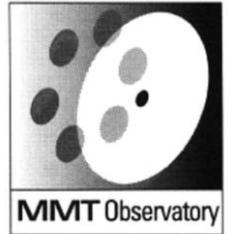


Smithsonian Astrophysical Observatory & Steward Observatory, The University of Arizona



Smithsonian Institution &
The University of Arizona*

Quarterly Summary

April - June 2018

MMT Observatory Activities

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

Administrative

Program Management

Engineering meetings were held on April 19 and May 17.

The MMT Council meeting was held on May 15.

Staffing

After nearly 10 years with MMT, Marilyn Guengerich retired on June 30. She will continue as a Technical Expert if needed.

Interviews were conducted in May for an Administrative Associate position. Susan Wahl accepted the position and started on June 18.

Nick Silvestri, a computer science major with astronomy minor, began work in May as a student software developer with the software group. Nick is a senior, and he plans to continue for a Masters in Computer Science at the UA.

Scheduling

Quarterly Reports

Strategic Planning

Reports and Publications

There were 18 peer-reviewed publications during this reporting period. See the listing of publications in Appendix I, pp. 25.

Presentations and Conferences

Six MMTO staff members (G. Williams, B. Weiner, J.D. Gibson, W. Goble, R. Ortiz, and T.E. Pickering) attended the *SPIE* Astronomical Telescopes and Instrumentation 2018 Conference held June 10-15 in Austin, Texas.

J.D. Gibson and R. Ortiz gave oral presentations, and the following MMT SPIE papers were presented:

Developing an infrared APD array camera for near-infrared wavefront sensing

A. Butko et. al.

SPIE, **10702**, 132

Queue Scheduling software at the MMTO

J.D. Gibson et. al.

SPIE, **10707**, 36

Re-aluminization of the 6.5m primary mirror at the MMT Observatory

W. Goble et. al.

SPIE, **10700**, 155

Developing new adaptive secondary electronics for the MAPS project

P. Hinz et. al.

SPIE, **10703**, 226

Upgrading the MMT AO system with near-infrared Pyramid wavefront sensor

S. Lui et. al.

SPIE, **10703**, 94

Lessons learned from wet washing the 6.5m MMT primary mirror in-situ

R. Ortiz et. al.

SPIE, **10700**, 2

Seeing statistics at the MMT Observatory 2012-2017

T. Pickering et. al.

SPIE, **10700**, 196

Upgraded wavefront sensor control and analysis software for the MMT Observatory

T. Pickering et. al.

SPIE, **10700**, 230

The MMT Observatory: Entering a New Era of Scientific Discovery

G.G. Williams

SPIE, **10700**, 99

B. Weiner also attended SPIE, and he presented on queue scheduling and remote/automated operation of Arizona telescopes.

Development of the Arizona Robotic Telescope Network

B. Weiner et al.

SPIE, **10704**, 107042H (2018)

T. E. Pickering was invited to, and he attended, the Python in Astronomy meeting hosted by the Flatiron Institute's Center for Computing in Astronomy in New York, NY on April 30-May 4. This is an annual meeting that brings together a mix of Python users and developers from the astronomy community for a week of talks, knowledge sharing, and collaboration. The two main outcomes of the meeting that pertain to the MMTO are that T. E. Pickering is now the lead developer for the AstroPy-affiliated package, 'specutils', and is on the Science Organizing Committee for the 2019 meeting.

Safety

A safety meeting was held on May 31. Some of the topics discussed were replacing the pit ladder with a more accessible hatch and high-angled stairs. Measurements, and a timetable for replacement, will be completed by the next meeting, August 7. Smithsonian will be contacted about the potential for a facilities project. The fall-arrest system for M1 washing and moving around the cell will be inspected. Vendors will be notified when this happens. Also, roof tie-off points will be reassessed and modified by the contractors; however, more information is necessary before any modifications are considered.

B. Comisso attended the Steward Observatory Safety Council meeting on April 4. Discussions of interest included soldering with lead-based solder, two-way radio usage while driving, and air quality (mold) in MMTO town offices.

Training

ReechCraft Access Solutions brought their PL60 power lift to the summit to see if it would be useful for a variety of tasks. The lift was used to access the weather stations located on the east and west flagpoles, but was short of comfortably reaching the east weather station and the cement flagpole base that is located at the west flag pole hampered positioning. The lift was also used in the chamber to access whether the lift would be a valuable asset to reach the optical support structure (OSS) for disassembly during aluminization. The lift was also moved close to the mirror to see if it could reach the mid-baffle. Although it would take some maneuvering, the PL60 would work in safely removing the mid-baffle. After the demonstration, there was a discussion about the feasibility of using the lift. Although there were many benefits, being light and easily transported around the summit, it had one major flaw: it uses a 4-foot extension to raise up and down. If one of these extensions should slip out of the operator's hand it could do extensive damage to the telescope or even to personnel. ReechCraft was contacted about this concern, and they said they could tether the extension. At this time, we do not feel comfortable with the ReechCraft PL60 as a possible solution to our current needs.

Training exercises were performed with the summit stokes basket and backboard system to determine whether or not there is a way to fit the system into all the standard vehicles that are brought to the summit. We found that we have medical transport capability with all of the standard vehicles that are driven to the summit, namely, the town Ford Explorer, the basecamp Ford Expedition, Jeep Liberty, Jeep Cherokee, and Chevrolet Colorado.

The Blackline safety device has been delayed. Starting with a couple of devices to test effectiveness, the telescope operators should be fully operating the device by July.

Safety Inspections

The 2018 MMT summit and basecamp chemical inventory was started in May, and is expected to be completed by the beginning of July.

Procedures and Protocols

Personal Protective Equipment

Interlock System

Primary Mirror

The transverse counterweight controller and power supply were removed and sent to campus for repair. Initial testing of the power supply revealed no problems; all voltages were present. The schematics for the power supply appeared to match the “as built” unit. The same could not be said for the controller. One set of schematics were for a future design of the controller. They included encoder inputs for both east and west transverse counterweights and circuit cards for the signals. An extensive search of the database revealed an accurate schematic for the “as built” controller. At the same time, a wire wrap controller test card was found in the test equipment locker. With the card, we were able to inject logic bits simulating computer inputs. All functions of the controller appeared to work properly except relay K1. This relay controls the directional movement on the east transverse counterweight, which was the failure mode on the telescope. The relay was replaced and successfully tested. The controller and power supply will be installed and tested during shutdown.

Coating & Aluminization

Ventilation and Thermal Systems

Hardpoints

Actuators

The OEM cell crate power supply was brought to campus to remove and replace the 5V and +/-12V power supply. Because of power fluctuations, this supply was swapped out and a new one was installed. While performing a function check, we discovered the -12V supply was producing -19V. Upon inspection, it was discovered that the load resistors for the -12V had not been installed in the supply. The manufacturer was contacted, and a new supply was ordered.

On June 27, the primary mirror actuator (A021) in location 139 was replaced with a spare actuator (A003). This was done to address an issue with the auxiliary axis on actuator A021. The removed actuator will be tested and repaired when resources permit.

Secondary Mirrors

f/9

f/5

f/15

Baffling

Hexapods

f/5 hexapod

f/9 and f/15 hexapod

The f/9 hexapod CPU card was tested in town with an RS-232 cable and a 5VDC power supply. Commands were sent over the serial link with limited replies, but we were not able to get the configuration file version. Downloading the installed file is still being researched. Notes in an engineering folder seem to indicate the operational card had a configuration file installed, but no mention of where the file is located.

Optics Support Structure

In April, A. Williams started creating a SolidWorks model of the primary mirror cell. This work is a continuation of the SolidWorks assemblies he has created of both the single and dual primary mirror actuators. Due to scattered and incomplete documentation, the creation of an accurate 3D digital model has been difficult. This work will continue as time permits.

Truss

Secondary Hub

Spider Arms

Neutral Members

Pointing and Tracking

Azimuth

Elevation

During this reporting period, work progressed on the elevation oscillations investigations. Accelerometers have now been mounted on the east/west elevation drive motors, and a Raspberry Pi has been employed to gather and record the accelerometer data for later storage over the network.

