MMT Observatory

Smithsonian Institution & The University of Arizona®

Quarterly Summary

January - March 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

An engineering meeting was held on March 22.

Reports and Publications

There were 17 peer-reviewed publications during this reporting period. See the listing of publications in Appendix I, p. 20.

Presentations and Conferences

G. Williams and T. Pickering attended the 231st American Astronomical Society (AAS) meeting held January 8-12 in National Harbor, MD. G. Williams presented a poster entitled "The Supernova Spectropolarimetry (SNSPOL) Project: Probing the Geometry of Supernova Explosions."

Safety

Personal Protective Equipment

An arc-flash suit and gloves were purchased in February and are located at the MMT. Due to safety issues with the quiet power electrical panels in the main enclosure, a category 2 arc flash protection is required to perform any work behind the outer door of these panels. For example, only trained individuals wearing the appropriate PPE are permitted to reset a tripped breaker. The quiet power panels, as well as other electrical deficiencies in the building, will be addressed by SI Facilities in the coming months.

In early March, a demonstration was given of a Blackline Lone Worker safety device for remote employee monitoring. It is a small, pager-like device that is worn and used when a health event or safety incident occurs while an employee is at the observatory without additional staff on site. The device allows an employee to signal or text an independent agency to alert local medical, police, and/or supervisory staff to the incident. The unit itself does not have voice capabilities. It can also be set up so that if the device detects a fall or the employee stops moving for a predetermined amount of time without checking in, it will contact the person and ask if they are in need of help. The device tested at the MMT uses satellite communication. It was determined that the satellite covers all of the summit buildings as well as the common building, and the summit and ridge dormitories.

Primary Mirror

Ventilation and Thermal Systems

The filters in the blower house were replaced. The filters were ordered and received last fall, but the task was postponed until telescope scheduling permitted, as it took the mirror thermal system out of service. This task was done on two engineering nights at the end of January.

In January, carrier3 was tested during the day under the control of ventauto2. Since this test was successful, carrier3 was operated under the control of ventauto2 from February 5 to February 9. carrier3 was able to maintain the building coolant at the appropriate temperature and is presently a working spare for carrier2.

Scripts were written during this reporting period to automatically generate movies that show changes in the thermal signature of the glass within the primary mirror (M1) over the course of a night. The movies can be accessed through a new HTML web page: http://ops.mmto.arizona.edu/m1-thermal-movies/. Data for the movies are sampled from MySQL database logs of E-series thermocouples that are attached to the back side of the M1 mirror at various depths within the hexcores. The frontplate temperatures are closest to the front of the mirror and most accurately reflect the temperatures on the front surface of the mirror.

Figure 1 shows a screenshot from one of these movies. This figure displays an M1 thermal pattern in which glass temperatures are nearly isothermal. Temperature values cluster around the mean temperature, and colors are nearly white across the mirror.

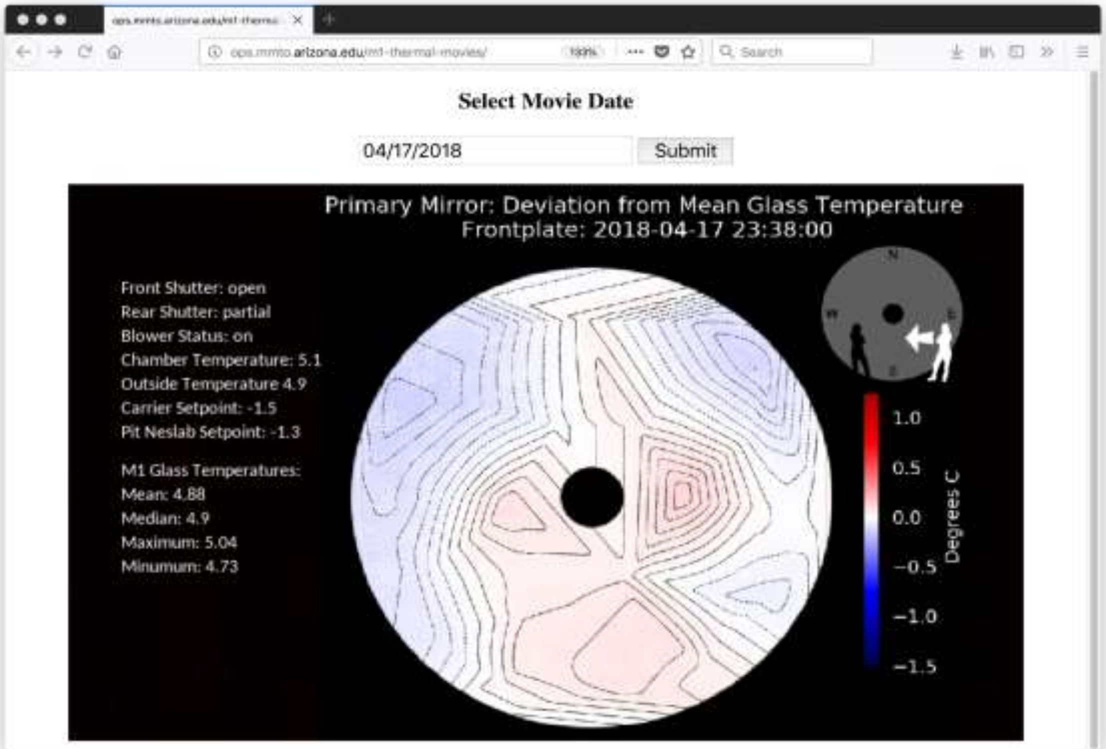

Figure 1. A “birds-eye” view of thermal gradients across the M1 mirror. Contour lines show the deviation from the mean glass temperature. The maximum gradient across the mirror is around 0.3°C in this screen capture, indicating that the mirror is nearly isothermal.

In contrast, Figure 2 shows a screenshot in which there are stronger thermal gradients indicated across the M1 mirror. The conditions that cause this and similar thermal anomalies are still being investigated. Playing the movie illustrates the time-dependent nature of these thermal gradients.

