Solar B - EIS

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EIS STRUCTURE REQUIREMENTS

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CHANGE RECORD

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	29 May 2000	All new	
02	31 May 2000	3,4,7 & 8	Par 3.1, up-issue of AD 4. Par 5.3, shear pins now 20mm. Par 12.1, second bullet - ‘grating’ changed to ‘mirror’. Par 13.3 Alignment Template added.
03	29 June 2000	3,4,	Par 5, reference now made to the ICD. Addition of AD 6 in par 3.1. Par 10, reference to ICD.

CONTENTS

1. INTRODUCTION

Solar-B will study the connections between fine magnetic field elements in the photosphere and the structure and dynamics of the entire solar atmosphere.
The mission will perform three basic types of observation with high spatial, spectral and temporal resolution :

Determination of the photospheric magnetic vector and velocity fields.
Observation of the properties of the resulting plasma structures in the transition region and corona.
Measurement of the detailed density, temperature and velocity of these structures.

The EUV imaging spectrometer (EIS) will obtain plasma velocities to an accuracy of <= 10 km s^{-1} along with temperatures and densities in the transition region and corona at <2 arc sec resolution. EIS consists of a multi-layer coated single mirror telescope, and a stigmatic imaging spectrometer incorporating a multilayer coated diffraction grating. The image produced by the primary mirror is imaged onto an entrance slit/slot and the light which passes through this spectrometer aperture is dispersed and re-imaged in the focal plane of the CCD camera.

2. SCOPE

It is the purpose of this document to specify the requirements of the structure of the EIS instrument that will allow it to fulfill the mission requirements, particularly in the context of the restraints imposed upon it by the Science Requirements, the proposed optical design and the environmental conditions specified for the launch vehicle.

3. DOCUMENTS

3.1 Applicable Documents

AD 1	SLB-124 rev 1.0, April 2000	Environmental Conditions for Solar-B,.
AD 2	TK7-00-0017, March 2000	Mechanical Integration and Alignment Procedures for Solar B Telescopes
AD 3	NRL/SLB-EIS/TN206.01	Provisional Optics Positioning Error Budget and Provisional Structural/Thermal Requirements for the Extreme Ultraviolet Imaging Spectrometer
AD 4	SLB-150 rev 2, May 2000	Solar B Telescope Thermal Interface Condition
AD 5	EIS_CC_Plan dr, 21 April 2000	Contamination Control Plan for EIS Instrument Components
AD 6	MSSL/SLB-EIS/SP003	Solar B EIS ICD Document

3.2 Reference Documents

RD 1	MSSL/SLB-EIS/SP/004	Mass Budget
RD 2	NRL/SLB-EIS/SP 202.01	EIS Components ICD, document.

4. SYSTEM DESCRIPTION

A block diagram of the system is shown in the Appendix.

4.1 Coordinates
Throughout this document, the X, Y, and Z axes are considered to be parallel to the spacecraft axes. Tilt, Pitch, and Roll refer to rotations about X, Y, and Z, respectively.
The spacecraft axes are included in the block diagram in the Appendix.

4.2 Environmental Requirements
The environmental conditions for the mission are specified in AD 1.

5. MECHANICAL REQUIREMENTS

5.1 Mass
The mass budget for the instrument is shown in RD 1. Further mechanical properties are given in the ICD, reference AD 6.

5.2 Stiffness
The stiffness requirements are given in the ICD, reference AD 6.

5.3. Mechanical Interface With Spacecraft
The mechanical interface with the Spacecraft is detailed in the ICD, reference AD 6.

6. ELECRICAL REQUIREMENTS

Should the material of the structure be non conducting, then provision shall be made for eliminating the build up of electrostatic charge.

7. OPTICAL REQUIREMENTS
7.1 NRL Component Drawings
Table 1 is a cross-reference to NRL drawings relevant to structural requirements for EIS. Each interface drawing contains a bolt pattern and all are prototype mechanisms at this point.

