Smithsonian Institution &
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End of Quarter Summary

July - September 2015

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

Staffing

An opening for an Electrical Engineer position was posted late in the previous quarter. Telephone interviews were conducted with six candidates on August 27, September 3, and September 24.

Two Queue Observer positions were posted on September 28. Interviews will be scheduled in the next quarter.

Scheduling

Summer shutdown started on July 21 and ended on August 24. An all-hands cleaning day of the observatory took place on the final day of shutdown, and the observatory reopened on August 25.

Reports and Publications

There were 13 peer-reviewed publications and four non MMT-related publications during this reporting period. No technical memoranda or reports were generated. See the listing of publications in Appendix I, p. 20.

Presentations and Conferences

J. Hinz gave a presentation entitled "MMT Observatory: Current Capabilities and Plans through 2016" at the Steward Observatory Internal Symposium on August 21.

J. Hinz gave a talk entitled "Updates from the MMT Observatory" on September 2 as part of *Cosmology Seminar Wednesday* at the Arizona State University's School of Earth and Space Exploration. ASU is a full Arizona consortium partner.

Safety

C. Knop, J. Di Miceli, and R. Ortiz attended the National Safety Council Expo held September 28-30 in Atlanta, Georgia. During this expo they attended presentations on topics including generating a workplace safety culture, cell phone use while driving, risk assessment, and strategies for management to promote safe environments. The conference also provided information on the latest safety industry trends, discovery of new products and available services, and networking with other professionals in the safety field.

The Smithsonian Institution (SI) commissioned a fall-prevention safety study as part of the project to re-panel the MMT roof shutters. The roofing plans have been updated per the study's recommendation, adding new caged access ladders and a rail/slider for clipping to a safety harness. This will allow personnel wearing a safety harness access over shutters with one clip-on.

Following up on a report by T. Gerl last quarter on an imbalance run-away that occurred May 8, a full report was prepared by D. Blanco and circulated to senior staff for comment and discussion. A lock-out tag-out procedure has been implemented in response to guard against a recurrence.

Safety Inspections

The annual laser audit was conducted on September 21.

Primary Mirror

Mirror Support

Earlier this year, a new power supply chassis for the mirror cell VME crate was built to unify the power supplies into a single Excelsys 6-slot 1U chassis and to incorporate the AC control switch for turning off the 48V actuator power supply. It was installed in the cell control rack during summer shutdown. During installation we found that the VME crate ground is tied to the AC earth ground somewhere in the system. This ground loop contributed to noise issues with the analog signals in the cell system, and made for random failure of the actuator bump tests on individual actuators. We will repair the old power supply chassis that failed before shutdown and re-install it until we can sort out the cell system grounding.

While the newer power supply has the noise issues, it is usable as a spare in the meantime.

Coating & Aluminization

Although additional aluminization control system testing at Sunnyside was included in the project schedule, the amount of time required to finish this task was greatly underestimated. Based on previous experience using the Sunnyside coating chambers, the testing was anticipated to take place within two weeks. Instead, three months were needed. This has ultimately resulted in a more reliable control system and a very well understood filament heating curve. However, the underestimation of time has delayed full system testing at base camp until January 2016.

The bell jar assembly at base camp was last pumped on June 24. When checked on September 22, the bell jar and roughing line pressures had risen from 20 milliTorr to 6 Torr. Since the bell jar is expected to be stored under rough vacuum at base camp between aluminizations, a mechanical vacuum pump has been purchased to periodically pump on the bell jar. With this pump, the pumping trailer will only be necessary for pumping if the bell jar has been brought up to atmospheric pressure. Additionally, this mechanical pump will serve as the foreline pump for the turbo when the bell jar is used at base camp. Delivery of the mechanical pump is expected by the end of October, and high vacuum testing of the bell jar assembly will be started shortly after this.

In early July, fabrication of the redesigned welder control boxes was finished, and the control boxes were moved to Sunnyside for testing using two welders and a load resistor. All eleven boxes (the ten required and one spare) were checked out, and two boxes were randomly selected for further use in both the small and large Sunnyside coating chambers. Small chamber testing revealed that a large inrush current was overloading the circuit board trace that handles the 24 VAC auxiliary power from the welder. The welder boxes were reworked to include a current limiting device for this trace, and all of the welder boxes were retested using a load resistor. The redesigned welder boxes incorporate a number of enhancements such as test points and separate grounds for the computer and welder side of the system. These enhancements have resulted in less noise in the welder data and have eliminated the uncontrolled interaction between the two welders at the start of the process.

In addition to testing the redesigned welder control boxes, this round of Sunnyside testing was used to verify proper operation of the software changes made since October 2014. The software process, Enable Manager, was added to enable the welders in a very controlled and predictable manner. With the two welders at Sunnyside, the Enable Manager would enable the second welder eight seconds after enabling the first welder. When the system is expanded to ten welders for base camp testing, the Enable Manager will be programmed to enable two welders simultaneously with a three-second delay between each pair of welders. Software was selected over hardware for handling the manner in which the welders are enabled. This will easily allow timing changes after more experience is gathered during full system testing at base camp.

During this campaign at Sunnyside, twenty small-chamber tests and three large-chamber tests were completed. As the coating process evolved, the control parameters were manipulated in order to reduce the possibility of reaching the internal current limit of the welders. Based on the gathered data, the filament power is initially increased and held at a level in which the aluminum has not yet melted. This allows the filament resistance to increase, which keeps the welders below the current limit (990 amps). Once the filament resistance in high enough, the filament power increases to the maximum value which is presently set to 9600 W. To verify process repeatability, the last two large-chamber tests were run with the same process parameters, and the process is very consistent (Figure 1). Furthermore, no drips were observed during testing using this filament heating profile. The Sunnyside coating facility has been returned to normal operation, and most of the coating system has been moved to base camp in preparation for testing there.

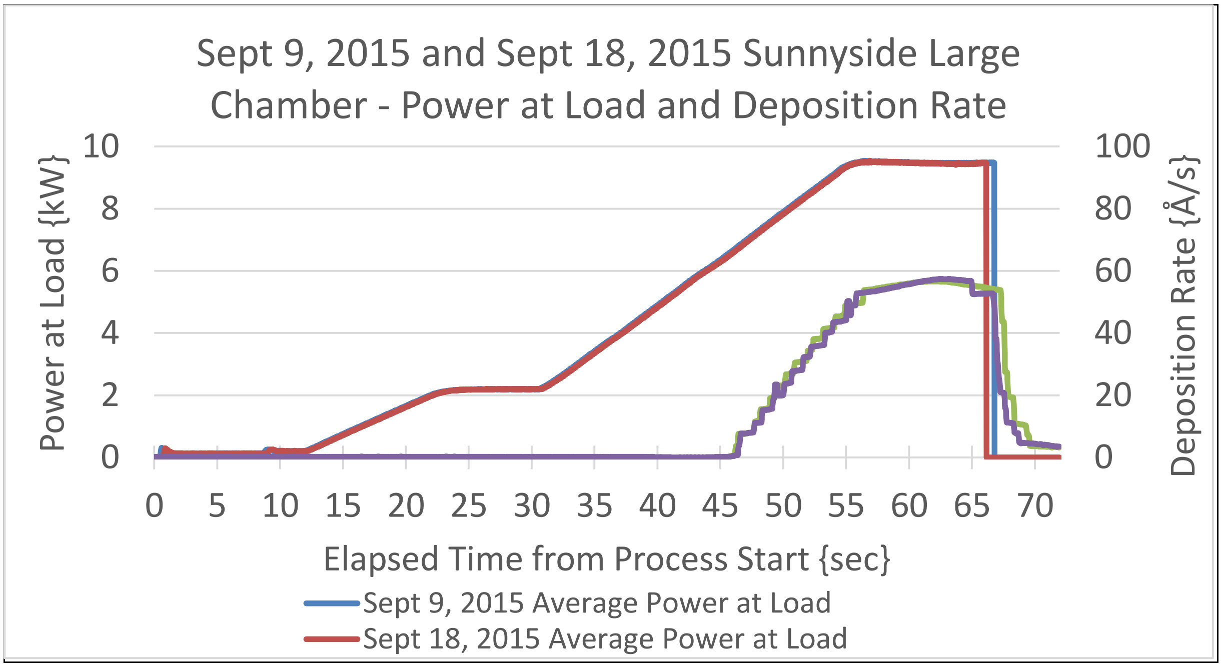

Figure 1. Comparison of last two Sunnyside large-chamber tests

Testing will resume after summer shutdown. At that time, we expect to freeze the control algorithm development and then work on data logging and safety-check software in the aluminization control system.

