LBT PROJECT 2×8.4 m TELESCOPE
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LBT PROJECT

2 X 8.4 m OPTICAL TELESCOPE

MODS
LBT MultiObject Double Spectrograph
Progress Review Report
Review Date: April 22-23, 2004

1. Revision History

Issue	Date	Changes	Responsible
a	May 6, 2004	First issue	R. M. Wagner, J. Brynnel, J. Kraus

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3. About this document

3.1. Purpose

This document describes the results of the MODS Progress Review held in Columbus Ohio on April 22-23, 2004. Attending from the Project were R. M. Wagner, J. Brynnel, and J. Kraus. This is a project-mandated review of the current status and schedule of the MODS instrument.

3.2. Summary

The Project and the MODS team conducted a two-day progress review of the Multi-Object Double Spectrograph in Columbus on April 22-23. Presentations by the MODS team included an overview of the instrument (D. DePoy), optics (P. Byard), mechanical (T. O'Brien and M. Derwent), software (R. Pogge), image motion compensation system (J. Marshall), and detectors (DePoy). In a guest presentation, C. Lewis of Navigator Management Partners LLC, discussed the MODS project management initiative and its objectives. In addition to the formal presentations, the MODS team lead a tour of the lab facilities showing finished parts of the MODS1 instrument and a demonstration of the image motion compensation system. The MODS team was commended for their presentations and the documentation delivered to the committee.

The committee felt progress on MODS1 was acceptable although late with respect to the original schedule; however, this was due in part to the effort devoted to aluminizing by many of the same people. It is anticipated that MODS1 will be delivered to the LBT in early 2006, but it will consist of a complete blue-red double spectrograph. A detailed schedule of future activities and milestones needs to be completed which includes the resources currently allocated to the aluminizing effort. It will be finalized in the next few months based on the management initiative and will then be passed on to the LBTO. It was jointly agreed that the MODS contract will be sent to the Board sometime after the disposition of the TSIP proposal to NSF for MODS2 funding is received.

There are two principal areas of concern. First, the ideal detector for MODS is currently not available. Ideally this would be an 8K x 3K CCD with 15 micron pixels since MODS can illuminate such a detector without vignetting. The baseline plan in the absence of the ideal detector is a 4K x 4K CCD in each channel processed by SOITL and controlled by the standard OSU array controller. The greatest risk is the delivery date of suitable devices. A fallback plan might be to purchase commercial devices from E2V similar to the detectors used in the LBC.

Second, the review committee was concerned about the limited manpower available to complete the MODS software on the timescale that is required. OSU has forseen this problem and is seeking a new full-time programmer. A software design document is in preparation.

4. MODS Overview

Darren DePoy reviewed the MODS design plan which builds on the successful implementations of previous OSU instruments deployed at CTIO, MDM, and other observatories. The group has developed its own set of internal standards and interfaces which are quite evolved, reliable, and certainly well-tested in the field. Thus there is a considerable amount of legacy hardware and software on which MODS can be constructed with little risk. The group intends to deliver a complete blue-red MODS1 to the LBT in early 2006 but a detailed project schedule is not currently available to confirm this delivery date.

5. Project Management

Carrie Lewis of Navigator Management Partners LLC summarized the MODS project management initiative. This firm has been hired by the group to help with the management of the MODS and aluminizing projects. Over the next few months the firm will help the team with time, resource, cost, and risk management/planning. The group is committed to improving their project management and planning given the limited resources available and size of the current projects in the Imaging Sciences Lab, particularly MODS and aluminizing. The group also has a considerable number of commitments to support installed instruments at other observatories such as CTIO and MDM which require some degree of time management on their part.

6. Optics

Paul Byard summarized the status of MODS optical design work, procurement, and fabrication. MODS is a double-beam blue-red optimized optical spectrograph consisting of two spectrographs at a single telescope focus. A dichroic beam splitter and fold mirror directs the light after emerging from the entrance slit into the blue and red channels. The large optics for both MODS1 and MODS2 were purchased together from Hextek (collimators and camera mirrors), Corning (blue corrector), and Ohara (red corrector). The aspheric camera correctors were fabricated two at a time from a single substrate element. Sagam-Resoc has delivered 4 of 4 collimators. SOML has completed 1 of 4 camera mirrors, in final figuring of the blue corrector, and has generated and fine ground a red corrector. The current figure of the blue corrector needs to be improved by a factor of about 3. The team receives test reports from the vendors which are incorporated into the Code-V design to predict the actual imaging performance of the MODS optical system. The delivered camera mirror structure function meets or exceeds the specifications on all spatial scales of interest. The team seems happy with the optics they received from SOML.

Additional smaller optics (field lenses and field-flatteners) have also been received from SOML. The red and blue channel R = 2000 gratings have been purchased from RGL.

Also the imaging flats for both channels for both spectrographs have also been purchased from JML. Other optics currently out for bids include the folding flat mirrors and dichroics and the pupil imaging lens for the calibration system (see below). Bids have been received for the reflective and AR coatings on the red and blue collimator and camera optics.

