BIMONTHLY SUMMARY

September - October 2000

Jupiter at 4.8 microns as observed with MIRAC/BLINC on the 6.5-m telescope. Image courtesy of P. Hinz.

Personnel

D. Fisher (computer specialist), hired part-time by Steward's Center for Astronomical Adaptive Optics in July, now works for CAAO full time.

Ron James, a former Steward Mirror Lab employee, was hired in early October as a Staff Technician, Sr. Unfortunately Ron suffered an accident shortly thereafter in which he sustained compound fractures of both legs. We wish Ron a full and speedy recovery.

Temporary electronic technician Fernando Rivera was hired in October to assist D. Clark with various electronic construction projects.

Craig Foltz served on a review committee September 26 to make recommendations on the future use of the KPNO 0.9-m telescope. An oral report was given to S. Wolfe, NOAO Director. Foltz also attended the NOAO workshop October 27 in Scottsdale, AZ on the O/IR Ground-Based System.

Development

Instrument Commissioning

PISCES

Don McCarthy led a team that brought the PISCES near-infrared camera to the MMT on September 5. The instrument was successfully mounted on the telescope, and images were collected despite bad weather. Image quality better than 0.7 arcsec FWHM was achieved.

F-Spec

F-Spec was mounted on the telescope for the first time on September 8 for a brief commissioning run. The focal plane position was found not to be ideal; best focus was achieved near one end of the secondary hexapod's travel. Alternative mounting schemes will be investigated prior to F-Spec's next observing run in December.

Minicam

The Minicam was shipped to Arizona and mounted on the telescope on October 10. Brian McLeod, the Minicam PI, led a team of SAO scientists and engineers to work with MMT personnel over the next ten nights to begin the integration and commissioning of the instrument. This was a very successful and enjoyable run. Although not all of the problems were worked out, it is anticipated that most will be solved by year's end. Thanks go to all who contributed to this instrument and its commissioning run.

Flamingos

Due to problems with the array readout, the Flamingos near-infrared instrument did not arrive at the MMT during this reporting period.

Flatfield Panels

The large, multi-panel flatfield screens on the ceiling of the observing chamber were painted during the week of September 25. This work was carried out by outside painting contractors, necessitating the tenting of the telescope.

Aluminizing

Disassembly of the aluminizing control unit was performed. Redesign and repackaging of the control unit is in progress.

Building Drive

Several modifications to the building drive were added. These modifications include a reduced gain limit for ten seconds after start-up and a three-phase protection module.

The H-file documentation is underway and is about 75% complete.

Mirror Support

The hardware for repackaging the primary mirror support backplane is now in hand. John McAfee built a connector shroud retention block for use on the backplane so that good mechanical rigidity can be maintained on the backpanel/backplane transition connectors. A. Milone finished applying connector pins to the DAC wiring backplane. This work will be completed when 19" racks arrive on site and have AC power delivered to them. We can proceed with more of this work as a background task but will soon need a decision on how to wire the DACs to the actuators.

The f/5 mirror support electronics design was completed. Once the prototype has been built and verified, we will reduce it to a printed-circuit for final installation in the mirror cell.

A lightning strike may have caused a number of hardware failures that occurred in October. These were not noticed until a week later since the primary mirror cell was never powered in the interim. The first failure to be diagnosed was a bad chip in the translation board in the cell computer. This prevented the system from applying air pressure to the primary actuators. This same chip also drives the integrator on/off lines to all actuators. An actuator board had an analog switch chip fail from a short between the input and the negative power rail. This put undesirable voltages on the other actuators via the integrator on/off line, and may possibly have caused the first failure.

A seemingly unrelated failure occurred in a hardpoint loadcell amplifier, which caused the hardpoint to go into the lower limit. The spare boards, which had been received, were quickly assembled and the unit was replaced. The new boards were assembled with IC sockets. This creates a new problem in that the assemblies will no longer fit in the housings. J. McAfee and K. Van Horn have sketched a replacement cover that should solve this problem.

Thermal System

Design work on the thermal readout system continues. Several methods of connection to control electronics and to the Hewlett Packard data acquisition unit (DAU) are being considered and evaluated.

One method consists of the direct differential readout – reading the thermocouple differential microvolt signals directly into a remote computer/DAU (50+ feet away) and then using the computer/DAU for conversion and control. This is a simple implementation but possibly noisy and inaccurate, and also bulky (massive wiring).

A variant is to mount the computer/DAU at the mirror cell to transmit data digitally via RS232 (or similar) to remotely located control electronics/computers. This method simplifies the wiring but may create an unacceptable source of heat. The HP DAU's power consumption is rated at 12 watts. Once the system is better characterized, the DAU can be replaced with a single board computer (SBC) such as the Tern system used for LVDT/load cell measurement on the secondary. The present Tern SBC configuration at the secondary consumes 2.5 watts and features a power save mode and remote power on/off capability. In the power off mode the SBC consumes very low micro amp power. Other Tern SBC features are 6 channels of 24 bit analog to digital conversion (ADC) and 22 channels of 12 bit (ADC).

