BIMONTHLY SUMMARY

November - December 2000

The Minicam, open for engineering. Image by S. West.

Personnel

Designer/drafter Pam Garrison left the MMTO in early November.

Ron James returned to work on a part time basis in early December.

Tony Nichols, a temporary from Progress Products, was hired to help with f/5 hexapod control system construction and other minor electronic support items. He replaced temporary employee Fernando Rivera, who found permanent employment.

Craig Foltz gave a talk on large telescopes, and the new MMT in particular, to the Smithsonian Institution's National Associates study tour on December 8.

J.T. Williams attended the dedication of the Magellan I 6.5-m telescope at OCIW Las Campañas Observatory December 9.

Development

Instrument Commissioning

MMT Spectrograph

The Blue Channel of the MMT Spectrograph was commissioned in November and used for scientific observation immediately. A lot of hard work by D. Smith and the MMT staff resulted in very routine and familiar operation. All top box functions work, as do the old intensified CCD and the Apogee camera, which was mounted in place of the intensified vidicon. Mark Wagner (LBTO) helped with the commissioning run and has loaned us a hardware box that can be used for leaky-memory video integration. Under good conditions, the limiting magnitude of the acquisition camera was about V=21. The Red Channel will be commissioned during the next trimester.

In December, an unfortunate runaway of the instrument rotator caused it to run beyond its software limits. It broke a number of the spectrograph and top box cables as a result. Fortunately, these were quickly repaired and the spectrograph was returned to service within about three days. The runaway problem has been solved, and an additional level of protection has been provided by an adjustable lanyard that will power the motors down if preset limits are exceeded.

Minicam

Commissioning and repairs continued with support from SAO, FLWO, and D. Smith.

F-Spec

At the end of December, S. Callahan and B. Kindred worked with George and Marcia Rieke to make a new interface hardware for mounting the F-Spec instrument to the top box. This allows the instrument to be mounted much closer to the nominal focal plane. Doing so has two effects: 1) reducing the amount of spherical aberration, and 2) moving the secondary hexapod away from its operating limit, thereby reducing the stress in the hexapod actuator flex couplings.

Thermal System

R. James, R. Ortíz, J.T. Williams, and S. Callahan made several improvements in the seals on the ventilation system. Beginning with a new 4-inch o-ring seal, they reviewed all connections and made several modifications in preparation for bringing the ventilation system online.

R. Ortíz completed installation and alignment of a rotating air duct baseplate, and coated the plate with Teflon for a sliding seal.

M. Alegria and D. Martina (FLWO) coordinated detail layout and construction of a shelter and filter array for the 6.5-m mirror ventilation blower unit.

Development work on the thermal readout system continues. Design and evaluation of an appropriate method of measurement and conversion of thermocouple voltages to temperatures are currently underway.

Several experiments were performed using differentially connected thermocouples, a Peltier cooler/heater, and the HP Data Acquisition Unit (DAU). The Peltier device (actually a large thermopile) was used as the cold leg of a differentially connected thermocouple pair. The other leg was placed at ambient. The differential pair was then read in one channel of the DAU as a voltage. A standard T thermocouple was thermally coupled to each leg of the differential pair and read by the DAU as a temperature. This generates a voltage to temperature correspondence between the difference voltage generated by the differentially configured thermocouple pair and the temperature difference of the Peltier cooler and ambient temperature. The data give a conversion formula for difference voltage to temperature. The formula can then be programmed into the HP DAU, microprocessor, or PC and used to read temperature directly from differentially connected T thermocouples. An example of the data is shown in the following graph.

A new line of precision analog to digital converters (ADCs) from Crystal Semiconductor was evaluated to replace the HP DAU for low power data acquisition. These units are well suited for acquiring low level voltage signals from thermocouples, loadcells, and LVDTs. The ADCs are highly integrated delta sigma converters that include an instrumentation amplifier, programmable gain amplifier, a multi channel multiplexer, digital filters, and calibration circuitry, all of which are programmable. The manufacturer provides an inexpensive evaluation board, which contains an 8051 microcontroller, RS232 driver/receiver, and software for data capture, possibly making the evaluation board useful as an inexpensive, low power stand-alone DAU.

