

End of Quarter Summary

January - March 2015



Dallan Porter is shown at the MMT table during the Tucson Festival of Books held March 14-15. A visitor is taking a virtual tour of the MMT chamber using an oculus, programmed by Dallan. Read more on p. 22.

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

Strategic Planning

During this period, senior staff continued discussions to identify and prioritize projects for FY16.

Reports and Publications

There were 22 peer-reviewed publications and two non MMT-related publications during this reporting period. No technical memoranda or reports were generated. See the listing of publications in Appendix I, p. 29.

Safety

Improved tie points for life lines on the roof of the MMTO main enclosure will be included as part of the on-going Smithsonian Institution (SI) project to replace the roof. More details can be found on p. 12.

New covers for deck penetrations were fabricated and installed to prevent potential hazards. The penetrations are holes made in the cement floor between floors when the building was constructed. The holes were used to house cords and wiring for electronics racks when the control room was located on the second floor.

A new gate was installed on the scissor lift truck to prevent fall hazards while transporting instruments into the main building.

New emergency lights were installed in the telescope control room and kitchen area.

Construction debris that had accumulated behind the shop was cleaned up by mountain staff, making it safer for everyone when walking in that area.

Training

New safety videos, including one covering asbestos safety, were added to address safety concerns identified by staff and inspectors.

Safety Inspections

Routine safety inspections instituted last December are being continued by various volunteer staff members. Along with providing added safety, they have helped increase staff awareness and bring fresh perspectives to identifying potential safety concerns.

Procedures and Protocols

A new method for inventory of hazardous chemicals was explored this period. We have identified SiteHawk as a potential vendor due to their impressive online Safety Data Sheets (SDS) management program that can handle several of our HAZMAT concerns. A decision will be made in the near future as to its possible purchase.

Personal Protective Equipment (PPE)

A new PPE locker was installed in the mountain shop to help with keeping equipment clean. New PPE purchased for staff include safety glasses, hearing protection, and cut-resistant work gloves. For staff helping with aluminization preparation work at the basecamp/warehouse location, the following items were also purchased: wide-brimmed hardhats, first-aid kit, safety sunglasses, regular safety glasses, and cut-resistant work gloves.

Interlock System

On the nights of March 25-26, a fault in the interlock system caused the building drives to drop out intermittently, bringing the building to a hard stop. The fault cleared after drives were restarted, and the system was recovered with minimal loss of observing time.

Primary Mirror

The primary mirror support system continued to have intermittent problems when raising or lowering. The log records excessive Z-moments and occasional panics on February 11, 12, 18, 22, and March 26. Each time, the system recovered with no significant loss of observing time.

Coating & Aluminization

The design for the bearing pads required to support the rear bell jar tilt frame and the bell jar cart tracks was finalized, and detailed drawings were circulated to three vendors. After vendor selection, the bearing pads were fabricated and the finished pads arrived at basecamp on February 24.

To support the upcoming assembly of the rear bell jar, bell jar extension, and MMT bell jar for M1 (primary mirror) aluminization basecamp testing, equipment within and in front of the warehouse

was further rearranged and reorganized. The F.L. Whipple Observatory (FLWO) HSHMC-25 crane (the “Green Crane”) was utilized to temporarily relocate the bell jar extension cradle and the bell jar cart. Additionally, the FLWO crane was used to position the rear bell jar tilt frame in a location that allowed the tilt frame and tracks to be leveled with the minimum amount of grout. On March 27, the MMT bell jar was loaded onto a trailer and moved out of the warehouse. It was then positioned on the trailer next to the rear bell jar in preparation to be lifted and placed on the bell jar cart. The crane operations required to set the rear bell jar, bell jar extension, and MMT bell jar have been scheduled for April 15.

After leveling the tilt frame and bell jar cart tracks, the process of grouting these components in place was started. Partially due to the warm temperatures, the working time of the cement grout was shorter than anticipated; the short working time limited the grout pours to multiple small batches.



Figure 1. This image taken during the grouting process shows the tilt frame and bell jar cart tracks in position.

Once the rear bell jar, bell jar extension, and MMT bell jar have been mounted on the tilt frame and bell jar cart (respectively), the knowledge and practice gained from handling and using the remaining components for the coating system at basecamp will be directly applicable to aluminizing the primary mirror during the 2015 summer shutdown.

Lab testing with the prototype version of the newer welder-control electronics for realuminization went well. We have proceeded with the design for a final version of a power supply card and welder command servo card that will separate the individual welder grounds from one another and the control computer. It will also provide support for a “sanity-check” output feedback for pre-coating end-to-end tests to ensure the system is ready before turning on the welders. A new version of the welder remote control interface board was designed to enable individually turning on the welders for finer control over the start of the coating process when the largest inrush currents occur. We expect to have the new welder boards ready for a round of tests at the Sunnyside vacuum facility before the

full-scale basecamp tests. The new remote control card may not be ready for the Sunnyside testing, but should be for the testing at basecamp.

To better support mass production of surface-mount boards, mainly for aluminizing electronics, a toaster oven was purchased that will be converted to a solder reflow oven. It will be used for semi-automated board production and for easing the transition from the old hand-soldered through-hole boards to modern, more reliable, and less expensive surface-mount boards.

The Linux-based main aluminization computer was upgraded to Fedora 20. This upgrade included re-compiling the Comedi kernel modules used to communicate with the power welders during aluminization. Other portions of the aluminization software framework were also re-installed on the aluminization computer, including the Simulink-based servo software, the MariaDB/MySQL aluminization database, and the node.js graphical user interface (GUI) and logging software.

Software was also written and a Windows-based computer was configured to capture webcam images at up to ~5Hz to record activities in this area, such as moving the aluminization bell jar into the proper position for the upcoming aluminization tests.

The software group interacted with SI staff to install a new Cisco wireless access point (AP) on the south side of the upper warehouse at basecamp. This new AP provides excellent wireless network connectivity for both data and VOIP phone service to the entire lower warehouse area at basecamp, including where the aluminization testing is taking place.

Mirror Support

The new power supply chassis with a unified 48V A/C supply control was fabricated. The new chassis uses an Excelsys UX6 power supply, similar to that used in the new f/15 deformable mirror (DM) power supply. A total of five supply modules were installed to provide the 5V, 12V, -12V, (VME chassis), and 15V, -15V supplies (analog circuits). A supply monitor circuit was added to each output to provide a power-good LED indication if the supply voltage is within a 10% tolerance. This allows us to quickly see if a supply is degraded or non-functional.

After assembly, the unit was checked in the shop under load and everything looked good. It was then taken to the mountain for operational checkout. All cell actuators were disconnected before initial powering up of the power supply. Upon connection, everything looked good and all voltages were within limits. The cell actuators were connected and power was applied. Once again all voltages checked out. However, when a bump test was run on the actuators, random failures of different actuators occurred. The old power supply was re-installed and there were no failures during the bump test. It was determined that there was an excessive amount of A/C ripple riding on the supply output lines. The supply was brought to the campus shop for installation of additional output line filtering to fix the problem.

While installing the new supply in the cell crate rack, we determined that two more A/C outlets should be added to the back panel: one for power to the cell crate fans and one for the actuator loop air valves. Adding these also helped considerably to clean up the crowded A/C distribution in the rear of the rack. We are finishing up the wiring of the new filter circuit while awaiting a new rear panel, and we will then install it in the mirror support system again.

Ventilation and Thermal Systems

A problem was noted with the cell-thermal E-series system. There have been problems with the type E thermocouples #60 and #28 in the past. After some cell exploration, it was found that all type E thermocouples are fed through the mirror cell on DB50 connectors located on 60 degree radials around the cell. Thermocouple #60 was found to have a pushed pin in the cell side of the DB50 connector. Thermocouple #28 is still being investigated. The connector is in the northeast corner of the cell under a dual actuator, and is difficult to access.

The “elephant hoses,” the flexible ventilation air ducts at the back of the telescope, have been problematic. The day crew has prevented significant down time by monitoring the hoses for incipient leaks, but they continue to be a maintenance problem. D. Blanco developed a concept for re-routing the ventilation air to eliminate the elephant hoses. Ventilation air will now be routed near the elevation bearings and onto the mirror cell through a rotary joint and a short section of flex duct – a truncated elephant hose.

A major upgrade of the primary mirror ventilation system, including existing sensors for temperature and flow, is underway in parallel with renovation of the HVAC system. More details can be found in the General Infrastructure section on p. 12.

