

## BIMONTHLY SUMMARY

July - August 2006



*Top left: The new instrument lift arrives at the MMT (photo by John Glaspey, MMTO). Right: Summit flagpole arcing during summer thunderstorm (photo by Thomas Stalcup, MMTO). Bottom left: Installation of new ventilation pipe for the primary mirror thermal system (photo by John Glaspey).*



*Photos of wildlife recently seen on Mt. Hopkins. Top, center, and bottom row left photos by John Glaspey (MMTO); bottom row right photo by John McAfee (MMTO).*

## **Personnel**

John Di Miceli, originally hired for the summer only, was hired to assist the mechanical engineering group for the duration of his undergrad program at the university.

Undergrad Daniel Soria Sanchez left the MMTO in late August.

The week of August 28, Skip Schaller attended a course in Phoenix, Arizona on systems, networking, and security administration entitled “RH300, RHCE Rapid Track Course,” resulting in certification as a Red Hat Certified Engineer.

Betty Stobie serves on the Local and Program Organizing Committees for the Astronomical Data Analysis Software and Systems Conference (ADASS XVI) to be held in Tucson at the La Paloma Resort October 15-18, 2006. During the last two months she has been responsible for the selection and planning of all conference catering including the opening reception, morning and afternoon breaks, box lunches, and the conference banquet. She also assisted in the development of the conference logo and poster, voted for the selection of the financial aid recipients, voted for the contributed oral program from among the requested oral presentations, and reviewed the Birds of a Feather and focus demonstration proposals.

Betty also serves on the International Astronomical Union Flexible Image Transport System Working Group (IAU FITS WG). However, she did not attend the August FITS Working Group Meeting as it was held at the IAU Conference in Prague.

Faith Vilas attended the Second Hayabusa Science Symposium held in Tokyo July 12-14, 2006, highlighting the results of the Hayabusa observations of near-Earth asteroid 25143 Itokawa during the encounter in 2005.

Faith also traveled to Cambridge, Massachusetts for the August 22 MMTO Council meeting.

## **Primary Mirror Systems**

### **Primary Mirror Support**

The primary hardpoint test stand was fabricated during the month of July, and the electronics were installed in early August. The MMTO Electronics Group made a complete set of cables, a chassis containing all the interface hardware and power supplies, and assembled a Windows PC running LabView. A LabView GUI was built to control the hardpoint test hardware and store the data collected in Excel spreadsheet format. We plan to characterize, repair, and return to service the spare hardpoint first, and then repeat the process on the units in the cell as time permits.

The NE hardpoint #7 was removed from the mirror cell for testing. The spare hardpoint #6 was also tested. Both hardpoints were found to have excessive play in the breakaway mechanism, which was removed by adjusting the diaphragm spacing. Hardpoint #6 was then found to have a loose lock ring securing the leadscrew bearings. At the end of summer shutdown hardpoint #7 was re-installed. The hardpoint stand is being calibrated for characterization of the hardpoint load cell and

lvdt, and to measure stiffness. The motor on hardpoint #2 was replaced to match the other five hardpoints.

### Optics

Primary mirror reflectance and scattering measurements are routinely made before and after CO<sub>2</sub> cleaning. Ricardo Ortiz has added data taken in mid July (see Figures 1 and 2).

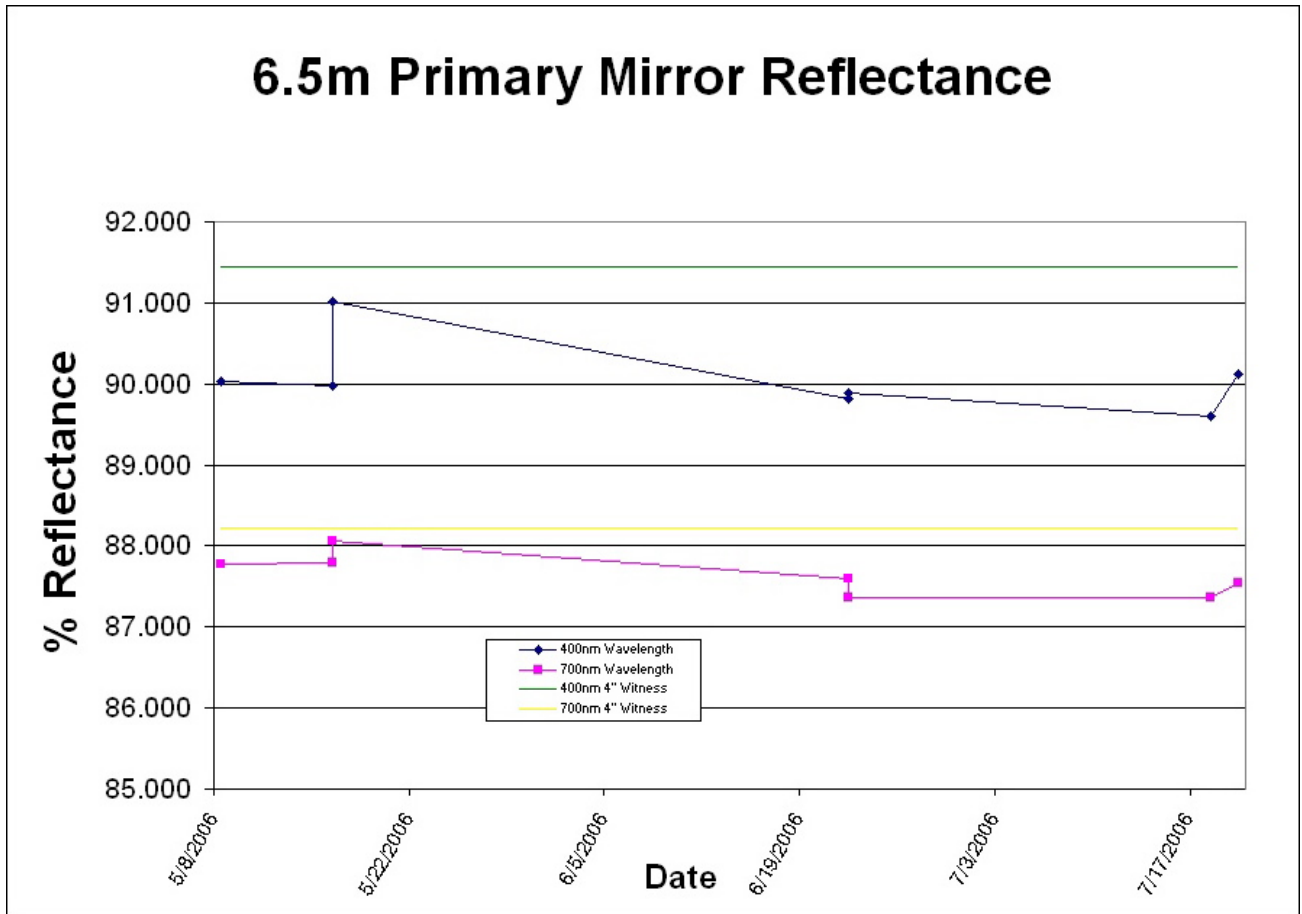


Figure 1: Primary mirror reflectance.

