Smithsonian Astrophysical Observatory & Steward Observatory, The University of Arizona

MMT Observatory
Smithsonian Institution & The University of Arizona®

BIMONTHLY SUMMARY

September – October 2006

Top left: Chemically stripped of its old aluminum coat, the lightweight f/9secondary is shielded from adjacent mirror support hardware, likely sources of contamination during the vacuum pumping viscous phase.

Top right: Suspended on the vacuum chamber cover, the f/9 secondary mirror gets a final bathing with CO_2 (carbon dioxide) snow.

Bottom: Several hours later, the fresh aluminum coating reflection catches the crew admiring their handiwork – a textbook success on a very challenging mirror.

Photos by Ricardo Ortiz (MMTO).

Personnel

Faith Vilas and Grant Williams gave talks (Status of the MMT: Report on Summer Shutdown) at the Steward Observer's Lunch on September 12. Matt Kenworthy gave a talk on everything one must know about the MMT NGS AO proposal process at the Steward Observer's Lunch on September 26.

Dondi Gerber finished her 6 month probationary period and is now a permanent part of the MMTO team. Her current efforts are directed towards the rework and eventual renewal of the T series thermocouple system.

Shawn Callahan, Creighton Chute, Brian Comisso, Dondi Gerber, Tom Gerl, Cory Knop, Ricardo Ortiz, Grant Williams, and J. T. Williams attended an on-campus vacuum technology seminar October 3. The seminar was sponsored by Varian Inc. Vacuum Technologies, and was taught by two Varian representatives. This short course provided an excellent basis of training for the wide range of vacuum systems currently used at the MMT, and serves as the first step in training personnel in the aluminization process.

In late October, Ian Shelton was hired as an Astronomical Observing Support Engineer (backup telescope operator and instrument support) and will start his position November 6.

16th Annual ADASS Conference

The 16th annual Astronomical Data Analysis Software and Systems (ADASS) XVI Conference was held October 15-18 at the Westin La Paloma in Tucson. There were 290 attendees and 185 papers presented. Duane Gibson, Tim Pickering, Dallan Porter, Skip Schaller, Betty Stobie, Tom Trebisky, and Grant Williams all attended.

Betty Stobie was a member of the Local Organizing Committee for ADASS and was responsible for all catering. She insured that there was ample and tasty food for the opening reception, evening banquet, daily breakfasts, morning and afternoon breaks, and lunches — without going over budget. As a member of the Program Organizing Committee, she also chaired one oral session and attended the annual POC business meeting.

She serves on the International Astronomical Union Flexible Image Transport System Working Group (IAU FITS WG). Along with most other members of the working group, she attended the FITS Birds of a Feather Session at ADASS.

38th Annual Division for Planetary Sciences Meeting

Faith Vilas attended the 38th annual meeting of the Division for Planetary Sciences, American Astronomical Society, in Pasadena, California, from October 11-13. She presented a paper on MMT spectra of irregular outer Jovian satellites, and was co-author of four other papers. In addition to her presentation, two abstracts below include data take in spring 2006 at the MMT.

- MMT Reflectance Spectral Observations of Irregular Outer Jovian Satellites: Testing the Presence of Aqueous Alteration
  Faith Vilas

- Optical Spectra of the Large Kuiper Belt Objects 2003 EL61 and 2005 FY9
  Stephen C. Tegler, W. Grundy, G. Consolmagno, W. Romanishin, K. Mogren

- Visible and Near-Infrared Spectroscopy of Potentially Hazardous Asteroid (68950) 2002 QF_{15}
  Paul Abell, F. Vilas, V. Reddy, M. J. Gaffey, K. S. Jarvis

- Space Weathering Effects at UV Wavelengths: Asteroids and the Moon
  Amanda Hendrix, F. Vilas

- Photometry and Surface Mapping of Asteroid Itokawa from Hayabusa Nirs Observations
  Kouhei Kitazato, B. E. Clark, M. Abe, S. Abe, Y. Takagi, T. Hiroi, O. S. Barnouin-Jha, P. A. Abell, F. Vilas

- Las Campanas-Lowell Observatory Ground-based Observing Campaign: UBVRIJHK Hapke modeling of Hayabusa Spacecraft Target Asteroid 25143 Itokawa
  Susan M. Lederer, J. E. Thomas-Osip, D. Domingue, F. Vilas, D. J. Osip, S. L. Gill, K. S. Jarvis

Primary Mirror Systems

Primary Mirror Support

Construction of the primary hardpoint test stand was completed during the previous reporting period. We continue to test and optimize the unit, and refine the electronics and LabView GUI for data collection.

Six "hardpoint" struts rigidly define the 6.5-m primary mirror position in the telescope optical system. The struts contain motorized linear actuators to control the position of the mirror at all elevation angles. Each hardpoint is equipped with a "breakaway" mechanism. This mechanism protects the mirror by limiting the maximum force applied to the mirror. The hardpoints must be sufficiently rigid over the normal operating range of the telescope to keep the lowest eigenfrequencies of the mirror above 10 Hz.

A flaw was discovered in the measurement technique being used to determine hardpoint stiffness. With a new technique in place, repeatable results are being achieved. New lock nuts for the hardpoint breakaway shaft are being fabricated to replace the easily damaged original locknuts. New springs were ordered to replace the existing springs of the breakaway. The new springs will raise the breakaway force to well out of the range of operation. Spring keepers are being fabricated to prevent the springs in the breakaway mechanism from falling out of the hole where they reside, and to lower the stiffness of the hardpoint. A characterization method is in its final development stages. If the method is successful, the hardpoints will be able to be placed into any position on the telescope without needing to re-collimate.

Tom Gerl is developing a more detailed operating procedure for the actuator test stand. This will be refined and made available for the users.

Primary Mirror Thermal Monitoring

On September 8, it rained throughout the night. This provided a unique opportunity to allow the primary mirror to remain at a nearly constant temperature for a period of 12 hours. All heat sources in the mirror were off during this period. In the morning, the thermocouples throughout the mirror were recorded. These data will be collected again throughout the year to improve the calibration of the thermocouples.

The logs show 1 degree variations between thermocouples. These data indicate that the accuracy of the current calibration of certain thermocouples is only 1 degree C. Additional data will be taken at other temperatures to improve the calibration of the thermocouples.

Dondi Gerber and Dusty Clark have turned their attention back to fabrication of the new T-series thermocouple readout system. The system design had previously been completed, and we plan to begin PC-board layout and construction of the first few units in the next few months. In the meantime, Dondi has been given some initial training and design support from Dusty to bring the drawings up to date, complete inventory of parts, and begin the board layout and construction. She is currently redesigning a surface mount circuit card to standardize and simplify the thermal system electronics.

Ventilation System

Small variations in air flow can cause large variations in the cooling rates of the primary mirror. Shawn Callahan and Faith Vilas used a precision manometer to measure the air pressure in the back of the primary mirror cell. The air pressure varied between 0.42 inches of water (1.0 mbar) and 0.67 inches of water (1.7 mbar). From these pressure measurements, the flowrate and the effect on the thermal time constant of the mirror can be mapped and compared to temperature profiles measured on the mirror.

Optics

The primary mirror continues to be regularly CO_2 cleaned. There are no major changes to report on its condition. We plan to wash the primary mirror during the first trimester of 2007.