Ventilation and Thermal Systems

The southeast Type T thermal enclosure was assembled and tested in the electronics shop. Two differential thermopile cards and one absolute temperature card were installed. This final T-series enclosure was mounted next to the air control cabinet on the SE side of the mirror cell.

All thermocouple cables had Omega two-pin connectors installed. The probes were connected to each card, and a document was created describing the location and channel of each probe. Testing showed good data from the unit. The software group is adding the data to the engineering page.

Secondary Mirrors

f/15

Final assembly of the adaptive optics (AO) smart card enclosure was completed. The unit will now be programmed and tested with the AO power supplies. We will also construct a lab cable for pre-deployment testing of the power supply system before releasing it for use on the telescope.

During summer shutdown, a round of cleanup and removal of old parts was done on the f/15 NGS Topbox. Several items no longer used inside the enclosures were removed. The cable runs inside the top box were reworked to help alleviate reliability issues with the connections and wiring inside the top box. Unfortunately, the (very delicate) pellicle lens was broken during the cleaning process and had to be replaced. An improved bracket was made to support the cables and cooling lines going to the WFS camera, as well as more clearly marking the rotation zero and limits on the WFS stage. The alignment laser wiring was reworked to remove the loose cable terminal blocks in the top box as well.

Hexapods

f/9 and f/15 hexapod

B. Comisso worked on finding the source of the noise on the f/9 hexapod transducers that has occasionally tripped the annunciator encoder/transducer mismatch warning. We had earlier information that the problem arose repeatedly when the chamber was open and the telescope azimuth was between 50 and 60 degrees. He identified the cause as the radio repeater for the FLWO radio repeater, which has a large amplifier driving the antenna located near the water tank behind the shop.

We isolated the RF interference by connecting a spare f/9 hexapod strut to the test box. Measurements of the signal conditioner output were taken in the electronics shop using a scope and DMM. The test fixture was then put in the loading dock and the same measurements were taken. In both the electronic shop and in the loading dock area with the doors closed, the transducer output was nominal. But when the mountain radio was keyed, an increase of about 10% in the transducer signal output was noticed.

The loading docks were then opened and the same test was run. A significant change in the transducer output occurred whenever the FLWO radio was keyed, large enough to cause an annunciator warning. The work done so far regarding this issue are in SR#1118; we reported the issue to FLWO, and we are unsure how to proceed to mitigate the RFI problem, which may affect other equipment in the MMT besides the hexapods at azimuths towards the repeater antenna.

Optics Support Structure

Nothing to report.

Pointing and Tracking

Rotator

During summer shutdown, a "best effort" was attempted to get the rotator tape heads aligned, but was not as successful as hoped. Shortly after shutdown one of the two heads failed and had to be replaced with a spare from the elevation axis, which is a different type. This difference required an inline adapter to make it compatible with the encoder interpolator box. Pricing and delivery information was requested and received from the vendor Heidenhain for replacing the rotator tape heads. We are also discussing replacing the entire tape.
The failure reinforced the need for good mechanical drawings to ensure being able to properly locate and align the heads with a new bracket.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on the MMT for 10.5% of the available nights from July 1 through September 30 (not including summer shutdown). There were only 48.2 hours allocated for f/9 observations this quarter, all of which were with the Blue Channel Spectrograph. Of these hours, 83% were lost to weather conditions as the monsoon season began. Two hours were lost due to focus issues involving the spectrograph.

f/5 Instrumentation

The network ports set aside last reporting period for the SAO Instrument VLAN were each labeled early in this period, and plugs were installed in the ports to remind users that these are specialized ports without access to the mmto and external network. Cat 6 cables on the SAO Instrument network are yellow. One MMT network cable in 2E, which happened to be yellow, was tagged with blue tape to identify it as non -SAO-VLAN.

There were many cloudy and stormy nights this quarter following similar weather at the end of the previous quarter. There were 397 scheduled hours for HectoSpec, HectoChelle, MMIRS, and MMTCam this quarter. Weather prevented operation for 285 of those hours. The weather improved in late September. A failure of an electronics card for the secondary support system resulted in four hours of lost sky time while the problem was diagnosed and the spare card was installed. Another hour was lost to issues with the blower. A half hour was lost, attributed to issues with the MMIRS WaveFrontSensor software as people took time to learn to operate with the new software and fixes made to it to accommodate brighter targets.

There were difficulties with the computer that controls the Hecto acquisition/guiding cameras this quarter. It would often boot up but not properly initialize its three PCI frame grabber cards. Eventually it properly initialized the cards after a few reboots, but it took time to establish the proper diagnostics for the situation. It is not clear if the issue is with the computer's PCI bus controller/electronics or with the frame grabber cards themselves. The spare computer with additional frame grabber cards failed to boot when we attempted a switchover. That issue was corrected by cloning the hard drive from the first computer and installing it in the spare computer. Additional testing is planned.

There was an issue during a switchover night from Chelle to Spec. The electronics failed to detect that the fiber shoe had been mounted on the Spec bench. The problem was corrected with a little double-stick tape and shim stock. For some reason the "on" position of the mechanical switches had shifted a little.

The power from the new SAO UPS does not seem to agree with the power supplies on the new MMIRS server computers. The *endeavour* computer went down on the night of Sept. 24 because of this. The computer was then plugged directly into an outlet connected to the MGE and has operated happily for more than three weeks in that configuration. Similar issues had been noted when we were able to bring up the computer in July, but the root cause is not certain. The power produced by the UPS, in addition to having some higher harmonics (not a smooth sine wave), has occasional dips/spikes of 2%-15% for a fraction of a second. We are exploring some options to smooth out these spikes. A better line filter, such as those installed on the Hecto racks, might be needed to clean the power.

The MMIRS commissioning run continued this quarter, and several issues were corrected for operation at the MMT with a new computer configuration and updated code. There are still some issues including low data transfer speeds which are being investigated. During the seven nights that were not clouded out, 1,420 science exposures were taken. Almost 1,000 calibration images were taken to support these science images including dark, mask alignment, test, flat field, and comparison lamp exposures. The installation and operational procedures are being updated to reflect what was learned during this run.

Very little HectoSpec and HectoChelle data was gathered over the scheduled 35 days this quarter due to the weather. Sixty science exposures were taken on seven nights between two runs in early July and early September. Nearly 800 calibration exposures (bias, flat, comp, dark, and sky) were taken, many in anticipation of improving weather that didn't materialize on the given night. The motherboard in the *clark* computer was changed to correct the issues noted in the last report, and the computer operated properly through the quarter.

No MMTCam images were gathered and SWIRC was not scheduled.

f/15 Instrumentation

There was one adaptive optics run during August. The run consisted of three Maintenance & Engineering (M&E) nights, and one engineering and development night for the nonlinear curvature wavefront sensor (nlCWFS) being developed by Olivier Guyon. All three M&E nights were lost to weather. We were, however, able to open on the nlCWFS development night and had stable, excellent seeing throughout the night. The observers left with more than enough data to proceed with development work for the next stage.

