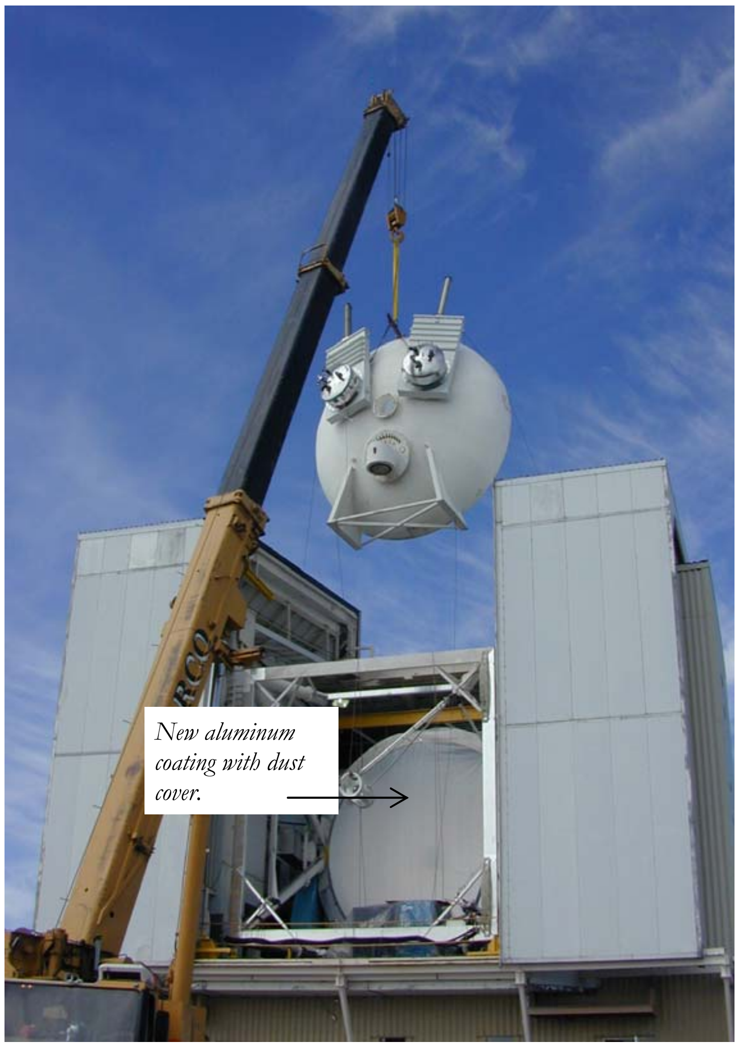
MMT Observatory
Smithsonian Institution &
The University of Arizona®

BIMONTHLY SUMMARY

September – October 2005



Removal of the vacuum head, with two cryogenic pumps and valves, following successful re-aluminizing of the MMTO 6.5-m primary mirror. Photo by Ken Van Horn (MMTO).

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Personnel

Bill Kindred, who had been on medical leave for several months, retired on medical disability on September 21. In his 25 years as chief operator and engineer of the 4.5-m MMT and the converted 6.5-m telescope, Bill brought and acquired exceptional knowledge and skills in telescopes, optics, and mirror coatings. "He taught us how to really operate the 6-shooter MMT." Through a generation of developing and refining aluminum coating techniques, he became the coating engineer's engineer. We wish him the best retirement, and look forward to many coating discussions with him in the future.

Creighton Chute shattered his heel in a rock climbing mishap September 25 and was out for the remainder of the reporting period. His orthopedic surgery went well and he is expected to recover completely.

Phil Ritz left the MMTO September 30 and returned to Nevada. For 2.5 years Phil was our model employee: enthusiastic, responsible, and universally liked and respected by staff and observers alike. We are confident he will do well in his new endeavors.

Johnathan Labbe left the MMTO October 7 for his long sought job in avionics. His new job initially required that he work nights, which allowed MMTO to rehire Johnathan as a part-time technical expert to complete re-assembly of the primary mirror thermal monitoring system. We will miss his congenial good humor and, of course, his very productive work ethic.