Secondary Mirror Systems

f/9 Secondary Aluminization

In preparation for the f/9 secondary aluminizing, a new octagonal lifting and transport fixture was fabricated by Bill Stangret. This fixture, designed by J. T. Williams, allows plenty of working room around the mirror and rigging points for safe transportation. Bill and J. T. worked extensively on the new fixture, and we now have a safe way to transport and handle the f/9 during chemical stripping and re-aluminization.

All control electronics were removed to prevent damage to the actuators and transducers, and all air lines were vented to ambient to safely evacuate the complete secondary and cell assembly.

In order to remove the old aluminum coating, we faced new challenges. This is the first time we have had to re-aluminize a mirror mounted in its regular working cell. To protect the cell, we were forced to test a variety of chemical vs. sealing compounds in search of a peel-able glue-like compound. We decided to use CosCoat 4560 (by General Chemical Corporation) mirror cleaning solution to seal the plastic dam that was inserted around the perimeter of the f/9 mirror and to protect the cell during stripping. This improvisation performed very well.

After stripping and final cleaning of the mirror, we used oil-free aluminum foil and Kapton tape to shield the "clean" mirror and cover adjacent mirror cell parts that face the filaments in the vacuum chamber. The cell was then suspended from the chamber lid and a final CO_2 cleaning was performed. Everything was now ready for the much anticipated pump-down and aluminum deposition.

Figure 1: Bill Stangret (right) operates a hydra-set lift, lowering his new multi-purpose logistics frame onto the f/9 secondary mirror and its telescope cell. Ricardo Ortiz, Mike Alegria, J. T. Williams, and Dennis Smith give the new tool a favorable review. Photo by John Glaspey (MMTO).

On October 17, 2006, we re-coated the f/9 secondary mirror in the 84" diameter vacuum coating chamber at the Steward Observatory Sunnyside Coating Lab. The deposition material is acid-etched aluminum, 99.999% pure. The total coating thickness was measured using a Maxtek TM-100 microbalance. We calculate the maximum deposition rate was 56 angstroms per second, and the total thickness was 978 angstroms. The reflectivity numbers look normal for bare aluminum. After good aluminum adhesion was confirmed by scotch tape tests on microscope slide witness samples, J. T. conducted tape tests at the mirror center and at several places at the mirror edge. The secondary mirror has several edge supports bonded to the side of the glass immediately adjacent to the coated mirror surface. We were expecting outgassing from these supports since they cannot be properly cleaned and masked. All areas passed the tape test except one place at the edge next to one of the supports where the tape lifted approximately 1/10 square inch of aluminum. This is better adhesion than expected.

Our thanks to everybody that worked so hard to make this possible in such a short amount of time: Gary Rosenbaum and Mike Bradshaw (Steward), Bill Stangret, Ricardo Ortiz, and the rest of the MMTO mountain staff. Thanks also to Gary Schmidt who played a pivotal role in keeping the f/9 secondary coating in the queue at the Sunnyside Vacuum Lab.

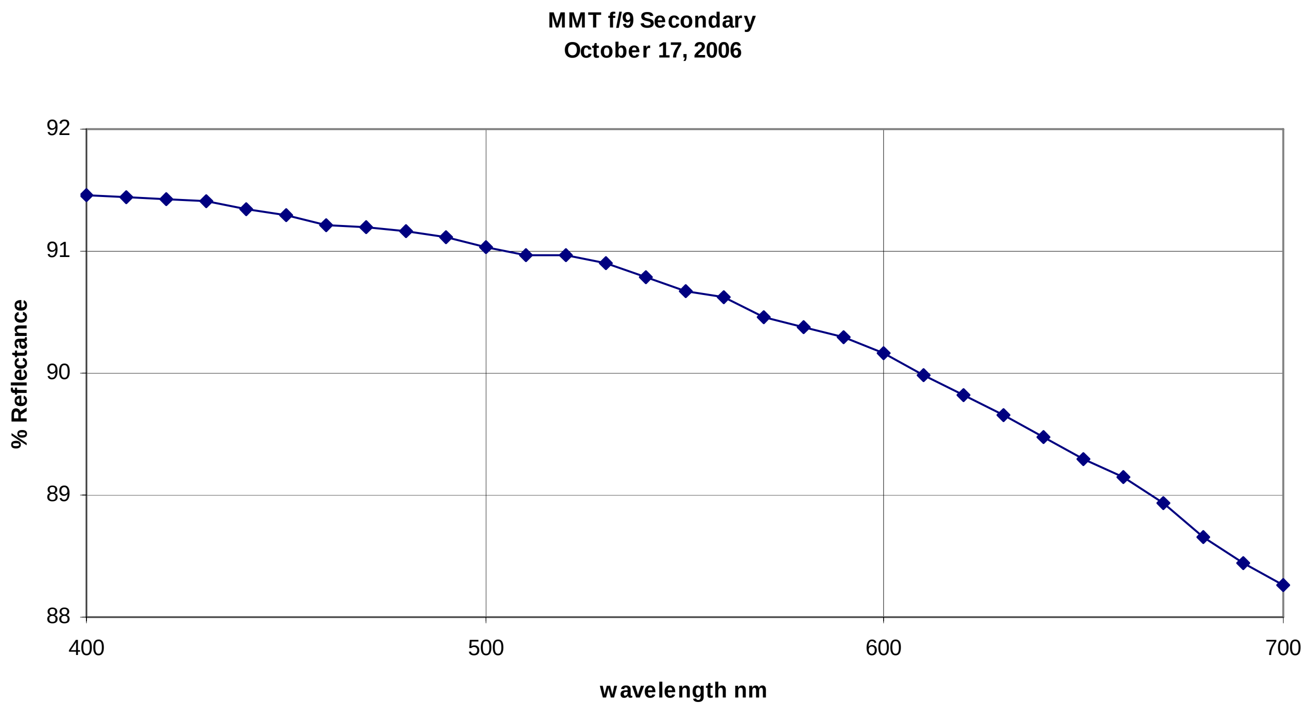


Figure 2a: Reflectivity plot for the center of the f/9 secondary following the October re-aluminization. Measured with Minolta Spectrophotometer #CM-2002.

