Introduction

This is the eleventh monthly progress report on the HMI program at LMSAL. We/LMSAL are collaborators with Stanford University on the HMI/SDO solar physics investigation being led by Prof. P. Scherrer of Stanford University. Phase A began on 1 October 2002 and will last 12 months. A proposal for the Phases B-E effort at LMSAL was provided to Stanford and onward to GSFC as part of the Phase A Concept Study Report that was submitted in early July.

Summary of Status

There were no major meetings with, or submittals to, the Project this month. We did have meetings with two of our major suppliers, LightMachinery for the Michelsons and Vision Composite for the OP structure. Near the end of the month we received an updated Spacecraft-HMI ICD and began to review it. We are also reviewing a draft SOW for Phases B-E and are iterating comments with the Project on the draft CDRL. We continued to solidify designs in a number of technical areas and to enlarge the team to efficiently take the designs to the next level. We also continued to have weekly SDO Project telecons, weekly HMI-specific telecons, weekly CCD camera system telecons, weekly telecons with LightMachinery, weekly HMI status meetings, and a constant stream of internal technical meetings.

Schedule and Milestones

The original HMI proposal contained a top-level schedule that was based on the dates given in the AO. Now that the program is in full swing, a more detailed schedule has been developed. The latest version was provided with the CSR, and a further update will be provided in September. Feedback on both format and content of the CSR version was received from the Project and the next submission will take those comments into account. Shown below are some key milestones, with an emphasis on those that will occur in the near term, or have occurred recently (for completeness).

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Project visited Palo Alto</td>
<td>July 23-24</td>
<td>S/C-HMI ICD was the primary topic</td>
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<tr>
<td>Began Michelson study contract</td>
<td>August</td>
<td>Vendor is LightMachinery</td>
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<tr>
<td>Visited LightMachinery</td>
<td>Aug 6-7</td>
<td>Michelson vendor</td>
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<td>Evaluate stock of calcite</td>
<td>September</td>
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<tr>
<td>Status Review at GSFC</td>
<td>Sept 9-10</td>
<td>Discuss ICD and CSR/proposal</td>
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Visit RAL Sept 23-24 CEB technical discussions
Update many program plans September Need Project comments on drafts first
Begin shutter life test October
Receive prototype HCM November Vendor is H. Magnetics
Order Life-test HCMs October May extend Phase A three months
Begin Phases B-E October Camera Systems PDR Oct/Nov
HMI PDR Early Nov At Palo Alto
Define GSFC common buy November EEE parts
Mission PDR Dec 2-4 (tbc) At GSFC
CDR July ’04
Deliver HMI to S/C July ’06
Launch Aug ’07
Five year baseline mission

**Major Activities During this Reporting Period**

As noted in the last progress report, a productive working session on the HMI-S/C ICD took place in Palo Alto on 23-24 July. Since HMI was the first team to have such a session with the Project and all of the instrument ICDs are structured in a similar manner, this was a pathfinder for the other instruments. The Project then had a similar session with EVE. After the EVE session, they provided us with a revised draft S/C-HMI ICD to review and conducted a SDO wide telecon on the ICDs in general. We are presently performing the review with the intent of providing comments to the Project during the first week in September. They will work those comments into an updated draft, which will then be iterated face-to-face when we visit GSFC on 9-10 September.

Major progress was made in the optical discipline this month. Four members of the LMSAL team plus Rock Bush visited LightMachinery on the 6th and 7th. Many technical aspects of the strawman Michelson design were discussed with emphasis on the options for the spacer in the vacuum leg. As a result of these, and subsequent discussions, a decision was made to increase the size of the Michelson beam splitter cubes from 40 to 45 mm. Consequently, modest revisions are being made to the rest of the optical/mechanical/thermal systems. A drawing that captures all of the optical parameters of HMI continued to mature (and expand). A preliminary analysis was made of the change in focus as a function of despace errors between the secondary and primary lenses, temperature variations, and several other parameters. The front window requirements/specifications continue to mature based on the increased maturity of its thermal analysis and discussions with potential vendors. After considering the pros and cons of different types of waveplates, we elected to go with the higher performance (and more expensive) type being used on Solar-B FPP.

The mechanical configuration remained stable during August, but will likely change next month in response to the growth in the Michelsons. With Vision Composite now under contract, major decisions in terms of how to manufacture the OP structure neared closure. This was aided by several persons from Vision Composite visiting us for a one day working session on 4 August. In
addition, they now participate by telecon in the (first few minutes of the) weekly Mechanical Team meeting.

Software continued to move forward on a variety of fronts. These included several interactions with the Project to gain a better understanding of the details associated with how the 1553 bus deals with commands, housekeeping telemetry, and on-board messages. Internally, an approach for handling high-speed sampling of ISS parameters and motor current when performing specialized health checks on the ISS and mechanisms matured. The key element of the approach will be tested with some (non-SDO) hardware next month. A preliminary/partial HMI command list was drafted and discussed.

