DEIMOS
SSC Presentation: July 12, 2001
Twenty-Eighth Quarter

Camera/optics:

- The science filters were designed (broadband and order-blocking), and the glass blanks for them have arrived. We will send the outer surfaces out for AR coating, then Dave Hilyard will cement them. Dave has been carrying out experiments with different types of cements. We are discussing AR coatings with Andover and ZC+R.
- We received a quote from Barr Associates to AR-coat the clear spectroscopic window for $5,000. This was considerably less than the original quote by Coherent for $20,000, but the reflectivity losses will be 1% higher.
- Altogether DEIMOS has six aluminum reflections, including the telescope. Aluminum has a reflective minimum of 0.86 at 8000 Å, which means a throughput of only 0.40 for six surfaces at that wavelength. We need to reduce the total number of Al surfaces inside DEIMOS, and to that end we are exploring the possibility of using overcoated Ag on the tent mirror. We are also going to purchase two gold-coated gratings (1200-line and 830-line) from separate funds at no expense to DEIMOS. We take this occasion to remind CARA that we are also relying on their original pledge to silver the Keck 2 mirrors (and our collimator as well). The fundamental design concept for DEIMOS relied on this assumption.

Blue detector/controller:

- The blue mosaic has been operating consistently with few problems. The controller has been working well, but 2 (out of 8) video boards do not achieve their required voltage norms on power-up. The problem resolves spontaneously after 5 minutes. This will be looked at when the red CCD mosaic is installed.
- In April we reported a supposed problem with the Motorola VME Power PC board that prevented 16-amp operation. The problem was in fact traced to a subtle timing error in the SDSU-2 (Leach) VME board; the SDSU-2's VMEbus timing fails VME spec by 1-2 nanosec. A software workaround has cured it, and we are now reading out in 16-amp mode in 39 sec reliably.

Red detector:

- Through the good offices of Jim Beletic, a deal appears to have been struck with ESO that would give us an additional high-quality CCD in the final draft pick from Lot 14. That would bring our total number of science-grade devices to 8, plus 2 spares. Gerry Luppino is drafting a letter to the consortium members (Keck, Subaru, ESO) to finalize this.
- Several changes are being made to the red mosaic backplane to improve installation and alignment of the red CCDs. Metrology was carried out on six available Lot 14 CCDs, and it was found that they are much less well centered and aligned on the AlN packages than the blue CCDs, with variable overhangs and rotations of up to 300 microns. A new alignment procedure is being designed to cope with these variations and will use a TV and microscope system to observe the CCDs during placement.
- Metrology on the red CCDs and moly blocks preceding assembly will begin July 23.

Dewar/LN2 system:

- We lose temperature control of the CCD mosaic by a few degrees at one particular PA when the outside temperature is warm and the LN2 level is low. This is thought to be due to loss of contact between the LN2 and the cold finger inside the LN2 can. A new LN2 can is being fabricated with 10% larger capacity, higher buffing to reduce radiative losses, and a larger cold finger to improve performance and increase hold time.

Structure/system installations:

- Alterations were made to the nose structure to eliminate a clearance problem with the Keck 2 elevation bearing.
- The glycol cooling system was installed and tested, including an interface panel to the CARA glycol supply.
- The pressurized air system is now complete, including an interface panel to CARA air.
- A second air cylinder was added to strengthen the front hatch closure mechanism.
- Cladding is being added to the main barrel as time permits.

Flexure/image motion/grating system:

- As of our report last April, we had worked through and corrected image motion due to flexure in the grating box, and forces transmitted from the drive system to a mounted slider. Since then, we have concentrated on finding and fixing flexure inside the grating sliders, tilt drives, and cells.
- Dial-gauge and optical flexure tests were made on sliders 3 and 4 in the spectrograph and on a rotating test stand. Many pixels-worth of flexure were seen. An FEA model was created that matched these observations. It suggested that strengthening one plate in the slider and moving a mounting clamp from one corner to the middle of one edge would reduce total image motion by a factor of four.
- The grating tilt servo-control was also activated to improve stiffness in the Y direction. It has a novel design that maintains the tilt encoder near the boundary of two encoder counts, effectively increasing the resolution of the encoder. The scheme seems to work well.
- Both of these modifications were tested in the spectrograph, with the new clamping scheme being mocked up with a temporary clamp. Total image motion was reduced to 12 pixels in both X and Y peak-to-peak (from previous values of 23 px in X and 40 pixels in Y). These are roughly half the correctable ranges of 25 px in X and 21 px in Y (see below). This fact, plus motions of only 6-8 px peak-to-peak in direct imaging mode, suggest that flexure has now been reduced to adequate levels. However, they are *not* significantly less than *half* the correctable range, which means that clever software may be needed to calculate the corrrect homing position for the FC system at the beginning of an exposure.
- Parts have been designed for the new slider clamping scheme and are being fabricated.
- Part of the image motion is known to be due to motion of an optical element within the camera (13 px peak-to-peak). It may no longer be necessary to fix this, as it appears to be cancelled by flexure in another part of the system, most likely the detector stage.
- We inserted sliders 2, 3, and 4 at all position angles and decided to place precision reference marks (PRMs) on the grating slide drive to compensate for the effect of flexure during the mounting process. At various PAs, weakness in the slider connection to the drive screw causes the bottom of the slider to sag and the capture pin to miss the pin hole. Adding PRMs will compensate for this, but new software will be required. The PRMs are being installed.
- The plan is to test sliders 2, 3, and 4 before the Preship Review (PSR) and then do a fit check of slider 5 (the smaller replacement version of slider 1) as the spectrograph is being disassembled. Slider 5 will be installed and commissioned in Hawaii.
- A small mirror was mounted rigidly to the camera mouth to produce new ghost images in addition to the known ghosts reflecting off the grating. The new ghosts tell specifically about image motions caused by the camera elements and detector stage. A second small mirror on the grating box is planned that will measure its flexure separately. A final flexure analysis will be carried out on each modified slider as it is added to the system, showing how each optical element moves with PA.