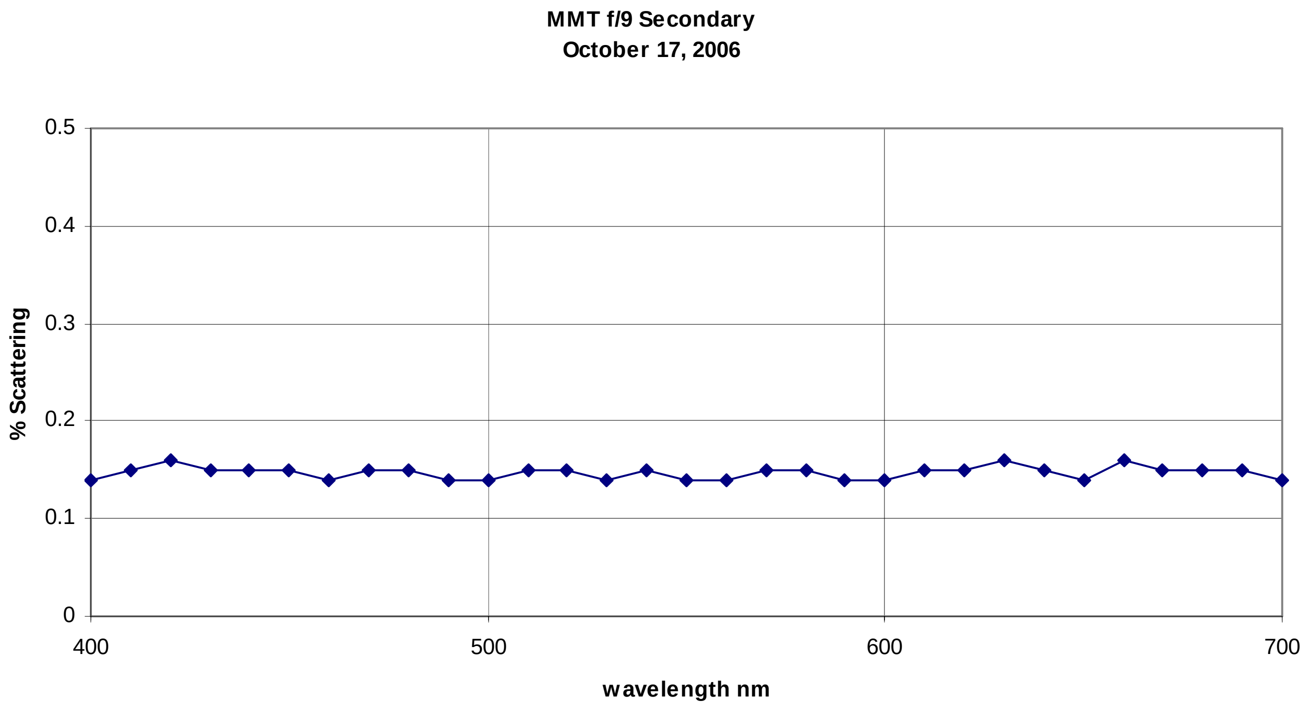


Figure 2b: Scattering plot for the center of the f/9 secondary following the October re-aluminization. Measured with Minolta Spectrophotometer #CM-2002.

f/9 Hexapod

The f/9 hexapod was reported to have problems moving actuator A. After troubleshooting and replacing Pod A with the spare actuator, Dusty Clark determined that the motor nut was a likely suspect. He disassembled the actuator and found the motor nut was less than finger tight. The f/9 hexapod was removed and brought into town for a complete overhaul. The hexapod was disassembled by Cory Knop, Dondi Gerber, and Brian Comisso. After disassembly of the first pod, it was decided to replace the self locking motor nuts with new nuts. Shawn Callahan ordered the new nuts and a commercially available tool to tighten them. The tool was modified to allow a 1" wrench to fit the collar. All the actuators were disassembled, the nuts replaced and torqued, and then the actuators were reassembled. Written procedures for this operation are being developed.

Evaluation of the f/9 hexapod and secondary was done following the recent re-aluminization, and new software limits were systematically mapped for the f/9 hexapod. Prior to this mapping, it was thought that the f/9 hexapod was unable to contact any part of the telescope hub. Although software limits have not been implemented in the past, it has been shown that they are indeed necessary to prevent this contact. Therefore software limits have been put in place to prevent excessive tilting of the f/9 cell in the removable hub. The individual hexapod pods will run out of travel mechanically before reaching any collision points. Nevertheless, a set of tape limit switches using the AO tape setup will be implemented.

f/5 Support

Two mirror support pucks that attached the positioning tangent rods to the side of the f/5 secondary mirror failed. This caused the mirror position to become unstable. The support system electronics were modified to press the mirror against the upper rubber bumpers temporarily. In this configuration, the mirror was stable enough to continue with observing.

Creighton Chute and Shawn Callahan bonded two new pucks to the mirror with a modified procedure provided by Blaine Olbert (Steward). After a two day cure, the tangent rods were re-attached. The f/5 mirror assembly was later removed from the telescope to allow rebalance of the electronics. The wavefront sensor was used to re-collimate the telescope optics and determine the offset of the mirror due to the replacement of the pucks.

The image quality of the f/5 has proven to be unstable during the past two months. To assess the cause of the problem, extensive analysis of f/5 hexapod background data was done by Brian Comisso, Ricardo Ortiz, and others. High resolution (1 Hz) hexapod data were collected and analyzed to quantify hexapod/support system behavior. One possible source is the southeast axial hardpoint, but no definitive problem has been found yet. The wavefront sensor (WFS) has had to make large corrections during tracking that are not attributable to anything else. Testing continues.

Telescope Tracking and Pointing

Servos and Encoders

Progress was made on the new electronics for the absolute encoders during the reporting period. Development of the Rabbit RCM3305 middleman software is now nearly complete. It implements all the hardware I/O functions and several network-centric functions using μC-OSII, a real-time kernel written by Jean Labrosse for small embedded controllers. The middleman will handle reading the encoder to digital conversion electronics, writing the data to a hardware FIFO for reading by the mount computer, and make the raw encoder data available for troubleshooting over the network. We have yet to connect the FIFO to the middleman and finalize the testing in the lab, and look forward to resuming this work in November.

We continue to have difficulty implementing the new elevation-axis controller. Dusty Clark checked the archival data against the controller as implemented and found several problems: a) the controller gains being used were from the wrong parameter file; and b) the telescope controller does not appear to be working correctly, even in the previously-successful xPC Target incarnation. In order to better understand this phenomenon, tests were done to verify that the latest version of Simulink correctly generates real-time code, and to measure the open-loop response of the telescope axis to ensure that any changes in the hardware over the past year have not had a deleterious effect.

It turns out that the current release of Matlab/Simulink (R2006a) does indeed have difficulties with generated code. A bug listed on their support website comments on subsystem blocks not properly propagating their sample rates to other downstream code blocks; this appears to be what is causing the digital servo filters to operate incorrectly. The Mathworks has released a newer version, R2006b, in just the past 2 weeks, so we will be following up on this to make sure that the generated code does in fact work properly. What is more problematic is that the open-loop telescope response does not match with that measured in 2004 and 2005. This means that the modal-resonance suppression filters are decentered from the apparent telescope modal responses. Some work remains to be done to bring the open-loop model into agreement with the measured actual telescope, and to re-design the filters before we again attempt to test the new controller.

Computers and Software

Mount Servos and Mount Computer

Work continues on the mount servo software. Servo algorithms designed as block diagrams via Simulink are converted to C code by Simulink:Real Time Workshop and then compiled using our Linux-hosted cross compilers. This code is then linked with the mount code and run under VxWorks. We use the same code image on both the downtown simulator and the actual mount computer on the mountain.

Tests on the mountain exposed one bug (we were updating encoder information at 100 Hz instead of the 1000 Hz rate at which we run the servos), which was quickly fixed. We were then able to move the mount using the new servos, but not in a completely satisfactory manner. The motor command output shows substantial high frequency noise, which we have traced to a malfunctioning differentiator block being used to calculate commanded velocities from commanded positions. This can be fixed by the addition of a suitable low pass filter after the differentiator.

Servo response, when performing real moves with the telescope, does not match the response from simulated moves using a model of the telescope transfer function. This indicates that the telescope model (transfer function), for which the current servo model was designed, does not match the response of the current telescope configuration. This indicates that the telescope itself or the control system hardware, or both, have changed. It also suggests that the servo model may be more sensitive to the exact telescope configuration than we anticipated. We do not believe that our basic model is flawed; it simply needs to be "tuned" (i.e., parameters adjusted) in order to obtain stable performance. We will need to investigate how sensitive the model is to actual telescope configuration, and whether one set of parameters will have enough latitude to allow operation of the telescope in all configurations.

