Solar-B **EIS** * EUV Imaging Spectrometer	EIS CCD camera - System Requirements Document

Title	EIS CCD camera - Systems Requirement Document
Doc ID	MSSL/SLB-EIS/SP01
ver	1.0
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Date	3 November 1999

Contents

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

1 Introduction

1.1 The purpose of this document is to establish the requirements for the EIS CCD camera. The user requirements for the camera have been derived from *EIS-sysreg-eng-userneed*, which establishes the science requirements for EIS, and *EIS-sys-eng-sysreq* which describes the system level requirements for EIS.

1.2 The system requirements for the camera can come from three different areas:

- directly from the science requirements - e.g the need to achieve a particular cadence rate or dynamic range;
- as technical requirements from the EIS system design, which themselves have been derived from the science requirements;
- requirements which are not specficied by the telescope design or science requirements but which can be thought of as being implicit, e.g sufficient calibration facilities must be provided

1.3 The EIS design will consist of a mirror, a slit, a grating, and a detector (the exact specifications of the EIS are still TBD). 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 seperate spectral regions, a low wavelength regions (170-210°), and a high wavelength region (250-290°), and these regions are then focused by the grating onto two CCDs mounted in the camera head.

2 Scientific Requirements

The following table describes the relevant Scientific Requirements, as laid out in the Systems Requirements document, and their implications for the CCD camera head design.

	Requirement	Value	Implications for CCD specification
1	Wavelength range	low - 180-204Å high - 250-290Å	Two CCD detectors will be required
			The CCDs should be backthinned to maximise the Quantum Efficiency at these wavelengths
2	Temporal resolution	commensurate with evolution of features	The CCD must support a number of imaging modes
			Separate amplifier paths may be provided to maximise the cadence
3	Spatial resolution	< 2"	The design of the spectrometer assumes a CCD pixel size of 13.5µm

			The camera head must 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
4	Spectral Resolution	<20km/s/pixel	The design of the spectrometer assumes a CCD pixel size of 13.5um
5	Field of View	1000" (spatial direction) x2000" (spectral direction)	Size of CCD must be sufficient to cover entire FOV, this requires a CCD size of 2048 x 1024 pixels to allow for alignment issues
6	Sensitivity	must be as high as possible	The CCD must have a high QE at the required wavelengths, and the dynamic range of the CCD should be as high as possible
			A low on chip read out noise must be available. This will require the use of correlated double sampling (cds). Variable cds times will enable the operator to trade off read out noise with cadence rate
			The CCD must minimise both dark noise and CTI as much as possible. This requires an appropriate trade off between temperature (via a cold finger) and dither clocking to minimise the dark noise; and temperature, shielding, and operating parameters to minimise the effect of radiation on the device
			The device will be backthinned to maximise QE. Precautions must be taken to reduce the effect of contamination on the CCD backface

3 Technical Requirements

	Requirement		Implications for CCD specification
7	CCD mounting	The two active wavelength areas will be separated by 27.8mm ± TBD	
		The depth of focus is TBD	A self contained housing is required for the CCD and Read Out Electronics which must be capable of mounting accurately onto the appropriate position on EIS

			The mounting must be capable of alignment in all three axes
		The camera head will need to be mated with the EIS structure, and tests established to show that a correct alignment has been achieved	The CCD will be operated at room temperature to allow the tests to be conducted efficiently. The device may have to be operated with dither clocking, or an MPP CCD may need to be selected
8	CCD power consumption	The power consumption should be within the values established for EIS (TBD)	

4 Operational requirements

	Requirement		Implications for CCD specification
9	The nominal mission lifetime of Solar-B is 3 years	Sufficient calibration functionality should be provided to allow the CCD to operate within its required performance limits for this time	The camera head must be able to send CCD images to ground based users
			The camera head must be configurable by ground-based users
			Sufficient test functionality should be available to allow the CCD detector to provide calibration data to ground based users. This may include provision of a suitable flat field at the detector face and an Fe55 source, suitably housed in the camera head
10	The radiation environment over the mission lifetime should not cause a degradation of the CCD		An appropriate choice of temperature, shielding and device operating parameters will be necessary to minimise radiation damage and its effects
			Heaters must be provided to maintain the optimum operating temperature, and to allow removal of contaminants, and "annealing" of ionisation induced dark noise

5 Notes

5.1 Temporal resolution

A number of measurement modes must be provided. In particular:

- readout window:
  a known area of the image can be selected. Charge from pixels prior to the read out window do not need to be read and can be quickly dumped.
  The window will be specified in terms of two co-ordinates (xstart,ystart) and (xend, yend) - where x refers to the pixel number (i.e the spectral direction) and y refers to the line number (i.e the spatial direction).

- binning in the serial and parallel registers:
  It should be possible to bin pixels in both the parallel and serial directions

  The binning ratio can be specified in terms of m x n where m refers to the binning ratio in the spectral direction, and n refers to the binning ratio in the spatial direction. Note - due to saturation of charge in the summing registers, there will be a physical limit to the amount of charge that can be binned in either direction.

- specification of windows:
  up to two windows will be available per CCD. One window can be readout to the right hand amplifier, the other to the left hand amplifier. Both windows must be the same row height.

- integration time:
  as well as a range of integration times, it should be possible to specify a zero integration time as an additional calibration mode.

- flush the CCD:
  i.e dump all the charge from the CCD before taking an image.

5.2 Calibration facilities

The camera head design will need to support the following specialised measurement modes:

1 Dark Current
2 Flat fielding
3 Overscan
4 CTI
5 Read out noise
6 Bias value