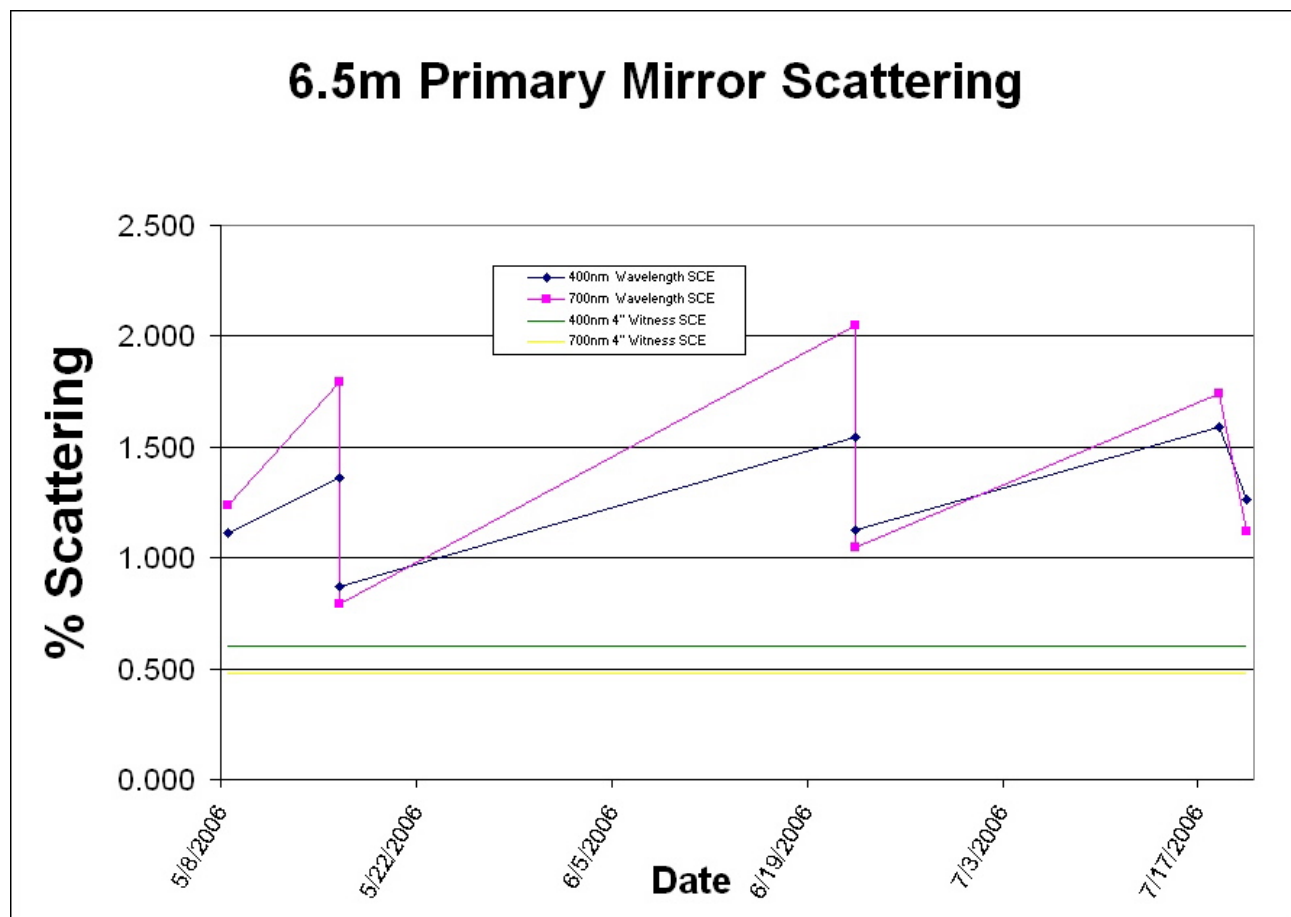


Figure 2: Primary mirror scattering.

## Secondary Mirror Systems

### f/9 Secondary Aluminization

The f/9 secondary mirror was washed on August 21. Because the secondary is scheduled for realuminization in early October, we used the opportunity to test alternative cleaning methods. These alternative methods were all performed in the unused portion of the center of the mirror. Three cleaning solutions were tested: two made by General Chemical Corporation, Discoat (4210 E) and Costcoat (4560), and one manufactured by Photonic Cleaning Technology, First Contact. All three solutions were applied to the surface wet with a soft brush and allowed to dry for approximately 30 minutes. The dried cleaners were then carefully peeled off. Although all solutions were effective in removing dust from the surface, there was not a significant improvement in reflectivity or scattering.

The mirror was then washed in a traditional manner using cotton saturated with Liquinox soap and water dabbed over the surface, and thoroughly rinsed with steam distilled water. Water was removed with jets of UHP nitrogen. The reflectivity and scattering were measured before and after the wash with the Minolta CM-2002 spectrophotometer using the normal procedure. The visual appearance

and the measured results show that the wash made a significant improvement in both reflectivity and scattering. The reflectivity at 400 nm increased from 87.9 to 90.5 and the scattering decreased from 11.5% to 2.3% (note these numbers are representative and may be slightly inaccurate because of the curvature of the surface). More detailed results and plots are posted at <http://www.mmtt.org/~rortiz/Minolta/f9%20Reflectance%20ScatteringData.htm>.

A draft procedure for washing the secondary has been added to the dokuwiki.

## **f/9 Hexapod**

The hexapod test cables have had no more problems since mentioned in the last report.

## **Telescope Tracking and Pointing**

### **Servos and Encoders**

Keith Powell and Dusty Clark further investigated the resonant behavior of the telescope front end to determine correlation between a servo driving function and modal excitation of the secondary hub. It turns out that the lack of modal-suppression filters in the servo forward path makes it possible for the servo loop to have positive gain in the frequency range of the MMT structural modes; in other words, the closed-loop servo amplifies modal resonances.

They did other investigative work to determine what, if any, performance gains may be had by adjusting parameters in the existing servos. To this end, they developed an open-loop telescope model with the existing voltage-source amplifiers and closed the loop in simulation with the same servo gains as used in the real system. There was remarkably good agreement with the empirical data, except for modeling the LM628 derivative gains, which required “fudging” to bring them into agreement with the actual data. Looking further into the behavior of the LM628 derivative action, they found that the derivative function in the hardware unfortunately exhibits two bad characteristics: 1) the derivative output is delayed by the derivative sampling interval; and 2) the derivative sampling interval is an integer multiple of the primary resonant mode of the top end. These two combine to input a quasi-squarewave into the drive system, and pump energy into the structural modal response. The plan is to adjust the derivative sampling interval to try to reduce this problem, although the improvement is expected to be modest due to stability constraints in the closed-loop servo that make more than small changes impracticable.

