MDI Guide

The Use and Operation of the MDI Instrument

Ver 0.11
1-Jun-95

M. Morrison

This Copy Printed: June 1, 1995

MDI-????
SOI Tech Note#: ??

Some suggested reference books, material, and methods of finding more information:

- "MDI Guide: MDI/SOI Data Flow"
- "MDI Guide: An Overview of the /mdisw System"
- "MDI Guide: IDL Calibration and Analysis Software"
- "MD340027: MDI Standard Sequence Summary"
- "MD340011: High Rate Data Product Header"
- "MD340016: Low Rate Science Data Description"
- "MD340023: Image Processor Lists and Tables"
- "SOI-RD-019: SOI MDI Experiment Operations Manual (EOM)"
- "SOI-RD-018: SOI MDI Mission Operations Plan (MOP)"
- The official MDI IDL software should have a detailed description of the routine in the header of the source file. It is possible to access this header from within IDL by using DOC_LIBRARY. A sample call is:

  IDL> **doc_library,'mdipict'**

If you have general comments, suggestions, or questions regarding this document or software, please send them to:

`morrison@quake.stanford.edu`

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Preface

The conventions used in this manual are:

- Bold face for examples of what the user should type
- Program names are capitalized when mentioned in the text, but are not capitalized in the user input examples
- Variable names are italicized when mentioned in the text
- Dates and times are in Universal Time (UT) and have the convention "dd-mmm-yy"
- There are several different types of prompts that appear in the examples. The prompt IDL> is used for when the user has already entered and is running IDL. The prompt % is used to signify Unix commands, and the prompt $ signifies VMS commands. There are also FTP> prompts for 'File Transfer Protocol.'

For example, you would only type **.run show_data** for the following description. You would not type IDL>.

IDL> **.run show_data**

1 Introduction and Overview

1.1 Terminology

Observation Modes		
Type	*SCI160K telemetry*	*Running*
Normal	None	PRIME60
Dynamics	24 hour/day	PRIME60
Campaign	8 hour/day	PRIME30/CAMP-N

MDI Terminology	
Term	*Description*
Observation	generally 30 or 60 seconds of filtergram exposures and an IP program.
Sequencer	TBD Mike
Sequence	TBD . Mike... (the logic control flow)
Frame List (OR) Filtergram List	A list of images to be taken. Each image can specify an instrument configuration (michelson tuning, ...). The IP program is invoked with EVERY filtergram in the observation.
IP Program	The list of instructions in the IP queue. Typically a porition of the program is started with the frame gate of a CCD image.
Observation Series	An observing objective that takes longer than one observing cycle (which is 30 sec for campaigns). For example, an objective that needs 2 minutes is broken into 4 observations and is an observation series.
Observation List	A list of observations to be run in campaign mode (see CAMPAIGN Program)
Campaign	Same as Observation List ???
Campaign List	NO SUCH THING (see Observation List)
STRUCTURE Program	An IP program that collects 5K structure data. There are two such programs; one for 60 second and one for 30 second observation.
CAMPAIGN Program	An IP program that operates on the frames collected in the 30 seconds between successive executions of the 30 second structure program. Campaigns execute during the daily 8 hour contact.
DYNAMICS Program	An IP program that computes and downlinks velocity and continuum intensity in 160K telemetry and the normal structure data in the 5K telemetry.
Call Back	??
???New Items???	??