John Glaspey was hired as MMT Operations Manager October 17. John was the Kitt Peak National Observatory Science Support Supervisor for the past 7 years. Previously he was in leadership roles at HET in Texas and at CFHT in Hawaii. John is an astronomer and a proven observatory operations manager. He comes with years of large telescope experience and keen interests in facility instrument support and utilization.

Grant Williams was formally designated MMTO Acting Technical Coordinator in October. He is doing a great job executing the many duties as coordinator of engineering activities. He will continue his varied duties as Associate Staff Scientist in the tradition of such MMTO luminaries as Steve West and Craig Foltz.

Tim Pickering attended a Benson Outdoor Lighting Code meeting on September 8. Grant Williams attended at Cochise County Outdoor Lighting Code meeting on September 14.

Primary Mirror Systems

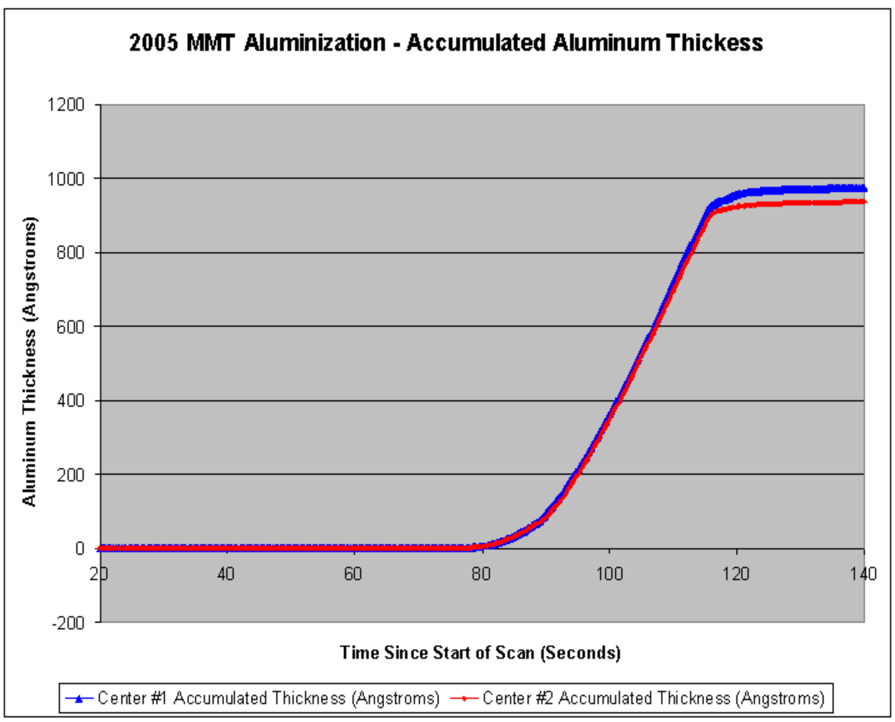
Aluminizing

The 6.5-m MMTO primary mirror was successfully re-aluminized September 27. After weeks of preparation and delays, all critical systems worked well and the optimum coating was deposited with only minor hitches. The coating is uniform and classical pure aluminum in all respects. Measurements on test plates show the aluminum to have textbook reflectance of 91.3% in the blue spectrum (4500 Å) with very low scattering indicated. Crystal monitors measured the thickness at nominal 930 Å near the mirror center. Excellent adhesion was verified by "scotch tape" tests.

