Meeting Team Engineering Meeting, MSSL, July 27-29, 1999

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Matthew Whyndham (MWT) chaired this meeting.

Contents

(Actions are at the end)

Agenda

The previously distributed agenda was followed. There were additional splinter meetings on the following days.

Opening Remarks

Present activities

On the J-side, there is a satellite design meeting every two months. After the end of Phase A, (e.g. first week of December) there will be meeting of all foreign teams in Japan. This will be a joint science and technical meeting to confirm the design results obtained during Phase A. Consequently there may be a need for an EIS meeting to prepare for this joint meeting.

In the US, most effort is being directed towards the NASA reviews at the beginning of September. The documents required by NASA, to be submitted on the 18th August, include a Development Plan, a Requirements Flow Matrix, and an Instrument Requirements Document wherein the subsystem requirements will be expressed. At the end of Phase A, end of October, a concept study report relating to the US side components only is required. However this will require an instrument level description to provide top-level context. At this time NASA will also require a Statement of Work and Phase B proposal.

Objectives

There are several outstanding issues in instrument design. Some areas of manufacturing and design responsibility have not been clearly defined. These will be addressed during discussions of to the work breakdown structure.

- Decide whether we need a further engineering meeting later in the year, and whether system-side involvement should be requested.
- Review the system hierarchy.
- Decide the purge philosophy, particularly in relation to the pre-launch period and faring interfaces.
- The vacuum line to the clamshell should be defined. It was noted that the TRACE vacuum would hold for tens of days. A pressure measurement device is an essential requirement in the EIS. And a rigid vacuum line may not be required.

Hiro Hara presented a number of overheads relating to EIS/spacecraft issues. (also in PDF)

“Documents for subsystem design". This shows the history/schedule of these documents. The draft document "Electrical DESIGN Standards " was distributed.

Request from system side to EIS.

The phrase "System Side" refers to the Solar-B spacecraft development team. The phrase "Subsystem" refers to EIS.

ACTIONS shown like this

1. Mechanical interfaces (legs). It was believed that the new structure iterations had successfully addressed this problem, namely that the - z end of the structure conflicted with the spacecraft mounting on to the rocket. Considering the aperture end of the structure, it was noted that there was a large view factor to the SOT MLI, and a consequent exposure to any contamination that might be present on it.

A-125 ***BU*** **consider view of SOT MLI in thermal model**

2. The electrical relationship among the EIS components had been satisfactorily described to the systems side.

3. Justification for the stated temperature ranges for each component should be given.

A-126 ***NRL*** **elaborate/justify component temperature ranges**

4. The system side needs to assess the disturbance torques for each subsystem. Therefore the disturbance torque of each moving component in the EIS should be calculated more thoroughly.

A-127 ***NRL*** **elaborate component disturbance torques**

At present, the NRL team is devoting its efforts towards the NASA reviews. Therefore the progress on these two issues is unlikely to be great before September.

5. Heat load on the entrance filter. Charlie Brown prepared an estimate of the filter temperature, and which also showed the flows of solar heat in the instrument, which showed the heat absorbed by the filter was of the order of 5 Watts.

6. Number and position of survival heaters. Resolution of this issue depends on the thermal model of the EIS, which is yet to be developed. The present design position is that three heater/control circuits are allocated for EIS in the system equipment. There was a discussion on the thermal conductance of carbon fibre laminate materials. Due to the nature of these materials, it is common to have an anisotropy of the conductance. The optical properties of the material (black) means that radiative terms are likely to be quite strong.

A-128 ***BU*** **state number and position of required survival heaters**

Solar-B system issues

Referred to figure 1 (p. 6 in H. Hara overheads) for the electrical interfaces. The physical layout of the spacecraft components in the bus structure was reviewed. It was noted that the EIS ICU (electronics box) had dimensions that were considerably smaller than many other electronics units. The linear structure adjacent to the ICU, "MTQ", is part of the attitude control system (a magnetic torquer).

A-129 **HH** **Request information about the MTQ flux reaching ICU**

Power budget. An increase of around 10 W for heaters is likely after the thermal design has been completed. The system side knows this fact. But power is a critical resource so the actual values of the EIS power use are required as soon as they are available.

The system side is eagerly awaiting the structure math model and thermal math model of the EIS.

Optical layout

The optical layout drawing (Autocad format, also in PDF) related to the 4200 lines per mm grating option was displayed and discussed.

We note that for the long wavelength end of the detector, at 290 Angstroms, is now approximately 20 mm away from the incoming beam. If more clearances are required, for example in order to accommodate a structure wall, then the optical design would have to be revised. Opening up the angles in this way is predicted to worsen the optical performance. The usual spot diagrams and summary plots were reviewed.