With the help of the software group, our tracking error plot utility is now able to plot accelerometer data time stamped with our tracking error plots. So far we have been able to confirm an anomaly in the west motor when the telescope balance is incorrect. Two example plots are shown in Figure 1 & 2. Currently we are studying the west motor anomaly and trying to relate the acceleration peaks to a mechanical or electronic issue.

Filename: /mnt/Logs/mount/slewlog/rd_20180704_002502
Length: 120.24
Peak to Peak: 0.60311556
Rate: 100
RMS Error: 0.05379281215793306

Start: 1530689102224.317
Start Alt: 53.3450912433
Start Az: 323.9134876973
Start Rot: -9.0516623253
Start R.A.: 16.20844049
Start DEC: 56.11598223

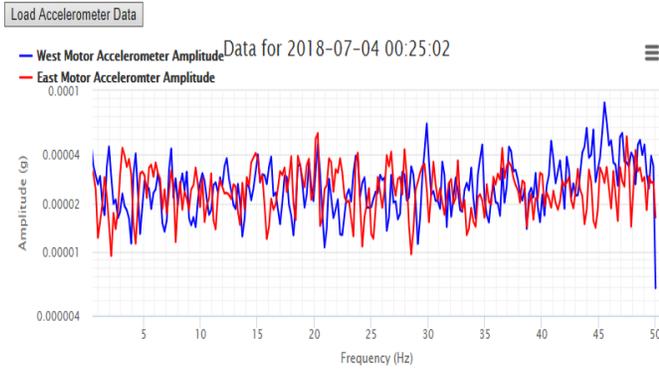
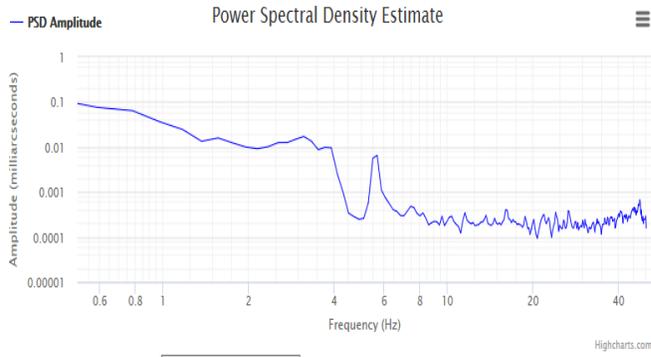


Figure 1: Elevation tracking and accelerometer tracking plots.

Filename: /mnt/Logs/mount/slewlog/rd_20180704_223501
 Length: 120.24
 Peak to Peak: 1.08513792
 Rate: 100
 RMS Error: 0.14189446863567587

Start: 1530768901294.362
 Start Alt: 38.549372164
 Start Az: 327.1151225036
 Start Rot: -57.1721798546
 Start R.A: 12.63582444
 Start DEC: 62.13129898

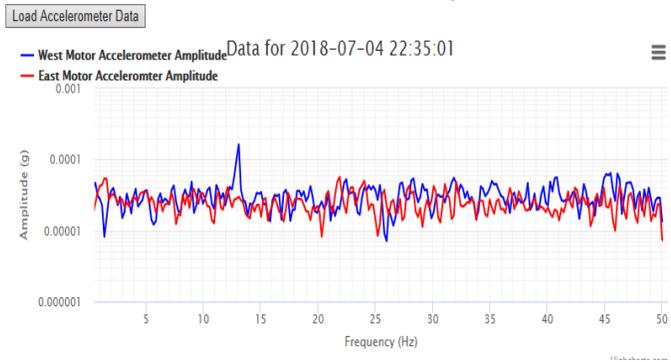
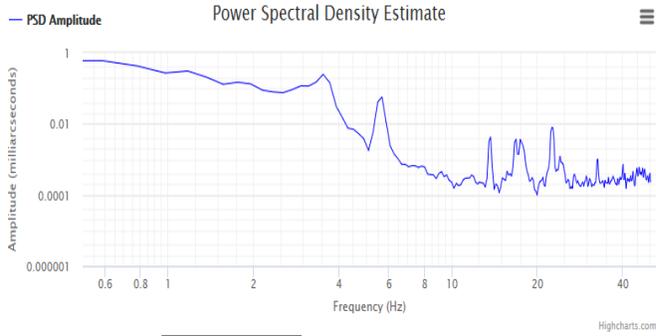
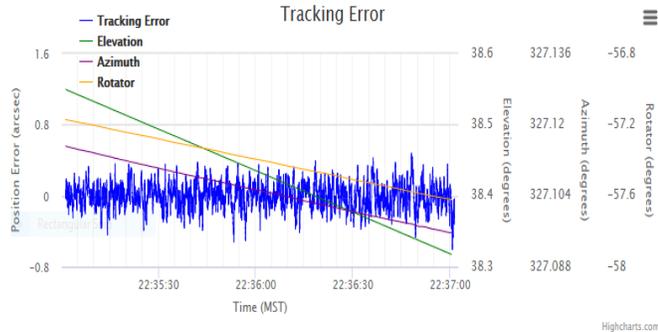


Figure 2: Elevation tracking and accelerometer tracking plots.

Rotator

Axis Encoders

Extensive work has been done on the Inductosyn encoder power supply, which powers both the azimuth and elevation encoders. There have been numerous reports of oscillation in azimuth, and the fix seemed to be reseating the connectors on the back of the power supply. The documentation for the power supply was less than optimal, so continuity voltage checks were taken so that proper documentation could be created. All documentation is now current for the Inductosyn encoder power supply and for the cabling to both the azimuth and elevation encoders. New connectors are on order so the keying of the connectors will prevent swapping of the azimuth and elevation cables in the future. Also, the new connectors will be on both the power supply and associated cables. All cables

will have correct pins, and all connectors will be fully populated to insure proper seating of the cabling. This work will be completed during the next trimester over the second summer shutdown.

Work has also begun on the azimuth and elevation axis absolute encoders. The Inductosyn absolute encoders on both axes contain a resolver-to-digital chip that has become harder to obtain over the years. The main issue is that the 40-pin dip package, for all practical purposes, has become obsolete. Research on replacements yielded a 44-pin Plcc package that can be obtained, which will aid in keeping encoder spares at a level that will allow telescope operations to continue while new axis encoders are identified.

During the start of this project it was noted that the original encoder PCBs had a few yellow wire modifications and component additions over the last few years. A decision was made to redesign the entire set of printed circuit boards containing the obsolete chips in order to allow interfacing of the new 44-pin package, as well as incorporate all yellow wire and component changes into one updated PCB with updated schematics. This task proved to be time consuming due to lack of up-to-date documentation. The electronics group attempted to locate all encoder interface documents showing signal paths from the encoder all the way down to the drive room. However, the documents could not be located, so all the signed wires were traced using a DVM (digital voltmeter) to generate as-built drawings.

The goal was to have the new encoder electronics ready to test by the July 24 summer shutdown. However, the effort spent locating and generating documentation cut into the new board design completion time. As a stopgap measure, a surfboard design was chosen. K. Duffek created a surfboard CCA that will allow the installation of the surface mount ADS280ALD. Along with populating the surfboard, ribbon cable to the IC chip clip testing cable needed to be fabricated to test the new packaging. The surfboard was designed to convert a 44-pin Plcc into a 40-pin dip socket. This design will enable ample spare chips to be installed into the original encoder PCBs, thereby increase serviceability of the encoders, as well as provide time to complete checkout of the new encoder boards.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on the MMT for 25% of the available nights from April 1 – June 30, not including the 2-week shutdown for shutter seal work. Approximately 60% of those nights were scheduled with the Blue Channel Spectrograph, 10% with Red Channel, and 30% with SPOL. Of the 173.5 hours that were allocated for f/9 observations, 28% were lost due to weather. Instrument, facility, and telescope problems accounted for 1% of lost time. Blue Channel lost 38% of its time to bad weather, with Red Channel losing 22%, and SPOL losing 11%.

f/5 Instrumentation

MMIRS was on the telescope from April 25 – May 10, with observations run exclusively in queue mode. The run consisted of 9 programs, with 6 new slitmasks, and 180 submitted targets. All masks were cut at SAO with the Binospec laser-cutter. No mask changes were needed due to the small

number of requested masks. Of the 137.9 hours allocated, 39.6 hours were lost to weather (approximately 29%), and 3.75 hours were lost to primary mirror or instrument issues (2.7%). We obtained 99% of the objects labeled as priority 1 by the principal investigators, with 51% of priority 2 targets completed, and 15% of priority 3 targets completed. Observations for these programs will continue in the July 2-4 scheduled run.