Table 1. NRL Drawings cross-reference

EIS Component	Assembly Drawing	Interface Drawing
Primary Mirror (MIR)	NRL-EIS 3511C	NRL-EIS-MIRMECH
Mirror Blank	NRL-EIS 3550C	NA
Slit/Shutter (SLA)	NRL-EIS 3510C	NRL-EIS-SLAMECH
Grating (GRA)	NRL-EIS 3513C	NRL-EIS-GRAMECH
Grating Blank	NRL-EIS 3511C	NA
Zero Order Trap	TBD	TBD
Light Baffle apertures	TBD	NA
Alignment Tools	TBD	TBD

7.2 General NRL Component Mounting Tolerances

All of the optical components provided by NRL mount to the structure via three bolt patterns. All mount to a sub plate or spacer that adjusts their spacing from the mounting surface. Threaded or clearance hole patterns must be provided in the structure that allow +/- 0.5mm accuracy in locating the designated center point of each mechanism to the optical plan. General angular accuracy should be 1 arc min. Fine adjustments are contained within the NRL provided mechanisms and such adjustments will be made during instrument alignment. Provisions for pinning the mounting plates or mechanisms to the structure should be made as it will be necessary to hold the adjusted components to the higher accuracy described below. Details of the mounting and alignment tolerances for each component are presented in the Provisional Optical Positioning Error Budget (NRL/SLB-EIS/TN/206.01).

7.3 Provisional On-Orbit Dimensional Stability

The EIS structure serves as an optical bench for all the optical components of a high performance EUV telescope and spectrometer. As part of the optical design study, NRL has presented a report on the system error budget entitled "Provisional Optics Positioning Error Budget and Provisional Structural/Thermal Requirements for the Extreme Ultraviolet Imaging Spectrometer" reference AD 3. The stability requirements on the optical bench were derived from error coefficients reported in the above report. In general, they are consistent with the properties of a very stiff composite structure with a CTE of <1 ppm and a CME of <100ppm/% (<20ppm total moisture related change) with a corresponding of absolute thermal control of 2 degrees C and a corresponding control of gradients of 0.5 degrees C. Stability requirements for each component (tilt and defocus) is given in AD 3.

7.4 Interface to Components

NRL Drawings EIS 3546C, EIS 3547C and EIS 3548C show the mounting bolt pattern for the MIR, GRA, and SLA. A mounting sub-plate should be provided for each mechanism. The thickness of this sub-plate will be set to bring the center of each optic to the height of the optical axis. A separate bolt pattern will be used to mount the sub-plate to the structure. A second purpose of the sub-plate is to allow minor changes to take place within the optical design or structure without re-work on expensive components. Further details of the mechanical interface and envelope of the NRL supplied components are given in RD 2.

7.5 Alignment fixtures

Attachment points on the structure will be required for several alignment tools such as micrometers, mirrors, microscopes, etc. that will be used during the alignment process. Usually these are sets of tapped holes in the structure for mounting a holder or bracket. The locations [TBD] will be chosen by NRL in consultation with the structure designer to have a low impact on the structure.

8. STRAY LIGHT

A number of baffles will be required to suppress stray light within the instrument. They will be strategically placed to do their job whilst being compliant with structure requirements and constraints. NRL will specify the [TBD] baffle locations in collaboration with the structure designer and define the aperture shape and size. NRL will be responsible for the surface finish and performance of these baffles. Baffles are generally non-structural and can be fabricated from light metal such as irridited aluminum or from composite sheet.
A light trap will be provided by NRL to collect and suppress the zero order light from the grating. It will be located in the spectrometer box forward of the MHC electronics module. Its mounting will be a three bolt pattern in the spectrometer box floor. NRL will specify its [TBD] location after the more critical items are located.

9. COMPONENT MOUNTINGS

The position of the optical components described in par 6, shall be as shown in the drawing SR 8160 issue B, GA Proposal.
In addition to these components there is a Clamshell, which is designed to act both as an instrument door and also provide a protective environment for a delicate aluminium filter prior to launch.
Not clearly represented on this drawing are 2 Quartz Contamination Monitors which are designed to measure molecular contamination within the instrument.

10. THERMAL REQUIREMENTS

The thermal interface conditions are specified in AD 4.

