Smithsonian Institution &
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BIMONTHLY SUMMARY

July - August 2003

The Hectospec/Hectochelle fiber positioner and derotator mounted at the Cassegrain focus, prior to installing the fibers. (Image by D. Fabricant.)

Personnel

Inadvertently omitted from the previous Bimonthly Summary was the hiring in late April of UA undergrad Alberto Ramos as a student engineer.

We bid farewell to Reid Young, a Purdue University CIS/graphic arts student who worked with us during the summer. Reid helped Phil Ritz organize the MMT warehouse at the FLWO basecamp – sorting, moving, and stacking several tons of equipment. On-site, Reid painted, caulked, and cleaned to prepare for the August rains. In his spare time Reid developed our new MMT web page. We all wish him the best in his future studies.

Primary Mirror Systems

Primary Mirror Support

A problem identified with the internal power wiring of the cell crate (see the May-June Bimonthly Summary) was deferred for repair until the summer shutdown period. However, examination of the crate power supply during August suggested that reworking it as previously envisioned was a higher risk option than was prudent. The new plan is to build a complete spare to replace this chassis and then rebuild the old supply as a spare.

Optics

The primary mirror was washed in August. For details see Internal Tech Memo #03-6, which is available at *http://www.mmto.org/MMTpapers/pdfs/itm/itm03-6.pdf*.

On August 6, while preparing for the mirror wash, a mishap occurred that resulted in several fractures in the primary mirror. The mirror received two impacts to the cylindrical inner edge of the Cassegrain hole about 5 inches from the front face. At each impact point there are several fractures in the rib structure ranging in size from 2 to 8 inches long; none extend to the mirror surface.

The following afternoon Randy Lutz and Rick Teachout of the SO Mirror Lab inspected the fractures and took steps to stabilize them against propagation, with Blain Olbert joining by telecon. For the next 3 days the fractures were soaked with a UV-curing liquid adhesive in order to allow it to wick into the cracks. The cement was then cured for 24 hours under a UV flood lamp. Following this step, Randy Lutz returned to drill eight ½-inch diameter stop holes at the ends of the fractures. One fracture was not stop-drilled because it is in a difficult location near the mirror face where drilling may do more harm than good. Obviously, this causes us concern and we will continue to monitor the area closely for spreading.

We are now back to normal operations; however, the area around the Cassegrain hole has been weakened and will need to be treated with extra caution and care. This is a reminder of just how fragile a honeycomb mirror can be. The blows to the mirror were not severe, but the damage was extensive nevertheless. The entire staff accepts the event as a rude wake-up call to maintain the utmost caution and vigilance when working around the optics.

Many thanks to Randy, Blain, Rick and all at the SO Mirror Lab for their quick, expert response and continuing support.

Thermal System

A thermocouple database was created in Excel. To date, most of the Type E thermocouple electrical configuration has been entered into the database.

Aluminization

The welding inverter on loan from Lincoln Electric was tested at Sunnyside using the 20-filament test fixture installed in the small (18”) vacuum chamber. Unfortunately, the welding unit turned out to have what appears to be a current-limiting circuit that prevents it from developing any significant voltage across the cold filaments (which appear as practically a dead short). Switching from constant-voltage mode to constant-current mode, we were able to get enough energy into the filaments to begin heating them. However, once the filaments were heated and the aluminum began to melt, insufficient power headroom in the inverter prevented them from being driven to the wetting/boiling point. It appears that the aluminizing circuit model used to guide the selection of the inverter misses the mark by significantly underestimating the thermal time constant of the filaments. We plan to work on the model and continue discussions with the vendor to identify a more appropriate candidate power supply for this system; the welding inverter approach continues to hold out great promise for improvements in system safety, ease of use, and reliability.

Secondary Mirror Systems

f/5 Instrumentation

Another major milestone for the MMT and SAO was marked on July 18 with the delivery to the summit of the 6,000 lb Hectospec fiber positioner. The following day the equipment was rigged for the overhead lift into the observing chamber. This was a very tight fit requiring a coordinated tilt of the telescope while six people pushed the instrument through the narrow gap, all in the face of a thunderstorm that bore down upon the mountain.

Over the next five weeks crews from SAO and MMTO uncrated the instrument and assembled the two halves (derotator and positioner) using the newly installed laboratory instrument lift. After assembly the positioner was test fitted onto the telescope. The test fit went well, but revealed several minor problems in the handling clearances that were solved one by one. After software checkout, Joe Zajac (SAO) arrived to install the 320 fibers into the derotator. He was assisted in this painstaking task by Steve Nichols and a temporary crew assembled by MMTO for the purpose: Creighton Chute, Jim Harper, Geneva Hickey, and Alberto Ramos. Kudos to the team for a job well done.

