MMT Observatory
Smithsonian Institution & The University of Arizona®

End of Quarter Summary

April - June 2016

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

R. Ortiz, Mountain Operations Manager, attended a site manager meeting held May 23-26 at MacDonald Observatory in Texas.

G. Williams visited CfA/SAO on May 19-20 to learn about the status of the Binospec instrument and to hold discussions with colleagues.

The following meetings were held during this reporting period: two engineering and one telescope operators.

Staffing

Michael Anaya (mechanical) and Joe Wood (electrical) started as staff technicians at the telescope site on April 11.

Seven staff members were recognized by the University of Arizona (UA) in April for their longtime employment at the UA. Those honored and their number of years employed were: Ale Milone (20), Grant Williams (15), Brian Comisso (15), Duane Gibson (15), Cory Knop (15), Ricardo Ortiz (15), and Dallan Porter (10). All have been employed at the MMTO for all of those years, except for D. Porter who has been at the MMTO for all but one of his years.

Richard Cool, Assistant Staff Scientist, accepted another position and his last day was May 13.

Interviews and site visits were held this reporting period for the Principal Engineer, Electrical position. An offer was accepted by Ken Duffek and he will start in September.

Reports and Publications

There were 15 peer-reviewed publications during this reporting period. See the list of publications in Appendix I, p. 19.

Presentations and Conferences

The 2016 SPIE Astronomical Telescopes and Instrumentation Conference was held June 26 – July 1 in Edinburgh, Scotland. Attending were: G. Williams, J. D. Gibson, R. Ortiz, and W. Goble.

G. Williams and J. D. Gibson each gave oral presentations. W. Goble presented a poster. Titles and authors are listed below:

"The 6.5-m MMT Telescope: Status and Plans for the Future"
G. G. Williams, R. Ortiz, W. Goble, J. D. Gibson
Proc. SPIE. **9906**, Ground-based and Airborne Telescopes VI, 99060V. (August 8, 2016)

"Automation and Control of the MMT Thermal System"
J. D. Gibson, D. Porter, W. Goble
Proc. SPIE. **9913**, Software and Cyberinfrastructure for Astronomy III, 99131K. (July 26, 2016)

Results of a comprehensive analysis of MMT thermal system data from 2006 to 2016 was summarized. The current status of the ongoing heating, ventilation, and air conditioning (HVAC) upgrade at the MMT was also described.

"Characterization of an Integrally Wound Tungsten and Aluminum Filament for use in the MMTO 6.5-m Primary Mirror Aluminization Chamber"
W. Goble and R. Ortiz
Proc. SPIE. **9912**, Advances in Optical and Mechanical Technologies for Telescopes and Instrumentation II, 991238. (July 22, 2016)

Safety

Dallan Porter, MMTO computer specialist, was presented with a Steward Observatory Safety Award on April 18 for his safety website development. Dallan created the MMTO safety website and expanded it for the Steward Observatory safety website, making text and video materials easily accessible as well as easy for safety coordinators to assign and track usage of materials. For his work, Dallan received a cowboy hardhat and a certificate, shown below.

Figure 1. Pictured with Dallan (right) is Steward Observatory Director, Buell Jannuzi (left) and Grant Williams (center), MMTO Director.

Training

Mountain staff attended a fire extinguisher refresher training held on May 4 at the FLWO base camp.

Mountain staff attended refresher training on CPR, AED, OxySure, and First Aid on May 16 at the FLWO base camp.

Safety Inspections

A METRE inspection was held at the telescope site during the week of May 23-27.

Interlock System

On June 10, after powering the drive room on from lightning shutdown, neither the building drive rack nor the telescope azimuth amplifiers would come on when commanded from the tools graphical user interface (GUI). The building rack GUI reported the drive as being on while the telescope amps GUI showed "Fail." The drive room power was cycled with the same result persisting. However, there were no problems with the elevation and rotation axis. After engaging the azimuth bypass in the 26Volt rack, the building drive came on, but with a strange light pattern displaying on both amps. The top one showed: "Normal" and "DC Fault" red, and "Chan On" off, while the bottom amp blinked a “Normal” green/red. “Minor Fault” was not lit up in the long vertical row of LEDs on the blue panel. Abnormal constant clicking noises from both driving wheels could be heard in the pit, particularly in the SE wheel. The telescope azimuth amps also came on showing normal numbers in their displays, and paired as normal.

Bad weather kept the dome closed for the night and the system was troubleshot the next morning. The drive motors were inspected and connections verified in the drive room. With the azimuth bypass turned on, the azimuth amps and building drives could turn on, but the building drives showed minor faults and the status lights flickered. The system was taken out of bypass, and voltages were checked in the 26V rack. At TB 2-6, the location of a new dock lift that is being installed, the voltage dropped to 9V. This was causing the 26V rack to show errors. There is a bypass switch in the rack. When it is in bypass mode, the wires are still connected to the outside lift area. It was suspected that the wires became wet from rain. The wires were disconnected and capped in the pit at the terminal strip. The telescope and building were moved and verified operational.

Primary Mirror

The primary mirror was CO_2 cleaned on April 13.

Coating & Aluminization

Testing of the V6000 Turbo pump was conducted in early April at the base camp. The turbo pump ramped up to 14,000 rpm as expected and was operated at full speed for a little more than an hour. The inlet of the turbo pump reached a pressure of 1.4×10^{-6} milliTorr, and the inlet of the foreline trap was 9.5 mTorr at this time. Without using the midstage vent, the turbo pump took approximately two hours to spin down in the blanked off condition and worked properly.

The welder power system was reworked and configured to allow low power welder testing using the FLWO generator. All ten welders were reconfigured to operate at 400V, which best matched the 416V from the FLWO generator. Two welder pairs were operated in a low power mode using the load resistors.

The load resistors were connected and configured to operate the ten welder system. However, issues with the genset and a GPIO board initially prevented testing the ten welders together. During low power testing, the aluminization controller would not enable one of the welders. The fault was isolated to a bad optocoupler card in the controller. No spare was available so the card was sent to the campus MMT electronic shop for repair. The card was repaired, reinstalled, and tested the next day. Spare optocoupler and GPIO cards were also manufactured.

