Smithsonian Astrophysical Observatory & Steward Observatory, The University of Arizona

# End of Trimester Summary

## September – December 2008

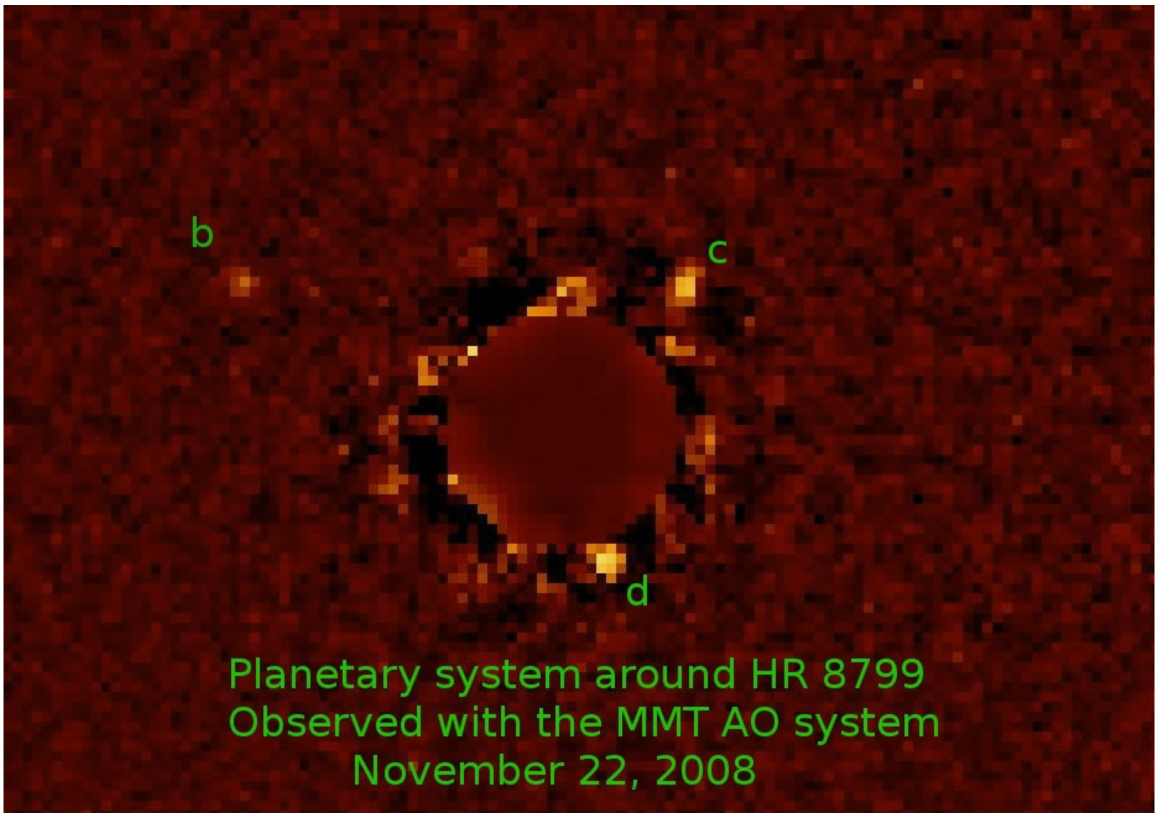



Image taken at the MMT with Clio at 3.8 microns wavelength by
P. Hinz, M. Kenworthy, T. Pickering, T.J. Rodigas, and M. Meyer

## Personnel

Howard Lester retired as Business Manager on October 3 after 30 years of service to the MMTO.

Barbara Russ assumed Business Manager duties beginning on October 6.

Marilyn Guengerich started as Administrative Associate on October 6.

Thomas Stalcup left the MMTO on October 17 for a position at the Keck Observatory in Hawaii.

Creighton Chute left the MMTO on October 31 for a position in Colorado.

Dennis Jankovsky left the MMTO in November.

## Talks and Conferences

### Internal Presentations

Presentations were given to an MMT Council meeting in September. D. Gibson spoke on automating control of the MMTO primary (M1) mirror ventilation system, B. Comisso spoke on ground isolation, D. Clark gave an update on the MMT servos, and S. Callahan presented modeling of airflow on Mt. Hopkins pertaining to the building of a new facility for instrument storage. Information from some of these presentations is also part of this trimester summary report.

A presentation by F. Vilas was given to the MMT Council in December in response to their recommendations following the September meeting.

C. Knop gave presentations on SiteScape and on the Safety Training web page at the November engineering meeting. SiteScape is a documentation tracking system and provides a central repository of information available to staff. This tool will be useful as new instruments are added and will also aid in providing more seamless telescope maintenance operations.

The Safety Training presentation provided information regarding the safety web page. Included on the web page are safety training videos, lists of employee certifications, and aids in documenting and tracking reoccurring training requirements. The importance of following ongoing safety protocols was also re-emphasized. The web page address is: http://safety.as.arizona.edu.

### External Presentations

F. Vilas also attended the 40$^{th}$ Division for Planetary Sciences, American Astronomical Society, conference in Ithaca, NY, from 10 - 15 October. She conducted a NASA Small Bodies Assessment Group town hall meeting on Sunday, 9 Oct. In addition to chairing two sessions (Main Belt Asteroids and Trojans, Mercury), she authored or co-authored the following presentations, one based on MMT data:

S. C. Tegler, M. R. Abernathy, W. M. Grundy, W. Romanishin, D. Cornelison, F. Vilas*, Digging Into the Surface of the Icy Dwarf Planet Eris* (36.06)

L. R. Nittler with 12 co-authors including F. Vilas, *MESSENGER Investigations of the Surface Composition of Mercury* (51.02).

F. Vilas also attended a Planetary Sciences Subcommittee (PSS) Meeting in October. She resigned from the PSS in December in order to accept an appointment as the Vice-Chair of the of the National Academies study on Near-Earth Object Detection, Characterization, and Mitigation, and Chair of the Detection and Characterization Subcommittee of this National Academies study. She attended the inaugural meeting of the National Academies study in December.

### MMTO Home Page Addition

In October, MMTO started a "blog" listed under "MMT Latest News" on our website. New postings are added on a daily or weekly basis. Examples include general MMT updates, observing proposal information, instrument manual updates, observing statistics, and videos of some operations. Our goal is to provide current and easy access to a range of information pertaining to the MMT for observers' use. Users can comment and provide feedback on each of the postings.