B. Weiner managed user interaction with Binospec, including user uploaded catalogs, slitmask design, and data access, for Binospec's second and third regularly scheduled science runs in April and June. He also planned daily slitmask exchanges and nightly schedules for the observers, to aid in night-time decisions and to manage queue priorities and observability issues for a number of targets.

The fiber positioner was serviced by a team at SAO from May 1 to May10, and Hecto is ready for use. The guide probes were not positioning properly so the guider rails and bearings were cleared and polished. There was also a problem with the Y-axis not achieving the proper speed. The wiring and sensors were inspected, and the lubricant was replaced with lighter weight grease. Finally, the Z-axis was getting stuck "hunting" for a position, so the motor amplifier was changed and the belt was replaced.

A pressure sensor was added to the Binospec purge air compressor tank. This sensor is connected to the BAS20 controller in the dry air cabinet, and the tank pressure is recorded in the `air_cabinet_background_log` as `air_cabinet_binospec_air_purge`. An annunciator check will be added in the near future to notify staff if the tank pressure drops below an acceptable level.

f/15 Instrumentation

The critical path for the MAPS program continues to focus on the development of voice coil actuator (VCA) electronics. Several revisions of the VCA electronics package have been made in order to improve performance and simultaneously reduce heat dissipation. Modifications to the coil cross-section (square wires) and new coil caps to reduce the coil-magnet gap distance have increased the maximum applied actuator force. Redesign of the electronics board to run off a 3V power supply rather than a 5V supply will significantly reduce the necessary heat dissipation, hopefully allowing for passive heat dissipation only (no liquid cooling). All modifications need to be tested and verified prior to approval of full scale production for the DM336.

Although the basic architecture of the actuator (inner loop) controller has been well defined, the decision must still be made whether to proceed with old "force feedforward" design or a new one based on integrator gains scheduling. The new design promises greater performance, robustness, and a reduced need for recalibration of the DM336 on the test stand. The old design has the benefit of familiarity and proven reliability. The outer loop (atmospheric correction) has been completed and is being evaluated using the SPAM simulation to estimate Strehl and image correction.

In May, the front side aluminum coating of the thin-shell deformable mirror was stripped, and it will be re-coated in August. After the stripping and cleaning of the optical side was completed, the magnet side of the thin shell was coated with aluminum. An environmental chamber was delivered to Steward in order to perform low temperature tests with the new actuator design. All of the original f/15 actuators have been de-integrated from the cell, during which six were destroyed in the process. The goal for the upcoming quarter is to begin functional testing with the 19 actuator system up and running.

Phase II of the MAPS proposal was submitted to NSF on April 23. Funding has not yet been approved, although there have been informal indications that some additional funding will be provided. This funding will be contingent upon the successful demonstration of an operational VCA and associated electronics package, making the development and demonstration of the actuator electronics even more critical.

Instrument Handling

Topboxes and Wavefront Sensors (WFS)

f/5 WFS

f/9 Topbox

Due to continuing problems with the videoscope, which is currently out of service, the camera was removed for repair. Initial contact with Video Scope International indicated that they had modified another manufacturer's system and no longer provided service for our obsolete system. A data plate on the electronics box indicated Dage-MTI as the original manufacturer. Contact was made with their repair department, and an RMA was requested. They indicated the camera is obsolete, but they could evaluate the system for reparability. The camera system has been shipped, and we are awaiting word from the repair personnel.

Due to a failure with the f/9 acquisition camera within the f/9 topbox, the remote observers had no way to remotely see a live view of the target as they normally do. As a workaround while the camera was out for repair, a new web-based tool was created to intercept raw Steward Observatory Guider (SOGuider) images, auto-scale the levels from 16bit to 8bit, convert them into a browser-friendly format (PNG), and push them immediately to all web browsers that have a new webpage open.

This technique of intercepting and processing the images in near real-time required the creation of 1) a new service to run on Hacksaw to watch for guider images to appear from the guider server, perform the conversion, and finally publish an event notification to the network (Figure 3) and 2) a web-based client front-end hosted on Ops that is publicly accessible for remote observers in addition to the telescope operators. This webpage contains JavaScript that connects back to Ops using a websocket, and subscribes to the notification events published by the service on Hacksaw. When the browser receives an event notification, it immediately downloads the latest processed image, keeping the image as new as possible without any browser "polling". This work-around proved to be a sufficient interim solution while the camera is being repaired. So far, this new webpage has been used for multiple f/9 runs without any major problems or lost time.

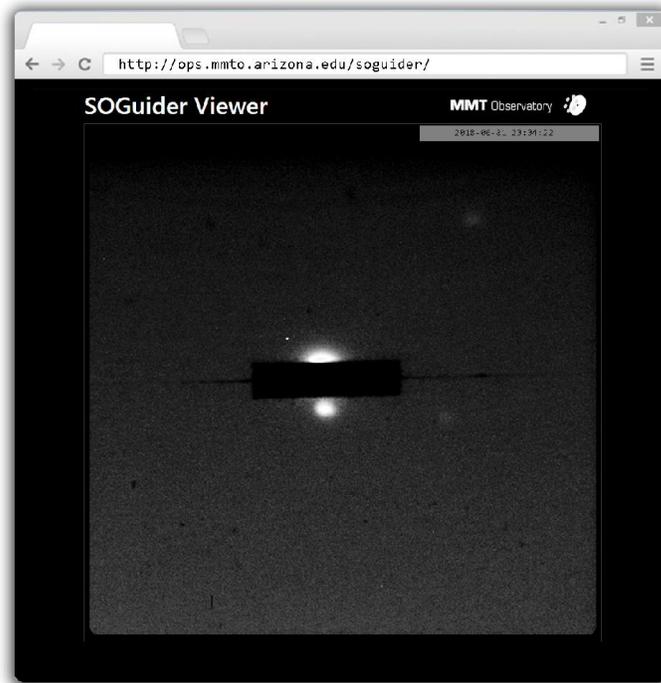


Figure 3: A screen capture of the new SOGuider Viewer webpage while a target star is over the spectrograph slit.

Natural Guide Star (NGS) Topbox

Laser Guide Star (LGS) Topbox

Facilities

In May, the six cranes at the summit passed their annual inspection, and they successfully passed.

Main Enclosure

In late March, the flexible compressed air line for the instrument air caster that had previously burst, was replaced with a new copper line, which was routed to the chamber floor.

In May, SI Facilities funding was secured to upgrade electrical panels in the facility. A start date for the project has not been finalized.

On June 18, in preparation for the shutter seal replacement, the Blue Channel spectrograph and f/9 secondary mirror were removed, and the telescope was parked at horizon pointing and covered with a tarp. Kappcon, Inc. then began the process of replacing the EPDM material used to seal the two

MMTO shutter halves when closed. The horizontal seal section was replaced using a custom access platform borrowed from the LBT Observatory (as seen in figure 4). The vertical seal section was replaced using a rented boom lift. Work was completed on June 26, and after completing other maintenance tasks the telescope was returned to normal nighttime operation on June 30.



Figure 4. Shutter seal replacement using a custom access platform.

While the telescope was closed for shutter seal replacement, the PVC compressed air lines in the pit were replaced with copper pipe. As time permits, the compressed air piping will be extended to the primary mirror actuator test stand in 4West. This will eliminate the need for the dry nitrogen cylinders presently used to operate the actuators on the test stand.