Following the fiber installation, an optical test grid was inserted into the positioner for calibration purposes. The fiber positioner was then rolled from the garage and mounted onto the telescope while the procedure was carefully documented. Finally, the derotator was tested with the real fibers. Calibration and flexure tests of the full system were run at several elevations and rotator angles. Several minor mechanical modifications were made to the positioner and positioner cart. The positioner was then removed from the telescope and stowed in the garage, and the removal procedure was carefully documented.

f/5 Baffles

S. Callahan and C. Wainwright compiled the design specifications for the *f*/5 baffle from the optical designer (N. Caldwell), the operations staff, and the mechanical design team. The specifications became the basis for the design and analysis of each component of the three-part baffle system.

A finite element model of the mid-level baffle was developed to determine the modal characteristics, deflections, and stress of the large structure. An iterative approach was taken to optimize the size of each component. At the same time, the lower baffle attachment was reviewed as a means to protect the inner Cassegrain hole of the primary mirror from further damage.

f/5 Hexapod

J. Roll, D. Fabricant, and T. Gauron of SAO have come into agreement with MMTO Engineering on the hardware requirements for the new *f*/5 hexapod controller. To this end, T. Gauron generated a design document spelling out the cabling, interface, and location requirements for the new controller. SAO also received a quotation from Axis New England (formerly known as Delta Tau Systems), which was used as the basis for a UA purchase order. We await the arrival of the unit, which we expect sometime in October, to finalize cable and hardware design.

f/9 Hexapod

P. Spencer and C. Wainwright inspected the *f*/9 hexapod limit switches and readjusted all switches. The adjustment procedure consists of first finding the existing limits by commanding each of the six hexapod actuators to their extrema and noting LVDT readings. The existing limits were all found to be at approximately ±5000 microns range from "HOME" (HOME being the center of the actuators' travel range). Readjusting the limits requires loosening two small Philips head screws and sliding a micro switch to a best guess position, then tightening the two screws and testing the position via software commands and LVDT readings. This procedure is repeated several times for each positive and negative limit on each of the six actuators. With help from D. Gibson, all six were adjusted to trip at ±9500 microns. This is just shy of hitting a mechanical hard stop at approximately ±10,000 microns. Also adjusted were the safety cables to accommodate the expanded limit range.

Other *f*/9 hexapod work included the construction of hexapod extension cables for easing the task of secondary changes. These will be tested during the next *f*/5 run.

Neutral Members

Modifications are required to the neutral members to allow repeatable, efficient, and safe installation of the *f*/9 and *f*/15 secondaries. Several design reviews were held in July and August to insure that all design objectives were met. Prototype hardware was ordered for testing by C. Chute and A. Ramos. C. Wainwright is heading the effort to produce the full set of fabrication drawings. A prototype connection will be fabricated for review before final modification to the existing neutral members.

Telescope Tracking and Pointing

Encoders

The test bench setup for measuring and evaluating the absolute encoder electronics was completed during the reporting period. It was necessary to make several changes to the preamplifier sorting tool to more accurately measure the Inductosyn preamplifier units. All the preamp cards and INA110 instrumentation amplifiers have now been through the sorting and marking process. The spare chip carrier box, with a list of marked and measured results, has been returned to the spares box on the summit.

Several measurements were taken with the PIC-based sine/cosine measurement tool at various stations around the spare encoder unit. It turns out that the gain changes seen at different locations in the Inductosyn cycle were measurement artifacts; more careful testing with many samples across the electrical encoder cycle show that the encoder indeed outputs the same signal levels around the shaft rotation. Armed with this information and a couple of representative measurements, the test tool script gives satisfactory results for setting up the gain-matching network on the conversion board with just a few iterations. With two iterations, the gain matching went from 40 counts (out of 38,000) to 2 counts. This should give good results on the sky.

With new gain-matched resistors in hand, we have modified two of the spare conversion boards and await the availability of telescope time to install, adjust, and test the new setup.

Computers and Software

Unified Hexapod Software

New VxWorks code was developed in C and deployed in the hexapod crate after summer shutdown. This code presents a common interface for the different hardware of the *f*/5, *f*/9, and *f*/15 secondaries. When *f*/5 motion control migrates to PMAC hardware, it will be straightforward to add a PMAC back-end to this software and retain the bulk of our software investment. In particular, the GUI should be almost totally insulated from such a change.