Work on a revised MMTO website has been started this trimester and we hope to debut it during the next trimester.

## Primary Mirror Systems

### Primary Mirror Support

Actuator 147 failed on Saturday, November 15. The load cell always showed 60 pounds of force even when the air was disconnected. As a first step, the actuator was disabled in the software. A replacement actuator was installed, but 147 position still failed a bump test. Troubleshooting revealed a blown fuse on the sector distribution board. The fuse was replaced and the actuator passed a bump test. In December actuator 147 displayed numerous warnings, even with a new actuator installed. Efforts are underway to determine if this is an electronics issue.

### Optics

A mirror wash scheduled for December was canceled due to problems with an instrument. Plans are to reschedule the mirror washing for April 2009.

### Thermal System

With the construction of the first enclosure for the new T-series thermocouple electronics, the process of testing and calibrating thermocouple boards began. Testing and calibration of the absolute-type boards was completed in late December. Work on the thermopile-types will begin in January 2009.

We expect to install the first of four enclosures with electronics in early 2009, with completion after all thermopile boards pass calibration.

### Aluminizing

Many problems arose with the glow-discharge power supply rebuild. We discovered that at some time in the past, the Variac in the power supply had been dropped, and shorts developed in the windings. We found a standard replacement that "bolted in" and is sturdier than the original unit. We modified the power supply wiring to support sense resistors in order for digital panel meters to display the output voltage and current during operation. The old, unsafe banana plugs were removed and MHV coax-type connectors were installed. In this way, the outer shell of the cables is tied to a chassis ground, while the dangerous high-voltage connection is hidden away inside the Teflon shell around the center conductor. A pair of new coax cables with MHV connectors was built to replace the old, stiff solid-conductor cable that was vulnerable to breakage. We also plan to replace the existing vacuum head connection with a dual-MHV unit that can be sealed from the weather better than the existing fragile wire-exit feedthrough. The light-bulb current limiter circuit was rebuilt to support the new wiring/connector arrangement in the supply rack.

Work continued on the glow discharge controller and it is now fully operational. Different light bulb banks were tested in order to establish optimal performance. This provides 1000VAC across the load with the Variac at 58%. A final modification will be the addition of 115VAC muffin fans to cool the light bulbs during operation.

T. Gerl has nearly completed the rework of the aluminization data panel. We await coax connectors for the sensors, which will eliminate having to reach inside the panel as required in the past. Then the entire rear panel will be available for connections to the vacuum system gear.

## Telescope Tracking and Pointing

### Instrument Rotator

Reliability issues continued with the instrument rotator tape encoder heads. These occasionally failed to detect the quasi-absolute index marks used to calculate the absolute position of the rotator at startup.

Careful measurement of the tape encoder head mounting hardware, and reference to the original Heidenhain mounting drawings, revealed that the heads are mounted very slightly off the recommended position with regard to the tape encoder strip centerline. In addition, the very tight radial rotation specification of the head (perpendicular to the tape axis to within 5 arcmin) is almost impossible to meet with the manual method of turning the head within the clearance of its mounting holes.

To allow for better alignment, C. Chute and D. Clark developed a Belleville spring-loaded adjustment plate to make the fine tilt adjustments of the head possible. This, when used with a new plate to attach the head to the rotator bearing, will make robust alignment of the head a more tractable problem. We await approval of the mechanical drawings and fabrication of the parts to install this new mounting system.

**Elevation Encoders**

C. Chute assembled the west tape encoder head mount with all the adjustable micrometer stages for alignment of the encoder head to the tape on the elevation drive arc. Optical-micrometer measurements of both elevation tapes were done in November to verify that the two tapes were still mounted on the drive arcs co-planar to the elevation axis rotation before attempting to replace the existing west tape head mount with the new one (the east unit is of the new type). The east tape has about 1.5-2mm runout over the range 0-90°, while the west has about 1.5-3mm. The acceptable variance over the length of the tape is about 3.2mm. Therefore, some effort is required to ensure both tapes, which haven't been touched since their original installation, are as square as possible to the elevation motion before attempting changes to the head mounts.

To support this work, D. Clark and B. Comisso built and programmed a new digital dial gauge readout box, based on a Rabbit Semiconductor RCM2000, that reads out a pair of Sylvac digital dial gauges and returns their readings over Ethernet to a small Python GUI that saves the data to the MMTO SQL database. This makes possible a simultaneous measurement of the axial and radial runout of the drive arc tape surface. The radial runout was measured years ago before installation of the encoder tapes, and the data from that appear to have been lost; saving to the SQL database system will prevent this in the future. Measurement of the radial runout will help to confirm that this surface can be used as a reference to square up the tapes on the drive arc.

Once we have these measurements in hand, a gauge block can be used to square both tapes to the radial surface, and the axial runout data can be used to set the tape head air gap at the median elevation angle to minimize the effects of air gap variation on the tape encoder output.

**Servos**

A committee comprising 5 people from SAO, UAO, and the MMTO was formed by the MMT Director to review the progress made in developing a new elevation axis servo system and to make any recommendations for improvements to the functionality of the servo system, if necessary. The review/scrub team met on Sep. 4 – 6 to scrub in detail the design of the elevation servo system. The committee reported to the Director that they found no problems or deficits with the elevation servo that has been implemented, and recommended that we collect additional data on the operation of the servo over time. An internal technical memorandum is being drafted to report on the committee's findings.

The elevation controller simulation continues to be studied; the latest iteration supports use of the high-resolution servo logging file data to drive the Simulink model of the controller and telescope model at the full sample rate (1kHz). This helps to illuminate expected performance as well as operational issues with disturbance decoupling, velocity estimation, and other facets of the controller design. We now routinely review nightly tracking data for early detection of tracking problems. An internal technical memorandum is being written to report on the tracking performance over the last trimester of 2008.

## Computers and Software

### M1 Mirror Ventilation System

A presentation was made to the MMT Council in September on the current approach to automated control of the MMTO primary (M1) mirror ventilation system. This new approach, contained in the "vent_auto" mmtservice, attempts to maintain the temperature of the M1 mirror at or slightly below the ambient air temperature. The approach completely automates the control of the Carrier and pit Neslab chiller setpoints, the two parameters of the M1 ventilation system that can be controlled through network commands. Figure 1 shows a schematic diagram of the M1 ventilation system.