Primary Mirror Temperature Monitoring

Due to concerns about potentially dangerous thermal gradients being produced in the primary mirror, routine monitoring of the glass temperature distributions has begun using the original thermal system installed at the mirror lab. There is concern when the chamber and ambient outside air have a temperature difference greater than 5 C. Since the primary thermal control is not yet implemented, the primary mirror temperature cannot be slewed to outside ambient prior to opening the chamber. It was not clear whether the chamber could be fully opened under these conditions without inducing a temperature gradient in the mirror blank greater than the 4 C specification. A script was written to read about 45 thermocouples every 15 minutes when the support system is turned on. An alarm is provided in case the average backplate and frontplate temperatures become greater than 4 C. Thus far, the largest average front to back temperature difference has not exceeded 2 C. To illustrate the behavior of the primary mirror in the absence of a thermal control system, two graphs are shown below that depict the typical behavior of the primary mirror temperature under mild and more aggressive slews of the ambient air temperature. The glass responses shown are typical and depend highly on wind speed and relative orientation of the mount. Each graph plots the spatially averaged temperature of the frontplate (green), backplate (blue), midribs (red), and ambient (black) temperatures vs. time (sec). The first plot shows mild air temperature changes throughout the night, while the second shows 2C/hr ambient slew rate.

Low Resolution Shack Hartmann Systems

Work continues on choosing the optimum Shack Hartmann lenslet geometry for the possible dedicated wavefront sensor units for f/9 and f/5. Using the scripting options for the OSLO design program, a compiled C program was written to automatically find the spot positions produced by various lenslet arrays and collimators vs. telescope aberrations. The back calculation of these spot positions into wavefront errors, using Octave and compiled C, has been finished.

High Resolution Interferometric Hartmann

The high-resolution wavefront sensing system was not used during this reporting period.

f/5 Hexapod

ADS Italia made significant progress on the f/5 hexapod system. The photo below shows various actuator parts prior to assembly.

The next photo shows a clasp of the finished cardan joints (which replace the blade flexures used on the f/9 hexapod). These universal joints provide for greater articulation angles and higher load capacity than the flexures used on the f/9 hexapod.

Next is the fit-test of the hexapod assembly prior to actuator performance testing.

The first actuator is shown on the performance test fixture.

f/5 Hexapod Interface and Control

K. Harrar, P. Spencer, and D. Clark have begun the design and construction of the f/5 hexapod electronics. This system will be a software-compatible clone of the f/9 hexapod with new electronics, amplifiers, and cables. We expect to construct and test this unit and have it ready for testing on the "iron maiden" test stand once the hexapod arrives from ADS Italia.

S. Bauman and S. Callahan began development of the interface of the f/5 hexapod to the removable hub. By the end of December they completed the preliminary design and began final detailing.

f/5 Secondary

K. Harrar, D. Clark, P. Spencer, and T. Nichols performed initial work on the f/5 secondary. This included coordinating the refurbishing and modification of a power supply system. At this time the f/5 secondary power supply is 90% complete.

K. Harrar worked on the f/5 secondary electronic system control design. This system will use the same topography as that of the f/9 but will be upgradable when software support is available.

f/5 Mirror Support

MMTO now owns a C compiler for Microchip PIC microprocessors; a PIC will be used on the f/5 mirror support system to report the support forces experienced by the lateral and axial support servos over a serial link. Some testing of the air control valve and control amplifier has been done on a jig in the MMTO electronics lab. Once the design and firmware are finalized, we expect to begin construction of a prototype mirror support servo card and then reduce it to printed circuit once testing and debugging are complete.

f/5 Mirror Cell

During November and December, S. Callahan, C. Wainwright, S. Bauman, R. Ortíz, R. Stavish, and P. Garrison completed the fabrication drawings of the f/5 mirror cell and all mirror support hardware. Fabrication of the mechanical components began at the instrument shop at Arizona State University. During the latter part of December the f/5 cell weldment underwent a review at the

University of Arizona instrument shop, and the design for the weldment was sent out for fabrication bids.

Servos and Controls

Much effort was spent during the reporting period modeling the 6.5-m azimuth servo drivetrain to try to better understand and predict its behavior. Previous measurements show an anti-resonance at ~3.8 Hz, with a resonance at ~80 Hz. The model constructed was compared with that produced by B. Ulich in the early 1980s. The difference between the two was striking; large velocity loop gains made the Ulich loop very linear, with the 3.8 Hz notch almost completely eliminated. In contrast, the gains achievable with the existing LM628-based loop are too small to servo out the anti-resonant frequency; larger gains only create an unstable servo. More research is necessary in order to discover what can be done to improve the servo performance.

The measured data from the elevation axis was sent to Tom Hoffman for his opinion on the sources of the several resonances measured on the drivetrain. The FEA model for the cell and OSS predicted the lowest frequency to be 12.2 Hz; this is not that obtained with the DSA measurements, which show anti-resonances at 5, 7, and 35 Hz. Tom had several suggestions for determining the source of these, and the investigation will continue in the next reporting period.

The new mount interface chassis was nearly completed and should be installed sometime in February. This new rack will hold printed circuits for handling the interface between the mount VME and the external electronics (amplifiers, encoders, etc.).