After installing the repaired GPIO board, all ten welders were successfully operated as a system using the low power playback script. Over the next few days, installation of the electrical power for the turbo pump was completed. D. Porter also completed various software changes. The ten-welder system tested operational again, verifying compatibility. Electrical receptacles required for running the turbo pump on the bell jar were installed and tested for proper voltage.

The turbo pump was mounted to the bell jar, and the bell jar was pumped down to 7 milliTorr using the pumping trailer. A number of low power welder tests were performed in order to investigate the noise levels seen in the data from previous base camp tests. Pump-down testing continued over several days with a final high vacuum pump of the bell jar taking place for most of a day, reaching a lowest pressure 2.8×10^{-5} Torr. This was reached after approximately 4.5 hours of pumping, and will be considered the baseline pressure of the bell jar for now, using only the turbo pump.

The first of the full scale aluminization tests took place on May 4. The used filaments were removed the next day and all two hundred filaments were uniform in appearance. However, eight tapped holes for the filament mounts were damaged. All of the damaged holes could be repaired by chasing the threads, and replacing the bolt with a black oxide version.

During the testing, it was identified that the welder feedback cable crimps were coming loose when connected to the test resistors and were heating up. Also, the distance between the positive and neutral cables was noticed to be insufficient. The feedback cables were modified to allow for ease of hookup, and the terminal rings were crimped and soldered to ensure connectivity.

After more testing, it was decided to use cabling with 4-pin CPC connectors and banana plugs to facilitate connecting the welder feedback cables to the welder interface boxes, ground plate, and bell jar. The welder interface boxes were modified to accommodate the CPC connector, and new feedback cables were manufactured with banana plugs.

During the May 4 test, the turbo pump controller lost communication with the turbo pump. After inspection, the cable from the controller to the pump was found to be damaged. The 15-pin MS connector was inspected and found to have all of the wires broken off from twisting of the backshell. The MS connector was repaired and the cable was placed back into service. After re-connecting the cable, there was still no communication between the controller and the turbo pump. It was identified that a jumper wire installed in the J21 DB15 connector on the back of the controller allows for communication to take place. Unfortunately, the jumper was in the wrong location. The proper location for the jumper is between pins 5 and 13. A proper DB15 jumper was constructed, labeled, and physically attached to the controller, fixing the communication problem.

Figure 2. The bell jar assembly (front, extension, and rear) used to conduct coating tests at the base camp. The pumping trailer is shown in the top portion of the photo, and the welders (blue) are on the left.

A second full scale test followed a week later on May 11. The primary goal for the second test was to demonstrate the repeatability of the process. As such, the only change that was made was to increase the end trigger on the center deposition monitor from 1000Å to 1100Å. This was done to increase the thickness of the coating at the edge and to show the center and edge scale. The measured center thickness during the first test was 1040Å, and the edge thickness was 689Å. The second test resulted in a center thickness of 1145Å, and an edge thickness of 780Å.

In addition to demonstrating the repeatability of the process, the team also measured the overall power requirements, and placed mylar in the chamber from 3 o'clock to 9 o'clock around the circumference to test for dripping. The power requirements were slightly lower than was calculated, which may allow an increase to the rate of deposition, already at a healthy 30 Å/s. Based on our tests at the Sunnyside testing facility, some drips were anticipated. There were eleven small drips, much fewer and smaller in size than in the past.

The third and final full scale test was conducted on June 23. A mylar drip indicator was placed in the bell jar extension and a second layer was also overlaid on the bottom section of mylar. Small changes were made to the aluminization "play-back" control algorithm to help maintain higher aluminization deposition rates during the end of the aluminization sequence. The bell jar vacuum was $2x10^{-5}$ Torr when the coating test was started. The recorded coating thickness was center 1153Å, 2/3 radius 1040Å, and edge 855Å. The maximum deposition rates recorded during the test were center 46 Å/s, 2/3 radius 42 Å/s, and edge 33 Å/s.

Ventilation and Thermal Systems

MMT staff worked with Smithsonian Institution (SI) HVAC contractors to perform an upgrade of the OpenUPC firmware for the older Carrier ("Carrier1") chiller. Tests were conducted to ensure that the new firmware allows limited network control and monitoring of the chiller. This OpenUPC gateway device allows communication between the internal proprietary Carrier Comfort Network (CCN) protocol and the open-source BACnet protocol, which is used universally elsewhere within the HVAC upgrade. This firmware upgrade resulted in a completely new re-mapping of CCN parameters to BACnet parameters for the chiller. Changes were made to the automated ventilation software, "vent_auto2," to reflect these new parameters. The Carrier1 chiller is approximately 20 years old. It proved very difficult to find OpenUPC firmware that would support this aging chiller. Only a limited number of BACnet parameters and control points are available for this chiller. Future plans may include upgrading this chiller so that more complete network control and status monitoring of the chiller via BACnet is possible. The newer Carrier2 chiller, which is currently being used by the automated M1 ventilation/HVAC system, has more recent OpenUPC firmware and a more complete set of BACnet control and status parameters available.

Actuators

On April 22, the cell crate power strip began shorting whenever power was applied. A temporary power strip was installed returning the telescope to operation, and a new rack mount power strip was ordered. The new power strip was installed and plugged into the 20A outlet connected to the lightning shutdown knife switch in 2E. The outlet was marked with yellow/black safety tape to identify it as the cell crate power outlet.

Secondary Mirrors

Nothing to report.

Hexapods

f/9 and f/15 hexapod

On the M&E night of May 18, the f/15 hexapod would not move properly. Any platform movement would cause the hexapod to trip the tape limit switch. It appeared that pod B, pod E, and pod F would not release their respective brakes. After several hours of troubleshooting, it was discovered that the motor brake cable at the hexapod was not fully seated. (Plotter information later showed that some of the pods did release their brakes.) The cable connector was reseated and the hexapod moved normally. However, the tape switch was tripping at an abnormal limit position. The next day, the secondary was removed, and several electronic boxes on the secondary were found to be poorly positioned. Adjusting the boxes removed a "bulge" in the tape limit tape, and this allowed proper movement of the hexapod. Several days after this repair, hexapod pods A-F were timing out and not moving when commanded. Reseating the analog and digital cards in the hexapod controller seemed to fix this error.