All communication to hardware and secondary-related calculations, such as transformations between hexapod actuator lengths and platform coordinates, now occurs in the hexapod crate, not in the GUI. In the previous version, the VxWorks code was only involved in pod motions and was unaware of platform motions (such as focus changes). By handling platform coordinates in the crate code, we have the opportunity to handle limits in platform coordinates (which was previously highly problematic), and to maintain all position information in the real time code.

Finally, changes were made to the *f*/9 (and *f*/15) motion control so that it is no longer necessary to perform a hexapod calibration (which involved hexapod motion) when the system initializes. This makes operation simpler and faster.

System Software Updates

With the advent of redhat 9, work has been done to port and test the various pieces of software we use or have written ourselves. So far there haven't been any show-stoppers, so upgrading the various linux machines should go fairly smoothly. The main server, mmto.org, will be among the first to upgrade since it is the furthest behind. The mountain machines will follow later, though the relatively minor differences between redhat 8.0 and 9 make the need somewhat less pressing.

Engineering Web Pages

A series of engineering web pages has been developed that displays the status of the thermal systems, secondary, mount, and part of the cell subsystems. The pages allow convenient display of telescope engineering parameters on any connected machine using only a web browser. Their construction was facilitated by the recent development of unified network access to system parameters via a simple ASCII protocol.

The URL for the pages currently is *http://www.mmto.org/~jdgibson/engineering.html*. They are expected to soon move to the staff MMT web site as well as to be mirrored on *hacksaw*.

Instruments

Blue Channel Spectrograph

D. Smith cleaned the Blue Channel gratings using the same CO_2 cleaning procedure that is used to clear dust from the primary mirror.

General Facility

Summer Shutdown

Concurrent with the fiber positioner installation, our August shutdown activities were very productive. The list of specific tasks is too long to include here, but a few of the highlights include:

- Installation of a new PI cable run from a panel in the control room onto the east drive arc.
- Installation of a new gigabit ethernet backbone throughout the building.
- Washing of the primary mirror using a new, hands-off, spray technique. The resulting reflectivity averages about 2% below a new coating.
- Enlarging the MMT office.
- Carrying out preventive maintenance on the primary mirror support compressors, building shutters, and Cassegrain instrument lift.
- Installing a ladder on the front shutter for access to the secondary hub. This is already proving useful for secondary changes and maintenance.

Following shutdown, several systems failed to awaken properly. Problems included the ability of the cell crate to read elevation encoders, a cell air pressure monitor solenoid failure, an actuator electronics card failure (#109), an integrator lockout failure (U17), a rotator amplifier failure, and a shop-to-Cyclades communication failure. Some of these failures are likely attributable to a lightning strike.

Summit Radio Link

During spring 2003 it was determined that one of the pieces of equipment on the downtown end of the radio link is not what was specified in the original order. The equipment in question is a Marconi ES-3810 modular switch that is used to convert between ethernet and ATM. Similar ES-3810's on the summit and ridge are equipped with "Segment" ethernet modules that support the up to 8192 ethernet addresses per ethernet port. The ES-3810 downtown, however, is equipped with a "Workgroup" ethernet module that only supports 4 (yes, four!) addresses per port. It works well enough as long as only one port is used, and it has been used in this way for years now. However, it would be desirable to have two 100 Mbit ethernet feeds into the downtown ES-3810 so that we could fully utilize the 155 Mbit radio link as well as segregate MMT, Ridge, and IOTA network traffic. In August a segment module was acquired via eBay (along with spares for various other pieces of gear), installed, and tested. Setting up the second ethernet link to the radio gear downtown will require some coordination with people at UA CCIT, and has been put on hold while they deal with severe network problems elsewhere on campus.

Instrument Rotator

C. Wainwright, B. Comisso, and S. Callahan designed and installed a limit switch for the instrument rotator. This adjustable, 4-cam commercial switch mounts to the motor gearbox assembly. In the event that the switch is triggered, power is cut from the motor and a fault condition is displayed on the telescope operator's interface. A. Ramos and C. Chute provided drafting support for the fabrication drawings.

At the same time, it became clear that manual control of the rotator should be made through the interlock system and utilize the new limit sensing. A design has been generated to accomplish this via a connection to the east drive arc. Fabrication of the necessary hardware is underway and will be staged as soon as possible.