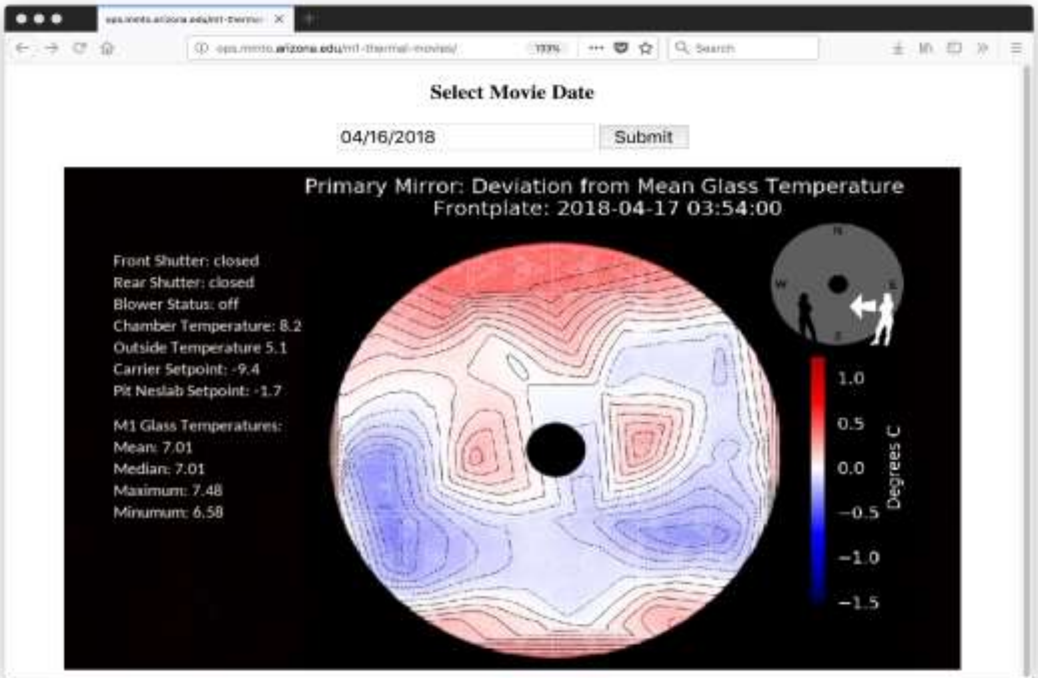

Figure 2. A "birds-eye" view of thermal gradients across the M1 mirror, similar to Figure 1, but showing increased thermal gradients across the mirror. These data were taken from a night in which the telescope chamber remained closed due to weather conditions. Strong thermal gradients in the primary mirror can impact image quality and require larger wavefront-sensor corrections.

The script-generated movies have been enhanced over the course of several months, reformatting content and adding more details. The movies are currently generated with a cron job at 7:00 AM each morning. Movies are generated in a variety of encoding formats so that they can be viewed in different web browsers. Each movie is roughly a minute in final length, depending on the length of the night. The current version of the movie (see Figure 1) looks at the deviations from the mean temperature throughout the mirror. Deviations above the mean are colored red, while deviations below the mean are colored blue. The contour interval for the plot remains the same as the mean temperature varies. Additionally, the movie now has supplemental information regarding the M1 ventilation system and air temperatures surrounding the mirror. This information is organized in a table to the left of the mirror display. Scripts were also written that can generate separate nightly movies over the course of up to a year or more.

Hardpoints

A new Bellofram air transducer was installed for the hardpoint breakaway air loop. The output range was adjusted to 0 to 45 psi. A 50 psi pressure pop off that opens at 48 psi was also installed.

Cell Crate

There were numerous negative actuator warnings on the M1 mirror. Analysis of pre- and post-summer shutdown measurements, for all 316 actuator channels, identified an increase in noise. The "spare" cell crate power supply was installed, and it has less noise than the "OEM" power supply. A new +5 V +/- 12 V power supply was purchased for the OEM cell crate power supply. It will be replaced, and the OEM power supply will be tested in the near future.

Air Control Box

The primary mirror support air control system experienced a failure on February 24. Troubleshooting began with the primary mirror cell crate air control box. The control logic was checked during air-on commands to verify correct operation (i.e., all relays activating). Passing this test confirmed the failure was at the cell air control box in the chamber.

After removing the cover to the air control box, we confirmed that the 120 V AC to the yellow air loop pilot valve was present. We then reconnected to the yellow pilot valve and commanded yellow air-on, and confirmed no rotation on the main 180-degree air valve. We swapped the yellow and blue 120 V AC control cables as a second test to confirm a pilot valve failure. The yellow control cable turned on the blue air loop while the blue control cable failed to control the yellow air loop. We swapped blue and yellow control cables back to normal operating configuration and confirmed we could control blue air loop with no problems. However, yellow was still a fail.

A decision was made to remove the yellow pilot control valve for troubleshooting. After constructing a test rig, we actuated the pilot valve using nitrogen. At first, the pilot valve was slow to respond. Then, after the second actuation, the valve exhibited a clear and fast response. We performed this test at 40 psi, 80 psi, and at 120 psi cell operating pressure. All tests passed.

After re-installing the yellow air loop pilot valve and re-connecting the cell air, we commanded the yellow loop on. The yellow main air valve actuated just fine (180-degree rotation). Several air on/off commands were issued without fail.

In conclusion, our interpretation of the yellow air loop failure is that the pilot valve may have had ice contamination inhibiting actuation. After commanding two mirror raises successfully, all systems appeared normal.

Secondary Mirrors

Nothing to report.

Hexapods

f/9 and f/15 hexapod

Testing of the f/9 repaired cards was scheduled and performed. The CPU card still displays an error code “C.” We were informed by Delta Tau technical support that the “C” error meant the card was missing its configuration file. We are unsure of the location of the original configuration file or how to download it from the operational CPU card.

The ACC24E2A card sent out for repairs was deemed non-reparable. The original card is obsolete so a new version of the ACC24E2A will be ordered. Software changes, as well as compatibility issues, are anticipated.

Optics Support Structure

Nothing to report.

Pointing and Tracking

Elevation

During this reporting period, the elevation axis experienced oscillations on several occasions. The oscillations seemed to appear mainly after an instrument change from Binospec to Blue Channel. It was noted, during the change to Blue Channel, weight had to be added to the bottom of the telescope to allow the axial counterweights to have sufficient range to achieve balance. When analyzing elevation drive motor currents, a pattern started to develop showing that the telescope seemed to be running bottom heavy. This condition could have something to do with the appearance of this oscillation.

