SOLAR-B EIS
Proposed Science Operating Modes

11-Jun-99 *Draft*,V0.3, R.A.Gowen, MSSL

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1 INTRODUCTION

This document proposes possible EIS onboard instrument science operating modes. (It does not cover instrument non science operating modes such as standby, safe, or maintenance modes.).

These are initial proposals only, intended as an iterative starting point. Structures, items and numbers are subject to change as requirements emerge and become clearer.

The overall concept is that the instrument can be commanded into one of 2 major science operational modes :-

- **Time-Tabled Science Operational Mode**

  Instrument performs science exposures from a table of modes to be operated at given times.

  To cope with normal operations where the command opportunities are infrequent.

- **Real-Time Science Operational Mode**

  Instrument immediately aborts any current time tabled exposure and begins new exposures according to command received in real-time.

  To cope with real-time requests for correlated observations of unplanned events such as flares detected by the XRT.

2 TIME-TABLED SCIENCE OBSERVING MODE

Commands to define science observing modes for up to one day are uplinked at command uplink opportunity.

By holding the tables permanently onboard in keep-alive RAM, only changes to modes require to be uplinking to save on command uplink time.

The proposed capability and structure for these tables are as follows :- (See also attached figure.)

Observing Time Table (up to 64 timed modes). For each observation :-

(Allows controlled times for occasional flat field obs, synoptic obs, image obs and high resolution obs at local areas.)

Mode Start time

Mode End time

Mode id

(Mode id's allows repeating modes without having to uplink or store same info twice. E.g. repeated synoptic observations around the orbit.)

Mode Definitions Table (up to 16 modes). For each mode :-

Data Processing Mode	(e.g. imaging,snapshot,movie)
Mirror control	(initial position, x-inc)
Feature tracking	(y/n) (update positions to allow for solar rotation)
CCD flushing control	(before exposure after moving mirror)
CCD exposure sequence	(up to 4 for each mirror position)

(e.g. allow fast strong lines, followed by weak lines, & then possibly flat field for each mirror position, in gradual image build up.)

For each exposure in sequence :-

-Exposure Aperture	(Wedge, Slit, Closed)
-Accumulation time control	(fixed[secs]/AEC[ccd window,thres,min,max])
-CCD data windows	(up to 50 window ids [0,49])

CCD Windows Processing Table (up to 50 windows)

(allows repeated window processing definitions without having to uplink or store info twice)
(e.g. one for certain strong lines, one for weak lines, one for image section, etc)

Window coordinates	(xstart,ystart,xend,yend)
Spatial resolution	(nx,ny) (may be performed by on-chip binning)
Time resolution	(e.g. integrate certain lines for lower time res.).
Data compression	(type, control parameters)
Despiking	(y/n)

Solar- B EIS
Proposed(*draft*)
Observing Control Tables

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Observing Time Table

Time Slot	Mode Start time	Mode End time	Mode Id
0	00:00:00	01:00:00	00
1	01:00:00	01:30:00	02
2	01:30:00	04:00:0	15
.	.	.	.
63	--	--	--

Mode Definitions Table

Mode id	Data proc mode	Mirror Scan Control	Feature Tracking	CCD flush-ing (?)	CCD Exposure Sequence for each mirror position						
					exposure -0				exp-1	exp -2	exp-3
					Aper -ture	Acc time Cntrl	windows				
		init pos,x-inc					height	ids			
0	imaging	tilt0, xinc0	y	10	s	f 1200	128	0,1,2			
1	movie	tilt1, xinc1	n	20	w	a oxxx	64	5			
2	snapshot	tilt2, xinc1	n	10	c	f 2400	512	-			
.	.	.	.	.	.	.	.	.			
15	imaging	tilt15, xinc15	y	10	s	a 2xxx	128	0,1,2			

CCD Windows Table

Window id	Position, Width	Spatial Res	Time Res	Data Comp	De-spiking
0	x1,w1	nx1,ny1	nt1	dc0,p1	y
1	x2,w2	nx2,ny2	nt2	dc0,p2	n
2	x3,w3	nx3,ny3	nt3	dc4,p1	y
.	.	.	.	.	
50	xn,w4	nxn,nyn	ntn	dc0,p3	n

Notes:

- The control tables presented here are an evolution of earlier control tables as follows :-
  - Upgraded to include timed observations, image scanning, filter selection, shutter control, solar tracking and flushing control.
  - Allow fast cadences by only reading out CCD windows relevant to particular exposure.