The MODS calibration system has also been designed. It consists of a 12-inch integrating sphere and a 4-inch exit port with three 10W quartz-halogen lamps and 5 PenRay spectral line lamps (Hg, Ne, Ar, Kr, and Xe) mounted inside. These mimic the spectral line lamps in use at MDM but are not suitable for high resolution spectroscopic applications. A lens in front of the focal plane images the exit port onto the grating or imaging flat. Images of the aperture stop on the MODS focal plane look very uniform.

The MODS guider and wavefront sensing system has been designed and some parts acquired. In particular, SOITL has delivered to the OSU one guide camera identical to those to be used in the standard LUCIFER AGW units. OSU has some concerns regarding the implementation of the AGW WFS system in both the AGW and in MODS. Their concerns are attached to this report.

7. Mechanical

Tom O'Brien and Mark Derwent summarized the status of the various mechanical systems. The major mechanical systems consist of the focal plane mechanisms such as the slit mask cassette, dark slide, calibration unit, guiding/WFS system, and dichroic select; dual collimator system with image motion compensation system; grating turret select and positioning; camera assemblies; filter wheels; the MODS mechanical structure; and the instrument handling apparatus. All optical support designs and a deflection analysis of the collimator, grating, and camera primary are complete. Also the effects of instrument flexure and misalignment on image quality have been evaluated.

The mechanical systems are at various stages of design and fabrication. Functional testing of some units has been completed. Additional work needs to be devoted to the detailed design of the multi-slit cassette and the dichroic changer. The red and blue collimator mounting has been completed but the two halves need to be joined in addition to other work. The blue grating turret is assembled in the shop and has undergone functional testing. Work remains on the grating tilt mechanism and the fabrication of the red grating turret. A blue camera truss is complete and has been tested for stiffness and alignment repeatability. The assembly includes a complete filter wheel, shutter, and focus adjustment. Some parts of the red camera corrector are complete as well. Full integration and testing of the blue camera including all the mechanisms needs to be completed. Fabrication, integration, and testing of the red camera remains to be completed as well.

Two identical upper frames have been ordered and fabricated by Indian Creek Fabricators in Tipp City, Ohio. The first upper frame was inspected and found to be within 1 mm of the specification and it is considered finished. The segments and sub-frames for the 2nd frame have been finished. Recent discussions involving the Gregorian instrument mounting flange have been resolved to the MODS team satisfaction. The collimator support components have been fabricated and the tube reducers need to be welded into place. Two MODS instrument carts are on order from Indian Creek. Cart 1 is in progress and the material for cart 2 has been purchased. The cart will also be used for instrument flexure testing. Other MODS handling equipment is being fabricated including the grating select cart, camera cart, and camera crane. The skirt or MODS enclosure needs to be designed and verified that it fits on the telescope in the required envelope at the straight-through Gregorian focus.

8. Software

Rick Pogge summarized the current status of the MODS software effort. There are clearly defined requirements involving MODS control functions, observatory interfaces, and user interfaces; coding standards (open and public domain packages);
and documentation plans (Doxyen for software, HTML and PDF for user manuals). They are working on instrument control, detector control, and data handling systems along with observatory and user interfaces. The software envisioned for MODS builds on their 15 year instrumentation heritage which is open and modular and evolves for each new instrument. Many of the MODS modules are already in deployed instruments. Every effort is being made to keep the software development in parallel with the hardware efforts. The server and client API libraries are written and deployed. Some aspects of the instrument control system are resident in deployed instruments while other aspects require further development for MODS. MODS has 32 mechanisms but only 3 basic drive topologies which simplifies the drive interfaces. The detector control system depends on the nature of the final detector and its controller but options and code already exist for the OSU CCD controller. Other developments underway include the interfaces to the observatory, user interfaces, data handling, and observer support and preparation tools.

Currently the SW staff consists of Rick Pogge, a faculty member who is in charge of the overall SW management and design, and Jerry Mason, who is and has been involved in the computer and data handling HW and general SW tasks but is a non-LINUX person. The committee feels he may be successful in developing Windows applications with commercial HW libraries if desired. The group is seeking a new full-time programmer who will take on the main coding tasks.

9. IMCS

Jennifer Marshall summarized the status of the Image Motion Compensation System (IMCS) for MODS. This system will compensate for gravity, temperature and mechanical ticking which together could be as large as 100 microns (~seven 15 micron pixels) in the MODS focal plane. The IMCS is a closed-loop compensator which does not need any external input to function and accounts for all sources of XY image motion in the focal plane. It uses an infrared laser beam following the same path as the science light and in the shadow of the secondary mirror to measure deflections on an infrared array detector in the same plane as the science array. Corresponding adjustments are made to the collimator mirror steering motors. The infrared source was chosen to not interfere with the optical science light. The system performance goal is to achieve better than ~1.5 micron stability in the focal plane on time scales of less than hour.

