare bare boards are now in use and we will produce more, if necessary.

Prior to summer shutdown, the actuator test stand mechanics were aligned and the software brought online in anticipation of testing and recalibrating all actuators. S. Schaller was instrumental in making some last-minute software changes to the test stand graphical user interface (GUI) that were necessary to support adjustments to the actuator test process and pass/fail criteria.

During shutdown, all of the primary mirror actuators and spare units were cycled through the test stand, some multiple times due to needed repairs or adjustments. This was accomplished in just over three weeks, a vast improvement to the throughput with the old test stand electronics.

A new mechanical interface was made for connecting actuators to the test stand work plate. The interface requires only two bolts and two locating pins. It supports all three possible attachment methods for the actuators (one for dual-axis actuators, and two variants of single-axis actuators), thus saving time when working with the test stand.

## Secondary Mirrors

### f/5

While reviewing the f/5 optical design, our graduate student, Xiaoyin Zhu, discovered a discrepancy that affects the f/5 hexapod controller. This moves the secondary about two points; a tilt about the f/5 center of curvature does not move the image, but does change the coma, while a tilt about the so-called zero coma point (ZCP) moves the image without changing the coma. These two motions are used to collimate the telescope at the start of each night. Xiaoyin pointed out that the location of the ZCP changes slightly when the field corrector is in place, but our controller was still set to the bare f/5 value. We are reviewing the hexapod control code and we expect to make appropriate changes. These changes should be transparent to users, but should result in a slight improvement to the system.

### f/15

The tape limit switch jumper plug was replaced. The old one had been bent through handling and was difficult to connect.

Unnecessary cables in the telescope cable drape to room 3E were removed to clean up the drape and lower the cable drag load on the telescope. The fiber-optic cable run from 3E through the drape to the secondary hub was replaced with a more robust armored-jacket version and a new terminating box in the SE corner of the upper telescope frame. Now, if a fiber failure occurs, it is only necessary to replace the run across the spider vane to the hub rather than the entire length from the 3E racks to the secondary.

## Hexapods

### f/9 and f/15 hexapod

The signal-conditioning circuits for the hexapod length potentiometers have historically required periodic adjustment, and they also suffer temperature drift. Together, these add to the burden when trying to determine the absolute repeatability of secondary mounting. To address this issue, a new version of the signal-conditioner was designed to handle both the hexapod inputs and the primary mirror support air pressure sensors. This new unit uses digitally-adjusted circuits to provide the necessary gain and offset adjustments and will be more sensitive to time and temperature drift than the original design. The new boards were sent to OSH Park for manufacture and we expect to implement them within a few months, along with the necessary serial-input hardware and software required for adjusting the circuit.

## Optical Support Structure

Nothing to report.

## Pointing and Tracking

### Elevation

The failed Copley Controls elevation drive amplifier was repaired by the vendor, Power Clinic, Inc. The amplifier was returned to service and worked well for about six weeks before failing again. Several weeks later, the slave amplifier on the other elevation motor channel failed as well. We found a second vendor to repair the slave amplifier, and returned the master amplifier to Power Clinic for repair as it was still under warranty.

To prepare for replacement of the end-of-life Copley amplifiers, a new amplifier model and vendor were identified and a single unit was ordered for evaluation. We plan to build a complete test chassis to run the new candidate amplifier in the lab, and to test it driving the rotator and elevation motors. If successful, we will build a complete spare amplifier chassis to have on hand to swap out if the one in use fails, making it possible to immediately regain elevation drive operations.

Investigation of the 25 Hz oscillation in the elevation servo continues. D. Clark produced a report for internal use on the issue. The current theory is that the elevation servo exhibits low-level friction that produces an encoder feedback signal that switches between zero change and a few encoder counts of change, each portion lasting several servo ticks. In this case, the velocity estimator output from the encoder feedback becomes sinusoidal. If the "stick-slip" encoder signal is near the known structural resonance frequencies, the sinusoidal character can be magnified through the servo and structure to produce significant tracking jitter.

We are considering more advanced velocity-estimation algorithms, as well as continuing to pursue installation of a new absolute encoder. Brian Cuerden (Steward Observatory) is assisting with the analysis and design of a mounting fixture. The fixture will need to accept the Heidenhain RCN8500 series 29-bit encoder that will replace the aging 25-bit Inductosyn units. It will also need to meet the challenging alignment tolerances and be stiff enough to take full advantage of the encoder resolution when attached to the telescope reference mechanics.

Significant effort was made to understand the current code-generation tools from Simulink in order to make test fixtures using C software for the eventual production of testable modules in C software. This effort is from the servo-engineering side in Simulink to the software-implementation side for development and test of deployable controller software under the mount computer software environment. There is significant overlap between this effort and the effort to deploy aluminization control software.

## Science Instruments

### f/9 Instrumentation

The f/9 instruments were on the MMT for 38% of the available (non-shutdown) nights from July 1 through September 30. Approximately 71% of those nights were scheduled with the Blue Channel Spectrograph and 29% with Red Channel. SPOL was not scheduled this quarter. Of the total 214.3 hours allocated for f/9 observations, 159.3 hours (74%) were lost to monsoon weather conditions.

Instrument, facility, and telescope problems accounted for 8% of lost time, with most of this due to primary mirror support issues. Blue Channel lost 73% of its time to poor weather, with Red Channel losing 77%.

A number of bugs were fixed with the automated logging system for the Red and Blue Channel Spectrographs. These fixes will require another f/9 run to ensure that any lasting problems are solved. Work is now being done to "generalize" the logging software to work with data obtained with SPOL and ARIES.

New pen-ray style neon and argon calibration lamps and corresponding power supplies were ordered from Newport and delivered to the mountain mid-September.

**f/5 Instrumentation**

An active monsoon season, along with the scheduled telescope summer shutdown, reduced the number of observing nights for this quarter.

Thirty-one nights were scheduled for f/5 observations and operations, including a couple of nights of Maintenance & Engineering (M&E) to work on the MMTCam operation.

Over 60% of the scheduled sky time was lost, mostly to weather. In August, we lost a couple of hours one night to a cell crate problem. A couple more hours were lost the next night to a crash of the *hacksaw* computer server. A total of a half hour was also lost to issues with the building drive and the wavefront sensor (WFS) software.

There were four nights scheduled for SWIRC that were lost to storms. Of the 25 nights scheduled for Hectospec/Hectochelle/MMTCam, the dome was open for parts of 17 nights. 146 Hecto science exposures were obtained on 46 fields. There were approximately 1,000 bias, flat, comp, dark, and sky exposures in addition to the science exposures. There were 78 MMTCam science exposures this quarter with almost 300 bias, flat, and dark exposures.

On July 3, the WFS computer was unresponsive. Troubleshooting by the MMT staff revealed a dead computer power supply, which was quickly replaced. The WFS and the Hecto positioner were remounted, and the instrument was ready for observations by sunset. A power monitor unit has since been installed behind the SAO rack on the power line to the WFS computer that indicates if the computer is drawing normal power (about 50 watts).

The Hecto crew from Cambridge visited for their annual service mission. This year's was a little longer than usual. The four gimbal actuators were replaced. Two refurbished units were found to be defective and had to be replaced again. The positioner was cleaned, as were the mirrors in the WFS. Though we tried several sets of test measurements, we were unable to locate fault in the Y1 axis linear encoder. That axis continues to be controlled by the rotary encoder.

Light contamination was discovered in the Hecto positioner in late September. Through a process of elimination, the source was found to be fiber fed fiducial markers that were used for engineering. We were unable to get the relay that controls the lights to turn off, so the electronics processing box was opened and the wires for the lights were disconnected. It is still unclear why the relay turned on.

