

BIMONTHLY SUMMARY

March - April 2002



Minicam image of NGC 3190. Image courtesy of Pete Challis.

Personnel

UA undergrad David Jones was hired as a student engineer mid April. David is working with the mechanical group on the $f/5$ secondary mirror cell.

Members of the Board of the National Zoo visited the MMT on April 4. The visit was set up by David Challinor and was hosted by C. Foltz.

C. Foltz delivered an invited talk to the UA Alumni Club of Yuma on April 18. The venue atop a historic hotel building in downtown Yuma afforded a beautiful view of the evening planets. A reporter from KYMA TV in Yuma interviewed him after the talk.

Development

Primary Mirror Hardpoints

During a routine primary mirror actuator bump test at the beginning of the night on April 25, the MMT primary mirror hardpoints extended to their upper limits. The reason why the hardpoints activated during an actuator bump test is still unknown. In itself, this should not have put the mirror in harm's way because the upper proximity switch on each unit should stop the hardpoint extension.

After an unsuccessful attempt by the telescope operator to troubleshoot, the operation of the telescope was suspended until engineering help arrived later that night. The hardpoint force on one unit was at its electronic rail (~650 lbs.), and we assumed that a load cell amplifier box went bad. Upon inspection, however, it became clear that the upper proximity switch on that unit did not activate. The proximity switches on the other five hardpoints functioned normally and stopped their extension. This demonstrates the point that the only safety check for a hardpoint's extension beyond its allowed range of travel is derived from a single proximity switch. This is an unsatisfactory level of protection.

The state of the unit is shown in the figure below. As shown by the position of the small black block, the hardpoint extended more than 10 mm beyond its intended stopping point (the top edge of the block should have stopped near the center of the upper proximity switch). Inspection of the hardpoint LVDTs showed that this unit extended almost 2 mm beyond the travel of the breakaway mechanism.

After doing a cursory inspection of the E6 wedge, and the local back and front plates of the mirror, we manually brought the hardpoint roller nut back into specification. We determined that the gap between the block and the proximity switch on this unit was too large. We adjusted the gap for proper activation.

Why didn't the mirror break? Prior to performing any other operation on the mirror, we checked the mirror position on the static supports as shown in the cell hardpoint window. Astoundingly, the hardpoint apparently translated (slid) the mirror atop the static supports by ($dX \sim dY \sim 1.4$ mm)!

We have since inspected the other limit switch assemblies by manually extending and contracting the hardpoints in order to verify that the limit switches activate properly. We found that the bracket on one other unit had loosened. It was tightened.

We have added mandatory limit switch testing to our hardpoint installation procedure. We have adopted a hardpoint limit switch test as part of a regular six-month inspection procedure.