Miscellaneous

Jack Cohen, a fire behavior scientist with the US Forest Service, visited the site on August 25 to review our fire safety status. He complimented the efforts of the volunteer clean-up crew, and pronounced the Bowl in very good shape from a fire safety perspective. His many helpful suggestions are being incorporated into revisions to the Mt. Hopkins fire safety plan, including a radio-based mountain-wide alarm system.

Repairs were made to the Mattei air compressor auto drain, which was sticking and letting air outside through the drain.

Vents and a spill barrier were installed in the paint locker per the safety inspection in May.

Visitors

No activity to report.

Publications

MMTO Internal Technical Memoranda

03-5 Selected Results of Recent MMT Servo Testing
D. Clark

03-6 Effects of CO_2 Cleaning and Detergent Washing on Specular and Diffuse Reflectance of the MMT 6.5m Primary Mirror
(Addendum to ITM #02-1)
W. Kindred

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

03-8 The Composition Gradient in M101 Revisited. II. Electron Temperatures and Implications for the Nebular Abundance Scale
Kennicutt, Jr., R. C., Bresolin, F., Garnett, D. R.
ApJ, **591**, 801

03-9 Multiwavelength Spectrum of the Black Hole XTE J1118+480 in Quiescence
McClintock, J. E., Narayan, R., Garcia, M. R., Orosz, J. A., Remillard, R. A., Murray, S. S.
ApJ, **593**, 435

03-10 A Census of the Young Cluster IC 348
Luhman, K. L., Stauffer, J. R., Muench, A. A., Rieke, G. H., Lada, E. A., Bouvier, J., Lada C. J.
ApJ, **593**, 1093

03-11 High Resolution Images of Orbital Motion in the Trapezium Cluster: First Scientific Results from the MMT Deformable Secondary Mirror Adaptive Optics System
Close, L. M., Wildi, F., Lloyd-Hart, M., Brusa, G., Fisher, D., Miller, D., Riccardi, A., Salinari, P., McCarthy, D. W., Angel, R., Allen, R., Martin, H. M., Sosa, R. G., Montoya, M., Rademacher, M., Rascon, M., Curley, D., Siegler, N., Duschl, W.
To appear in *ApJ*, **599**

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@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 World Wide Web site (the MMT Home Page) which includes a diverse set of information about the MMT and its use. Documents that are linked to include:

1. General information about the MMT and Mt. Hopkins.

2. Telescope schedule.

3. User documentation, including instrument manuals, detector specifications, and observer's almanac.

4. A photo gallery of the Conversion Project as well as specifications and mechanical drawings related to the Conversion.

5. Information for visiting astronomers, including maps to the site and observing time request forms.

6. The MMTO staff directory.

The page can be accessed via URL *http://www.mmto.org*.

Observing Database

The MMTO maintains a database containing relevant information pertaining to the operation of the telescope and facility instruments, and the weather. Details are given in the June 1985 monthly summary. The data attached to the back of this report are taken from that database.

Use of MMT Scientific Observing Time

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	Lost to Telescope	Lost to Gen'l Facility	Total Lost
MMT SG	16	126.50	65.20	0.00	0.00	0.00	65.20
PI Instr	10	82.30	0.00	0.00	0.00	0.00	0.00
Engr	5	39.30	7.90	0.00	0.00	0.00	7.90
Total	**31**	**248.10**	**73.10**	**0.00**	**0.00**	**0.00**	**73.10**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	84.2
Percentage of time scheduled for engineering	15.8
Percentage of time lost to weather	29.5
Percentage of time not lost to weather lost to instrument	0.0
Percentage of time not lost to weather lost to telescope	0.0
Percentage of time not lost to weather lost to general facility	0.0
Percentage of time lost	29.5

March - July 2003

Instrument	Nights Scheduled	Hours Scheduled	Lost to Weather	Lost to Instrument	Lost to Telescope	Lost to Gen'l Facility	Total Lost
MMT SG	68	594.90	136.85	12.30	1.45	23.35	173.95
PI Instr	66	566.10	81.75	20.90	10.75	4.50	117.90
Engr	19	170.80	65.50	0.00	0.00	0.00	65.50
Total	**153**	**1331.80**	**284.10**	**33.20**	**12.20**	**27.85**	**357.35**

Time Summary Exclusive of Shutdown

Percentage of time scheduled for observing	87.2
Percentage of time scheduled for engineering	12.8
Percentage of time lost to weather	21.3
Percentage of time not lost to weather lost to instrument	3.2
Percentage of time not lost to weather lost to telescope	1.2
Percentage of time not lost to weather lost to general facility	2.7
Percentage of time lost	26.8