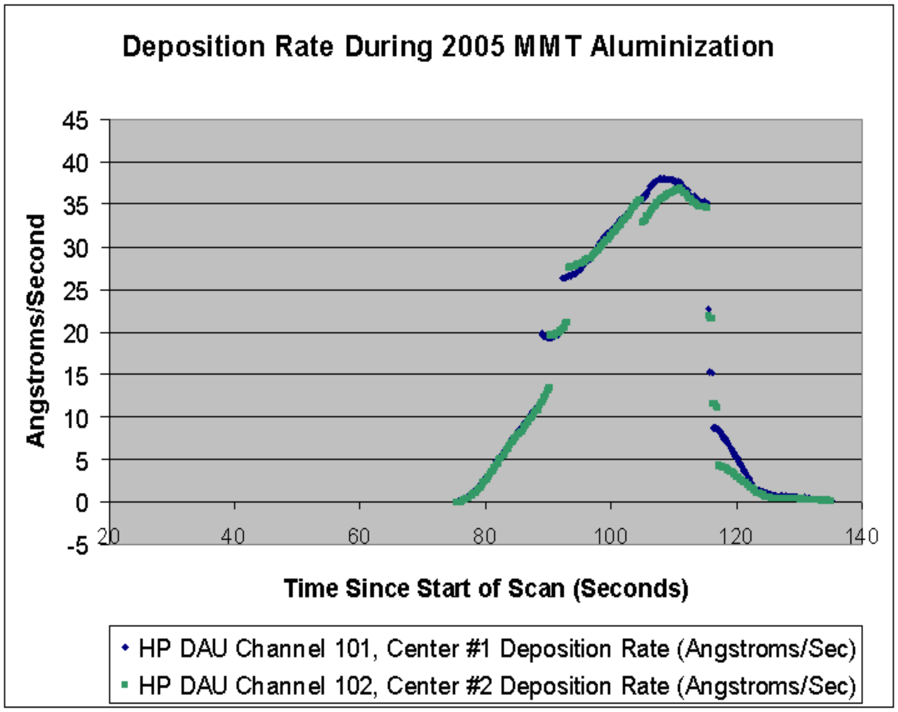
Detailed measurements and model results of the new coating will be the subject of a technical report on updates made to the system hardware, vacuum pumping and monitoring techniques, and data logging successes.

The new aluminizing welder power supplies worked well during the recoating shot, as did the data acquisition system for the power system. The data has been downloaded to both Excel spreadsheets and Matlab workspace files for visualization and study; copies on CD are available. See Dusty Clark for copies of plots of the 10 circuit output voltages and currents. An unsettling feature in the coating power data was a burst of power spikes early in the operation that will need further investigation. An off-line investigation is planned for this winter, servo work schedule permitting.

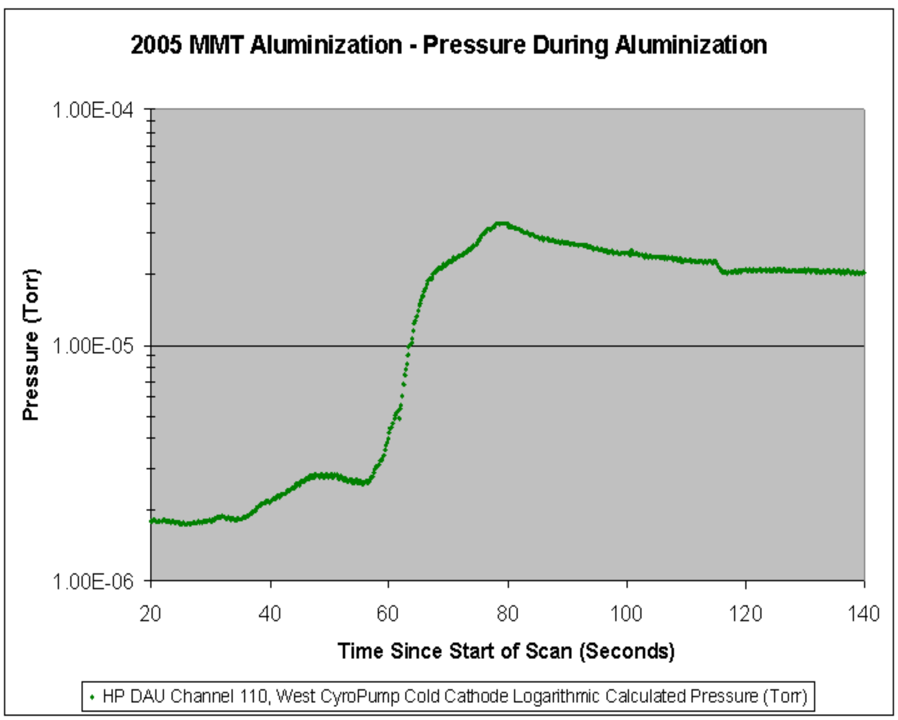
A new script for logging of aluminum deposition rate and pressure data before and during aluminization of the primary mirror was completed in August. In all, ten data channels from the MMT aluminization data acquisition unit (DAU) were logged. Prior to aluminization, background logging was done for several days of system testing by a new miniserver, "alum_hpdau," that was created specifically for this task. A separate Perl script was used to collect approximately 14 minutes of high-resolution (i.e., ~6 Hz) data during the actual aluminization. Analysis continues on the results. Plots of raw data follow:



a) A plot of accumulated aluminum thickness.