Work on the new absolute encoder electronics was paused in favor of construction of the new hardpoint test stand, which was required for tasks during summer shutdown.

## **Telescope Collimation and Optical Performance**

### **DONUT: A Method for Wavefront Sensing using Out-of-Focus Stars**

A recent paper by A. Tokovinin and S. Heathcote (astro-ph/0606388) describes a method for measuring wavefront aberrations using single images of out-of-focus stars. The ability to do wavefront sensing with single CCD frames and no extra hardware is a potentially very powerful tool. One obvious application for the MMT would be to quickly measure aberrations across a Megacam

field. The results of that could then be analyzed to determine alignment errors between M1, M2, and the wide-field corrector. Another possible application would be continuous wavefront sensing for f/9 using one of the existing guider cameras.

The authors made available an IDL implementation of this method, which we have been trying out. A screenshot is shown in Figure 3. It seems to work well, is easy to use, and is easily modified to support the MMT's optical specifications. A drawback of this method is that its iterative nature makes it somewhat computationally intensive. However, we have found that even the IDL implementation only takes at most a few seconds to converge on a solution. During engineering time in September we hope to take data at f/9 and f/5 to compare results between DONUT and our existing Shack-Hartmann wavefront sensors.

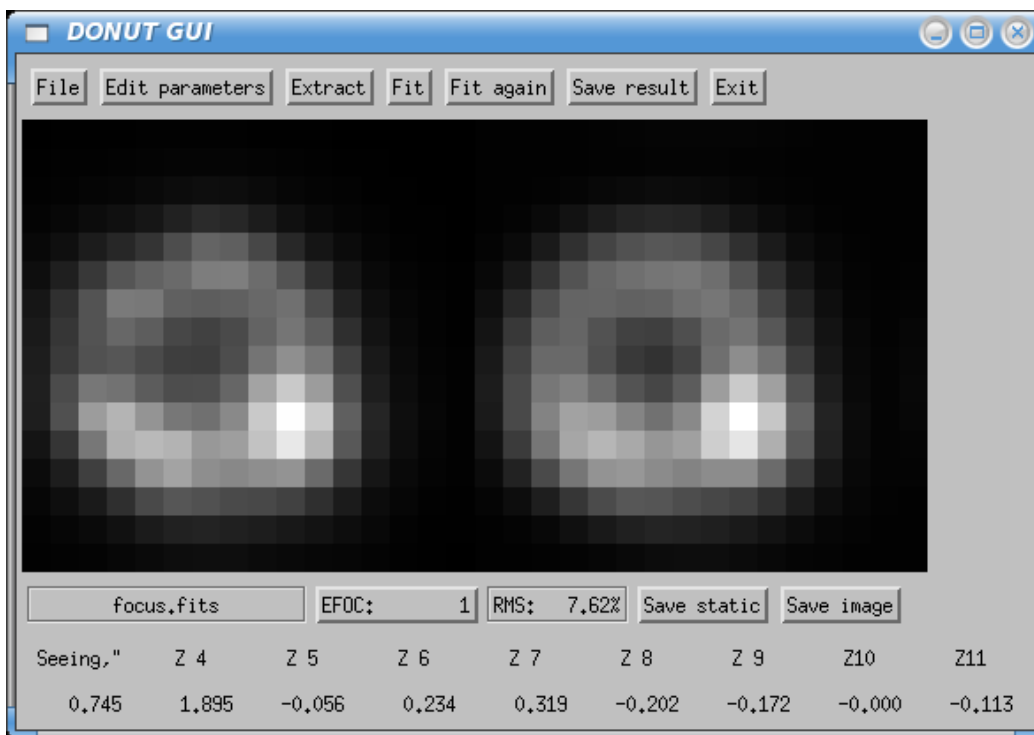


Figure 3: Screenshot of the DONUT wavefront sensing GUI as provided by A. Tokovinin. The image on the left is an observed out-of-focus star and the image on the right is the best-fit model. The model consists of a 21-term Zernike polynomial to describe the wavefront errors plus a Gaussian seeing blur. The number of Zernike terms is configurable and the best-fit coefficients for the most commonly used terms are shown in the bottom row of the GUI.

## Seeing

### Making a Low-End SBIG CCD Into a High-Speed Seeing Camera

Measuring seeing with a DIMM or similar instrument requires a detector that is capable of taking exposures short enough to “freeze” the atmosphere as much as possible. For a standard DIMM, short enough is generally 5-10 ms. This is possible with inexpensive CCDs with mechanical shutters, but the turnaround time between exposures is often of order a few hundred ms or more. This is fine

for determining seeing from a two aperture DIMM, but better temporal sampling is required to fully take advantage of a multi-aperture Hartmann-DIMM.

A solution would be to leave the shutter open and read the CCD out continuously. This way the exposure time would be limited by the readout speed of the CCD and there would be continuous sampling from exposure to exposure. The resulting image would have long strips for each aperture. Atmospheric turbulence parameters can then be derived from the RMS deviations from the average strip positions. The continuous sampling would make it possible to bin the strips to determine exposure time corrections.

CCD cameras from SBIG provide the capability of reading out while exposing, a feature widely used by amateur astronomers to do drift scan imaging. We obtained the smallest SBIG camera, the ST-402, since it has all of the sensitivity and features of the larger cameras and we don't need a large field. As a bonus the camera comes with an internal RGB+Clear filter wheel, making color imaging possible. A sample image taken during software testing is shown in Figure 4. The software to do the continuously exposed readout is mostly complete and we hope to do some on-sky testing of it this fall.



*Figure 4: A sample image created by taking R, G, and B images of equal exposure time with an ST-402 camera.*

## Computers and Software

### Servos and Mount Computer

In order to accelerate our efforts to develop new servo algorithms, we have made significant enhancements to our mount simulator. Up to this time, we have run (as a simulator) a version of the mount code, first on a spare VME computer running VxWorks, and later on a Pentium PC running VxWorks. Before the recent work, the code that we ran on the simulator had many sections “stubbed out,” in particular the modules that read the encoders. The new code no longer uses code



stubs, and in fact the simulator runs the exact same code image that we run on the actual mount. Telescope motion and encoder feedback are simulated using a model of the telescope. In the case of the elevation axis, a very precise state space model of the telescope is available and is used.

This simulator has been used to test and debug our new Simulink-generated servo algorithms. We have now integrated the new elevation servo model into the mount code. A number of initialization related problems have been solved, and we have a high level of confidence in going ahead with the next round of on-telescope tests. The new simulator is also expected to be useful for offline troubleshooting of other non-servo related issues.