Mount Servos

The new Shuttle DS81 computer had the RT-Preempt kernel Fedora 20 distribution from Stanford’s Planet CCRMA Project installed as the operating system. The collection of EtherCAT terminals for the mount control test interface was connected to it for testing. S. Schaller wrote and performed latency testing to check the robustness of the kernel with a base 1kHz sample rate over a 24-hour period. He found that the scheduling deadline could be met with less than 40 μ s of jitter 99.999% of the time, which is very encouraging. There are occasional large latencies in the EtherCAT data interchange that we will investigate further. We suspect that, due to use of a generic network interface driver, occasional interrupt delays are encountered getting across the Linux network stack. Additional testing is needed to be certain.

Secondary Mirrors

f/15

On March 9, while dismounting the f/15 secondary at the end of an adaptive optics (AO) run, the TSS (thin shell safety) system failed. There was no damage to the mirror. The failure was traced to a loose screw within one of the digital signaling processor (DSP) crates. The screw contacted two traces for the TSS system and created a short. The DSP board was replaced and ultimately tested on sky. In addition, the electrical short damaged a short section of the power cable to the TSS.

During checkout of the new adaptive optics deformable mirror (DM) power supply, we found that the current sensors had trouble with stray magnetic fields from the other conductors in the chassis. This made the current measurement data unreliable. New current sensors from LEM were installed and tested. Initial calibration of all three units in each power supply was accomplished. The new

units worked flawlessly and showed no changes due to interference from the other power supplies. The power supplies have been deemed ready for extensive testing.

Work started on building the smart card enclosure. The circuit cards have been manufactured and are ready to be populated with the surface mounted devices. Initial layout of the front and rear panels is in progress. LED display cards were drawn, laid out, and are being manufactured.

Hexapods

f/9 and f/15 hexapod

In March the f/9 hexapod was reported to be causing annunciator alarm “LVDT and encoder difference more than 250 microns.” While there was an annunciator alarm, the difference between the LVDT and encoder is only relevant at initial startup of the hexapod; it was determined that Pod A’s signal conditioner had failed and was causing the alarm. A spare signal conditioner was piggybacked onto the defective one. The telescope was tested and operated normally through the night. Unfortunately, moderate to severe LVDT noise levels on several pods was observed on the MySQL plotter over the next several nights. We were unable to duplicate the problem during the day. The UMAC ACC28E was swapped, but it did not fix the problem. Additional troubleshooting is required. A new design for the signal conditioner is underway and will replace the current conditioners.

Significant additional testing over time and temperature with the packaged version of the new signal conditioner was performed to ensure that it gives the same or better performance than the existing units. We expect to deploy the new units in the spring.

Optics Support Structure

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 exposure time calculators was tested. Several bugs were identified and are being corrected. Work continues on polishing the interface and preparing a user-friendly version, potentially in time for the next call for proposals.

The f/9 instruments were on the MMT for 50% of the available nights from January 1 through March 31. Approximately 80% of those nights were scheduled with the Blue Channel Spectrograph and 20% with Red Channel. SPOL was not mounted this quarter. Of the 495.1 total hours allocated for f/9 observations, 252.8 hours (51%) were lost to weather conditions. Instrument, facility, and telescope problems accounted for less than 1 hour of lost time, all to the repair of an elephant hose. Blue Channel lost 48% of its time to poor weather, with Red Channel losing 65%.

f/5 Instrumentation

There were 209 hours scheduled over 19 nights for observations with HectoSpec, HectoChelle and MMTCam. Nearly 94 of these hours were lost to weather, which is approximately 45% of the total time. In February, an approximate half night was lost to an issue with the mirror support system.

There were 220 hecto exposures gathered on 64 fields. Also, more than 900 calibration frames (bias, flat, comp, sky and dark) were taken. No sky data were taken on 4 of the scheduled 19 nights due to weather conditions.

Sky conditions were too poor for MMTCam scheduled observations on all but one night, on which 27 exposures were gathered on four objects. An additional 68 calibration exposures were taken on this and a couple of other nights.

No SWIRC observations were scheduled this quarter.

Three failing calibration lamps were swapped out during the quarter: two thorium-argon lamps from the Chelle can and the helium booster lamp that resides on the northwest dome box.

There was a communication problem with the wavefront sensor system at the start of the February run. The problem was corrected within a couple of hours by checking all of the fibers and then using the alternate media converter.

Discussions and preparations continued for the return of the MMIRS instrument to the MMTO in June. New power and communication lines were installed, and old connections were checked. In late March, M. Lacasse visited Las Campanas Observatory (LCO) to become familiar with current MMIRS operating procedures. Weather limited the amount of on-sky time, but increased the number of times the instrument was started and shut down. R. Ortiz will travel to LCO in April to help pack up the instrument for shipping.

f/15 Instrumentation

There were three adaptive optics (AO) observing runs during this reporting period. During this time, the Natural Guide Star (NGS)-AO system operated a total of twenty-five nights, more than any other instrument except Blue Channel. Throughout the three runs, there were no major issues or significant loss of time due to the AO system. There were a total of twenty-one science nights, with four of these nights including non-sidereal tracking of extended source objects.

Additional AO operators were again trained during this quarter, building on training that started the previous quarter. The number of personnel capable of operating the system is now nearly doubled, helping to accommodate the increased number of science nights.

January 2-5

This run included one Maintenance & Engineering (M&E) night and three science nights. The M&E night was used for testing non-sidereal tracking of objects, continued testing of PCR software, troubleshooting the wavefront sensor (WFS) camera, and for deformable mirror (DM) maintenance. During the typical science observing nights, the NGS-AO system also performed non-sidereal tracking of extended source objects on one of those nights, resulting in a very successful night of data collection.

January 29-February 8

This run included two M&E nights, eight science nights, and one night allocated to development of novel WFS techniques.

February 27-March 8

This run consisted of two M&E nights and eight science nights, one of which again involved non-sidereal tracking of extended source objects.

Continuing Work

Work continues on installation of the WFS camera fiber converter card to replace the current 80 foot-long SCSI cable. Initial testing indicated that converting to fiber could eliminate all current WFS camera freezing issues.

The WFS camera filter wheel has mechanical issues when changing filters. The filter wheel will be disassembled, inspected, and repaired.

Contamination at the bottom edge gap of the DM continues to be an issue. Although the gap has not prevented operation of the DM nor significantly impacted performance, its continuing recurrence is not understood and requires addressing.

Rotator tracking data not being properly sent by the telescope mount to the AO system continues to be an issue. This can result in the loop breaking when rotator tracking is enabled. A service request was opened to address the issue.

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. Significant progress was made this quarter on a new spot finding algorithm, as well as 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 WFS sensing with the MMIRS instrument, expected to arrive in June.

Laser Guide Star (LGS) Topbox

LGS electronics were removed from second floor west and taken to the Common Building to be stored with the LGS topbox.

Facilities

Main Enclosure

The building controls were relocated from the nearly forty-year-old box on the wall of the old control room on second floor east. As part of this, substandard electrical control circuits for the building ventilation fans were replaced with a new NEMA box and the proper three-phase contactors and motor overloads for the yoke room, pit, and trench fans. All contactors are now controlled via a web interface using a wired network connection to an Arduino Yun. Plans are to do similar revamping of the various remote control systems and monitoring throughout the facility as the HVAC upgrade project progresses. However, the Arduino interface will probably be replaced with BACnet equipment to match the Carrier chiller controls and HVAC equipment.

In preparation for the June arrival of the MMIRS instrument, new power lines were run in the second floor east, second floor west, and in the Instrument Repair Facility (IRF). The new power in 2 east and the IRF are 3-phase 30-amp receptacles. Pigtails were made and labeled for MMIRS.

The main umbilical on the front shutter was replaced after a faulty spring caused the wires to get caught on “L” beams on the shutter. A new method of routing the umbilical was used to help prevent similar problems in the future.

The heaters on the rear shutters were troubleshot. A wire had become loose on the breaker in panel PN2 and was fixed.

The ceiling heater tiles were replaced in the mountain manager’s office.

General Infrastructure

The road traffic indicator was repaired after the sensing loop was inadvertently broken. Also, the cabling in the old road heater control cabinet was replaced and updated with DIN rail components to address several safety concerns.

Progress was made on the following 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. Shop drawings have been prepared and are being reviewed. A complication developed as the result of an SI fall hazard risk assessment completed in June 2014 that cited inadequate tie points for life lines when working on the roof. The contract will be extended to include the addition of new tie points; however, with this further delay the start of work has slipped to the fall of 2015 to leave the summit clear for aluminizing during 2015 shutdown. Reports are available in the MMT Documentation Database under Administration/SI Projects/1383801 MMT Heated Roof.