Programming of the I2C unit was started. Previously used software would not work with the Arduino Yun. New code was written and tested on the f/9 digital signal conditioner unit. Initial results are positive, and the system will be tested over the next month. We are able to change the span and offset of the transducer signal from the f/9 hexapod, eliminating the 10 turn mechanical potentiometer that is currently installed. If the system works, eight digital signal conditioner assemblies will be constructed.

Optics Support Structure

Nothing to report.

Pointing and Tracking

Nothing to report.

Science Instruments

f/9 Instrumentation

The f/9 instruments were on for 25% of the available nights from April 1 through June 30. Approximately 61% of those nights were scheduled with the Blue Channel Spectrograph, 22% with Red Channel, and 17% with SPOL. Of the 201.9 total hours allocated for f/9 observations, 55.5 hours (27%) were lost to weather conditions. Blue Channel lost 37% of its time to poor weather, with SPOL losing 0%, and Red Channel losing 23%. Instrument, facility, and telescope problems accounted for 4.6 hours of lost time.

f/5 Instrumentation

There were 59 nights scheduled for f/5 observing. The weather was average, with 28% of the time lost to clouds, relative humidity, and rain. Approximately 1% of the scheduled time was lost to instrument, telescope or facility issues. Nine of the nights were totally lost, with the other lost time being partial nights. Forty-six nights were scheduled for Hecto observations - 27 for Spec and 19 for Chelle. Thirteen nights were scheduled for MMIRS observations. MMTCam observations were obtained on 16 nights, and calibration data was taken on an additional six nights when conditions were not suitable for the scheduled imaging.

Issues contributing to the non-weather lost time were mostly with the f/5 wavefront sensor (WFS). A couple of hours were lost to an internal USB cable that broke. The observations for the rest of the night were degraded since the WFS camera could not operate and focus, and collimation adjustments were made by eye with the StellaCam images. A couple more hours were lost later in the quarter when the WFS computer had issues with keeping the software running and required some restarts. The building drive dropped out momentarily a couple of times and one of the amplifiers died later in the quarter. Dealing with that issue cost one cloudy night, and about an hour was lost to the slower speed required with operation using only one building drive wheel. A small amount of time was also lost when the hexapod did not move to the correct coordinates, and a half hour when the server computer, *fields*, became non-responsive - most likely due to disk controller issues. Last fall, one of the gimbals in the fiber positioner occasionally oscillated when commanded to stow after acquiring guide stars. The issue comes up at times, but recovery has become routine and takes about a minute.

The Hecto instrument operated well throughout the quarter. 506 spectral exposures were obtained corresponding to roughly one hundred thousand spectra on 153 fields over the 41 nights of observations. An additional 1990 calibration exposures consisting of bias, flat, comp, dark, and sky images were also obtained. On June 9, two of the 298 fibers went dark for a couple of calibration exposures. After lots of guesswork, the prime suspects were insects or insect parts. We believe an insect body or wing landed on the two fibers near the end of calibrations. The obstruction went "away" when we tipped to open. Something was visible inside the positioner, well off the focal plane, but not safely reachable. Two new filters for Chelle were obtained and installed, replacing two old filters that were found to allow parts of two orders to be displayed. One thorium-argon hollow cathode lamp in the Chelle "can" failed and was replaced.

The majority of observations for the MMIRS June run were handled using the queue scheduler software written by R. Cool and run by J. Hinz. Two of the nights were reserved for a transiting object and were not scheduled via the queue software. The queue software was run each morning, with input from instrument operators, M. Calkins or P. Berlind, as to which programs and objects were observed the previous night. The input for completed observations is passed to the queue scheduler software via a text file that specifies object name, exposure time, number of visits (repeats), and total observing time including overhead. Once this completed observation file is passed, the queue scheduler software is re-run to generate a new schedule, excluding the dates of previous nights.

The MMIRS instrument obtained 1339 sky images and 755 spectral images on 32 fields over 9 nights. An additional 4 nights were lost to weather. 1078 calibration images consisting of dark, alignment, telluric, flat, comp, and test images were also obtained. Only 8 masks were required for this run and they were installed prior to the start of the run. Operations are smoother as observers become more familiar with the instrument, although some learning is still continuing.

Some engineering work was done on MMIRS this quarter. The wiring assembly, associated with the Wave Front Sensor/Guider 2 failures earlier in the year, was removed and returned to SAO/CfA for detailed inspection. No significant issues were found, but the problem pin was replaced and the wiring assembly was reinstalled. There were no repeats of these problems during the June run. The surface heaters added earlier in the year were tested. They were added to prevent condensation on the instrument surfaces, especially on the three instrument windows. Given that the instrument has a large reservoir of liquid nitrogen, the body tends to stay a few degrees below ambient. The initial tests were done essentially open loop with various fixed duty cycles to establish effectiveness of the current heater configuration and get preliminary data on response timescales (hours). A problem was discovered with the OMEGA temperature control units, which would stop working after some hours and stay in that failed state. The condition was fixed with a firmware upgrade. We are evaluating whether additional power is required, especially on the MOS section to improve the response time to changing ambient temperature. This might be accomplished with additional heater elements or by operating at a higher voltage.

The overlong power cables for the MMIRS instrument were shortened prior to the run so that there would be fewer "extra" loops at the drive arc. A protective guard was added to the MMIRS calibration unit to protect the top lamp, and a support was added to the integrating sphere to prevent its rotation, which had been an issue at the beginning of the March run in the previous reporting period.

A total of 265 object images were obtained with MMTCam on 27 objects. An additional 542 calibration exposures were obtained consisting of bias, dark, and flat images.