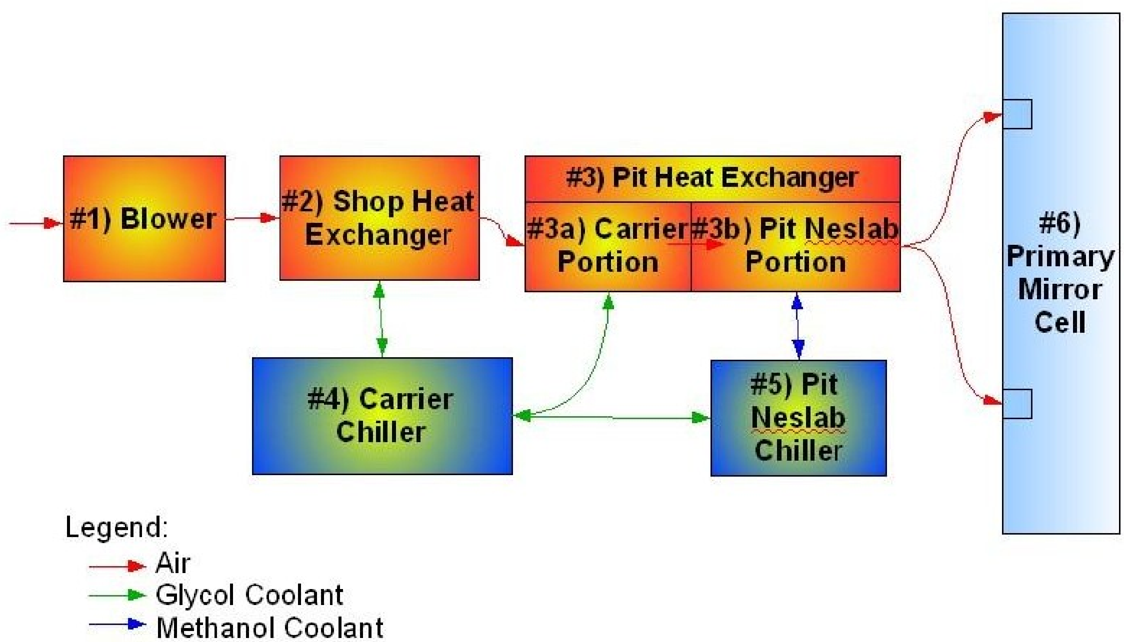



**Figure 1**. Schematic diagram of the M1 ventilation system. A centrifugal blower (#1) drives air through the shop (#2) and pit (#3) heat exchangers. This air is then delivered to the M1 mirror cell. Cooling of the air is provided by the Carrier (#4) and pit Neslab (#5) chillers.

Prior to June 2008, control of the M1 ventilation system relied on the telescope operator (TO) to set the Carrier setpoint directly (i.e., manual mode) or set an offset in degrees C from a reference temperature such as a chamber or outside ambient temperature (i.e., semi-automatic mode). The approach and amount of offsets varied between TOs. The pit Neslab chiller was used only under very cold or very humid conditions.

The automated approach computes a target ventilation air temperature at the exit of the pit heat exchanger that is based upon outside, chamber, ventilation air path, and M1 glass temperatures. The pit Neslab is always used. The control software calculates new Carrier and pit Neslab setpoints approximately every 15 seconds based upon current thermal conditions. When there is a change in the thermal conditions in outside, chamber, or ventilation system temperatures, the pit Neslab responds quickly to that change. With time, the cooling contribution from the Carrier chiller increases while that of the pit Neslab decreases. This automated approach provides consistent M1 ventilation system control among TOs. It also allows the ventilation to be easily started by the day crew in the mid to late afternoon.

Further refinement of the vent_auto software is underway, including automatic switching between data temperature and dewpoint measuring units, based upon availability of data. A prototype defrosting algorithm has also been implemented in the code.

Finally, work was started on migrating the vent_auto code for this automated ventilation system control into a centralized dataserver that can be used by other clients. Similar to the vent_auto software, the centralized dataserver switches automatically between data sources that sample the same physical parameter.

**Adaptive Optics Software**

A number of modifications and improvements were made to the AO software over the course of the fall trimester. These include:

***TSS Server***

The f/15 adaptive secondary includes a subsystem called Thin Shell Safety system (TSS). The TSS is an autonomous system, and can step in at any time when the state of a monitored parameter indicates that the safety of the deformable mirror (DM) is in question. The system has a communications interface that only allows one client to connect to it at a time. Most of the time, the one client would be a 'dm_status' GUI that displays parameters reported by the TSS. However, when preparing the mirror for operation or shutting it down, the one client limitation required the DM operator to close the dm_status connection so the other software could talk to the TSS and then reopen it afterward. A TSS server was developed to act as an intermediary to manage multiple simultaneous clients, a significant simplification of the operating procedure. The bulk of the work was performed by T. Trebisky with help from T. Pickering in testing and deployment and from S. Schaller to get TSS information incorporated into the AO GUI. A software framework was used patterned after the new MMT miniservers, making it straightforward to log TSS telemetry information, just as we now do for our various miniservers. The TSS server was fully commissioned and deployed during the weathered-out December AO run.

***Science Server***

The science server for the AO system acts as an intermediary that allows instrument control software to coordinate control of the MMT mount, the AO topbox, and the AO loop. AO instruments frequently need to nod or dither between exposures and the science server provides a way to automatically turn the loop gain down, move the telescope, move the field steering mirror, and then turn the loop gain back up when a dither or nod is commanded. Previously it was implemented as a stand-alone tcl/tk GUI. S. Schaller modified it to act as a server running in the background with the configuration interface incorporated into the main ao_gui interface. The new science server was deployed and used successfully during the November and December AO runs.