Perhaps the best, and possibly simplest, implementation of a cell thermal readout system is a network of 4 SBC's – one at each cell thermal quadrant reading/collecting and converting the raw (microvolt) thermal data, then transmitting the converted digital data via ethernet/RS232 to an off cell computer for processing and control. The advantage to this configuration is greatly reduced system wire, and wiring and reconfiguration ease and versatility. That is, no hard wiring changes would be required to reconfigure the thermopile since reconfiguration would be implemented in software.

An ongoing background task is to install remote viewing software for the thermal readout system (remote viewing and control software for the HP DAU). Freeware software that runs on NT was tried and proved unsuccessful. P. Spencer is investigating other possibilities.

Hexapod

Refinement of hexapod documentation continues. A CD containing the latest revisions was burned and is available for use at the MMT.

Servos

Work continued on characterization of the mount control servos. Disturbance injection/response measurement circuits were built and used on the azimuth, elevation, and rotator axes to measure the disturbance response of the servo loops when closed. This data will be used to verify models of the drive systems as we develop methods to improve the mount servo performance.

The new azimuth amplifiers continue to perform flawlessly. One more will be built for use as a spare. Three of the old CSRs will be kept for possible use in the future.

Computers and Software

The big news is the development of software to control the instrument rotator. This is treated as a third axis of the telescope (altitude and azimuth being the other two), and has a servo loop, identical to that of the other two axes, to control the rotator's motion. The rotator servo is tight and very well behaved.

VxWorks driver software was developed to interface with the Heidenhain IK320 encoder interface for the VME bus. This will be used to read the absolute encoder tape that is wrapped around the rotator as soon as some hardware issues in reading the tapes are sorted out.

Work continues on the operator interface software. The operators work with this software on a night by night basis. In addition to fixing known problems, a number of changes and additions have been made based on their suggestions.

Work continues on the telescope-instrument interface software, driven in large part by the advent of a usable rotator (which necessitates a more rational means to offset the telescope in RA and DEC). While the team from CfA was here, we sorted out a number of issues with regard to Minicam's needs in this area. Thanks go to John Roll and Maureen Conroy (SAO).

Optics

Primary Mirror Active Figure and Collimation Corrections

High Resolution Interferometric Hartmann

Using the interferometric Hartmann wavefront sensor as feedback, the first active corrections of the primary mirror support system and collimation were performed. The figure below shows the instrument attached to the f/9 top box.

Proper operation of the instrument was verified by analyzing the results of bending single modes into the primary mirror. These first tests examined 17 modes which included: tilt, defocus, astigmatism, coma, 3rd-order spherical, trefoil (3-theta), 5th-order astigmatism, 5th-order coma, 5th-order trefoil, and quatrefoil (4-theta). The results provided scaling factors required for the proper conversion of the observed wavefront aberrations into the corresponding axial force corrections. The influence of the M2 motion upon the wavefront errors was also examined.

Using these results, the figure below shows the effectiveness of a single iteration of correction based upon the observed wavefront sensor errors.

Here we have plotted the wavefront aberration coefficients (less tilt and piston) listed above before (open) and after (solid) the correction. Coma and defocus were corrected with M2 while the other aberrations were corrected by bending the primary mirror. A second iteration is required to further reduce the errors since high-order bending produces spurious bending of low order modes. This data is time-averaged to eliminate atmospheric effects from the optical aberrations.

The diffraction images corresponding to these errors are shown below. The starting psf (left) is plotted in a 0.75 x 0.75 arcsec box. The psf after the correction iteration (right) is plotted in a 0.1 x 0.1 arcsec box.

Please note that neither primary nor secondary mirror thermal control is yet implemented, so the uncorrected wavefront errors are much larger than we'd normally expect.

The results of this particular optimization on the sky are shown in the figures on the following page. Two binaries are shown along with IRAF radial energy Gaussian fits and 3D surface maps.

Finally, several higher order modes were added to the analysis, but inclement weather precluded any useful observations.

Sigma 2422 at MMT rededication (May 2000). Approximately 0.75 arcsec separation, white unfiltered light. No figure optimization.

COU 453 (separation ~<0.6 arcsec) with 7 low order Zernike modes removed. There is a slight horizontal elongation due to an elevation-oscillation. IRAF Gaussian fit to the image profiles shows ~0.35 arcsec FWHM.

Low Resolution Shack Hartmann

The interferometric instrument was designed as a stand-alone modular unit for all of the telescope's unique foci (including prime). In addition to testing mirror bending, collimation algorithms, and identifying thermal control problems, it is used to build look-up tables of those quantities that repeat.

Nightly routine collimation and mirror figure control will be provided by dedicated low-resolution Shack Hartmann wavefront sensors. One will be built for the f/9 top box and the other for the f/5 platform. Currently we are finishing optical modeling that allows us to optimize the design of the collimator/lenslet combination for these purposes. Construction of these units should begin shortly.

