

Helioseismic Magnetic Imager Program at LMSAL

Contract PY-2223 Progress Report for December 2002

Introduction

This is the third 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, 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, will last 12 months.

Summary of Status

Highlights during this reporting period included participating in the Mission Definition Retreat at GSFC, hosting a visit by several members of the SDO Project, discussing a wide variety of topics during the weekly Project-wide and HMI-specific telecons, continuing to model (thermally) the MDI front window as a prelude to designing the HMI window, and reacting to learning that our UK partners will not receive the funds necessary for them to produce the CCD camera systems. The LMSAL team is growing, primarily as people transition from other programs, with L. Springer formally taking over from J. Wolfson as Program Manager on 2 December.

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 will be developed. We will make the schedule using MS Project and update it monthly in phase with the monthly progress report. The first schedule submission will be in late January. 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
HMI Requirements Retreat	Mar '03	At Palo Alto & by us
HMI Team (Co-I) Meeting	Mar or Apr '03	
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

The HMI program at LMSAL officially began on 1 October under a letter subcontract from Stanford University, barely a day after Stanford and GSFC signed the Stanford contract; and the contract between Stanford and LM was signed in early November. A very quick start compared to most of our prior programs. We now have weekly Project-wide telecons, weekly HMI-specific telecons, and weekly HMI internal meetings; plus information exchanges and mini meetings whenever needed.

Seven members of the LMSAL team, and 4 from Stanford, participated in the Mission Definition Retreat that took place at/near GSFC on 3-5 December. Unfortunately, it coincided with a snowstorm that disrupted the flow of activities and actually cancelled the 3rd day of the meeting. However, useful exchanges did take place both technically and programmatically. It is clear that a lot of work needs to occur early in CY-2003 in order to accomplish the goals of the retreats and reviews that are scheduled for February, March, and April. A key aspect in this is baselining a mechanical/ thermal configuration for the entire observatory so that we can then continue with the detailed design of the HMI in an efficient manner. The Project is working hard to accomplish this. Likewise the electrical interfaces are being established but these have less of an impact on our internal work. Significant progress has been made in establishing a concept for handling the high rate science data, understanding our requirements on data completeness and timing, and conceptualizing methods to satisfy the stringent HMI timing requirements. The latter now includes incorporating a stable clock within our electronics so as not to impose additional requirements on the spacecraft.

Technically, significant optical and mechanical work continued in order to refine the optical layout that will be baselined for the instrument and the mechanical package that will contain it. In addition to the configuration in the proposal (with minor modifications) we are considering a configuration that has the CCDs mounted to a relatively permanent portion of the OP lid. The primary consideration in refining the optical configuration has been to study an option that is somewhat non-telecentric. This would result in smaller Michelsons and thus be a simpler configuration to implement. On the electronic side, we are refining the overall block diagram, performing a trade study on what CPU to use, and investigating higher density memories and FPGAs than presently baselined.

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 both scientifically and technically (and financially) as they have significant expertise in helioseismology and were going to provide state-of-the-art CCD camera systems (for SHARP as well as HMI). Along with NRL and the Project we are now considering how to recoup from this

loss. A number of options, and corresponding actions, were formulated at a meeting with NRL personnel on 9 December; and shared with the Project when they visited Palo Alto on 11 December.

Internally we are continuing to form the HMI team with initial emphasis on the disciplines that interface to the spacecraft. L. Springer became the official Program Manager on 2 December; J. Wolfson will continue to be part of the management and science team. B. Carpenter, who is presently the LMSAL SECCHI (on STEREO) Systems Engineer is transitioning onto the HMI team now that his replacement on SECCHI has been identified. He attended the MDR to become better acquainted with the total program. J. Drake has joined the team as our Software Lead now that his obligations on HIRDLS have pretty much been completed. He has begun working with R. Lindgren on a trade study to determine what CPU will be used within HMI. R. Deguzman has begun making a thermal model for the optics package in general, as well as one for the existing MDI front window – a prelude to designing and modeling the HMI front window. 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 December

1. On 22 November we provided the Project with a summary of our past and present power usage estimates. We hope additional power will be allocated to us to enable the simplified thermal control concept and improved high-rate telemetry interface reflected in the most recent estimate.
2. We ordered a Fillfactory CMOS camera system using internal LM funds. Using such a CMOS sensor/camera, but larger, is one possible option for dealing with the lack of cameras being provided by the UK and we need to evaluate it as soon as possible.
3. We continued to think about mechanism life testing. This will have 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 received the draft MAR and were disappointed that it was not aimed specifically at the instruments and that it appeared to invoke more requirements than any program we have participated in previously. Our general concerns were made know to the Project, discussions began between our Mission Assurance lead and his counterpart on the Project took place, and we began to formulate a specific set of comments to give to the Project.
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. Several members of the SDO Project visited Palo Alto on 11 December, having been at the AGU in San Francisco the days prior to this. Tours of both the Stanford and LMSAL facilities were conducted as were discussions on a number of (mostly programmatic) topics.

7. A long Holiday period was enjoyed by all; LMSAL having 7 working days off and many of our personnel taking an additional 3 days of vacation to turn it into a two week break.

Planned Activities During January

1. Freeze the optical design, thereby enabling the mechanical and thermal designs to mature efficiently.
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. Receive a CMOS camera from Fillfactory and begin to evaluate it.
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 on the, and on their action items, accordingly.
6. Continue to participate in weekly Project telecons and HMI-specific telecons, and conduct weekly HMI team meetings.
7. Provide the Project with many items including:
 - Comments on the draft MAR
 - Further information on pointing accuracy and alignment requirements
 - A simplified FEM and its mass properties
 - A thermal math model along with temperature requirements
 - Updates to Level-X requirements as well as minimum mission criteria
 - A preliminary reliability block diagram

Design Updates

- The baseline HMI wavelength has changed from 6768A to 6173A. This has minimal impact on the instrument design and what impact it does have makes the design slightly “easier.”
- Consideration is being given to changing the mechanical layout to where the CCDs mount on a relatively permanent piece of the OP lid; but the baseline is still the prior configuration.
- It is likely that a slightly non-telecentric optical configuration will replace the present configuration, resulting in smaller (and thus easier to manufacture “perfectly”) Michelsons.

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.
- Observatory mass needs to be decreased in order to have an adequate margin at this point in the program. Although we believe HMI has an adequate mass estimate as proposed and thus baselined, we would like to have a small amount of additional mass to enhance reliability. Plus, as part of the Observatory, we will be impacted by hunts for possible mass savings along with everyone else.