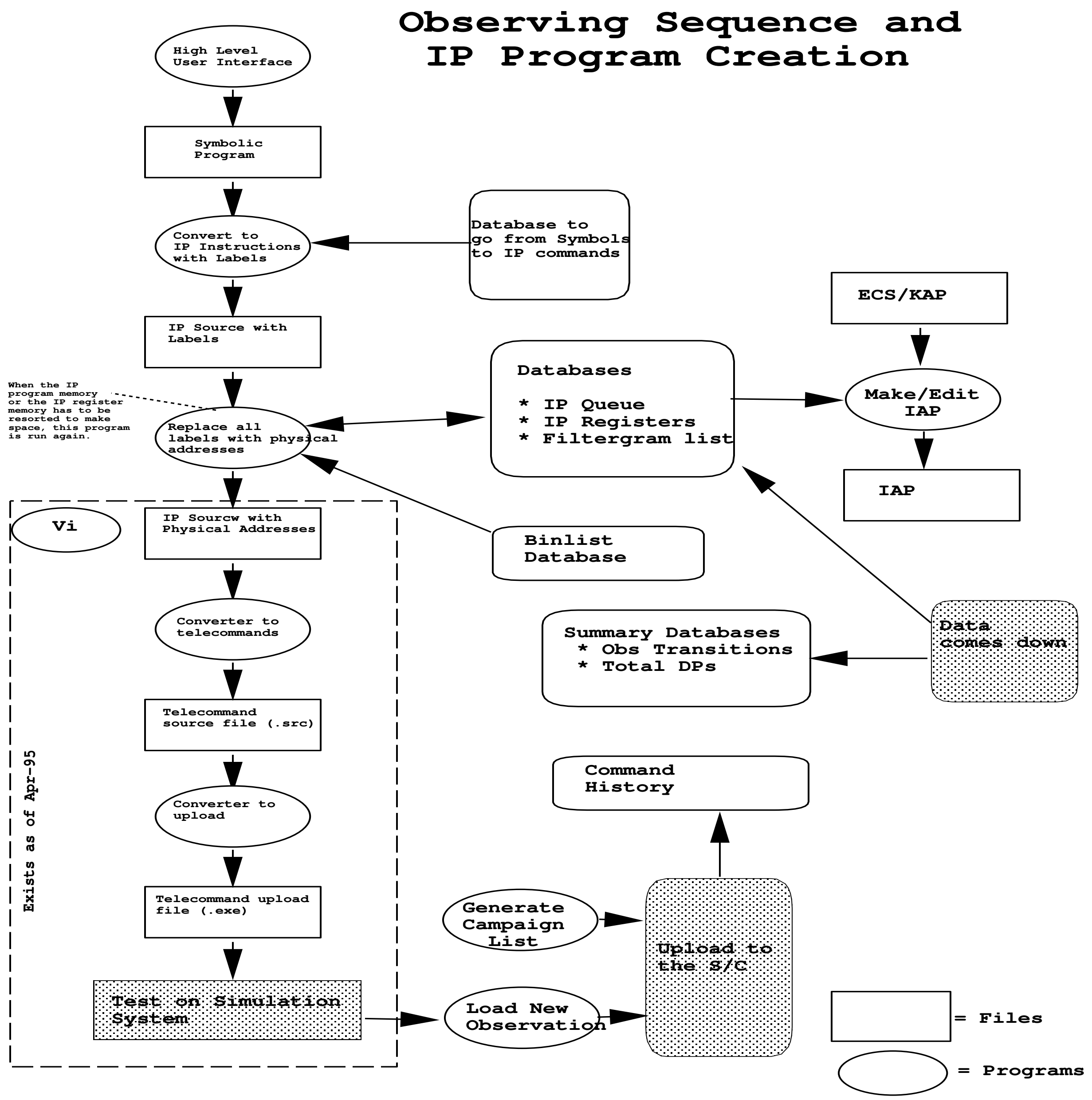

Figure 1: Overall Development and Database Flow

1.1.1 Definition of Observation

1/4, 1/2 and full observation sequence...

1.1.2 Definition of Filtergram List

The filtergram list consists of a single header and the specifications for each of the images. The header consists of:

- The number of frames to be taken (real and dummy)
- The observation ID
- An offset time for the first frame in "ticks".
- The default motion direction for CAL wheel 1 ???
- The default position for CAL wheel 1 ??
- The default motion direction for CAL wheel 2 ???
- The default position for CAL wheel 2 ??
- The default polarizer wheel position
- The default motion direction for michelson 1 ??
- The default motion direction for michelson 2 ??
- The IP address of the program to run with this observation

Each image have the following specifications:

- The time to take the picture relative to the minute mark (in "ticks" == 1/16th second). The offset time is added to this value.
- Michelson 1 tuning position
- Michelson 2 tuning position
- CAL Wheel 1 position
- CAL Wheel 2 position
- Polarizer wheel position
- Image type (true camera exposure or a "dummy" image)
- Exposure level
- Offset Pointer (OFP) for ...??
- The pages to write/add/difference the image to (up to four pages for a single image)