b) A plot of the aluminum deposition rate as measured at the center of the mirror during the ~60 seconds of aluminization.



c) A plot of belljar pressure during heating and aluminum deposition (Torr).

d) The vacuum head (belljar) is prepared for rotation to horizontal, and storage.

Primary Mirror Support

All primary mirror support actuators (and ventilation ducting) were removed during preparations to recoat the 6.5-m mirror. This major task allowed testing and recalibration of all pneumatic force actuator cylinders, their control valves, load cells, and control circuit boards. Much of the jet ejector ventilation ducting and circulation system was necessarily removed also. Ray Perry and Ken Daugherty (SOML) assisted with actuator reinstallation, along with restoration of the mirror cell ventilation system, during the week of October 10.

The mirror support system re-assembly process highlighted the need to repair additional spare actuators. Ken Van Horn revisited the board level test tools and wrote a procedure to allow others to perform card level testing. Detailed troubleshooting of several cards has refined this procedure to better test these boards.

As part of the recent effort to troubleshoot primary mirror support system panics, Dusty Clark did a considerable amount of measurement and data collection on the actuator teststand of both dual and single actuator servo cards. We now have both time and frequency-domain data that fully describe the servo card operation. The frequency-domain data have been used to build a Simulink model of the servo circuit. While it doesn't have perfect fidelity to the time-series measurements, due mainly to unmodeled nonlinear effects, it does stand as a starting point for discussion/design of improved servo card electronics. MMTO would like to see improvements to the cards in the areas of 1) power consumption, 2) elimination of "pull-back" forces when the integrator circuit is caged, 3) servo tuning to eliminate overshoot and ringing, 4) signal processing to avoid large force slew rates, and 5) attention to signal integrity on and off the board.

In addition, the slow analog conversion time on the teststand is detrimental to efficacious testing. Noise from pickup on the exposed wiring on the teststand requires low-pass filtering with a time constant of seconds, greatly slowing down test throughput. A more robust design with high noise immunity would be of great benefit to MMTO.

Linear regressions of volts-per-pound (VPP) data were done for load cells on all 104 primary cell actuators. These actuators include both the single and dual units. Statistical analysis of the quality of the regressions was also performed. Actuators that had poor quality regressions were identified, with corrective actions taken.

The data were also entered into Excel spreadsheets for further analysis. Graphs were made of force "step" functions, where a large positive or negative force command is applied quickly to the actuator.

A separate VPP relationship is used in the cell crate for each actuator to compute a load value (in pounds) from the measured voltage. Single actuators have one VPP relationship while dual actuators have separate VPP relationships for the main and auxiliary load cells.

These new VPP regression values are now in the code of the cell crate. The values include both the slope and y-intercept values from the regressions. Prior to this analysis, only slope data were used in the cell crate with an assumed y-intercept of zero.

Actuator teststand data prior to 2005 were also analyzed. A comparison of pre-2005 and 2005 data is in progress.

Airflow data were collected during a typical cell crate "bump" test where individual actuators are given positive and negative target forces. Little change in airflow was measured during the various phases of the test, indicating no significant high pressure air leaks.

Mirror Cover

A new mirror cover has been installed and is fully operational. There are a few changes worth noting. The tarp-like material is slightly heavier, 7.5 oz versus 6 oz. Instead of two 3-inch pipes, only one 6-inch pipe is used to span the diameter. This limits the minimum elevation of the telescope to 15 degrees unless the cover is rolled up partway. The strapping material used to actuate the cover has also changed. Two ½" wide straps, one for each side, are used instead of the previous combination of nylon strap with steel cable. Tuning of the new cover and mechanism continues.