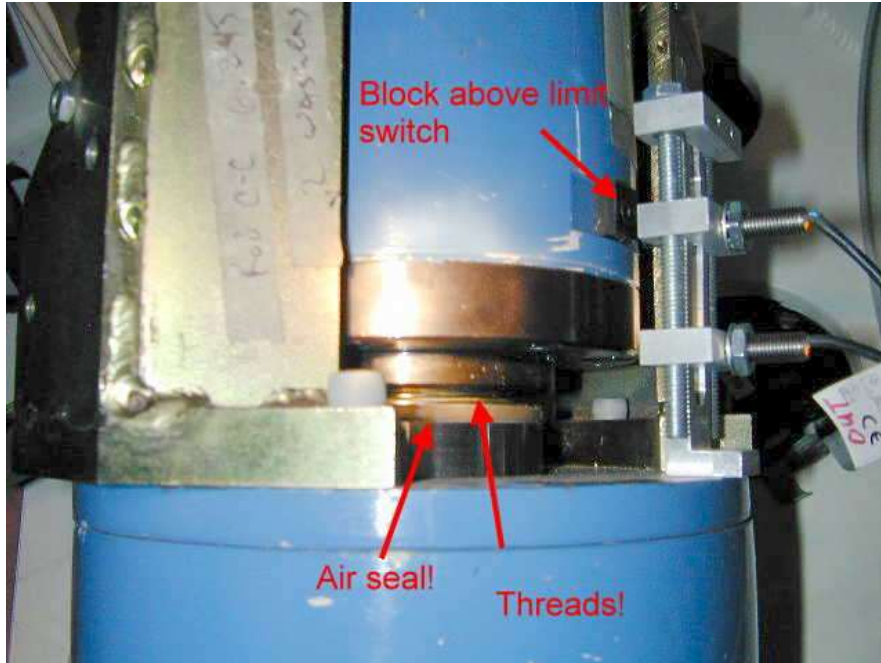


Figure 1: The hyper-extended hardpoint.

We've concluded that we do not want the safety of the primary mirror to depend solely upon these proximity switches without some kind of hardware backup. We've agreed that we want the block to activate mechanical switches "outside" the proximity envelope. These mechanical switches would interrupt power to the hardpoint stepper motor. Furthermore, we'd like to develop a new rock-solid mounting surface for both the proximity and mechanical switches.

When the hardpoint is in the breakaway condition (and the mirror on its static supports), the internal LVDT (which reports hardpoint length from the upper to lower flexures) cannot be used to determine the location within the breakaway envelope. To do this, we propose adding an LVDT that senses the distance of the limit block from the lower body of the hardpoint. Using this sensor, we could determine the exact position of the block (hence roller nut) within the breakaway envelope.

We have discussed this problem in detail with members of the Mirror Working Group and with Matt Johns and Charlie Hull (Magellan). We are working together to develop a plan for the elimination of this serious failure mode.

Thermal System

The T thermocouple readout system was reinstalled. The thermal readout computer, called *camera*, was moved to B. Kindred's lab, and the two RS232 interface cables from the DAU were rerouted to accommodate the computer change.

A lightning strike caused considerable damage to electronics within the thermal system, necessitating replacement of serial connection interfaces on the Carrier, Neslab, and associated linux machines.

Further work is needed to finish repair of the Neslab, so the thermal system is currently running with only the Carrier chiller.

Mount Servos

D. Clark and S. Callahan began a series of measurements to determine the rigidity of the elevation motor mounts. R. James and S. Callahan designed new flexures for the elevation motors' drag link mounts to increase the rigidity of the mount. These flexures were fabricated in the University Research Instrumentation Center and installed on the east motor by S. Callahan, R. Ortiz, and R. James. The east motor was then re-aligned to minimize axial runout. Subsequent tests showed no discernable improvement in the drive system stiffness, although the lost motion from motor body windup was reduced by a factor of eight. In the course of this work, it was discovered that the elevation motors had been installed without grease being applied to the motor bearings (in fact, the grease zerks were not even installed). Grease was applied to the motors, and the next, more insidious problem cropped up: the grease seals in the motors do not contain the grease to the bearing races, but let it drip out onto the drive wheel. The consequences are serious: the drive motor slips and we lose control of the elevation angle with concomitant servo problems. Much subsequent work went into removing motors and cleaning the drive wheels and drive arc to alleviate this problem, but until new seals are installed this problem may recur.

The drive arc tape encoder mounting surfaces were measured for runout by D. Clark using a PC and digital dial indicator. Early results indicate the drive arc can indeed accept the Heidenhain tapes with minor shimming required only on the south end of the east side. For the rest, the radial runout is within the Heidenhain air gap tolerance of 300 microns. R. Ortiz designed the elevation tape head mounting bracket and hardware.

F/9-F/15 Hexapod

During this reporting period a problem with the f/9 hexapod actuator #1 LVDT was found by D. Gibson's background logging software. The software would see sporadic LVDT readings that could not be correlated to physical movement of the hexapod. The f/9 hexapod was then inspected for any faulty wiring and connections and was found to be intact. The LVDT signal condition board was then replaced, which corrected the problem.