Filter and clamshell

There was discussion of the filter requirements. If this is placed a deeper in the telescope tube as there is potential for more thermal coupling. Because the filter material is mounted loosely in the frame, it doesn't behave as a perfect specular reflector, and therefore reflects the Sun's thermal energy into the cavity in which it is mounted. It is planned to arrange the filter ribs in a tetrahedral fashion to counteract this effect.

A-130 CMB send Saad example filter drawing.

Done. A simple filter drawing was exchanged at the meeting.

A-131 CMB/MWT clarify debris issue.

Charlie Brown presented the document "Rough Estimates of the Temperature of a Thin Aluminium Solar Filter" (also in PDF). The summary result from this analysis was that the temperature of the filter would reach some 490 K in the centre. The instrument would absorb about 5 W of solar heat, which would be distributed to the telescope tube in front of and behind the filter. The model did not contain any supporting ribs for the filter material. The inclusion of these would cause more heat to be transmitted to the structure. There are various requirements related to the filter temperature. The effect of thermal cycling during the eclipse seasons should be considered. Due to the possible outgasssing from the glue holding the filter material to the supporting mash, there should be a delay between opening the doors of the clamshell. The front door is usually opened first to promote the flow of outgassed materials away from the main instrument. Given the size of the filter there is thought to be a definite need for a clamshell. It was noted that the given the acoustic load of the M-V rocket, (a figure of 143 dB had been given in an earlier document), this need was emphasised.

Charlie had had a useful conversation with Jay Bookbinder (also in PDF) on the subject of filters.

Mechanism Properties

New drawings of the mechanism subassemblies were shown. For the mechanisms, we envisage a having a stand-alone checkout system. There was a short discussion about provision of mechanism simulators. A mechanism interface control document is being prepared.

A-132 *NRL* Mechanism ICD

Mirror subassemblies

The "shim" is 20 mm to match the 1 % (manufacturing) tolerance of focal length in the optic. The assembly and alignment process was discussed. Workshop effort will be needed where the integration is performed (RAL).

Shutter/slit assembly

The present drawing does not show the “encoder station” associated with the shutter. The preferred direction of access is from the top, in other words the legs would be pointing “up” (+y).

Grating subassemblies

The access requirement for the subassemblies should be defined more clearly. This relates to the alignment procedure. Because alignment of this item can only be performed in EUV illumination, adjustment of this component will require that the vacuum be broken and remade after each operation. Therefore it should be a straightforward procedure to gain access to the adjustment screws etc.

As it is presently drawn in the structure, the input beam from the slit interferes with the grating focus motor. This can probably be resolved by rotating the subassembly by 90 degrees.

Structure

Further discussion of access requirements for each component. Positions also need to be defined for electrical connectors, purge ports around the event holes, and contamination monitors. Each relevant institute will mark up and indicate approximate locations on a copy of the structure drawing (Autocad format only).

A-133 ***MSSL*** **show wiring harness concept on structure drawing**

A-134 ***NRL*** **show access requirements on structure drawing**

A-135 ***RAL*** **show purge harness concept on structure drawing**

Certain design rules will be used in resolving the access requirements. The main rule is that the removal of any element will not disturb any existing electrical connection. All access ports will be light tight when closed. The access requirement conflict with the stiffness requirement! This is because any hole in the structure causes a loss of stiffness.

The recent modifications of the structure were discussed. The structure had gained some stiffness by virtue of the telescope tube being shorter. This seemed to be some benefit in bringing the legs closer together, for example in order to bring the leg closer to the centre of mass of the ROE.

A-136 **HH** **to find out what freedom existed in the leg position.**

Structure qualification philosophy. The system side prefers to provide representative legs, but it wasn't clear out whether this also included a representative portion of the optical bench structure.

The finite element structure model was being worked on at the time of the meeting. This would need a few more days work before it was ready.

Door concept

Saad Mahmoud showed the current concept for the front door. It incorporated a magnetic latch, a stepper motor, and a gearbox. There was a discussion about the door in relation to the clamshell. One option would be to unify the aperture door with the clamshell front door. The decision will be related to the risks of meteorite strikes on the entrance filter at various possible locations in the entrance tube. The damaging effects of thruster ingress should also be considered. If the thruster gases aren't considered to be harmful then the aperture door, or its ability to be re-close, could be eliminated. This will depend on the purity of the hydrazine being used. It was expected that Solar-B will use its thrusters about once per year for station keeping.