Additional f/5 related equipment installed this quarter includes a new UPS for the f/5 rack in 3 East. It is a 205Volt full conversion unit. The output is generated directly from the batteries, thus allowing fewer of the fluctuations that are present on the input power lines (even the "clean" ones) to pass through to the output. The output is generally stable to better than half a volt with some 1.7V excursions when larger building systems are started. With the previous UPS system, the excursions for MMT equipment startup were about 4.3 volts on the 120V nominal. The power fluctuations are thus about 1/4th as large as they were previously. The fluctuations had been an issue, causing computer(s) to spontaneously restart if the magnitude and phase of the fluctuation was right. Since replacing the UPS, there have not been any spontaneous restarts. Also, the computer no longer displays a red power condition warning. Note: the computer/servers *Endeavor* and its spare, *Endurance*, are supplied 205V power from this UPS through a distribution box. The connectors are identical to the connectors for computers, monitors, and other equipment requiring lower voltage. The cables were flagged with yellow tape as a reminder that they are 205V and not 120V.

SAO/CfA obtained a second "system 76" computer, *hectokat*, as a spare for the regular VNC server unit, *meerkat*, used for the display when MMIRS and Hecto are operational. *Hectokat* and its two monitors will be used for Hecto service missions. There were some initial problems, but they were fixed with a firmware upgrade and the assistance of S. Moran at CfA.

f/15 Instrumentation

There was one adaptive optics (AO) run during this quarter, May 18-26. The nine nights consisted of two maintenance and engineering (M&E) nights and seven science nights. The M&E nights were intended for trying out the WFS camera fiber converter card on-sky and testing its functionality. Unfortunately, we were unable to get on sky either night due to the weather and issues with the f/15 hexapod. This resulted in needing to swap the WFS camera configurations between the fiber and SCSI configurations on multiple nights during the run. Three nights and most of a fourth night were lost to weather. A half hour was lost to a loose hexapod tape issue. Another half hour was lost to computer and network issues causing the resetting of AO computers. Nearly an hour was lost due to a software issue with the secondary mirror. Nearly two hours were lost to issues with the new fiber card.

Additional testing was done to characterize and understand WFS camera issues, accelerometer feed-forward algorithms, and previous 60 Hz noise issues on the WFS camera slope values (although no noise issues occurred during this run).

The "MAPS" proposal submitted in February to the National Science Foundation for the upgrade to the AO system was awarded "seed" money in June to allow technical progress of the instrument development until the next proposal cycle. The award will be used for software improvements, refurbishing the secondary deformable mirror (DM) and its associated electronics, and also to provide upgrades to the ARIES instrument. Funding is scheduled to begin in October 2016. This will affect the availability of the AO system during 2017-2018.

Topboxes and Wavefront Sensors (WFS)

Nothing to report.

Facilities

Main Enclosure

Safety hooks were added to the new roof in April. Some final work remains to be completed regarding a few of the safety hooks and some of the roof heating panels.

During several weeks in June, the building drive had a few "washing machine" incidents as well as complete drop-outs of the drive due to "Building Major" faults, usually occurring at the beginning of a slew. During day tests on June 21, the upper amplifier (motor #1) DC FLT indicator briefly flickered red and then returned to its normal "Unlit" state. The "Normal" indicator changed from yellow to red, and the "Chan On" went from green to "Unlit." This also caused a "Minor Fault" indication on the building drive status panel and in the interlock GUI. The drives would not drop out. The resistors, modified in October 2015, were checked and appeared to be within normal operating temps (90°-100°F). The "dumper" fuse was checked as well and found to be in good condition. It was decided to operate the telescope that night with the upper amplifier inhibited and the telescope AZ velocity limited to 0.75 deg/sec (set in ALT/AZ GUI). Although not optimal, the hope was to reduce further damage to the amplifier.

The next day, the motor #1 Copley drive amplifier failed in a manner that prohibited the building from rotating properly. The Copley amplifiers were removed, inspected, cleaned, and then swapped. The discrepancy followed amplifier 1. Both amplifiers were reinstalled in their normal location and tested again. The problem still followed amplifier 1. A spare Copley 262 (there is no spare 264) was swapped into the motor #1 slot. However, when booted up and a load applied, a loud screeching noise was emitted, the unit "Hot" LED came on, and it shut down. Since the Copley 262 was an unsuitable spare, it was removed from the building drive and the motor #1 amplifier slot left empty. The hand paddle was connected and it was noticed that the building seemed to move faster. The building was coupled to the telescope and good speed was achieved during the rotation of the building. Analysis of the schematic drawing identified that the hand paddle bypassed the "Minor Fault" error, received due to no functional Copley 264 amplifier in the motor #1 slot.

Jumpers were installed on the building drive fault status card between R45 and R46, and between pins 2 and 3 on the U12 chip. This essentially fooled the system into thinking there were two functioning amps installed. The system was tested up to 1 degree/sec. There was a "washing machine" effect upon acceleration and deceleration, but the angular speed was good for slews. This was a vast improvement from the previous 0.03 degree/minute slew speed. The system will stay in this configuration until the Copley 264 amplifier is repaired and returned to service. The 100A power fuse was removed from the motor #1 circuit to eliminate power on the input cables.

During installation of the Blue Channel instrument on April 5, a loud bang was heard from the chamber lift area. A visual inspection was performed but no problems were found. During nighttime operations, the 26V safety chain indicated a chamber lift fault. Upon further inspection the next day, the chamber lift "Y" connector plug that controls the limit switches was found damaged. The banging noise heard the day before had been the lift coming out of its base and smashing the connector plug. Mechanical jacks were used to lift the chamber lift out of its base to gain access to the limit switch cabling. A new "Y" connector plug was re-terminated and a new jumper plug was made, restoring operation of the lift.

General Infrastructure

The new in-ground instrument lift was installed in April and is semi-operational. Work still being completed includes installation of limit switches and safety railings.

Work to replace the pavement on the steepest portion of the road between the summit dorm and the MMT was mostly finished. Some general maintenance issues remain, such as patching, and will be finished in the fall. The new guardrail system for this portion of the road was completed.