F/9 Collimation

We continue to refine the passive collimation stability of the telescope. The secondary system continues to remain stable since the extensive work late last year. As stated in the January-February 2002 Bimonthly Summary, the intermittent collimation problems we've been experiencing have their origin in the primary mirror hardpoint system. In short, we have identified a problem hardpoint (described below), replaced it, and now the incidence of passive collimation problems (aside from gravity flexure) is rare.

We previously described a new in-situ test to assess hardpoint performance. The hardpoints are scanned through the tension and compression breakaway regions while reacting against the mirror resting on its static supports. This provides a detailed breakaway profile. Figure 2 shows the six initial breakaway profiles measured in this test. The left part of the graph shows the stiffness profile for the tension breakaway. The rapidly rising center portion shows the area contact lock-up. The

right side shows the two-stepped compression breakaway stiffness (spring and then air). Clearly, two hardpoints (3-green, and 0-black) have an unknown source of stick-slip in their lock-up profiles. We replaced the worst case (#3) and remeasured the profiles (Figure 3). After replacement of this hardpoint, the passive collimation discontinuities have been largely eliminated.

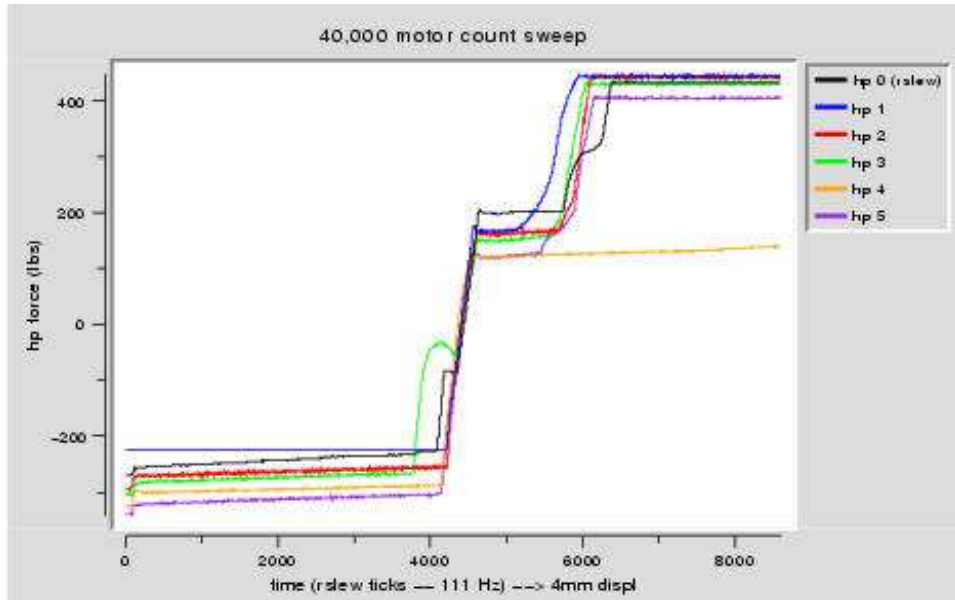


Figure 2: Stiffness profiles of the hardpoint breakaways reacting against the mirror when we were still experiencing periodic collimation problems.