Remote Protocol Improvements

The mount, hexapod, and cell computers all support distributed computing via what we call the "remote protocol." This is a simple ASCII-based protocol that can be manipulated using a telnet session for diagnosis, and which supports our logging system, the various miniservers, and most of the graphical user interfaces used by the operators. Recent efforts to design a new set of graphical user interfaces for the cell computer exposed throughput limitations of this protocol. In particular, we discovered a limit of approximately ten of our "all" commands per second communicating to any of the VxWorks crates.

We have found that the delay is happening in the TCP protocol itself, and in many cases the crate is simply waiting for a TCP ACK packet to be sent by the client end of the connection. We can make and break approximately 1000 connections per second, even with our older m68k processor based VxWorks systems, two orders of magnitude more than we can manage when actually moving data.

The addition of output buffering has given a substantial improvement: we can now make over 30 connections involving the "all" command in a second. Now that we understand the nature of the throughput throttling it is likely that we will be able to make additional improvements. However, 30 connections per second is entirely adequate for our current needs and anticipated future use.

Open-Loop Models

We commissioned a new approach to hexapod operation during the past two months. This approach integrates the functionality of the "hex_predict" script directly into the hexapod control software. This gives the hexapod the ability to configure itself automatically for the current elevation, OSS temperature, and instrument configuration. The key architectural change came in how we handle corrections to this basic model. Rather than applying all corrections using a single set of relative commands, we now define a set of individual offsets that cover the most common and anticipated sources of corrections.

This new approach allows much easier monitoring and logging of contributions to the final hexapod position from different sources, such as thermal and elevation effects, guiders, instruments, and wavefront sensors. This approach will also make it much easier for instruments to apply focus offsets to account for changes to their internal configuration. SWIRC and PISCES, for example, have large focus offsets between filters that in the past required manual intervention by the operator or observer to handle. These focus changes, as well as those applied by the WFS to help correct for spherical aberration, greatly complicated off-line analysis of logged hexapod data.

Some specific tasks that were part of this effort included:

- Tim Pickering recalculated parameters for the open loop model that is now included in the hexapod control software using data from the most recent f/9 and f/5 runs.

- Tom Trebisky implemented new code in the hexapod crate, including position calculation from the offsets and automatic updating of OSS temperature and elevation corrections. The remote protocol for the hexapod crate was expanded.

- Duane Gibson created a web-based GUI to expose the new functionality. This GUI will replace the existing "hexgui" for normal nighttime operations, though "hexgui" is still appropriate for daytime engineering. A "hexpods" web page had already been created to replace the "Pods" GUI.

- Dallan Porter has created a web-based "hexlimits" GUI.

- Modifications were made to the setting server to accommodate the new instrument configuration parameters.

- Modifications were made to MySQL tables and miniserver scripts to log the new parameters.

- New web pages were created and existing web pages modified to display the new offsets in tabular and graphical form.

Engineering Web Pages

The following tasks were completed to create new or to modify existing engineering web pages:

- The cell error log display, the "rerr" GUI, was converted to an Ajax-enabled web page.

- Pages were created to present thermal movies of primary mirror temperature data, creating images on-the-fly from E-series thermocouple data obtained from MySQL background logs.

- Additional work has been done on XY scatterplot web pages for presenting MMT background log data to engineers and other end users.

- Various web pages were created and modified for possible use on new control room monitors. These web pages include weather, environmental, and systems status information. Final layout for displays in these new monitors is underway.

- Modifications were made to PHP scripts used to generate RRDTool images from RRDTool databases with the inclusion of additional parameters.

- Additional functionality was added to the "Miniserver" and "xajaxMMT" PHP classes. These modifications include new methods for communication with the cell crate using an ASCII protocol. Work is underway by Skip Schaller to generate new cell GUIs to replace the existing windex GUIs.

- PHP classes are also being developed to generalize the PHP/MySQL interface to background logs and for plotting this background log data.

- An inferred roof relative humidity is now being calculated and displayed for operator use. In principle, it should help determine whether the skin of the building may be cold enough to condense water. However, it has become clear that we need a better measure of ambient dewpoint and a more carefully mounted temperature sensor on the building.

Windows Domain Controller

The new Windows Domain Controller server is now online. All remaining MMT Windows users will be migrated onto the new domain over the next few weeks. The domain controller provides a centralized mode of administration and allows any MMT user to log into any Windows computer on the MMT domain with their existing username and password.

All of the MMT's Autodesk Inventor files have been moved onto the new Windows server, and these files are accessed using Autodesk's Vault software. The Vault provides a robust method for checking in-and-out files and maintaining appropriate permissions.

We are currently evaluating "roaming profiles," which will permit Windows users to store their computer settings and "My Documents" on the server instead of their desktop computer. This will give users their same "desktop" regardless of which computer at the MMT they are logged into.

A centralized backup system for Windows desktops is currently being evaluated. This will provide Windows users with automatic backup of important documents onto the server on a regular basis.

Skip Schaller did some research into implementing LDAP authentication on our Linux machines. This would in principle ease migrating user account info between machines, allow integration of samba, system, and web passwords, and allow integration with the Windows Domain Controller's Active Directory as well as the UA's NetID system. However, allowing both local and LDAP accounts on a machine created numerous complications. The showstopper is a bug in the GDM login manager that most Linux systems use that prevents LDAP-based users from logging in at all. We will further investigate whether the newly released Fedora Core 6 helps with this issue.

Observing Catalogs

Since the roll-out of the new observer catalog submission tool, many changes and additions have been requested and implemented. A couple of the major enhancements are:

- The ability for the observer to edit catalogs online after they have already been submitted.
- Plotting catalog targets and graphing air mass.
- Administration page for managing submitted catalogs.

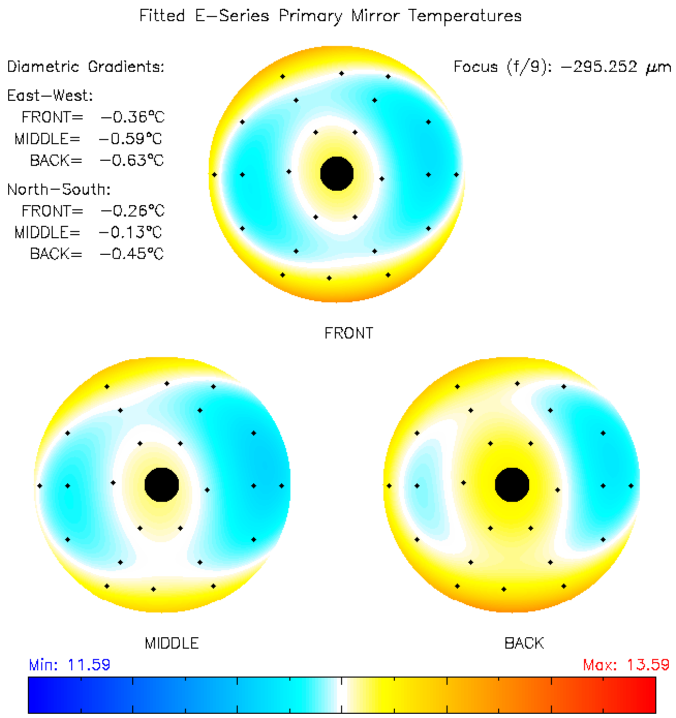
Tests of the new interface to catalogs of non-sidereal objects were performed on sky during engineering time. We were able to successfully acquire and track two different asteroids.