Repairs to heated road at summit: Bid documents were completed and will be released soon for competitive bid. In addition to installing a new cable barrier and hand rail, the documents ask for bids on three options: replacing the existing asphalt pavement, milling the asphalt down to the old concrete planks that underlie the road and applying three inches of concrete to cover the old road bed, and installing a test section of concrete roadway with embedded heating cable. The test section would be beside the Common Building. Documents are posted at Administration/SI Projects/MMT Heated Road/Submissions.

Fire alarm: The fire alarm system still awaits final check and approval by SI. The Honeywell building fire alarms are in place and active, but the Keltron monitoring system has continued to cause problems. Because of this, fire alarms are not presently being monitored. Though a local alarm will sound in the event of a fire, the local fire department does not get notified. With fire season upon us this is a matter of concern.

HVAC upgrades: Work continued on this project which includes a number of needed upgrades to aging HVAC equipment. Piping and conduit was run to the new chiller (the former “Carrier on the Rock”). New glycol pumps and an automatic makeup supply unit were installed next to the UPS room. Three new electrical panels were installed under the awning at the IRF. Conduits were run and power lines were installed to connect the new breaker panel to the main transformer. Three aging air handlers have been disconnected and four new fan coil units were set in place in the control room ceiling, the loading dock, and the computer equipment rooms (third floor east and second floor west).



Figure 2. Shown are power and network control connections completed for the second Carrier chiller (left), also known as “CH2” and “Carrier-on-the-Rock.” New junction boxes and plumbing (right), mounted to the left of the CH2 unit, were installed during this reporting period. The view is to the southeast from behind the support building at the summit. Work will continue on integrating this Carrier CH2 chiller into the HVAC and M1 ventilation system. The HVAC system is being configured so that cooling can be quickly changed between this second chiller (CH2) and the existing chiller (CH1). These two chillers will eventually be integrated into an upgraded HVAC system, using the BACnet network protocol.



Figure 3. New red glycol pumps were installed next to the shop heat exchanger, shown on the left. The two new pumps will soon be connected to the newly upgraded HVAC system. These two 10-horsepower Bell & Gossett Series E-1510 pumps will greatly increase the glycol circulation capacity of the HVAC system. Additional new plumbing and electrical work is also shown in the photo. Work on the HVAC system will continue into the summer.

Computers and Information Technology

Computers and Storage

Pixel, one of the observer computers, developed an intermittent reboot issue wherein it reboots itself every other Monday at approximately 2:45pm two consecutive times. This has been very troublesome to troubleshoot. A replacement computer, also updated to Yosemite, has been completed to provide a stable machine while the debugging of *pixel* continues.

Network

The following network tasks were performed during this reporting period:

- the annual offload of historical data from /mmt was completed, along with the regular monthly backups and reboots
- the following machines were upgraded to Fedora 21: *backsaw*, *pipewrench*, *chisel*, and *mmt0*
- the IDL license on *mmt0.org* was updated to 8.4
- an LDAP password problem was fixed
- high loads on *nas2* was investigated
- the upcoming Univ. of Arizona (UA) campus VPN change and its potential impact on the MMTO was researched
- all networked devices were verified and updated on the internal online spreadsheet
- a new annunciator check for the hexapod was implemented
- the linux `reset_mmtobs` script was updated
- ethercat and actuator teststand application software were re-installed and configured on the new teststand computer

Work continued on evaluating slowness in GUI user responsiveness. “Ipkg,” a Linux package manager, and “dstat,” a resource statistics tool, were installed on *nas2*, the shared NFS file server for several Linux and Mac computers at the summit. Migration of software from *backsaw* to *ops* has reduced the overall impact of NFS mounting of the /mmt directory. This directory is not NFS-mounted on the *ops* server. No new insights were found for these issues.

Hardware/Software Interfaces

Aluminization

Within the scope of the primary mirror ventilation system and HVAC upgrade is the use of an open communication network protocol: BACnet (Building Automation and Control Network). BACnet is an ASHRAE, ANSI, and ISO 16484-5 standard protocol that has been widely adopted within the HVAC and building automation and control industries. BACnet will be used for a significant portion of the HVAC and ventilation system upgrades. Its use may be expanded in the future to include additional monitoring and automation control for MMT operations. A proposed BACnet network topology that includes three BACnet/IP routers, one each in the support building, pit, and main enclosure, was submitted to SI for consideration. The new BACnet infrastructure will need to be integrated into the existing MMTO IT and software framework. This will involve modification of data acquisition, logging, and process control software. Work began during this reporting period on learning details of the BACnet protocol, objects, parameters, and services. The BACnet devices may be controlled using higher-level control and automation software, such as the Niagara AX Framework by Tridium Corporation, from a JACE embedded computer. Open-source software options are also being evaluated for use in BACnet communication.

Programming

Pure Python implementation of “edb_gui”

A Perl/Tk version of a Xephem-based GUI was ported to a pure Python/Tk PyEphem-based GUI. The Perl version of this GUI used the Inline C Perl module to compile Xephem C code as part of the GUI. The GUI was no longer working. Rather than attempting to fix issues in the Perl version, the GUI was re-implemented using the native Python PyEphem library. This work also increased familiarity with the PyEphem library. The GUI was used for earth-orbiting satellite observing during

this reporting period. It can also be used for both sidereal and non-sidereal objects, using the two-line element (tle), Xephem (edb), or standard MMT catalog formats. Work on this GUI may resume when efforts resume on the mount upgrade project.

Blower watchdog script

A new mmtservice was written that compares the state of the Carrier chiller and the blower. The new “blower_watchdog.py” script will turn off the blower if the Carrier is not running. This prevents the blowing of hot air from the blower onto the primary mirror. The watchdog successfully shut down the blower automatically during nighttime operations during this reporting period.

Mount time-to-limit value calculations

An ongoing issue has been the discontinuous time-to-limit (TTL) calculations performed in the mount crate. This code was modified so that the TTL values change more smoothly, particularly as the limit is being approached. This modification to the mount code allows astronomers to better plan their science programs as they are observing. Another bug in calculating the day of the week was also addressed in the mount crate.

Node.js server for hexapod and thermal GUIs

The web-based M2 hexapod and thermal system GUIs can now be used either through the Apache web server on *hacksaw*, as done for years, or through a new node.js server that currently runs on *hacksaw*. This new node.js server can be used if the Apache web server were not available for any reason. This ensures that telescope operations related to these GUIs are not dependent on the web server on *hacksaw*. This web server hosts public web pages and is exposed to the outside world and possible malicious attacks.

Scheduler System

A significant amount of progress was made this quarter on the new scheduling and program management system. The majority of the MySQL database schema was completed, and tables have been created on the server. The PHP class structure was designed, and code templates for each class were created. An application programming interface (API) was also started; this will provide an asynchronous interface to the scheduler using HTML and JavaScript.

In addition to the back-end progress, the front-end is also being developed at the same time. Several of the forms and web-based utilities are under development and are now updating the new database with new data. Some examples of the front-end pages created this quarter are:

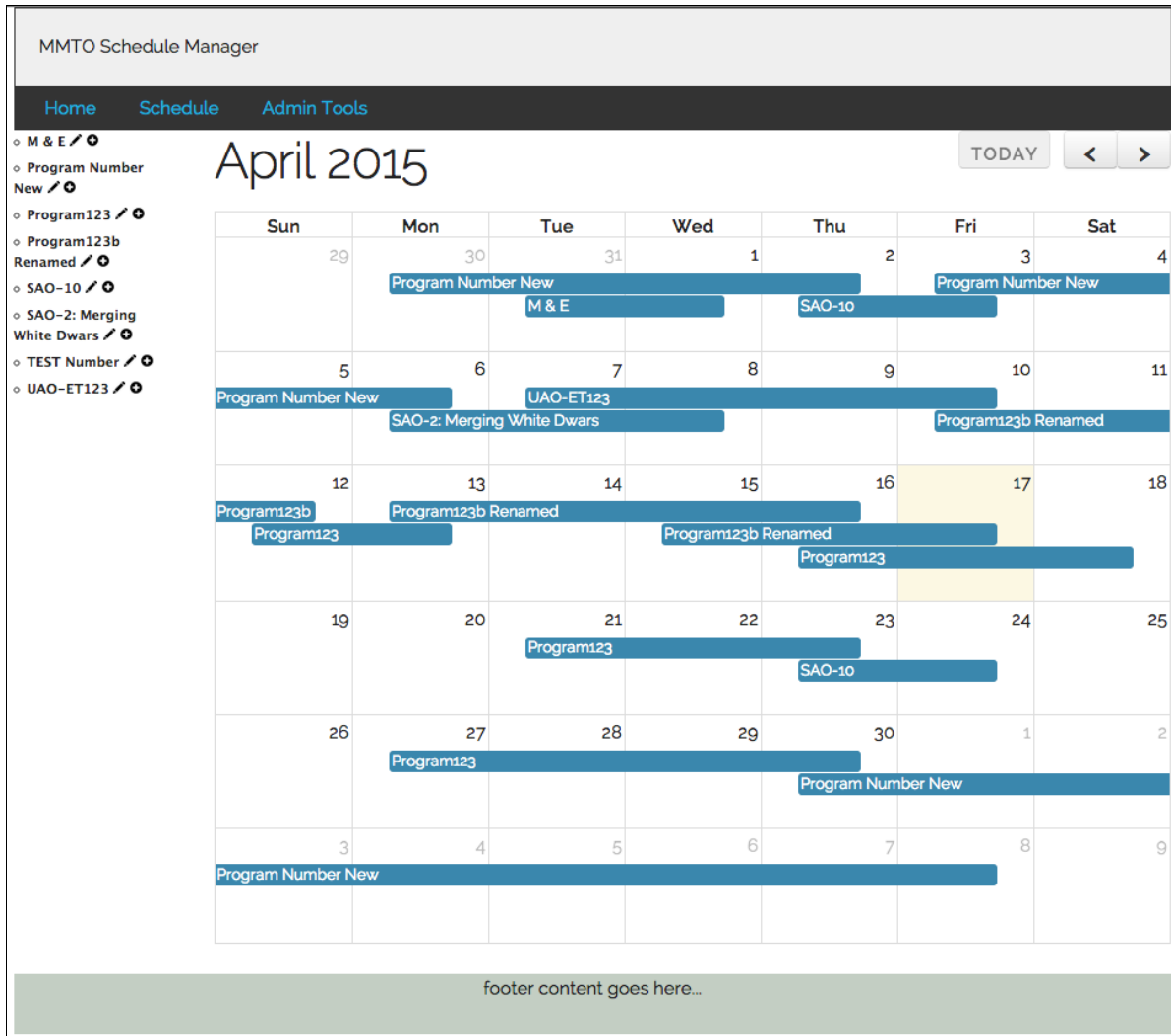


Figure 4. The calendar schedule creator for creating and modifying the observing schedule.

MMTO Schedule Manager

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Program ID 10

Number	Institution	Program Name			
<input type="text" value="M & E"/>	<input type="text" value="MMT Observatory"/>	<input type="text" value="MMT M & E"/>			
Year	Term (Arizona)	Trimester (CfA)	Dark Nights Req.	Gray Nights Req.	Bri. Nights Req.
<input type="text" value="2015"/>	<input type="text" value="Jan-Jul"/>	<input type="text" value="n/a"/>	<input type="text" value="4"/>	<input type="text" value="1"/>	<input type="text" value="0.5"/>
Optimal Start	Optimal End	Acceptable Start	Acceptable End		
<input type="text" value="2015-04-16"/>	<input type="text" value="2015-04-10"/>	<input type="text" value="2015-04-08"/>	<input type="text" value="2015-05-08"/>		

Scheduled Observing Runs

Start	End	Info	Instrument	Observers
2015-03-31	2015-04-01	1 bright night		[put observers here]

<p>P.I. Create New</p> <input type="text" value="Porter, Dallan - MMT Observatory"/>	<p>Abstract</p> <div style="border: 1px solid #ccc; padding: 5px; min-height: 100px;"> This is a test program submission. Creating from scratch. </div>
<p>Co-Investigators Create New</p> <input type="text" value="Add Co-Investigators"/>	<p>Special Instrument Requirements</p> <div style="border: 1px solid #ccc; padding: 5px; min-height: 100px;"> i.e. multi-slit, ap. plates, etc. </div>
<p>Instrument(s)</p> <input type="text" value="Add Another Instrument"/> <ul style="list-style-type: none"> aries blue red hectospec hectochele mmtcam swirc pisces mmt-pol maestro spol 	<p>Additional Notes</p> <div style="border: 1px solid #ccc; padding: 5px; min-height: 100px;"> Notes (i.e. dates unavailable or special requirements) </div>
<p>Proposal Type</p> <input type="text"/>	

SAVE CHANGES

DELETE PROGRAM

Figure 5. The program input and edit form.

MMTO Schedule Manager

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I. Program Title and Dates

Observing Program: [fixed] Dates Scheduled: [fixed]

P.I.
Firstname Lastname - Institution (email)

Colleagues
◦ Firstname Lastname - Institution

Remote Observing
 Yes, we will be observing remotely

Remote Observing Notes

Actual Observers
No Observers Scheduled.

Add New 'Actual Observer'

Req. Dorm Room

ADD

Have the observers used [instrument name] before? Yes No
 If 'yes', when was the last time?

Cryogenic Requirements

Comments

II. Observing Catalogs

Observers are expected to prepare catalogs of their observing lists prior to their run and to submit them well in advance of their scheduled observations. The catalog submission page can be found at hacksaw.mmt.org/catalogs/

III. Instrument

The MMTO maintains on-line documentation, to obtain up-to-date information on the spectrograph, detector status, etc., load the following URL: www.mmt.org/instruments/
 Note: Observers are strongly encouraged to obtain evening flats rather than morning flats given that weather or other issues could impact morning flats. Extended morning calibrations may require additional MMT staff support, please indicate below if you feel this is necessary.

Do you require twilight flats? Yes No If yes, || Evening || Morning || Evening & Morning

Do you require morning calibrations? || yes || No

If Yes, please specify

Figure 6. The observing form to be submitted by observers prior to their observing run.

MMTO Schedule Manager

Home Schedule Admin Tools

Almanac

Start Date End Date

Date	Sunset	end civil twilight	end nautical twilight	end astronomical twilight	begin astronomical twilight	begin nautical twilight	begin civil twilight	Moon Set	Moon Age	length night
Apr 17	18:51	19:18	19:48	20:19	04:27	04:58	05:24	16:52	-0.8	9.2
Apr 18	18:52	19:19	19:49	20:20	04:26	04:56	05:23	17:59	0.2	9.1
Apr 19	18:53	19:20	19:50	20:21	04:24	04:55	05:24	19:06	1.2	9.1
Apr 20	18:53	19:21	19:51	20:22	04:23	04:54	05:23	20:12	2.2	9.1
Apr 21	18:54	19:21	19:51	20:23	04:22	04:53	05:23	21:15	3.2	9.0
Apr 22	18:55	19:22	19:52	20:23	04:20	04:51	05:22	22:15	4.2	9.0
Apr 23	18:55	19:23	19:53	20:24	04:19	04:50	05:20	23:09	5.2	9.0
Apr 24	18:56	19:24	19:54	20:25	04:18	04:49	05:19	23:59	6.2	8.9

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Figure 7. The almanac generator.

Telescope Status (Telstat) Weather Display

Design changes were made to the weather display on the control room telstat monitors. After receiving feedback from users, we have enlarged the weather maps, added wind and temperature time series plots and enlarged the Skycam timelapse video.