There were some issues with the chelle can, used to calibrate HectoChelle observations. Two of the nineteen lamps in the can were defective and were replaced. All of the lamps were reseated in their connectors. Their behavior improved but some drop outs continued to occur. MMT Camera6 was temporarily relocated from the Instrument Repair Facility (IRF) and will be used by the robot operators to monitor the current meters on the lamps during operations.

**f/15 Instrumentation**

One adaptive optics (AO) observing run was conducted from September 12-19. The eight-night run consisted of: one M&E night, six science nights with NGS/ARIES, and one engineering night with the new nonlinear curvature WFS. In summary, issues with the AO power supply resulted in several hours of lost time during the M&E night; issues with the WFS camera electronics, along with poor seeing, caused a significant loss of time during the first two science nights; and a ground loop in the AO WFS camera electronics box was found and fixed after the third night of the run, resulting in much improved system performance for the remainder of the run.

The f/15 M&E night included general checkout of the f/15 operation on-sky, f/15 hexapod pointing, and ARIES alignment. The AO power supply failed at the beginning of the night, resulting in several hours of lost time. The VCCA lambda power unit was swapped out for another unit, which enabled us to get back on sky. Testing the following day revealed that the power supply unit was shutting itself off when the temperature reached 160 degrees, re-emphasizing the need for good ventilation. Other than the power supply problem, the system was on-sky for several hours without issues.

Multiple issues resulted in significant lost time during the first three science nights. The first two science nights were affected by a combination of bad seeing and WFS camera problems. In addition to the usual WFS camera syncing issues, the camera was also dropping frames where the image data were either partially or completely blank, causing the loop to crash. This appeared to be caused by a ground loop in the AO topbox. It was fixed prior to the fourth night of operation.

Another problem was the AO topbox mirrors being homed incorrectly, resulting in a large pointing error on-sky. This type of failure is very unusual and subsequent testing with the topbox homing revealed no issues of any kind. The AO operators were advised to use the f/15 alignment laser at the start of each night to verify correct alignment of the topbox mirrors.

The final two nights of the NGS/ARIES science time were without incident, with the system performing well.

The last night of the run was used to perform engineering and integration tasks on the new nonlinear curvature WFS. Despite approximately 1.5 hours of lost time due to lack of a fold mirror (where the ARIES science dichroic is usually positioned), the night was very productive in getting the system up and running, as well as collecting image data with the WFS camera.

## Topboxes and Wavefront Sensors (WFS)

### f/5 WFS

Work is ongoing to improve the quality of WFS measurements when the seeing is relatively poor (>1.5") or when the primary is significantly deformed, leading to very non-Gaussian WFS spots. Primarily, we are developing an algorithm to ensure that WFS spots that "touch" in the wings of a wide Gaussian or due to very distorted spot patterns are identified as two separate spots to compare to the reference. Not only will this increase observing efficiency when the seeing is poor, it will be a requirement when we begin off-axis WFS measurements with MAESTRO and Binospec (as the intrinsic distortions arising from observing the stars off-axis are enough to confuse the current spot finding algorithm).

We have implemented two major changes to the f/5 WFS software that should increase both the efficiency of observations and operator quality of life. First, we added a button to the f/5 WFS display that simultaneously deploys MMTCam on-axis and commands the secondary to account for the focus offset between either Hectospec/Hectochelle or SWIRC. When the operator uses this button to stow MMTCam, this focus offset is removed. Previously, the operator would need to issue a command to deploy MMTCam and manually enter the focus offset, which can easily be forgotten. As MMTCam has no guide camera, a missed focus offset wouldn't be noticed until an image was read out, resulting in a not-insignificant efficiency reduction. The new GUI should remedy this issue.

Previously, when the operator would slew to an f/5 target, they would then use the WFS GUI to select a nearby star, slew to it, complete the WFS measurements, and return to the target. At this point, if the operator had "auto offsets," (the routine that corrects for elevation and temperature changes with the hexapod, enabled before WFSing), it would become re-enabled when slewing back to the target. However, if these auto-offsets were never enabled (such as the first WFS of the night), the operator would have to manually turn on auto-offsets. We have added a check in the code that will default to always enabling these offsets when returning to a target after completing the WFS measurements. While it is unclear if any data were ever affected by possibly not turning on these hexapod corrections, the code should remove that as a possibility for future runs.

### f/9 Topbox

We have ordered and obtained a set of UV LEDs that will be mounted inside the f/9 topbox when the final replacements for the HeNeAr lamps have arrived and are installed and verified. The UV LED will sit where the current HeAr lamp resides, and should provide significantly improved continuum counts in the UV for work with the Blue Channel Spectrograph.

The current f/9 WFS camera utilizes a connection to a computer board that is no longer in production. To eliminate this single-point failure, we have obtained an SBIG STT-8300M camera as a replacement for the current f/9 WFS camera. This new camera has a number of features that will be useful for long-term use of the topbox. Primarily, it is a network camera, removing the need for maintaining the computer system and special communication hardware needed for the previous camera. Software has been written to command the new camera to take an image and download it. Before final installation can be completed, a mounting system inside the topbox will need to be built and new WFS references will need to be obtained. The process to ensure the new camera shares the same focus as the current system will take some time. After the new camera is installed, M&E time will be used to ensure that any software changes needed in the WFS code are complete. This work will likely be best suited for early 2014.

### Natural Guide Star (NGS) Topbox

ARIES was mounted on September 12, coinciding with the first night of the f/15 engineering run. The 2k x 2k 1-2.5 micron detector was installed on the spectroscopic side of ARIES. However, there were intermittent communication problems with the new detector. Imaging with the old detector continued while these problems were diagnosed. A likely grounding issue inside the dewar made it impractical to attempt a repair during the run.

## Facilities

### Main Enclosure

Considerable work to revamp the MMT control room was undertaken during summer shutdown. The objective was to improve the work environment, reduce clutter, and update the furniture as well as the floor, ceiling, and wall surfaces.

The bookcase, stereo, and carpet panels on the south side of the control room were removed and new drywall was installed. The cabling in the ceiling and behind the consoles was cleaned up and unused cables removed. New electrical outlets and network drops were installed to better support visiting staff and scientists with power and Ethernet for laptops or other equipment. The bookshelves on the north and west sides were removed and that area cleaned and rearranged as well.

All ceiling tiles were removed and replaced for a second time due to contamination from mice and ringtail cats. The staff sealed all openings in the walls between the control room and adjacent areas within the building to resolve this issue.

D. Porter rendered various new layouts for the control room using 3ds Max software from AutoDesk (http://www.autodesk.com/). As seen in the following three figures, this software provides very realistic modeling of the control room with the ability to add different types of desk units, chairs, partitions, wall/floor/ceiling coverings, and computer equipment.