10.1 Calculated Internal Heat Dissipation

This is provided in the ICD, reference AD 6.

10.2 Acceptable Temperature Ranges

This is provided in the ICD, reference AD 6.

10.3 Thermal Stability

Calculations from the System Error Budget (AD 3) give the following provisional thermal control system requirements:

Overall temperature change	<2 degrees/hour or 0.033 degrees/minute
Overall gradient variation	<0.5 degrees/hour or 0.0083 degrees/minute

10.4 Control Power

The survival heater power available is 15 watts in positions yet to be decided.
The operational heater power is currently proposed as follows:

Hot-case	Mirror Assembly Heater 1W
Cold-case	1. Mid-box heaters, 1.5W. 2. Grating assembly heater, 2W. 3. Mirror assembly heater, 2.5W.

Total 6W plus margin.

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11. CONTAMINATION

Accumulation of carbon contamination in the optical path will result in very significant reduction of the sensitivity of EIS, the greatest effect being in the long wave band. Hydrocarbon coatings of reflective surfaces will have a double effect since they are passed through twice. Materials selection, vacuum conditioning, and handling procedures must be such that the hydrocarbon contamination accumulation is less than 180Å at the end of the life of the mission
A detailed contamination control plan has been drafted describing the vacuum conditioning and handling procedures for EIS AD 5. An end-of-life buildup for internal surfaces is A/5 corresponding to 2nm of volatile contamination.

12. OTHER PROPERTIES

12.1 Accessibility

Hatches
Access hatches must be provided for each EIS optical component. These must be sized to allow installation of the assembled component and to allow manual access to the fine adjustments during instrument alignment. A provisional set of access hatches have been chosen and are shown of drawing UB SR 1860-B.
Viewports
There is considerable flexibility in the location of viewports, and their location should be negotiated with the NRL optical team. The number and size of viewports is summarized below.

- Two viewports should be provided for viewing the grating, one for the rear mirrored surface, and one for the mirrored flat on the margin. These viewports should be >20mm in diameter.
- One viewport should be provided for viewing the mirrored rear surface of the mirror, again >20mm in diameter
- One viewport should be provided for a periscope to be used to view the focal plane at the slit. A location and size of for this port is proposed on drawing SR 8160-B.

12.2 Handling and Storage

A detailed handling and storage procedure shall be written for any deliverable structural model. The complete instrument is over 3 metres long and has a mass of 60/70 kg. Handling points will therefore be essential.
The flight structure, prior to assembly of the optical sub-systems, should be stored in an environment of at least Class 10,000 cleanliness, at a temperature of 23+/-5 Centigrade and at a relative humidity not exceeding 55%.
It is possible that these conditions may be relaxed for the MTM/TTM.

13. DELIVERABLES

13.1 Mechanical and Thermal Model (MTM/TTM)

The MTM/TTM is a flight representative structural model, which will be fitted with dummy masses as necessary, to enable qualification testing to be carried out in Japan.
Mechanical testing will be conducted first and the model will then be reconfigured in Japan for thermal testing. Included will be thermal balance and thermal vacuum tests.
Strictly this model is not intended to be "clean". However, the Japanese will be treating it as though it is, in order to test out their own handling systems.

13.2 Flight Model

The flight model must be delivered to RAL (Oxfordshire), where the rest of the flight parts will be fitted to it. The instrument will then be commissioned and environmentally tested at RAL, prior to being shipped to Japan.