1.1.3 Definition of IP Queue Program

1.2 Telemetry

1.2.1 Types of Telemetry

There are three types of telemetry streams

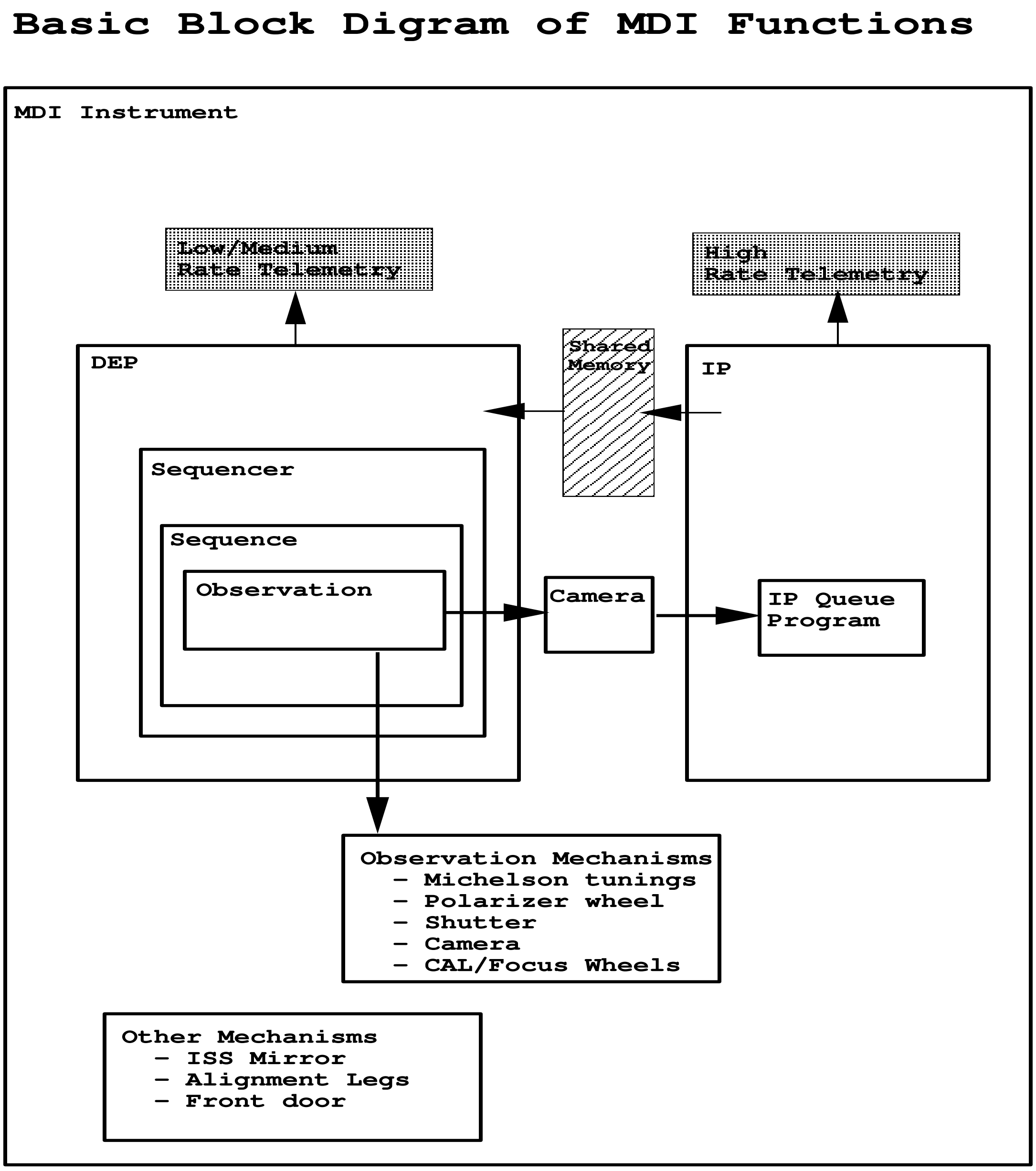

Figure 2: Basic Functions of the MDI Instrument

Telemetry Types		
Type	*Data per minute*	*Description*
Housekeeping	(8) 338 byte packet	Housekeeping data (voltages, temperatures,modes)
SCI5K	(24) 398 byte packet	The structure program data
SCI160K	(1000+) 1113 byte packets	The campaign and some of the dynamics data