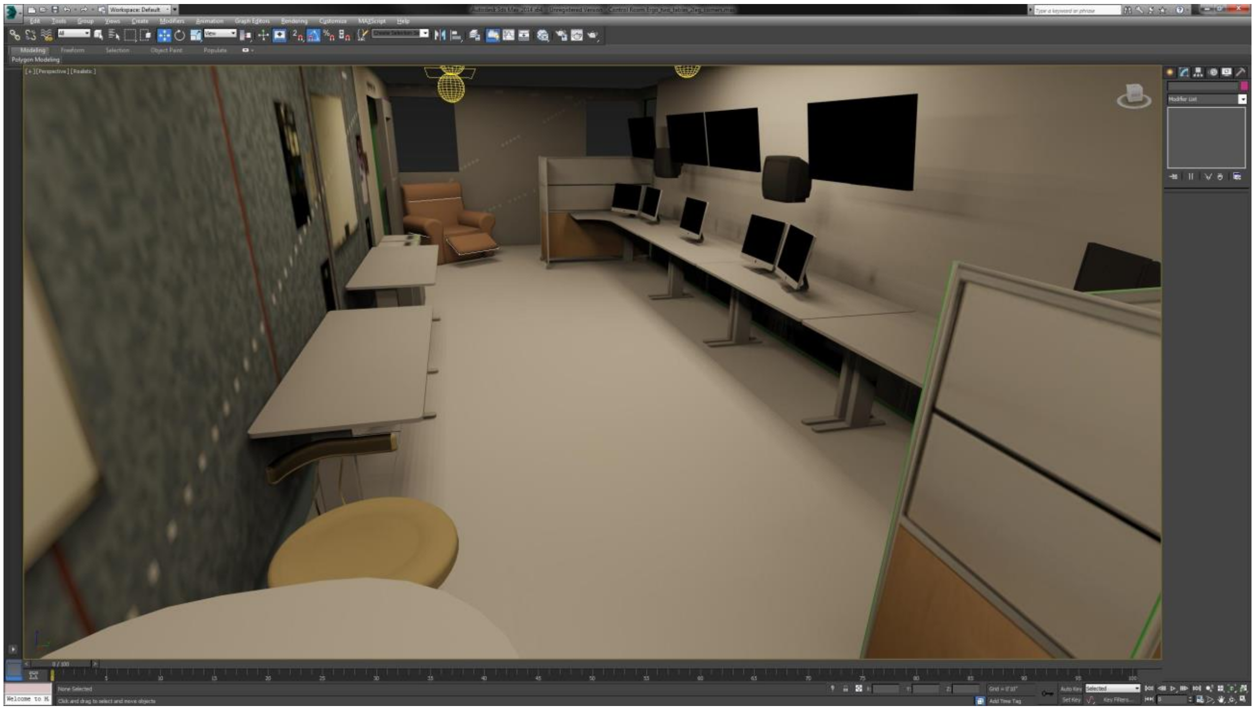

Figure 1. Modeled rendering of a proposed modified configuration of the control room, viewed from the "southeast" corner next to the loading dock door.

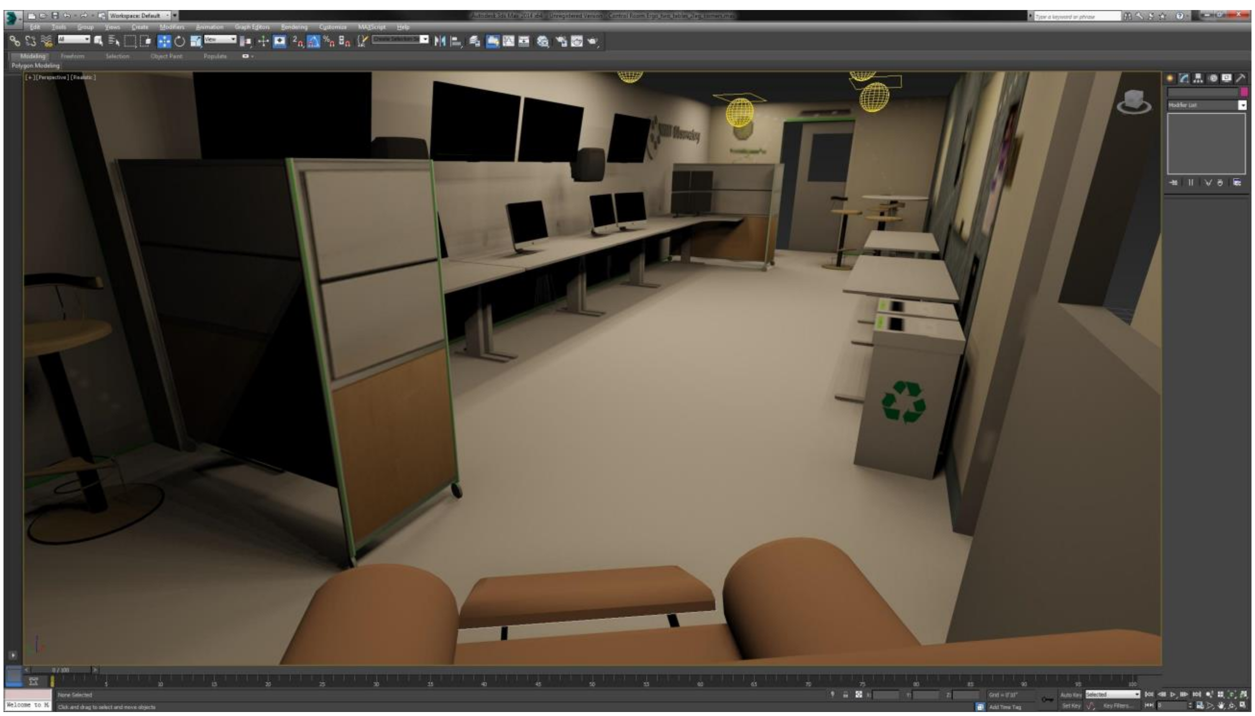

Figure 2. Modeled rendering of a proposed modified configuration of the control room, viewed from the "southwest" corner next to the kitchen door.

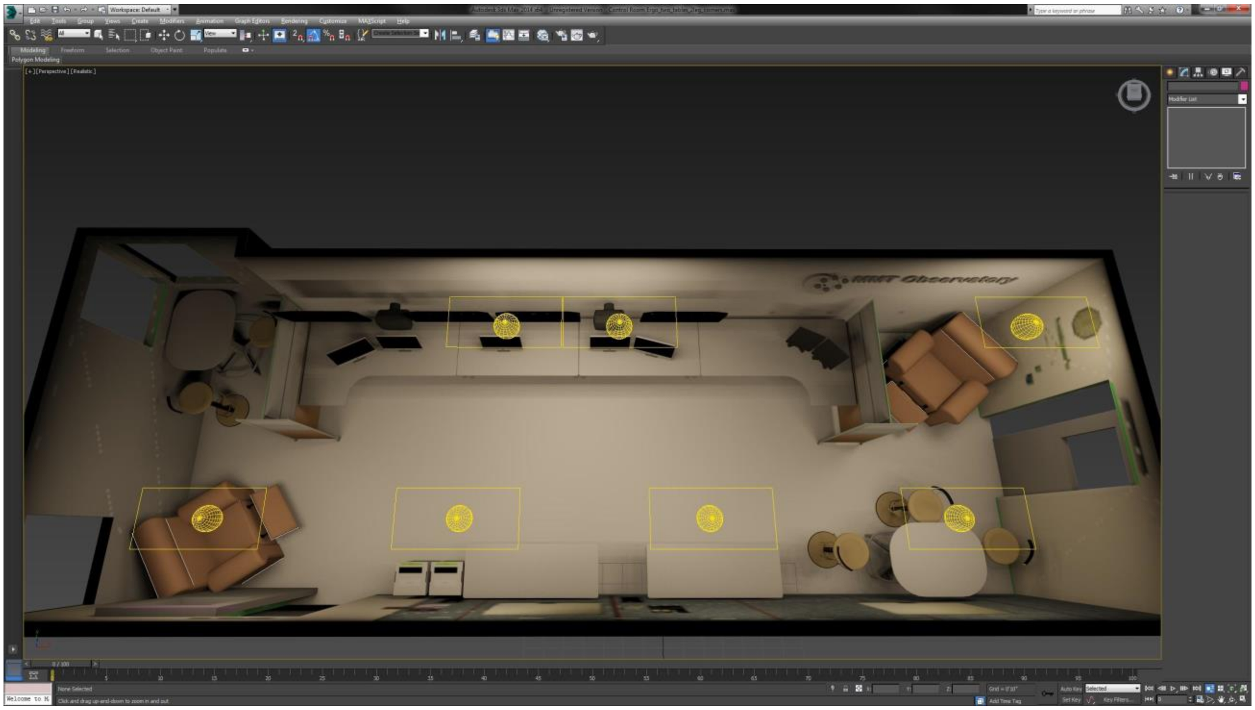

Figure 3. Modeled rendering of a proposed modified configuration of the control room, viewed from above.