In addition to the August AO run, the following considerable work was performed over the summer shutdown to improve both the reliability and performance of the NGS-AO system:

1) The highest priority work for improving the system reliability was to replace the WFS camera 80 ft. long SCSI cable with fiber, and integrate a Cameralink-based fiber converter frame grabber card in the control computer ao-pcr. The work was nearly completed, but a lack of on-sky time prevented us from testing the system completely.

2) Additional work was done to improve system performance. The optimal PID code, which had previously been the baseline version of the controller, was re-implemented. Again, lack of sky time due to weather prevented us from final performance evaluation.

3) A seeing-limited mode was implemented and tested. Issues with the code were identified and fixed, and we hope to test the algorithm during the next available M&E night.

4) We now have the capability of reading in accelerometer data from the deformable mirror (DM) which will allow us to use a feed-forward algorithm for image stabilization of the 20 Hz structural mode of the secondary hub. Implementing this algorithm has the greatest potential for improving system performance.

5) New reconstructors are being developed that will correct more spatial modes and provide better position calibration for the DM. This work is ongoing and will probably not be ready to test during the next available M&E night.

Topboxes and Wavefront Sensors (WFS)

f/5 WFS

Work continued on the WFS software for MMIRS as in the previous quarter.

Based on the progress during the June MMIRS commissioning run, further tweaks were made to the WFS code. These tweaks have provided a more stable background subtraction (using a large-scale filtered image rather than two-dimensional planar fit to the background). This higher fidelity background subtraction, combined with the allowance for the software to identify spots to slightly fainter thresholds, has resulted in a more robust spot-finding. The presence of high background with fainter stars, compared to the very bright V~6 stars utilized when doing WFS on-axis, will lead to a more delicate system than on-axis operations. Therefore, further refinements are planned to allow the detection of fainter spots and to increase the fidelity of spot identification for faint spots.

In addition to MMIRS-specific changes to the WFS, a prototype system has been designed (and is currently being ported to be compatible with the existing WFS software suite) which will utilize the outputs of the WFS fitting to predict the best possible seeing given the Zernike residuals. This best-seeing can then be compared to the seeing that's being measured by spot size in the WFS images, and will give the operators a quantitative signal when further iterations of the WFS software will no longer result in improved image quality. In tandem with this, new, more informative, plot outputs are being designed that will be displayed during the WFS fitting process, which should shed more light on the overall image quality and robustness of the Zernike fitting and spot correlation.

Facilities

Main Enclosure

Summer shutdown activities included:

- extensive cleaning of the pit and the building track
- the front shutters were rewired
- new circuits were added to the control room bench
- the leak above the crane was sealed
- new pulleys and new cover attachment line were installed on the primary mirror cover
- telescope air compressors were serviced
- the deck west of the yoke was painted

General Infrastructure

Progress was made on these Smithsonian Institution-funded projects:

<u>MMT Lift</u>

This is a new project to replace the existing dock lift with a new in-ground lift capable of raising six tons to the observing chamber door. The contract was bid and awarded to SM&R. Specifications for the lift were reviewed and approved, and an order for the lift has been placed. Excavation is expected to begin in December. (OFEO #1583804)

<u>HVAC Upgrades</u>

Work continued on the HVAC project, which includes a number of needed upgrades to aging HVAC equipment at the MMT. Most of the new HVAC mechanical equipment has been installed. Plumbing runs have been completed from the new Carrier to new glycol pumps by the shop, but this plumbing has yet to be tied in. Conduits and electrical boxes for the control system were installed and inspected, and the new BACnet control system is now in place. Communications with the new system have been established. Four fan-coil units were installed in the building, and were connected to a BACnet controller. With these we were able to cool the control room during the last warm nights of the summer season. (OFEO # 1283807)

The MMT engineering group is now working on establishing communications with the new equipment through the new BACnet control system. BACnet is a versatile industry standard communications and control protocol specifically developed for building and industrial building automation systems. This will replace much of our aging logging and telemetry equipment currently used for thermal control of the primary mirror. BACnet also provides a path for upgrading many other aging control systems at the observatory.

During the interim, we will maintain the present thermal control scheme, but the new control system is intended to operate differently. Rather than changing the chiller set point to track ambient temperature, the new system will regulate the flow of glycol to the air heat exchangers using variable control valves, while maintaining the glycol at a constant temperature well below ambient. This is a more common scheme for industrial thermal control and should provide responsive and efficient control of the primary mirror temperature.

Repairs to Heated Summit Road

Work started on demolishing some of the old concrete and asphalt on the summit road, making way for a new covered drainage ditch on the inner edge and a new cable barrier along the outer edge. This work will continue through the fall with completion expected in the spring of 2016. Documents are posted at Administration/SI Projects/MMT Heated Road/Submissions (OFEO # 0883805)

Computers and Information Technology

Computers and Storage

The previous backup for the observer machine, *gilead,* was retired from its location in 3E. In its place, a computer identical to *pixel* has been set up as the right monitor (in dual monitor mode) at the observer's station. In the event that *pixel* suffers a catastrophic failure, a simple swap of USB hardware in the left screen to the right screen and rebooting the computer will result in a fully functioning second *pixel* while any problems are solved with the primary observing computer. *Gilead* has been retired to the campus offices as has the previous second monitor in use on *pixel.*

Hardware/Software Interfaces

Telescope Operator Acquisition Monitor Upgrades

A new LCD acquisition monitor was installed at the operator's station in the control room for the telescope operators to evaluate during this quarter. This new system overlaps with the old system so that the operators can begin evaluating it while still having the old analog version available. The existing analog acquisition display uses a CRT (tube) monitor mounted on a small shelf/arm above the operator station. The CRT monitor is quite heavy and bulky compared to more modern flat screen TVs and monitors. The goal is to transition from old CRT technology (which is becoming/has become obsolete) and replace it with more modern technology. In addition, the current CRT monitor is showing symptoms of a worn out tube and is likely to fail at any time. Replacements of this current CRT model are no longer available.

The existing display system takes the analog video feed from the acquisition camera (in the topbox typically) and sends it through coax cables into the control room. The control room has a video splitter that splits the video feed into three outputs. One of those outputs is to the CRT mounted above the operator. The main advantage the CRT has over a typical computer LCD monitor is that the CRT has a very wide range of adjustment of its brightness and contrast. These controls are easily accessed by using knobs on the front of the monitor. The glass tube of the CRT allows the operators to draw notes and shapes onto the glass using dry erase markers, making it easy to remember each instrument's "sweet spot," for example.

In the past, a few different attempts were made to replace the CRT monitor with various brands/models of LCD computer monitors. Each of these attempts quickly failed as limitations were discovered and no workarounds could be found. Each of these attempts used an LCD monitor connected to the coax (BNC) connection using various VGA-to-BNC converters, thus the signal remained analog. It was discovered that the brightness and contrast range of the LCD display was extremely limited compared to the CRT, and proved unusable by the telescope operators on very dim stars and in cases where the telescope was not yet focused due to a secondary mirror change earlier in the day. Also, brightness and contrast adjustments for almost all LCD monitors are made through confusing on-screen menus making it time consuming to make adjustments.

The new approach being evaluated by the operators is different from the previous attempts in several ways. The LCD chosen is a 13" 1080p HD display that is also a touch screen. This new LCD is not capable of handling an analog input signal like the earlier attempts, so the analog signal is first digitized using an AXIS M7001 network video encoder. The AXIS M7001 converts the analog video signal into a digital motion JPEG (MJPEG) video stream and makes it available on the MMT computer network. A small "shuttle" computer running Windows 10 was placed on the operators' desk and connected to the new LCD using an HDMI cable. The LCD was installed on a sturdy desk-mounted adjustable arm allowing for easy positioning of the display as well as providing a stable structure to minimize wobbling as the building rotates. The touch capabilities of the new monitor allow for shapes and text to be drawn on the screen with an operator's finger or with a stylus (similar to an iPad app).