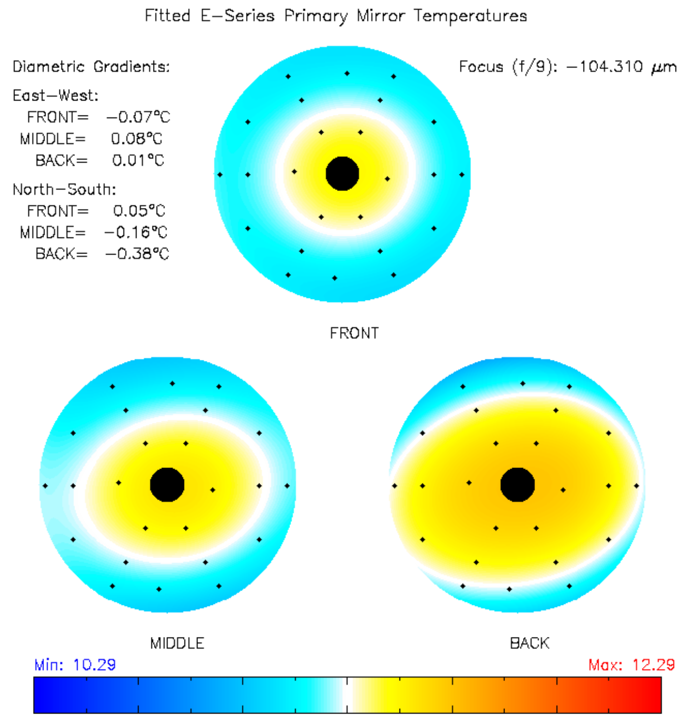
Primary Thermal Structure Modeling Tools

Betty Stobie has continued the development of IDL procedures to model the thermal structure of the primary mirror. The two main procedures are "draw_temp" and "batch_temp." The draw_temp procedure was developed to run as an interactive GUI, while batch_temp runs non-interactively. In both cases the input may be from a file, a list of files, or the thermocouple values may be taken directly from the cell miniserver on *hacksaw*. The output consists of log files and displays of the raw and fitted data written to eps files.

Save files of the procedures were created so that they could run on machines without IDL licenses. Running these IDL procedures can be done with the IDL Virtual Environment. However, this does not work in batch mode because the IDL VM creates an interactive display that must be acknowledged before the program will execute. The main remaining feature to implement is the modification to the batch_temp procedure so that it may be called directly from another program such as a shell script.

Tim Pickering used these tools to analyze thermal data from the last f/9 to run to see if they could explain the large focus shifts that were observed. The night of October 29, for example, showed deviations from the open loop model of 150 μm in focus over the course of the night. Figure 3 shows the results of fits to the primary mirror's thermal structure using batch_plot. The first shows the results at 1:22 UT, the seconds at 4:25 UT, and the third at 8:29 UT. The magnitude of the changes in the focus error reported by batch_temp is consistent with the observed focus changes. However, the timing of the measured and predicted focus errors don't quite match up. This behavior has been seen before when analyzing tempfoc engineering data. Better agreement was seen during the night of October 28 when the thermal conditions were much more stable. Work is ongoing to refine the calibration of these tools and incorporate them into our existing open loop model.





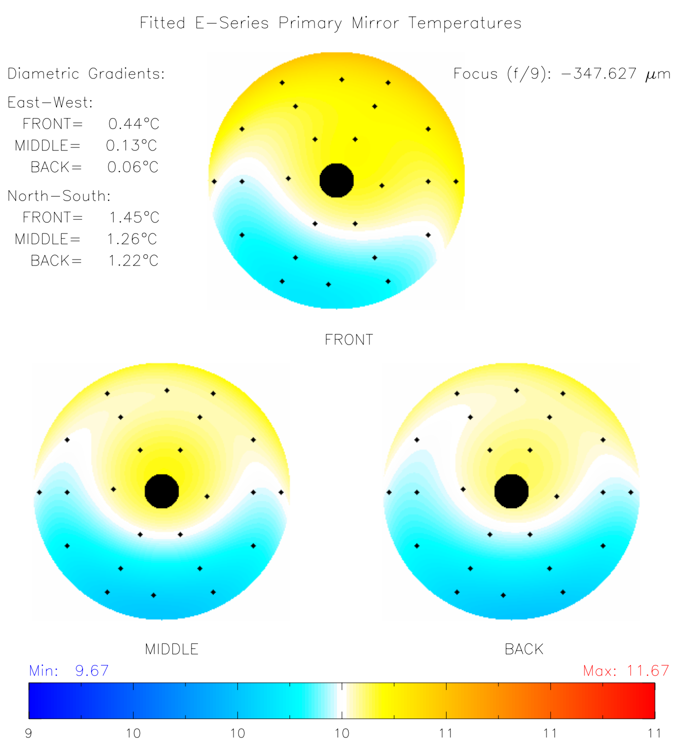


Figure 3: Results of analyzing primary mirror thermal structure during the night of October 29. The data were taken at 1:22 UT (top left), 4:25 UT (top right), and 8:29 UT (bottom). Each plot shows the results of polynomial surface fits to E-series temperature data for the front, mid, and back plates. The diametric gradients are determined directly from the fits and the focus error is determined from the fits in combination with FEA models.

Analyzing Sky Camera Data

Betty Stobie has been experimenting with an IDL procedure to locate transient events in all-sky camera data. The procedure uses the Hough Transform to look for linear features in difference images between successive sky camera frames. The program produces a log of detected events and a composite image of all frames in which events were detected (Figure 4). So far it is quite effective at detecting things like meteors and airplanes when they're overhead. Further work is needed to improve detection of more point-like transients. We should be able to detect planes early enough to provide early warning of potential flyovers, and may be able to generate measures of hourly meteor rates that could be scientifically interesting.

