Solar B - EIS

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EIS CCD Camera - System Requirements Document

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Change Record

Date	Issue	Section	Description of change
3/11/1999	1.0		First Issue
16/3/2000	1.1	5.2	Updated to include reduction of windows to two per CCD
15/6/2000	2.0	All sections	Document re-written
4/7/2000	3	All sections 3.5 (3.2a and 3.2e in table)	Requirement numbering changed to reflect science requirements. arcseconds changed to pixels

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1 Introduction

1.1 The EIS camera head will consist of two CCDs, the focal plane array, which supports the CCDs at the focal plane, and the Read Out Electronics (ROE) which will convert the analogue CCD voltages into digital values and transmit these values to the EIS Instrument Control Unit (ICU). Therefore, the purpose of this document is to establish the top level requirements for the EIS CCD camera system. These requirements have been derived from the EIS Science requirements (MSSL/SLB-EIS/SP007), and the EIS system definition (MSSL/SLB-EIS/SP011.01). Individual sub-systems may have more detailed design requirements which are not explicit scientific or technical requirements. For example, the provision of a master reset facility in the ROE to deal with any camera "hang-ups". Consequently, the detailed requirements for the ROE are listed in the Design requirements for the Solar-B EIS Read Out Electronics (MSSL/SLB-EIS/SP05).

1.2 The EIS design will consist of a mirror, a slit, a grating, and a detector. An area of the sun (selected via uplinked command) is focused onto the slit. In turn, this image is dispersed by the reflection grating into two separate spectral regions, a low wavelength regions (180-204Å), and a high wavelength region (250-290Å), and these regions are then focused by the grating onto two CCDs mounted in the camera head.

2 Applicable Documents

EIS Science Requirements	MSSL/SLB-EIS/SP007
EIS System Definition	MSSL/SLB-EIS/SP011
Design Requirements for the Solar-B EIS Read Out Electronics	MSSL/SLB-EIS/SP05

3 Scientific Requirements

The following table describes the Scientific Requirements of direct relevance to the CCD choice and design, as laid out in the Science Requirements document.

	Requirement	Req. No	Value	Implications for the camera specification
1	Spectral resolution	2.1	To perform EUV spectroscopy with a high spectral resolution.	1. The design of the spectrometer assumes a CCD pixel size of 13.5µm which matches the plate scale of the telescope spectrometer. 2. To minimise the dark current, and hence improve the signal to noise ratio, an MPP device shall be used. 3. To minimise any degradation of line widths, the CCD must minimise both dark noise and Charge Transfer Inefficiency (CTI). This requires an appropriate trade off between temperature (via a cold finger) to minimise the dark noise, and temperature, shielding, and CCD operating parameters to minimise the effect of radiation on the device. 4. To minimise the potential effect of ionising radiation on CCD dark noise, it shall be possible to alter certain CCD bias voltages whilst in flight.
2	Spatial resolution	2.2.	To perform EUV spectroscopy with high spatial resolution equal to or less than 2"	1. The design of the spectrometer assumes a CCD pixel size of 13.5µm which matches the plate scale of the telescope/spectrometer
				2. The camera head shall be located within the Rowland

				circle associated with the spectrometer sufficiently accurately to enable a good focus to be achieved and maintained throughout the working life of Solar-B.
3	Temporal resolution	2.4, 2.7	To perform both the imaging and spectroscopy mode with high temporal resolution. To respond to highly dynamic phenomena	1. A fast readout speed of 500 kpixels/s (i.e 2µs per pixel) shall be required. 2. On chip windowing shall be implemented to minimise readout time. 3. A dump drain shall be necessary to enable fast dumping of unwanted CCD rows. 4. It shall be possible to simultaneously clock charge from the two amplifiers (on at each end of the readout register) on each CCD.
4	Wavelength range	2.5.	low - 170-204Å high - 250-290Å	1.Two CCD detectors shall be required
				2. The CCDs shall be backthinned to maximise the Quantum Efficiency at these wavelengths
5	Read Out Requirements	3.2.a	To expose and readout the image area (2048 x 512 pixels) of both CCDs simultaneously	1. It shall be possible to specify the window heights and widths such that it is possible to clock out the entire image area.
		3.2.b	To allow any fraction of the CCD to be downloaded in the spatial direction.	1. It shall be possible to set a window height in the spatial direction.
		3.2.c	To allow any fraction of the CCD to be downloaded in the spectral direction.	1. It shall be possible to set a window width in the spectral direction.
		3.2.d	To have minimum	1. It shall be possible to set

			of 1 spectral window and a maximum of 25 spectral windows	one spectral window which will enable only certain portions of the CCD to be physically clocked out. Additional spectral windows will be handled in software.
		3.2.e	To expose and process 1x512 pixels (eg, readout, compression) in the order of fractions of a second.	1. The use of windowing is available to allow substantial fractions of the CCD to be downloaded in 0.25/0.5 seconds.

4 Technical Requirements

The following table describes additional Requirements of direct relevance to the CCD choice and design which are imposed by the overall EIS instrument requirements, as described out in the EIS system definition document.

	Requirement	Value	Implications for the camera specification
6	Field of View	TBD 1000" (spatial direction) x2000" (spectral direction)	1.Size of CCD shall be sufficient to cover entire FOV, this requires a CCD size of 2048 x 1024 pixels to allow for alignment issues
7	CCD power consumption	The power consumption should be minimised.	1. Clock speed and ADC speeds shall be selected to minimise power consumption
8	Mass	The mass available is constrained	1. To minimise potential charge transfer inefficiency effective shielding will be required. However, increased shielding will lead to increased mass.