A. Williams began developing a design to adapt the Binospec lifting jacks, provided by SAO, to the MMT instrument lift. The Binospec jacks are intended to replace the jacks currently used to level the instrument lift deck because these jacks seem to have a much shorter service life than originally anticipated. Storage of the Binospec jacks has always been awkward, so A. Williams is designing a storage cart as well.

The generator currently in use at the ridge is in poor condition. Its existing fuel system needs to be replaced but there is no funding at this time. The option of using a new generator with a temporary fuel tank is being explored, although the temporary tank might be smaller than desired.

Instrument Repair Facility (IRF)

Contractors removed the air handlers from the IRF in preparation for a cleaner environment for Binospec repairs.

MMIRS was moved from the IRF to the main enclosure on April 18 and installed on the telescope on April 25.

Common Building

Work in the laser cutter room for Binospec masks is expected to continue until July.

Bowl Dorm

General Infrastructure

On May 29 the contaminated soil from air compressor oil migration at the summit was picked up at the base camp. On June 19, after the Forest Service approved our request to use bio-remediation on the soil around the air compressor, soil treatment began by filling the hole (approximately 96" x 32" x 24") with 100 gallons of potable water, mixing in five gallons of Micro-Blaze, and then filling in the hole with another 100 gallons of water. The soil was kept moist for two weeks, and then another application of Micro-Blaze/water solution was applied on July 3. The soil has been kept moist since. Southwest Hazard Control will be taking soil samples on July 20. If successful, no further treatments will be necessary.

Computers and Information Technology

S. Schaller performed the usual monthly backups of mmto and hacksaw, along with reboots to pick up new kernels and virtualbox drivers. He installed pending updates on nas1, nas2, and nas3, and also upgraded vmhost1, vmhost2, vmhost3, and vmhost4 to Fedora 28. S. Schaller continued work on the f/9 topbox control project, changed the logic for annunciator green alerts to reduce clutter, and also deleted the annunciator checks for the shop_hpda, which has been permanently removed. He added timeouts to the hexapod_linux code in some places where it used to hang when it lost the network connection to the umac, but there are still more places where timeouts need to be added.

B. Lara and C. Oswald, two student hires at the MMTO, continued their work on a variety of topics. B. Lara worked on developing Python code as part of the ZMQLogger distributed logging system for querying data through a USB/serial connection on a Raspberry Pi computer. She developed this code initially for the Edgetech dew point sensor that will be incorporated in the upgraded compressed air system at the MMT. Additional code was also added to the ZMQLogger library for an airflow meter for this compressed air system. Python code was written to incorporate BACnet protocol into ZMQLogger clients. B. Lara also worked on thermal movies for the MMT primary mirror. She is doing an internship at Google this summer and plans to return to work part-time as a student hire at the MMT in the fall semester.

C. Oswald worked primarily on creating a device database for the MMT, listing the network-connected devices located both on the mountain and the campus offices. This involved the creation of both a Google Sheets spreadsheet, containing details of the devices, and numerous interactive maps (done on Google Drawings) that showcase the location of the devices. C. Oswald will be graduating this year, and his last day at the MMTO is July 27.

N. Silvestri has been working on a variety of software topics for the MMTO. He continued the work on the ZMQLogger code, implementing classes for the Vaisala2 weather station. This code will be

implemented in a new `vaisala2-pi` Raspberry Pi with a USB/serial connection to the Vaisala2 device, replacing its existing external Lantronix device server. He also refactored the ZMQlogger PHP code to reduce code duplication. He worked on an `air-cabinet-bacnet` logger service. He has also been working with D. Gibson and D. Porter on a webpage to monitor Binospec temperatures, dew points, and relative humidities. A similar web page will be developed for the MMIRS instrument. He also wrote code to monitor and diagnose our R.M. Young wind anemometer, which is currently being repaired.

Computers and Storage

Several new features of the Observatory Manager (OM), formerly referred to as the “Scheduler Database”, have finally been implemented during this past quarter (Figure 5). A significant amount of time has been invested in coding the framework for creating, editing, and publishing telescope schedules, which will eliminate the labor-intensive manual steps that M. Guengerich currently uses. We have set the goal to completely schedule the 2018C trimester using the Observatory Manager.

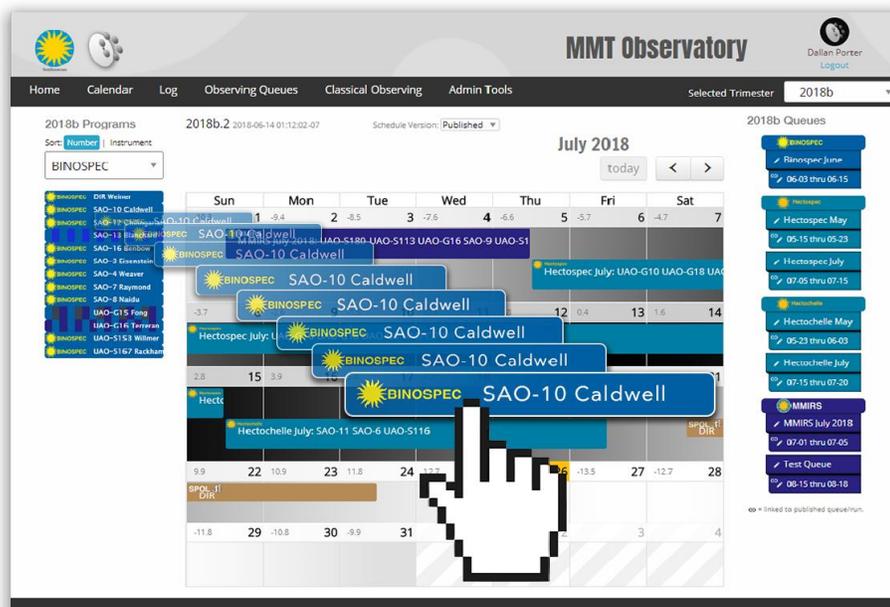


Figure 5: Observatory Manager will help distribute final observer’s schedule more efficiently and effectively.

Another OM milestone is the addition of raw data distribution to the observer catalogs (Figure 6). Working with the software team at SAO, newly acquired raw images from both Binospec and MMIRS are detected automatically by the OM, and become available for PIs and observers to download immediately from their catalog interface with the OM. Since some data sets are huge (in terms of file size), an archiving service on DBShare was written to allow observers to trigger an archive download of the entire set, which triggers a background process to tar and compress all files into a single large download. When the archive process completes (this can take over an hour in some cases), an

automatic email is sent to the observer with the download link. Additionally, a morning cron script checks for raw data acquired the previous night, and automatically sends the P.I. an email with a summary of their observations and instructions for downloading the raw data.

This new distribution system greatly simplifies the old workflow for raw data distribution that SAO has been doing for years. Another goal set for the next quarter is to implement the distribution of the reduced data sets using a similar approach.

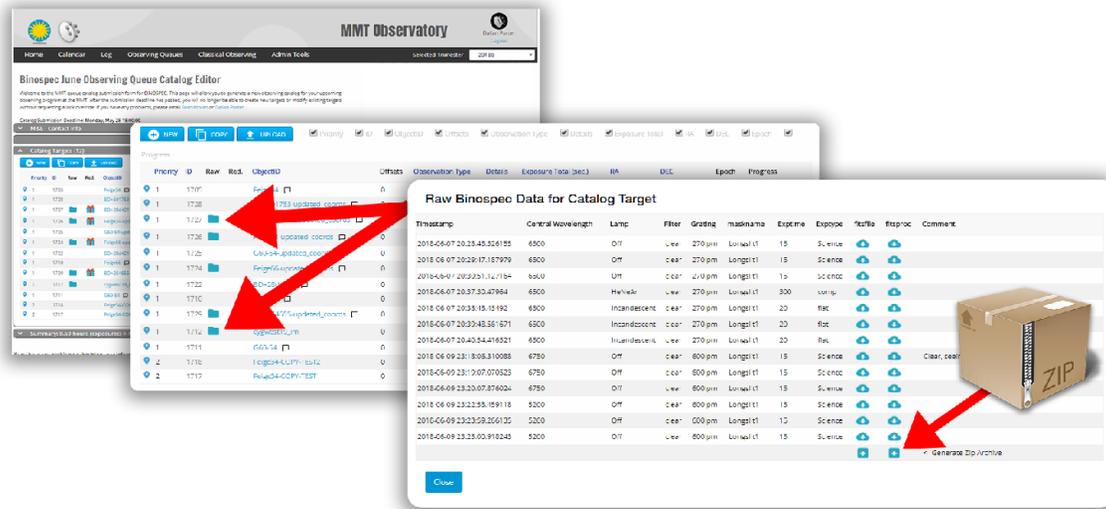


Figure 6: Archiving service on DBShare will allow observers to download multiple files then compress all files into a single large download.