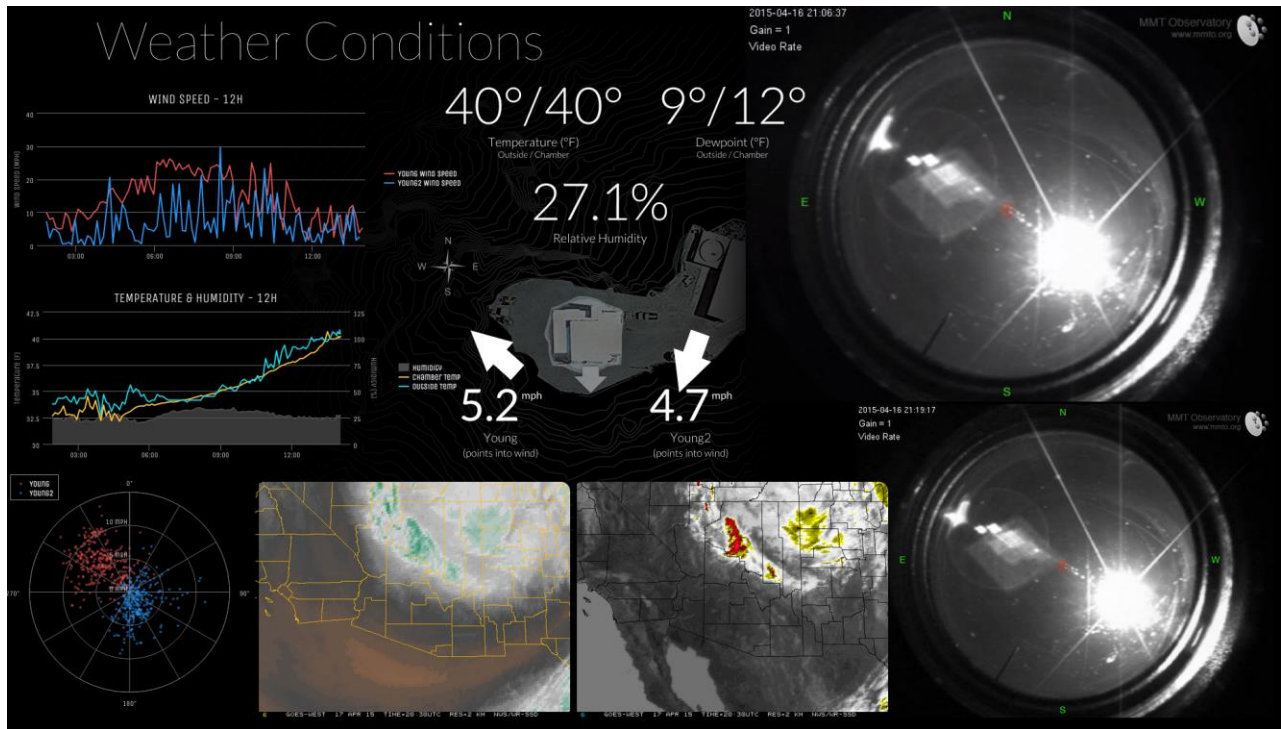


Figure 8. Screen shot of the updated weather display on the control room telstat monitors.

Oculus Virtual Reality Tour

Using an Oculus Developer Kit 2, D. Porter created a virtual tour of the MMT chamber for visitors to the MMTO table at the 7th annual Tucson Festival of Books, held March 14-15 on the UA campus. Visitors were able to experience what it is like to stand in the telescope chamber at sunset with the chamber doors open while the telescope is tipped down and uncovered. An estimated 500-700 people visited the table and experienced the virtual tour. Their response was very positive! A Google Earth flyby also played in a loop on a large monitor at the table, showing the location of the MMTO relative to the UA campus.

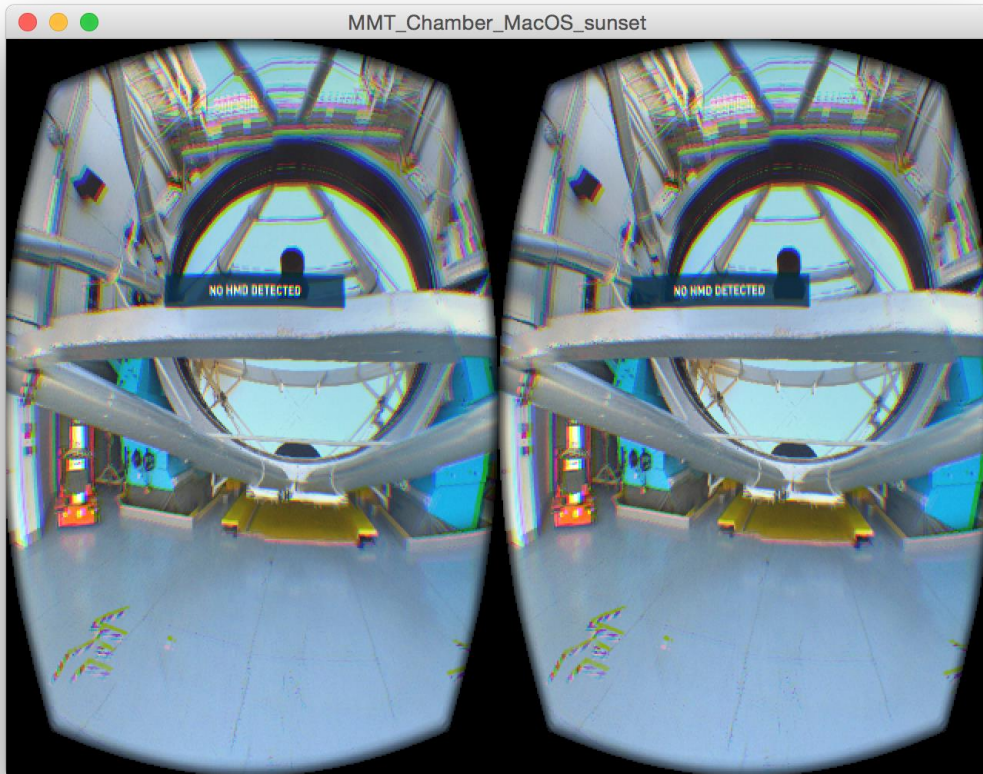


Figure 9. View of the telescope chamber as seen through the Oculus (headset shown).

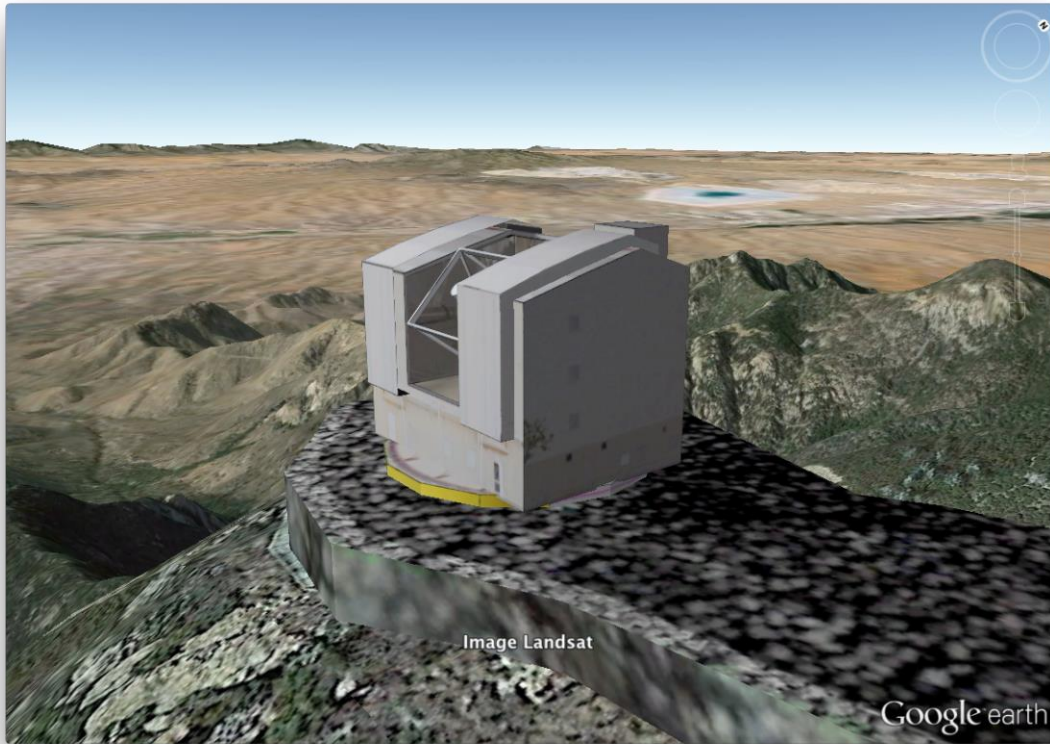


Figure 10. Screen shot of the Google earth flyby showing the MMTO on Mt. Hopkins with Tucson in the distance.

Weather and Environmental Monitoring

Weather Stations

Telescope operator reports stated that the wind monitor Young1 was displaying wind direction 90° different from Young2. Young1 was inspected and the following issues were discovered: a loose wire was found in the RS232 adapter box in the lower electronics enclosure and fixed, two questionable wires were re-terminated, the propeller on the wind sensor assembly was tightened after inspection revealed that it was loose, and each pin on the CPC connector was removed and checked for proper crimping.

The upper junction box was inspected and found to be in good condition. The second junction box was found to have ice in its lower half. The ice was removed and the box was resealed to prevent leakage. The unit was rotated through several rotations, and it displayed an accurate direction. If it fails again, it will be removed and taken to the campus shop for further repair of the internal potentiometer.

The chained ground fault interrupter (GFI) outlets were removed from the east flagpole. The outlets are now properly connected and still GFI protected. The chaining was causing the main GFI to trip on power cycles.

All Sky Camera and Web Cameras

A new power switch was added to the Skycam control box to allow cycling power of the outside NEMA box independent of the inside control box. This fixed the problem of the control signals not working after a power cycle to the whole assembly.