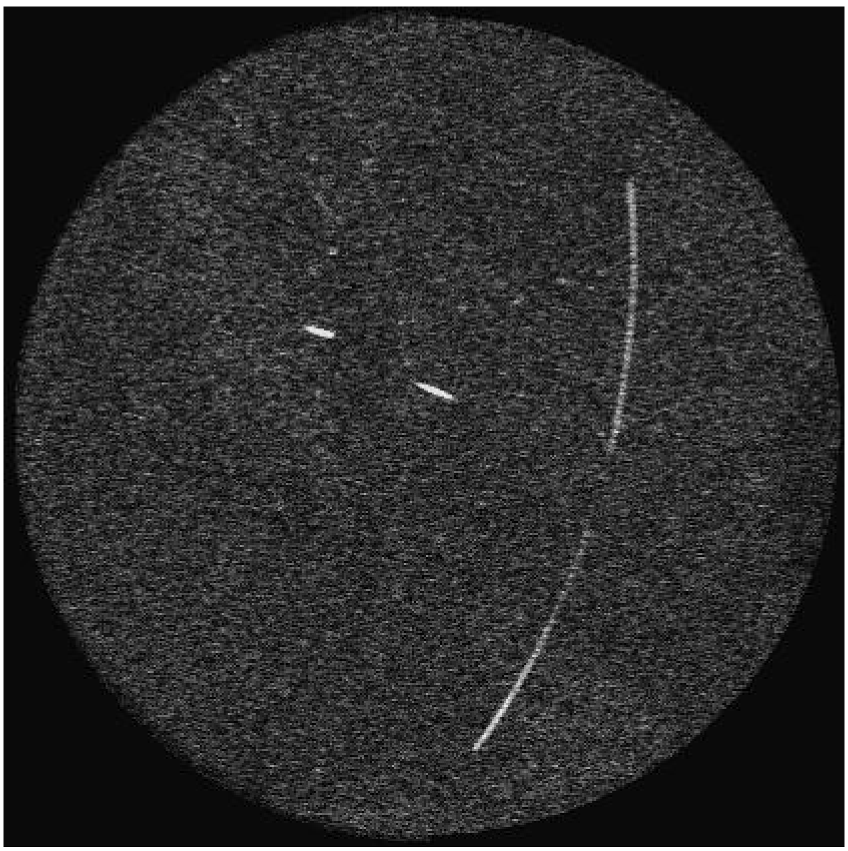


Figure 4: Example of a composite of images containing detected transient events. This image was created by processing approximately 100 sky camera frames and clearly shows two meteors and a plane.

Tim Pickering has been experimenting with using SExtractor to detect sources in sky camera images, measure their fluxes, and subtract them off to create sky background maps. Figure 5 shows examples of such a sky background map and a background-subtracted image. The initial results are very encouraging. An easy first step will be to monitor the sky background in the area surrounding the north celestial pole. This will provide some measure of how light pollution from Tucson is affecting conditions on Mt. Hopkins. The next step will be to select and monitor patches of the sky that are relatively uncontaminated by galactic or zodiacal light. We will also want to monitor the position of the moon to exclude heavily moonlit images from analysis. Work is ongoing to determine whether the source fluxes can be used to provide a quantitative measure of cloud cover.

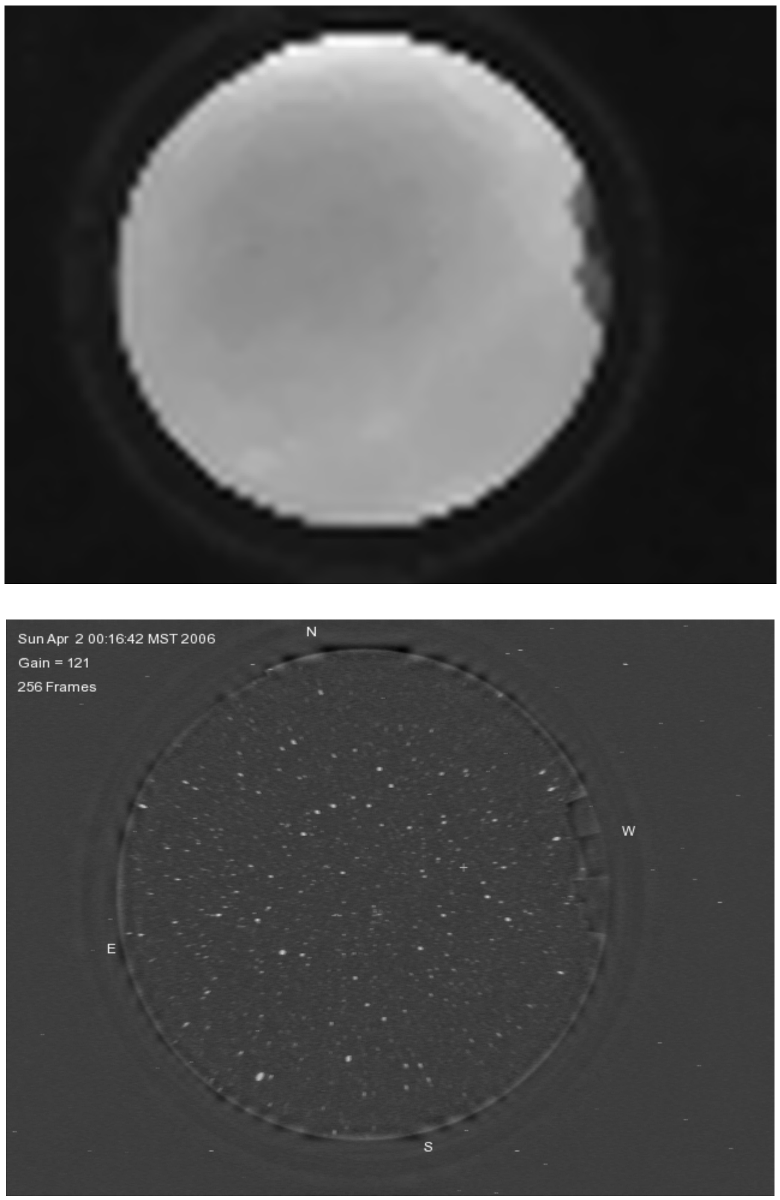


Figure 5: Example of a sky background map (top) and background-subtracted sky camera image bottom) generated by SExtractor.

MMT Documentation

In conjunction with Shawn Callahan and Steward Observatory, Cory Knop is developing a central database (SiteScape) for MMT documentation. This will provide MMT staff a central location for old, new, and updated documentation. For example, if an MMT system has been having repetitive problems, SiteScape will provide a location for engineers to go and look at what previous maintenance was performed, and then do a trend analysis to track down the malfunction. SiteScape will also be used to track test procedure results of a particular item and will also track items that require scheduled maintenance inspections.

Cory Knop and Shawn Callahan are currently organizing the directory structure, and several engineers are now using the system for their current projects. Cory will monitor the system and continue to organize it.

Stacy Oliver and Paul Hart (Steward) presented an introduction to SiteScape, which is being used by several telescope projects at Steward (LOTIS, LBT, GMT) and NRAO. MMTO purchased two SiteScape licenses.

Drawing Archive

Thomas Hair from the LBT helped Dallan Porter and Creighton Chute move more than 1000 archived drawings into a secure server using the latest version of AutoDesk Vault. Having a centralized server allows a multi-user environment for shared drawings.

Miscellaneous

All MMTO Technical Reports have been scanned and are now available on the MMT web site at *http://www.mmto.org/MMTpapers/tr.shtml*.

Instruments

Red Channel Spectrograph

Mike Lesser, Roy Tucker, and the ITL staff completed the evaluation and preparation of a set of deep depletion CCDs, provided by Lawrence Berkeley National Laboratory (LBL), that are considered potential replacements for the current Red Channel CCD. Of the several devices that were tested, two were deemed useful for scientific application. A review of the performance of those devices by Mike Lesser, Gary Schmidt, and Xiaohui Fan resulted in a recommendation that the MMTO proceed with the upgrade. The Red Channel dewar was delivered to ITL in early October to have the detector replaced. The new camera will be completed in late November to allow time for software modifications, testing, and on-sky commissioning in early December.

The new device has a 1112 x 1012 pixel format with 18 micron pixels. The quantum efficiency beyond 9000 angstroms is more than double that of the current Red Channel CCD. In addition, because the silicon is as much as 300 microns thick in deep depletion devices, there will be no fringing in the upgraded Red Channel. The new camera will use an SDSU gen2 controller, which has already been purchased through the generous support of Xiaohui Fan’s Packard Foundation grant.