Telescope Tracking and Pointing

Servos and Encoders

The new version of the absolute encoder conversion electronics was committed to printed-circuit, and Cory Knop and Brian Comisso populated the first few boards. More electronics required to pass the data to the mount computer are awaiting final design and printed-circuit layout. We plan to build up the complete system at the campus labs, test all the new boards and associated cabling, and then deploy it on the mountain once complete.

The new mount control PC was set up by Tom Trebisky to run VxWorks, and was installed in the appropriate spot in the drive room racks for later connection to the mount control hardware. We await construction of a "bridge" panel that will allow us to connect the new servo hardware while leaving a path to roll back to the existing servo system so testing can be done in parallel with the existing system. This work should be completed in the next reporting period.

Computers and Software

Operator Log System

We make daily use of a web based operator log system, officially known as the "MMT Web Information System" or "WIS." This software is written in the PHP language and maintains the log as an XML file, presenting a set of forms to the operators which they use to make entries. With the advent of PHP version 5.0 as part of Fedora Core 5, several bugs in the operator log software appeared that could not be quickly solved. The task of bringing the operator log software up to present day PHP coding standards was tackled. A byproduct of this effort (apart from fixing the bugs) is that it is no longer necessary to run the WIS system with an ancient compatibility switch enabled, closing a potential security hole. Also, the revised software can now be more easily enhanced in any number of ways. Hyperlinks to the "event log" are again functional, and we will soon augment the software so it can have follow-up entries submitted by engineers responding to problems.

Mount Computer

Work continued on software development to run our new Pentium hosted mount computer. Because the Pentium system clock runs at a bizarre 1.9318 MHz, we can no longer get precise 1000 Hz clock ticks as expected by the mount software. (The closest tick interval of .00099985 seconds caused us to gain an entirely unacceptable 0.534 seconds per hour.) The timekeeping code was extensively revised to support arbitrary clock rates, and the new scheme developed was also ideally suited to handle the sidereal time clock, making it possible to do tracking rate calculations in a more rational manner.

Other revisions of the mount software were to add additional commands to our ASCII network protocol. This made it possible to entirely abandon the original binary communication protocol that the mount computer came on-line with back in 2001. The last few operator GUIs that used the binary protocol were converted to use the new ASCII protocol.

Miscellaneous Software

Various software tasks were completed during this reporting period, many related to summer shutdown and the subsequent tasks of getting the telescope operational again. Several of the weather miniservers and related hardware required attention after summer shutdown. There was some lightning damage to hardware during the summer. Some engineering web pages needed modification because of system upgrades during summer shutdown. Most of these modifications were related to changes from PHP 4.0 to PHP 5.0. Changes were made to the Perl code for several miniservers to provide more consistent error messages. A miniserver status page, *http://hacksaw.mmto.arizona.edu/engineering/mmt_engineering/mini_server_status.php*, was updated to include more recently developed miniservers and to include all of the MMT "services" that are running on hacksaw.

Instruments

f/5 Instruments

The Hectospec/chelle fiber positioner was separated to perform routine maintenance and to modify some possible fault locations. The fiber gripper wiring on both robots was replaced with rated flex cable in the region that flexes with z-axis motion. The solder joints in the flexed region were eliminated, and the connectors in that area were removed. The x and y axis linear encoders for both robots were replaced. The fiber run was inspected to identify any Teflon tubing displacements, which can cause exposed bare fiber. Some mechanical support was added inside the fiber transition box to keep the Teflon from displacing in the future. Following this work the fiber positioner was calibrated using the large calibration grid.

Over two 1-week periods, a team led by Ed Hertz (SAO) and including Tim Norton, Bill Brymer, and Joe Edmunds, rebuilt the Hectospec/chelle spectrograph room enclosure. The previous cloth panels were replaced with a combination of 1-inch thick and 2-inch thick Isofoam core with 0.025" thick black anodized aluminum skins. They were fabricated by Plascore Incorporated in 4' x 8' panels and cut to fit. The 2-inch panels were located on all walls where no panel insulation previously existed. The 1-inch thick panels were placed on walls where panel insulation was already in place.