Further examination of the nightly tracking logs confirmed that oscillations occurred, and the peak energy was centered around 25 Hz in the power spectral density plot. The oscillations amplitude was around 4 arc second peak to peak and was clearly visible on the science camera. It was also observed from the tracking plots, while tracking down through 75-degrees and lower, that the elevation motor currents indicated a total of 3 amps per motor (east, west). While tracking up through 75-degrees, a total of 0.67 amps per motor had been recorded. A typical motor current was estimated to be around +/- 2 amps per motor, independent of direction. This motor behavior prompted a review of the elevation balance procedure.
A plan to develop to test and measure elevation drive currents under various counterweight position changes. Since the initial problem occurred at elevations of 75-degrees or higher, the transverse counterweights were investigated first. The east and west transverse counterweight positions, which have not been changed for several years, were measured and recorded before a balance run commenced.

The transverse counterweight controller was found to be inoperable. The east counterweight moved north, but not south. The west transverse weight would not move at all when commanded. An alternative method (a 24 V DC power supply) was used to continue our work. It was determined that moving the east weight was enough to achieve balance.

With the elevation axis positioned at 75-degrees, and the primary mirror cover open, the east transverse counterweight was commanded to move until we saw an increase in motor currents. The direction of motion was reversed until we crossed over zero current into negative values. Once negative motor current values were established, a re-zeroing of the elevation drive current was accomplished to fine tune the elevation balance.

With this more precise elevation balance established, tracking tests were performed at the 75-degree elevation. While tracking down, the east/west motor currents were 1.21 amps / 1.19 amps, respectively. Tracking up, east/west motor currents were -1.22 amps / -1.28 amps, respectively. This was a vast improvement over the previously recorded values of 3 amps / 0.67 amps. Tracking data was gathered and analyzed, and it showed an interesting result: the oscillations with peak power centered around 25 Hz were gone! Several elevation tracks from 60-degrees through zenith were performed, with no oscillations occurring.

One final test was to prove whether the balance truly affected the elevation oscillation. The transverse counterweight was re-positioned randomly, and the elevation axis was confirmed to be unbalanced. At 75-degrees elevation, tracking up/down resulted in an oscillation with peak energy centered around 25 Hz. We then returned the transverse counterweight back to the balanced position, and found that we can eliminate the oscillation of the elevation axis.

There clearly appears to be a direct relationship between telescope balance and the elevation oscillation. It's unclear whether this relationship is due to a pre-load problem in the friction drive system, in the motor amplifiers, or to a conditionally stable servo controller. Further monitoring of the elevation tracking data will continue in order to determine if the new balance procedure for the telescope has addressed the oscillation on a permanent basis.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on the MMT for 50% of the available nights from January 1 – March 31. (The large amount of time scheduled was due to the pending repairs on the MMIRS and Hecto instruments.) Approximately 42% of those nights were scheduled with the Blue Channel Spectrograph, 58% with Red Channel, and no nights with SPOL. 517 hours were allocated for f/9 observations. 37% of these hours were lost due to weather. Instrument, facility, and telescope problems accounted for almost no actual lost time: 1 hour was lost due to an issue with the grating. Blue Channel lost 36.6% of its time to bad weather, with Red Channel losing 37.4%.

Blue Channel experienced a vacuum leak on January 11, and Red Channel was installed on the telescope in its place. Blue was transported down the mountain and taken to the UA Imaging Technology Lab (ITL) where the leak was fixed. After undergoing and passing full testing, it was transported back to the MMT on January 16, and reinstalled on the telescope on January 18.

f/5 Instrumentation

B. Weiner managed user interaction with Binospec, including user uploaded catalogs, slitmask design, and data access, for Binospec's first regularly scheduled science run in February. He also planned nightly schedules for the queue observers to aid in night-time decisions, and managing queue priorities as well as observability issues for a number of targets.

No MMIRS observing was conducted this quarter due to complications in repairing the vacuum leak experienced in the fall.

f/15 Instrumentation

The MAPS actuator electronics design review was held on March 20. The review committee stated their belief that the actuator and associated electronics board design were technically sound and should proceed. Some minor action items were recommended including having a separate review for the MAPS simulation and control algorithm approach, which will be scheduled for May. The committee also recommended that more work be completed on the upper level software especially the reconstructor computer. A failure mode analysis and low temperature actuator testing were also recommended.

The MAPS simulation (SPAM) was modified to model the Four Actuator Test fixture (FAT). The physical properties of the actuator model were also changed to reflect the latest version of the hardware. The figure below shows a step response comparison between data from the actual hardware (FAT) and the simulation prediction. The correlation for parameters such as position, current, force, and voltage were excellent. The SPAM simulation is now being used to design the system gains, and as a tool to improve the control algorithm.

The project is planning to request a one year no-cost extension from the NSF.

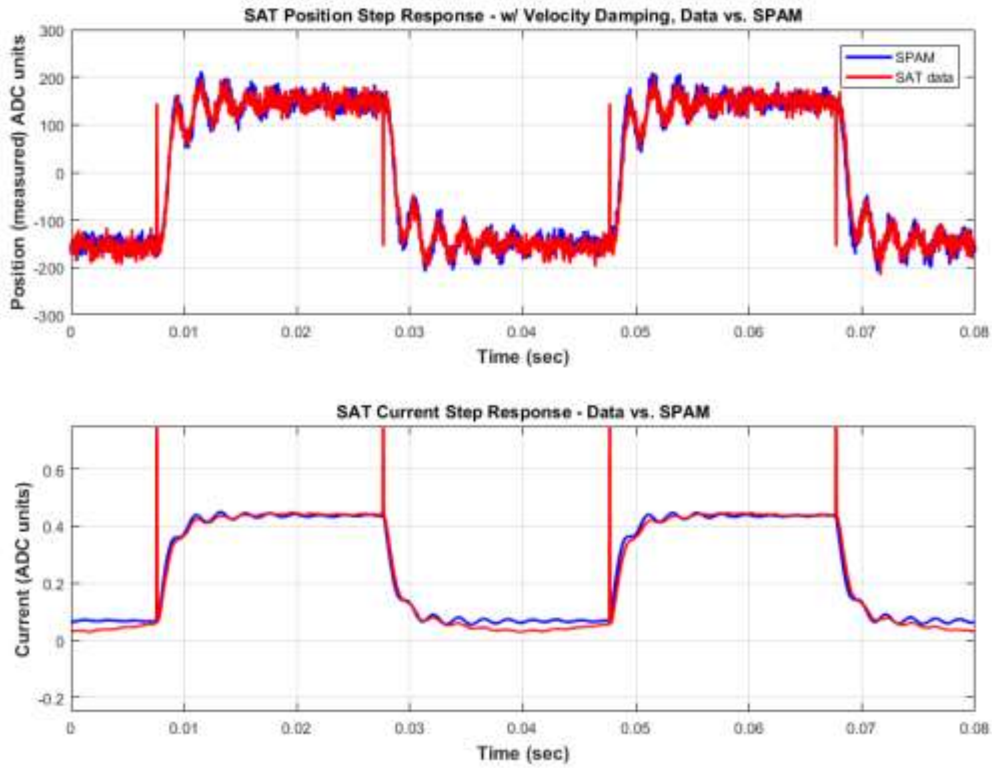

Figure 3. Step response comparison of hardware test fixture results with simulation prediction for position and current.