Computers and Information Technology

Hardware/Software Interfaces

The virtual reality tour of the MMTO, used at outreach events, was updated for our participation in Spacefest VII held at a Tucson resort in June.

A custom Windows 10 PC was purchased to serve as D. Porter's Windows desktop computer as well as the dedicated virtual reality outreach computer. This new computer requires a power graphics card (a GTX 980 used in this case) to render frame rates fast enough to prevent lag in the Oculus headset. Too much lag causes the viewer to get motion sickness, so it's the most important part of the setup. A looping video of a Google Earth MMTO flyby was displayed on a 27" iMac next to the virtual reality tour exhibit. The flyby was made using standard screen capture software while flying the roundtrip route between the resort and the MMTO. A 3DConnexion controller was used to achieve the smooth flying motion that can't be created using a standard mouse. Photos of the event can be found in the Public Presentations section, p. 18.

Annunciator

A new email warning system was created for the annunciator. Its purpose is to provide email alerts for those important conditions that require prompt attention during the day. These conditions currently include the Loft Neslab setpoint, MMIRS rack temperatures, glycol pumps, and Blue/Red Channel dewar temperatures. Each alert has its unique email distribution so that the appropriate staff can respond to the alert. Minor modifications were also made to the compressor mode annunciator checks.

Weather and Environmental Monitoring

Seeing

As discussed in previous reports, the MMT and Magellan Infrared Spectrograph (MMIRS), a wide-field near-IR imager and multi-object spectrograph, generates WFS-related seeing values much more quickly than other f/5 or f/9 instruments. This instrument was on the telescope during June, and 4203 of the 6163 total WFS data samples for the period of April 1 to July 1 are from MMIRS. There are 1398 f/5 seeing values that are not from MMIRS (e.g., Hecto), plus 562 seeing measurements from f/9 instruments.

Figures 3 and 4 present seeing values, corrected to zenith, at the MMTO during this reporting period. These values are derived from measurements made by the f/5 (MMIRS and non-MMIRS) and f/9 WFSs. Figure 3 presents the seeing values as a histogram with 0.1 arcsec bins while Figure 4 presents the same data as a time-series chart. f/5 WFS values are divided into MMIRS and non-MMIRS categories. In Figure 3, f/5 (MMIRS) seeing data are shown in blue, f/5 (non-MMIRS) data are in green, f/9 data are in red, and the combination of all three WFS values is in cyan. In Figure 4, seeing measurements for the f/5 are similarly shown as blue (MMIRS) and green (non-MMIRS) diamonds while f/9 WFS seeing measurements are represented by red squares.

The median f/5 seeing value for MMIRS data is 1.07 arcsec. This represents a degradation from the 0.95 arcsec median seeing in the January-March quarter. The median non-MMIRS f/5 seeing is 0.95 arcsec while the median f/9 seeing value is 0.80 arcsec. This latter value represents an increase in seeing quality from the 0.93 arcsec value of the January-March quarter. The combined median seeing for all data WFS systems is 1.03 arcsec. As previously stated, the combined data set is biased towards nights of MMIRS observing.

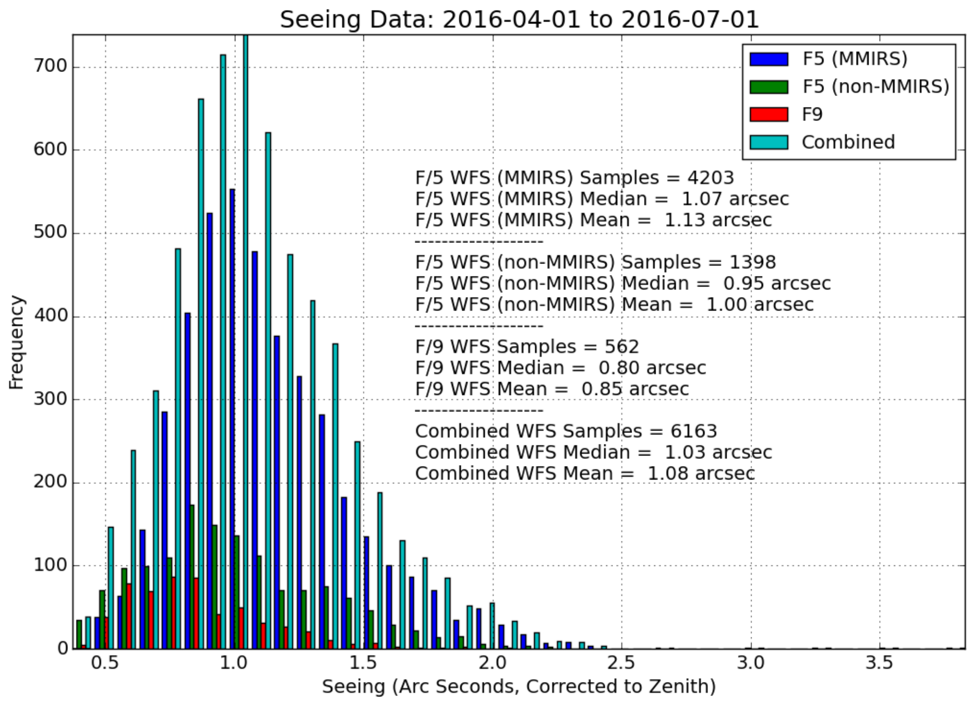


Figure 3. Histogram (with 0.1 arcsec bins) of derived seeing values for the f/5 (MMIRS and non-MMIRS) and f/9 WFSs from April through June 2016. Seeing values are corrected to zenith. The median f/5 MMIRS seeing is 1.07 arcsec and f/5 non-MMIRS seeing is 0.95 arcsec while the median f/9 seeing is 0.80 arcsec. A combined median seeing value of 1.03 arcsec is found for the total 6163 WFS measurements made during this period.