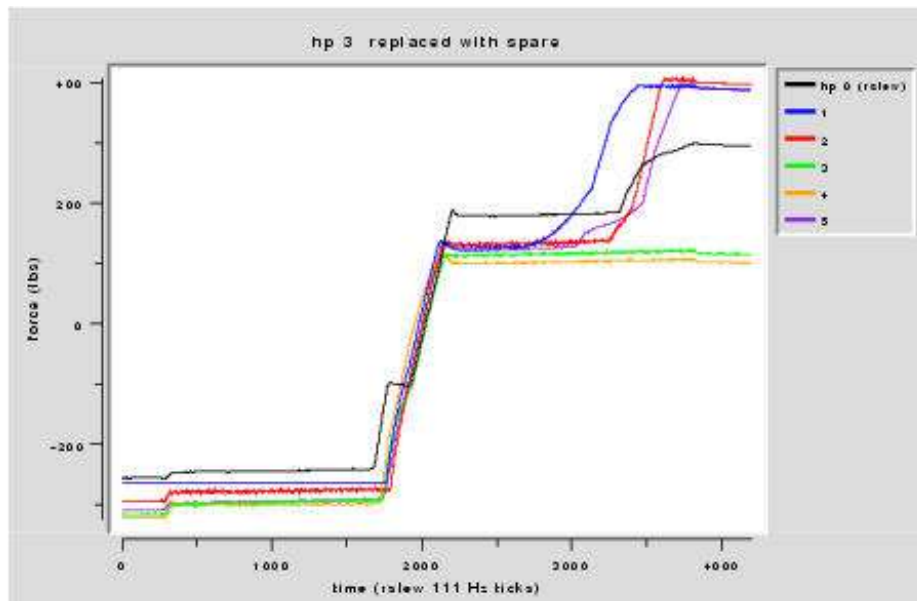


Figure 3: Stiffness profiles after replacing hardpoint #3.

F/9 Topbox Shack-Hartmann Wavefront Sensor

During this period all parts of the topbox f/9 Shack-Hartmann wavefront sensor were fabricated. R. Ortiz and R. James modified a two-axis stage for mounting the optics. S. Callahan and R. Ortiz designed a new mirror mount for the topbox comparison stage. The unit has been installed in the f/9 topbox (Figure 4).

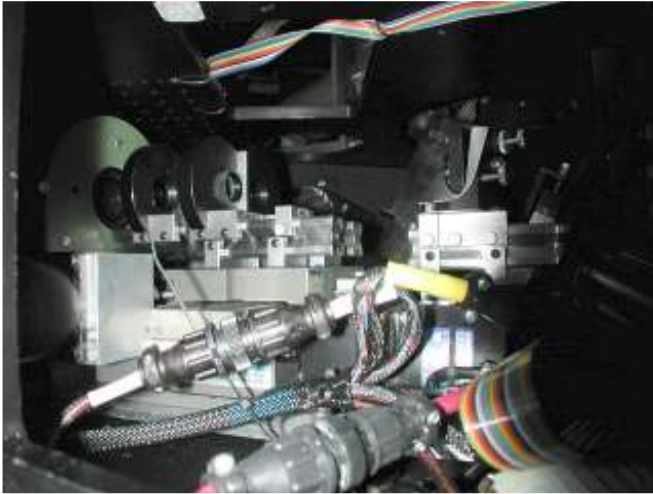


Figure 4: Image of the wavefront sensor mounted inside the f/9 topbox.

A laser alignment tool (built by B. Kindred) was used to align the wavefront sensor in the topbox. Two crosshairs are located on the rotator axis (one each at the top and bottom of the topbox). The laser is centered on the crosshairs. The wavefront sensor was aligned to the rotator axis by adjusting two steering mirrors while keeping the laser centered on a target slid along one of the unit's optical benches. The unit was tested by bending the mirror in various low-order modes and misaligning the secondary. Subsequent data reduction verified that detection of the applied optical aberrations and the core analysis software is working. We are now packaging the software in a form that can be used by the telescope operators.

Figure 5 shows one of the first spot patterns obtained at the end of April.