Seeing

Figures 11 and 12 present apparent seeing values, corrected to zenith, at the MMTO for the period of January 1, 2015, to April 1, 2015. These values are derived from measurements made by the f/5 and f/9 wavefront sensors (WFSs).

Figure 11 shows the time-series seeing data for January through March 2015. 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 12. The median f/5 seeing value is 0.90 arcsec while the median f/9 seeing value is 0.84 arcsec. The combined median seeing for the two WFS systems is 0.87 arcsec. The f/5 WFS data set is smaller than the f/9 WFS set with 491 points for f/5 versus 748 points for f/9, for a total of 1239 data points.

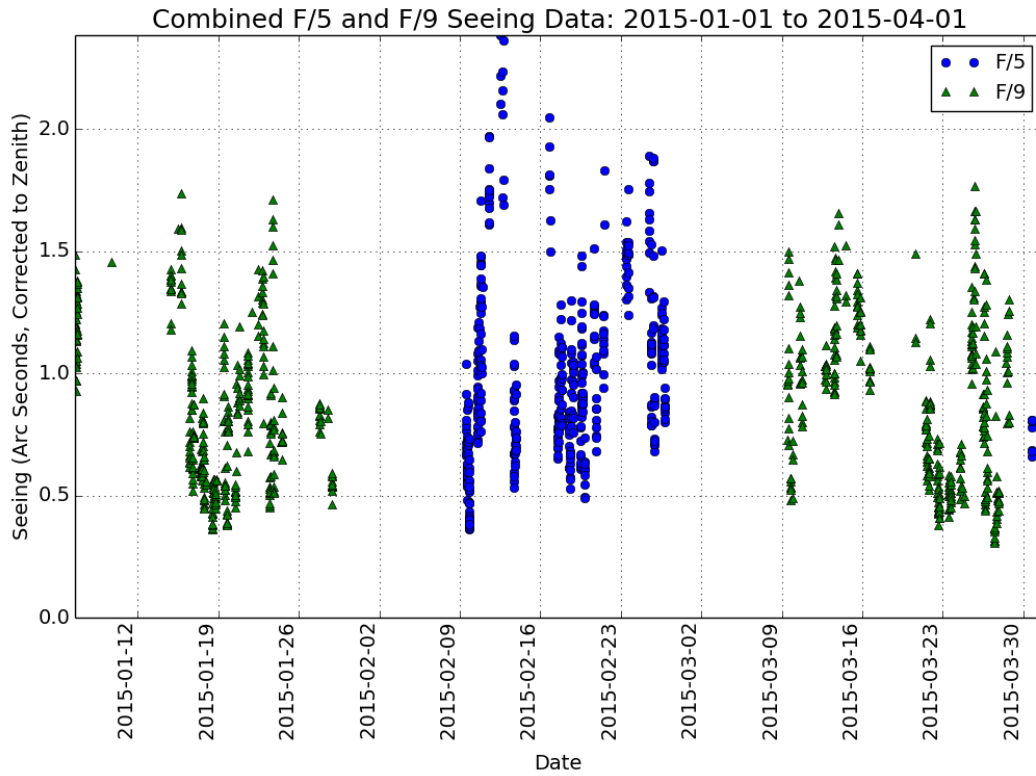


Figure 11. Derived seeing for the f/5 and f/9 WFSs from January through March 2015. Seeing values are corrected to zenith. f/5 seeing values are shown in blue, while f/9 values are in green. An overall median seeing of 0.87 arcsec is found for the 1239 combined (f/5 and f/9) WFS measurements made during this period.

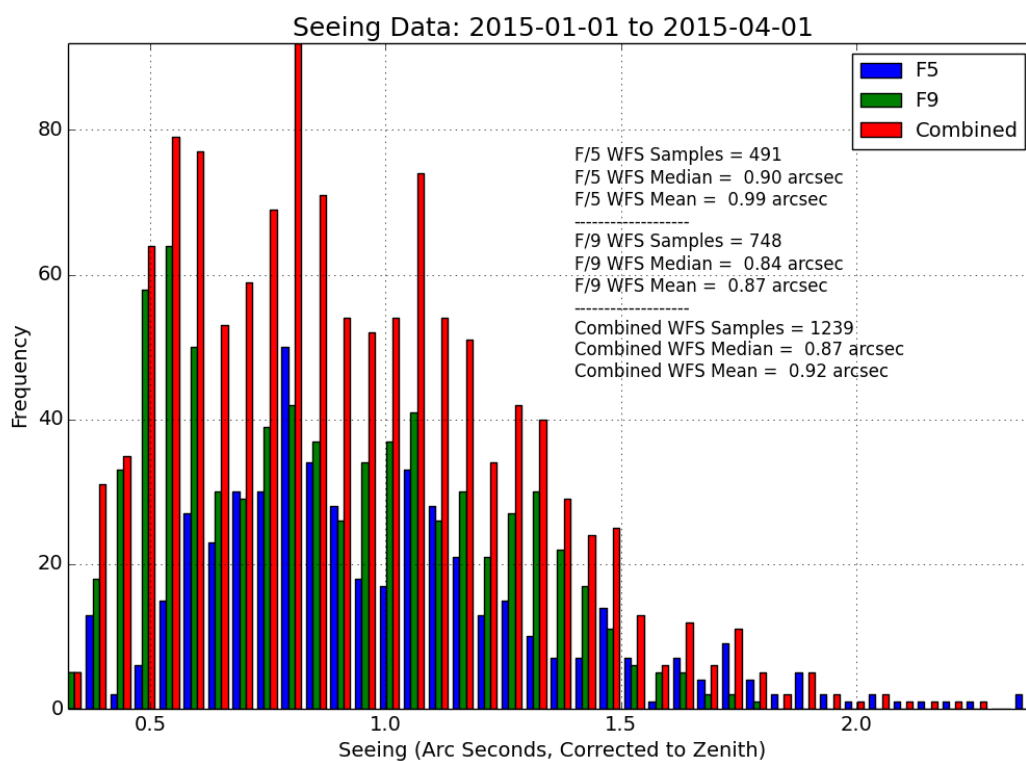


Figure 12. Histogram (with 0.1 arcsec bins) of derived seeing values for the f/5 and f/9 WFSs from January through March 2015. Seeing values are corrected to zenith. Median f/5 seeing is 0.90 arcsec while the median f/9 seeing is 0.84 arcsec. A combined (f/5 and f/9) median seeing value of 0.87 arcsec is found for the 1239 WFS measurements made during this period.

User Support

Remote Observing

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

Documentation

Nothing to report.

Public Relations and Outreach

Visitors and Tours

1/7/15 – F. Vilas, former MMTO director, was filmed at the MMTO by a film crew from NHK Japan TV, regarding her research on the target asteroid for the Hayabusa 2 mission launched last month.

2/10/15 – G. Williams conducted a tour of the MMTO for seven guests (engineers and a project manager) from CIDESI (Center for Engineering & Industrial Development) in Mexico and the director and an astronomer from the Institute of Astronomy at the UNAM in Mexico. Plans are for a 6.5-m mirror (same as the MMT) to be made at the UA Steward Obs. Mirror Lab for a telescope with which CIDESI and UNAM will be involved with the operation and management.

2/23/15 – Five guests from Monrad Engineering, Musco Lighting, and Benya Burnett Consultancy were given a tour of the MMTO by G. Williams. The group was composed of lighting engineers, designers, and manufacturers of lights that are environmentally sensitive and protective of the dark sky, benefitting observatories.

2/27/15 – X. Debeerst, a Belgian gallerist and noted collector of historical astrophotography, was given a tour of the MMTO by R. Ortiz. Mr. DeBeerst was a participant in an exhibition entitled “Astronomical: Photographs of Our Solar System and Beyond” held at the UA’s Center for Creative Photography in February and March.

3/7/15 – D. McCarthy led a tour of the MMTO for 9 prospective UA astronomy graduate students.

3/14/15 – The spring SAO Advisory Board meeting was held in Tucson. A tour of the MMTO led by G. Williams was provided for members on the final day of the meeting.

3/24/15 – Dr. D. Arion, four astronomy students, and a photographer from Carthage College in Kenosha, WI, were given a tour of the MMTO by Erin Martin, Senior Telescope Operator Specialist and alumnus of Carthage College. The group traveled to Tucson for an observing run at Kitt Peak Observatory. The photographer took pictures for a story about Erin to appear in the college magazine on how Carthage College helped her to achieve her current position at the MMTO.