A-137 **HH** **system side to comment on purity of thruster gas**

A-138 HH system side confirm thruster usage frequency

It will need to be determined whether the door mechanism will be required to lift the weight of the door. This might be the case if the instrument was oriented vertically during thermal vacuum or thermal balance tests. A helper spring arrangement could be provided in principle.

There must be provision for door status indicators in the door mechanism.

Thermal control

Saad had already measured the thermal connectivity a longer of all in the longitudinal direction of a sample of the carbon fibre material (reported in the March 99 meeting). Manufacturers of the material usually decline to give any data on this property even for a single layer or for the "UDT" raw material (tape).

Example values

Al	160	W/°C/cm^2
CF	32	(longitudinal)
	~5?	(transverse)
GRP	.037	- effective insulator

Thermal blankets having an insulation factor of .01 - .003 were being considered.

Clarence Korendyke described a general procedure for developing the basic thermal parameters, which would answer the basic question of how much power would be required from the survival heaters to bring the instrument into the operational range. In a discussion of other instruments it was felt that around 10 W was typical.

A-139 *BU* Develop thermal model of instrument

Hiro Hara described some of the features of the 28 V heater bus. There are 3 channels capable of 5W each.

The instrument performance, for example the quantum efficiency of the camera may be a function of the temperature.

It may be worthwhile building a model (QM) and subjecting it to various tests mechanical and thermal. The performance of the joints would be a particular area of interest. There do exist cheaper materials with similar mechanical but not thermal properties.

There was a discussion on procurement issues relating to the carbon fibre material. Minimum order quantities were of the order of 600 metres of tape. The shelf life when stored at –20 °C was 6 months. BU are purchasing a walk-in freezer for storage purposes. There was a general discussion about carbon fibre properties.

A-140 CK trace information from the FUSE carbon composite experience.

Contamination control

A later email exchange with Barry Kent related to contamination control took place after the meeting. The conclusions are consistent with the following discussion which took place during the meeting.

The basic data for contamination control planning is the amount of material that can accumulate on the optics during manufacture, integration, test, launch and operation. The contamination budget is formed around this number. This number will be driven by the desired efficiency of the optics at end of life. The target efficiency should be selected by the consortium. The engineering teams should state the steps (costs) that must be taken to achieve a particular efficiency. An appropriate efficiency loss target value was felt to be in the region of 10 %. (90 % efficient at end of life). The next step is to calculate what amount of material, assumed to be carbon, that this loss of efficiency was equivalent to. This calculation could be based on published transmission data for carbon at the wavelengths of interest.

A-141 MWT/CMB calculate (roughly), carbon load for 90 % efficiency. Density = 1 g/cc may be assumed.

Note: following the meeting, the appropriate transmission data were found, and reported calculated by the "Berkeley labs x-ray website" (also in pdf)- http://www-cxro.lbl.gov/optical_constants/, or based on tabulated Henke data (also in PDF). Judging by these estimates, the desired contamination budget amounts to 1000 $ng.cm^{-2}$, and is driven by the long wavelength band (the short band is less sensitive).

It was noted that of all the optical surfaces, the detector would be the coldest. Since contaminants will condense preferentially on the detector, then the effective area of the entire instrument will contribute to the contamination of the CCD. It was also noted that the Lyman-α radiation is the most sensitive to contamination. At this wavelength one Angstroms of material reduces the throughput by one per cent. Instrumentation such as witness mirrors, RGA, TQCM, will allow us to determine how long the instrument can be exposed to a given environment, such as a test chamber. Contamination considerations may well give rise to requirements on the operation of thermal test chambers, for example that certain parts of the chamber must always be colder than any part of the instrument.

An outline contamination control plan is needed for the Requirements Review. A full contamination control plan will be needed for the PDR. The EIS contamination control plan will be based on the CDS contamination control plan, and also on other such plans such as the XMM-OM contamination control plan. EUVE may be useful guideline, as this was the first satellite at Goddard to employing a quantitative contamination control approach.

A-142 CK forward EUVE instrument contamination control plan to EIS technical teams via MWT. EUVE spacecraft contamination control plan to Solar-B side via HH.

The output of the contamination control plan will include the following.

- Design rules
- Material selection guidelines
- Procedures for handling and processing
- Conditioning processes, for example vacuum bake out procedures and monitoring requirements
- Prescribed build-up sequences
- Clean room gowning procedures

Integration and test in Japan

Information about cleanliness levels at Japanese facility is required prior to the integration and test.

A-143 HH to report on observed levels of (e.g. particulate) contamination in the ISAS clean rooms.