What makes this new version work more effectively than the previously failed LCD attempts is that the video is now digital rather than remaining analog. The shuttle computer connects to the MJPEG digital video stream through the network, and displays it within a new custom user interface. The limitations of brightness/contrast encountered with the previous attempts are addressed by processing the video in real-time on the computer, and modifying the displayed video frames with adjusted pixel values. This video processing is done using the shuttle computer's integrated graphics hardware resulting in no noticeable video delay. Having this ability to adjust the pixel data in real-time as it's being displayed not only increases the range of the brightness contrast to levels that exceed the CRT, it also allows for many new custom filters to be created, giving the operators even more flexibility. Some of these new custom filters include image sharpening and gradient color mapping among others. A list of the ten filters present are available in the new user interface, as well as a color gradient slider that gives the operator full control of the filter parameters.

Early tests have shown that this new system is effective for the operators in the situations where the earlier LCD attempts failed. The operators will continue to evaluate the new system for a few additional weeks and provide more feedback. If the operators are comfortable with the new system after that time, a final version will be assembled based on the feedback, and will be installed permanently. The hardware being used for the current prototype will be moved to the observer's station in the control room.

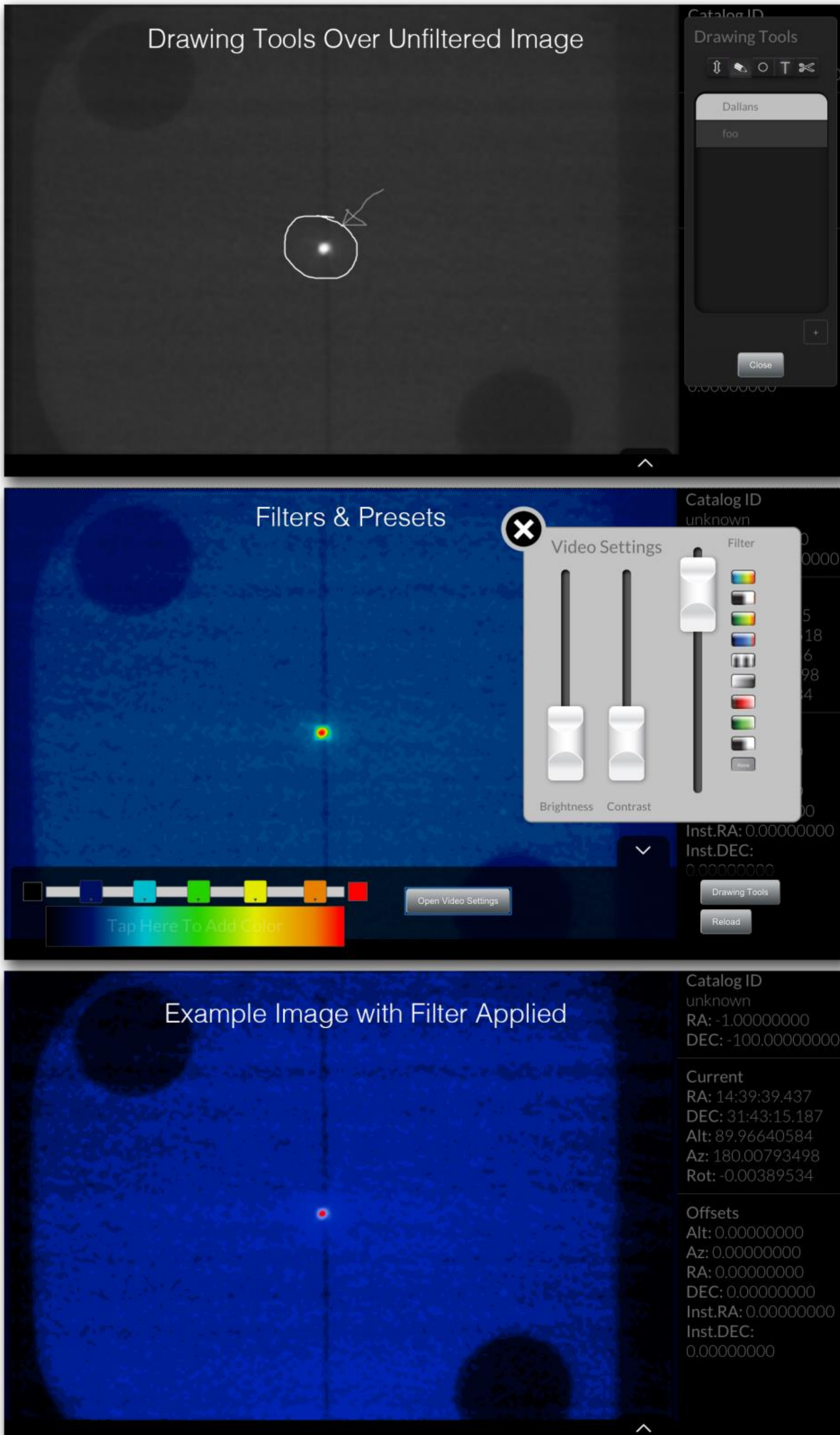

Figure 2. Examples of an image with available drawing tools and filters.

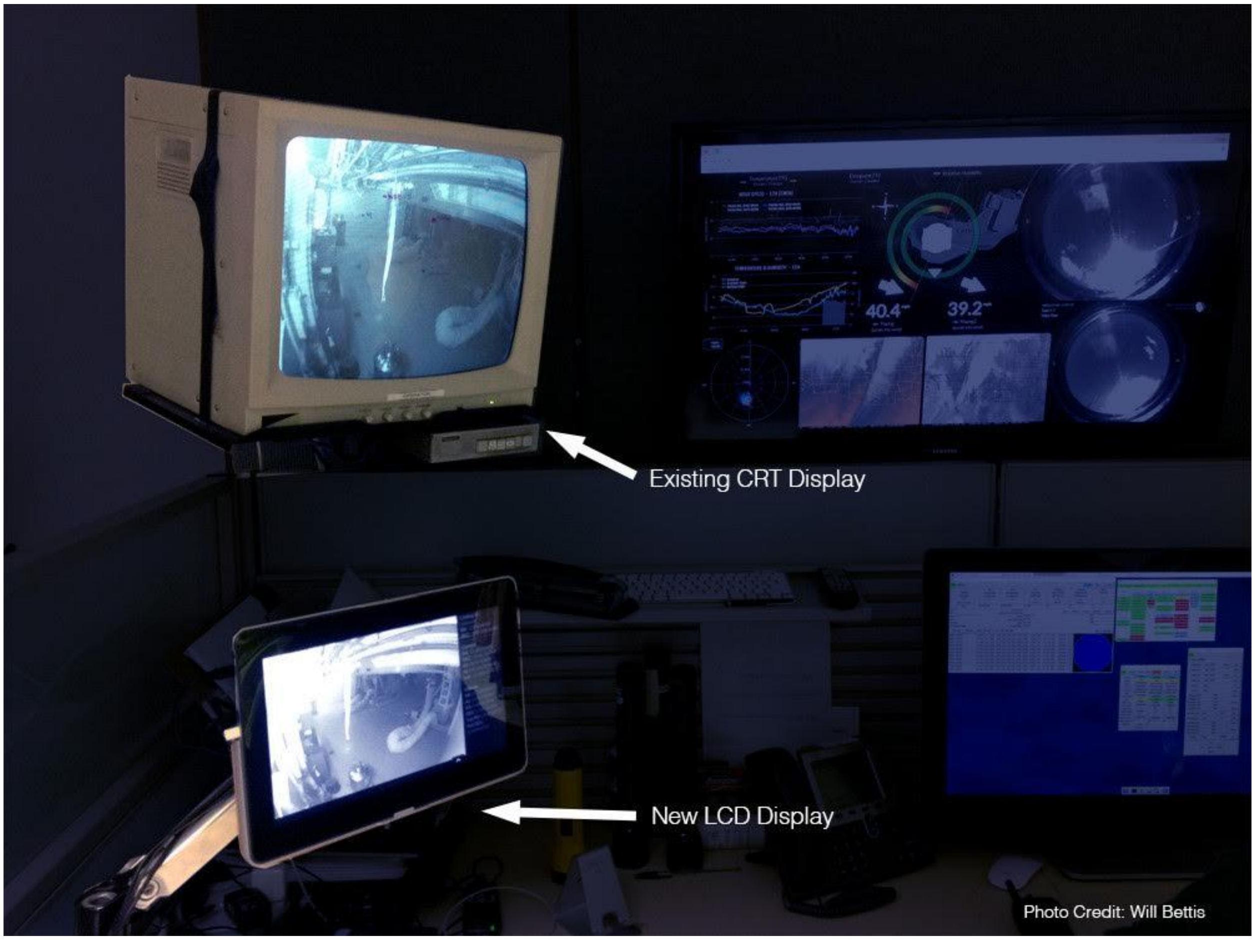

Figure 3. Old and new displays.