Slitmask system:

- New plungers with increased retractive force were installed in the slitmask system, and the system was carefully aligned and subjected to thorough testing. The system performed well except for two problems:
  - Masks occasionally became disengaged from the "hot dog" insertion tool in certain PAs.
  - One out of six brand-new masks hung up on a retraction plunger and would not retract. No failures were seen with used masks.
- The width of the hot dog has been increased in the Z direction so that masks cannot fall around it. This necessitated giving up one cassette slot, so we are now reduced to 12. The original specification was 10 slots.
- It was realized that a tolerance on mask width of no greater than ± 0.01 in. is critical to proper insertion. Some of the previous problems were due to having masks too wide.
- The slitmask barcode reader was installed and is working.
- Keyword control of the slitmask system was achieved, and K-testing has begun.
- We are contemplating deleting the special longslit masks on the grounds that normal slitmasks may perform adequately and would save considerable work. Without the longslits, the unvignetted FOV on the mask itself in the TV guider will be limited to a narrow strip about 30-arcsec wide centered at the nominal 4.5 arcmin distance off axis. Comments on this proposal are welcome.

Rotation system:

- Small mechanical modifications were completed, and keyword control has been achieved.
- Twelve reflective fiducials at roughly 30-degree intervals were attached to the drive disk. Preliminary tests indicate that repeatability of the Renashaw encoder counts at these fiducials is good, indicating satisfactory mechanical stability of the system.
- An absolute calibration of angle versus encoder counts will be provided at a few angles using precision levels in Santa Cruz, and the final calibration will be derived from sky measurements in Hawaii.
- Integration with CARA DCS began with a visit from Al Honey in April and is continuing this week as Bob Kibrick visits CARA.

Carriage mover/trolley:

- The final design concept was cleared with CARA, and fabrication is starting next week.
- We are beginning to lay out tracks for testing the carriage mover/trolley system in the high-bay. CARA has asked us to have a full working system as a requirement for the Preship Review. Part of the reason for the mock up is to verify that the Nasmyth tracks will be adequately stiff.
- Vern Wallace carried out a stress analysis of the system and found that several aspects pushed the yield limits of materials. Improvements were made, but the local stresses on the track itself are still near the material yield strength.

Electronics: In addition to participating in most of the above projects, the Electronics Shop completed the following tasks:

- Wiring, fiducials, and interlocks were installed for several stages and for general AC power.
- Alarms and panic buttons for motion and movement were installed.
- A final decision was made on the implementation of push-button controls for the TV and science filter stages, the grating drive system, and the slitmask cassette. They will be installed for the Readiness Review.
- Fabrication continued on the replacement CCD cables.

Flexure compensation system:

- The FC fiber feeds were aligned so that their f/15 beams are centered on the grating/mirror.
- The FC X and Y stages were commissioned, and their total travels were measured to be 25 pixels in X (in dewar) and 21 pixels in Y (tent mirror piezo). The resulting motion of FCS spots was captured via FCS CCD images.
- The FCS system is emerging as an important tool in testing DEIMOS. Plans have been outlined for scripts that will run overnight and collect approximately 1000 FCS images in all position angles. A summer student has been hired who is working full time to reduce the image centroid data from these scripts.

Calibration system:

- Mounts for the wavelength-calibration lamps were altered to make lamp replacement easier.
- CARA measured the UV flux from LRIS lamps (same types that are used in DEIMOS) and found that the UV flux levels were not dangerous.

TV guider:

- The TV camera was installed, but communications could not be established. After many delays, the camera head was removed, and an incompatibility was discovered in the SCSI bus communications speed (many thanks to Myrna Subota at Keck, who sent a crucial email). The A2S unit from Photometrics also malfunctioned and was sent to back Photometrics in trade for a used unit. In the meantime we are using a spare unit from CARA. Reinstallation and testing are resuming.
- The TV system is no longer supported by Photometrics, which is a concern.
- The TV filters were ordered and have arrived.