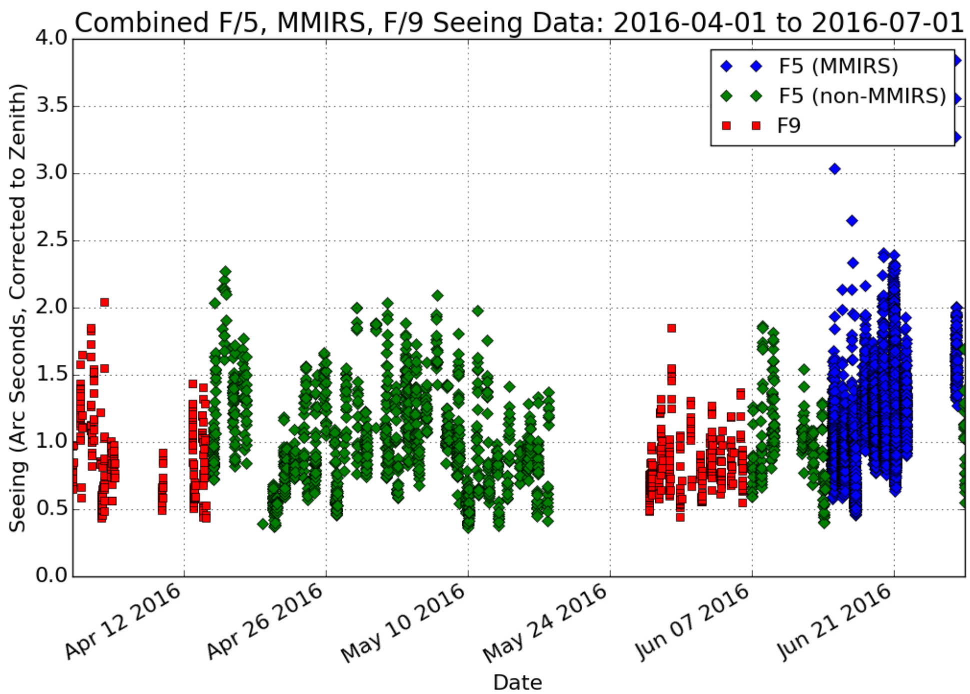


Figure 4. Derived seeing for the f/5 (MMIRS and non-MMIRS) and f/9 WFSs from April through June 2016. Seeing values are corrected to zenith. f/5 seeing values are shown in blue (MMIRS) and green (non-MMIRS) while f/9 values are in red. Data from MMIRS are typically sampled more frequently than for other instruments.

User Support

Remote Observing

The MMTO supported 11 nights of remote observing this quarter. Six nights were for UA observers, with five nights for CfA observers.

Documentation

Nothing to report.

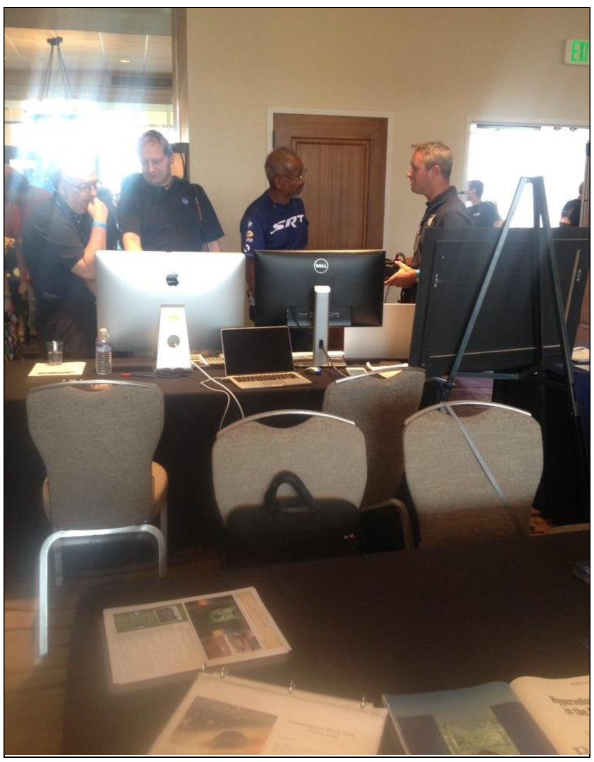
Public Relations and Outreach

Public Presentations

J. Hinz represented the MMTO at "A Night Under the Stars" public event at the Historic Hacienda de la Canoa on Saturday, May 7. Along with a self-guided tour of the historical ranch, the Sonora Astronomical Society also set up telescopes for night sky viewing. Read more about this event in the Site Protection section, p. 19.

G. Williams was the speaker at the Sonora Astronomical Society monthly meeting on May 10. His topic was supernovae explosions, and his talk included data taken at the MMTO.

The MMTO supported a booth at the STEAM portion of Spacefest VII, held June 10-11 at the J.W. Marriott Starr Pass Resort in Tucson. Activities included a virtual reality tour of the MMTO, informational handouts, and tour information.



Figures 5 and 6. D. Gibson and G. Williams speak with visitors to our table at Spacefest VII.

MMTO in the Media

An article written by Warren R. Brown (SAO) entitled "Hypervelocity Stars in the Milky Way" appeared in the June issue of *Physics Today*. The article describes his research on hypervelocity stars, conducted in part at the MMTO, and a photo of the MMTO is featured.

Site Protection

J. Hinz attended "A Night Under the Stars" stargazing event at the Historic Hacienda de la Canoa on May 7. The ranch is located near Interstate 19 exit 56, Canoa Road, which is the exit for the MMTO and the F.L. Whipple Observatory. Ranch staff is interested in partnering with us and FLWO to promote tours of both facilities and encourage the appreciation of dark skies in the area. Future star parties may include talks by MMTO staff.

Astronomy, Planetary, and Space Sciences in Arizona (APSS) has re-started regular monthly meetings to address site protection issues. G. Williams and J. Hinz attended the first of these meetings on May 25. J. Hinz has taken over as administrator of the APSS website and has begun regular updates to the News section. The APSS comprises local observatories along with the MMTO, several related UA departments, and a related non-profit institute.