As noted previously, we have defined in detail the two mechanisms upon which we will perform extensive life tests; the hollow-core motors (HCM) and the camera shutters. The parts for the 4 shutters that will be life tested have almost all been received and we anticipate starting that life test in October or early November. We have ordered a prototype HCM from H Magnetics (who made similar items for our last 6 flight instruments) and anticipate receiving it in November. It will come with two rotors; one with skewed magnets and one with straight magnets. The former has less detent torque. We have used both types in the past for different HCMs with different requirements. We will evaluate which type is best for HMI and then order two of them for use in its life test. We have also defined in detail the filterwheels and are making the final drawings for them. The requirements and design concepts for the front door mechanism and alignment mechanism matured considerably this month. Both are quite similar to what was used on MDI, however we will use a motor-gear system procured from Controllable Drive Actuators Intercorp. The unit will be basically the same for both mechanisms and quite similar to one we obtained from them for the door on EPIC.

**Other Activities During August**

1. Negotiating the Phase B-E proposal that was submitted with the Concept Study Report in a timely enough manner to begin the contract on 1 October was determined to not be feasible. An extension to the Phase A contract will be put in place instead.

2. The details of what fixed assets need to be ordered by LM to support the HMI development matured, the ordering of items continued, and several items that were previously ordered were received.

3. The TAAs for LightMachinery and for e2v plus RAL were approved by DoD, NASA, and the NP/ECNP (Export Controls Conventional Arms Non-proliferation) agency and provided back to the State Department for final approval. This should happen in early September.

4. We, primarily Rock Bush of Stanford, reviewed the SDO Data Capture Budget and concurred that the HMI entries were correct.

5. Feedback from the Project on the Concept Study Report we provided in early July primarily consisted of the reviews they did on the PAIP and topics associated with the PAIP. Responses are being provided to those comments and resolutions are being reached. Significant progress in
this area took place when Ed McFeaters stopped by GSFC when on the East Coast for other matters and spent a half day talking with Bob Calvo.

6. We provided the Project with an electronic/Excel version of the costs that were in the CSR proposal to make it easier for them to evaluate them.

7. An expanded thermal model for the OP was nearly completed. It will be provided to the Project in early September.

8. We received a draft SOW and draft CDRLs for Phases B-E, and provided preliminary (top-level) comment upon it.

9. Progress continued on defining in detail the S/C Simulator(s) that will be GFE’d to us, how it will fold in with the remainder of our EGSE and Ground System, and when it/they will be delivered. A staged delivery is likely. We have requested two units.

10. Internal requirements/design meetings were held on the front door, the front window (twice), the telescope, the oven, the focal plane assembly (FPA), and the alignment mechanism/legs.

11. We learned from the Project of a potential radiation hardness issue with the ATMEL 1355 device; and of their plans to perform some radiation testing on it.

12. We received an updated SDO Structural Test and Analysis Requirements Document and provided comments upon it.

13. Draft Specifications and SOWs were produced for the flight CCD and CEB programs. We are now in the process of revising them before sending them to the UK groups, first for information and then as part of formal RFPs

**Planned Activities During September**

1. Firm up dates for the HMI PDR and the CCD Camera System PDR; the later to be a portion of either our or SHARPP’s PDR.

2. Establish an extension to Phase A of the program.

3. Submit the remainder of our responses to RFAs from the Mission SSR/SCR and elsewhere.

4. Continue to increase the size of the LMSAL HMI team, primarily in the electronics area.

5. Continue drafting procurement specifications for the optical elements.

6. Evaluate our existing in-house stock of calcite and determine the path for making it adequate if it already isn’t. A preliminary evaluation says it will be adequate.
7. Visit Vision Composite, the vendor selected to produce the OP structure. This will be the third face-to-face interaction with them.

8. Make the next iteration on a number of draft plans, in response to comments received on the copies that were provided with the CSR.

9. Continue to participate in weekly Project telecons, HMI-specific telecons, and CCD Working group telecons; and to conduct weekly HMI team meetings.

**Design Updates**

There were no major design updates this month. However it was determined to increase the size of the Michelson cubes by about 10%. The remainder of the optical/mechanical systems will now be refined to be consistent with this.

**Resource Requirements**

The monthly power and mass status reports are being provided as separate files. The HMI estimates are on changed this month but the allocations have been increased in accordance with CCR-016.

**Issues/Concerns**

- The lack of UK-provided camera systems puts an additional burden on us and will be a cost impact to NASA. The design-by-committee aspect of this effort is not efficient.

- Based on past experiences we expect obtaining TAAs will be a lengthy process and may impact our ability to interact efficiently with E2V, RAL, and LightMachinery; although progress to date has been better than in the past and we did get an early start on this activity.

- The launch of Solar-B has slipped a year making the transfer of personnel from Solar-B FPP to HMI more of a programmatic challenge for both programs.