## Hexapod Control and Performance Evaluation

Tom Trebisky, Duane Gibson, and Skip Schaller worked to deploy and test new hexapod code to move all the motors in a coordinated fashion. This should ensure that a focus command will not make the target image move around in the field during the motion. Various anomalies were discovered in both hexapods during the release and application of the brakes as well as other erratic behavior of the pods. An example of the anomalies seen in the Pod F encoder output is shown in Figure 5. This discovery led to more detailed evaluation of hexapod performance.

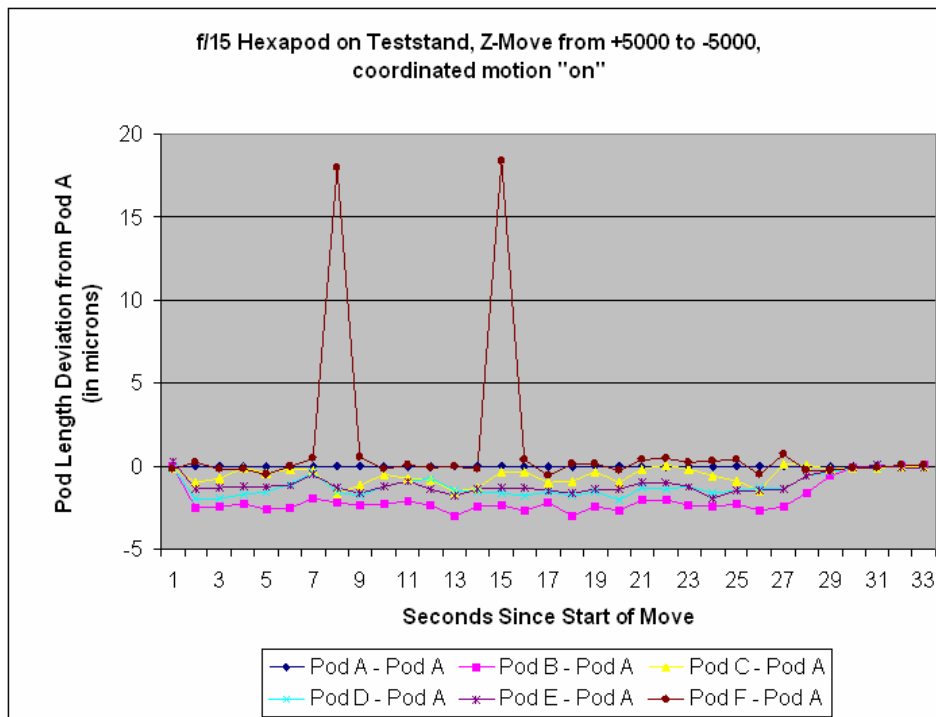


Figure 5: Examples of the Pod F glitches observed during hexapod testing. In this case, no secondary is mounted and the hexapod is mounted on the test stand. The hexapod was moved from  $Z = +5000$  microns to  $Z = -5000$  with data sampled every 1 second. The data are plotted with the length of each pod minus the length of Pod A. Ideally, the value for each pod would remain at zero throughout the move.

This evaluation included comparing and contrasting coordinated and uncoordinated motion, the release and application of brakes and servo control during each move, and the trajectory of motion for each pod during a move. Data were collected at different telescope elevations and with different payloads on the hexapods. New data acquisition and analysis tools have been developed for logging hexapod data at 1 Hz, a higher resolution than has been available in the past. Real-time visualization tools have also been developed as part of this testing. We still need to do more daytime testing as well as on-sky tests during upcoming engineering nights to fully characterize hexapod behavior.

## Hexapod Offsets

Work is underway on incorporating different types of hexapod/secondary mirror offsets into a more systematic approach to improve hexapod control, trend analysis, and data mining. Unique hexapod offsets have been defined for instruments, thermal-dependent effects, elevation-dependent effects, guiders, and wavefront sensors. Input from the telescope and instrument operators are captured into their own separate offsets.

In the past, these various hexapod offsets have been lumped together, making analysis of individual effects on hexapod location and behavior difficult. This functionality has now been implemented in the hexapod crate code and is available through the “remote” network protocol. Further work is needed to augment the “msg” protocol to handle these offsets. A new web-based GUI is also being developed and is ready for testing. Modifications were made to the existing “settings” server to include the various offsets and to improve the XML format of the stored data.

## DT3155 Framegrabber Driver

In early July it was discovered that the framegrabber driver, and thus the SAO guider, had quit working. The driver had worked fine with the 2.6.12 and 2.6.14 Linux kernels, but did not work at all with 2.6.16 or newer kernels. The driver would build and install fine and generated no runtime errors, but SAOguider and other framegrabber tasks would hang up. A key hint to the root of the problem was that one of the test programs that come with the DT3155 driver did work. There are two ways to grab frames from the DT3155: 1) by polling the card until it’s in a frame-ready state; or 2) by having the card generate interrupts when frames are ready. The SAO guider and our software use the interrupt mode while the test program that worked used the polling mode. Thus the driver and card were fine, but the card was not generating interrupts for some reason. Checking `/proc/interrupts` while attempting to grab frames in interrupt mode confirmed this to be the case. Further testing found that the more recent kernels were configured to use the more modern IO-APIC interrupt controller for all interrupts while the older ones used the legacy XT-PIC mode for the DT3155. Forcing the newer kernels into the legacy XT-PIC mode via the “noapic” boot parameter got the DT3155 working again in all modes. Under a heavy interrupt load there can be a performance penalty when using the XT-PIC mode, but it’s not enough to be a concern. The machines such as *boseclamp* that host DT3155 cards have had their boot configurations modified to include the “noapic” flag, and the SAO guider now works properly.

## Update of *hacksaw* to a Rackmount Server

With a single CPU and less than 1 GB of RAM (due to DT3155 driver limitations), *hacksaw* was buckling under the demands of running dozens of telescope control system (TCS) servers, continuous logging and monitoring of TCS systems, and the dozens of windows that operators use

to control everything. Splitting the TCS server duties off to a dedicated machine would go a long way towards improving the responsiveness of the operator's desktop. Since we've had very good luck with our mmto.org rackmount server from ASL, we acquired a similar system to become the new *backsaw*. It has dual dual-core Opteron™ CPUs, 2 GB of RAM, and 3 TB of RAID5 disk spanning 11 drives plus a 12th as a hot spare. This will provide plenty of room for our growing data archiving and analysis needs.