Because the devices are thick, they suffer from a higher rate of cosmic ray depositions than do thinned devices. This will likely limit the maximum integration time for the upgraded system. Charge localization is also reduced, resulting in a slightly larger point spread function. However, the Red Channel resolution should not be affected significantly in typical seeing conditions because of the oversampling inherent in the optical design. Finally, the read noise of the devices is larger than the current device: 10 electrons versus 3 electrons.

We expect that the upgrade will lead to a higher demand for the echellette mode. At that resolution, the spectrograph will be resolving most of the OH forest in the red. Even with the decreased efficiency when using the cross disperser, the S/N reached (after rebinning) is going to be a factor of 2 - 4 higher than in low resolution mode. An echellogram calculated by Gary Schmidt shows that a 20" slit would result in order overlap. Therefore, the MMTO is considering having a set of 10" long slits manufactured.

More details about the upgrade are provided at: *http://www.mmto.org/instruments/rc_upgrade.shtml*

SCCS Updates

Over the past two months, Skip Schaller has made significant changes and enhancements to the spectrograph control and image acquisition systems for Blue and Red Channel. This initial round of changes included:

- Modifying existing SCCS GUI to split it up into a client and server so that multiple clients can connect to and control the spectrograph.

- Create a new ccdacq detector interface to support the new AzCam interfaces to the science cameras. The old VxWorks-based CCD crate is now completely retired.

- Create a ccdacq instrument interface to Blue and Red Channel. This allows spectrograph information to be included in image headers and makes it possible to control the spectrograph from within IRAF. It is now possible to script spectrograph behavior.

- Create a ccdacq telescope interface to the telstat SOAP server. This is a lot simpler and more robust than our previous telserver-based scheme of querying TCS information to include in image headers.

These changes were commissioned and used successfully during the September f/9 run. After the September run, work was done by Skip Schaller, Cory Knop, Brian Comisso, and Dondi Gerber to implement computer control of the comparison lamps that are used by Blue and Red Channel. This involved, among other things, resurrecting the SCCS parallel ports on the back of GAITS, interfacing a digital I/O box to those ports, debugging out-of-date and inaccurate documentation, implementing a ccdacq interface to the digital I/O box via a Lantronix, and modifying some ccdacq tasks to automate comparison mirror and lamp control. Now if the observer runs the "comps" command, the requested lamps are turned on and the comparison mirror inserted automatically, the images are acquired once the mirror is in place, and then the lamps are turned off and the mirror removed when the task is complete. The WFS software was also modified to take advantage of this comparison mirror automation. These changes were commissioned successfully during the October f/9 run.

Some other minor changes were made to ccdacq to prepare for the new Red Channel camera that is due to arrive in early December. The changes involved moving some initialization code out of the client and into the AzCam server. These changes were tested successfully and used during the October f/9 run.

f/9 Top Box

We have had a number of incidents where the f/9 top box appeared to have problems with the individual camera shutters. The usual response has been to lock these shutters open until such time when they could be accessed. When investigated, no problems have been identified most of the time. We investigated this further and found that a holding current power supply was not providing quite enough output voltage to do its job. This was modified to provide more (and regulated) output, which seemed to solve the problem for one of the shutters. The other shutter solenoid was replaced and now both seem to function properly.

Fiber Positioner

On October 4, while setting up on a field, guide probe number three in the hecto fiber positioner would not move from the forward limit during a homing sequence. Nighttime debugging did not uncover the problem, but a temporary work-around to guide with the robot cameras was implemented.

Marc Lacasse, Ken Van Horn, and Tom Gauron (remote from SAO) troubleshot the guide probe system on Thursday, October 5. They found an open circuit on phase A of the guide probe three-stepper motor that was localized to inside the positioner. This was similar to a previous failure caused by oxidation on the pins in the internal connector.

Mark Mueller (SAO) traveled to the MMT on Monday, October 9, to access the guide probe system and evaluate the mechanical system. The guide probe 3-stage was manually moved approximately one inch, and that cleared the open circuit on the motor phase, indicating an intermittent connection (connector or wire) in the insulation displacement connector to the motor. Ken Van Horn spliced in a new, wired connector to eliminate the problem part. The guide probe worked for the remainder of the run.

Mark Mueller also observed that the stiction of the brake mechanism of probe three was higher than normal, but that the brake was opening. The solenoid was serviced to smooth the operation.

Megacam

The colored glass filter in front of the Megacam guider chips was replaced with higher quality glass to allow for guiding the telescope focus during an observation. Part of the engineering night of September 21 was used to perform defocus observations to define correct focus zero point.

Following the removal of the instrument on September 28, inspection of the Megacam focal plane revealed that five of the CCDs had the appearance of haze or condensation on their surface. The instrument was monitored as it warmed up and the haze dissipated when the camera reached -90 C. The nature of the haze is still unknown; compound testing is underway.

An error in the Megacam PC board schematic and a faulty relay were contributing to problems with the CCD heater. We purchased replacement parts from Radio Shack to replace the originals and installed a jumper wire on the PC board.

Mounting Procedures

A new method of raising large instruments for mounting has been tested. The lift is raised in a normal fashion until four mechanical jacks can be placed under it. The lift is then raised with the mechanical jacks while the lift hydraulics are operated to follow the lift, as required. This new procedure works well and allows for the instruments to be raised in a controlled and level manner while allowing for small adjustments in alignment. This method is now default, and the mounting procedures have been updated to reflect this.

Adaptive Optics

The Microgate reconstructor that the Laser Guide Star (LGS) group will use to control the f/15 secondary was tested on the mountain in early October. Mario Andrighettoni from Microgate in Italy was present for the testing. The goal of this work was to test the mirror safety checking routines that prevent sending dangerous commands to the mirror, and also to check for excessive current or position conditions. This testing was successful, and the LGS group was cleared to send commands to the f/15 secondary during their upcoming run in December.

General Facility

Mining in the Santa Rita Mountains

On September 20, Faith Vilas and Dan Brocious met with James Sturgess, a representative of Augusta Resources, which plans to open a mine at the Rosemont site in the Santa Rita mountains. The mine lies within E1a and E1b zones around Mt. Hopkins, which underscores its possible effect. The mining plan that has been distributed says the operation will voluntarily comply with the Pima County Outdoor Lighting Code. James made positive responses about the need for good lighting and dust control, but the full effect of the lighting can't be quantified until some kind of lighting plan is produced. FLWO/MMTO will be supplying some guidelines for Augusta's planning documents.

Other Facility Improvements and Repairs

Cory Knop replaced a defective DAU in the pit. The defective DAU was sent in for repairs and has been returned to service. Additionally, Cory replaced numerous relays that had exceeded the manufacturer's life expectancy on a pair of HP3970A DAU multiplexer cards. Brian Comisso developed written procedures that will be used to reset the multiplexer card CPU after the replacement of relays.

The spare glycol pump was installed when one of the old pumps began to fail. As predicted, the spare pump is large enough to supply enough glycol to the entire building. However, to be safe when AO is on the telescope, we plan to use one of the old pumps in conjunction with the new one until a booster pump is purchased.

We have received a quotation from Comfort Controls for the repair of the Freon chillers in the pit. This contract needs to be issued to complete the work.

The transverse counterweight drive work has stalled but is still ongoing. Software needs to be developed to provide GUI access.