This project was by no means an easy task, but the outcome is an enclosure that should make a noticeable improvement as a dark room and as a temperature controlled space for the two bench spectrographs. The enclosure is also in compliance with the SI Office of Safety and Environmental Management.

As part of the modification a new oxygen sensor was installed. The control box is located on the exterior wall, just outside the enclosed space near the liquid nitrogen fill tank. A remote sensor is mounted to a pole inside the spectrograph room. One alarm is mounted just outside the sliding door of the enclosure and the other alarm is mounted in the corner of the first-floor control room.

Grant Williams and Tim Pickering visited Las Campanas Observatory, Chile, to participate in an SAO engineering run at the Magellan Clay Telescope. The engineering run was used to test fit the Magellan *f*/5 wide field corrector cell into the Cassegrain hole. The test fit was very successful. The visit was also used to exchange general operations information between observatories. Frank Perez and Alan Uomoto will visit the MMTO in November to witness a secondary change from *f*/5 to *f*/9.

General Facility

All-Sky Camera

The all-sky camera was brought back on-line after installing fiber links for the video and RS232 feeds. The extra level of digitization proved not to be an issue for video image quality. In fact, replacing the long run of coaxial cable seems to have improved quality somewhat. While the camera was off-line, the field-of-view and focus adjustments on the lens were tweaked to better match the size of the detector. The focus also is improved a bit from before. Once back on the sky, images were analyzed to build a new mapping between elevation and azimuth and sky camera image coordinates. The increase in field size changed the pixel scale from 2.94 pixels/degree to 3.2. The second and third order terms to convert zenith angle to radius from image center are the same within the uncertainties, and the offset between azimuth and image angle changed from 10.2 to 12.9 degrees. The RMS scatter of the transformation fit across the image remains a little over 2 pixels.

Other Shutdown Activities

During re-assembly of the telescope, an incident occurred to the upper fixed hub spiders on October 3. The overhead secondary hoist was used as part of the hub installation process and left attached as a safety precaution. When the shutter doors were opened the following Monday, the fixed hub was pulled diagonally by the 2-ton hoist, bending the upper spiders (lower spiders were not attached). Fortunately, the bends were gentle and easily "cold" bent to straighten. Dye penetrant was used to check for cracks or surface defects near the welds and bends. None were found. Installation of the fixed hub was completed the following week. This incident identified the need to interlock the secondary mirror hoist into the shutter drive interlock chain to prevent shutter operation when the hoist is not parked. This has been done within the 26 volt rack, but a "hoist parked" detector still must be fabricated and installed in series with the existing "trolley parked" interlock switch.

An electronic control incident occurred with the *f*/5 hexapod mid October. Lab test cables were left attached to the UMAC controller during testing, driving one actuator to its extreme limit, damaging a limit switch on the actuator, and locking up the mechanical roller nut. This points out the need for electronically detecting when the lab cables are connected and locking out motion until the cables are properly attached. MMTO Engineering will be working on this soon.

A new digitalized airflow meter (Fluid Components International Model ST75) was installed to monitor airflow into the primary mirror support system. A new miniserver, "airflow," was created to gather and log data from this meter. Current values, graphs, and logs of the data are available on the MMT engineering web page under "Airflow Meter" (*http://www.mmto.org/engineering/#airflow*).

Other Facility Improvements and Repairs

Damage to the in-ground dock lift necessitated its removal, and required bypassing the 26 volt interlock within the 26 volt rack. This was later removed after the proper wires in the lift pit were identified and shunted to allow the lift chain interlock to function normally. The lift pit has now been covered with a steel plate, and the snow plows have been reinstalled on the building after their necessary removal to clear the damaged lift platform. The damaged hydra-mechanical will be replaced.

The Vaisala weather monitoring unit behind the support building has been replaced and is back on-line. The RainWise weather instrument has been installed on the flagpole and is functioning. The R.M. Young weather instrument on the west side of the summit has been repaired to read correct wind direction.

Ricardo Ortiz and Brian Duffy (Steward LOTIS project) implemented a new inventory system to keep track of specialized aluminizing equipment and parts. The system uses preprinted "MMT Aluminizing" bar code labels, and is cross referenced to a list that describes hundreds of vacuum fittings and odd widgets by item and function.