The new machine was deployed as *backsaw*, and the former *backsaw* renamed to *yggdrasil* during the last week of August. This provided some engineering time to iron out the kinks and weed out implicit and explicit assumptions about hostnames and where operators are logged in. This mostly involved boot configurations for VxWorks crates, but also the cell rerr window and the operator log screenshot mechanism. These issues were successfully resolved and we now seem to be running smoothly with the new configuration. We are now in a position to deal with a failure of a control room computer much more smoothly and easily. Any one of them will be able to run all TCS interfaces nearly equally well. In the case of a failure of *backsaw*, the mmto.org server downtime can easily be reconfigured on the fly to respond to *backsaw*'s IP number and run all of the TCS services that *backsaw* hosts.

### **IDL Tool for Visualizing and Analyzing the Thermal Properties of the Primary Mirror**

Betty Stobie has developed an IDL visualization program to:

- read E-series thermocouple values from a file
- plot the values for the sets of thermocouples in the front, middle, and back plates
- select which of the sets to plot, and control the temperature range for the plots
- fit the front, middle, and back values with 9 coefficient Zernike polynomials
- display the fitted surfaces for each plate
- calculate and display the focus correction predicted by FEA modeling done by Tim Pickering
- output all fitted results to the designated log files
- print view of the raw data display or the fitted image display by creating .png or .eps files

The user may select the desired thermocouple data file to read or process a list of data files where a timer controls the delay between the reading of each file in the list. Remaining items to implement include:

- read the thermocouple values from the cell mini-server on *backsaw*. The timer will control the delay between reads of the socket.
- create a save file so that draw\_temp can run in the IDL virtual environment, which does not require an IDL license.

Screenshots of the raw data and surface fit displays are shown in Figures 6 and 7.

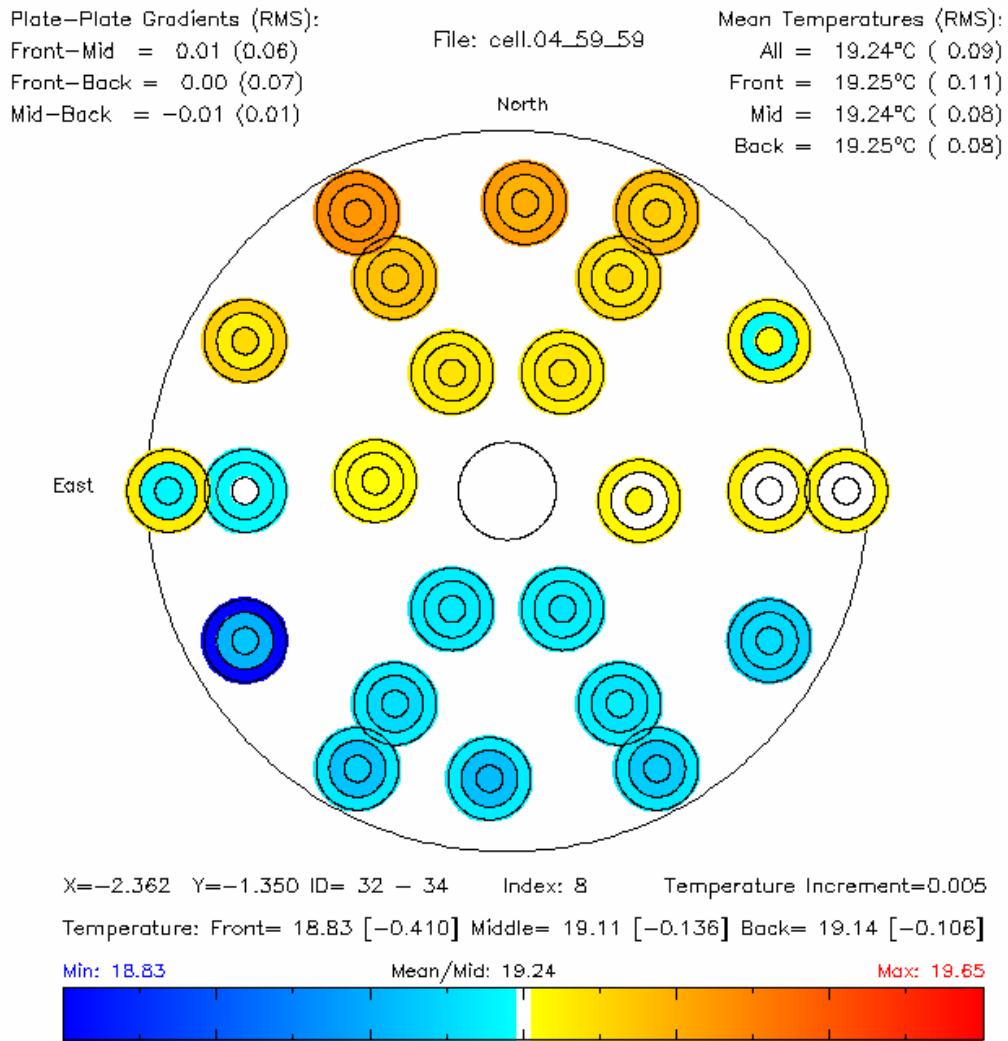


Figure 6: Screenshot showing the raw data display. The outer circle denotes the front plate, the middle the mid plate, and the inner circle the back plate. Clicking on a thermocouple position will display the temperatures at that position in the three plates along with their deviations from the mean mirror temperature.

