Solar B - EIS

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DEVELOPMENT PLAN FOR MSSL's CONTRIBUTION TO EIS

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CHANGE RECORD

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	23 November 1999	All New	
02	29 June 2000	All	Minor editorial changes. Addition of appendices.

CONTENTS

1. PROGRAMME OVERVIEW

Japan's next solar physics mission, Solar-B, will place the first solar optical telescope in space. Launch is scheduled in August 2004.
Whereas Yohkoh (Solar-A) continues to be highly successful in studying the active Sun, with emphasis on high-energy phenomena in the corona, 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.

A coordinated set of instruments will deliver these observations :

A 0.5 m optical telescope equipped with a vector magnetograph, narrow band imager and to obtain photospheric magnetic and velocity fields at 0.2 arc sec (~150 km) resolution.

An EUV imaging spectrometer to 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.

An X-ray/EUV telescope to image transition region and coronal plasma in the range 0.5 - 20 MK at ~2 arc sec resolution.

The EUV imaging spectrometer (EIS) will be built by a consortium led by MSSL.
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 and entrance slit/slot and the light which passes through this spectrometer aperture is dispersed and re-imaged in the focal plane of the CCD detector.
The UK will provide the structure of the EIS instrument, the CCD camera and its electronics, and the main instrument electronics system. The CCDs for EUV detection will procured from UK industry (Marconi Applied Technologies). The UK will also provide the flight software.
The Naval Research Laboratory, Washington DC, in association with the NASA Goddard Space Flight Center, Greenbelt MD, will provide the instrument's optics and their mechanisms, including the entrance filter, multilayer-coated mirror and grating, and the spectrograph slit.
The members of the UK consortium having a hardware role are MSSL, Birmingham University and the Rutherford Appleton Laboratory. Other consortium members are in university research groups in Cambridge, Imperial College, and St. Andrews.
Japan's National Astronomical Observatory will be involved in the interaction with ISAS, Japan's Institute for Space and Astronautical Science.

This Development Plan relates only to the MSSL contribution to the EIS Instrument.

2. MAJOR MILESTONES

Preliminary Design Review	6/7 July 2000
Critical Design Review	01 March 2001
Prototype Model delivery	12 March 2001
Mechanical/Thermal Model delivery	01 May 2001(responsibility of Birmingham)
Flight Model first delivery	3 January 2003
Flight Model second delivery	July 2003
Launch	August 2004

3. MODEL PHILOSOPHY

Breadboard Model
A breadboard model of the ICU electronics will be constructed to test the interfaces to the spacecraft.

Prototype Model
Engineering models of the ICU, CCD Camera and MHC will be prepared on PCBs that will develop into flight versions and will ultimately provide full functionality. However, initially they will form the Prototype Model. Some environmental testing will be conducted on this model.

Software development Model
A version of the electronics will be made available for software development.

Mechanical/Thermal Model
This will be a single model and will be qualification tested in Japan. It is the responsibility of Birmingham University and will be fitted with dummy masses of the sub-assemblies.

Flight Model
The flight model will be built once the prototype model has been built and tested in Japan.

Spares
There will not be a spare model. Enough flight quality components will be purchased to provide a sensible level of support to the flight model.

Contamination Model TBD

4. PROJECT DELIVERABLES

A Prototype Model of the electronics
The Mechanical/Thermal Model (Birmingham)
The Flight Model
Flight Software
EGSE
Supporting documentation

5. MSSL TEAM MEMBERS

Project Manager
Ady James (from September 2000)

Electronics
Alec McCalden - Systems Engineer
Rahil Chaudery - ICU
Chris McFee – CCD and Camera System
Phil Thomas – Camera design
Robert Card - Power
Jason Tandy - MHC

Mechanical/Thermal
Wilf Oliver - Systems Engineer
Peter Coker

Software
Rob Gowen - Systems Engineer
Khalid Al-Janabi
Matthew Whillock

Quality Assurance
Tony Dibbens

6. FUNDING

This project is funded by a grant from PPARC.

7. AREAS OF WORK

7.1 Electronics

The system design is described in a block diagram (MSSL/SLB-EIS/DD001.01), see Appendix 1.
There are 3 readily identifiable electronic boxes that make up this electronics design, the Instrument Control Unit (ICU), the Camera and the Mechanisms and Heater Control Box (MHC).