Topboxes and Wavefront Sensors (WFS)

The updated python-based WFS analysis software is now in routine use for all wavefront sensors in all modes. There are now two WFS options available for Binospec: on-axis curvature wavefront sensing using the single-object guider, and off-axis wavefront sensing using a movable Shack-Hartmann WFS. Alignment issues in the off-axis WFS were discovered and characterized during Binospec's November and December 2017 commissioning runs. A new, properly-aligned pick-off mirror was installed before the February 2018 run. Its performance was verified on the first night of the run by using it simultaneously with on-axis curvature wavefront sensing. After fixing a couple of sign error bugs in the handling of the off-axis aberration model, the on- and off-axis WFS methods produced the same results. The off-axis WFS was then routinely used for the rest of the February run and it produced good results.

Some minor changes were made to the Shack-Hartmann analysis routines to improve handling of changing pupil position and vignetting. These effects are relatively minor for Binospec, but do need to be accounted for to avoid biasing the measurement of the wavefront. They are much more significant for MMIRS. The wavefront model used in the analysis has been extended to include many more modes (37 for f/9 and 81 for the others). The need for this was especially obvious with data from the f/5 WFS. Otherwise, perfectly good data was producing large and systematic residuals when only 21 modes were used. Only low order modes that correspond to mirror bending modes are used to calculate force corrections, but the robustness and accuracy of determining these is improved by including higher order modes in the model that is fit to the data.

f/9 Topbox

During observations, the telescope operator reported that "The intensifier knob on videoscope is very jumpy and hard to control. [There is] flashing between various brightness[es] when [the knob is] twisted." The videoscope box was taken apart. The Potentiometer, used to adjust intensity, was cleaned with contact cleaner. The videoscope control box was reassembled, reconnected, and the system was tested. The videoscope worked correctly. The system still needs to be tested on the sky.

Facilities

Main Enclosure

A report describing the existing building drive was provided to Smithsonian Facilities. This report was requested to start the process of creating a Smithsonian Facilities project of modernizing the building drive system.

On January 30, a meeting was held on the MMT roof with representatives from Kappcon, Smithsonian Facilities, and MMT to gather additional information about the shutter seals, including both the p-seal and the flap seal. This work was completed in preparation for a follow up meeting at Kappcon on February 1 to plan for the shutter seal installation that's scheduled to start on June 18. Both seals have been received by Kappcon, but the details of the installation are still being worked out.

General Infrastructure

A BACNET BAS20 controller was installed in the main air cabinet. It will be used to monitor the input and output pressure of the dry air. Air pressure transducers were installed in the plumbing to facilitate the measurements. The BAS20 is wired to read up to four inputs, enabling future expansion.

It was discovered that oil had migrated into the gravel and soil next to the air compressors. A barrier was placed around the edges of the concrete slab underneath the air compressors and has contained the oil, preventing further migration.

T. Oldham began removing the contaminated gravel and soil in March, creating a hole approximately 96" x 32" x 24"; the hole is presently covered with grating. Hazardous waste barrels were ordered from Southwest Hazard Materials for the contaminated gravel and soil. This work will continue into the next quarter.

Computers and Information Technology

S. Schaller performed the usual monthly backups of *mmto* and *hacksaw* and reboots to pick up new kernels and virtualbox drivers, installed pending updates on *nas1*, *nas2*, and *nas3*, and did the yearly offload of historical data from /*mmt*. All Fedora machines were upgraded to Fedora 27.

Additional work included:

- Changes to the settings_server and hexapod_linux to support instrument specific coefficients for cos, sin, and t_oss;
- Changes to the annunciator server to better protect it from ill-behaved clients that send it the wrong data type;
- Adding the camera temperature parameter to the *mmtccd* miniserver and making an annunciator check for it;
- Implementation of annunciator checks on carrier3, and modified annunciator checks for the rotator offset and the carriers; modification of the compressor mode annunciator checks;
- Debugging of a problem with the oplog and removal of Vaisala 3 wind data from the derived parameters in *dataserver2*;
- Began work on a new hardware and software interface for the f/9 topbox control project.

C. Oswald returned in January and continued work on the new website. His initial efforts focused on migrating over the media files lost after the website crashed last summer. After migrating the files, he then applied a consistent format design to each page.

Afterwards, it was decided that the next step in the website's development was to gather individuals from across the MMTO to help plan, choose, and write the necessary content for the webpage, alongside another major design overhaul. In the meantime, C. Oswald will be creating sitemaps and general content mock-ups to help facilitate the next planning stage.

Hardware/Software Interfaces

During the two previous trimesters, two separate versions of the Observatory Manager (OM), a.k.a "the scheduler," have been running side-by side while big changes were being made to facilitate Binospec queue observing integration. The first version of the OM continued to run throughout on the *ops* server, handling all MMIRS related programs, target submission and editing, queue observing, and scheduling/dispatching as it did before. The second "new" version runs on a new server named *dbshare*. Located at the summit, it is a powerful server that is shared between the MMTO and CfA teams. *dbshare* was purchased for the dedicated role of hosting the OM, reducing observed queue data, interfacing directly to instruments and their GUIs, and storing and distributing the data to the P.I.s, post-queue run. The CfA software team was using PostgreSQL as the database backend for Binospec control and management software, so the decision was made to port the OM from MySQL to PostgreSQL. This makes it possible to combine both into a single shared database. The conversion to PostgreSQL went fairly smoothly due to the similar nature of both MySQL and PostgreSQL. The *dbshare* version of the OM was successfully used for the first two Binospec queue runs. It was tested for all aspects of the runs, including slit-mask creation and submission, catalog target submission, queue observing, and raw data distribution.