Network

Hardware/Software Interfaces

Telemetry, Logging, and Database Management

Annunciator

Weather and Environmental Monitoring

Weather Stations

After several discussions, it was decided to remove the R.M. Young #1 bird and send it to campus for a complete overhaul. Since a lift for the shutter seal replacement was available, the bird was removed prior to summer shutdown. The parts needed for repair were inventoried, and ordered if not on hand.

All Sky Camera and Web Cameras

Seeing

The overall seeing for the quarter was a bit worse than the historic average with a median of 0.94" (Figure 7). The sampling is dominated by the two Binospec runs (9272 measurements) and the MMIRS run (3998 measurements). f/15 and f/9 combined for 602 measurements. The month of May had the best seeing overall with a median of 0.79" (Figure 8), with April and June having median seeing closer to 1".

The re-analysis of archived wavefront sensor data going back to 2003 revealed a very clear trend where the seeing is better during the second half of the night. Curiously, the inverse is true in 2018 Q2 (Figure 9). The best seeing was observed during the first half of the night with a median of 0.92" vs. 1" for the second half. The first half histogram has a second peak around 0.7" and clearly more frequently <0.8", but also has a longer tail towards worse seeing.

The trend of good seeing in May is also seen in the nightly median values (Figure 10). Most of the nights had seeing <1.5", and several nights where it remained <1" throughout. Only two nights saw seeing exceed 2", while April and June had four such nights. June was also a truncated month due to the work done on the front shutter.

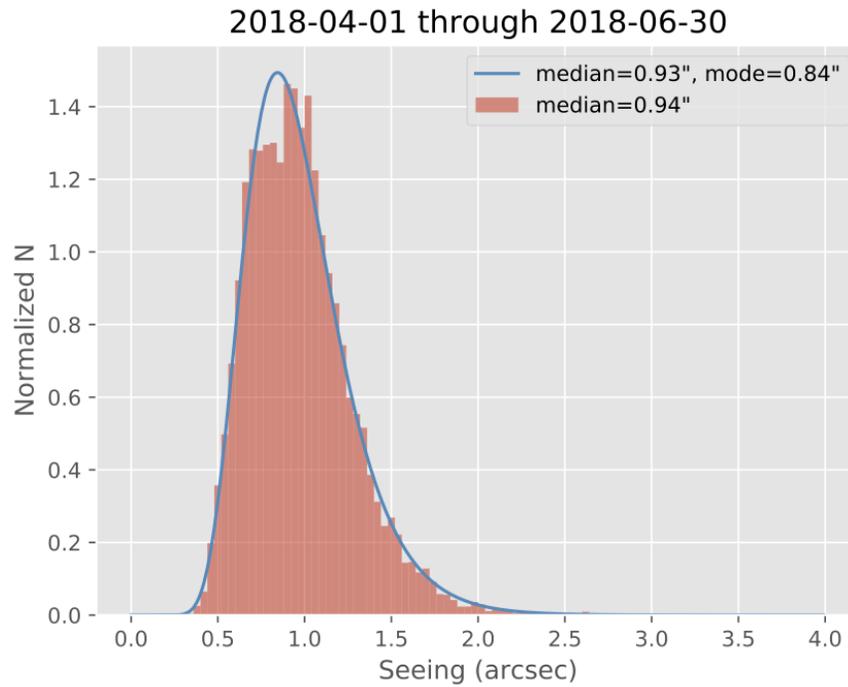


Figure 7: Histogram of overall seeing for the second quarter of 2018 with best-fit log-normal distribution.

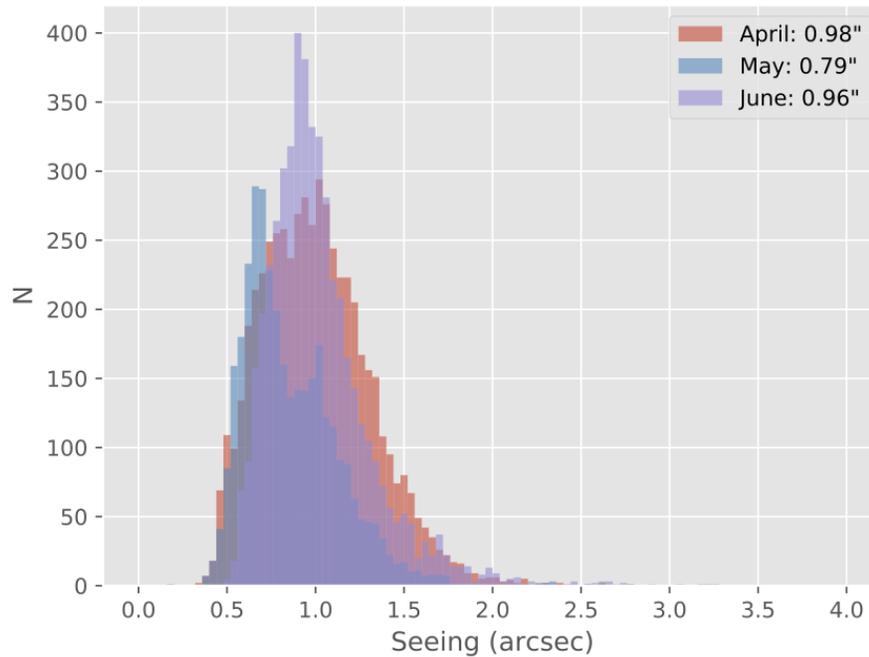


Figure 8: Seeing histograms for each month.

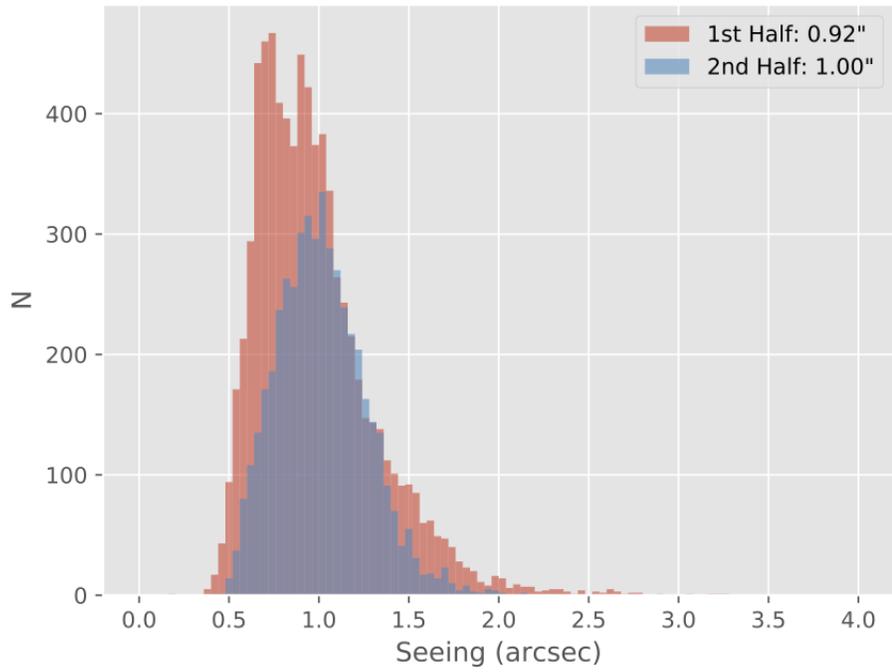


Figure 9: Seeing histograms for data taken during the first and second halves of the night.