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)

16-15 Metallicity Gradients in Local Universe Galaxies: Time Evolution and Effects of Radial Migration
L. Magrini, L. Coccato, L. Stanghellini, et al.
A&A, **588**, 91

16-16 Spectroscopic Binaries in the Orion Nebula Cluster and NGC 2264
M. Kounkel, L. Hartmann, J.J. Tobin, et al.
ApJ, **821**, 8

16-17 The Double-peaked SN 2013ge: A Type Ib/c SN with an Asymmetric Mass Ejection or an Extended Progenitor Envelope
M.R. Drout, D. Milisavljevic, J. Parrent, et al.
ApJ, **821**, 57

16-18 The Stellar Mass Fundamental Plane and Compact Quiescent Galaxies at $z < 0.6$
H.J. Zahid, I. Damjanov, M.J. Geller, et al.
ApJ, **821**, 101

16-19 Narrow-line X-Ray-selected Galaxies in the *Chandra*-COSMOS Field. I. Optical Spectroscopic Catalog
E. Pons, M. Elvis, F. Civano, et al.
ApJ, **821**, 130

16-20 Galaxy Structure from Multiple Tracers – II. M87 from Parsec to Megaparsec Scales
L.J. Oldham and M.W. Auger
MNRAS, **457**, 421

16-21 Comparative Analysis of SN 2012dn Optical Spectra: Days -14 to +114
J.T. Parrent, D.A. Howell, R.A. Fesen, et al.
MNRAS, **457**, 3702

16-22 Toward a Network of Faint DA White Dwarfs as High-precision Spectrophotometric Standards
G. Narayan, T. Axelrod, J.B. Holberg, et al.
ApJ, **822**, 67

16-23 ALFALFA Discovery of the Most Metal-poor Gas-rich Galaxy Known: AGC 198691
A.S. Hirschauer, J.J. Salzer, E.D. Skillman
ApJ, **822**, 108

16-24 Spectroscopic Confirmation of a Protocluster at z≈3.786
A. Dey, K.-S. Lee, N. Reddy, et al.
ApJ, **823**, 11

16-25 Light Curves of 213 Type Ia Supernovae from the ESSENCE Survey
G. Narayan, A. Rest, B.E. Tucker, et al.
ApJS, **224**, 3

16-26 SHELS: Complete Redshift Surveys of Two Widely Separated Fields
M.J. Geller, H.S. Hwang, I.P. Dell'Antonio, et al.
ApJS, **224**, 11

16-27 SDSS J1152+0248: An Eclipsing Double White Dwarf from the *Kepler* K2 Campaign
N. Hallakoun, D. Maoz, M. Kilic, et al.
MNRAS, **458**, 845

16-28 Massive Star Mergers and the Recent Transient in NGC 4490: A More Massive Cousin of V838 Mon and V1309 Sco
N. Smith, J.E. Andrews, S.D. Van Dyk, et al.
MNRAS, **458**, 950

16-29 Star Clusters in M31. VII. Global Kinematics and Metallicity Subpopulations of the Globular Clusters
N. Caldwell and A.J. Romanowsky
ApJ, **824**, 42

MMT Technical Memoranda / Reports

None

Non-MMT Related Staff Publications

None

Appendix II - Service Request (SR) and Response Summary: April - June, 2016

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 7 presents the distribution of SR responses by priority during the period of April through June. As seen in the figure, the highest percentage (40%) of responses are "Critical" priority, followed by 33% "Important" and 26% "Near-Critical." There are no SRs of Low or Information-Only priority.

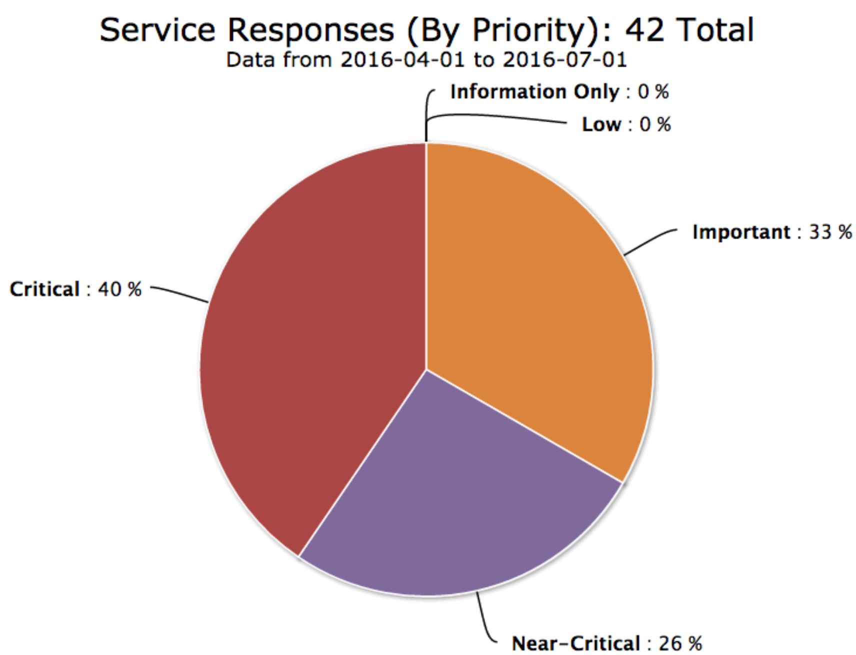


Figure 7. Service Request responses by priority during April through June 2016. 40% are "Critical" responses, 33% "Important," and 26% "Near-Critical." This is an increase of Critical and Near-Critical SRs than in previous reporting periods, although the total number of SRs has dropped.

"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 42 SRs during this three-month period, down from 67 SRs during the previous three-month reporting period.

Figure 8 presents the same 42 SR responses grouped by category. These categories are further divided into subcategories for more detailed tracking of issues. The majority of the responses from April through June are related to the "Building" and "Telescope" categories with 15 and 7 responses, respectively. Responses also occurred in the "Cell," "Chamber," "Computers/Network," "Electronics," "Software," "Support Building," and "Weather Systems" categories.