Public Presentations

J. Hinz organized the 2015 Smithsonian Lectures on Astronomy held in Green Valley, Arizona. There were five lectures. G. Williams gave a talk entitled “The Giant Magellan Telescope: The Next Big Thing in Ground Based Astronomy” on January 14. J. Hinz gave a talk entitled “A Dark and Stormy Night: What Astronomers Do When Good Weather Goes Bad” on January 21.

March 14-15 – The MMTO participated in the nationally known seventh annual “Tucson Festival of Books” held on the University of Arizona campus. The MMTO table was run by volunteer staff members and was in the “Science City” portion of the festival. An estimated 500-700 people came by the table and took a virtual tour of the MMTO chamber using an oculus (see p. 22-23 for more details). Many informational handouts about the MMTO were also given out.



Figure 15. D. Gibson explains the oculus and virtual tour of the MMTO to an interested visitor before she looks through the oculus. The MMTO banner is shown hanging above the table.



Figure 16. Five children busily working on astronomy-related activity worksheets created by J. Hinz.

MMTO in the Media

A team of astronomers from UA and China, including X. Fan, discovered the brightest quasar and the most massive black hole known in the early universe. This research, which made use of MMT data, was accepted to *Nature* and issued as a press release on February 25 through eurekaalert.org. It appeared thereafter in many media outlets.

On March 30, UA researcher B. Frye released a result to the press entitled “Mystery Galaxies: Astronomers Discover Likely Precursors of Galaxy Clusters We See Today.” The data were taken in part with the MMTO and Hectospec, and the article appeared on *Science Daily* and other online news sources.

Site Protection

E. Falco and J. Hinz met with two members of the Town of Sahuarita Planning and Building Department on February 24 to discuss existing outdoor lighting codes and possible improvements.

G. Williams, E. Falco, and J. Hinz sent a letter on March 3 to the Mayor and City Council of Sierra Vista expressing support for modifications to their outdoor lighting code, with particular emphasis on restricting the brightness and color temperature of LED signage.

D. Blanco and J. Hinz staffed a booth at the Dark Sky Celebration at the Oracle State Park on March 21. The MMTO was presented with a certificate for their letter of support for the designation of Oracle State Park as an International Dark Sky Park.

Appendix I - Publications

MMT Related Scientific Publications

(An online publication list can be found in the MMT ADS library at <http://www.mmt.org/node/244>)

- 15-01 *Chandra* Survey in the AKARI North Ecliptic Pole Deep Field – I. X-ray Data, Point-like Source Catalogue, Sensitivity Maps, and Number Counts
M. Krumpe, et al.
MNRAS, **446**, 911
- 15-02 Model-Independent Evidence in Favour of an End to Reionization by $z \approx 6$
I.D. McGreer, A. Mesinger, V. D’Odorico
MNRAS, **447**, 499
- 15-03 On the Nature of Type IIIn/Ia-CSM Supernovae: Optical and Near-Infrared Spectra of SN 2012ca and SN 2013 dn
O.D. Fox, et al.
MNRAS, **447**, 772
- 15-04 Constraining the Galaxy Mass Content in the Core of A383 Using Velocity Dispersion Measurements for Individual Cluster Members
A. Monna, et al.
MNRAS, **447**, 1224
- 15-05 Measuring Consistent Masses for 25 Milky Way Globular Clusters
B. Kimmig, et al.
AJ, **149**, 53
- 15-06 Spectral Energy Distributions and Masses of 304 M31 Old Star Clusters
J. Ma, et al.
AJ, **149**, 56
- 15-07 An Optical Spectroscopic Survey of the Serpens Main Cluster: Evidence for Two Populations?
K.L. Erickson, et al.
AJ, **149**, 103
- 15-08 A Spin-down Clock for Cool Stars from Observations of a 2.5-billion-year-old Cluster
S. Meibom, et al.
Nature, **517**, 589
- 15-09 An Ultraluminous Quasar with a Twelve-Billion-Solar-Mass Black Hole at Redshift 6.30
X.-B. Wu, et al.
Nature, **518**, 512

- 15-10 A Machine-learning Method to Infer Fundamental Stellar Parameters from Photometric Light Curves
A.A. Miller, et al.
ApJ, **798**, 122
- 15-11 The Broad-Lined Type Ic SN 2012ap and the Nature of Relativistic Supernovae Lacking a Gamma-Ray Burst Detection
D. Milisavljevic, et al.
ApJ, **799**, 51
- 15-12 Brightest X-Ray Clusters of Galaxies in the CFHTLS Wide Fields: Catalog and Optical Mass Estimator
M. Mirkazemi, et al.
ApJ, **799**, 60
- 15-13 Simultaneous Multiwavelength Observations of Magnetic Activity in Ultracool Dwarfs. IV. The Active, Young Binary NLTT 33370 AB (=2MASS J13142039+1320011)
P.K.G. Williams, et al.
ApJ, **799**, 192
- 15-14 WISEP J004701.06+680352.1: An Intermediate Surface Gravity, Dusty Brown Dwarf in the AB Dor Moving Group
J.E. Gizis, et al.
ApJ, **799**, 203
- 15-15 Toward Characterization of the Type IIP Supernova Progenitor Population: A Statistical Sample of Light Curves from Pan-STARRS1
N.E. Sanders, et al.
ApJ, **799**, 208
- 15-16 Characterization of the Most Luminous Star in M33: A Super Symbiotic Binary
J. Mikolajewska, et al.
ApJ Lett, **799**, L16
- 15-17 Unshifted Metastable He I* Mini-broad Absorption Line System in the Narrow-line Type 1 Quasar SDSS J080248.18+551328.9
T. Ji, et al.
ApJ, **800**, 56
- 15-18 The Identification of Z-dropouts in Pan-STARRS1: Three Quasars at $6.5 < z < 6.7$
B.P. Venemans, et al.
ApJ, **801**, 11
- 15-19 Dwarf Galaxy Annihilation and Decay Emission Profiles for Dark Matter Experiments
A. Geringer-Sameth, S.M. Koushiappas, and M. Walker
ApJ, **801**, 74

- 15-20 Selection of Burst-like Transients and Stochastic Variables Using Multi-band Image Differencing in the PAN-STARRS1 Medium-deep Survey
S. Kumar et al.
ApJ, **802**, 27
- 15-21 The Next Generation Virgo Cluster Survey. VI. The Kinematics of Ultra-compact Dwarfs And Globular Clusters in M87
H.-X. Zhang, et al.
ApJ, **802**, 30
- 15-22 The Most Metal-rich Damped Ly α Systems at $z \geq 1.5$ I: The Data
T.A.M. Berg, et al.
PASP, **127**, 167

MMT Technical Memoranda / Reports

None

Non-MMT Related Staff Publications

- The Mass Profile and Shape of Bars in the Spitzer Survey of Stellar Structure in Galaxies (S4G): Search for an Age Indicator for Bars
Kim, T., Sheth, K., Gadotti, D. A., et al. (J. Hinz)
ApJ, **799**, 99
- Globular Cluster Populations: First Results from S4G Early-Type Galaxies
Zaritsky, D., Aravena, M., Athanassoula, E., et al. (J. Hinz)
ApJ, **799**, 159

Appendix II - Service Request (SR) and Response Summary: January - March, 2015

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, staff members create responses to address and eventually close the SR. These SRs and associated responses are logged into a relational database for later reference.

Figure 17 presents the distribution of SR responses by priority during the period of January through March 2015. As seen in the figure, the highest percentage (85%) of responses was “Important” priority. “Critical” and “Low” responses were 4% and 7% of the total number of SRs, respectively. “Information Only” SRs were the remaining 4%. There were no “Near-Critical” 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 56 SRs during this three-month period.