Visitors

October 18: Howie Schlossberg (Program Manager, Physics and Electronics Directorate, Air Force Office of Scientific Research) and Erin Crawley (AFOSR Public Affairs office), accompanied by Thomas Stalcup and Michael Lloyd-Hart (CAAO).

October 18: Laura Helmuth, Senior Science Editor at *Smithsonian Magazine*, toured the MMT and Ridge telescopes with Emilio Falco (FLWO) in preparation for a story on VERITAS (*http://veritas.sao.arizona.edu/index.html*).

Publications

MMTO Internal Technical Memoranda

None

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

05-27 Mid-Infrared Selection of Active Galaxies
Stern, D., Eisenhardt, P., Gorjian, V., Kochanek, C. S., Caldwell, N., Eisenstein, D., Brodwin, M., Brown, M. J. I., Cool, R., Dey, A., Green, P., Jannuzi, B. T., Murray, S. S., Pahre, M. A., Willner, S. P.
ApJ, **631**, 163

05-28 SBS 0335–052W: The Lowest Metallicity Star-Forming Galaxy Known
Izotov, Y. I., Thuan, T. X., Guseva, N. G.
ApJ, **632**, 210

05-29 The Initial Configuration of Young Stellar Clusters: A *K*-Band Number Counts Analysis of the Surface Density of Stars
Gutermuth, R. A., Megeath, S. T., Pipher, J. L., Williams, J. P., Allen, L. E., Myers, P. C., Raines, S. N.
ApJ, **632**, 397

05-30 Outflows in Active Galactic Nucleus/Starburst-Composite Ultraluminous Infrared Galaxies
Rupke, D. S., Veilleux, S., Sanders, D. B.
ApJ, **632**, 751

05-31 The Hamburg/SAO Survey for Emission-Line Galaxies. VI. The Sixth List of 126 Galaxies
Pustilnik, S. A., Engels, D., Lipovetsky, V. A., Kniazev, A. Y., Pramskij, A. G., Ugryumov, A. V., Masegosa, J., Izotov, Y. I., Chaffee, F., Márquez, I., Teplyakova, A. L., Hopp, U., Brosch, N., Hagen, H.-J., Martin, J.-M.
A&A, **442**, 109

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.
- 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

October 12 - 31, 2005

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	* Lost to Telescope	Lost to Gen'l Facility	**Lost to Environment	Total Lost
MMT SG	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI Instr	19.00	209.50	57.70	28.00	3.30	0.00	0.00	89.00
Engr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sec Change	1.00	10.70	0.00	0.00	0.00	0.00	0.00	0.00
Total	**20.00**	**220.20**	**57.70**	**28.00**	**3.30**	**0.00**	**0.00**	**89.00**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	95.1
Percentage of time scheduled for engineering	0.0
Percentage of time scheduled for secondary change	4.9
Percentage of time lost to weather	26.2
Percentage of time lost to instrument	12.7
Percentage of time lost to telescope	1.5
Percentage of time lost to general facility	0.0
Percentage of time lost to environment	0.0
Percentage of time lost	40.4

* Breakdown of hours lost to telescope

wavefront sensor + hexapod 0.5
wavefront sensor 0.5
primary panic 0.8
az drive 1.5

Year to Date October 2005

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	33.50	333.70	186.70	0.00	4.75	2.50	47.80	241.75
PI Instr	168.25	1615.70	540.90	121.35	26.20	0.00	9.60	698.05
Engr	6.75	60.15	3.00	0.00	0.00	0.00	8.00	11.00
Sec Change	6.50	64.05	11.50	6.00	0.00	0.00	0.00	17.50
Total	**215.00**	**2073.60**	**742.10**	**127.35**	**30.95**	**2.50**	**65.40**	**968.30**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	94.0
Percentage of time scheduled for engineering	2.9
Percentage of time scheduled for secondary change	3.1
Percentage of time lost to weather	35.8
Percentage of time lost to instrument	6.1
Percentage of time lost to telescope	1.5
Percentage of time lost to general facility	0.1
Percentage of time lost to environment	3.2
Percentage of time lost	46.7