The ICU
This unit houses the main instrument processor and serves as the interface between the camera and MHC on the EIS instrument and the Mission Data Processor (MDP) on the spacecraft. Command and telemetry data is controlled by the processor and communication with the MDP is via the command, status and mission data interfaces. Communication with the Camera is via a Low Voltage Differential Signaling (LVDS) bi directional link for the data transfer. Image processing is carried out by the processor prior to being prepared for telemetry. The processor chosen for flight is a Temic TSC 21020 DSP (an Analogue Devices chip made under license). This chip is made by an inherently rad-hard process and will be used with the Virtuoso real time operating system. The ICU also controls the MHC.
A custom designed power conditioning system will be needed to take the raw 28V from the spacecraft and provide the necessary smoothed outputs for the ICU.
The ICU will be fitted on the spacecraft, some five metres from the EIS instrument.

The Camera
It is proposed to use two CCDs in the camera in order to be certain that the whole of the spectrum can be observed. The type of CCD chosen is Marconi's CCD42 series.
Radiation testing will need to be performed on this type of device. The camera design will draw form the experience gained with the Integral project, but major redesigning will be necessary because of the use of two CCDs and the requirement for dither clocking.
Special cooling requirements are envisaged to run the CCDs as low as possible. The target temperature is –60 degrees C, but a higher temperature may be acceptable.

The MHC
The mechanisms and heater controllers will be sited in a box that will be close to the camera on the instrument. It will include an arming facility to avoid accidental actuation of key mechanisms and will have some local power conditioning. A high voltage system will be necessary for the mirror adjustment mechanism.
A major part of the PM version of this box will be made by NRL (the American Co-I for this project.) MSSL will construct the box and design and make the high voltage controller for the mirror adjustment mechanism.

Harnesses
The flight harness between the ICU and both Camera and MHC will be supplied by ISAS. MSSL will therefore only provide internal harnesses within the electronic boxes.

7.2 EGSE
A number of simulators representing each of the three boxes will be required in order that development work can proceed independently on the boxes. A spacecraft simulator will also be needed for the ICU development and for testing of the whole system.

7.3 SOFTWARE
MSSL is responsible for supplying the flight software for the whole instrument.
The ICU interfaces with the Mission Data Processor on the spacecraft. This is a new Japanese design and key interface documents on telemetry, commanding, housekeeping and timing will be required from the Japanese before significant progress can be made on the instrument flight software.
Software support will also be required for the various pieces of EGSE that are envisaged.

8. WORK BREAKDOWN STRUCTURE (WBS)

The WBS is shown in EIS-sys-eng-wbs, EIS Work Break-down Structure.

9. CONTROLS AND REVIEWS

A formal review of all MSSL projects occurs once a month and the project manager must submit a written report on the status of the project. This report will contain information on Technical progress, Model Status, Risks, Schedule, Finances and a List of Concerns. If at all possible, the Project Manager must attend this meeting.
Periodic reviews will also be held by the PPARC Steering Committee for the Solar B project and these must be supported with a progress report and cost data.
Local meetings are at the discretion of the individual System Team Members.
Engineering meeting for the whole team are anticipated every 3 months and the location of these will be shared by the participating organizations, including Japan.

10. VERIFICATION PLAN

The verification plan is shown in the following table:

	Interface	Shock	Vibn	Accoustic	TB	TV	Calibra tion	EMC	Func tion
PM	Yes								Yes
MTM/TTM	Yes	QL	QL	QL	Yes	Yes			
FM	Yes	AL	AL	AL	Yes	Yes	Yes	Yes	Yes

QL = Qualification Level
AL = Acceptance Level
Two deliveries of the Flight Model are anticipated. At the first delivery, mechanical, electrical and software integration checks will be performed. Following this, the instrument will be returned to RAL in the UK for calibration. Calibration will be performed in the RAL vacuum facility to a procedure that will be published by RAL and agreed by the consortium.

11. SCHEDULE

The schedule for the MSSL work is shown in Appendix 2.

12. DOCUMENTATION AND PA

The Project Manager shall organize and operate a project documentation system that has a numbering system as defined in the MSSL Quality Handbook. A list of project documents shall be kept and this shall be made accessible on the Web.
The particular documents to be prepared shall be as defined by the MSSL system and additional ones as determined by the project requirements.
The project manager shall ensure that all the required Product Assurance measures specified by the project are put in place.
Configuration control procedures shall be operated by the MSSL PA manager.