Solar B - EIS

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EIS SCIENCE REQUIREMENTS

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CHANGE RECORD

ISSUE	DATE	PAGES CHANGED	COMMENTS
01	30 May 2000	All new	Major revision and new reference number.

CONTENTS

I. **Major Science Goals**

Coronal Heating - to determine the physical mechanisms responsible for coronal heating in the quiet Sun and active regions (e.g. detect magnetic reconnection, wave heating).

Transient Phenomena - to determine the physical mechanisms responsible for transient phenomena, such as solar flares, coronal mass ejections, jets, network brightenings, in the solar atmosphere (e.g. determine energy transport and mass motions during transient events).

Energy Transfer from the photosphere to the corona - to investigate the causal relationship between dynamics in the photosphere and coronal phenomena (relate EIS observations to data obtained by the solar-B SOT and XRT).

II **Science Requirements**

1) *To perform EUV spectroscopy with high spectral resolution.* EIS is required to determine Doppler velocities to an accuracy of ~ 3km/s from spectral line shifts and non-thermal motions as small as 20 km/s from line widths.
2) *To perform EUV spectroscopy with high spatial resolution.* EIS is required to resolve structures equal to 2 arcsecs resolution.
3) *To perform monochromatic EUV imaging.*
4) *To perform both the imaging and spectroscopy mode with high temporal resolution.* In spectroscopy mode, EIS is required to obtain accurate measurements of strong line intensities and line widths in < 1s in highly dynamic events such as flares, and every 10 s in less dynamic phenomena such as active region loops. In imaging mode, EIS is required to obtain monochromatic images of an active region (~4 x 4 arcmins) in ~ 3 s for dynamic events and 10 s for active region loops.
5) *To obtain imaging and spectral measurements from spectral lines in the transition region, corona and solar flares.* This temperature range is from 0.1 MK - 20 MK, which requires observations in the extreme ultraviolet (EUV). The selected wavebands are 180-204 A and 250-280 A.
6) *To obtain accurate coronal density measurements.* EIS is required to measure densities in coronal holes (~10^8 cm^{-3}) and solar flares, which are the most dense phenomena in the solar atmosphere (~10^{12} cm^{-3}).
7) *To respond to highly dynamic phenomena.* EIS is required to obtain high temporal resolution observations of dynamic phenomena. Since intensities will change on orders of magnitude EIS is required to change the observing mode by responding to an external or internal event trigger.
8) *To locate and change the observing mode to a region of brighter intensity.* EIS is required to be able to locate regions of higher intensity in an observation (e.g. a bright point) and relocate to observe a small field of view with a different observing sequence.
9) *To observe a range of sizes of solar phenomena.* EIS is required to observe small transient network brightenings (on order of a few $arcsecs^2$) to a large active region (6X6$arcmins^2$).

III Instrument Design Requirements

1) Pointing and Field of View

(a) To select a slit or slot as required. Four slit positions are available. *Currently 2 positions have been determined - 1" for just sampling our spatial resolution, and a 40" slot for providing monochromatic imaging with no blending for the stronger lines. The other 2 positions will be decided by Oct 1, 00. The remaining choices are 2", 5", multi-slit slot, short slit, and large slot.*

(b) To point EIS in the E-W direction with a coarse pointing in the range +/- 15' with an accuracy of +/- 3". *The coarse pointing will be used to obtain approximate pointing of each target.*

(c) To have fine pointing in the range 0-6'.

(d) EIS FOV is 360" X 512" (360" is the fine pointing range, and 512" is the maximum image height of the CCD).

(e) To have stability during an observation of 1" in 10 s (the average exposure time for the observation of an active region loop). *The spacecraft 3σ stability is 0.6" in 2 s, 1.1" in 20 s and 1.7" in 1 minute.*

(f) To determine EIS pointing with a fine pointing accuracy of 0.5". *It is required to point EIS with accuracy less than the spatial resolution.*

2) Readout Issues

(a) To expose and readout the maximum image area of both CCDs (2048"x512") simultaneously.

(b) To allow any fraction of the CCD to be downloaded in the spatial direction (i.e. not the full slit length). *This is to allow the observation of a smaller FOV.*

(c) To allow fractions of the CCD to be downloaded in the spectral direction (i.e spectral windowing).

(d) To have a minimum of 1 spectral window and a maximum of 25 spectral windows.*(The maximum value is being investigated by HEM).*

(e) To expose and process 1" X 512" (e.g. readout time, compression) data in the order of fractions of a second.

(f) To perform exposure times in the range 100 ms - few hundred s with an accuracy of 5 %. The ability to make shorter exposures down to 10 ms is desirable. *(CMB is investigating this).*

(g) To perform automatic exposure control.

(h) To perform data compression. The data compression is currently JPEG in the MDP, but the facility to include a different compression scheme in the ICU should remain open. *It is required that the compression can be varied in different studies.*

3) Mode of Observation

(a) Science operations shall be performed from ground command.

(b) The onboard software should be modular to aid code development and allow new software to be uplinked.

(c) The study sequences shall consist of a number of variables (e.g. exposure time, number of spectral windows, spectral window width, slit/slot size, mirror step). *The variables should not be constrained in any way i.e. the spectral window width can be different for each spectral line.*

(d) The instrument shall also collect data based on a number of uplinked observing sequences.
(e) The parameters (e.g. slit size, y size, exposure time) of the observation shall be changed by command.

4) Event Trigger
(a) To respond or not to XRT's flare trigger by moving to the flare location and starting a new observation sequence. Only respond if the flare is within the EIS FOV.
(b) To generate an internal EIS solar event trigger. This should have the flexibility to change the study.
(c) To respond to the event trigger by moving to the event and starting a new study within 30 s.*(This is being investigated by CMB and LKH to see if it is feasible)*

5) Instrument Health
(a) Have the ability to interrupt studies (abort or pause and restart).
(b) Monitor the health of the instrument and enter a safe mode if an anomaly is detected.
(c) The instrument must respond in an appropriate manner to spacecraft emergency.

Key Terms

Key Terms	Description
Line list	List of chosen spectral lines
Raster	An exposure at one slit location
Study	A sequence of rasters e.g. to build up an image
Observation	A study which can be repeated, pointing at the same object