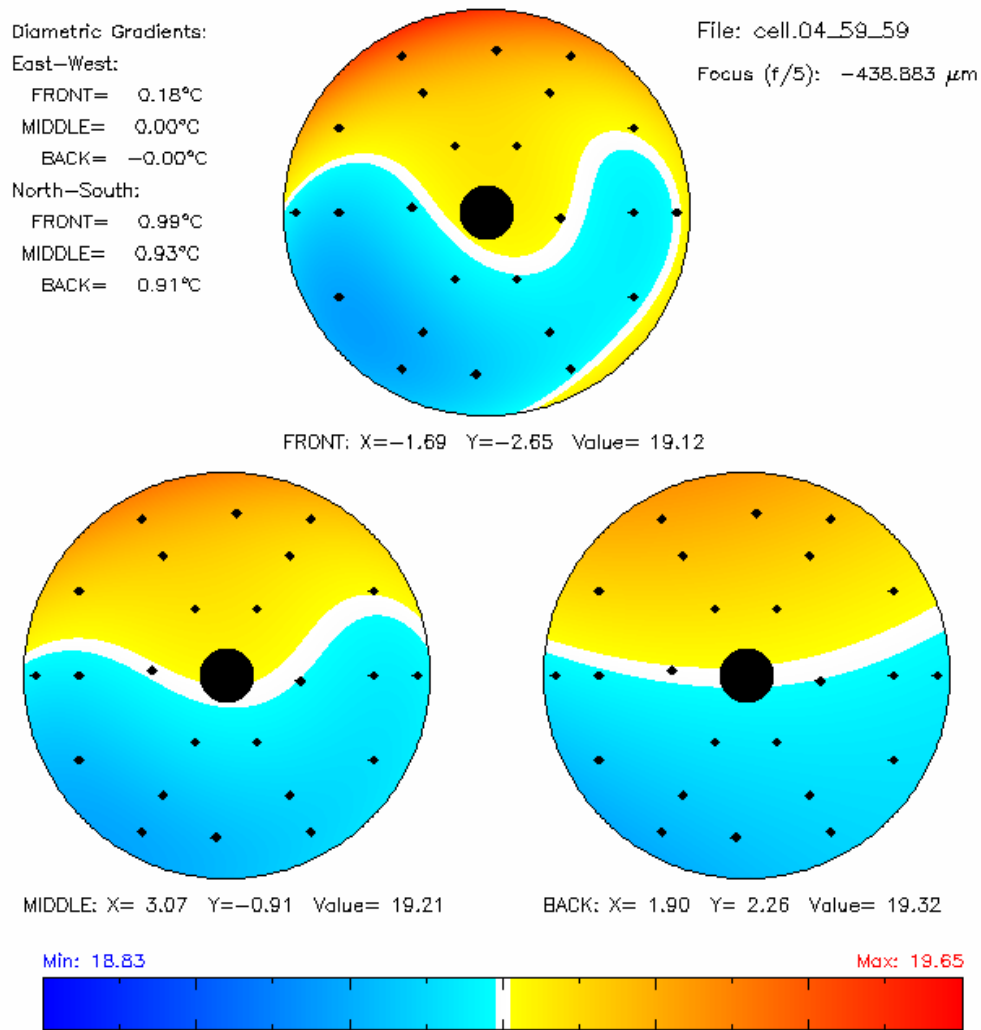


Figure 7: Screenshot showing the surface fit display. When the cursor is moved within one of the three images, the calculated temperature from the fit at that position is displayed.

## GUIs/Web Pages

Work continues on creating new and improving existing web pages and GUIs. A new PHP class, “xajaxMMT,” was created to centralize MMT-specific PHP/Ajax functionality. This class extends the PHP class, “xajaxResponse,” of the xajax PHP/javascript library (see <http://www.xajaxproject.org/>). The new xajaxMMT class: 1) minimizes web server/browser communication by only sending new values to the web browser; and 2) provides class methods for common MMT GUI functionality, such as changing background color based on system status. The existing miniserver PHP class was also augmented to allow active control of essentially all network-based MMT hardware, including the mount, hexapod, and cell crates. Methods for interacting with the settings server were also added to the miniserver class.

Thermal web pages that use these two PHP classes have been created for Carrier chiller and pit Neslab chiller control. Other thermal web pages, such as for the thermal transect and the Vaisala WXT510 status web page, are also now using this technology.

## **Observing Catalogs**

A new observer catalog submission webpage is now online on the MMT website for observers to utilize. This tool will help observers submit their existing catalogs or generate new catalogs from scratch. The page allows for observers to type in a target name (such as Vega or M45) and have that target's RA, DEC, and proper motion be automatically generated and added to the catalog. This works by making a connection under-the-hood (using a combination of Ajax and SOAP) to the SIMBAD database. The catalog format is interchangeable with other Steward Observatory telescopes so even non-MMT observers can utilize this tool to generate their own catalogs if desired. The URL is <http://hacksaw.mmt.az.arizona.edu/catalogs/>.

## **Non-Sidereal Tracking**

To help make tracking non-sidereal targets easier, a new tool has been developed for the MMT telescope control system. The MMT Horizons Ephemerides tool accepts a name of a non-sidereal object and establishes a connection behind the scenes (using PHP CURL and Ajax) to NASA JPL's Solar System Dynamics database to generate a 1 minute interval ephemeris for any desired time span. Modifications have been made to the mount crate to accept this new ephemeris table and to perform the interpolation of the ephemeris table.

## **Miscellaneous**

The UMAC CPU was replaced because of communication failures. We are also addressing an intermittent "Tape Status" error.

All of the mountain machines with the exception of *yggdrasil* have been upgraded from Fedora Core 4 to 5. It and *mmto.org* will be updated later in September. Two floating licenses for IDL 6.3 were purchased for observatory use, and IDL was installed on all of the observatory's Linux workstations.

Shawn Callahan and Dallon Porter have added a new Windows-based server to the MMT domain. This server will be used for management of drawings and archiving documentation.

## **Instruments**

### **Adaptive Optics**

The Natural Guide Star (NGS) system performed well during the July run. There were a few problems with the wavefront sensor camera Leach controller, but we were able to use the spare controller to continue operations. This controller will be replaced with a unit from Scimeasure sometime close to the first of the year when the PC reconstructor is finished. The PC reconstructor work is progressing nicely; preliminary mirror control tests are complete, and closed loop operation will be tested this fall.

At the beginning of summer shutdown, the Laser Guide Star (LGS) projection optics were removed from the hub to facilitate work on the secondary mirror cooling line manifolds, which needed general service. Clearance for the manifold was increased to make installation and removal easier in the future. The LGS projection optics were re-installed and aligned during the week of August 28. In addition, a new method was devised to mount the 4d interferometer, which is used to check the alignment, to the pupil box. Previously, the pupil box had to be removed in order to mount the interferometer. This is no longer the case, which will save several hours of time in the alignment process.

## **Blue Channel**

During the Blue Channel run in June the old image tube shutter began hanging up when opening and closing, mainly closing. Further inspection with the side covers open revealed a noise similar to an electrical short coming from the camera box shutter area. The cable was tested and checked out fine. Repair would require removing the whole camera box from the instrument and working in a clean lab. Since this shutter is no longer needed with the CCDs, the cable was disconnected and the shutter option was removed from the Blue Channel Control System (BCCS) GUI. Tests were performed to measure the background decay rate of the CCDs after being flooded with trouble lights. The background level fell to the noise level in less than 20 minutes.

The automatic log sheets currently used for the f/5 instruments were ported over by Nelson Caldwell for use with Blue and Red Channel. These log sheets will be tested on the engineering night of September 13.

## **Blue/Red Channel Image Acquisition and Spectrograph Control Software**

Over summer shutdown the Blue and Red Channel cameras were sent to the UA Imaging Technology Lab (ITL) to be modified to run with the new AzCam PCI-based controller systems. An AzCam interface is not required for our current Gen 1 controllers; however, we will require a new controller when Red Channel is upgraded with a new deep depletion CCD. We decided to take advantage of summer shutdown to do the migration to AzCam now rather than wait for the new camera.

The AzCam system uses a network protocol that is completely different than the one used by the VxWorks system. Therefore, we had to completely rewrite our image acquisition software to support it. Skip Schaller did this and based it on IRAF's ICE interface to retain backwards compatibility with the system with which observers and staff are familiar. Initial testing was done with the SO guider camera and we are currently testing with the science cameras and controllers downtown. We are planning to commission this new system during engineering on September 13.