HVAC Upgrade

Modest progress was made on the HVAC upgrade during this reporting period. Work by various contractors focused more on the mechanical and electrical installation aspects of this upgrade, rather than software-related automation and control.

Logging and plotting of dozens to hundreds of new parameters is anticipated as part of this upgrade. New methods of hardware automation and control are needed. The current "miniserver" approach, which uses a central Perl library, must be modified to accommodate the BACnet (http://www.bacnet.org/) communications protocol. Work continues on becoming familiar with this comprehensive but complex protocol. Various approaches to logging data and automated control of the primary mirror ventilation system ("vent_auto") were considered. It is hoped that the new HVAC system will be fully in place during the next few weeks to months. The performance of the new system can then be evaluated once it is online.

Miscellaneous

Additional software tasks included:

1) All SOAP communications protocols being used were replaced. This included the Blue/Red Spectrograph server and its clients, the comparison lamp server and its clients, and the telSOAP server and its clients.
2) Eleven Fedora 21 machines were upgraded to Fedora 22.
3) The IDL license on *mmto* was updated to 8.5.
4) A replacement for yum-cron was developed, since dnf-automatic being used doesn't do quite the same thing.
5) Work began on a problem with the alx ethernet driver that is used by *chisel* and *pipewrench*, but the issue is still presently unresolved.
6) Work was done on the audit daemon to reduce the number of needless messages.
7) Documentation on Cisco switches was researched to see if there might be a log to help find the rogue network device broadcasting with an invalid source MAC address of 00:00:00:00:00:00. There is such a log, but we do not have access to it. The device was found by other means and removed from the network.
8) The loft Neslab annunciator checks for the MMIRS instrument was reactivated. It had been deactivated when the instrument went to the Magellan telescope in 2010.
9) Work began on gathering and logging data from a new Edgetech model COM.AIR compressed air dew-point monitor. This device will monitor the compressed air used to lift the primary mirror, ensuring that the air is dry.
10) Machine-learning techniques were investigated as a replacement for the current primary mirror control software ("vent_auto"), including Python's scikit.learn module.
11) Various MySQL replication errors were fixed.
12) Work was done on a draft graphical user interface (GUI) for the new glycol pumps as part of the HVAC upgrade. Testing of this and related GUIs will need to wait until the pumps and other HVAC equipment are completely installed.
13) Telescope-site computers were opened and cleaned during summer shutdown. Old fans were also replaced in *pipewrench* (AO operator computer and backup to telescope operator computer).
14) Work continued at Sunnyside on testing for next summer's aluminization of the MMT primary mirror.
15) Coordination with the software staff at the Harvard-Smithsonian Center for Astrophysics (CfA) on re-commissioning MMIRS at the MMTO.

Weather and Environmental Monitoring

Seeing

Figures 4 and 5 present apparent seeing values, corrected to zenith, at the MMTO for the period of July 1-October 1. These values are derived from measurements made by the f/5 and f/9 WFSs. Figure 4 presents the seeing values as a histogram with 0.1 arcsec bins, while Figure 5 presents the same data as a time-series chart. In Figure 4, f/5 seeing data are shown in blue, f/9 data are in green, and combined f/5 + f/9 data are in red. In Figure 5, seeing measurements for the f/5 are shown as blue circles while f/9 WFS seeing measurements are represented by green triangles. This time-series chart in Figure 5 shows the summer shutdown from mid-July to mid-August, and the conversion from f/5 to f/9 configuration before summer shutdown. Very little data (27 seeing values) was collected in the f/9 configuration. No data were collected during f/15 configurations.

The MMT and Magellan Infrared Spectrograph (MMIRS), a wide-field near-IR imager and multi-object spectrograph originally commissioned at the MMT in 2009, was re-commissioned at the MMTO in June after five years at Magellan (2010-2015). MMIRS was on the telescope this quarter in both early July and in late September. Data from that instrument dominates the seeing data presented here as discussed below.

MMIRS generates WFS-related seeing values much more quickly than other f/5 or f/9 instruments. Of the 1766 total f/5 samples during this reporting period, 1650 are from MMIRS. There are only 27 seeing measurements from f/9 instruments and only 116 f/5 seeing values that are not from MMIRS. This results in the seeing data for this reporting period being highly biased towards the few nights that MMIRS was on the telescope. As previously mentioned, no seeing data was collected during summer shutdown, which represents a significant portion of the reporting period.

The median f/5 seeing value is 1.04 arcsec while the median f/9 seeing value is 0.83 arcsec. The combined median seeing for the two WFS systems is 1.04 arcsec. As previously stated, the data are highly biased towards the few nights that MMIRS was used for observing and are not representative of overall seeing trends at the MMTO.

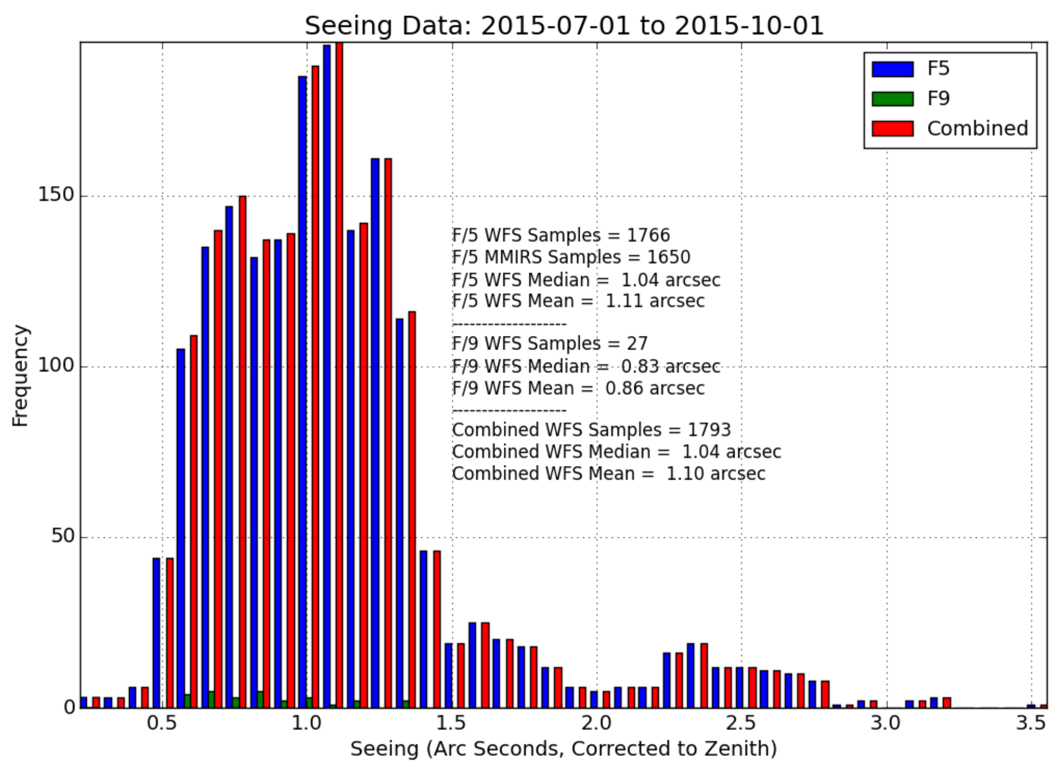

Figure 4. Histogram (with 0.1 arcsec bins) of derived seeing values for the f/5 and f/9 WFSs from July through September 2015. Seeing values are corrected to zenith. Median f/5 seeing is 1.04 arcsec while the

median f/9 seeing is 0.83 arcsec. A combined (f/5+f/9) median seeing value of 1.04 arcsec is found for the 1,793 WFS measurements made during this period. As discussed in the text, these data are highly biased towards the few nights that MMIRS was on the telescope. This bias results in the higher median f/5 and combined f/5 + f/9 seeing values than are typically seen at the MMTO.