Integration/alignment/optical testing:

- Little change since last report, as the sliders have been out for testing and modifications.
- The high-bay windows were blacked out, enabling optical tests to be carried out during the day. This will speed up future testing enormously.

Software/general testing:

- Testing overview—the following systems are now under keyword control and have been undergoing K-testing: science filter wheel, TV filter wheel, dewar focus, TV focus, dewar X-stage, tent mirror piezo Y-stage, rotation system, calibration lamps, HP temperature logger. The slitmask system is just entering K-testing. Low-level Galil software has been tested for grating select and clamp/unclamp but no keyword software yet exists. Software to read the slitmask barcode reader is being tested in the spectrograph using scripts. No software exists for the front hatch. Software is not needed for the carriage/trolley system.
- All systems in K-testing have been added to the engineering GUI. Little work other than basic design has been done on the observer GUI.
- Other aspects of software are mentioned under the various subsystems.

Website/documentation:

- The DEIMOS website has become a useful working tool. Dozens of images record the progress of the instrument and its various systems on a weekly basis. Team meeting notes are displayed there, along with test results and other shared data. The commissioning schedule will be posted there jointly with CARA when the time approaches.

Shipping/commissioning/CARA interface:

- The issue concerning the weight of DEIMOS has been resolved. We purchased accurate scales and found a weight of 18,760 lb. The completed instrument is expected to weigh about 19,000 lb. The agreed weight limit with CARA is no more than 20,000 lb.

- A draft agreement with CARA has been prepared that describes the desired state of the instrument and its various subsystems at the time of the Readiness Review and the Preship Review. That draft is attached to this report. With the exception of a couple of systems, it is agreed that all known mechanical work should be finished by the RR, and that software for all major systems should have reached the keyword stage by that time. This leaves the time between the RR and PSR for completion of minor software items and for integrated testing.
- An interface document has been worked out with CARA on regular maintenance procedures and the necessary access required.
- Shipping plans have been finalized with Matson, and contracts have been let with the crane companies, trucking companies, and Matson Lines. A Matson shipping container and the "rack" that will hold the main structure have been delivered; the design of our shipping container to hold and protect the main structure is progressing.
- Negotiations for insurance have been delayed pending appointment of the new UC insurance broker on July 1.
- CARA completed modifications to the elevation cable wrap of Keck 2. This was a major milestone for us.
- Modifications to the Nasmyth platform and deck are being designed and have been scheduled for September.

Concerns:

- Our main concern is that the mechanical fixes to the slitmask system and grating system that are now in progress will work as advertised without further modifications. The schedule assumes this. True integrated testing cannot begin without these systems.
- Software:
  ◦ The grating system software is on the critical path. It is said to be similar in design to the slitmask software and that we will benefit from that experience. However, the slitmask software took much more time than expected.
  ◦ The completion of Lickserv2 is many weeks behind schedule, for reasons that were not predictable at the time. The critical test of live mosaic readout displaying to DS9 is now set for mid-July.
  ◦ Considerable software is still needed for miscellaneous analog sensors such as coolant flow, air pressure, and temperatures.
  ◦ Long-deferred vacations for software staff are coming due.
- The TV system is not yet working in the spectrograph.
- The carriage mover/trolley system is more proving more formidable than originally foreseen. We can test the system in Santa Cruz, but the real tracks on the Nasmyth platform and deck may not flex like those here.

Schedule and Budget:

- Completion has slipped about two months since our January 2001 report, and about four months since our October 2000 report. Reasons for the delay include:
  ◦ Grating slider flexure took longer to diagnose than expected. This in turn delayed the software.
  ◦ Mechanical alignment of the slitmask system took much longer than expected. This in turn delayed the software.
  ◦ Unexpected troubles with the Motorola Power PS board and the TV system diverted attention from other tasks.
  ◦ CARA asked us to build a complete mock-up of the carriage/trolley system and test it before the PSR.

- ◦ A key software person was out for medical reasons, delaying completion of the slitmask system and grating system software.
- The current date on the schedule for the Readiness Review is August 8. However, we are trying to move it up to August 2 because key people will be away that day on vacation. Realistically, it may slip to August 15. The Pre-Ship Review will take place about one month after that.
- The major items on the current critical path are software and integrated testing. Completion of the carriage/trolley system is also close to the critical path. The schedule assumes that fixes now underway to the slitmask and grating systems will be successful.
- Our last formal cost-to-complete as estimated in October 2000 was $8,275,000. Our new estimate is $8,960,000, for an increase of $685,000. This consists of four extra months of hard effort ($600 K at the rate of $150 K per month), $50 K extra added to the commissioning budget, and other smaller items such as coatings.
- The current schedule calls for first starlight on Feb 26, 2001. We are strongly motivated to meet the goal of regular observing during the spring Galactic cap.