There is a need to maintain chamber hygiene procedures at spacecraft level. For example some part of the shroud must be colder than the instrument during the spacecraft-level thermal vacuum test. It was felt that it would be desirable to maintain a clean area within the main ISAS clean room. There may be requirements on the vacuum conditioning of the spacecraft MLI and harnesses. When the EIS contamination control plan has been developed the consortium may wish to recommend specific spacecraft procedures.

There was a short discussion about the purging sequence during ground activities. Red-tag pore filters may be incorporated into the design. A temporary aperture cover may also be provided.

Camera design

The FPA design must be reworked to conform to the present structural design concept. It is intended to keep the base-mounted ROE-box. The orientation of the ROE box can be adjusted to align with the axes of the instrument. The heat paths both radiated and conducted in the FPA had not yet been considered.

The apertures in the spectrograph wall (+z with respect the detector) should be small-this will suppress cryopumping of the spectrograph chamber by the CCD.

A possible location for the flat field source must be identified.

In the detector performance simulations that had been carried out so far, an equivalent of 3 millimetres of aluminium shield in had been assumed. There was discussion of how much shielding would come from either the structure or the surrounding electronics. There may be a requirement for additional shielding structures, either to increase the total amount of shielding, or to provide shielding in directions where there was little shielding.

Chris McFee is currently drafting the CCDs procurement contract. The next draft of the requirement specification will be shown to the mechanical engineers in the team. It is expected that EEV will supply an Invar mounting plate with the devices.

It was emphasised that the detector lead length must be kept very short! Attention must also be paid to the grounding of the devices through the stack of mounting pieces.

There were questions about the charging up behaviour of the composite material. The parameter that determines whether there is a problem is the bulk resistivity. As with its conductance, this property may be anisotropic. If there is a problem, it could be alleviated by straps across joins or metal inserts through the layers. There is a need to look at existing practice of grounding of carbon structures.

A-144 *MSSL* Measure resistivity of BU's Cycom plate sample
A-145 *BU* Review grounding practice in carbon structures

CCD test plan

Chris McFee presented the draft CCD test plan. This is divided into phases A, B and C.

The device procurement options involved a certain amount of trading of quality, i.e. grade, and documentation detail against the available funds.

It was generally felt that radiation damage tests, particularly of the CTI parameter, should be carried on representative devices as soon as possible - these devices could well be inexpensive commercial devices.

A-146 CJM to investigate test facilities and device options.

A-147 CJM test CCDs for radiation-induced performance effects

EEV Presentation

Dr. Mark Robbins of EEV gave a talk about radiation effects in CCDs.

Basic information about the radiation dose of Solar-B, both ionising and non-ionising energy losses (NIEL) had been estimated from models in the public domain (AE-8 and AP-8). It was noted that the later part of the mission was when there was an increase in the rate of solar protons (anti-correlation with solar activity). He thought that CREME was not appropriate for a long-term average of solar proton spectra and JPL-91 was recommended instead.

In the modelling of device performance it is very difficult, with a simple model, to show how non-simple images will be affected by CTI losses. Here simple means either a flat field or a point source. Anyway, the models predict (these results were shown in the BU meeting) that the worst case is found when the pixels are clocked slowly. For confident knowledge of the critical operating parameters, such as temperature, tests on the actual devices with representative illumination patterns need to be performed. The CTI effects are independent of wavelength, as long as an appropriate image is formed with an equivalent amount of charge, and also independent of whether the device is front-illuminated or back illuminated.

The possible benefits of using a device in an MPP mode were discussed. If a "cold" device temperature could be reached then there were essentially no benefits of this mode. If the device were warmer then the MPP mode would reduce the surface dark current.

Strategies for annealling were discussed. There are two defects in the silicon lattice that are significant. The silicon e-centre, which contributes about 85 % of the CTI peakn will be annealled at temperatures significantly higher than 30 °C, in fact the annealling begins to operate between 100 and 130 °C. The di-vacancy defect, which contributes about 15 % of the CTI peak, is only annealled at 350 °C. He was felt that the proposed annealling temperature of 30 degrees C was certainly a bit low. More background information about annealling could be found in the XMM RGS Radiation Report, jointly authored by Leicester and Brunel. or see Holland et al, SPIE Proc, 1344 1990, p. 378

Radiator study

Daniel Tye, a contractor at MSSL, presented a report of his work so far (also in PDF), to determine what temperature could be reached with a passive radiator in EIS. The predictions are generally very poor in relation to the assumed target temperature of -80 degrees C for the CCD. The predictions showed an approximately sinusoidal variation of temperature. The extremes would be smoothed out when real heat capacity is included in the model. It would be interesting to compare the variation of temperatures with the parts of the orbit where a high radiation flux would lead to the instrument being switched off.

