Helioseismic Magnetic Imager
Program at LMSAL

Contract PY-2223
Progress Report for January 2003

Introduction

This is the fourth monthly progress report for 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. The investigation was selected on 15 August 2002, in response to NASA Announcement of Opportunity AO 02-OSS-01. Phase A, which includes the periods described as Phase A and the Bridge Phase in the AO, began on 1 October and will last 12 months.

Summary of Status

A key accomplishment this month was providing a large amount of information to the Project, mostly as a result of either action items from the Mission Definition Retreat or in preparation for the upcoming Systems Requirements Retreat. In addition, we continued to progress in several technical areas and to have weekly SDO Project telecons, weekly HMI-specific telecons, and HMI weekly status meetings. We received the Fillfactory camera that will be evaluated as to the potential for using a derivative of it in the HMI instrument now that our UK partners are no longer going to be able to provide the planned CCD camera systems. The LMSAL team continued to grow, primarily as people transitioned from other programs.

Schedule and Milestones

The HMI proposal contained a top-level schedule that was based on the dates given in the AO. Now that the program has begun, a more rigorous schedule has been developed. It will be provided to the Project shortly and updated periodically in the near term and monthly during Phases B-D. Shown below are some key milestones, with an emphasis on those that will occur in the near term, or have occurred recently (for completeness).

Mission Definition Retreat	Dec 3-5	Occurred at GSFC
Project Personnel Visited CA	Dec 11	Both Stanford and LMSAL
Systems Requirements Retreat	Feb 11-12	At GSFC & by the Project
Science Working Group Meeting	Feb 13	At GSFC
HMI Requirements Retreat	Mar 13	At Palo Alto & by us
HMI Team (Co-I) Meeting	Apr or May	Likely at Stanford

Systems Concept Review	Apr 1-2	At GSFC & by the Project & us
Submit Concept Study Report	Jun ’03	Includes a formal cost proposal
Begin Phase B-E	Oct ’03	
PDR	Fall ’03	
CDR	Fall ’04	
Deliver HMI to S/C	Summer ’06	
Launch	Aug ’07	
Five year baseline mission		

Major Activities During this Reporting Period

A major activity this month was providing the Project with information in response to action items from prior meetings and discussions as well as information needed for them to prepare for the upcoming System Requirements Retreat. The following items were provided:

- A FEM of the baseline Optics Package (OP), along with its mass properties and a sketch.
- A summary of our understandings in the area of C&DH based on a telecon on 21 January.
- Reduced Thermal and Geometry Models for the baseline OP, along with a sketch.
- A table of allowable operating temperatures and estimate radiator heat loads.
- Comments on the DRAFT Mission Assurance Requirements document.
- An initial set of comments on the MDR spreadsheet dated 1/14/03.
- A set of information concerning the Electronics Box – dimensions, connector locations, etc.
- A preliminary/typical EEE parts list.

In addition to producing the above items, we continued to progress on a variety of technical fronts. A modified optical design, that is not quite telecentric, matured to where it is the new baseline. The primary advantage of this design is that it enables the Michelsons to be smaller, which in turn will make it easier to manufacture them closer to perfect. Other items within the OP and the OP itself may become a bit smaller as well. Various mechanical packages for the revised optical layout are now being created. Consideration of how to obtain enhanced reliability by adding two hollow-core motors to the system progressed to the state that we will include them in the revised mechanical layout, with the intuitive feeling that their additional mass may be offset by mass savings in the non-telecentric configuration.

On the electrical and software front, we continued with the trade study of what central processor to baseline; a version of the RAD6000 is the lead candidate at present. We also continued to investigate what oscillator might be included in the electronics design to provide the highly stable clock that is required for helioseismology. Efforts were initiated towards producing a draft Software Management Plan and a draft Software Requirements Document. Both will likely be modeled after those in use on the Solar-B FPP program.