Service Responses (By Priority): 56 Total

Data from 2015-01-01 to 2015-04-01

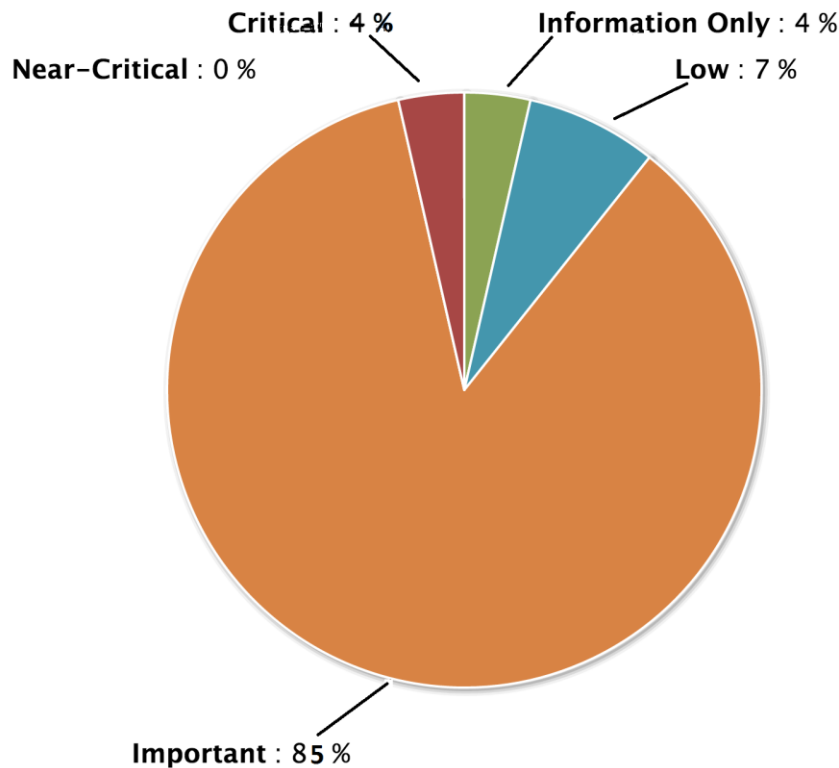


Figure 17. Service Request responses by priority during January through March 2015. The vast majority (85%) of the responses are related to SRs of “Important” priority, while 7% were “Low,” 4% were “Critical,” and 4% were “Information Only.” There were no “Near-Critical” responses.

Figure 18 presents the same 56 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. The majority of the responses from January through March were related to the “Building,” “Telescope,” and “Weather Systems” categories with 15, 10, and 9 responses, respectively. Responses also occurred in the “Cell,” “Computers/Network,” “Logs,” “Software,” “Support Building,” and “Thermal Systems” categories.

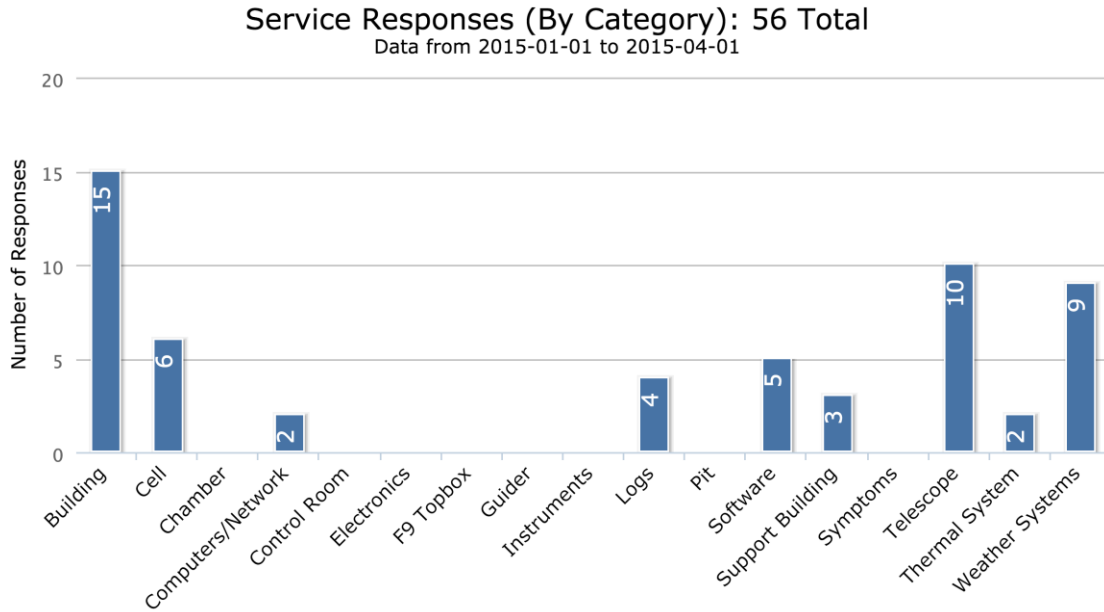


Figure 18. Service Request responses by category during January through March 2015. The majority of responses were within the “Building,” “Telescope,” and “Weather Systems” categories.

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

January 2015

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>*Lost to Instrument</u>	<u>**Lost to Telescope</u>	<u>***Lost to Gen'l Facility</u>	<u>****Lost to Environment</u>	<u>Total Lost</u>
MMT SG	25.00	294.20	187.10	0.00	0.00	0.00	0.00	187.10
PI Instr	3.00	35.80	3.00	0.00	0.00	0.00	0.00	3.00
Engr	3.00	35.00	29.00	0.00	0.00	0.00	0.00	29.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	31.00	365.00	219.10	0.00	0.00	0.00	0.00	219.10

Time Summary

Percentage of time scheduled for observing	90.4
Percentage of time scheduled for engineering	9.6
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	60.0
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)	0.0
Percentage of time lost	60.0

February 2015

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>*Lost to Instrument</u>	<u>**Lost to Telescope</u>	<u>***Lost to Gen'l Facility</u>	<u>****Lost to Environment</u>	<u>Total Lost</u>
MMT SG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI Instr	27.00	301.40	123.05	1.00	7.25	0.75	0.00	132.05
Engr	1.00	10.80	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	28.00	312.20	132.05	1.00	7.25	0.75	0.00	141.05

Time Summary

Percentage of time scheduled for observing	96.5	* <u>Breakdown of hours lost to instrument</u>
Percentage of time scheduled for engineering	3.5	0.50 Aries readout problem
Percentage of time scheduled for sec/instr change	0.0	0.50 Aries imager crash
Percentage of time lost to weather	42.3	** <u>Breakdown of hours lost to telescope</u>
Percentage of time lost to instrument	0.3	0.75 Initializing hexapod
Percentage of time lost to telescope	2.3	1.50 f/15 contamination
Percentage of time lost to general facility	0.2	5.00 M1 panic and loss of air control
Percentage of time lost to environment (non-weather)	0.0	*** <u>Breakdown of hours lost to facility</u>
Percentage of time lost	45.2	0.75 Repowering Aries from noisy to quiet

Year to Date February 2015

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>Lost to Instrument</u>	<u>Lost to Telescope</u>	<u>Lost to Gen'l Facility</u>	<u>Lost to Environment</u>	<u>Total Lost</u>
MMT SG	25.00	294.20	187.10	0.00	0.00	0.00	0.00	187.10
PI Instr	30.00	337.20	126.05	1.00	7.25	0.75	0.00	135.05
Engr	4.00	45.80	38.00	0.00	0.00	0.00	0.00	38.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	59.00	677.20	351.15	1.00	7.25	0.75	0.00	360.15

Time Summary

Percentage of time scheduled for observing	93.2
Percentage of time scheduled for engineering	6.8
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	51.9
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	1.1
Percentage of time lost to general facility	0.1
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	53.2

March 2015

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>*Lost to Instrument</u>	<u>**Lost to Telescope</u>	<u>***Lost to Gen'l Facility</u>	<u>****Lost to Environment</u>	<u>Total Lost</u>
MMT SG	21.00	212.90	79.20	0.00	1.16	0.00	0.00	80.36
PI Instr	9.00	94.90	49.20	0.00	1.00	0.00	0.00	50.20
Engr	1.00	10.70	10.70	0.00	0.00	0.00	0.00	10.70
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	31.00	318.50	139.10	0.00	2.16	0.00	0.00	141.26

Time Summary

Percentage of time scheduled for observing	96.6
Percentage of time scheduled for engineering	3.4
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	43.7
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.7
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	44.4

** Breakdown of hours lost to telescope

0.50 WFS camera problems
0.50 f/15 contamination
1.00 East elephant hose tear
0.16 Primary mirror panic

Year to Date March 2015

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>Lost to Instrument</u>	<u>Lost to Telescope</u>	<u>Lost to Gen'l Facility</u>	<u>Lost to Environment</u>	<u>Total Lost</u>
MMT SG	46.00	507.10	266.30	0.00	1.16	0.00	0.00	267.46
PI Instr	39.00	432.10	175.25	1.00	8.25	0.75	0.00	185.25
Engr	5.00	56.50	48.70	0.00	0.00	0.00	0.00	48.70
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	90.00	995.70	490.25	1.00	9.41	0.75	0.00	501.41

Time Summary

Percentage of time scheduled for observing	94.3
Percentage of time scheduled for engineering	5.7
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	49.2
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	0.9
Percentage of time lost to general facility	0.1
Percentage of time lost to environment	0.0
Percentage of time lost	50.4