The way forward for the study is as follows. Certain assumptions of the model need to be examined-somewhat optimistic numbers had been assumed. The level of CCD shielding interacts with the temperature requirement as the CTI simple models indicate. Examination of the trapping probability of defect states as a function of temperature show that another option is to run "warm" rather than "cold", It is noted however that the quantum efficiency also varies as a fraction of temperature and this needs to be considered. The approaches are to a) optimise configuration number 4, including realistic figures for heat capacities and stray loads; b) agrees what tolerable level of dark current could be tolerated from a science point of view, and thereby reduce the temperature requirements.

A-148 ***MSSL*** **Continue radiator study**

A-149 ***MSSL*** **Determine tolerable temperature from dark current**

A-150 ***MSSL*** **Incorporate shielding in camera concept**

Alignment

Discussions of alignment and tolerance budgets are still on the basis of standard figures. There is no formal error budget at present. A full analysis will be carried out after the NASA Requirements Review. This will be based on ray-tracing results. It is not known at present whether an optical breadboard will be developed either for exploring the alignment and tolerance issues or for other reasons. A simple performance test is needed for use in the alignment procedure. Preparation of an alignment procedure document is a Phase B task. However some thinking about the alignment needs to be done now, because we must not oscillate the design between a closed and open structure concept. The Birmingham group need to be given the basic access requirements related to alignment. It was suggested that a u-shaped structure (i.e. with a lid) would be useful for the spectrograph portion of the instrument. Saad will try to include this in the next iteration.

There was a discussion of the error budgets as it relates to the optimum format for the CCD. This argument is shown in a general document that relates to the case for two CCD's (also in PDF). It is apparent there is a problem in that the baseline 512 pixel high detector format is inadequate to cover the probable drift of the field of view during AIV and launch. Part of the problem is related to the instrument having no pointing legs.

CCD requirements

A draft CCD specification has been sent to EEV and MSSL is waiting for a response. This is expected at the end of August. The consortium needs to think about the usable range of column and other defects. Other Requirements/variables include

- Format
- MPP mode
- Anti-blooming
- Channels (for CTI minimisation)
- Resisitivity
- Depletion depth
- Mounting options, e.g. Invar plate
- Qualification program
- Documentation details

MHC requirements

With reference to the electrical block diagram, the number of functions of this unit is potentially quite large. The new block diagram indicating the present the list of mechanisms will be issued soon. Note: this diagram EIS-sys-des-elecblok-7 has now been revised and placed on the project web site.

The location of this unit on the structure should be determined urgently.

A-151 ***MSSL*** **propose MHC accommodation**

There was a discussion about the nature of the "protection" methods that the MHC would use to manage anomalous conditions, and to what extent the ICU would be involved in the operation of mechanisms.

This topic was covered in a splinter meeting that took place on 30/7/99.

Harness

Harness type	*Components*	*Purpose*	*Required*	*Responsibility*
Electrical	WIR S-WIR	EIS local wiring Spacecraft wiring	Yes Yes	MSSL MELCO
Purge gas	PUR S-PUR	EIS purge distribution Transfer gas to PUR	Yes TBD	BU System side ?
Vacuum	VAC S-VAC	Clamshell pumping Remote pumping	Yes TBD	= Clamshell System side ?

Table 1 . Definition of harnesses

The main electrical harness between ICU, located in the Solar-B bus structure, and ROE and MHC – located in or on the spectrometer (STR), has been identified as a MELCO responsibility. It is designated "S-WIR" in the present System Hierarchy document. Electrical harness on the instrument, which connects MHC to each of the mechanisms, is designated WIR, and is an EIS team responsibility (MSSL will provide the flight electrical harness). In the case of the spacecraft electrical harness, S-WIR, it is expected that parts of this harness will involve connections to the instrument with MDP and other spacecraft items (TBD). Spacecraft interfaces are not exclusively with ICU – for example HKU must connect directly with temperature sensors on EIS.

The same notation has been used to differentiate between parts of the purge harness (S-PUR and PUR) and clamshell vacuum line (S-VAC and VAC), although at present the requirements for these items have not been adequately determined. It is not known whether the system side will be able to provide such items. The local parts (PUR and VAC) will be provided as per the structure and clamshell respectively.

The need for a spacecraft purge harness S-PUR is more certain. It is highly likely that the EIS instrument must be continuously purged at all times during ground operations and as much as possible into the launch operation. The EIS side will provide a gas supply facility for purging the instrument during ground tests and a "flying" gas line may be adequate during those times. With the spacecraft in the launch configuration there are two ways of delivering purge gas to the instrument – either by purging the fairing volume, in which case the instrument may be subject to residual contamination products from other equipment on the spacecraft, or by having a system (S-PUR) that allows purge gas to be fed directly to the instrument. This is a contamination issue and requires further analysis on the EIS side. The EIS side would like the system side to comment.