- Operating concept for CCD Windows Control is presented in Figure 1.

Assumptions:

- Mirror is tilt only (1-dimensional scanning only).
- Rotational aperture disc with selectable wedge/slit/blocked etc elements (TBD) (replaces fixed slit/slot aperture).
- No filter selection.
- CCD readout rate is likely to be ≤500 kpixels/sec.
- Grating focus mechanism control required non-routinely.

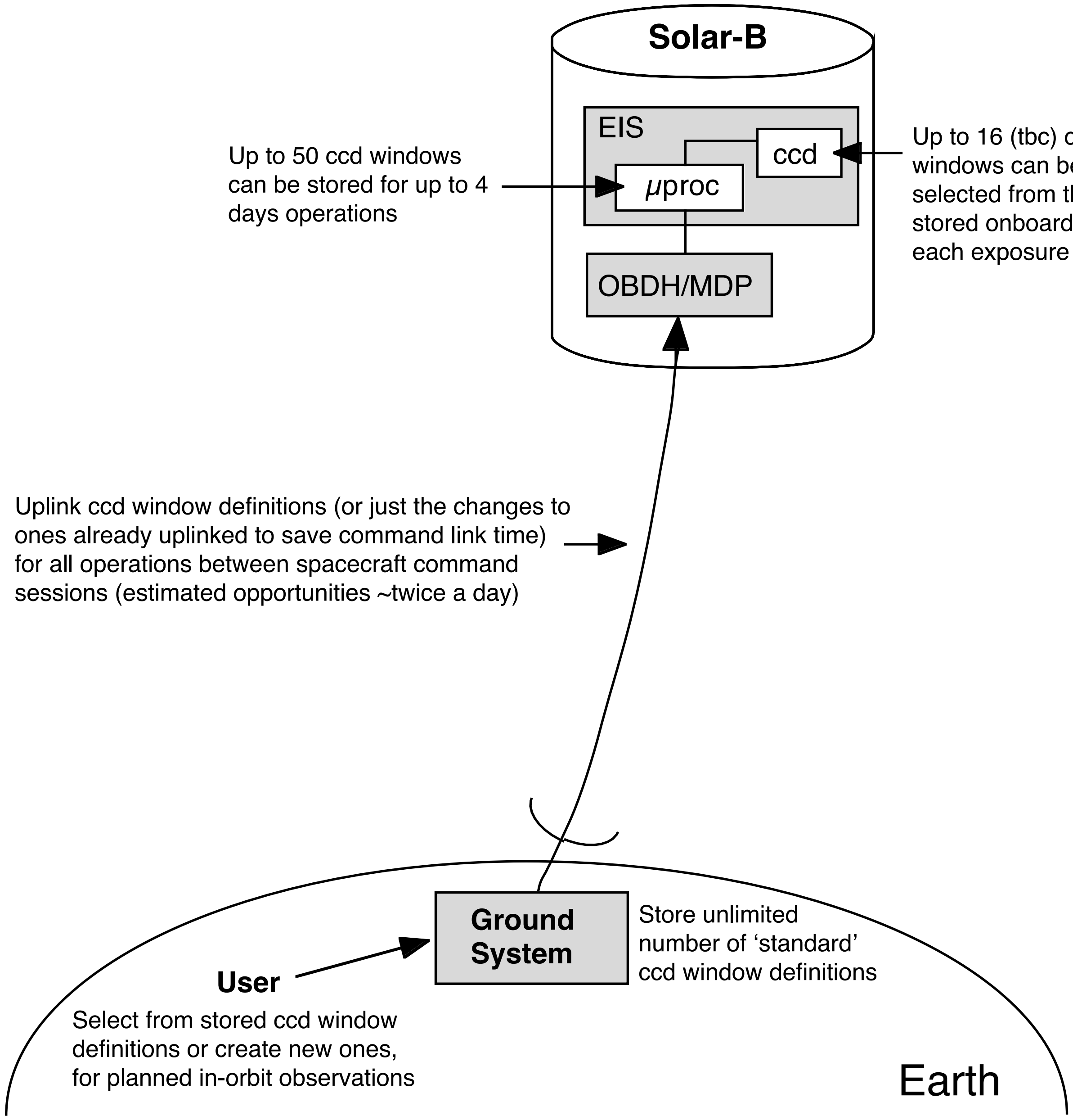

Figure 1: CCD Windows Control Schema

3 REAL-TIME SCIENCE OBSERVING MODE

At any time whilst in time-table observing mode the instrument will respond to a command requesting immediate start of a particular mode.

This is likely to arise from e.g. the XRT detecting a flare at some position on the solar surface.

In response to this command the instrument will :-

- Abort the current CCD exposure and any associated processing of its data. It will not, however, interfere with any telemetry packets already placed in the output telemetry buffer.

- Configure the instrument into the new commanded mode.
  This will require definition of suitable real-time commands. It may consist simply of a mode-id pointer to an already existing mode; modification of an existing mode (e.g. new mirror scan position and increments; or complete definition of a new mode.

- Start exposures in the required mode.

- Exposures will continue in the new mode until commanded to stop, such a command to cause resumption of time-table observations.

  In this case re-commencement may take place either :-
  (a) For the mode appropriate to the time as originally planned in the time-table.
  (b) For the originally planned times to be delayed by a commanded amount of time.
  A commanded ‘delay time’ could be appropriate, if the spacecraft wished to resume planned time correlated studies by all the Solar-B instruments.
  (E.g. if the unexpected active region studies took a half hour, then a command to delay all the rest of the pre-loaded planned observations by a half an hour could be useful.)

  Option (b) may be preferable to starting a planned observation sequence halfway through and consequently not getting a complete data set. It could also allow the previous planned observation sequence to be completed, from where it was left off.

4 RELATION TO SCIENCE REQUIREMENTS