13.3 Mechanical Ground Support Equipment (MGSE)

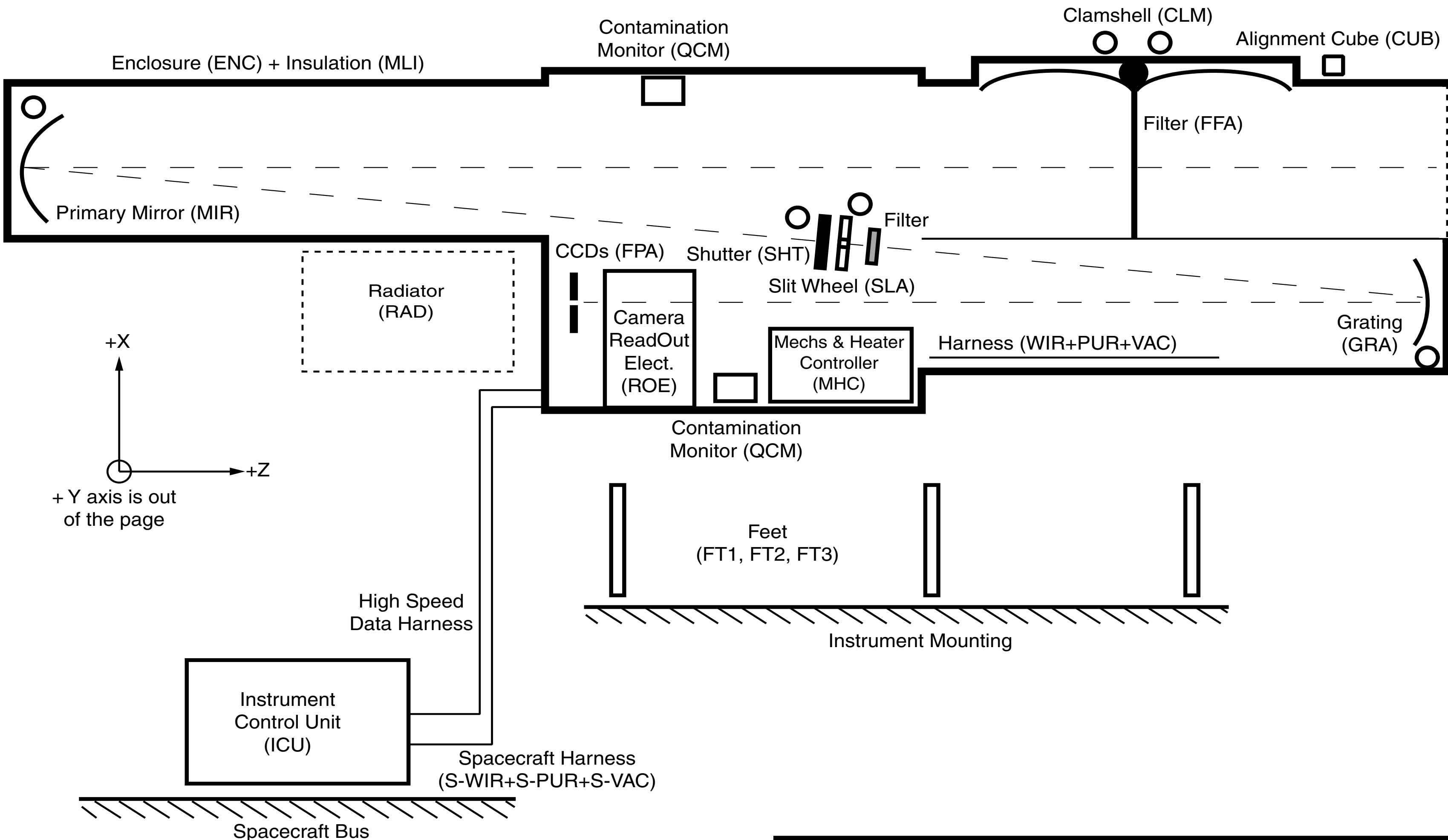
Any necessary special MGSE for either model must be provided and be available to travel with it. Typically this would include the Alignment Template, attachments for a hoist, special slings, vacuum fittings for the Clamshell and nitrogen fittings for the purge gas.

13.4 Transport Containers

Each Model will require its own transport container. It is not envisaged that the container for the MTM/TTM would need to be highly sophisticated. However, that for the Flight Model may need to be a vacuum vessel, or as a minimum, capable of being purged with dry nitrogen gas during transit.

13.5 Documentation

Documentation for the design, materials and processes of the structure would be expected to be of the standard usually provided for a space project that involves NASA, ISAS and PPARC.



○ Mechanisms

Changes: 01 First issue this format. Redrawn.

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Solar-B EIS

Physical Block Diagram

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