Factoids:

- The SCI160K rate translates into 72 MBytes/hour.
- The SCI5K data products must be broken into segments 8K words (bytes?) or less.
- There is a 32K byte buffer for the SCI5K telemetry stream

1.2.2 Telemetry Use

SCI5K Telemetry Use			
Observable	*Description*	*Frequency*	*Amount of Telemetry*
Medium-L	Velocity	1 per minute	85 %
Limb Figure	Intensity	1 per 12 minutes (24 min average)	5 %
Flux Budget	Continuum	1 per 12 minutes (24 min average)	5 %
Golf Proxy	Line Depth	1 per 12 minutes (24 min average)	5 %
LOI-Vel	Velocity	1 per minute	1 to 2%
LOI-Int	Intensity	1 per minute	1 to 2%

```
Telemetry Available = 160K bits/sec * 60 second
                    = 9600k bits
                    = 1371k pixels (7 bits/pixel compression)
                    = 137k pixels if telemetering 10 images in the minute
                    = 370 x 370 pixels

                    = 457k pixels if telemetering 3 images in the minute
                    = 676 x 676 pixels
```

Sample Durations for Certain Compressions and Image Sizes (Seconds)									
#Bits/Pixel: Image Size	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
50x50	0.06	0.08	0.09	0.11	0.12	0.14	0.15	0.17	0.18
100x100	0.24	0.31	0.37	0.43	0.49	0.55	0.61	0.67	0.73
150x150	0.55	0.69	0.82	0.96	1.10	1.24	1.37	1.51	1.65
200x200	0.98	1.22	1.46	1.71	1.95	2.20	2.44	2.69	2.93
250x250	1.53	1.91	2.29	2.67	3.05	3.43	3.81	4.20	4.58
300x300	2.20	2.75	3.30	3.85	4.39	4.94	5.49	6.04	6.59
350x350	2.99	3.74	4.49	5.23	5.98	6.73	7.48	8.22	8.97
400x400	3.91	4.88	5.86	6.84	7.81	8.79	9.77	10.74	11.72
450x450	4.94	6.18	7.42	8.65	9.89	11.12	12.36	13.60	14.83
500x500	6.10	7.63	9.16	10.68	12.21	13.73	15.26	16.78	18.31
550x550	7.39	9.23	11.08	12.92	14.77	16.62	18.46	20.31	22.16
600x600	8.79	10.99	13.18	15.38	17.58	19.78	21.97	24.17	26.37
650x650	10.31	12.89	15.47	18.05	20.63	23.21	25.79	28.37	30.94
700x700	11.96	14.95	17.94	20.94	23.93	26.92	29.91	32.90	35.89
750x750	13.73	17.17	20.60	24.03	27.47	30.90	34.33	37.77	41.20
800x800	15.63	19.53	23.44	27.34	31.25	35.16	39.06	42.97	46.88
850x850	17.64	22.05	26.46	30.87	35.28	39.69	44.10	48.51	52.92
900x900	19.78	24.72	29.66	34.61	39.55	44.49	49.44	54.38	59.33
950x950	22.03	27.54	33.05	38.56	44.07	49.58	55.08	60.59	66.10
1024x1024	25.60	32.00	38.40	44.80	51.20	57.60	64.00	70.40	76.80

SCI160K Telemetry			
Observable	*Type*	*Compression Efficiency*	*Time To Telemeter*
Filtergram	Full 1024x1024	??	52 sec
Dopplergram	Cropped FD	??	??
	1024x1024 HR	??	??
Line Depth	Cropped FD	??	??
	1024x1024 HR	??	??
Continuum	Cropped FD	??	??
	1024x1024 HR	??	??
Magnetogram	Cropped FD	??	??
	1024x1024 HR	??	??
Line Center	Cropped FD	??	??
	1024x1024 HR	??	??

1.2.3 DSN Station Dumps

1.2.4 High Rate Telemetry Mode Transitions

See section 2.6.3 for details on how the different list addresses are used (campaign address, chain address, new address, ...). Also see section H for a more detailed description of the telemetry mode transition procedures.