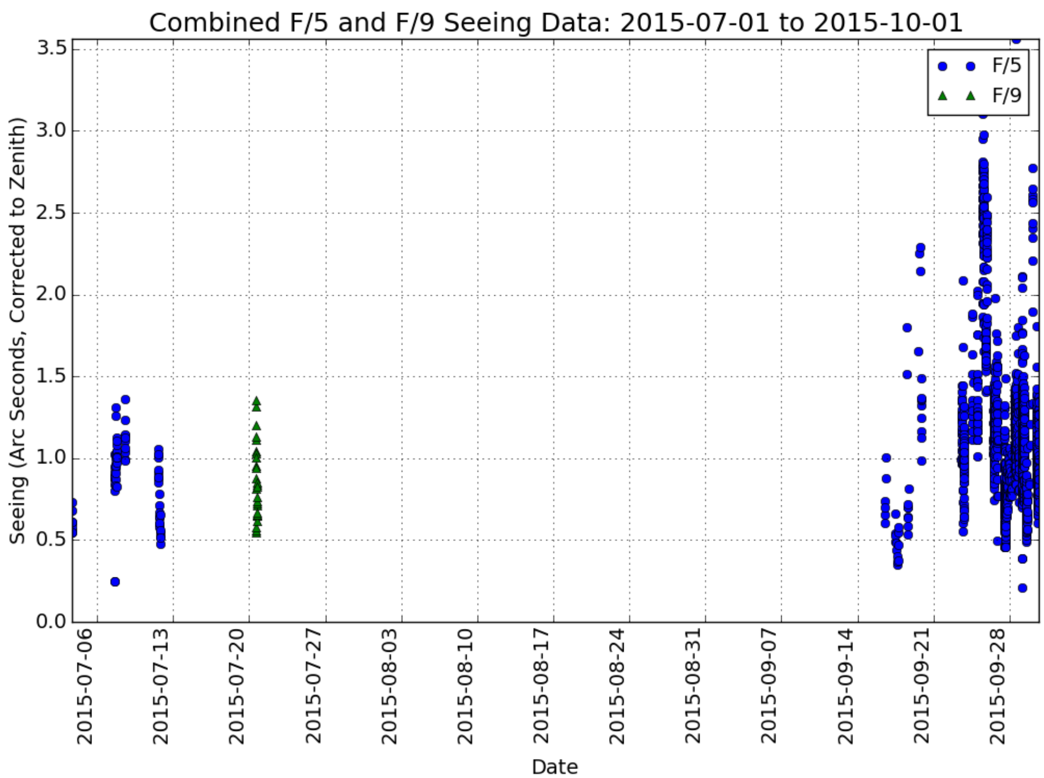

Figure 5. Derived seeing for the f/5 and f/9 WFSs from July through September 2015. Seeing values are corrected to zenith. f/5 seeing values are shown in blue while f/9 values are in green. Data from MMIRS, an f/5 instrument, dominates the data set. No data was collected during the summer shutdown from mid-July to mid-August 2015 and during an f/15 run in late August

User Support

Web Pages

A prototype for the Red and Blue Channel exposure time calculator went into a preliminary alpha for the 2016A (Jan.-April) observing proposal cycle with several missing features, but contained the bulk of the user interface and the backbone of the signal-to-noise calculations. A great deal of user feedback was obtained to make the system more user friendly, and to ensure the data products provided to the user are the most informative that can be provided. We are in the process of adding several missing features (blaze functions and filters) and doing some tweaks to the user interface and final data plots, and anticipate the calculator to be live in the next quarter.

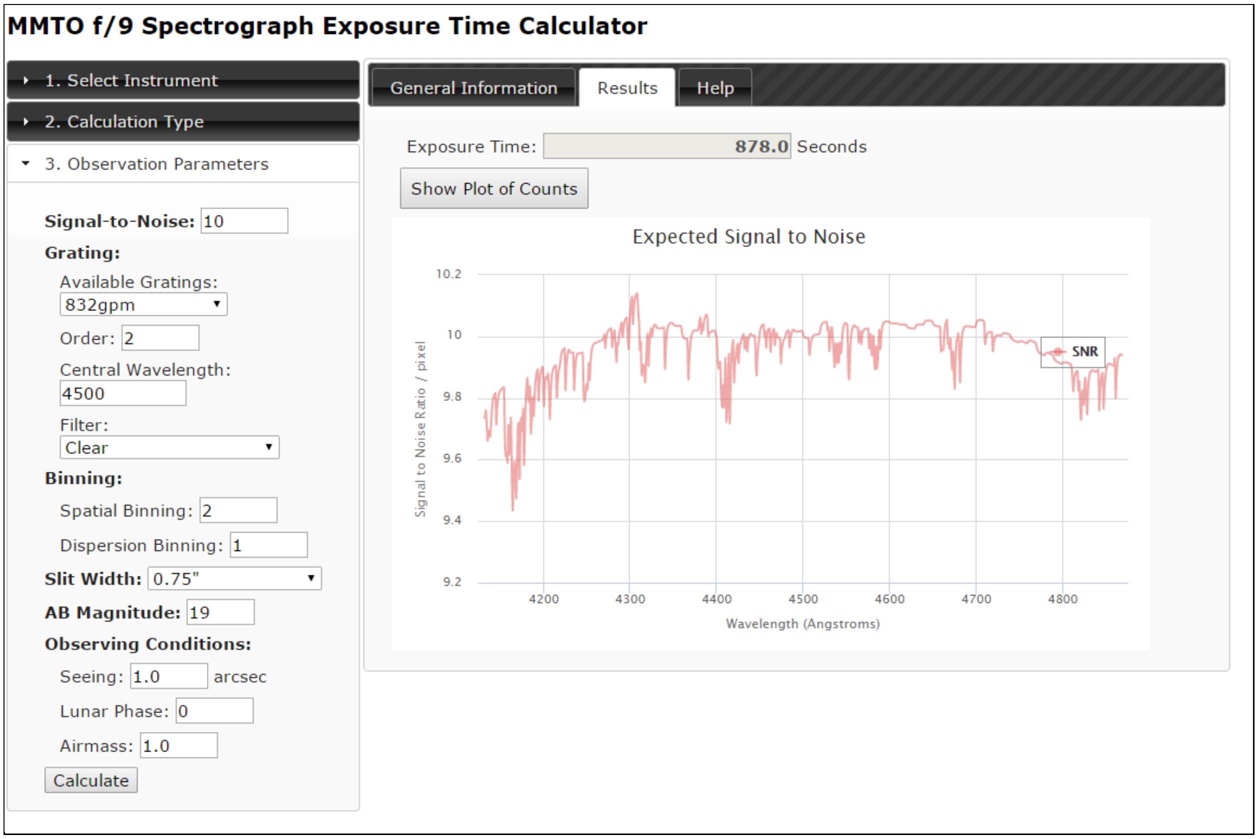

Figure 8. A screen shot of the f/9 exposure time calculator.