A portion of this proposed layout for the control room has been implemented. The L-shaped desk unit (near the loading dock) was removed at the end of summer shutdown. The remaining work desk units were shifted to the east (towards the loading dock) to open an area at the west end of the north wall. The work desks were also moved against the north wall, widening the available floor space within the room, and creating a more "open" feel.

Work will continue on implementing this re-design of the control room. The two existing telstat monitors and two additional telstat monitors will be mounted. New desk units, small tables, and partitions will be purchased.

The area surrounding the elevation and azimuth encoders was cleaned. The E-shop and east loft were cleaned and rearranged, and new cabinets and shelves were ordered to aid in organizing the area. The spares lockers were cleaned and organized.

A new thermostat was ordered and installed in the 2W air conditioner. The unit is now fully functional.

The UPS for VMHost failed and was sent out for repair. A replacement was installed.

Two UPSs associated with the f/15 DM failed and were replaced with new rack mount APC Smart-UPS 1500s. The f/15 UPS rack was replaced with a larger rack to accommodate the new units and improve the air flow between them.

To prevent the elevator penthouse lights from being left on by mistake, and to provide an indication when they are on, the lights were placed in series with the 4th floor elevator light lock lights so the same switch controls both.

After the chamber lift blew several fuses, an investigation determined that vibrations had caused several wires in the control box to become loose over time, causing intermittent connections that single-phased the motor and pitted contacts in the control box. The control box and the contacts were cleaned. Checking the tightness of connections in the control box on a monthly basis was added to a maintenance checklist.

The limit switches for the chamber lift were removed and cleaned. New mounting brackets were made in order to prevent damage to the switches if the lift platform lands incorrectly.

The north chamber camera was cleaned and the focus was adjusted.

## Computers and Information Technology

### Network

A significant effort was put into identifying and correcting infected computers on the MMT network. Infected computers included a computer operated by the FCC/Border Patrol, the "FCC-Hopkins" computer. After communicating with Paul Coburn at the FCC, the FCC-Hopkins computer was powered down. It will be assigned a static IP address on one of the Smithsonian subnets.

Infected personal laptops in routine use at the MMT were also identified, and software staff worked with the involved individuals to remove viruses.

A second telescope status MacMini computer, *telstat2*, was purchased along with two Samsung 40" monitors, similar to the two telstat monitors already in the control room. This computer and two monitors will be moved to the control room during the fall of 2013.

A backup iMac observer computer, *gilead*, has been configured and is waiting for final deployment. This computer will only be used in the control room if the main observer computer, *pixel*, crashes.

Extensive work was done on researching new web-based technologies, including redis, socket-io, angularjs, and nodejs. Redis servers are now running on *hacksaw* and *telemetry*, an alias for *pluto*. All miniserver data are now being published to these redis servers. These new technologies provide many opportunities to improve user interfaces.

The following Macs were upgraded to the latest Mac OS X operating system: *pixel, friction, telstat*, and *pluto*. Associated software has been kept up-to-date.

Fedora upgrades of the Linux machines were done. During summer shutdown, the virtual disk files of our virtual servers, along with the *mmto* and *hacksaw* servers, were compacted. Other issues addressed included: internal ethernet interface problems on *pipewrench*, display issues on *chisel*, grub.cfg not being updated after new kernel installs, alternatives to the lack of SOAP support in Fedora ruby rpms, PXE booting for servo work, miniserver timeouts, and hacksaw kernel oops.

**Hardware/Software Interfaces**

The software effort for re-aluminization focused on three aspects: 1) continued debugging of the hardware-software interface code (i.e., the DAC software controller); 2) setting up the redis server, standardized key:value pairs, and associated application programming interface (API); and 3) creating web-based user interfaces using modern web technologies.

Work continued on software development of the DAC software controller C code that queries the three PCI boards used to obtain the welder and vacuum chamber data. This code publishes the data to the redis server at either 10 Hz or 100 Hz, depending on the data parameter. Those parameters used for servo control are published at the faster rate. Parameters that are used only for user interfaces are published at the slower data rate. Besides reading data, this DAC software controller is able to set the welder setpoint, the single parameter used to control the entire aluminization process.

A list has been created for all aluminization parameters. This list of key:value pairs, combined with the get/set and publish/subscribe redis ASCII network protocol, represents an API that will be used by all software. The parameter list currently contains around 100 separate key:value pairs for the ten welders and various sensors in and around the aluminization vacuum chamber. A redis server was configured to start at boot-time on the upgraded "aluminization" computer. Some clients, such as the DAC software, are setting key:value pairs on the redis server while other clients, such as GUIs, are reading these key:value pairs. Testing to date shows that the redis server is able to handle large loads. This is required if 100 separate parameters are updated at 100 Hz, which is 10,000 operations per second. Separate operations are needed for the get/set and publish/subscribe redis protocols, doubling the number of operations per second. In addition, if clients are subscribing to all data updates, these clients will need to handle a similar number of operations per second and the subscriptions by the clients will add to the load on the redis server. Further testing is needed on these load levels as well as any latency and/or jitter in clients being notified of changes in data values. This latency and/or jitter could affect servo control.

Finally, four new HTML5-based web pages have been created for the 2014 aluminization effort (see Figure 4 below). These web pages will be displayed on the four 40-inch telescope status "telstat" displays during the aluminization process. These web pages use the standard 16:9 aspect ratio found in high-definition (HD) 1080p (1920x1080 pixel) displays. A nodejs (http://nodejs.org/) application was written to read key:value pairs from the redis server mentioned above. This nodejs application was originally programmed to subscribe to changes in all ~100 parameters on the redis server. This approach involved considerable CPU resources both on the server and on the client since, as previously mentioned, 10,000 or more redis operations can occur per second. The nodejs application is now written to poll for data at 2 Hz intervals and is, in turn, pushing any data changes through socket.io-based websocket connections to web clients. It was found that updating data in user interfaces at rates faster than 2 Hz is too fast for users. This update rate is faster than the normal 1 Hz update rate used by MMT GUIs.

The web pages also use a variety of HTML5-based gauges and strip charts to help visualize data (see Figure 4). These graphics are much more intuitive than a table of raw numbers. It is anticipated that several of these new web-based technologies will be used in future MMT user interfaces. This field is rapidly evolving and will undoubtedly change between now and future aluminization efforts.