Consequently, running two separate versions of the OM side-by-side generated a data-merging headache that needed be sorted out when the time came to combine the two into a single version. During the two MMIRS runs preceding the merge, the *ops* version continued to run as the de-facto system for MMIRS, and the data was duplicated to *dbshare* regularly to keep them in sync as the work progressed on the *dbshare* merged version. Once all of the catalog submission and observer forms were modified to handle both MMIRS and Binospec formats, a final data export was performed from o*ps* to *dbshare*. The o*ps* version of the OM was officially decommissioned prior to sending out observing queue forms to MMIRS observers for the upcoming April observing queue run. The merge has been completed, and both MMIRS and Binospec queues are now managed by a single system. Testing and bug fixes will continue for the next few MMIRS and Binospec queue runs. The next phase of OM development will focus on classical observing programs.

Compressed Air Cabinet Instrumentation

A new Raspberry Pi (RPi) model 3B was configured as "air-cabinet-pi" on the MMT internal network. This RPi uses the current "stretch" Raspbian operating system. Eventually, three different types of data will be collected by the RPi within the compressed air cabinet: 1) air dew point, 2) air flow, and 3) air pressure. Each of these data sets will be obtained through independent "systemd" Linux services that are running on the RPi.

Software work included refining a new "Edgetech" PHP class, which uses the PHP DirectIO class for communication between a USB port on the RPi to an RS232 serial port on the Edgetech 200M-DS2-AT-RS Meteorological sensor. The Edgetech sensor reads dew points for the compressed air system at the air cabinet. This ZMQLogger PHP client code reads and parses data from the Edgetech sensor. It uses the MMT's ZMQLogger framework, discussed in the previous quarterly summary, to log locally to comma-separated-value (CSV) log files on the air-cabinet-pi RPI, and remotely to CSV files and MySQL database tables on the *ops* and *ops2* servers. This distributed system provides data logging redundancy and reliability. Data is also pushed to the *Redis* server and can, potentially, be pushed to the *dataserver2* server on *tcs-server*.

Another aspect of this work is porting the PHP ZMQLogger client abstract class to Python so that additional clients can be written in either PHP or Python. The ZMQLogger server code is written in Python. Having a ZMQLogger client abstract Python class would allow both client and server code to be written in the same language. ZeroMQ (http://zeromq.org/), the technology on which ZMQLogger is based, has libraries in many languages so that the specific language of the client is very flexible.

Work will continue on converting the current Perl-based *airflow* miniserver to a ZMQLogger client, probably in Python. This miniserver measures the air flow rate and temperature for compressed air within the air cabinet. This work will allow the Lantronix device, which currently connects the FCI ST75 airflow meter to the network, to be replaced with a RS232-to-USB cable, similar to the direct device-to-computer connection for the Edgetech dewpoint sensor.

Finally, compressed air pressures are currently measured at the inlet and output of the air cabinet. These values are measured through a Contemporary Controls BAScontrol20 (BAS20) BACnet controller that is mounted inside the air cabinet. Contemporary Controls has recently released a BASpi "hat" (https://www.ccontrols.com/diy/baspi.php) that attaches to the top of a RPi model 3. A BASpi has been ordered, and testing will start soon to see if it can be used to replace the "airflow" BAS20. If this testing is successful, the air-cabinet-pi can be used to log all air-cabinet data, and then several hardware pieces required for logging can be removed. Available space is already limited in the air cabinet. An additional benefit is that data logging can continue on the air-cabinet-pi, even if the network connection is dropped, preventing remote logging. The BACnet air pressure logging is currently being done by a client running on *ops2*.

Weather and Environmental Monitoring

Weather Stations

The Young 1 anemometer continues to have wind speed dropouts and the wind direction appears to be 40 degrees off when compared to Vaisala 4 and Young 2. Troubleshooting has not yet isolated causes for either failure, although misalignment of Young 1 is the suspected cause of the incorrect wind direction reading.

Seeing

Overall, the seeing in the first quarter of 2018 was a bit worse than the historical averages. Figure 4 shows the total histogram of the seeing measurements along with a best-fit log-normal distribution. The observed distribution is much more strongly peaked than is usually observed, but this is likely due to the measurements being overrepresented by the first clear week of the Binospec commissioning run. When WFS data is being taken continuously, new seeing measurements are acquired every 30-60 seconds vs. every few hours. Still, the observed and best-fit median seeing values are in good agreement at ~1.1"

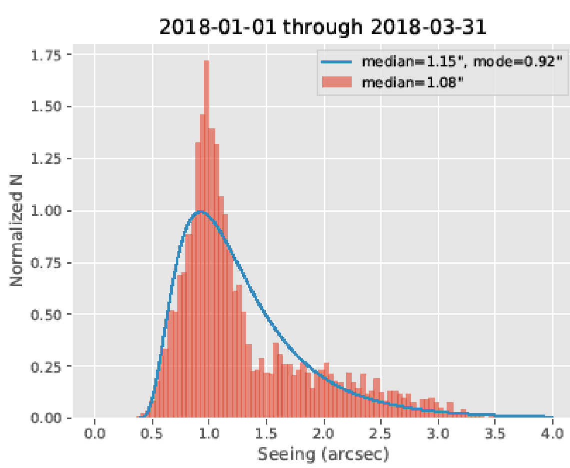

Figure 4. Histogram of seeing values for 2018 Q1 including best-fit log-normal distribution.

Breaking down the seeing histograms by month, Figure 5 shows that much more data was taken during February due to Binospec. Still, the median seeing values were pretty similar from month to month. The data for February actually appears bimodal with one set symmetrically distributed around 1” and another around 2”. This makes sense given that February’s weather was either pretty good or quite terrible.

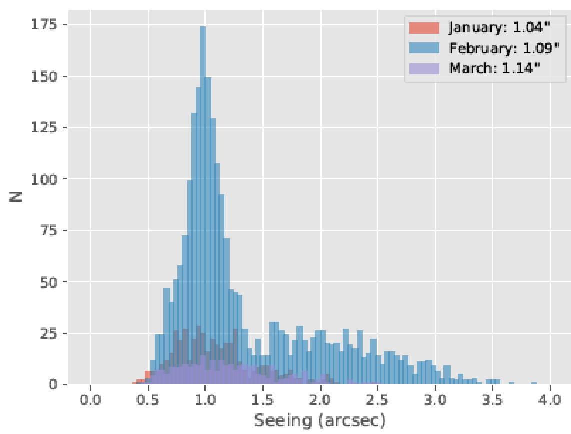

Figure 5. Seeing histograms broken down by individual month.