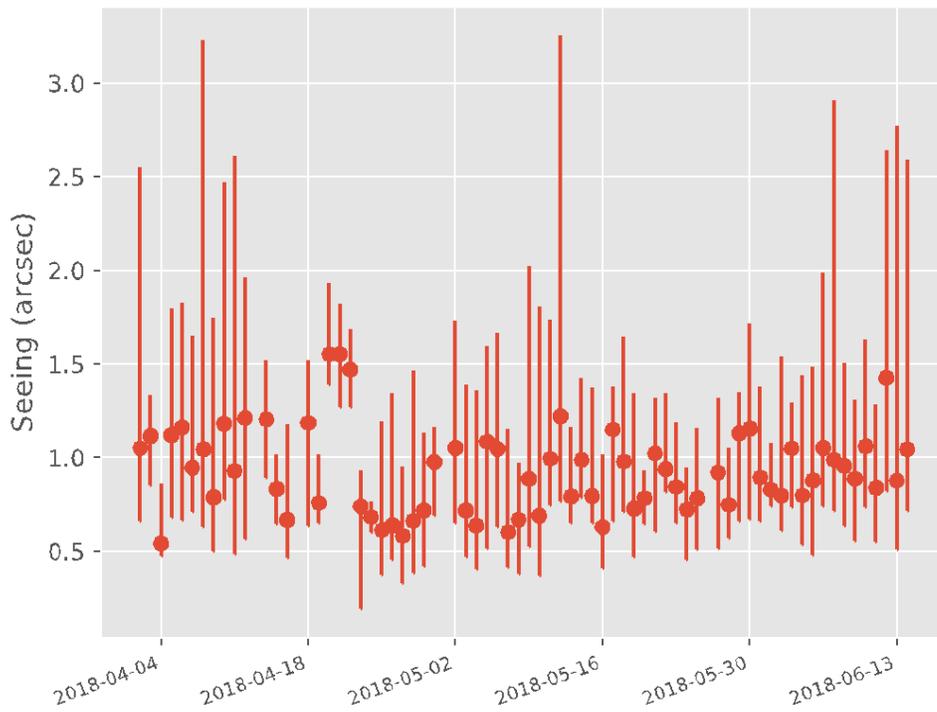


Figure 10: Median seeing for each night with bars denoting the minimum and maximum seeing.

User Support

Web Pages

B. Weiner continued to update information webpages on Binospec and Binospec slitmask design to guide users preparing for Binospec science runs this semester.

Remote Observing

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

Data Quality Assessment

Data Archive

The Binospec catalog management interface for PIs provides a dialog for users to download their data immediately after it has been observed (D. Porter with input from S. Moran and B. Weiner). This interface, tested in 2018 Q1, was used more extensively in 2018 Q2 Binospec science runs and works well. One user was able to download and reduce imaging data and submit a request for confirmation imaging on a short timescale, and another was able to reduce a long slit spectrum and use it as evidence in writing an Astronomical Telegram.

Reduction Procedures

Documentation

Document Database

Procedures

Public Relations and Outreach

P. Fortin was a judge for Southern Arizona Research, Science and Engineering Foundation (SARSEF) in which a middle school student won five awards with her presentation, "Capturing and Analyzing the Light Curve of a Variable Star". She won SARSEF Grand Prize, Astronomy Achievements Award for Middle School, Second place Middle School Award, Honorable Mention - Dark Skies, and the

Effort and Creativity in Astronomy award from the MMT Observatory and F.L. Whipple Observatory.

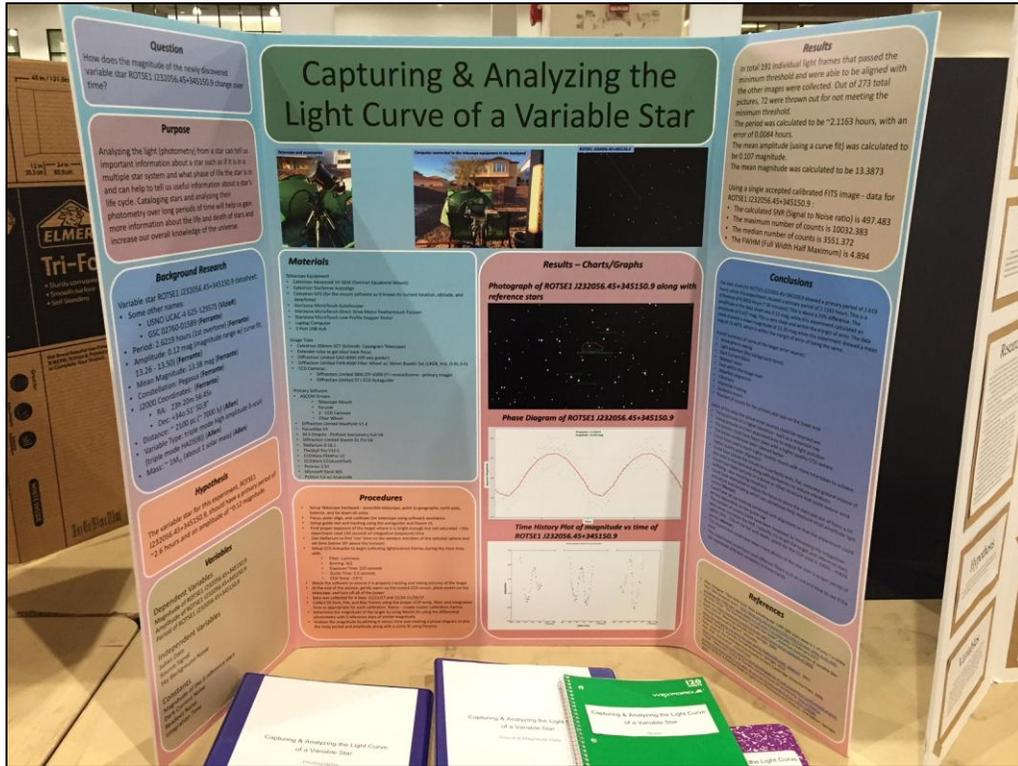


Figure 11. SARSEF winner's board on Capturing and Analyzing the Light Curve of a Variable Star.

Visitors and Tours

On April 10 a group from the Pima County Development Services was given a VIP tour of Whipple and MMT. J. Hinz and E. Falco were in attendance.



Figure 12. Dan Fabricant speaking with Pima County Officials during a tour of the MMT.

On May 15, Smithsonian Journeys brought nearly thirty people to the mountain for tours of the telescopes, dinner, and stargazing at the ridge. J. Hinz was there to give a tour of the MMT and to join them for questions at dinner.



Figure 13. Smithsonian Journeys taking a tour of MMT.

On June 6, G. Williams gave a tour of the MMT, and other Mt. Hopkins facilities, to personnel of the Steward and Mirror Lab business offices.



Figure 14. Steward and Mirror Lab business office taking a tour of MMT.

Public Presentations

On April 12, S. Kattner gave an Astronomy 101 level talk entitled “SpaceX: Falcon Heavy Rocket, and Private Companies’ Exploration of Space” for the volunteers of Whipple Observatory.

MMTO in the Media

Site Protection

J. Hinz served on the committee to hire a Public Affairs Specialist for Whipple Observatory. A short list of candidates was generated, and interviews were conducted on June 29. Site visits will begin in July.