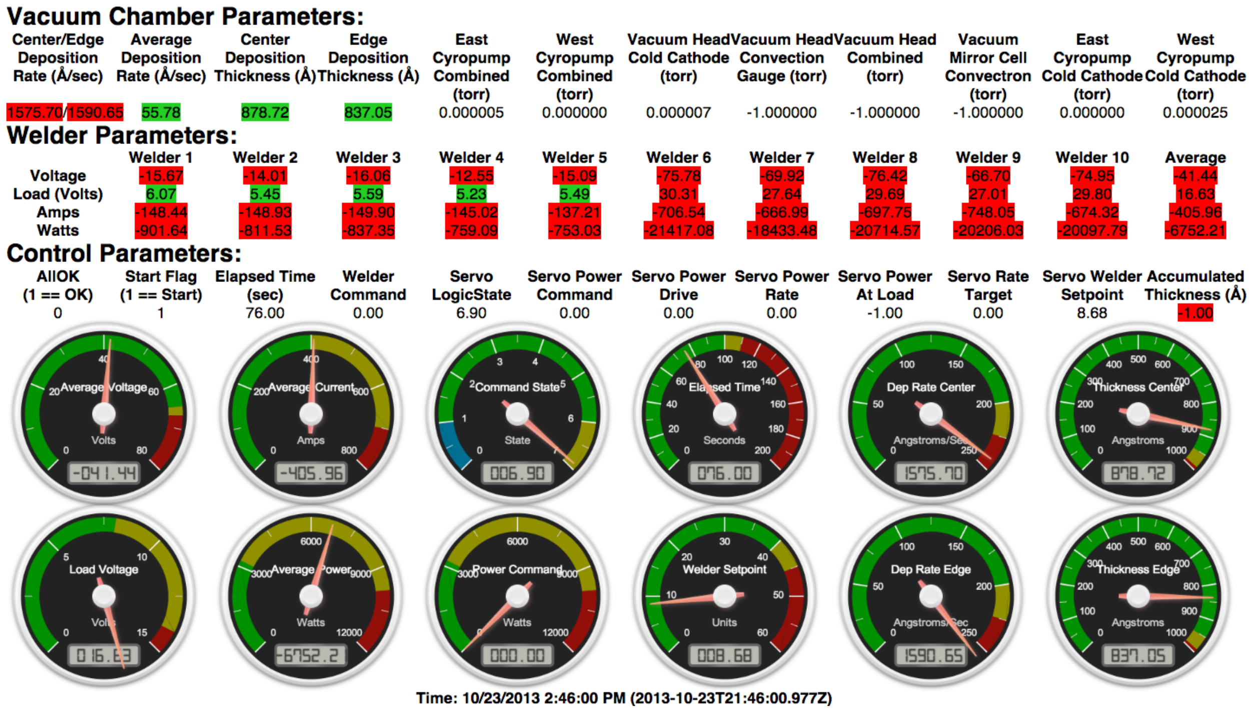


Figure 4. Draft aluminization summary web page. This page is formatted with a 16:9 aspect ratio to completely fill a 1080p (1920 x 1080 pixel) monitor. Test data show "OK" status (with green background) and "error" status (with red background). The same status colors (*e.g.*, red and green) are used in the gauges shown at the bottom of the page. Three additional web pages present more detailed data on the welders, vacuum conditions, and aluminum deposition.

## Telemetry, Logging, and Database Management

The primary mirror software was updated to include the actuator calibration data obtained during summer shutdown. Additional logging was also added to the code to debug primary mirror behavior.

Various modifications were made to the MySQL configuration on *hacksaw* to shorten the time to recover after a Linux crash. Code modifications were also made to the miniservers to turn off MySQL logging, if needed.

Seeing data for November 2012 through April 2013 were re-calculated and entered into the seeing MySQL database. Seeing statistics can now be calculated for this time period.

## Weather and Environmental Monitoring

### Weather Stations

The RCU-4 remote control unit for the roof heater failed. Its ACS-4 motherboard was found to be at fault, was sent out for repair, and reinstalled upon return.

The telescope operator reported that the RM Young wind sensor and Vaisala 3 weather station had stopped reporting wind and weather data. We found a blown fuse on the weather station's +15v power supply output as well as loose connections on the DIN rail terminal block fuseholder. The fuse was replaced, the connections tightened, and the system returned to working order.

During the summer monsoon season we evaluated a packaged version of the demo board for the Austria Microsystems AS2935 lightning detector. This IC uses a unique RF-signature detection method for discovery of local lightning, and uses a microprocessor to determine if the storm is approaching or departing and its estimated distance. We are considering mounting one outside to provide operators and staff with more information about nearby lightning conditions, but have not yet made a final decision.

We have acquired the hardware necessary to install a temperature-measurement system for the roof using a system similar to that reported by CFHT at the SPIE 2010 meeting. The hardware is designed such that both the surface and air temperatures can be measured at the same location to determine if supercooling conditions exist that might lead to condensing on the roof. We await some software and minor electronic packaging, and installation of a network switch in the elevator penthouse, to complete this work.

### Seeing

Figures 5 and 6 present seeing values, corrected to zenith, at the MMT Observatory for the period of July 1, 2013, to October 1, 2013. These values are derived from measurements made by the f/5 and f/9 wavefront sensors.

Figure 5 shows the time-series seeing data for July through September 2013. f/5 seeing measurements 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 from late July through much of August because of the annual summer shutdown.

Overall seeing trends for the two WFS systems are similar, although the median f/9 seeing value is significantly lower than the median f/5 value as seen in Figure 6. Median f/5 seeing values were 0.93 arcsec while median f/9 seeing values were 0.69 arcsec. The combined median seeing for the two WFS systems was 0.85 arcsec. It should be noted that the f/5 data set is much larger (483 samples) than the f/9 data set (150 samples).

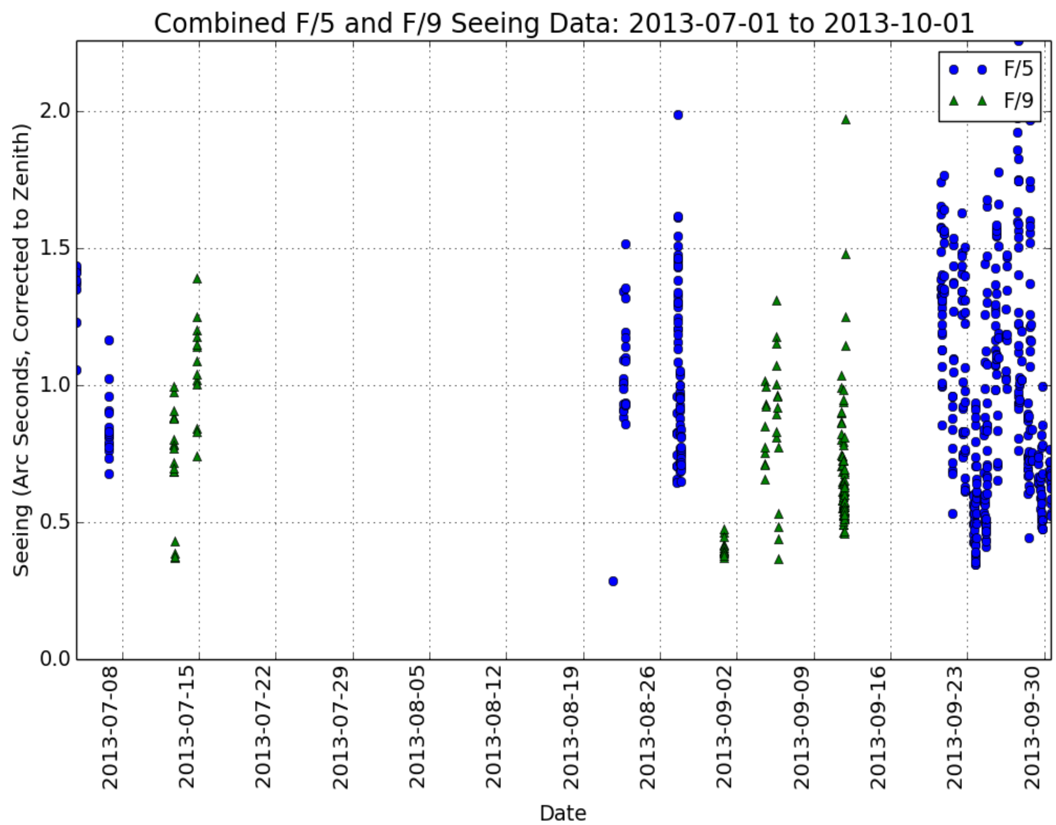


Figure 5. Derived seeing for the f/5 and f/9 WFSs from July through September 2013. Seeing values are corrected to zenith. f/5 seeing values are shown as blue circles while f/9 values are shown as green triangles. An overall median seeing of 0.85 arcsec is found for the 633 combined (f/5 and f/9) WFS measurements made during this period.

