EIS Manager's Report

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Summary

There has been considerable progress since the last steering committee meeting. The design parameters for the instrument are becoming known, but the consortium must now work to agree the critical items so that detailed design can take place. There is an urgent need to define the interface properties of the instrument to allow spacecraft design to proceed. A 3-country "engineering meeting" at NRL will be held on 18-19 May to address these issues.

This report refers to the Instrument and MSSL progress – refer also to the reports from BU and RAL.

Mission kick-off meeting

The mission kick-off meeting (March 8-13) brought together scientists from by ISAS and NAOJ with all three instrument teams - SOT, XRT and EIS - as well as staff from the main spacecraft system integrator, MELCO[1].

This meeting comprised several plenary sessions involving all groups, with the mission's development philosophy and details of the systems engineering approach were made known.

Each team then held parallel sessions to discuss the design of the three instruments. In the case of the EIS, the major topic was the selection of the instrument configuration - Cassegrain or off-axis paraboloid (OAP). In this discussion, other instrument teams and ISAS and NASA project scientists were actively involved.

The background to this debate was reported at the last panel meeting. Essentially it was felt that the solution would be found by considering, in the context of the Solar-B payload, the relative strengths of high spatial resolution against high throughput. Although there were substantial differences in the way the two configurations would be engineered, it was the opinion of the EIS hardware team members that none of these considerations were drivers in either direction.

During the EIS meeting in Japan, the relative merits of the two configurations were presented by their proponents, and thoroughly discussed. Although very detailed, this discussion did not result in a consensus view - there were still strong reasons to favour

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[1] Mitsubishi Electric Company, Kamakura Works.

either type of instrument.

A selection panel formed of Len Culhane (MSSL), Tetsuya Watanabe (NAOJ), George Doschek (NRL), Takeo Kosugi (ISAS) and Bill Wagner (NASA) then met separately to arrive at a decision.

It was the opinion of this panel that the Solar-B objectives could best be met by maximising the time-resolved spectroscopic capability of the EIS, and that this could best be done by selecting the high throughput configuration, namely the off-axis paraboloid. High spatial resolution information about the targets should be sought from the XRT data. Measures to improve the spatial resolution of the instrument should be sought where possible if they did not affect the throughput offered by the baseline design.

During a later EIS session, the team discussed and agreed the wavelength range for the instrument. If possible, there should be two wavelength ranges

a. 170-206 Å - known as the NRL1 range

b. 270-290 Å - known as the Baseline range

It was agreed that the optical design should proceed in the US based on these parameters, using a two-reflection OAP configuration. If possible, spectra from the two ranges should not be focussed at the same location. The UK agreed to further investigate the consequences of using two detectors.

The meeting addressed several other issues related to the EIS design and its Interfaces with the Solar-B spacecraft.

The project manager and Alec McCalden (MSSL) and spent an additional two days with NAOJ scientist ("secretariat") for EIS, Dr. Hirohisa Hara, in a discussion of the functional relationships between the EIS electronics and the Solar-B mission data processor.

Details of these meetings can be found in the minutes of the kick-off meeting.

Design studies

NRL and GSFC have recently (7 May) concluded their preliminary design study and released details to the consortium. Since then, both MSSL and BU have advanced their mechanical design concepts to a point where the problems of integration of the subassemblies can be addressed. A meeting at NRL has been scheduled for this purpose (18 to 19 May).

Whilst this is not a full consortium meeting, all hardware institutes, with the exception of RAL, will be represented. The panel is therefore invited to consult the project document archives, where the agenda of the meeting is available, as will be the meeting's minutes[2].

[2] http://www.mssl.ucl.ac.uk/solar-b/docs => Meetings

There remains an active debate in the consortium about the merits of the NRL optical design. It is hoped that this debate can be concluded at the NRL meeting in order to allow the design of hardware to progress.

The background to this is that NRL and GSFC have taken the view that a spherical variable line spacing grating, with a dimension of 15 cm x 15 cm, as in the original (NAOJ) design, represents a considerable technical risk. The risk in question is that the desired efficiency of the grating would not be achieved, thereby decreasing the throughput of the instrument, this being one of the chief requirements. This risk is very strongly related to the size of the grating. NRL/GSFC have therefore sought to use a smaller grating. They find that, after optimisations of the optical configuration, that an equivalent spectroscopic performance is achieved with a smaller (eight centimetre diameter) toroidal grating. As well as reducing the risk of manufacture, it also allows them to have two iterations of the manufacturing process, a fact that they regard as essential.

The debate revolves around the nature of the spectral line images formed by the smaller grating. In the best case of the original NAOJ design, the spot diameter was much less than the detector pixel size. In the NRL/GSFC design, the spot sizes are more nearly matched to the detector pixel size. The details of the resulting spectral line shapes, for example the amount of asymmetry in the line) have a bearing on how well the spectra can be used to determine velocities of solar plasmas. Again this is one of the main requirements of the instrument. It is hoped that the NRL meeting can be used as a forum to settle this issue.