Appendix I - Publications

MMT Related Scientific Publications

(An online publication list can be found in the MMT0 ADS library at <http://www.mmt0.org/node/244>)

- 18-18 Analysis of Candidates for Interacting Galaxy Clusters I. A1204 and A2029/A2033
E. J. Gonzalez, M. De Los Rios, G.A. Oio, et al.
A&A, **611**, 12
- 18-19 K2-231 b: A Su-Neptune Exoplanet Transiting a Solar Twin in Ruprecht 147
J. L. Curtis, A. Vanderburg, G. Torres et al.
AJ, **155**, 173
- 18-20 Evolution of Galaxies in Cluster Environment: Effects of High-speed Multiple Encounters with Early-type Galaxies
J. S. Hwang, C. Park, A. Banerjee et al.
ApJ, **856**, 160
- 18-21 The HectoMap Cluster Survey. I. redMaPPer Clusters
J. Sohn, M.J. Geller, K.J. Rines, et al.
ApJ, **856**, 172
- 18-22 New Candidates for Active Asteroids: Main-belt (145) Adeona, (704) Interamnia, (779) Nina, (1474) Beira, and near-Earth (162, 173) Ryugu
V. V. Busarev, A.B. Makalkin, F. Vilas, et al.
Icarus, **304**, 83
- 18-23 Warm-hot Gas in X-ray Bright Galaxy Clusters and the H I-deficient Circumgalactic Medium in Dense Environments
J.N. Burchett, T.M. Tripp, Q.D. Wang et al.
MNRAS, **475**, 1680
- 18-24 LOFAR-Boötes: Properties of High- and Low-excitation Radio Galaxies at $0.5 < z < 2.0$
W. L. Williams, G. Calistro Rivera, P.N. Best et al.
MNRAS, **475**, 3429
- 18-25 Periodic Optical Variability and Debris Accretion in White Dwarfs: A Test for a Casual Connection
N. Hallakoun, D. Maoz, E. Agol et al.
MNRAS, **476**, 933
- 18-26 SN 2013fs and SN 2013fr: Exploring the Circumstellar-material Diversity in Type II Supernovae
B. Bullivant, N. Smith, G.G. Williams et al.
MNRAS, **476**, 1497

- 18-27 A and F Stars as Probes of Outer Galactic Disk Kinematics
A. Harris, J.E. Drew, H.J. Farnhill et al.
MNRAS, **478**, 1680
- 18-28 Searching for Cool Dust. II Infrared Imaging of The OH/IT Supergiants, NML Cyg, VX Sgr, S Per, and the Normal Red Supergiants RS Per and T Per
M. S. Gordon, R.M Humphreys, T.J. Jones et al
AJ, **155**, 212
- 18-29 The Temporal Development of Dust Formation and Destruction in Nova Sagittarii 2015#2 (V5668 SGR): A Panchromatic Study
R. D. Gehrz, A. Evans, C. E. Woodward et al.
ApJ, **858**, 78
- 18-30 The Complete Light-curve Sample of Spectroscopically Confirmed SNe Ia from Pan-STARRS1 and Cosmological Constraints from the Combined Pantheon Sample
D. M. Scolnic, D. O. Jones, A. Rest et al.
ApJ, **859**, 101
- 18-31 The Spectral and Environmental Properties of $z \sim 2.0$ -2.5 Quasar Pairs
E. Lusso, M. Fumagalli, M. Rafelski et al.
ApJ, **860**, 41
- 18-32 SN 2017ein and the Possible First Identification of a Type Ic Supernova Progenitor
S. D. Van Dyk, W. Zheng, T.G. Brink et al.
ApJ, **236**, 44
- 18-33 Quasars Probing Quasars. X. The Quasar Pair Spectral Database
J. R. Findlay, J.X. Prochaska, J.F. Hennawi et al.
ApJS, **236**, 44
- 18-34 Strong Late-time Circumstellar Interactions in the Peculiar Supernova Iptf14hls
J. Andrews, N. Smith
MNRAS, **477**, 74
- 18-35 Probing Black Hole Accretion in Quasar Pairs at High Redshift
C. Vignali, E. Piconcelli, M. Pema et al.
MNRAS, **477**, 780
- 18-36 Kinematic Evidence for feedback-driven Star Formation in NGC 1893
B. Lim, H. Sung, M. S. Bessell et al.
MNRAS, **477**, 1993

MMT Technical Memoranda / Reports

Non-MMT Related Staff Publications

Development of the Arizona Robotic Telescope Network
B. Weiner et al.
SPIE, **10704**, 107042H (2018)

Appendix II - Service Request (SR) and Response Summary: April - June, 2018

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 15 presents the distribution of SR responses by priority during the period of April through June 2018. As seen in the figure, most (60%) of the SRs are of Near-Critical Priority. 33% are Important Priority and 7% are Low Priority. There were no Critical or Information-Only SRs.

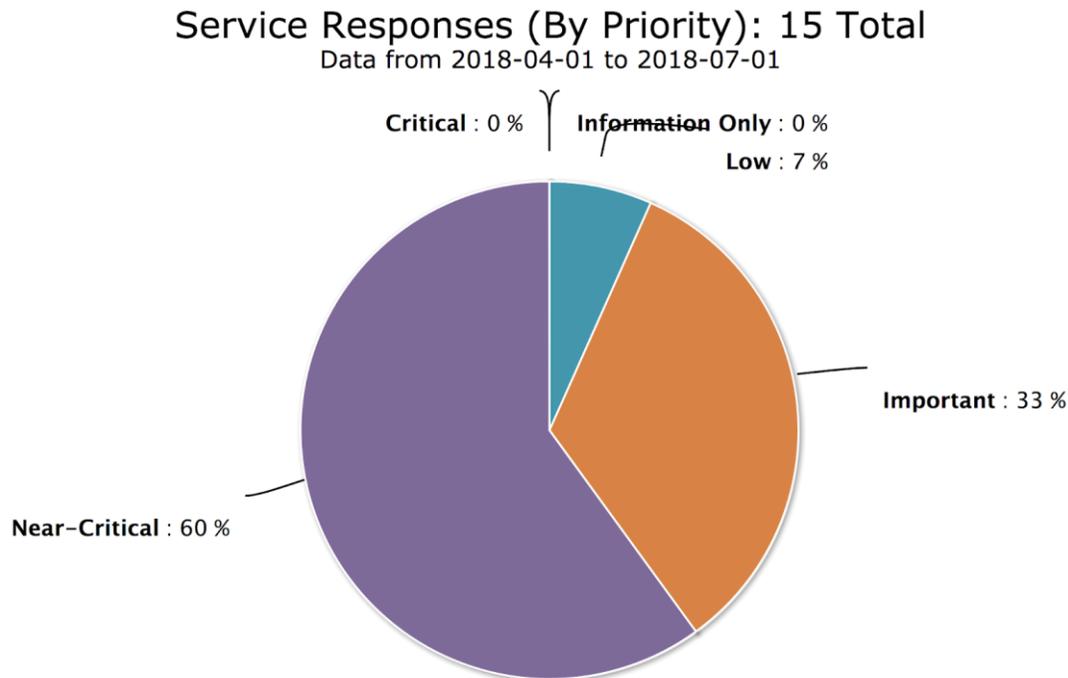


Figure 15: Service Request (SR) responses by priority during April through June 2018. 60% of the SRs were Near-Critical while 33% were Important priority and 7% were Low priority. There were no Critical or Information Only SRs.

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 15 SRs during this three-month period, compared with 29 from the previous reporting period and 37 for the reporting period prior to that. The 15 SRs for this reporting period is far less than normal for the SR system.

Figure 16 presents the same 15 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. Five responses from April through June are related to the Telescope category. Three responses were made under the Buildings and Instruments categories while two responses were within the Cell and Weather Systems categories. The Near-Critical SRs were in the Instruments, Telescope, Cell, and Building categories.