Miscellaneous

N. Caldwell and S. Callahan designed two baffles for the f/9 secondary. These baffles were in fabrication at the end of December.

Computer and Software

Work continued on the software to control the instrument rotator, in particular the operator GUI. Small changes and bug fixes were made to the operator GUI software, as well as "instcon," the protocol translator that allows instruments to control the telescope via commands over a serial port.

A piece of software was written to allow the integration and display of acquisition video on the control room monitors. This project was the result of a successful collaboration by V. Venkatraman, D. Fisher, and John Roll (SAO OIR). The code performs at least as well as the hardware video integrator does. It remains to modify the code to run on a 24-bit display device.

General Facility

K. Van Horn became more involved with Minicam and the top box during this reporting period. Instrument changes take a full day for at least two people. This may improve, as we become more familiar with the process and ways of handling the cable drapes. We made a number of repairs to the top box to deal with the Apogee camera interface and the cut cables that resulted from a rotator runaway.

Optics

No activity to report.

Maintenance and Repair

The telephone system continues to evolve. The Common Building connection to 621-7933 was disconnected and that line was moved to line 1 on the MMT phones. This has improved operation somewhat, but there are still problems with the phones talking to each other over line 1 (particularly in releasing the hold function). The manuals indicate that line lengths longer than 300 feet may give trouble. The old key set in the pit was turned off; it could be bypassed to provide a little more cleanup. The ringer in the chamber is no longer functioning as a result of disconnecting the key set. This has not proven to be a major problem so far, but K. Van Horn will work on getting a multi-line ringer installed.

The rotator servo was diagnosed with problems with at least one of the Copley amplifiers, possibly two. K. Van Horn continues this diagnosis. One obvious fact has made itself clear: When the external power supply is used to move the rotator, BOTH MOTORS must be disconnected from the servo. Ken will work on ways to assure that this happens; he has already placarded the power supply to this effect.

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The installation of the ventilation system necessitated the modification of the cable trays in the yoke room, creating some very tight fits. Cables have been moved and seem to be functional, but this poor planning has created a risk. In the process of moving cables a number were found that had been installed by various people (often visiting astronomers) without thought of proper installation or consideration of others who must deal with the mess created in the future. We need to know what cables we need to permanently install and maintain for which instruments, and request that temporary cables be removed by whomever installs them. Duct-taped cables on the floor are unsightly and dangerous, and those responsible never seem to even attempt to clean up the tape residue on the floor.

Visitors

November 18: Craig Foltz escorted Mr. and Mrs. Victor Braun of Tucson and three guests on a tour of the Mt. Hopkins facilities. This tour was offered as a silent auction item by Tucson Child & Family Resources Center and the CODAC Health Agency as part of their annual "The Oscars Please" fundraiser.

Publications

MMTO Internal Technical Memoranda

None

MMTO Technical Memoranda

None

MMT Conversion Internal Technical Memoranda

None

MMT Conversion Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

00-21 A Spectroscopic Study of the Companion Galaxy and Extended Emission Around I Zw 18
Izotov, Y. I., Chaffee, F. H., Foltz, C. B., Thuan, T. X., Green, R. F., Papaderos, P., Fricke, K. J., Guseva, N. G.
Accepted by *ApJ*

00-22 The Evolutionary Status of the Low-Metallicity Blue Compact Dwarf Galaxy SBS 0940+544
Guseva, N. G., Izotov, Y. I., Papaderos, P., Chaffee, F. H., Foltz, C. B., Green, R. F., Thuan, T. X., Fricke, K. J., Noeske, K. G.
Submitted to *A&A*

00-23 AAS Annual Report
Foltz, C. B.
BAAS, **33**.

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@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

Due to an oversight by C. Foltz, we neglected to note the following press release in the September-October 2000 Bimonthly Summary:

September 25, 2000
UA/Smithsonian 6.5-m Telescope Takes Its First Wide-Field Picture
Lori Stiles

This press release describes early results by a team led by Don McCarthy using the PISCES near-infrared camera on the new telescope. The release included an impressive image of the grand design spiral galaxy NGC 7479, which shows interesting structures in the very heart of the galaxy. The story was featured on the CfA web site and in the *Tucson Citizen* and the *Green Valley News* as well as one of the Tucson television news shows. It also was given full-page coverage in the Fall 2000 edition of the *Arizona Alumnus*, in the "Learning Through Discovery" department.

CfA astronomer Robert Kirshner and the 6.5-m MMT were part of a PBS *NOVA* presentation November 21. The program, entitled *Runaway Universe*, explored quintessence – a mysterious repulsive force that some scientists believe counteracts gravity on very large scales. The video footage of the new telescope was very impressive, as was Dr. Kirshner.

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.