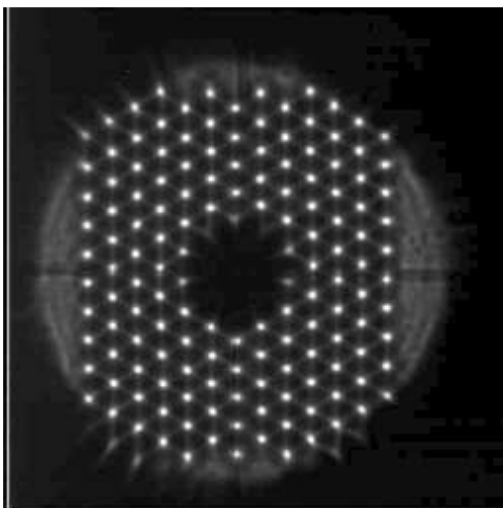


Figure 5: Early spot pattern obtained with the new f/9 topbox wavefront sensor. The spots are shown superposed on the out-of-focus pupil image. The flared edge spots are created by lenslets that overlap the mirror edge and are not used in the wavefront analysis.

During this reporting period P. Spencer designed and installed stepper motor driver electronics for the wavefront sensor X/Y positioning table. The electronics consist of a main controller card and a remote control. The main controller card has been mounted in an aluminum case on a removable panel on the outside of the topbox. The enclosure contains a 9 pin CPC (circular plastic connector) for interfacing to the remote control, and a 28 pin CPC for interfacing to the X/Y table inside the topbox. Included on the enclosure are two switches, each with a group of four LEDs. One group is for testing X positioning (focusing) operation and the other group is for testing Y positioning (engaging beam) operation.

When activated by switching into test mode, the LEDs will illuminate according to the present mode of operation determined by the remote control; in normal operation the LEDs are disabled. The remote control consists of a hand-held black plastic enclosure that contains two rotary switches (one to select positioning axis [focusing or engaging beam] and the other to select motor speed [step, slow, and fast]) and two momentary switches (one labeled MOVE/STEP and the other labeled DIRECTION). There are also LEDs to indicate mode and speed. Positioning the X/Y table requires that the remote be connected via the 9 pin CPC. To focus, select the speed (fast or slow), select focus mode, and engage the move momentary switch.

The focus axis will move as long as the move momentary switch is enabled; once released, movement will stop. When the focus axis hits an end limit, the direction of movement will automatically reverse. To engage with the beam, select beam mode and the beam axis will automatically move into position and stop when the limit is activated. To disengage from the beam, briefly activate the direction switch and the beam axis will automatically move to the corollary position.

Open-Loop Focus Correction

As stated in the January-February 2002 Bimonthly Summary, an open-loop tool was written to help the operator compensate focus for temperature variations (Figure 6) prior to the implementation of the topbox wavefront sensor. The algorithm was obtained from the hexapod logs by relating focus changes made by the operator to the temperature. Once a good focus is obtained on the instrument, the "Set Reference Focus" button is pushed. Thereafter, the secondary focus error and f/9 defocus blur are accumulated as a function of temperature change. The operator clicks the correct-focus button as needed. The operators have reported quite good results during this reporting period.

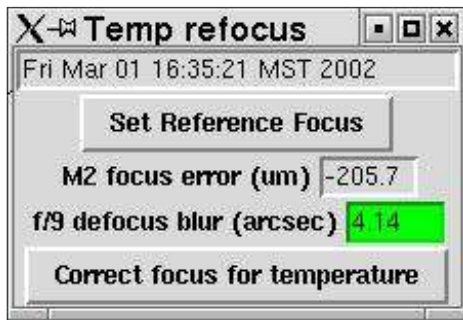


Figure 6: Window to assist telescope operator with maintaining focus as the temperature changes.

F/5 Hexapod

B. Comisso and C. Knop completed the f/5 hexapod electronics and cable harnesses. Also included in this high-quality work is a new junction box that will need to be mounted to the top of the OSS forward frame. This box transitions the round cable from the cable drape to flat cables; all this will fit inside the clips welded to the spider arms. The cables will thus be inside the spider arm shadow, a feature certain to please telescope users!