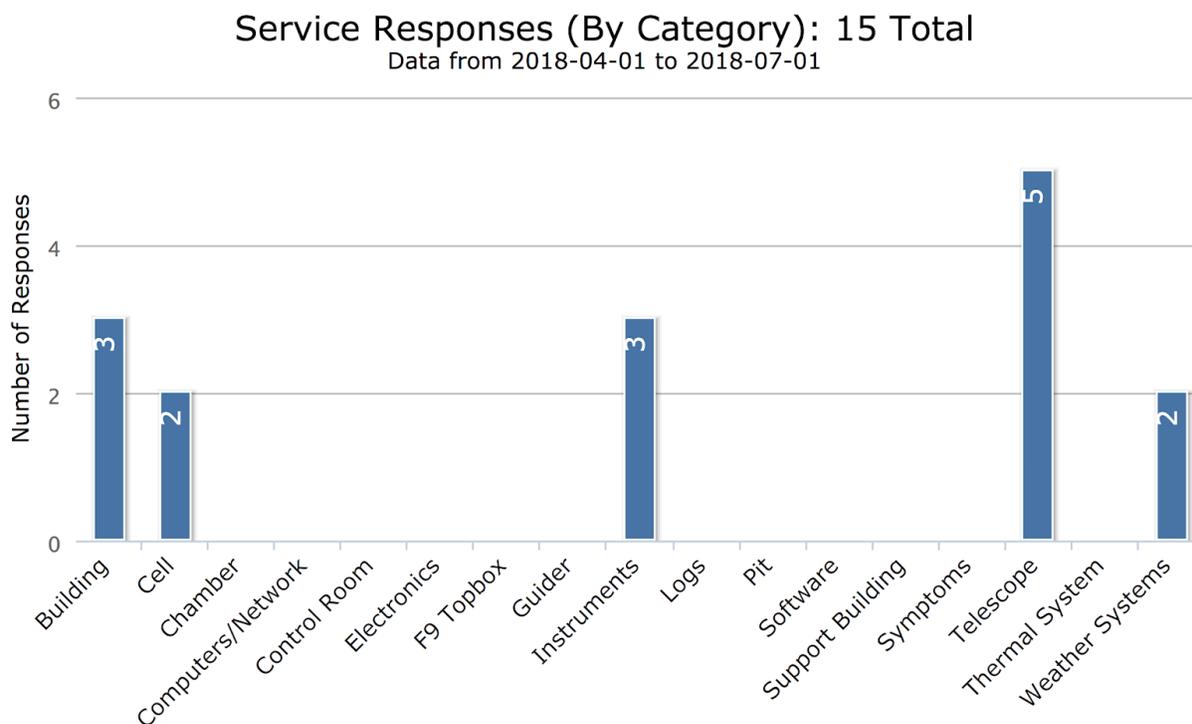


Figure 16: Service Request responses by category during April through June 2018. The majority of responses were within the Telescope, Buildings, and Instruments categories. The number of responses are listed with the category.

Appendix III - Observing Statistics

The MMTO maintains a database containing relevant information pertaining to the operation of the telescope, facility instruments, and the weather. Details are given in the June 1985 monthly summary. The data attached to the back of this report are taken from that database.

Use of MMT Scientific Observing Time

April 2018									
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	23.10	15.40	0.00	0.00	0.25	0.00	15.65	
PI Instr	15.00	117.00	19.60	0.30	0.00	0.00	0.00	19.90	
Engr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	18.00	140.10	35.00	0.30	0.00	0.25	0.00	35.55	

Time Summary									
Percentage of time scheduled for observing				100.0	* Breakdown of hours lost to instrument				
Percentage of time scheduled for engineering				0.0	0.20 Hecto guide probe alignment issues				
Percentage of time scheduled for sec/instr change				0.0	2.16 Hecto issues				
Percentage of time lost to weather				25.0	** Breakdown of hours lost to telescope				
Percentage of time lost to instrument				0.2	0.25 Focus change				
Percentage of time lost to telescope				0.0	1.25 Oscillation				
Percentage of time lost to general facility				0.2	0.50 Power cycling to remove oscillation				
Percentage of time lost to environment (non-weather)				0.0	0.50 WFS not grabbing frames				
Percentage of time lost				25.4	*** Breakdown of hours lost to facility				
					0.50 Problems with Pixel (Observer's computer)				
					0.50 Interlock safety check				

May 2018									
Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	*Lost to Instrument	** Lost to Telescope	***Lost to Gen'l Facility	****Lost to Environment	Total Lost	
MMT SG	4.00	33.30	11.25	0.00	1.25	0.00	0.00	12.50	
PI Instr	27.00	222.80	34.65	9.91	0.50	0.00	0.00	45.06	
Engr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	31.00	256.10	45.90	9.91	1.75	0.00	0.00	57.56	

Time Summary									
Percentage of time scheduled for observing				100.0	* Breakdown of hours lost to instrument				
Percentage of time scheduled for engineering				0.0	0.75 MMIRS Issues				
Percentage of time scheduled for sec/instr change				0.0	1.50 MMIRS software issues				
Percentage of time lost to weather				17.9	** Breakdown of hours lost to telescope				
Percentage of time lost to instrument				3.9	0.50 MMIRS WFS Issues				
Percentage of time lost to telescope				0.7	1.25 Backup guide cam				
Percentage of time lost to general facility				0.0					
Percentage of time lost to environment (non-weather)				0.0					
Percentage of time lost				22.5					

Year to Date May 2018									
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	57.00	618.10	233.40	1.00	1.25	0.75	0.00	236.40	
PI Instr	108.00	1007.70	343.83	31.10	6.00	0.50	0.00	381.43	
Engr	4.00	42.70	10.80	0.00	0.00	0.00	0.00	10.80	
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	169.00	1668.50	588.03	32.10	7.25	1.25	0.00	628.63	

Time Summary									
Percentage of time scheduled for observing				97.4					
Percentage of time scheduled for engineering				2.6					
Percentage of time scheduled for sec/instr change				0.0					
Percentage of time lost to weather				35.2					
Percentage of time lost to instrument				1.9					
Percentage of time lost to telescope				0.4					
Percentage of time lost to general facility				0.1					
Percentage of time lost to environment (non-weather)				0.0					
Percentage of time lost				37.7					

Use of MMT Scientific Observing Time

June 2018									
	Nights	Hours	Lost to	*Lost to	**Lost to	***Lost to	****Lost to		
<u>Instrument</u>	<u>Scheduled</u>	<u>Scheduled</u>	<u>Weather</u>	<u>Instrument</u>	<u>Telescope</u>	<u>Gen'l Facility</u>	<u>Environment</u>	<u>Total Lost</u>	
MMT SG	3.00	23.10	15.40	0.00	0.00	0.25	0.00	15.65	
PI Instr	15.00	117.00	19.60	0.30	0.00	0.00	0.00	19.90	
Engr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	18.00	140.10	35.00	0.30	0.00	0.25	0.00	35.55	

<u>Time Summary Exclusive of Shutdown</u>				<u>* Breakdown of hours lost to instrument</u>					
				0.30 SAO Network problems (Binospec)					
Percentage of time scheduled for observing				100.0					
Percentage of time scheduled for engineering				0.0					
Percentage of time scheduled for secondary change				0.0					
Percentage of time lost to weather				25.0					
Percentage of time lost to instrument				0.2					
Percentage of time lost to telescope				0.0					
Percentage of time lost to general facility				0.2					
Percentage of time lost to environment				0.0					
Percentage of time lost				25.4					

Year to Date June 2018

	Nights	Hours	Lost to	Lost to	Lost to	Lost to	Lost to		
<u>Instrument</u>	<u>Scheduled</u>	<u>Scheduled</u>	<u>Weather</u>	<u>Instrument</u>	<u>Telescope</u>	<u>Gen'l Facility</u>	<u>Environment</u>	<u>Total Lost</u>	
MMT SG	57.00	618.10	233.40	1.00	1.25	0.75	0.00	236.40	
PI Instr	108.00	1007.70	343.83	31.10	6.00	0.50	0.00	381.43	
Engr	4.00	42.70	10.80	0.00	0.00	0.00	0.00	10.80	
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total	169.00	1668.50	588.03	32.10	7.25	1.25	0.00	628.63	

<u>Time Summary Exclusive of Shutdown</u>									
Percentage of time scheduled for observing				97.4					
Percentage of time scheduled for engineering				2.6					
Percentage of time scheduled for secondary change				0.0					
Percentage of time lost to weather				35.2					
Percentage of time lost to instrument				1.9					
Percentage of time lost to telescope				0.4					
Percentage of time lost to general facility				0.1					
Percentage of time lost to environment				0.0					
Percentage of time lost				37.7					