### *New Actuator Current Limit Handling*

Previously, the actuator current limits in the DM were based on absolute values for individual actuators. If one actuator hit a limit, the loop would break. This highly conservative approach did not adversely affect NGS in a significant manner, but severely hampered LGS under all but the very best conditions. V. Vaitheeswaran investigated and found that in addition to the normal current limit checks, there was another that stopped the process if an actuator had a current that was 4.5 times the mean current. She implemented a new approach that monitors the RMS of all actuator currents over a period of time. This was a breakthrough for LGS operations and was ported over to NGS operations during the November run. On the first night the new limit scheme was used with NGS we were able to keep the loop closed on the same object from 5:50 PM until 12:40 AM without any interruption. The conditions during most of that time were exquisite, though there were numerous occasions where the loop would likely have broken with the original limit scheme. We also had no problems flattening the mirror at low elevations. This is a big help that avoids the costly time overhead of having to tip up to near zenith to reset the mirror if the loop breaks. We expect this new scheme to greatly improve the efficiency of AO operations and extend the range of conditions where the AO system (both NGS and LGS) is able to work.

### Miniserver Improvements

We run a large number (well over 50!) of what we call "miniservers" at the MMT. Typically these exist to provide a civilized interface to some piece of equipment (a weather station, environmental sensor, a telescope subsystem). We have some equipment with unique network protocols that don't always support multiple connections, or with serial interfaces (in which case we use lantronix units to provide a network interface). A miniserver provides a uniform protocol across devices, as well as supporting multiple simultaneous clients. The miniservers also provide a central node from which to initiate data logging.

As the number of miniservers we support has grown, and our dependence on them has increased, we have had to confront various reliability and performance issues. We are quite pleased with the reliability of the current software (written in the perl language), and have begun an effort to convert all of the miniservers to a new schema that replaces a dual process architecture with one using a single event driven process. As part of our rework of the miniserver framework, we have begun to generalize the miniserver software and allow them to dynamically configure themselves from a set of defining parameters (presently stored in database tables). We are finding that having the miniserver parameters in a central resource has advantages and uses beyond the miniservers themselves. One example is that this allows us to build general plotting tools that are capable of displaying virtually any variable from any miniserver.

S. Schaller also started on a replacement for the mmtservice command, which is responsible for controlling all the mmt services. This replacement is easier to configure, can handle distributed services, running under different user names, and can be used from any of our machines.

### Miscellaneous Software Topics

Some issues with regards to network connectivity for the SAO instrumentation were addressed after shutdown. The configuration of the SAO trio of computers in the yoke room was modified to generate an internal net and an external net. This isolates the instrument computers from outside network activity. Lewis and Clark are able to communicate on both networks. A couple of network switches and connections also had to be moved to get everything working properly.

Work continued on a variety of software topics including:

- Migration of miniserver code into subversion control
- Installation of Mediawiki on hacksaw and evaluation of its use compared to Dokuwiki and other wiki software.
- Continued development of MMTO documentation within Dokuwiki and Mediawiki.
- Addition of thermopile functionality to the thermocouple board testing software used by the electronics staff.
- Continued work of on-the-fly mount tracking plots.
- Work with S. Callahan on thermal analysis of MMT roof properties and associated effects on seeing.
- Investigations of different approaches to improving reliability of software systems, including MySQL clusters, MySQL database replication, and virtualization of servers using XEN and QEMU.
- Work with M. Hastie on development of a movie that documents a typical secondary and instrument change.
- Work with D. Clark on setup of a MySQL database and related software for logging of dial indicator readings.
- Continued work on updating miniserver/mmtservice related MySQL databases and tables.
- Continued work on web pages to display MMT telemetry and archival data.
- In late November, we learned that a frequently used software program (OrCAD Layout) would no longer be available. This program is being discontinued and will be replaced with Cadence ALLEGRO, so we will continue to have a circuit design assessor. In December we started to learn and use the new software. This process will most likely continue into the next trimester.

## Instruments

In November, the Instrument Interface Document was discussed, requiring all mountain instrument inventory to be recorded. The process of documenting every instrument stored at the MMT plus their external components such as various cables and connectors and their description, as well as requirements for each system, i.e. nitrogen, CO2, methanol, etc., was begun and merged with the actual Instrument Interface Document currently in progress by M. Hastie. This documentation will continue into the next trimester.

### f/15 Instrumentation

In November the f/15 mirror was mounted on the telescope for the first time since the departure of system experts, T. Stalcup and C. Chute. It was clear that the additions and updates to the documentation were necessary. Since then the installation and removal procedures have been updated and posted.

C. Knop is currently in the process of making a connection interface panel for the AO rack. This will provide a central location for all connections required for operation of the f/15 secondary mirror. When the AO rack is transferred between the bowl (Common Building storage area) and the summit, there will no longer be any connectivity issues. Starting in January 2009, the AO rack will be reorganized and rewired for ease of maintenance.

### *Natural Guide Star (NGS)*

Efforts to reduce the noise in the AO wavefront sensor camera heads continued. T. Stalcup consulted with P. Arbo from CAAO about possible changes to the internal wiring of the camera head. The ground system was altered to remove some ground loops, and the ground wire from the dewar connector to the CCD was changed from constantan to copper to reduce resistance in the ground path. This work was done on the spare camera head. Prior to this work, the four different outputs from the camera showed different noise characteristics ranging from 12 to 20 electrons rms. After the work was completed, three of the four outputs had virtually identical performance at about 9 electrons rms, with the fourth output a little higher at 10 electrons. Another significant improvement resulting from this work was that the read noise was no longer sensitive to external influences such as touching the camera head or grounding the camera head to the camera controller chassis. Previously this would cause the noise performance to change dramatically, but with the latest modifications there was no observable effect.

### *Laser Guide Star (LGS)*

Calibration data for the mirror actuators was measured on the test stand using the 4d interferometer in September. This is an important step that will enable several other projects such as recomputing the realtime reconstructor matrix, and will also allow computing a better reconstructor matrix for the LGS system.

The October run was extremely successful, producing well-corrected, round, stable images. The loop stability problems from May did not recur, and the new actuator scale factors resulted in a much more robust loop.

## f/5 Instrumentation

### *Hectospec*

The Hectospec positioner had a problem in early September as a result of metallic debris on the focal plane that attached to a few of the button magnets. The problem buttons were parked for the last few days of the run. The debris might have been generated during the previous service mission or it might have been generated by the mounting bolts and flange. B. Fata and company came down to do a thorough cleaning of the separated unit. Non-magnetic washers have been added to mounting bolts and an inspection and cleaning is now performed when mounting and dismounting the positioner.