Transitions of Telemetry Modes							
Mode From	*Mode To*	*General Actions*	*Camp Flag*	*Dynam Flag*	*Chain Flag*	*New List Flag*	*Telemetry Mode*
IDLE	VC2	Initiate mag dump Chain to campaign list	Set	-	Set	-	Set to 2
IDLE	VC3	Start Campaign (Non-standard transition)	Set	-	-	Set	Set to 3
VC2	IDLE	Stop Campaign/Dynamics Run PRIME60 Set Camp Address to VC2OBS	Clear	Clear	Clear	-	Set to 0
VC3	IDLE	Stop Campaign/Dynamics Run PRIME60	Clear	Clear	Clear	-	Set to 0
VC2	VC3	No change Continue Campaign/Dynamics	-	-	-	-	Set to 3
VC3	VC2	No change Continue Campaign/Dynamics	-	-	-	-	Set to 2

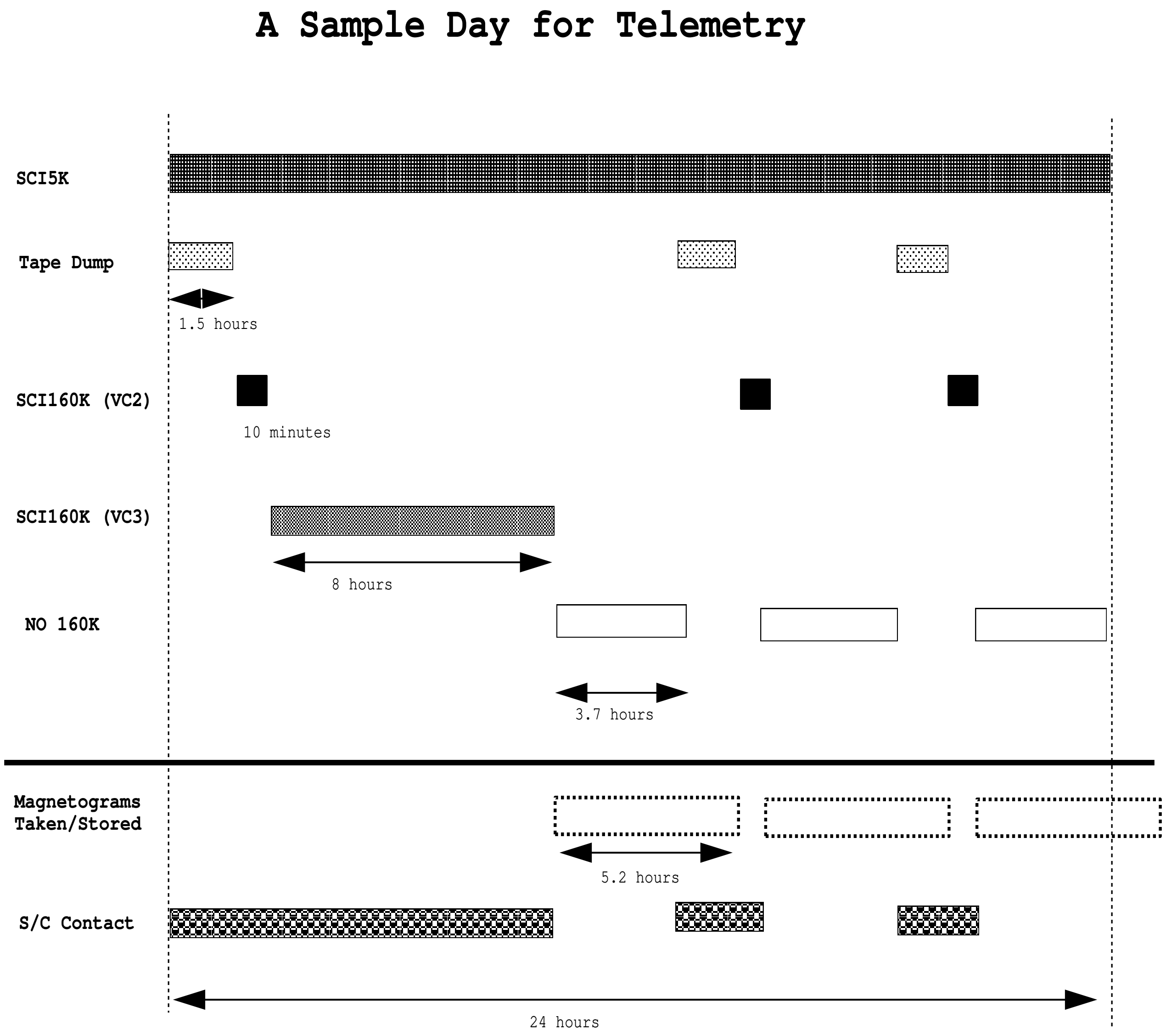

Figure 3: Timeline of Telemetry Use

2 The Standard MDI Sequence

2.1 Flow Control

NOTE: Discuss how the ALT cadence is defined – not based on absolute time (currently has two separate counters so the spacing is not maintained evenly) Talk about how the counter increments (ie: it counts the number of minutes in the ALT sequence. Example, cadence is set to 90, the ALT takes 5 minutes, the ALT sequence is run after 85 minutes of "other" stuff). See the table on 5 for a list of the 6 structure data products (DPs).

Tasks of Standard Observations for Different Modes			
Observation	*Normal Mode*	*Campaign Mode*	*Dynamics Mode*
PRIME60	Make 6 structure DPs Telemeter all 6 in SCI5K	Make 6 structure DPs Telemeter all 6 in SCI5K	Make 5 structure DPs Telemeter 5 in SCI5K Vel and Int in SCI160K
PRIME30	Make 6 structure DPs Telemeter all 6 in SCI5K	Make 6 structure DPs Telemeter all 6 in SCI5K	Make 5 structure DPs Telemeter 5 in SCI5K Vel and Int in SCI160K
CSTART15MAG	Zero out stored memory	N/A	Zero out stored memory
ALT30	Take 5 magnetograms Store average in memory (OR) Add to stored memory	Take 5 magnetograms Telemeter each in SCI160K	Take 5 magnetograms Telemeter avg in SCI5K (not 1
CEND15MAG	Increment memory counter?	N/A	Increment memory counter?
VC2CAMP	Telemeter stored Mags Take 4-6 cal/HR images	N/A N/A	?? ??
CAMP30	N/A	Anything	N/A