UK progress

Structure

BU have identified carbon composite materials for the EIS structure that have desirable mechanical properties, including CTE and stiffness to mass ratio. Materials are also available which have low levels of outgassing – which can be a major concern with composite materials.

The experience gained by RAL in contamination control in SOHO-CDS is proving highly valuable.

However, due to the sensitivity of EUV reflectivity of surfaces to molecular contamination, the suitability of these materials from the contamination point of view is not necessarily assured. In order to gain confidence about their, a sample of BU's current baseline material has been sent to NRL for analysis. These tests will involve heating of the sample in the presence of witness mirrors, coated with a multi-layer coating similar to the ones proposed for use in EIS. The reflectivities in the EUV region of the witness samples will be compared before and after the heating cycle. Measurements of evolved gases will also take place during the heating. It is hoped that results of these tests will be known at the NRL meeting.

BU has been preparing a number of conceptual designs for the spectrometer structure in response to the preliminary optical layouts from the US. These need to be advanced to the stage where dynamic and thermal information can be given to us spacecraft system integrator.

Focal plane assembly

Additional theoretical studies of the charge transfer efficiency of the EEV CCDs as a function of temperature and radiation dose have been carried out. We are gaining a fuller understanding of the required operating temperature of the devices, but we are not yet in a position to specify this as a firm requirement.

The design of the camera electronics and mechanical housing has continued to evolve slowly. We have been assuming that two CCDs will be present in the camera.

The mechanical design of the CCD housing will need careful engineering in order for it to maintain the correct alignment of the detectors as well as to allow cooling to the working temperature. In addition, the materials used must be compatible with the contamination requirements for the detectors and optics. One of the particular aspects that needs to be tested at a breadboarding level are the thermal properties of a spring loaded dry joint between a copper heat sink and the mounting plate of the CCD.

Estimates have been made of the mass and power consumption of camera systems employing one or two CCDs. Further work is necessary up before we can include these figures in a meaningful system resource budget.

Additional rough order of magnitude (ROM) quotations for the provision of CCDs have been obtained from EEV. The cost implications of two devices in the flight camera are still under negotiation. Therefore, the spending profile has assumed a number of delivered devices as per the original ROM quotation, but at the newly advised level. We will shortly be issuing a formal request for quotation of and we will expect to receive a technical proposal between four and six weeks after that. We can then discuss the terms of a contract, which we expect to be in place by the time of the next steering committee meeting.

A development plan for the camera (FPA) is outlined on the accompanying schedule.

Instrument electronics and on board software

Members of the MSSL team have been active in defining the requirements for the electronic and software. This has activity has progressed slightly since the last meeting. However, there is now a much better understanding of the capabilities of the spacecraft interface. We have been considering the use of various families of communications circuits (Firewire and USB) which could be incorporated into the spacecraft interface and camera interface which would allow us to use standard computer systems as testing equipment. The approach has the potential to release design effort for other areas of the project. Of course we must ensure that these types of communication solutions can be engineered for space use - we have some encouraging data to support this view.

Effort has been made in the determining what is the current state-of-the-art in microprocessor technology and software development systems that could be employed in the instrument electronics. One the Texas Instruments series of DSP chips has been identified as promising. At least one of the families concerned is already available in a radiation tolerant form, so there is at least one fallback position. The (large) processing power of these types of device will allow us to consider innovative means of solving the date bottleneck problem. Several commercial software development systems that support the processors have been identified. It is expected that one of these will be selected soon and experience gained in its use before the next meeting.

The functional requirements for the instrument software have been studied. More work needs to be done in these areas before software development work can begin in earnest. In addition the choice of processor and development environment, i.e. what programming language, will define the effort required for training.

Schedule

The GANNT chart shows activities related to Phase A (System Definition) with updated end dates, now assumed to be in coincidence with the end of Phase A (end September 99). Progress is also shown on the chart.

The chart now includes details of the breadboarding activities, mainly related to the focal plane assembly, in the coming year. Further work needs to be done on the plan in order to show all breadboarding activities in the UK. Details of the US activities are not yet shown.

CCD procurement is shown as a special activity, because of the particular costs incurred. This now shows the sequence of activities leading up to the devices being ready for integration in the flight equipment. The activities up to the issue of the contract show the planned durations. The activities following the contract being signed show notional durations only. They may be more information about the timescale of device delivery available at the steering committee meeting.

In the ICU design, it is aimed to Select a processor by end August 99.

In the prototype model (PM), mechanical thermal model (MTM/TTM), flight model (FM) activities, the phases have been planned in accordance with the ISAS schedule.

The ISAS and NASA master schedules are also shown on this chart. The ISAS schedule shows delivery dates for the EIS instrument for the various models.

In NASA master schedule: Requirements Review. We need to ensure that accurate dates are known, and what support needs to be given to the review.

Start of Phase B (EIS schedule). This milestone is linked to the ISAS schedule.

The PM and MTM/TTM phases (ISAS) appear to be linked to the phase B activities.

Future meetings

A full consortium meeting has been scheduled for the 15th and 16th of June at Birmingham University. This will address all open scientific and technical issues relating to the instrument. Other consortium meetings are anticipated during the year but not yet planned.