Minor firmware changes requested by D. Gibson were completed, and the test unit (aka the spare actuator) was turned over to him for software development of the control GUI. Work was initiated on software to communicate with the new f/5 hexapod I/O controller and actuators. This work proceeded in both VxWorks and Ruby. Serial control of actuator movement and reading of LVDT values for a single actuator have been completed. Work is underway on development of servo control for precise actuator movement and positioning.

F/5 Mirror Cell

The wiring and the prototype servo card were completed for the f/5 mirror support system. We also added air pressure sensors that will be digitally monitored to provide information on the cell air supply pressure and on the difference between the plenum and ambient air pressure. Initial check-out of the servo card was completed, and we await completion of the dummy mirror setup to finish the evaluation and documentation of the mirror support servo performance.

Preparation of the f/5 mirror cell continued for installation of the dummy mirror. R. James and M. Orr finished all pneumatic plumbing. The ventilation seals around the perimeter of the cell were fabricated. An engine stand was modified to aid in mounting the hexapod and removable hub to the cell. C. Wainwright redesigned the f/5 flexures and had them fabricated at Southwest EDM.

F/15 Preparations

R. Ortiz designed the plumbing layout that will provide cool glycol to the adaptive secondary's Neslab cooler.

Computers and Software

Telescope Pointing

During this period we finished work that allows the mount control software to obtain an accurate time from our GPS receiver. Time synch is not performed on a continual basis (as would be done with a full implementation of ntpd), but we obtain the current time when the software boots and when the telescope slews to a new object. We are reluctant to have timer-triggered time synchronization since this might cause tracking discontinuities during data acquisition.

Additional work was done to improve handling of aberration of starlight, including both diurnal and annual terms. A pointing run was then performed in mid-March that showed that the telescope is now able to point to 0.8 arcsecond RMS over the sky above elevations of ten degrees.

Telescope Simulator

For some time we have used a spare vme computer downtown to run a simulator version of the mount control software. Most of the code in the simulator is identical to what is run on the mountain to control the telescope, but because the simulator lacks encoders and servo hardware and the like, actual telescope functionality is, well, simulated. Initially the simulator was useful to test modifications to network communication subsystems, but it has recently been enhanced enough to aid the development and debugging of a new catalog GUI, and has been offered to the adaptive optics software group to use to develop and test the network software they will need to use to communicate with the mount this summer.

Telescope Offsets and “instcon”

In an effort to aid observers with instruments that cannot readily use our socket based network interface to communicate with the telescope control system, we have offered a serial port based protocol (which is implemented via a protocol translator dubbed “instcon”). This enables instruments like PISCES and F-Spec to send offsets to the telescope and to obtain telescope status. Recently this protocol has been updated in several ways. It now can provide rotator status information. A logging system that is useful in diagnosing misbehavior of the system has been implemented. We plan to soon use a serial port on our terminal server rather than an available serial port on one of our control room PCs.

A number of changes were made to the offsets GUI that the operators use each and every night. Much of what instcon does is manipulate telescope position offsets, and apart from the offsets window, this is done without the knowledge and intervention of the operator. Several changes were made in response to requests made by the operators that will make the handling of offsets more straightforward to understand.

Mount Logging

The mount control software now has a significantly improved logging system. At this time virtually every significant event within the mount control system is timestamped and logged in a daily file (daily files are rotated at noon so that they are continuous through an observing night). Examples of the events logged are: telescope drives enabled or disabled, slew to new object, slew to engineering position, fault conditions indicated by the 26 volt interlock system, and time resynchronization via NTP. The log file is an ASCII file using XML markup, and we intend to develop software to browse these log files in a flexible manner. The current system is a test of concept, and we expect to make revisions as we become better aware of how we exploit XML. New log items are added frequently as we get new ideas about information we want to collect.

Primary Cell Hardpoint Logging

We have in the past experienced some misbehavior of the primary support system, which manifested itself by erratic loss of telescope collimation. Ultimately this was traced to a faulty hard point in the primary mirror support. To aid diagnosis of this sort of problem, a facility was created that logs hardpoint lengths, forces, and telescope elevation angle on a periodic basis. This facility should ultimately be merged with the existing mirror support software logging facility and both should be converted to use the XML based logger now in use on the mount.