Remote Observing

Documentation for remote observers was reviewed to ensure any changes to the hardware and procedures were fully documented. Work to debug why some users experience slow loading of the VNC sessions when utilizing LINUX based vncviewer software was investigated, but no final solution was reached.

Due to the summer shutdown period and a September with only f/5 observing time, only 3.5 nights of remote observing were supported this quarter, with 2.5 for UofA and 1 for CfA.

Data Quality Assessment

Basic tests of data quality have been added to a script that runs weekly on R. Cool's office desktop. These tests monitor qualities such as camera temperature, and measure readnoise and bias levels, to watch for trends that could indicate problems with the detectors in either Red or Blue Channel before they result in lost time or poor data quality. Plans to extend these tests to include monitoring of lamp brightness in the flat and arc lamps are moving forward as well. Finally, a prototype for a "test suite" of routines has been sketched out that could be run after the instrument is mounted and set up. These routines would do a double check of aperture indexing, grating naming, and other steps which require manual assignment in our current software. These scripts would warn the instrument specialists if the central wavelengths, dispersion, or overall counts in a test suite of images appears suspect. The scripts would prevent any unfortunate mistakes that would affect observations.

Data Archive

The data archive on the *mmto1* and *mmto3* NAS boxes was verified and made cross-mountable for staff to utilize the data for data quality pipelines, and to provide data to users if needed. MMIRS data is archived by the CfA procedures in use for MMTCAM and Hectospec/Chelle.

Documentation

Procedures

Procedures for WFSing with MMIRS, as well as guiding with MMIRS, have been documented in the Documentation database. Operators have contributed to the document as the instrument gets more use. This cooperative style of documentation has also highlighted portions of the procedure where the highest chances for inefficiency may appear, which will allow for more robust system design in the future.

Public Relations and Outreach

Visitors and Tours

9/16/15 – A group of 30 visitors with the Smithsonian Journeys tour group visited the F.L. Whipple telescopes and the MMTO.

9/22/15 – C. Alcock, director of the Smithsonian Astrophysical Observatory and the Harvard-Smithsonian Center for Astrophysics, visited the F.L. Whipple Observatory facilities and met with FLWO and MMTO staff.

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)

15-46 Influence of Stellar Multiplicity on Planet Formation. III. Adaptive Optics Imaging of Kepler Stars with Gas Giant Planets
J. Wang, D.A.Fischer, E.P. Horch, J.-W. Xie
ApJ, **806**, 248

15-47 Type IIb Supernova 2013df Entering into an Interaction Phase: A Link between the Progenitor and the Mass Loss
K. Maeda, T. Hattori, D. Milisavljevic, et al.
ApJ, **807**, 35

15-48 Multiwavelength Observations of NaSt1 (WR 122): Equatorial Mass Loss and X-rays from an Interacting Wolf-Rayet Binary
J. Mauerhan, N. Smith, S.D. Van Dyk, et al.
MNRAS, **450**, 2551

15-49 A Systematic Study of the Inner Rotation Curves of Galaxies Observed as Part of the GASS and COLD GASS Surveys
G. Kauffmann, M.-L. Huang, S. Moran, and T.M. Heckman
MNRAS, **451**, 878

15-50 Late-time Spectroscopy of SN 2002hh: A Continued Visible Light Echo with no Shock Interaction Yet
J.E. Andrews, N. Smith, J.C. Mauerhan
MNRAS, **451**, 1413

15-51 A Non-LTE Analysis of the Hot Subdwarf O star BD+28° 4211. II. The Optical Spectrum
M. Latour, G. Fontaine, E.M. Green, P. Brassard
A&A, **579**, 39

15-52 Probing Hypergiant Mass Loss with Adaptive Optics Imaging and Polarimetry in the Infrared: MMT-Pol and LMIRCam Observations of IRC+10420 and VY Canis Majoris
D.P. Shenoy, T.J. Jones, C. Packham, E. Lopez-Rodriguez
AJ, **150**, 15

15-53 A New Catalog of Variable Stars in the Field of the Open Cluster M37
S.-W. Chang, Y.-I. Byun, J.D. Hartman
AJ, **150**, 27

15-54 The UV/Blue Effects of Space Weathering Manifested in S-Complex Asteroids. I. Quantifying Change with Asteroid Age
F. Vilas, A.R. Hendrix
AJ, **150**, 64

15-55 Stellar Radial Velocities in the Old Open Cluster M67 (NGC 2682). I. Memberships, Binaries, and Kinematics
A.M. Geller, D.W. Latham, R.D. Mathieu
AJ, **150**, 97

15-56 Near-Infrared Polarimetric Adaptive Optics Observations of NGC 1068: A Torus Created by a Hydromagnetic Outflow Wind
E. Lopez-Rodriguez, C. Packham, T.J. Jones, R. Nikutta, et al.
MNRAS, **452**, 1902

15-57 The Nature and Orbit of the Ophiuchus Stream
B. Sesar, J. Bovy, E.J. Bernard, N. Caldwell, et al.
ApJ, **809**, 59

15-58 AEGIS-X: Deep Chandra Imaging of the Central Groth Strip
K. Nandra, E.S. Laird, J.A. Aird, M. Salvato, et al.
ApJS, **220**, 10

MMT Technical Memoranda / Reports

None

Non-MMT Related Staff Publications

The Spitzer Survey of Stellar Structure in Galaxies (S4G): Precise Stellar Mass Distributions from Automated Dust Correction at 3.6um
Querejeta, M., Meidt, S. E., Schinnerer, E., et al. (Hinz, J.)
ApJS, **219**, 5

The Spitzer Survey of Stellar Structure in Galaxies (S4G): Multi-component Decomposition Strategies and Data Release
Salo, H., Laurikainen, E., Laine, J., et al. (Hinz, J.)
ApJS, **219**, 4

The Spitzer Survey of Stellar Structure in Galaxies (S4G): Stellar Masses, Sizes, and Radial Profiles for 2352 Nearby Galaxies
Munoz-Mateos, J. C., Sheth, K., Regan M., et al. (Hinz, J.)
ApJS, **219**, 3

The Odd Offset Between the Galactic Disk and Its Bar in NGC 3906
de Swardt, B., Sheth, K., Kim, T. et al. (Hinz, J.)
ApJ, **808**, 90

Appendix II - Service Request (SR) and Response Summary: July - September, 2015

The MMT Service Request (SR) system is an online tool to track ongoing issues that arise primarily during telescope operations, although the system can be used throughout the day and night by the entire staff. Once an SR has been created, staff members create responses to address and eventually close the SR. These SRs and associated responses are logged into a relational database for later reference.

Figure 9 presents the distribution of SR responses by priority during the period of July through September. As seen in the figure, the highest percentage (83%) of responses was "Important" priority. "Near-Critical" and "Low" priority responses were 7% and 5% of the total number of SRs, respectively. "Information Only" SRs were the remaining 5%. There were no "Critical" priority responses. "Critical" SRs address issues that are preventing telescope operation, while "Near-Critical" SRs relate to concerns that pose an imminent threat to continued telescope operation. There were a total of 41 SRs during this three-month period, down from 56 SRs during the previous three-month reporting period. This period includes summer shutdown during which there were no SRs.