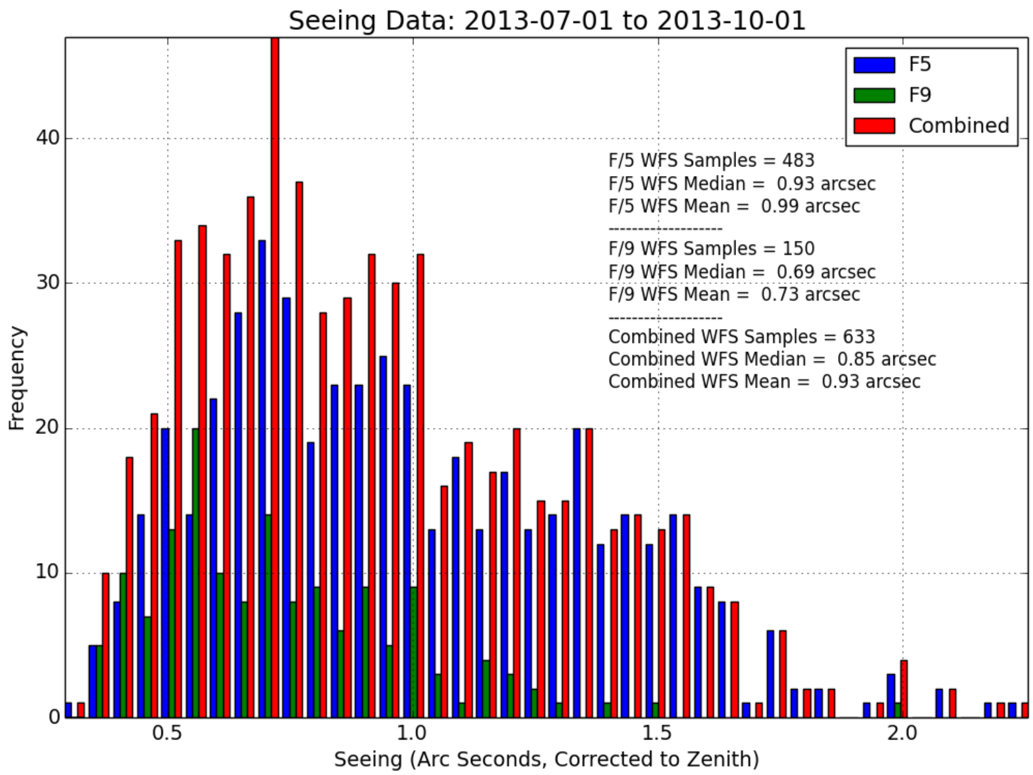


Figure 6. Histogram (with 0.1 arcsec bins) of derived seeing values for the f/5 and f/9 WFSs from July through September 2013. Seeing values are corrected to zenith. Median f/5 seeing is 0.93 arcsec while the median f/9 seeing is 0.69 arcsec. A combined (f/5+f/9) median seeing value of 0.85 arcsec is found for the 633 WFS measurements made during this period.

Weather patterns in southern Arizona during this period are dominated by afternoon monsoons. Much of f/5 data in late July and early August were collected with dominant winds from the east. These wind conditions typically result in poorer seeing conditions at the MMT. Higher wind speeds are seen for both the Vaisala 3 and Young weather stations in late September, suggesting variable wind conditions. Again, these wind conditions probably affected the f/5 seeing trends.

## User Support

### Remote Observing

The MMTO supported a total of 6 nights of remote observing this quarter. Two and a half nights were for UA observers, with 3.5 nights for CfA. Much of the remote support continues to be for scientists exploring supernovae or other transients where frequent trips to the MMTO would otherwise be necessary. All Blue and Red Channel Spectrograph users allocated time for fall 2013 were emailed in August regarding the remote capabilities. The webpage instructions were updated for use with the new observer computer, *pixel,* rather than *alewife*. The manuals for remote observing located in Steward 367A were also updated.

## Documentation

### Procedures

A new system for documenting preventative maintenance was started as well as the development of maintenance requirement cards (MRCs) for items that need maintenance. The new system also provides for scheduling and multiple notifications of upcoming work.

Documentation on the use of the instrument rotator was written by J. Hinz and vetted by the telescope operators. It has been added to the Documentation Database, the Cheat Sheets, and the Blue/Red Channel spectrographs areas of the MMTO website.

## Public Relations and Outreach

### Visitors and Tours

7/16/13 – A group of five, including the manager of the Korea Astronomy and Space Science Institute (KASI) and several members of Korean industry, were given a tour of the MMTO by G. Williams.

### MMTO in the Media

7/31/13 - Telescope operator E. Martin started a Facebook page for the MMTO at http://facebook.com/MMTObservatory. E. Martin and J. Hinz manage updates to the page including mountain photos, press releases, and other news items.

8/6/13 - Harvard/CfA issued a press release highlighting a gamma ray burst that is one of the most distant ever observed. Data taken at the MMTO showed the faint optical afterglow of this burst only hours after first detection of the gamma rays (see http://www.cfa.harvard.edu/news/2013-22).

9/24/13 – A press release by NASA/Chandra Observatory featured the discovery of the densest known galaxy, an ultra-compact dwarf known as M60-UCD1. MMT data helped contribute to the discovery.

## 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)

13-42 Two New Long-Period Hot Subdwarf Binaries with Dwarf Companions
B. N. Barlow, S.E. Liss, R.A. Wade, and E.M. Green
*ApJ*, **771**, 23

13-43 The Chemical Evolution of Star-forming Galaxies over the Last 11 Billion Years
H.J. Zahid, et al.
*ApJ Lett*, **771**, L19

13-44 Mid-infrared Selection of Active Galactic Nuclei with the Wide-field Infrared Survey Explorer. II. Properties of WISE-selected Active Galactic Nuclei in the NDWFS Boötes Field
R.J. Assef, et al.
*ApJ*, **772**, 26

13-45 Adaptive Optics Images. II. 12 *Kepler* Objects of Interest and 15 Confirmed Transiting Planets
E.R. Adams, A.K. Dupree, C. Kulesa, D. McCarthy
*AJ*, **146**, 9

13-46 Young Stellar Objects in Lynds 1641: Disks, Accretion, and Star Formation History
M. Fang, et al.
*ApJ Suppl*, **207**, 5

13-47 Submillimeter Observations of IRAS and WISE Debris Disk Candidates
J. Bulger, et al.
*A&A*, **556**, 119

13-48 The SDSS-III Baryon Oscillation Spectroscopic Survey: The Quasar Luminosity Function from Data Release Nine
N.P. Ross, et al.
*ApJ*, **773**, 14

13-49 The Quadruple Pre-main-sequence System LkCa 3: Implications for Stellar Evolution Models
G. Torres, et al.
*ApJ*, **773**, 40

13-50 Luminous and Variable Stars in M31 and M33. I. The Warm Hypergiants and Post-Red Supergiant Evolution
R.M. Humphreys, et al.
*ApJ*, **773**, 46

13-51 Erratum: "Kinematics of the Orion Nebula Cluster: Velocity Substructure and Spectroscopic Binaries" (2009, ApJ, 697, 1103)
J.J. Tobin, et al.
*ApJ*, **773**, 81