There was a short Hectochelle run in October followed by a longer Hectospec run through November and into December. The positioner was removed twice during the run. The cabling for the wavefront sensor was checked and re-secured in early November which required a "partial" dismount of the positioner. (There was a two-day ToO (Target of Opportunity) AO run around 11/20 to image the planets around HR8799.)

A problem developed with gripper 2 in the positioner in early December. The electronics indicated that the gripper was closed too far, as though it had dropped a button. This condition was labeled "trouble" in the GUI and the software was designed to stop if this condition was reported so an immediate fix was needed. The gripper seemed to be holding buttons so we bypassed the software interlock and monitored the situation on the screen during moves and with a direct inspection after some configurations and at the end of the night. A servicing mission by the SAO crew was planned for later, and spare grippers were shipped from Cambridge in case replacement was needed.

While unmounting the fiber positioner on December 8, the removal crew discovered that the energy chain for the fibers was broken. The cause of the break is still unclear. Throughput data indicated that the break actually occurred several days earlier. The situation in the chamber was frozen and D. Fabricant, B. Fata, J. Zajac and M. Mueller flew out to assess and correct the problem. A few feet of the energy chain and the mounting brackets were replaced, and all of the fibers were carefully repositioned in the chain to relieve stress. None of the fibers were broken, but several were exposed in the transition box. It appeared that the assembly of the fiber chain was not symmetric. There were internal rotation stops on one side of the chain and not on the other. The work was completed in time to mount SWIRC on the telescope on Friday, though the weather did not permit any observation for its three day run.

***Megacam***

Megacam had a short run in October with polarizing filters and another at the end of December. In between the two runs, all of the driver boards for the Megacam CCD's were shipped to Cambridge for modification to enable a lower range of driver voltages for the serial clocks. B. McLeod had discovered that there was a small but significant correlation between pixels in the output intensities, i.e. the noise did not have the proper poisson distribution. The output was improved when Brian tested it at the end of December.

***Wavefront Sensor***

We experienced the wavefront sensor (WFS) "hanging up" on a regular basis. C. Knop and R. Ortiz determined that the hang-ups were being caused by a malfunctioning and improperly routed USB cable. A new cable was installed and properly routed, and there have been no further problems.

## Seeing

The Fall 2008 trimester had some of the consistently best seeing that has been recorded in over 5 years. The median seeing for the entire trimester was 0.71" (based on 3545 f/5 and f/9 WFS observations) and the seeing was 0.5" or better more than 15% of the time. It culminated on the last night of the year when Megacam data were obtained with 0.3" FWHM stellar PSFs in images with 40-60 sec exposure times, no autoguiding, and smooth 10-15 mph winds. The seeing values measured directly in the Megacam images agreed very well with the ones measured by the WFS. This is further validation of our technique for deriving seeing values from the WFS data. Achieving such good image quality without guiding also shows how good our tracking can be.

The good seeing is in large part due to long stretches of stable, mild weather that we had the second half of September, most of October, and parts of November. The histograms of wind, temperature, and humidity help bear this out. The outside ambient temperature was between 10 and 15 C roughly half the time while the humidity was near saturation about 10% of the time, but generally dry otherwise. The winds were slightly lower overall with the median average and median gust speeds each down 2 mph from the summer.

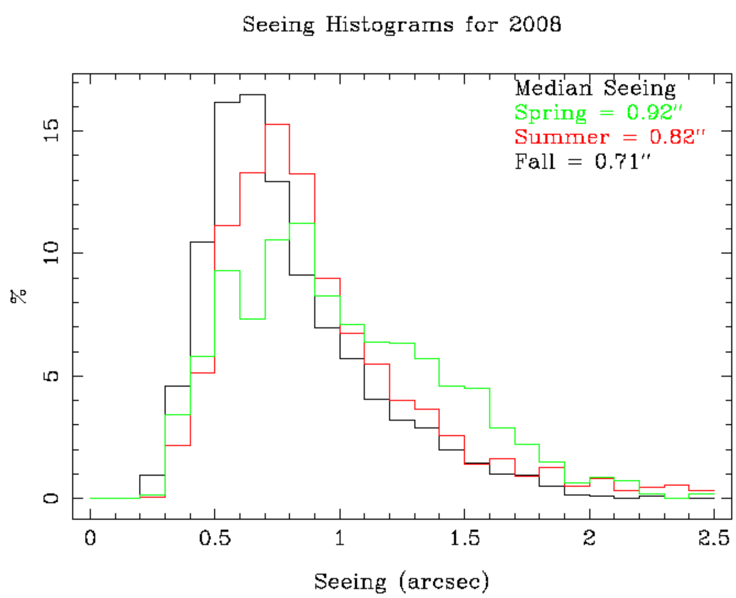
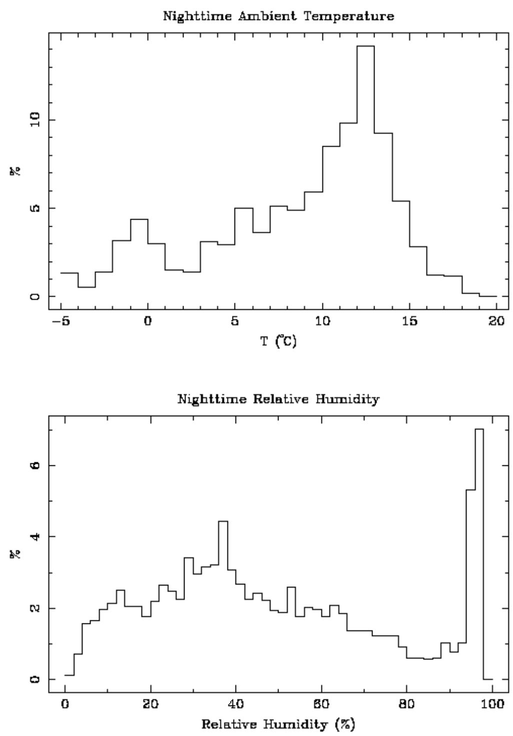



**Figure 2.** Seeing histograms for each trimester of 2008. The seeing values are corrected to zenith using the standard model of atmospheric turbulence. Note how the seeing was markedly better during the fall than during the spring or summer.