2.2 DEP Observation Specifications

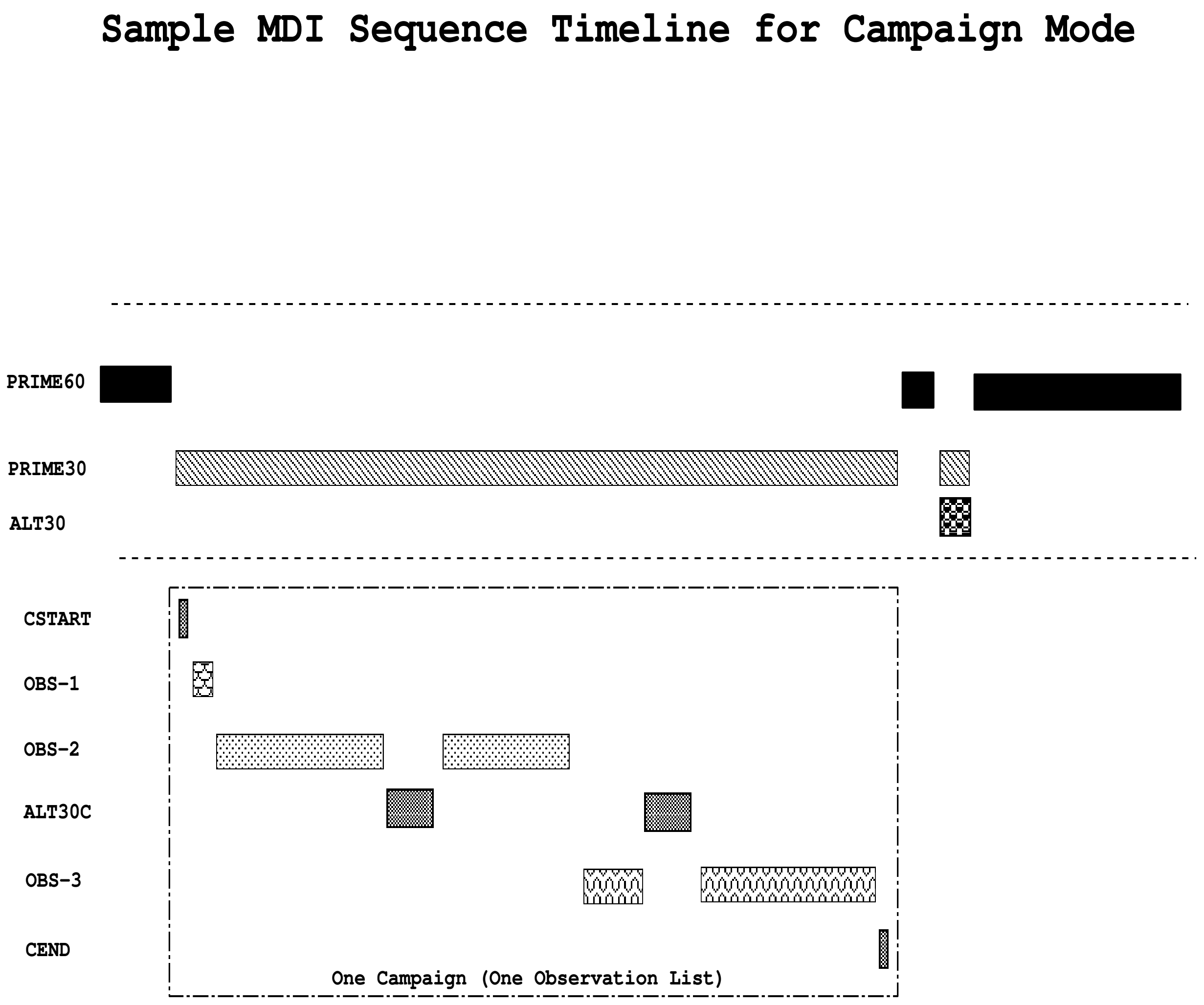

Figure 4: Timeline of a Sample