If, as was the case in the TRACE design, the clamshell can hold its vacuum for many days, there may be no need for S-VAC. Comments from the system side are also requested about this component.

A-152 *system side* **comment on Purge and Vacuum harness discussion**

A wooden model is envisaged for forming the flight wiring harness.

It was noted that test harnesses, corresponding to S-WIR, will be needed by the EIS team and also for PM tests.

ICU Design

Duncan Self will be the lead engineer responsible for all aspects of the ICU design. He presented the results of the studies made so far.

The ICU conceptual block diagram was shown. It is a single-string, single-CPU system utilising a DSP (Harvard-architecture Digital Signal Processor) with a commercial real-time operating system (RTOS) providing the framework for instrument software. The Harvard-architecture DSP uses two buses, the program bus and the data bus. Science data will flow on the data bus. Program code memory and program scratch memory is located on the data bus. This arrangement helps to increase data throughput by easing bus contention. Additional performance is gained by using a DMA controller to transfer data from the ROE interface. The ROE interface will conform to the IEEE 1355 standard. The Analog Devices ADSP21020 has been selected. Rad-hard versions of both the ADSP21020 and the IEEE 1355 chipset are available from TEMIC.

Note – the IEEE 1355 link will be carried over the MELCO harness. Further details of the standard are required by the system side to ensure compatibility.

Virtuoso from Eonic systems Inc. is likely to be selected as the RTOS. A copy and evaluation kit is currently being investigated at MSSL.

There are several instances of space systems that employ a similar architecture, processor and RTOS, the instrument control unit of Rosetta-Virtis being one example.

ICU interfaces

The MDP development schedule milestones are:

Design freeze – hardware	Aug 31, 1999
Design freeze – software	Nov 30, 199

Hiro Hara's presentation showed some details of the proposed spacecraft interfaces. Pages 11 and 12 relate to the PM tests.

The various interfaces are shown on p13. Page 14 shows the buffering within the MDP. The arrangement of the post-compression buffers has changed since the BU meeting.

The system side prefers to have a separate interface for status data (housekeeping data in ESA terminology), since the science stream will be used by EIS with a duty cycle of 0.5 s in 6 s, and hence giving an undesirably long latency of status data.

21 … if we require.

22 .. detection of stopped condition by means of response to status request pulse. Consideration of booting sequence needs to be added to this protocol. This is an issue for both the system side and the EIS side to resolve.

There was a discussion of the manner in which EIS may be powered off in the event of an emergency. Will there a be a warning signal distributed to instruments? And what will be the range of intervals between the warning and the power-off? What will EIS do to safe itself (possible responses include moving the shutter to the closed position, closing the door and saving the Program State in EEPROM)?

A-153 HH clarify instrument emergency power-off sequence

There was a splinter discussion on 30 July in which several of the electrical interface concepts were clarified.

The word length for the science link was agreed to be 16 bits. This will allow the maximum ease and speed of transfer of compressed data from EIS (assumed to be in 16-bit data – TBD). It also allows raw CCD data, memory dumps etc to be transferred without additional manipulation being required. The link will run at 1 Mbps.

Refer also to "Data Flow" by H. Hara Aug. 2, 1999 @ MSSL 5 pages (not distributed at the meeting, also in PDF).

Some additional queries arose in the splinter discussion:

A-154 HH/system impedance of twisted pair cable in "hardware command interface"
A-155 HH/system is HKU used for other than temperatures?

Answer – No.

A-156 HH/system How often is EIS status line requested by PIM?

Answer (discussion with Khalid on 3/8) variable every 2 s – 8s. This request is also treated as a heartbeat – if the requests stop, ICU assumes that MDP is down.

A-157 HH/system any pin allocations on the interfaces?

Questions to EIS side, ECG = EIS Compression Group

A-158 *ECG* Data rate performance of "Hcompress"
A-159 *ECG* Data length (bits) of hcompress
A-160 *MSSL* Does EIS use bi-level hardware status monitor, number of channels?
A-161 AJM/DGS Estimate Occurrence rate of SEU in ICU
A-162 DGS Concept diagram of ICU, showing switching etc… power converters

Telemetry and Command System

The first draft of the Telemetry & Command Design Standards document is expected at the end of August 1999.

Pages 25 and onward in the HH overheads (also in PDF) refer to the present design concepts.