13-52 Star-forming Galaxy Evolution in Nearby Rich Clusters
K.D. Tyler, G.H. Rieke, and L. Bai
*ApJ*, **773**, 86

13-53 Hectospec and Hydra Spectra of Infrared Luminous Sources in the AKARI North Ecliptic Pole Survey Field
H. Shim, et al.
*ApJ Suppl*, **207**, 37

13-54 Metal-rich Planetary Nebulae in the Outer Reaches of M31
B. Balick, K.B. Kwitter, R.L.M. Corradi, and R.B.C. Henry
*ApJ*, **774**, 3

13-55 GRB 130606A as a Probe of the Intergalactic Medium and the Interstellar Medium in a Star-forming Galaxy in the First Gyr after the Big Bang
R. Chornock, et al.
*ApJ*, **774**, 26

13-56 The LBT Boötes Field Survey. I. The Rest-frame Ultraviolet and Near-infrared Luminosity Functions and Clustering of Bright Lyman Break Galaxies at $Z \sim 3$
F. Bian, et al.
*ApJ*, **774**, 28

13-57 Long-term Spectral Evolution of Tidal Disruption Candidates Selected by Strong Coronal Lines
C.-W Yang, et al.
*ApJ*, **774**, 46

13-58 The Fast and Furious Decay of the Peculiar Type Ic Supernova 2005ek
M.R. Drout, et al.
*ApJ*, **774**, 58

13-59 Diffraction-limited Visible Light Images of Orion Trapezium Cluster with the Magellan Adaptive Secondary Adaptive Optics System (MagAO)
L.M. Close, et al.
*ApJ*, **774**, 94

13-60 The Densest Galaxy
J. Strader, et al.
*ApJ Lett*, **775**, L6

13-61 Environments of Strong/Ultrastrong, Ultraviolet Fe II Emitting Quasars
R.G. Clowes, et al.
*MNRAS*, **433**, 2467

13-62 SN 2007uy – Metamorphosis of an Aspheric Type Ib Explosion
R. Roy, et al.
*MNRAS*, **434**, 2032

13-63 The TAOS Project: Results from Seven Years of Survey Data
Z.-W. Zhang, et al.
*AJ*, **146**, 14

13-64 Structural Parameters for Globular Clusters in M31
S. Wang and J. Ma
*AJ*, **146**, 20

13-65 The Same Frequency of Planets Inside and Outside Open Clusters of Stars
S. Meibom, et al.
*Nature*, **499**, 55

13-66 S0 Galaxies in the Coma Cluster: Environmental Dependence of the S0 Offset from the Tully-Fisher Relation
T.D. Rawle, J.R. Lucey, R.J. Smith and J.T.C.G. Head
*MNRAS*, **433**, 2667

13-67 Star Formation and Metallicity Gradients in Semi-analytic Models of Disc Galaxy Formation
J. Fu, et al.
*MNRAS*, **434**, 1531

13-68 Stacked Reverberation Mapping
S. Fine, et al.
*MNRAS Lett*, **434**, L16

13-69 Gamma-ray Burst Optical Light-curve Zoo: Comparison with X-ray Observations
E. Zaninoni, et al.
A&A, **557**, 12

13-70 Cold Gas in the Inner Regions of Intermediate Redshift Clusters
P. Jablonka, et al.
*A&A*, **557**, 103

13-71 The DEEP2 Galaxy Redshift Survey: Design, Observations, Data Reduction, and Redshifts
J.A. Newman, et al.
*ApJ Supp*, **208**, 5

**Non-MMT Related Staff Publications**

PRIMUS: An Observationally Motivated Model to Connect the Evolution of the Active Galactic Nucleus and Galaxy Populations out to z~1
Aird, et al. (R.J. Cool)
*ApJ,* **775**, 41

On the Origin on Lopsidedness in Galaxies as Determined from the Spitzer Survey of Stellar Structure in Galaxies (S4G)
Zaritsky, D., Salo, H., Laurikainen, E., et al., (J. Hinz)
*ApJ*, **772**, 135

## Appendix II - Service Request (SR) and Response Summary: July-September, 2013

Figures 7 and 8 illustrate the number of responses from the beginning of July through the end of September 2013, by priority and category, respectively. A total of 55 responses were created during this period. This compares with 53 responses for the previous three months, April through June 2013. Tables 1 and 2 show more details of "Critical" and "Important" SRs that were active from July through September 2013.

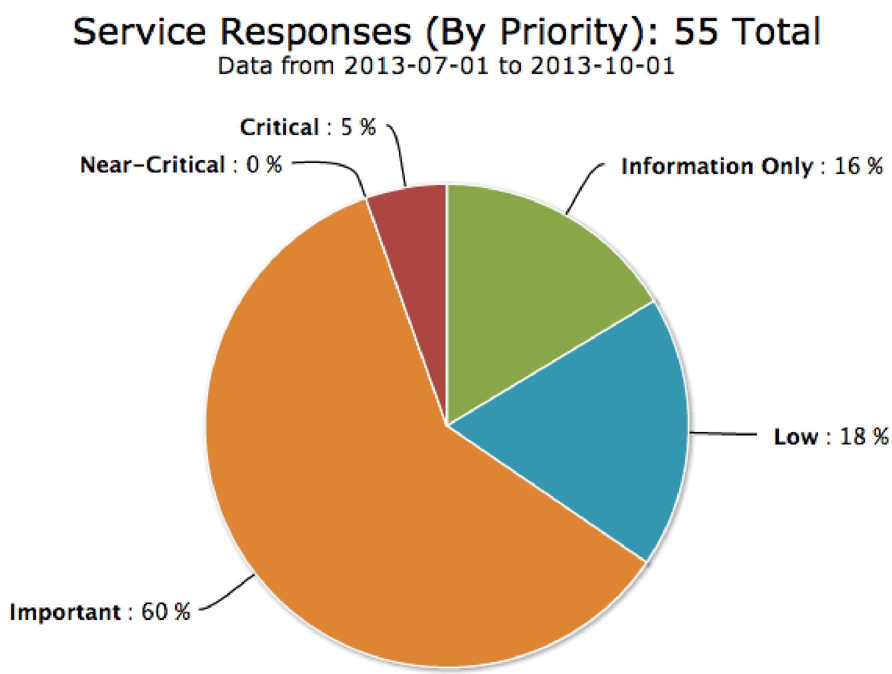


Figure 7. Percent of Service Request responses by priority from July through September 2013. The majority of responses were of "Important" priority.