New Servo Parameter GUI

For many years our VxWorks based mount control system has used a set of windows that were based on WindX, an implementation of the X windows system that runs under VxWorks. Over time we have been reimplementing our user interfaces using scripting languages and sockets. A new GUI to handle servo tuning was developed during this period using the Ruby language and the GTK bindings. This was the last of the WindX GUIs to be reworked, and we have eliminated WindX from our control code (which frees up a significant amount of memory and other resources). In addition, the new tuning window already has improved functionality, and it will be easy to provide a long desired ability to have sets of servo parameters in collections of ASCII files that can be browsed and selected by the operators.

Non-Sidereal Tracking with mmt_xephem

A variety of features were added to Xephem, a general-purpose astronomical software package available from Clear Sky Institute, to make this software useable for the MMT. The resulting software package is called “mmt_xephem.” These new features include the ability to track virtually any type of sky object, including planets, earth satellites, and other non-sidereal bodies. These features are integrated into mmt_xephem so that the user only needs to right click on the mouse to access the new functionality. The user can elect to either go to the object (without tracking) or continuously track the selected object. Mmt_xephem can also be used to build an MMT-format star catalog by selecting objects from the user interface, then adding the objects to the catalog. This code was used for several asteroid-based MMT projects during this reporting period. Time was spent on both training the operators for use of this new software and working with observers to ensure that they had properly formatted input for mmt_xephem.

Catalog GUI

A working version of a new scope/catalog GUI was provided to the telescope operators. The GUI uses Ruby/Gtk+ to provide a spreadsheet-like listing of catalog parameters. The catalog can be sorted by any column, allowing great flexibility in locating objects with specific properties. The telescope can be moved to a selected catalog object by a single button click. The GUI can also be used to add or modify entries in an MMT-format catalog. This work included the creation of a Ruby “Astro” class that can be used for a wide range of astronomical calculations.

New Spectrograph Observer Machine

Due to *ringo's* deteriorating health and reliability, spectrograph observing was moved over to the linux box, *alewife*. The mmtobs account was configured to emulate *ringo's* mmtobs account, but also enhanced to take some advantage of the more modern linux desktop environment. So far it has worked quite well, and the observers have been pleased with the 10x increase in speed and memory capacity the new machine provides. At the moment, either the network or the cd-writer provides data backup. A DDS3 DAT drive will be obtained for *alewife* for larger capacity backup. However, observers will still be encouraged to use the cd-writer due to the lower cost, higher reliability, and greater portability of cd-r and cd-rw media.

GSPEC - A GTK+-based Replacement for SCCS

Currently, the observers control the spectrographs via a ten-year-old DOS PC. This PC then interfaces to the spectrographs via RS232. GSPEC is the first step in creating a new graphical interface for controlling the spectrographs and topbox lamps. Figure 7 shows the layout of the current incarnation. The GSPEC GUI is built using the gtk+ graphical toolkit so that it integrates well with the gnome-gtk+ desktop environment that is used on the mountain computers. Another advantage of gtk+ is the glade GUI builder (<http://glade.gnome.org>) that hugely simplifies the task of laying out, coding, and maintaining user interfaces. The next step in replacing SCCS is to write a server that will take commands from GSPEC or other programs like command-line tools or IRAF's ICE environment, and then configure the spectrograph accordingly via RS232 (via the cyclades). This way the spectrograph can be controlled from any computer or any number of computers at a time in a sane and safe manner.



Figure 7: Layout of current GUI for controlling the spectrographs and topbox lamps.

Miscellaneous

A new Ruby "Mount" class was developed that allows an object-oriented interface to the mount crate. This class encapsulates all socket communication and protocol details.

Optics

No activity to report.