The upload rate of 4 kbps seemed to be adequate for routine purposes, e.g. observing table maintenance.

There were additional splinter meetings at MSSL relating to the Telemetry and Command sytem during 30/7/99 – 3/8/99.

Science

There was a general discussion about the scientific requirement for the instrument. Had the emphasis changed since the original proposals (J-side, UK proposal to PPARC, NASA science definition study and AO, NRL proposal)? Will the forthcoming NASA review be an opportunity to consolidate recent thinking?

NASA will require a short summary of the scientific goals of the instrument. This can be used a s a basis for iterating a team science document. They will also require a requirements table showing how each instrument technical parameter is derived from the stated scientific goals.

A-163 ***MSSL*** **UK proposal (science part) to NRL**

It was important to establish priorities in the science goals so that the instrument development can be planned around the most important drivers. Some science considerations are direct drivers of the technology, for example in the pre-(flare)-trigger concept, the duration of pre-flare data required drives the amount of mass memory required for the pre-flare circular buffer. Opinions vary as to whether this mode of observation is necessary. For example HH calculated that 8 lines at 2 s cadence would be adequate for flare observations, and that this data could be streamed continuously (no data rate limit – only DR capacity limit). However by the use of a circular queue, the "hit rate" for flares in the final data product could in principle be improved.

Some things had indeed changed since the above documents were first published. The wavelength ranges had now been determined, and hence the emphasis on the transition region was not as strong. The effective area of the instrument was now slightly different (due to the selection of round optics) from the estimated values used at the January 99 consortium meeting.

Certain aspects of the instrument were effectively now fixed and others could be changed. Some of those most important to science include:

Fixed parameters	*TBD's*
Number of reflections	Slit width and height
Optical layout	Step size
Dispersion	Cadence
Wavelength range	Raster organisation
Spatial resolution	Processor Speed
Spectral Resolution	On-board algorithms
No independent pointing	Memory size

A-164 **MWT** **to prepare a complete table of instrument specifications for consumption by EIS scientists** **1 Sept**

It was hoped that there would be UK science meetings every 3-6 months in future.

There was a discussion about the value of calculating moments of spectral lines. It was felt that since it was expected to be difficult to guarantee that a shifted or complex spectral line would not confuse the moment-calculating algorithm, that this was a high-risk method of obtaining only a moderate compression ratio.

Another discussion related to the provision of flexibility in the instrument. Whilst there would undoubtedly be a means of uploading code patches to the ICU, this should not be regarded as the primary means of changing the instrument behaviour. Besides the parameters in the observing tables/scripts, other processes (for example "flare trigger") could be built flexibly (having variable parameters) that would allow their operation to be fine-tuned. Another concept giving flexibility is that of modularity of software components. For example, suppose a brightness-tracking (=over time) function existed in some part of the code. If this could be generalised into a brightness finding function and a value-tracking function then the latter could be used for another purpose (for example to track the value of an engineering parameter). Naturally there will be a tradeoff between the provision of such flexibility and the complexity (cost, schedule) of the software.

It was felt that a model of the data throughput was required that would show the amount of data generated per unit time in any given observation. This would be useful for conceptual thinking about operations. MWT will include the known ranges of data rates and link speeds in the instrument specification tables.

Data Compression

This work is being coordinated by the "EIS compression group" under the direction of Louise Harra and Dave Pike. In a discussion of compression schemes, the following basic properties of compression schemes were understood.

pixel compression "bit compression" square-root	CR = 14/12	errors confined to original pixel, can be made less than Poisson-noise
Lossless RICE	typically CR~2	
Image compression JPEG Hcompress	lossy, but CR much greater	error distributed around the image. Distribution depends greatly on algorithm

Rob Gowen reported on some work being done to evaluate Hcompress at MSSL. The code as used on LASCO had been sent by Dennis Wang. It had been compiled on various machines and some tests on a synthetic EIS data window had been done. The Hcompress scale factor=0 produces a lossless mode. In lossy modes there were reports of some problems but these need to be quantified. The level of brightness of the test data set should cover a representative range. The output data should be examined quantitatively.

Further work will include implementation of compression under Virtuoso.

A-165 LH/MWT Plan of action for compression group

Operations

There is a need to design a "low maintenance" system – but what does that mean?

A requirement is to ensure that the time taken by the operator to confirm the safe condition of the instrument should be short, as contact passes are of limited duration (10 minutes total for all instruments). This also applies to the routine loading and verification of observing table updates. In Yohkoh SXT, there are parallel sets of observing tables so that a single command is used to change to a pre-verified table.