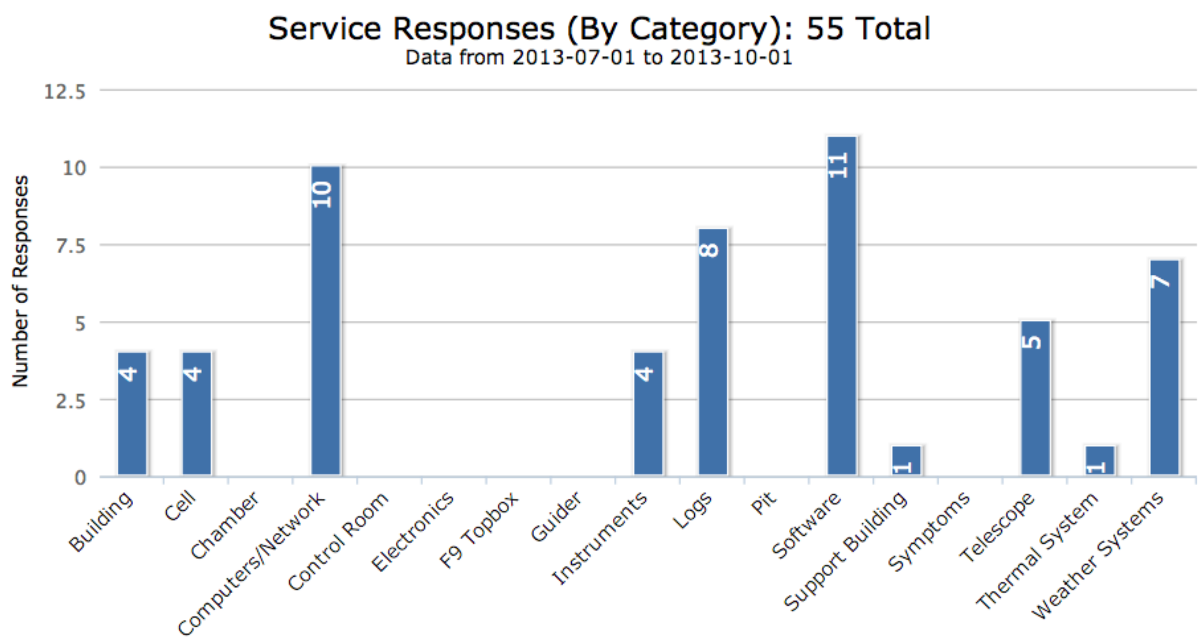


Figure 8. Summary of Service Request responses by category from July through September 2013. The majority of responses are related to software, computer/network, and logs.

Table 1. Active critical-priority Service Requests from July through September 2013.

| Service Request Number | Category | Name |
|---|---|---|
| #998 | Cell | Contamination of the primary air support system |
| #1032 | Thermal System | Carrier (chiller) failure after power outage |
| #1039 | Cell | Cell crate issues |

Table 2. Active important-priority Service Requests from July through September 2013.

| Service Request Number | Category | Name |
|---|---|---|
| #913 | Telescope | Servo shuts down due to bogus tape error |
| #1012 | Cell | Primary Cell actuator location #52 fails bump test |
| #1017 | Support/Shop Building | Air hose failure |

| | | |
|---|---|---|
| #1038 | Software | Cell crate booting issues |
| #1040 | Weather Systems | Young 1 windspeed/direction |
| #1043 | Logs | Timestamps in rerr logs are inconsistent |
| #1046 | Weather Systems | Vaisala 3+Young 2 problems |
| #1047 | Software | mmtccd_dewtemp |

## 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

### July 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 | 8.00 | 63.30 | 56.90 | 0.00 | 0.00 | 0.00 | 0.00 | 56.90 |
| PI Instr | 12.00 | 94.70 | 83.50 | 0.00 | 0.00 | 0.00 | 6.20 | 89.70 |
| Engr | 3.00 | 24.00 | 24.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24.00 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **23.00** | **182.00** | **164.40** | **0.00** | **0.00** | **0.00** | **6.20** | **170.60** |

Time Summary

| | |
|---|---|
| Percentage of time scheduled for observing | 86.8 |
| Percentage of time scheduled for engineering | 13.2 |
| Percentage of time scheduled for sec/instr change | 0.0 |
| Percentage of time lost to weather | 90.3 |
| Percentage of time lost to instrument | 0.0 |
| Percentage of time lost to telescope | 0.0 |
| Percentage of time lost to general facility | 0.0 |
| Percentage of time lost to environment (non-weather) | 3.4 |
| Percentage of time lost | 93.7 |

**** Breakdown of hours lost to environment
6.20 Report of forest fire

### August 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 | 3.00 | 28.00 | 28.00 | 0.00 | 0.00 | 0.00 | 0.00 | 28.00 |
| PI Instr | 7.00 | 63.70 | 46.50 | 0.00 | 2.80 | 2.70 | 0.00 | 52.00 |
| Engr | 1.00 | 9.00 | 9.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.00 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **11.00** | **100.70** | **83.50** | **0.00** | **2.80** | **2.70** | **0.00** | **89.00** |

Time Summary

| | |
|---|---|
| Percentage of time scheduled for observing | 91.1 |
| Percentage of time scheduled for engineering | 8.9 |
| Percentage of time scheduled for sec/instr change | 0.0 |
| Percentage of time lost to weather | 82.9 |
| Percentage of time lost to instrument | 0.0 |
| Percentage of time lost to telescope | 2.8 |
| Percentage of time lost to general facility | 2.7 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 88.4 |

** Breakdown of hours lost to telescope
0.30 WFS server & camera communication issues
2.50 Cell crate issues

*** Breakdown of hours lost to facility
0.20 Building rotation problems
2.50 Hacksaw server crash

### Year to Date August 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 | 76.00 | 744.00 | 231.45 | 7.16 | 3.25 | 7.00 | 0.00 | 248.86 |
| PI Instr | 124.00 | 1154.00 | 413.70 | 6.15 | 33.85 | 15.25 | 6.20 | 475.15 |
| Engr | 15.00 | 145.60 | 63.40 | 0.00 | 0.00 | 0.00 | 0.00 | 63.40 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **215.00** | **2043.60** | **708.55** | **13.31** | **37.10** | **22.25** | **6.20** | **787.41** |

Time Summary Exclusive of Shutdown

| | |
|---|---|
| Percentage of time scheduled for observing | 92.9 |
| Percentage of time scheduled for engineering | 7.1 |
| Percentage of time scheduled for sec/instr change | 0.0 |
| Percentage of time lost to weather | 34.7 |
| Percentage of time lost to instrument | 0.7 |
| Percentage of time lost to telescope | 1.8 |
| Percentage of time lost to general facility | 1.1 |
| Percentage of time lost to environment (non-weather) | 0.3 |
| Percentage of time lost | 38.5 |

**September 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 | 12.00 | 115.00 | 66.45 | 0.00 | 15.90 | 1.00 | 0.00 | 83.35 |
| PI Instr | 17.00 | 171.70 | 48.60 | 0.00 | 16.50 | 0.00 | 0.00 | 65.10 |
| Engr | 1.00 | 9.80 | 4.50 | 0.00 | 0.00 | 0.00 | 0.00 | 4.50 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Total** | **30.00** | **296.50** | **119.55** | **0.00** | **32.40** | **1.00** | **0.00** | **152.95** |

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 | 40.3 |
| Percentage of time lost to instrument | 0.0 |
| Percentage of time lost to telescope | 10.9 |
| Percentage of time lost to general facility | 0.3 |
| Percentage of time lost to environment | 0.0 |
| Percentage of time lost | 51.6 |

** Breakdown of hours lost to telescope

15.90 M1 support
6.25 AO camera; bad actuator in secondary
5.00 AO camera
3.50 Problems with AO alignment
1.75 AO M2

*** Breakdown of hours lost to facility

1.00 Hacksaw server crash

**Year to Date September 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 | 88.00 | 859.00 | 297.90 | 7.16 | 19.15 | 8.00 | 0.00 | 332.21 |
| PI Instr | 141.00 | 1325.70 | 462.30 | 6.15 | 50.35 | 15.25 | 6.20 | 540.25 |
| Engr | 16.00 | 155.40 | 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** | **245.00** | **2340.10** | **828.10** | **13.31** | **69.50** | **23.25** | **6.20** | **940.36** |

Time Summary Exclusive of Shutdown

| | |
|---|---|
| Percentage of time scheduled for observing | 93.4 |
| Percentage of time scheduled for engineering | 6.6 |
| Percentage of time scheduled for secondary change | 0.0 |
| Percentage of time lost to weather | 35.4 |
| Percentage of time lost to instrument | 0.6 |
| Percentage of time lost to telescope | 3.0 |
| Percentage of time lost to general facility | 1.0 |
| Percentage of time lost to environment | 0.3 |
| Percentage of time lost | 40.2 |