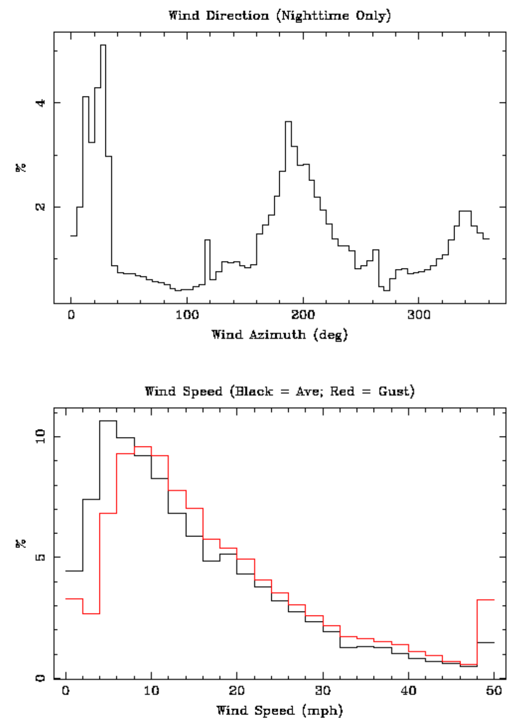




**Figure 3**. Histograms of nighttime temperature and humidity during the fall 2008 trimester. Only data acquired between 6 PM and 6 AM are included.

**Figure 4.** Histograms of nighttime wind direction and speed during the fall 2008 trimester. Only data acquired between 6 PM and 6 AM are included.

## General Facility

### Spectrograph Room Fire Suppression

Durant Architecture was hired by the Smithsonian Project Office to perform a feasibility study to provide fire suppression for the MMT's third floor spectrograph room. After review of this study by MMT staff and astronomers, it was decided the significant impact on the observatory, potential risk to the instrument, and high cost outweighed the risk reduction gains provided. This project has been cancelled.

### Freon Refrigeration Overhaul

The Freon system has been upgraded to provide refrigeration to the drive room and the second floor east lab.

### Enclosure Painting

Lead testing was performed on the exterior paint. A positive detection was found in one location of the building. This has resulted in a modification of the contract. Smithsonian funding has not been approved for this fiscal year.

### Instrument Repair Facility

M3 completed the 100% review. The design package is now being prepared to go for bid as soon as funding becomes available from the Smithsonian Project Office.

### Road Heaters

The road heaters to the summit continue to be unreliable. T. Welsh (FLWO) continues to keep the ailing system on-line. S. Criswell issued a scope of work document for review by the Smithsonian Project Office, detailing the history and need for improvements.

### Building Drive

The building drive experienced several intermittent shutdowns due to a building hand-crank error from the 26V rack. Troubleshooting revealed no obvious causes. As a preventive measure, relays K7 on the building drive fault card and in the building drive breakout box were replaced. Additionally, all connections for this safety circuit were inspected. When another fault occurred, the mount for K7 in the building drive was replaced as well. Since then, there have been no dropouts due to hand-crank errors.

### Weather and Environmental Monitoring

Within a month of the new WXT-520 weather station (Vaisala 3) being received and installed on the east flagpole, the system had a failure of the wind sensor. The unit was sent back to Vaisala and repaired. It appeared that the rubber sections of the wind probes had either decomposed or been picked off by an indigenous avian species. A mylar strip was hung by the WXT-510 to try to scare away any birds, but the strip did not tolerate the high winds on the summit. In December the unit showed a lag of twenty minutes between actual and displayed data. D. Gibson found that the data were in a continuous mode from the Vaisala unit. The software was changed to force the Vaisala WXT-510 to be in polling mode only.

The WXT-510 (Vaisala 4) located on the west side of the MMT structure failed in late December. While the temperature and humidity information is good, the wind sensor is not operative. The unit was removed and is awaiting funding for repair.

The R.M. Young unit lost its propeller and shaft assembly during a severe ice storm in late December. The unit was removed, the shaft and propeller replaced, and the unit reinstalled. Spare parts were ordered to replace the used parts.

## Other Facility Improvements and Repairs

- Work continued on cleaning and organizing the e-shop and its surroundings.

- Since its inception, the interlock display for the operators has displayed a red status for the power section of the rotator and the elevation drives. While not critical, explaining to each observer why it was a red status on an otherwise green display was inconvenient for observers and staff. The wiring from the appropriate panels in the drive room was connected to the 26V rack. The GUI now displays a green status when the system is operational.

- The ventilation 50 hp blower motor was replaced with a 60 hp spare motor and is fully operational. Those involved in completing this swap were: J.T. Williams, T. Welsh (FLWO), R. Ortiz, C. Knop, W. Stangret, D. Jankovsky, and D. Smith.

- A complete ventilation hose, clamps, and flanges unit was made to serve as a spare backup.

- W. Stangret replaced the west counterweight hook assembly that had been damaged from the side-pulling of counterweights. J.T. Williams attached slings to the counterweights to prevent this type of damage from recurring in the future.

- An old Mattei shop air compressor was swapped out for a Gardner/Denver model. The same oil and filters are now used for all three compressors. Valves were also added to better distribute the flow of air from the air compressors, and regular maintenance was performed.

- J.T. Williams, C. Lopez (FLWO), R. Harris (FLWO), W. Stangret, and D. Jankovsky repaired the scissor lift by the loading dock. The repair required significant metal work and re-plumbing. After reinstalling the lift, it was painted and a skirt trim was added. The lift is frequently used by both MMT staff and P.I. observers.

- The telestat monitor, still under warranty, failed and was sent back to Samsung for repair.

- A cylinder from the chamber instrument lift was rebuilt after the detection of a leak.

- The extension arms on the hexapod cart were pinned to avoid installation errors

- Repairs were made to the roof gate and railing.

- The roof snow plows were reinstalled.

- A small cover was made in the front of the chamber to block light during day calibrations.

- Several employees attended the safety courses, "Crane Operation" and "CERTEX Rigging Class".

## Visitors

September 25-26: A film crew for the PBS series *NOVA* visited the mountain as part of a program on exoplanets. Filming was done at the MMT as well as at several new MEarth telescopes also located on Mt. Hopkins.

October 3: A group of Smithsonian Associate members toured the MMT Observatory.