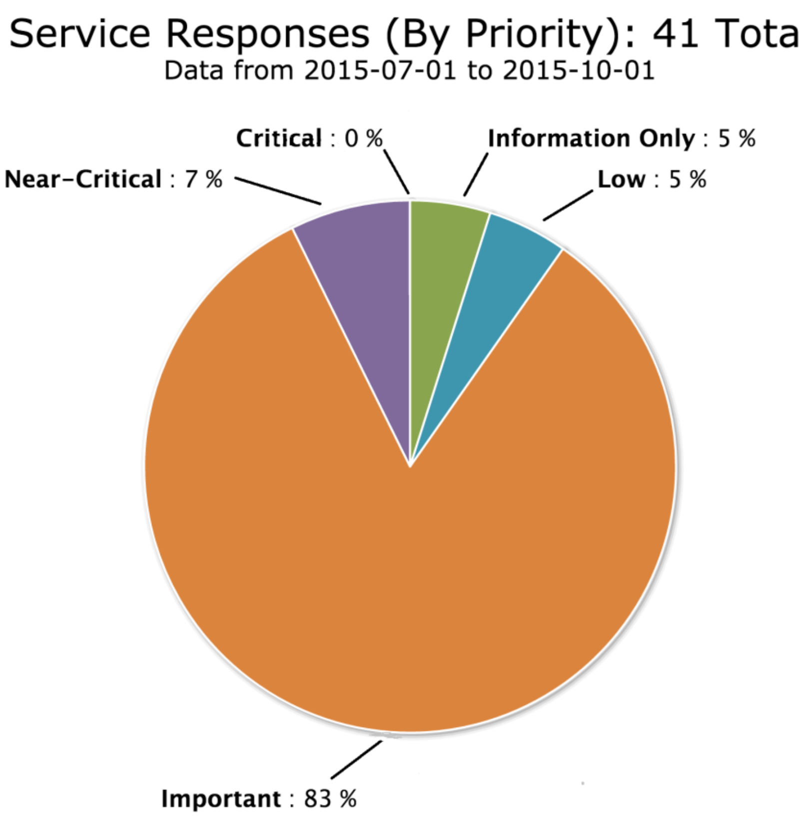

Figure 9. Service Request responses by priority during July through September 2015. The vast majority (83%) of the responses are related to SRs of "Important" priority, while 7% were "Near-Critical" responses. 5% of the responses were "Low" and "Information Only" each, representing 10% of the total. There were no "Critical" responses.

Figure 10 presents the same 41 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. The majority of the responses from July through September were related to the "Weather Systems," "Logs," and "Telescope" categories with 9, 8, and 8 responses, respectively. Responses also occurred in the "Building," "Cell," "Computers/Network," "Support Building," and "Thermal Systems" categories.

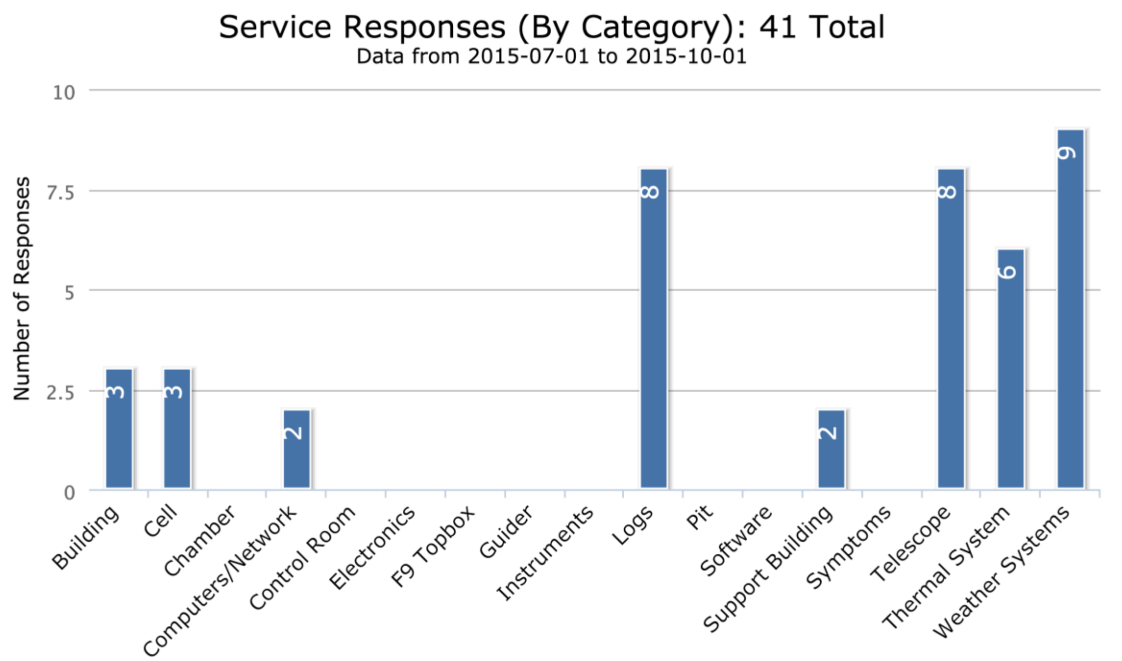

Figure 10. Service Request responses by category during July through Septemer 2015. The majority of responses were within the "Logs," "Telescope," "Thermal System," and "Weather Systems" categories.

Appendix III - Observing Statistics

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

Use of MMT Scientific Observing Time

July 2015

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	48.20	40.10	2.00	0.00	0.00	0.00	42.10
PI Instr	15.00	117.60	102.90	0.00	0.00	0.00	0.00	102.90
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	**21.00**	**165.80**	**143.00**	**2.00**	**0.00**	**0.00**	**0.00**	**145.00**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	100.0
Percentage of time scheduled for engineering	0.0
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	86.2
Percentage of time lost to instrument	1.2
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	87.5

* Breakdown of hours lost to instrument
  2.00 Blue Channel focus and guider issues

August 2015

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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI Instr	3.00	27.90	18.70	0.00	0.00	0.00	0.00	18.70
Engr	3.00	27.60	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	**6.00**	**55.50**	**18.70**	**0.00**	**0.00**	**0.00**	**0.00**	**18.70**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	50.3
Percentage of time scheduled for engineering	49.7
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	33.7
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.0
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	33.7

Year to Date August 2015

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	73.00	729.00	362.65	11.50	1.75	0.50	0.00	376.40
PI Instr	121.00	1118.00	459.50	7.10	8.50	6.00	0.00	481.10
Engr	14.00	135.20	56.50	0.00	0.00	0.00	0.00	56.50
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**208.00**	**1982.20**	**878.65**	**18.60**	**10.25**	**6.50**	**0.00**	**914.00**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	93.2
Percentage of time scheduled for engineering	6.8
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	44.3
Percentage of time lost to instrument	0.9
Percentage of time lost to telescope	0.5
Percentage of time lost to general facility	0.3
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	46.1

September 2015

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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI Instr	30.00	296.50	199.20	0.00	4.50	1.00	0.00	204.70
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	**30.00**	**296.50**	**199.20**	**0.00**	**4.50**	**1.00**	**0.00**	**204.70**

Time Summary Exclusive of Shutdown

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	67.2
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	1.5
Percentage of time lost to general facility	0.3
Percentage of time lost to environment	0.0
Percentage of time lost	69.0

** Breakdown of hours lost to telescope

4.00 f/5 secondary problems

0.50 Problems with WFS correctios

*** Breakdown of hours lost to facility

1.00 Issues with starting blower

Year to Date September 2015

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	73.00	729.00	362.65	11.50	1.75	0.50	0.00	376.40
PI Instr	151.00	1414.50	658.70	7.10	13.00	7.00	0.00	685.80
Engr	14.00	135.20	56.50	0.00	0.00	0.00	0.00	56.50
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**238.00**	**2278.70**	**1077.85**	**18.60**	**14.75**	**7.50**	**0.00**	**1118.70**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	94.1
Percentage of time scheduled for engineering	5.9
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	47.3
Percentage of time lost to instrument	0.8
Percentage of time lost to telescope	0.6
Percentage of time lost to general facility	0.3
Percentage of time lost to environment	0.0
Percentage of time lost	49.1