Breaking down the seeing data between the two halves of the night, Figure 6 doesn’t show as clear a trend as has been observed in the past. The second half median is slightly better, formally, but the difference is not significant.

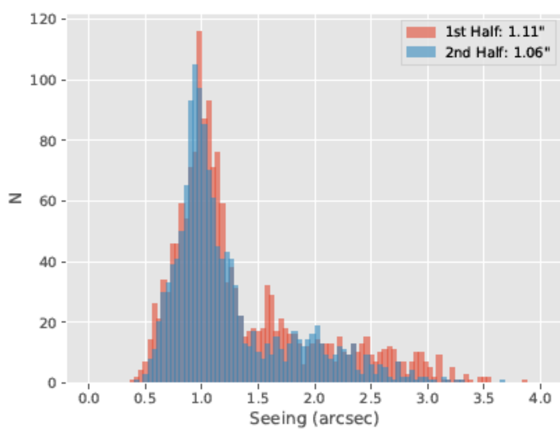

Figure 6. Seeing histograms broken down between 1st and 2nd halves of the night.

Figure 7 shows the median and range of seeing for each night of the quarter. The gap due to the bad weather in the second half of February stands out. There is some clustering of good nights and worse nights, but also lots of variation from night to night as well as within a given night in some cases. Again, this is fairly consistent with behavior observed during previous quarters.

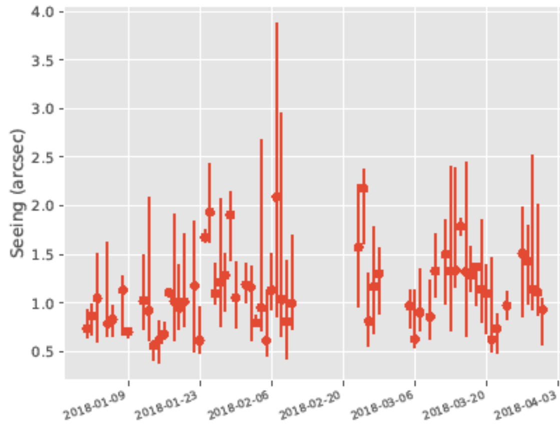

Figure 7. Median, minimum, and maximum seeing values for each night where seeing data was available.

A caveat to these seeing measurements is that some may have been compromised by tracking or secondary support issues. The longer exposure times that are now more commonly used when acquiring WFS data can exacerbate the effects of tracking errors. Work is ongoing to do more robust analysis to either filter out affected data by rejecting WFS spots that are too elongated, or by using other information (e.g., guider or mount logs) to deconvolve the effects of tracking and seeing. The results of this analysis, and of the seeing data acquired using the MMTO's Shack-Hartmann wavefront sensors since 2003, are being written up to present at the SPIE Astronomical Telescopes & Instrumentation conference in June.

User Support

Web Pages

B. Weiner created and updated information pages on Binospec and a Binospec slitmask design tutorial to guide users in preparation for the first Binospec science runs this reporting period.

Remote Observing

The MMTO supported 41 nights of remote observing this quarter. 32.5 nights were for UA observers, with 8.5 nights for CfA observers. Nearly the entire month of January consisted of remote observing, due to the MMIRS and Hecto instruments being unavailable.

Data Archive

The Binospec catalog management interface for PIs now provides a dialog for users to download their data immediately after it has been observed. It was created by D. Porter, with input from S. Moran and B. Weiner. This interface was tested during 2018A Binospec science runs and it works well. A Binospec PI was able to download, reduce, and analyze long-slit spectra on a ~1 day timescale.

Documentation

Nothing to report.

Public Relations and Outreach

Visitors and Tours

3/3/18 – D. McCarthy led a tour of the MMTO for prospective Steward Observatory graduate students.

3/15-16/18 – The Smithsonian Astrophysical Observatory (SAO) Advisory Board meeting was held in Tucson. G. Williams gave an evening tour of the MMT on March 15 where members were also able to do eyepiece viewing on the telescope. M. Alegria, W. Goble, E. Martin, C. Ly, and R. Ortiz assisted.

Public Presentations

J. Hinz gave a talk on March 9 to the Whipple Observatory volunteers and tour guides at the VERITAS building before public tours resumed in mid-March.

J. Hinz hosted the 2018 Smithsonian Lectures on Astronomy, held in Green Valley at the Recreation Center West beginning on January 10. The five speakers were:

> "NASA's Dawn Mission: Exploring the Dwarf Plant Ceres"
> Dr. David O'Brien, Planetary Science Institute
>
> "Supernovae: Life and Death Among the Stars"
> Dr. Patrick Young, Arizona State University
>
> "The Birth of Astronomy in Southern Arizona"
> Dr. Thomas Flemings, University of Arizona
>
> "How Bright is Your Night Sky?"
> Dr. Emilio Falco, Whipple Observatory
>
> "Black Holes, Galaxies, & Cosmic Fireworks"
> Dr. Stephanie Juneau, National Optical Astronomy Observatory

The MMTO hosted a table at the 100th Anniversary of Steward Observatory Open House on February 17 where visitors were able to take a virtual tour of the MMTO. D. Porter, J. Hinz, and B. Weiner were present to assist them and answer questions.

Figure 8. Visitors at the MMTO table looking through the oculus, taking a virtual tour of the MMTO during the Steward Observatory Open House.

The MMTO once again hosted a booth at the 2018 Tucson Festival of Books in the Science City area on March 10 and 11.

Figure 9. M. Alegria working at the MMTO table at the Tucson Festival of Books.

MMTO in the Media

The MMTO was mentioned in a UA News article entitled "UA-Led NASA Survey Seen as Steppingstone for Astronomy" on March 28. The observing techniques of nulling interferometry used by the "Hunt for Observable Signatures of Terrestrial Systems" (HOST) on the LBT was originally tested on the MMT in 1998.

The Green Valley News published a feature article on E. Falco of Whipple Observatory on January 8, entitled "King of the Hill: He keeps his eye on the sky on Mt Hopkins." The MMT is mentioned among the telescopes in operation.