Lab tests of a 1-dimensional version of the IMCS have been completed for some time. Future tests will include 2-dimensional motion using a rotating glass slide placed into the beam. A completion date for these tests has not been defined. The current lab bench-based system controls motion to ±0.3 micron and demonstrates the feasibility of the system.

10. Detectors

Darren DePoy summarized the status of the science detector arrays for MODS. The instrument can illuminate an 8K × 2.88K device utilizing 15 micron pixels with no vignetting. This is the preferred detector for MODS but it is currently not available. The baseline plan is to equip each MODS channel with a 4K × 4K blue-red optimized CCD with 15 micron pixels and a RON ~ 2-3 e^- provided by Mike Lesser and the SOITL as an Arizona contribution to MODS. With this detector and the R=2000 grating the entire spectrum can be covered in a single grating tilt. The system would utilize the standard OSU array controllers for which legacy HW and SW are available and which have been shown to be reliable in the field. The principal risk according to the team is the delivery date of the detectors from SOITL.

Other possible detectors include 4.6K × 2K and 6K × 2K devices from E2V which utilize 13.5 micron pixels. The former devices are currently implemented in the LBC and would provide the same spectral coverage as the 4K 15 micron pixel devices. The latter devices give ~30% more spectral coverage for a 50% increase in cost per detector; however, the Project has not seen any availability of this device from E2V at the present time. Additional funds and technical information need to be identified to pursue the feasibility and fabrication of an 8K device. Buttable 4K square devices can meet the requirements but the mosaic suffers from a gap in the middle of the spectrum. A decision in the near future is urgent in the view of the Project.

11. Schedule

The schedule is currently being reviewed and updated as part of the new management initiative. The group plans to deploy a two-channel MODS1 instrument in early 2006. Currently the group is developing a detailed integration and test plan and continues some design and component level testing. They are awaiting the delivery of the blue corrector and hope to implement a prototype 4K square device at MDM by the end of the year. It is hoped that integration and testing of a portion of MODS1 can begin early in 2005.

It was subsequently learned after the progress review that the MODS proposal sent to the TSIP program in the amount of $2.6M was approved. These monies provide full funding for both MODS spectrographs as well as the R=8000 gratings. Congratulations to the MODS team.

12. Additional Progress Reviews

It was decided that another MODS Progress Review would be held in November 2004. This will be a 1-day review in Columbus to examine the progress since April and the revised schedule as well as the lab test protocol and commissioning plans.

13. Development status (April 2004)

	Design	**Manufacturing Or Coding**	**Integration and Test**
Optics	90%	80%	0%
Mechanics	70%	55%	5%
Electronics	90%	10%	0%
Software	75%	25%	25%
Documentation			15%

Concerns expressed by the MODS group regarding the Project's choice of active optics wavefront sensing lenslet array and camera:

Date: Thu, 06 May 2004 09:11:12 -0400
Subject: Wavefront sensor concerns
From: Darren DePoy <depoy@astronomy.ohio-state.edu>
To: <jbrynnel@as.arizona.edu>,
<rmw@as.arizona.edu>
CC: "Thomas P. O'Brien" <obrien@mps.ohio-state.edu>,
"Paul L. Byard" <byard@astronomy.ohio-state.edu>,
"Patrick S. Osmer" <posmer@astronomy.ohio-state.edu>
Message-ID: <BCBFB1B0.BFD%depoy@astronomy.ohio-state.edu>

Joar and Mark --

We mentioned at the last MODS progress review that we had some concerns about the design and implementation of the AGW off-axis ("slow") wavefront sensor. I list these concerns below just for the record. While I do not expect that the design of the wavefront sensor will change due to our concerns, I do believe these issues should be closely monitored. In particular, the spares situation should be worked out carefully with Potsdam (or whomever is responsible for sensor spares).

Cheers,
Darren

The bonding of the microlens array directly to the CCD makes the wavefront camera a special unit that requires its own spares. This special camera cannot be a spare for the guide cameras; conversely the guide cameras cannot operate as spares for the wavefront unit. As we expect (hope?) that these units will be an integral part of the telescope for many years, sufficient spares should be acquired early to ensure appropriate lifetime.

The proprietary process of bonding a microlens array to the CCD has some risk to the detector. This is a cost and availability issue. If the process proves to be destructive to the CCD, then the expense of the wavefront cameras could rise substantially. Future availability of the wavefront cameras is also unknown (if the group that makes the microlens array disappears, where would future cameras come from?).

The availability of these lenses is not known. Although we understand that one has been made (although perhaps not extensively tested), we will need many more (4-5 plus spares?). Is there any evaluation of the availability of these particular microlenses?

Long term reliability of these devices is not known. De-bonding of the microlens array could be a very expensive event. With adequate spares, this concern can be ameliorated. However, once spares are used how are replacements obtained?

The fixed size and format of the microlens array limits its flexibility as a wavefront sensor. A separate replaceable microlens array would allow changes to be made to the wavefront sensor in the future. Experience at Magellan and other telescopes suggests that optimal choices for wavefront sampling are not well known prior to deployment. Constraining ourselves to a particular geometry seems risky and changing that choice given the current design nearly impossible.