As noted in the last report, in early December we learned that our UK partners have not been able to secure the funds required for them to participate in the HMI program as planned. This is a setback scientifically, technically, and financially. Along with NRL and the Project, we are now considering how to recoup from this loss. As part of these considerations we procured a Fillfactory CMOS camera and began to evaluate it with a view towards whether a derivative of it

could be a viable candidate for HMI. We also began looking at what it would take to evolve the CCD camera we are building for the Solar-B FPP into one for HMI/SDO. Reducing its power usage would be a major design consideration.

Internally we are continuing to form the HMI team. The initial emphasis was on the disciplines that interface to the spacecraft, but we are now putting more emphasis on personnel primarily involved with the instrument internals. R. Rairden joined the team to lead the optical effort, including the very important Lyot and Michelson filters. L. Springer became the official Program Manager on 2 December; J. Wolfson will continue to be part of the management and science team. And, a number of other LMSAL personnel are becoming more and more involved in HMI. A local web site, modeled after those in use on our other programs is now functional as are several e-mail lists.

Other Activities During January

1. Members of the team went to two different Trade Shows in San Jose. At the first one they interacted with the Fillfactory folks as well as with several CCD vendors. At the second one they interacted with groups who are interested in building the Michelson Interferometers. One of these is the group (now called GSI Lumonics) who built the Michelsons for MDI.

2. Efforts began to produce a preliminary reliability block diagram.

3. We continued to think about mechanism life testing. This will need to begin very early in the program for the mechanisms that will move every 2-4 seconds during the 5 year mission in order to be able to undergo an accelerated life test that is adequate.

4. We reviewed the draft MAR and sent a detailed list of comments to the Project. It appears to invoke more requirements than any program we have participated in previously and we hope/trust this can be changed.

5. The analysis of the behavior of the MDI front filter/window on orbit continued in order to learn more about how to best design the HMI front filter/window.

6. D. Duncan went to E2V in the UK to participate in a meeting on CCDs with them and in a meeting on cameras with N. Waltham of RAL. D. Moses, of NRL, organized these meetings and participated in them as well.

7. We learned that a larger launch vehicle has now been baselined, which should remove the need for severe mass cuttings throughout the observatory and enable efficient progress in establishing a viable mechanical-thermal Observatory configuration.

Planned Activities During February

1. Participate in the SRR that will be held at GSFC on 11-12 February, technical splinters on the 12th, and an SWG on the 13th.

2. Submit an updated mass estimate that includes additional mass to enhance reliability and a mass reduction by taking into account some shielding of the electronics by the existing S/C structure.

3. Provide the Project with a preliminary schedule for the entire program. Also provide them with an updated cost ROM.

4. Increase the size of the LMSAL HMI team.

5. Work on our action items concerning a CCD Camera Recovery Plan and interact with NRL to produce a White Paper on the recovery options.

6. Continue to participate in weekly Project telecons and HMI-specific telecons, and conduct weekly HMI team meetings.

7. Prepare for the HMI Requirements Retreat that will take place in Palo Alto on 13 March.

Design Updates

- A slightly non-telecentric optical configuration has become the new baseline, primarily because it results in smaller (and thus easier to manufacture "perfectly") Michelsons.

- Consideration is being given to adding two hollow-core motors to the optics package to provide redundancy for the four units already there.

- Consideration is being given to changing the mechanical layout to where the CCDs mount on a relatively permanent piece of the OP lid.

- A somewhat larger OP may be desirable in order to have a longer lever arm for the active mirror and thus increase the range of the ISS. The present range is marginal in terms of the anticipated Observatory pointing drift with time and the drift may become worse with the more massive spacecraft.

Issues/Concerns

- The numbers of reviews and additional documentation required by NASA on flight programs ever since the Mars failures make it difficult to put adequate effort into doing "real work."

- Although the MAR is only a draft document at present and the PAIP will be the governing document, it appears that requirements may be imposed that exceed those on any of our prior programs and what can be afforded on this one.

- The lack of UK-provided camera systems puts an additional burden on us and will be a cost impact to NASA.

Note – we have removed the concern of the observatory mass being over budget since a larger launch vehicle has now been baselined.