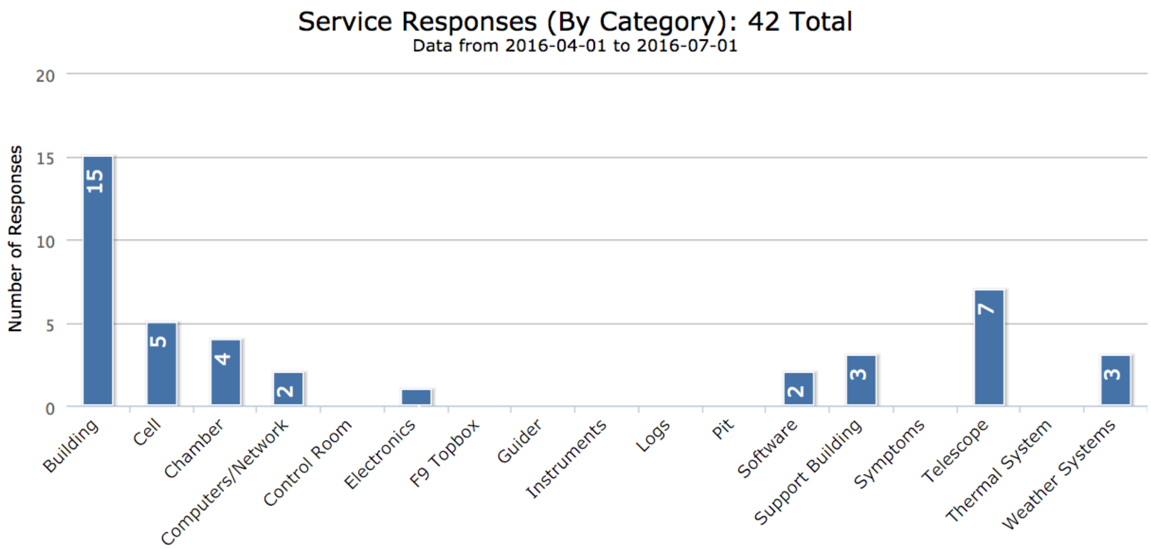


Figure 8. Service Request responses by category during April through June 2016. The majority of responses are within the "Building" and "Telescope" categories.

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

April 2016

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	9.00	84.60	53.30	0.00	0.00	4.00	0.00	57.30
PI Instr	21.00	192.00	23.13	0.38	2.85	0.00	0.00	26.36
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**	**276.60**	**76.43**	**0.38**	**2.85**	**4.00**	**0.00**	**83.66**

Time Summary

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	27.6
Percentage of time lost to instrument	0.1
Percentage of time lost to telescope	1.0
Percentage of time lost to general facility	1.4
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	30.2

* Breakdown of hours lost to instrument
- 0.38 Hecto Endeavor computer problems

** Breakdown of hours lost to telescope
- 0.60 Two M1 panics
- 0.50 Hexapod coordinates wrong/WFS camera issues
- 1.75 f/5 WFS camera issues

*** Breakdown of hours lost to facility
- 4.00 Chamber lift - crushed connector affected elevation chain

May 2016

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	*Lost to Instrument	**Lost to Telescope	***Lost to Gen'l Facility	****Lost to Environment	Total Lost
MMT SG	4.00	31.60	2.80	0.00	0.00	0.00	0.00	2.80
PI Instr	24.00	200.00	62.11	0.00	3.47	0.00	0.00	65.58
Engr	3.00	24.50	4.20	0.00	0.00	0.00	0.00	4.20
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**31.00**	**256.10**	**69.11**	**0.00**	**3.47**	**0.00**	**0.00**	**72.58**

Time Summary

Percentage of time scheduled for observing	90.4
Percentage of time scheduled for engineering	9.6
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	27.0
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	1.4
Percentage of time lost to general facility	0.0
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	28.3

** Breakdown of hours lost to telescope
- 0.30 Loose hexapod tape issue
- 0.50 Resetting of AO computers
- 0.75 AO-M2 software issue
- 1.92 New fiber card issue

Year to Date May 2016

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	40.00	426.70	200.98	0.00	1.91	5.00	0.00	207.89
PI Instr	105.00	1043.80	225.38	6.38	13.52	0.33	0.00	245.61
Engr	7.00	68.60	15.30	0.00	0.00	0.00	0.00	15.30
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**152.00**	**1539.10**	**441.66**	**6.38**	**15.43**	**5.33**	**0.00**	**468.80**

Time Summary

Percentage of time scheduled for observing	95.5
Percentage of time scheduled for engineering	4.5
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	28.7
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	1.0
Percentage of time lost to general facility	0.3
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	30.5

June 2016

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	47.10	8.40	0.00	0.00	0.00	0.00	8.40
PI Instr	24.00	185.40	77.93	0.00	1.50	0.83	0.00	80.26
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**	**232.50**	**86.33**	**0.00**	**1.50**	**0.83**	**0.00**	**88.66**

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	37.1
Percentage of time lost to instrument	0.0
Percentage of time lost to telescope	0.6
Percentage of time lost to general facility	0.4
Percentage of time lost to environment	0.0
Percentage of time lost	38.1

** Breakdown of hours lost to telescope

1.50 WFS stage issues

*** Breakdown of hours lost to facility

0.50 Building drive issues
0.33 Slow building slews

Year to Date June 2016

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	46.00	473.80	209.38	0.00	1.91	5.00	0.00	216.29
PI Instr	129.00	1229.20	303.31	6.38	15.02	1.16	0.00	325.87
Engr	7.00	68.60	15.30	0.00	0.00	0.00	0.00	15.30
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**182.00**	**1771.60**	**527.99**	**6.38**	**16.93**	**6.16**	**0.00**	**557.46**

Time Summary

Percentage of time scheduled for observing	96.1
Percentage of time scheduled for engineering	3.9
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	29.8
Percentage of time lost to instrument	0.4
Percentage of time lost to telescope	1.0
Percentage of time lost to general facility	0.3
Percentage of time lost to environment	0.0
Percentage of time lost	31.5