General Facility

F. Rivera built a set of spare cards for the primary mirror support electronics, completed wiring of the new mount interface chassis, and built several cables for use in the top box and spectrograph controls, which will be recommissioned in November. He also cleaned and partially reorganized the MMTO electronic shop. In the course of the shop cleanup, many ICs used in support of the MMT systems (1970s vintage) were removed from stock and placed in storage. Newer parts were placed in the bins for future use on the converted telescope.

New telephones have been procured and some were installed on the mountain. Compatibility with the old system remains a problem in that the old system needs to be removed and the new system allows only 12 extensions where we previously had 17.

P. Spencer installed Orcad one seat server software on computer ASPC105 in the electronic shop. Client software has been installed on two computers (mmpc5 and mmpc2).

T. Trebisky and P. Spencer removed the hexapod VME computer from its portable enclosure and placed it into a rackmount case.

D. Smith relocated the CCD VxWorks computer from the third floor to a mobile rack on the second floor.

Maintenance and Repair

The rear shutter wiring removed during building modifications has been replaced and cleaned up. Documentation was generated to avoid the difficulties of having to repeat the process. A problem remains with computer control of the operation: the chain bounces during the early stages and hits the open limit switch. As soon as this occurs, the software thinks the door is open and shuts down the open operation. Mechanical steps have been taken to stop the chain bounce, with limited success. It is possible that a time delay in the software might bypass this early trip of the limit switch.

All the old top box and Gaits cables have been sorted and redressed, and additional lengths added to reach the new control room. A broken wire in one cable, a bad switch in one paddle, and a mechanical problem with the camera shutter have been resolved, and the top box is now functional.

The anemometer was repaired and reinstalled.

Visitors

October 1: Dr. Bruce Peterson (Mt. Stromlo and Siding Spring Observatory) and Drs. Kimiaki Kawara and Masuo Tanaka (Institute for Astronomy, University of Tokyo), all of whom are involved in the planning of two 6.5-m class telescopes for sites in Chile, accompanied by Peter Wehinger of the Steward Director's Office.

October 5: LBT donors Mr. David Patterson, Mr. and Mrs. Roy Feher, and Miss Mary Lou Rentfrow, accompanied by P. Wehinger.

October 25: LBT donors Dr. and Mrs. Ben Bova, accompanied by P. Wehinger. Ben Bova is a member of the Arizona Astronomy Board and is a well-known science fiction author. He recently donated a half dozen of his books to the Common Building library on Mt. Hopkins.

Publications

MMTO Internal Technical Memoranda

00-1 VATT Optical Performance During 98 Oct as Measured with an Interferometric Hartmann Wavefront Sensor
S. C. West, D. Fisher, M. Nelson

MMTO Technical Memoranda

None

MMT Conversion Internal Technical Memoranda

None

MMT Conversion Technical Memoranda

None

MMTO Technical Reports

None

Scientific Publications

00-16 A Merger Scenario for the Dynamics of Abell 665
Gómez, P. L., Hughes, J. P., Birkinshaw, M.
ApJ, **540**, 726

00-17 The Initial Mass Function of Low-Mass Stars and Brown Dwarfs in Young Clusters
Luhman, K. L., Rieke, G. H., Young, E. T., Cotera, A. S., Chen, H., Rieke, M. J., Schneider, G., Thompson, R. I.
ApJ, **540**, 1016

00-18 The Properties of the X-Ray-Selected EMSS Sample of BL Lacertae Objects
Rector, R. A., Stocke, J. T., Perlman, E. S., Morris, S. L., Gioia, I.
AJ, **120**, 1626

00-19 High-Resolution Keck Spectra of the Associated Absorption Lines in 3C 191
Hamann, F. W., Barlow, T. A., Chaffee, F. C., Foltz, C. B., Weymann, R. J.
Accepted by *ApJ*

00-20 PISCES: A Wide Field, 1-2.5 μm Camera for Large Aperture Telescopes
McCarthy, Jr., D. W., Ge, J., Hinz, J. L., Finn, R. A., de Jong, R. S.
To appear in *PASP*

Observing Reports

M. Meyer: October 5-7, MIRAC/BLINC

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@as.arizona.edu* or to the following address:

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University of Arizona
Tucson, AZ 85721-0065

MMTO in the Media

Michael Lachmann (BBC) and a crew of three interviewed Bob Kirshner on October 30-31 at the MMT and Ridge telescopes. (Lachmann visited the mountain several weeks ago to scout the site. The program is entitled *Final Frontier*.) D. Brocious escorted the crew to the MMT where they obtained control room and exterior shots and interviewed Bob Kirshner. The next day the BBC crew visited the 1.2 and 1.5-m telescopes late in the afternoon for exterior and interior shots and to interview B. Kirshner at this site as well.

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.