October 9-12: Footage at the MMT Observatory was shot for the French film "Around the World, Around the Sky 2009", a homage to astronomers and the International Year of Astronomy in 2009. French astrophysicist, Pierre Léna, from the Sciences Academy, and Michel Serres, philosopher and historian of sciences from the French Academy, were hosts of the film.

October 28: The annual Whipple Observatory Volunteer recognition night on the mountain was held for volunteer staff and interested regular staff. The group visited the MMT, as well as other telescopes located on Mt. Hopkins.

## Publications

### MMTO Internal Technical Memoranda

None

### MMTO Technical Memoranda

None

### MMTO Technical Reports

None

### Scientific Publications

08-45 Constraining Cosmic Evolution of Type Ia Supernovae
R. Foley, et al.
*ApJ*, **684**, 68

08-46 The Evolution of Late-Time Optical Emission from SN 1986J
D. Milisavljevic, R. Fesen, B. Leibundgut, R. Kirshner
*ApJ*, **684**, 1170

08-47 New Young Brown Dwarfs in the Orion Molecular Cloud 2/3 Region
D. Peterson, et al.
*ApJ*, **685**, 313

08-48 The Rapidly Flaring Afterglow of the Very Bright and Energetic GRB 070125
A. Updike, et al.
*ApJ*, **685**, 361

08-49 Trigonometric Parallaxes for Two Late-Type Subdwarfs: LSR 1425+71 (sdM8.0) and the Binary LSR 1610-00 (sd?M6pec)
C. Dahn, et al.
*ApJ*, **686**, 548

08-50 Galaxy Clusters in the IRAC Dark Field. I. Growth of the Red Sequence
J.E. Krick, et al.
*ApJ*, **686**, 918

08-51 The Extreme Kuiper Belt Binary 2001 $QW_{322}$
J.-M. Petit, et al.
*Science*, **322**, no. 5900, 432

08-52 The First Retrograde Transneptunian Object
B. Gladman, et al.
*BAAS,* **40**, 3805

08-53 Waves in Pluto's Upper Atmosphere
M. Person, et al.
*AJ*, **136**, 1510

08-54 Long-Wavelength Density Fluctuations Resolved in Pluto's High Atmosphere
D. McCarthy, et al.
*AJ*, **136**, 1519

08-55 Leo V: A Companion of a Companion of the Milky Way Galaxy?
V. Belokurov, et al.
*ApJ*, **686**, L83

08-56 Double-Peaked Oxygen Lines Are Not Rare in Nebular Spectra of Core-Collapse Supernovae
M. Modjaz, et al.
*ApJ*, **687**, L9

08-57 Mapping the Asymmetric Thick Disk: The Hercules Thick-Disk Cloud
J. Larsen, R. Humphreys, and J. Cabanela
*ApJ*, **687**, L17

08-58 Is the Optically Unidentified Radio Source First J121839.7+295325 a Dark Lens?
R. Ryan, et al.
*ApJ*, **688**, 43

08-59 Boötes II ReBoöted: An MMT/MegaCam Study of an Ultrafaint Milky Way Satellite
S. Walsh, et al.
*ApJ*, **688**, 245

08-60 Deep *L*'- and *M*-band Imaging for Planets Around Vega and ϵ Eridani
A. Heinze, et al.
*ApJ*, **688**, 583

08-61 New Complexities in the Low-State Line Profiles of AM Herculis[1]
S. Kafka, et al.
*ApJ*, **688**, 1302

08-62 A Slowly Accreting ~ 10 Myr-old Transitional Disk in Orion OB1a
C. Espaillat, et al.
*ApJ*, **689**, L145

08-63 The Spitzer View of Low-Metallicity Star Formation. II. Mrk 996, A Blue Compact Dwarf Galaxy with an Extremely Dense Nucleus
T. Thuan, L. Hunt, and Y. Izotov
*ApJ*, **689**, 897

08-64 Line Broadening in Field Metal-Poor Red Giant and Red Horizontal Branch Stars
B. Carney, et al.
*AJ*, **135**, 196

08-65 V723 Cassiopeia Still on in X-Rays: A Bright Super Soft Source 12 Years After Outburst
J.-U. Ness, et al.
*AJ*, **135**, 1328

08-66 Tidal Synchronisation of the Subdwarf B Binary PG 0101+039
S. Geier, et al.
*A&A*, **477**, L13

08-67 Estimating the Total Infrared Luminosity of Galaxies up to z ~ 2 from Mid- and Far-Infrared Observations
N. Bavouzet, et al.
*A&A*, **479**, 83

08-68 Asteroseismology in Action: A Test of Spin-Orbit Synchronism in the Close Binary System Feige 48
V. Van Grootel, et al.
*A&A*, **483**, 875

08-69 Testing the Forward Modeling Approach in Asteroseismology I. Seismic Solutions for the Hot B Subdwarf Balloon 090100001 With and Without *a priori mode* Identification
V. Van Grootel, et al.
*A&A*, **488**, 685

08-70 Spectrophotometry with Hectospec, the MMT's Fiber-Fed Spectrograph
D. Fabricant, et al.
*PASP*, **120**, 1222

**Non MMT Scientific Publications by MMT Staff**

> The Inner Jet of an Active Galactic Nucleus as Revealed by a Radio-to-γ-Ray Outburst
> A. Marscher, et al.
> *Nature*, **452**, 966

**Observing Reports**

Copies of these publications are available from the MMTO office. We remind MMT observers to submit observers' reports, as well as preprints of publications based on MMT research, to the MMTO office. Such publications should have the standard MMTO credit line: "Observations reported here were obtained at the MMT Observatory, a facility operated jointly by the Smithsonian Institution and the University of Arizona."

Submit publication preprints to *bruss@mmto.org* or to the following address:

MMT Observatory
P.O. Box 210065
University of Arizona
Tucson, AZ  85721-0065

**MMTO in the Media**

No activity to report.

**MMTO Home Page**

The MMTO maintains a web site (*http://www.mmto.org*) that includes a diverse set of information about the MMT and its use. Documents that are linked to include:

- What's New at MMTO. We have expanded this section to include a "blog" that gives current information pertaining to various aspects of the MMTO. (See p. 2 for more detail.)
- General information about the MMT and Mt. Hopkins.
- Telescope schedule.
- User documentation, including instrument manuals, detector specifications, and observer's almanac.
- Scientific and technical publications
- A photo gallery of the Conversion Project as well as specifications related to the Conversion.
- Information for visiting astronomers, including maps to the site.
- The MMTO staff directory.