General Facility

A fiber optic link has been installed between the drive room and the RUPS room. The Carrier and the HP DAU are now connected via this link, and the Neslab will be connected as soon as it is repaired. K. Van Horn is in the process of fabricating an interface that will allow us to also carry the RUPS status and the blower controls through this link. The new fibers also made it possible to upgrade our connection to Summit Support from 10 Mbit to 100 Mbit, thereby eliminating that bottleneck in our network link to the outside world.

D. Jones and B. Kindred began detail drawings for fixtures to mount two dewpoint sensors to the rear shutters.

Maintenance and Repair

The east elevation drive motor failed, and it was discovered that its brush holder had a bad brush. The resulting high motor current at the resistive brush caused the motor wiring to melt and short out. The motor was removed and the carbon and melted parts on the commutator ring re-machined by Industrial Motor & Control. While the motor was at campus, R. James rebuilt the brake housing to make it easier to remove for service, and added reliefs to the housing to allow for tool access to the brush assembly.

New brushes and holders were installed and the motor was re-wired. The motor was put back in service and has been problem-free. The west motor brush assembly was removed and inspected, with some readjustment of the brush setting to prevent this failure from happening there as well.

The topbox has been modified to accommodate the new mirror stage positions required to support the wavefront sensor. The shutter control card has been replaced with a fully functional card, and both shutters are operating. It was discovered that the original design of this card was faulty in that unused CMOS inputs were floating. This is a serious problem, as it can cause strange intermittent events that are very difficult to identify. These problems are being repaired as other work uncovers them.

Visitors

March 12: Dr. Roland Gredel, site director of Calar Alto Observatory, visited the MMT accompanied by J.T. Williams. Later in the day J.T. also hosted Eric Hansen and three other Gemini Project engineers.

March 31-April 3: Ms. Mariana Tres, the inaugural artist for CfA's newly established Artist in Residence Program, visited all projects atop Mt. Hopkins. Ms. Tres is a faculty member at Pacific Northwest College of Art and at Pacific Crest Community School in Portland, Oregon. Her work is inspired by astronomical imagery and phenomena.

April 4: D. Brocius and D. Eisenstein (SO) escorted Drs. Xiaohui Fan and Jin Young Kim. Dr. Fan is a Steward faculty candidate currently at Princeton, and Dr. Kim has been offered a position with the IR group.

April 4: Dr. David Challinor (former SI Assistant Secretary for Science) and members of the Board of the (Smithsonian) National Zoo, accompanied by C. Foltz.

April 4: The Green Valley Hiking Club made its biannual trek from the gate to the Bowl picnic area, hosted by tour guide Ben Coppock (FLWO volunteer).

April 22: Longtime dark sky advocate, amateur astronomer, and University Medical Center physician, Dr. Eduardo Vega and his family toured the MMT, accompanied by D. Ketelsen (SOML) and hosted by C. Foltz.

Publications

MMTO Internal Technical Memoranda

None

MMTO Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

02-3 Spectroscopic Binaries in a Sample of *ROSAT* X-Ray Sources South of the Taurus Molecular Clouds
Torres, G., Neuhäuser, R., Guenther, E. W.
AJ, **123**, 1701

02-4 Interferometric Hartmann Wave-Front Sensing for Active Optics at the 6.5-m MMT Observatory
West, S.
Accepted to *Applied Optics*, **41**, #19, July 2002

Observing Reports

Copies of these publications are available from the MMTO office. We remind MMT observers to submit observing 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 observing reports and publication preprints to bruss@as.arizona.edu 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 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 in two ways. First, it can be loaded via URL <http://sculptor.as.arizona.edu>. Second, it can be accessed via a link from the OIR's MMT page at URL <http://cfa-www/cfa/oir/MMT/mmt/foltz/mmt.html>. The former should be used by interested parties west of the Continental Divide; the latter is a copy, which is locally mirrored at SAO and is much faster for East Coast access.