Discussion about how abnormal situations should be handled if detected by the instrument away from ground contact. This is part of the full risk analysis, but the least risk design that will be adopted is that the instrument should make safe and halt observations then wait for a command from the ground.

Other factors related to "low maintenance", mostly related to ground software design:

Planning tool prediction of run-time for observations
prediction of data volume
information about SOT pointing

Analysis of HK data easy / automatic. Network-accessible.

Daily plots of status easy to do

Daily meetings of observing targets are expected to take place at ISAS during operations.

The planning tool would be useful at an early stage to allow scientists to become familiar with the instrument capability. It could evolve into a production command-generation tool. The CDS planning tools should be looked at.

There was a brief discussion about operations, responsibility for equipment and interfaces between EIS and Solar-B ground equipment. The level of planning is at an early stage on the Solar-B side.

Rob Gowen presented "Flight Software Development and Testing". This shown in a diagram the evolution of checkout, EGSE and operational ground equipment.

EGSE

Software status:

More effort for EGSE work is being sought within the UK. Some conceptual thinking has taken place. The next step is to form a PM development plan for EGSE. We need to know when the PM test programme will begin and what functionality will be required.

Summary of Actions

Actions arising

A-125	***BU***	**consider view of SOT MLI in thermal model**	
A-126	***NRL***	**elaborate/justify component temperature ranges**	
A-127	***NRL***	**elaborate component disturbance torques**	
A-128	***BU***	**state number and position of required survival heaters**	
A-129	**HH**	**Request information about the MTQ flux reaching ICU**	
A-130	**CMB**	**send Saad example filter drawing.**	
A-131	**CMB/MWT**	**clarify debris issue.**	
A-132	***NRL***	**Mechanism ICD**	
A-133	***MSSL***	**show wiring harness concept on structure drawing**	
A-134	***NRL***	**show access requirements on structure drawing**	
A-135	***RAL***	**show purge harness concept on structure drawing**	
A-136	**HH**	**to find out what freedom existed in the leg position.**	
A-137	**HH**	**system side to comment on purity of thruster gas**	
A-138	**HH**	**system side confirm thruster usage frequency**	
A-139	***BU***	**Develop thermal model of instrument**	
A-140	**CK**	**trace information from the FUSE carbon composite experience.**	
A-141	**MWT/CMB**	**calculate (roughly), carbon load for 90 % efficiency. Density = 1 g/cc may be assumed**	**complete**
A-142	**CK**	**forward EUVE instrument contamination control plan to EIS technical teams via MWT. EUVE spacecraft contamination control plan to Solar-B side via HH.**	
A-143	**HH**	**to report on observed levels of (e.g. particulate) contamination in the ISAS clean rooms.**	
A-144	***MSSL***	**Measure resistivity of BU's Cycom plate sample**	
A-145	***BU***	**Review grounding practice in carbon structures**	
A-146	***MSSL***	**Measure resistivity of BU's Cycom plate sample**	
A-147	***BU***	**Review grounding practice in carbon structures**	
A-148	***MSSL***	**Continue radiator study**	
A-149	***MSSL***	**Determine tolerable temperature from dark current**	
A-150	***MSSL***	**Incorporate shielding in camera concept**	
A-151	***MSSL***	**propose MHC accommodation**	
A-152	***System side***	**comment on Purge and Vacuum harness discussion**	
A-153	**HH**	**clarify instrument emergency power-off sequence**	
A-154	**HH/system**	**impedance of twisted pair cable in "hardware comand interface"**	
A-155	**HH/system**	**is HKU used for other than temperatures?**	**complete**
A-156	**HH/system**	**How often is EIS status line requested by PIM?**	**complete**
A-157	**HH/system**	**any pin allocations on the interfaces?**	
A-158	***ECG***	**Data rate performance of "Hcompress"**	
A-159	***ECG***	**Data length (bits) of hcompress**	
A-160	***MSSL***	**Does EIS use bi-level hardware status monitor, number of channels?**	
A-161	**AJM/DGS**	**Estimate Occurrence rate of SEU in ICU**	
A-162	**DGS**	**Concept diagram of ICU, showing switching etc… power converters**	

A-163	***MSSL***	**UK proposal (science part) to NRL**	
A-164	**MWT**	**to prepare a complete table of instrument specifications for consumption by EIS scientists**	**1 Sept**
A-165	**LH/MWT**	**Plan of action for compression group**	

Existing Actions

Please refer to the list in EIS-man-actions. (4)

Next Meeting

The following dates are provisional

UK Science Team discussion MSSL 29th September

Engineering Meeting NRL Early October
This is an opportunity for other Solar-B instrument scientists to coordinate with EIS.

Solar-B team meeting ISAS Early December