The up limit switch has been mounted and calibrated for the new instrument lift.

Most of the old incandescent light fixtures have been removed from the second floor, where they could interfere with the movement of instruments. Some have been left in place, and the dimmers have been reinstalled with the intention of adding some additional "goose neck" fixtures where needed.

Some lightning damage was identified in the encoder system, which was repaired by Brian Comisso.

Tom Gerl provided electrical support to the MIRAC/BLINK group to give them the three-phase AC power they needed on the skirt of the building. He is also in the middle of updating and redoing the documentation for the GAITS system as a result of the request to provide computer access to the comparison lamps. Tom also has been making an inventory of the ICs that we stock and need to maintain for spares.

The blower control failed to start the blower properly the night of Sunday October 1. Ken Van Horn made a trip to the mountain to get it started until a replacement part could be obtained from the vacuum pumps at the FLWO basecamp on Monday morning. The failed part is now obsolete and no longer supported by the manufacturer. Four used parts were found on the web and purchased as spares.

Another Sunday night trip to the mountain to troubleshoot the building drive was not as successful in that the ultimate failure was the Ridge generator operating at the wrong frequency. We were unable to do anything about the problem until FLWO support could get it repaired. The building drive did its job in protecting itself from poor quality power. Unfortunately, this was not so quickly identified as to prevent the loss of sky time.

During removal of the f/5 wavefront sensor (WFS) on September 28, the crew discovered debris from a cable that was torn from the Stellacam acquisition camera. It was found that the cable caught on a linear translation rail within the WFS. The camera was not being used during normal operation because it caused the WFS computer to become unstable. The cables were cleaned up and will be replaced.

Dennis Smith and Bill Stangret conducted overall maintenance of the trench fan. This included replacement of the motor and belts, greasing the bearings, and checking for shaft wear. This unit extracts heat from the pit and runs constantly.

Dennis Smith and Bill Stangret installed new heat strips on the septic tank vacuum breaker to prevent freezing and subsequent septic backups.

Shawn Callahan compiled a list of tasks from Ken Van Horn, Tom Gerl, Creighton Chute, Ricardo Ortiz, Dusty Clark, Brian Comisso, and Dondi Gerber. The compiled list was presented to Faith Vilas and will be used to set the engineering priorities by the management team.

Visitors

October 15: Tim Pickering and Grant Williams led a tour of FLWO and the MMTO for participants of the ADASS XVI conference.

Publications

MMTO Internal Technical Memoranda

None

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

06-47 Black Hole Masses and Eddington Ratios at $0.3 < z < 4$
J. A. Kollmeier, C. A. Onken, C. S. Kochanek, A. Gould, D. H. Weinberg, M. Dietrich, R. Cool, A. Dey, D. J. Eisenstein, B. T. Jannuzi, E. Le Floc'h, D. Stern
ApJ, **648**, 128

06-48 Kinematics of NGC 2264: Signs of Cluster Formation
G. Furesz, L. W. Hartmann, A. H. Szentgyorgyi, N. A. Ridge, L. Rebull, J. Stauffer, D. W. Latham, M. A. Conroy, D. G. Fabricant, J. Roll
ApJ, **648**, 1090

06-49 Type II Quasars from the Sloan Digital Sky Survey. V. Imaging Host Galaxies with the *Hubble Space Telescope*
N. L. Zakamska, M. A. Strauss, J. H. Krolik, S. E. Ridgway, G. D. Schmidt, P. S. Smith, T. M. Heckman, D. P. Schneider, L. Hao, J. Brinkmann
AJ, **132**, 1496

06-50 Hectochelle: High Resolution Multiobject Spectroscopy at the MMT
A. Szentgyorgyi
New Astronomy Reviews, **50**, 326

06-51 Evolution of High-Redshift Quasars
X. Fan
New Astronomy Reviews, in press

06-52 Hosts of Type II Quasars: An HST Study
N. L. Zakamska, M. A. Strauss, J. H. Krolik, S. E. Ridgway, G. D. Schmidt, P. S. Smith, L. Hao, T. M. Heckman, D. P. Schneider
New Astronomy Reviews, in press

Non MMT Scientific Publications by MMT Staff

Detection and Discrimination of Sulfate Minerals using Reflectance Spectroscopy
E. A. Cloutis, F. C. Hawthorne, S. A. Mertzman, K. Krenn, M. A. Craig, D. Marcino, M. Methot, J. Strong, J. F. Mustard, D. L. Blaney, J. F. Bell III, F. Vilas
Icarus, **184**, 121

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:

- 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

September 2006

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	69.80	16.60	0.50	0.00	0.00	0.00	17.10
PI Instr	17.00	168.90	72.40	4.80	18.15	1.05	0.00	96.40
Engr	2.00	20.00	2.50	0.00	0.00	0.00	0.00	2.50
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**26.00**	**258.70**	**91.50**	**5.30**	**18.15**	**1.05**	**0.00**	**116.00**

Time Summary Exclusive of Summer Shutdown

Percentage of time scheduled for observing	92.3
Percentage of time scheduled for engineering	7.7
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	35.4
Percentage of time lost to instrument	2.0
Percentage of time lost to telescope	7.0
Percentage of time lost to general facility	0.4
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	44.8

* Breakdown of hours lost to telescope
az encoder 16.6
hexapod 1.05
f/5 secondary 0.5

** Breakdown of hours lost to facility
blower 1.05

October 2006

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	* Lost to Telescope	** Lost to Gen'l Facility	Lost to Environment	Total Lost
MMT SG	6.00	67.00	23.95	0.00	0.00	11.20	0.00	35.15
PI Instr	24.00	258.85	92.20	5.25	2.50	0.00	0.00	99.95
Engr	1.00	10.55	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**31.00**	**336.40**	**116.15**	**5.25**	**2.50**	**11.20**	**0.00**	**135.10**

Time Summary Exclusive of Summer Shutdown

Percentage of time scheduled for observing	96.9
Percentage of time scheduled for engineering	3.1
Percentage of time scheduled for sec/instr change	0.0
Percentage of time lost to weather	34.5
Percentage of time lost to instrument	1.6
Percentage of time lost to telescope	0.7
Percentage of time lost to general facility	3.3
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	40.2

* Breakdown of hours lost to telescope
hexapod 1.75
primary mirror 0.5
wavefront sensor 0.25

** Breakdown of hours lost to facility
Ridge generator 11.2

Year to Date October 2006

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	70.00	668.55	243.25	7.50	4.55	12.70	0.00	268.00
PI Instr	189.50	1838.20	697.10	120.90	43.80	10.55	0.00	872.35
Engr	10.00	94.90	28.35	0.00	0.00	0.00	0.00	28.35
Sec Change	0.50	3.85	3.85	0.00	0.00	0.00	0.00	3.85
Total	**270.00**	**2605.50**	**972.55**	**128.40**	**48.35**	**23.25**	**0.00**	**1172.55**

Time Summary Exclusive of Summer Shutdown

Percentage of time scheduled for observing	96.2
Percentage of time scheduled for engineering	3.6
Percentage of time scheduled for sec/instr change	0.1
Percentage of time lost to weather	37.3
Percentage of time lost to instrument	4.9
Percentage of time lost to telescope	1.9
Percentage of time lost to general facility	0.9
Percentage of time lost to environment (non-weather)	0.0
Percentage of time lost	45.0