Skip Schaller wrote a new ICE interface to query the MMT TCS systems for information to insert in image headers. The new system gets information via the SOAP protocol from the telstat server that also feeds the telstat monitors. This should be much more robust than the MSG-based server we had used, and is certainly far simpler and more flexible.

Skip modified the SCCS control software for the Red and Blue Channel Spectrographs, separating it into client and server pieces. The server can now handle multiple clients that the previous GUI could not. An ICE instrument interface was written to communicate with this new server. This

allows ICE to control spectrograph functions as well as fill in header information with spectrograph values, a feature long-requested by observers.

## Hecto

A team from SAO, led by Dan Fabricant and Ed Hertz, came to the MMT for a servicing mission during the period of August 8-16, 2006. The fiber positioner was separated to accommodate the work. The following tasks were performed:

- The electrical cables for six linear encoders inside the fiber positioner were replaced and rerouted. The insulation on one of the encoder cables had cracked, exposing bare wire that resulted in an electrical short. All six cables of this type were replaced with a higher performance cable used elsewhere in the instrument.
- The outer gimbal drive actuator on robot 1 was replaced because it was starting to show evidence of wear. Following the replacement, the actuator was tuned and tested.
- The robot 2 pellicle beam splitter was replaced because of the concern, based on an earlier failure of the robot 1 pellicle, over aging. The associated optics were cleaned and the system was recalibrated.
- The hardware on the two small instrument access covers was replaced in order to secure loose hardware and improve the fit of the covers.
- The ball screws and translation rails for the X and Y axes were lubricated.
- The mounting brackets for the fiber transition box were modified to accommodate use of the “lower” casters. The “higher” casters are no longer required because of the added width of the larger instrument lift.
- The SAO team made a presentation to the MMT staff on the topic of f/5 instrument electronics. This will aid the MMT staff in troubleshooting instrument problems.
- The upper and lower units of the fiber positioner were thoroughly cleaned.
- A full system check was performed following final reassembly.
- The f/5 wide field corrector optics and structure was thoroughly cleaned and inspected. The top surface of lens 1 will require further cleaning. An acetone wash has been recommended for next summer. This will require shipping part of the corrector to Cambridge.

The RS232/DB9 connectors for the StellaCam that is inside the f/5 wavefront sensor were replaced with MS connectors inside the Cassegrain cone and at the instrument.



## **SO Guider**

The SO Guider documentation was added to the dokuwiki page.

## **General Facility**

### **Carrier and Neslab Chillers**

A Carrier technician came up to install a kit that allows the two compressors to share operation in order to even out the number of hours on each. They also replaced one fan motor, which needs a new bearing.

We still await the quote from George Michels of Comfort Controls, who will repair the glycol cooled Freon chillers in the pit.

### **Instrument Lift**

In early August the old instrument lift in the chamber floor was removed and replaced by Creighton Chute, Shawn Callahan, Dennis Smith, Jill Cooper, and John Di Miceli. The new floor lift is wider by 30 inches (90 inches inside), which allows easier loading of larger instruments. An access port (manhole) was added to the new lift to provide access to the azimuth encoder without having to raise the lift. The lift has been tested and is operating without problems.

The down limit switch for the lift and the interlock “daisy” chain was installed. The up limit switch has been mounted but still needs to be adjusted and connected into the hydraulic pump control.

### **Shutters**

The cable to the rear shutter paddle has been extended to reach the fourth floor for ease of maintenance of the upper latch. The cable for the front shutter has also been extended. The cable for the bridge crane hand control has been replaced.

Work has been started to reduce the force the garage door spring exerts on the rear shutter. This spring pulls the shutter back after reaching its full open position. A length of chain has been used to reduce the effective force of the spring; a new spring replacement will be designed.

### **Other Facility Improvements and Repairs**

On July 6, 2006, several engineers from M3 Engineering met with FLWO and MMTTO staff to discuss the building criteria and constraints on the size and location for a new instrument storage building. The group also inspected the MMTTO and shop building for alternative modification for additional instrument storage.

Shawn Callahan and J.T. Williams investigated the cause of the damage to the chamber floor. They calculated that the contact stress from the wheels on the instrument carts is routinely exceeding the yield strength of the flooring. They have looked at a variety of solutions and plan to present a set of options.

The ON/OFF switch for the heat scavenger pump has been moved to the third floor near the secondary systems, which are the prime users of this function. The adaptive optics (AO) tall rack has been moved from the second floor to the third floor. A lightning cutoff switch has been mounted adjacent in order to supply power for this and the short rack that travels with the DM (deformable mirror) when it is transported between the summit and Common Building. All the necessary cabling has been rerouted in the second floor ceiling. Additional cabling has been installed to reach the AO top box to allow testing while it is parked in the garage.

Additional fluorescent light fixtures and switches have been installed in the chamber. These provide much better lighting during day operations without having to turn on the high pressure lights that generate significant heat. Webcam2 has been moved to the fourth floor north, looking down.

The transverse counterweight drive has been installed in the drive room, and the position sensor “string pots” will be completely installed soon. Some cable stretching and reconnecting is yet to be completed. Software needs to be developed to provide GUI access.

Several AC extension cords have been removed from the chamber and replaced with proper AC outlets. The Yankee thermohygrometer and the mounted cameras have all had this treatment. Tom Gerl spent several days in the ceiling above the second floor east removing obsolete AC wiring, some of which was still hot. This work will be ongoing.

Bill Stangret and Dennis Smith replaced the old 18" black ABS ventilation piping with 18" galvanized piping. Bill fabricated and anchored new stands and straps to support the new piping. They also changed the oil in the Grizzlies building drive gear boxes, cleaned the filters and greased the building drive motors, greased the building radial bearings and pivots, changed the oil and greased the azimuth gear boxes, and changed the azimuth bearing oil.

Daniel Sanchez Soria and John Di Miceli replaced the 12-inch flexible duct that supplies air to the rotating duct in the pit. A 3-inch spacer was installed to give the hoses a better fit, along with other minor changes.

The glycol pumps were serviced during shutdown. The old pumps were temporarily removed, the new spare pump was hooked up and operated, and everything was re-tested. All the electronics and fuses inside the starter box were also checked. The system is running fine.

The bell jar manifold was powder coated by Anderson Painting in order to prevent oxidation or rust buildup. Inspection revealed that Anderson Painting did a fine job.

With the new instrument lift in place, it was discovered that the old transmission jack for removing actuators and hardpoints is too large to be placed between the drive arc and the new lift. The transmission jack cart is being modified in order to use the jack around the new lift.