How the above tables are intended to satisfy draft science requirements gleaned from an initial discussion with Louise Harra-Murnion, is presented below :-

Science Requirements:

Science Requirement	Description	Handled by EIS Science Op Mode
Imaging	- Exposures at defined sequence of mirror positions. o Capable of full sun rastering o Capable of off-limb rastering (expected to be infrequent due to constraints imposed by optical telescope)	Imaging
Spectra	- Repeated exposures at fixed mirror position	Imaging
Flare	- Respond in real-time as fast as possible (≤secs) to perform new imaging/spectra, in response to XRT request.	Real-time imaging (abort current exposure and start commanded new one asap)
Calibration	- (Ask Matt) - Approx once a week imaging involving open & closed shutter light control and flat field observations (TBD)	imaging/snapshot (TBC)
Movie	- (Louise and Alec to talk) - Useful for flares ?	Movie (TBC)

Safety Requirement:

- Automatically close shutter if count rate too high to protect the CCD. (This could have to be handled in all exposure modes by checking each pixel read out for max count limit, or sum of counts over all pixels [TBD].)

5. CONCLUSIONS

Propose:

1. Science requirements to be evolved :-
   - Nominal orbit observing plan to be developed.
     (to determine nominal capabilities of control tables)
   - Worst case orbit observing plan to be developed.
     (to determine maximum capabilities of control tables)
   - Movie mode to be discussed with Alec.
   - Calibration mode to be reviewed with Matt.

2. Compare requirements and design with that used on CDS.

3. Clarify what data compression schemes are required on EIS c.f. MDP.

4. Clarify need for low frequency & spatial scanning interspersed with high time and spatial resolution scanning ?

5. Determine where ‘readout windows definitions’ translation to ‘clock sequence readout control patterns for CCD readout’ be performed ? In the CCD readout electronics or in the onboard image processor ? This will have implications for onboard processor loading versus extra hardware (processor/ram/software) requirements for CCD electronics.

6. Discuss despiking requirement ? Seems not high priority, and possibly only for use with movie mode ? May be important prior to image compression onboard.