Site Protection

Nothing to report.

Appendix I - Publications

MMT Related Scientific Publications

(An online publication list can be found in the MMTO ADS library at http://www.mmto.org/node/244)

18-01 Spectral Analysis of Four Surprisingly Similar Hot Hydrogen-rich Subdwarf O Stars
M. Latour, P. Chayer, E.M. Green, et al.
A&A, **609**, 89

18-02 Hydrogen-poor Superluminous Supernovae from the Pan-STARRS1 Medium Deep Survey
R. Lunnan, R. Chornock, E. Berger, et al.
ApJ, **852**, 81

18-03 Large Fluctuations in the High-redshift Metagalactic Ionizing Background
A. D'Aloisio, M. McQuinn, F.B. Davies, et al.
MNRAS, **473**, 560

18-04 Neutral Hydrogen (H I) Gas Content of Galaxies at z ≈ 0.32
J. Rhee, P. Lah, F.H. Briggs, et al.
MNRAS, **473**, 1879

18-05 The Origin of Double-peaked Narrow Lines in Active Galactic Nuclei – III. Feedback from Biconical AGN Outflows
R. Nevin, J.M. Comerford, F. Müller-Sánchez, et al.
MNRAS, **473**, 2160

18-06 LoCuSS: Pre-processing in Galaxy Groups Falling into Massive Galaxy Clusters at z = 0.2
M. Bianconi, G.P. Smith, C.P. Haines, et al.
MNRAS Lett, **473**, 79

18-07 M101: Spectral Observations of H II Regions and Their Physical Properties
N. Hu, E. Wang, Z. Lin, et al.
ApJ, **854**, 68

18-08 hCOSMOS: A Dense Spectroscopic Survey of r ≤ 21.3 Galaxies in the COSMOS Field
I. Damjanov, H.J. Zahid, M.J. Geller, et al.
ApJS, **234**, 21

18-09 Deep CFHT Y-band Imaging of VVDS-F22 Field. II. Quasar Selection and Quasar Luminosity Function
J. Yang, X.-B. Wu, D. Liu, et al.
AJ, **155**, 110

18-10 The Faint End of the z = 5 Quasar Luminosity Function from the CFHTLS
I.D. McGreer, X. Fan, L. Jiang, et al.
AJ, **155**, 131

18-11 The Spread of Metals into the Low-redshift Intergalactic Medium
C. T. Pratt, J.T. Stocke, B.A. Keeney, et al.
ApJ, **855**, 18

18-12 A Close Relationship Between Lyα and Mg II in Green Pea Galaxies
A. Henry, D.A. Berg, C. Scarlata, et al.
ApJ, **855**, 96

18-13 The HectoMAP Cluster Survey. II. X-ray Clusters
J. Sohn, G. Chon, H. Böhringer, et al.
ApJ, **855**, 100

18-14 The Next Generation Virgo Cluster Survey (NGVS). XXXII. A Search for Globular Cluster Substructures in the Virgo Galaxy Cluster Core
M. Powalka, T.H. Puzia, A. Lançon, et al.
ApJ, **856**, 84

18-15 Galaxy Structure from Multiple Tracers – III. Radial Variations in M87's IMF
L. Oldham, M. Auger
MNRAS, **474**, 4169

18-16 Quasar 2175 Å Dust Absorbers – II. Correlation Analysis and Relationship with Other Absorption Line Systems
J. Ma, J. Ge, J.X. Prochaska, et al.
MNRAS, **474**, 4870

18-17 SN2012ab: A Peculiar Type IIn Supernova with Aspherical Circumstellar Material
C. Bilinski, N. Smith, G.G. Williams, et al.
MNRAS, **475**, 1104

MMT Technical Memoranda / Reports

Nothing to report.

Non-MMT Related Staff Publications

Nothing to report.

Appendix II - Service Request (SR) and Response Summary: January - March, 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 10 presents the distribution of SR responses by priority during the period of January through March 2018. As seen in the figure, most (28%) of the SRs are of Critical Priority. 24% are Important Priority, 21% are either Near-Critical or Low Priority, and 7% are Information-Only.

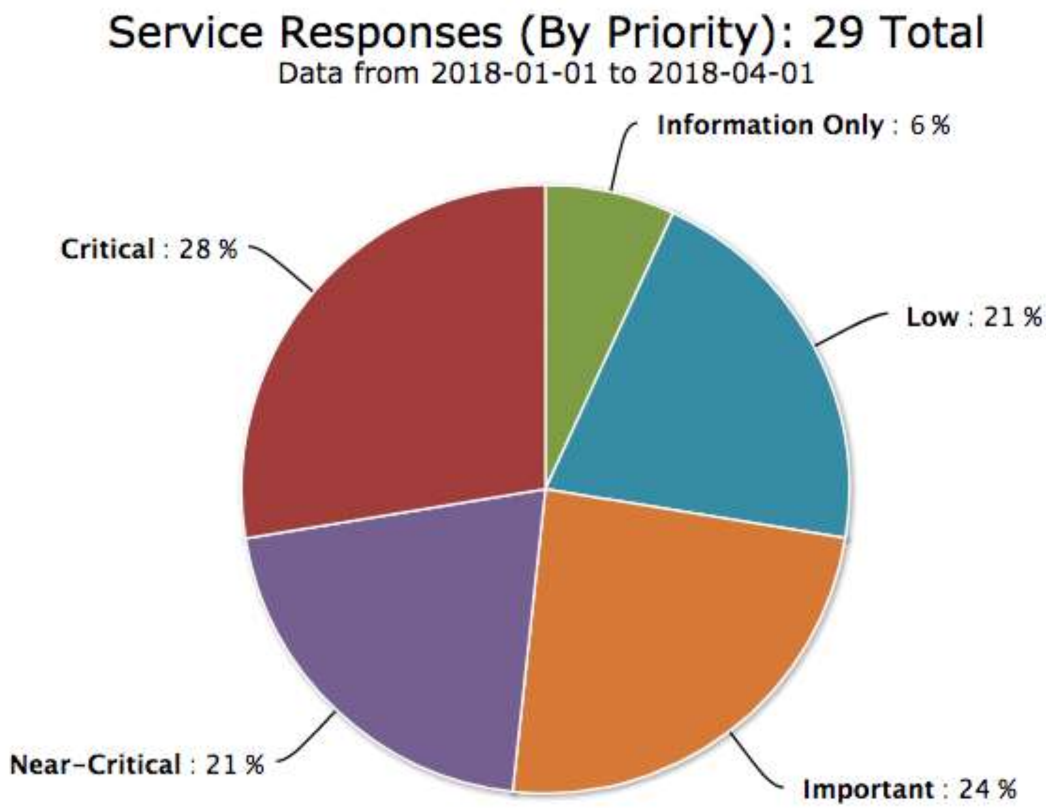

Figure 10. Service Request (SR) responses by priority during January through March 2018.