### **New Guidelines for MMT Users and Visitors**

Guidelines for telescope users and prospective visitors to the MMT have been posted on the MMTO web site at <http://www.mmt.org/misc/ObsPolicy.pdf>

Our priorities on the mountain are:

Safety of personnel  
Safety of equipment  
Science

These guidelines remind people that the MMT staff has authority to limit those people on the summit, and control access to areas in the telescope building. In particular, the Telescope Operators have authority over nighttime mountain operations.

## Visitors

August 17: Prof. Yuzuru Yoshii, Director of the Institute of Astronomy at the University of Tokyo, one of his colleagues, and Dr. Fujiwara, who is CEO of Internet Research Institute in Tokyo, accompanied by Peter Wehinger (Steward). Dr. Fujiwara is a potential donor to Dr. Yoshii's proposed 6.5-m telescope at the summit of Cerro Chajnantor (elevation 18,650 ft). The telescope would be optimized for the infrared and remotely controlled from Tokyo.

## Publications

### MMTO Internal Technical Memoranda

None

### MMTO Technical Memoranda

None

### MMTO Technical Reports

None

### Scientific Publications

- 06-39 Asteroseismological Studies of Long-Period Variable Subdwarf B Stars. II. Two-Color Photometry of PG 1338+481  
S. K. Randall, E. M. Green, G. Fontaine, P. Brassard, D. M. Terndrup, N. Brown, M. Fontaine, P. Zacharias, P. Chayer  
*ApJ*, **645**, 1464
- 06-40 Dynamical Masses in Luminous Infrared Galaxies  
J. L. Hinz, G. H. Rieke  
*ApJ*, **646**, 872
- 06-41 Hypervelocity Stars. I. The Spectroscopic Survey  
W. R. Brown, M. J. Geller, S. J. Kenyon, M. J. Kurtz  
*ApJ*, **647**, 303

- 06-42 Resolving the Dusty Circumstellar Structure of the Enigmatic Symbiotic Star CH Cygni with the MMT Adaptive Optics System  
B. A. Biller, L. M. Close, A. Li, M. Marengo, J. H. Biegging, P. M. Hinz, W. F. Hoffmann, G. Brusa, D. Miller  
*ApJ*, **647**, 464
- 06-43 A Genuine Intermediate-Age Globular Cluster in M33  
R. Chandar, T. H. Puzia, A. Sarajedini, P. Goudfrooij  
*ApJ*, **646**, L107
- 06-44 Hot DB White Dwarfs from the Sloan Digital Sky Survey  
D. J. Eisenstein, J. Liebert, D. Koester, S. J. Kleinmann, A. Nitta, P. S. Smith, J. C. Barentine, H. J. Brewington, J. Brinkmann, M. Harvanek, J. Krzesiński, E. H. Neilsen, Jr., D. Long, D. P. Schneider, S. A. Snedden  
*AJ*, **132**, 676
- 06-45 The Discovery of Three New  $z > 5$  Quasars in the AGN and Galaxy Evolution Survey  
R. J. Cool, C. S. Kochanek, D. J. Eisenstein, D. Stern, K. Brand, M. J. I. Brown, A. Dey, P. R. Eisenhardt, X. Fan, A. H. Gonzalez, R. F. Green, B. T. Jannuzi, E. H. McKenzie, G. H. Rieke, M. Rieke, B. T. Soifer, H. Spinrad, R. J. Elston  
*AJ*, **132**, 823
- 06-46 Outflows from the High-Mass Protostars NGC 7538 IRS1/2 Observed with Bispectrum Speckle Interferometry  
S. Kraus, Y. Balega, M. Elitzur, K.-K. Hofmann, T. Preibisch, A. Rosen, D. Schertl, G. Weigelt, E. T. Young  
*A&A*, **455**, 521

### Non MMT Scientific Publications by MMT Staff

The Effects of Space Weathering at UV Wavelengths: S-Class Asteroids  
A. R. Hendrix, F. Vilas  
*AJ*, **132**, 1396

### 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 University of Arizona and the Smithsonian Institution."

Submit publication preprints to [bruss@mmtto.org](mailto:bruss@mmtto.org) or to the following address:

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

Please also notify the MMTO office of any especially noteworthy or newsworthy results; the MMTO plans to highlight work resulting from observations at the MMT on its website.

### **MMTO in the Media**

No activity to report.

### **MMTO Home Page**

The MMTO maintains a web site (<http://www.mmtto.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.
- 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

**July 1 - August 1, 2006**

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>Lost to Instrument</u>	<u>Lost to Telescope</u>	<u>*Lost to Gen'l Facility</u>	<u>Lost to Environment</u>	<u>Total Lost</u>
MMT SG	6.50	54.00	51.40	0.00	0.00	0.00	0.00	51.40
PI Instr	23.00	182.40	108.90	7.75	0.00	4.50	0.00	121.15
Engr	2.50	20.10	20.00	0.00	0.00	0.00	0.00	20.00
Sec Change	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>32.00</b>	<b>256.50</b>	<b>180.30</b>	<b>7.75</b>	<b>0.00</b>	<b>4.50</b>	<b>0.00</b>	<b>192.55</b>

Time Summary Exclusive of Summer Shutdown

Percentage of time scheduled for observing	92.2
Percentage of time scheduled for engineering	7.8
Percentage of time scheduled for secondary change	0.0
Percentage of time lost to weather	70.3
Percentage of time lost to instrument	3.0
Percentage of time lost to telescope	0.0
Percentage of time lost to general facility	1.8
Percentage of time lost to environment	0.0
Percentage of time lost	75.1

\* Breakdown of hours lost to facility neslab 0.5

**Year to Date August 1, 2006**

<u>Instrument</u>	<u>Nights Scheduled</u>	<u>Hours Scheduled</u>	<u>Lost to Weather</u>	<u>Lost to Instrument</u>	<u>Lost to Telescope</u>	<u>Lost to Gen'l Facility</u>	<u>Lost to Environment</u>	<u>Total Lost</u>
MMT SG	57.00	531.75	202.70	7.00	4.55	1.50	0.00	215.75
PI Instr	148.50	1410.45	532.50	110.85	23.15	9.50	0.00	676.00
Engr	7.00	64.35	25.85	0.00	0.00	0.00	0.00	25.85
Sec Change	0.50	3.85	3.85	0.00	0.00	0.00	0.00	3.85
<b>Total</b>	<b>213.00</b>	<b>2010.40</b>	<b>764.90</b>	<b>117.85</b>	<b>27.70</b>	<b>11.00</b>	<b>0.00</b>	<b>921.45</b>

Time Summary Exclusive of Summer Shutdown

Percentage of time scheduled for observing	96.6
Percentage of time scheduled for engineering	3.2
Percentage of time scheduled for secondary change	0.2
Percentage of time lost to weather	38.0
Percentage of time lost to instrument	5.9
Percentage of time lost to telescope	1.4
Percentage of time lost to general facility	0.5
Percentage of time lost to environment	0.0
Percentage of time lost	45.8