**Observing Database**

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.

NOTE: Beginning January 2005, the formula for accounting lost time on the telescope has been changed. Previously, time lost to weather was deducted from the total observing time before calculating time lost to instrument, telescope, and facility from the remaining balance. From now on, the time lost to each source is computed as a fraction of the total scheduled time.

And beginning June 2005, a new category, environment, was added to account for time lost to natural, uncontrollable, non-weather events such as flying insects melting in laser beams and forest fires.

# Use of MMT Scientific Observing Time

## Use of MMT Scientific Observing Time

### September 2008

| 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 | 5.00 | 51.10 | 20.35 | 0.50 | 0.00 | 0.00 | 0.00 | 20.85 |
| PI Instr | 22.00 | 216.90 | 55.35 | 8.25 | 2.50 | 0.25 | 0.00 | 66.35 |
| Engr | 1.00 | 9.70 | 9.70 | 0.00 | 0.00 | 0.00 | 0.00 | 9.70 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 28.00 | 277.70 | 85.40 | 8.75 | 2.50 | 0.25 | 0.00 | 96.90 |

| Time Summary | |
|---|---|
| Percentage of time scheduled for observing | 96.5 |
| Percentage of time scheduled for engineering | 3.5 |
| Percentage of time scheduled for sec/instr change | 0.0 |
| Percentage of time lost to weather | 30.8 |
| Percentage of time lost to instrument | 3.2 |
| Percentage of time lost to telescope | 0.9 |
| Percentage of time lost to general facility | 0.1 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 34.9 |

* Breakdown of hours lost to telescope
2.5 M2

** Breakdown of hours lost to facility
0.25 Bldg collision

### October 2008

| Instrument | Nights Scheduled | Hours Scheduled | Lost to Weather | *Lost to Instrument | ** Lost to Telescope | Lost to Gen'l Facility | Lost to Environment | Total Lost |
|---|---|---|---|---|---|---|---|---|
| MMT SG | 8.00 | 87.40 | 7.90 | 0.00 | 1.50 | 0.00 | 0.00 | 9.40 |
| PI Instr | 22.00 | 238.40 | 54.90 | 0.50 | 3.30 | 0.00 | 0.00 | 58.70 |
| Engr | 1.00 | 10.60 | 0.00 | 0.00 | 6.00 | 0.00 | 0.00 | 6.00 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 31.00 | 336.40 | 62.80 | 0.50 | 10.80 | 0.00 | 0.00 | 74.10 |

| Time Summary | |
|---|---|
| Percentage of time scheduled for observing | 93.7 |
| Percentage of time scheduled for engineering | 3.2 |
| Percentage of time scheduled for sec/instr change | 3.1 |
| Percentage of time lost to weather | 18.7 |
| Percentage of time lost to instrument | 0.1 |
| Percentage of time lost to telescope | 3.2 |
| Percentage of time lost to general facility | 0.0 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 22.0 |

* Breakdown of hours lost to instrument
0.5 hecto server probs

** Breakdown of hours lost to telescope
10.8 Secondary, rotator, primary, tracking

## Use of MMT Scientific Observing Time

### November 2008

| 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 | 7.00 | 79.60 | 14.25 | 0.00 | 0.00 | 0.00 | 0.00 | 14.25 |
| PI Instr | 23.00 | 269.00 | 77.00 | 4.25 | 5.25 | 1.00 | 0.00 | 87.50 |
| 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 | 348.60 | 91.25 | 4.25 | 5.25 | 1.00 | 0.00 | 101.75 |

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 | 26.2 |
| Percentage of time lost to instrument | 1.2 |
| Percentage of time lost to telescope | 1.5 |
| Percentage of time lost to general facility | 0.3 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 29.2 |

* Breakdown of hours lost to telescope
5.25 wfs failure, hacksaw crash, pointing/rotator issues

** Breakdown of hours lost to facility
1.0 Unscheduled instrument change

### December 2008

| 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 | 11.00 | 132.00 | 64.70 | 0.00 | 0.50 | 0.00 | 0.00 | 65.20 |
| PI Instr | 16.00 | 191.30 | 73.00 | 27.50 | 0.75 | 0.00 | 0.00 | 101.25 |
| Engr | 3.00 | 36.00 | 12.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.00 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 30.00 | 359.30 | 149.70 | 27.50 | 1.25 | 0.00 | 0.00 | 178.45 |

Time Summary

| | |
|---|---|
| Percentage of time scheduled for observing | 90.0 |
| Percentage of time scheduled for engineering | 10.0 |
| Percentage of time scheduled for sec/instr change | 0.0 |
| Percentage of time lost to weather | 41.7 |
| Percentage of time lost to instrument | 7.7 |
| Percentage of time lost to telescope | 0.3 |
| Percentage of time lost to general facility | 0.0 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 49.7 |

* Breakdown of hours lost to telescope
1.25 M1 panic, guider server crash, wfs failed attempts

### Year to Date December 2008

| 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 | 88.00 | 902.90 | 226.25 | 10.75 | 4.38 | 0.25 | 0.00 | 241.63 |
| PI Instr | 226.00 | 2259.60 | 765.10 | 116.10 | 55.15 | 2.50 | 0.00 | 938.85 |
| Engr | 19.00 | 187.60 | 73.50 | 0.00 | 8.75 | 0.00 | 0.00 | 82.25 |
| Sec Change | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Total | 333.00 | 3350.10 | 1064.85 | 126.85 | 68.28 | 2.75 | 0.00 | 1262.73 |

Time Summary

| | |
|---|---|
| Percentage of time scheduled for observing | 94.1 |
| Percentage of time scheduled for engineering | 5.6 |
| Percentage of time scheduled for sec/instr change | 0.3 |
| Percentage of time lost to weather | 31.8 |
| Percentage of time lost to instrument | 3.8 |
| Percentage of time lost to telescope | 2.0 |
| Percentage of time lost to general facility | 0.1 |
| Percentage of time lost to environment (non-weather) | 0.0 |
| Percentage of time lost | 37.7 |