"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 29 SRs during this three-month period, compared with 37 for the previous reporting period. This number is less than normal for the SR system.

Figure 11 presents the same 29 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. Ten responses from January through March are related to the "Cell" category. These Cell-related responses included many of the Critical and Near-Critical SRs. Five responses were made under the "Instruments" category while four responses were within the "Building" category. Responses also occurred in the "Computer/Network," "Pit," "Telescope," "Thermal System," and "Weather Systems" categories.

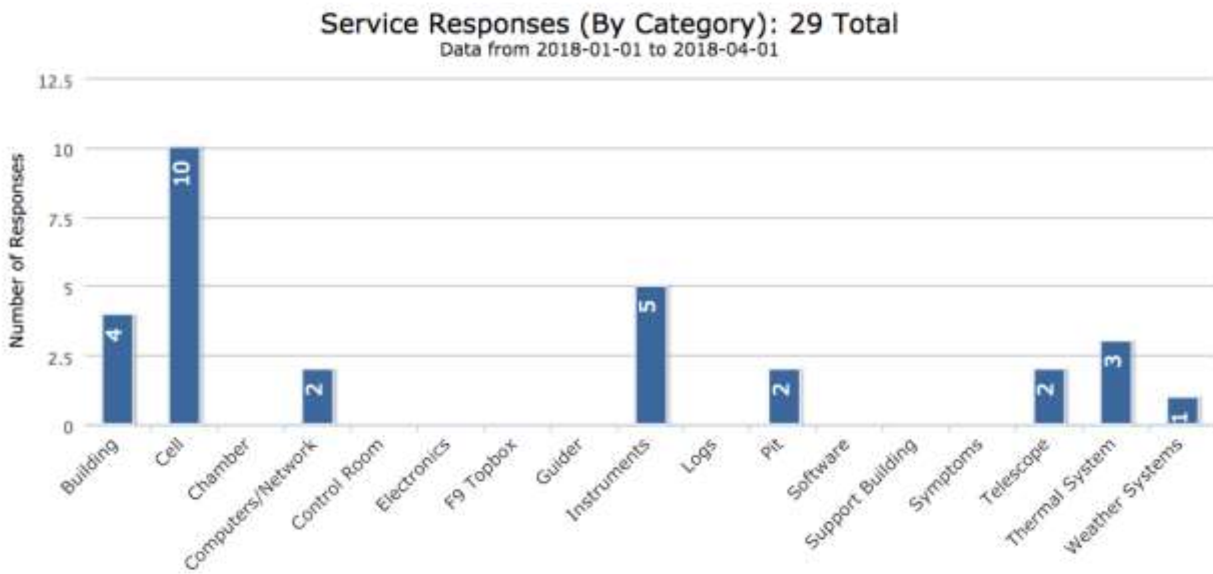

Figure 11. Service Request responses by category during January through March 2018. The number of responses are listed with the category.

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

January 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	30.00	353.50	120.65	1.00	0.00	0.00	0.00	121.65
PI Instr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Engr	1.00	11.50	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**31.00**	**365.00**	**120.65**	**1.00**	**0.00**	**0.00**	**0.00**	**121.65**

Time Summary

Percentage of time scheduled for observing	96.8
Percentage of time scheduled for engineering	3.2
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	33.1
Percentage of time lost to instrument	0.3
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	33.3

* Breakdown of hours lost to instrument

1.00 Grating issue with Blue Channel

February 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	6.00	67.90	12.25	0.00	0.00	0.00	0.00	12.25
PI Instr	20.00	222.00	145.46	11.05	0.00	0.00	0.00	156.51
Engr	2.00	22.30	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	**28.00**	**312.20**	**168.51**	**11.05**	**0.00**	**0.00**	**0.00**	**179.56**

Time Summary

Percentage of time scheduled for observing	92.9
Percentage of time scheduled for engineering	7.1
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	54.0
Percentage of time lost to instrument	3.5
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	57.5

* Breakdown of hours lost to instrument

1.00 Binospec software issue
10.05 Hecto gripper failure

Year to Date February 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	36.00	421.40	132.90	1.00	0.00	0.00	0.00	133.90
PI Instr	20.00	222.00	145.46	11.05	0.00	0.00	0.00	156.51
Engr	3.00	33.80	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	**59.00**	**677.20**	**289.16**	**12.05**	**0.00**	**0.00**	**0.00**	**301.21**

Time Summary

Percentage of time scheduled for observing	95.0
Percentage of time scheduled for engineering	5.0
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	42.7
Percentage of time lost to instrument	1.8
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	44.5

March 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	8.00	85.20	56.90	0.00	0.00	0.00	0.00	56.90
PI Instr	23.00	233.30	103.66	7.48	3.00	0.00	0.00	114.14
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**	**318.50**	**160.56**	**7.48**	**3.00**	**0.00**	**0.00**	**171.04**

Time Summary

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	50.4
Percentage of time lost to instrument	2.3
Percentage of time lost to telescope	0.9
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	53.7

* Breakdown of hours lost to instrument

1.50 Hecto following error
1.00 Hecto guide probe 3 problem
1.00 Hecto robot problem
0.75 Hecto robot following error
1.90 Hecto following error; guide probe not aligning;
1.33 Hecto fiber positioner robot failure

** Breakdown of hours lost to telescope

3.00 Primary support line failure

Year to Date March 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	44.00	506.60	189.80	1.00	0.00	0.00	0.00	190.80
PI Instr	43.00	455.30	249.12	18.53	3.00	0.00	0.00	270.65
Engr	3.00	33.80	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	**90.00**	**995.70**	**449.72**	**19.53**	**3.00**	**0.00**	**0.00**	**472.25**

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	45.2
Percentage of time lost to instrument	2.0
Percentage of time lost to telescope	0.3
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	47.4