Campaign Sequence

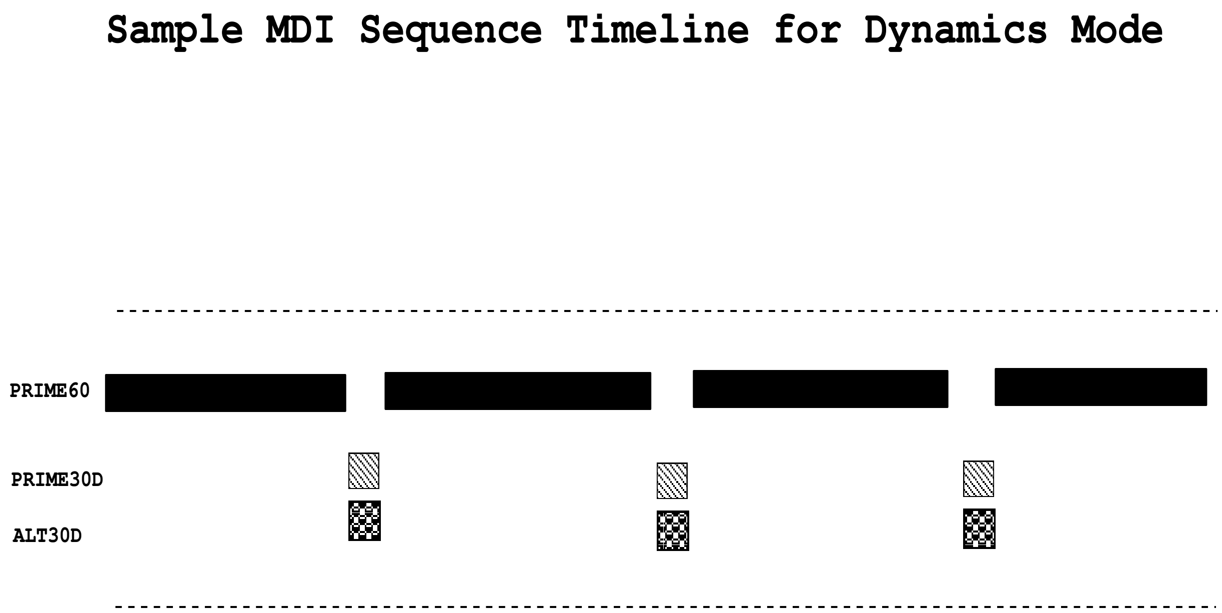

Figure 5: Timeline of a Sample Dynamics Sequence

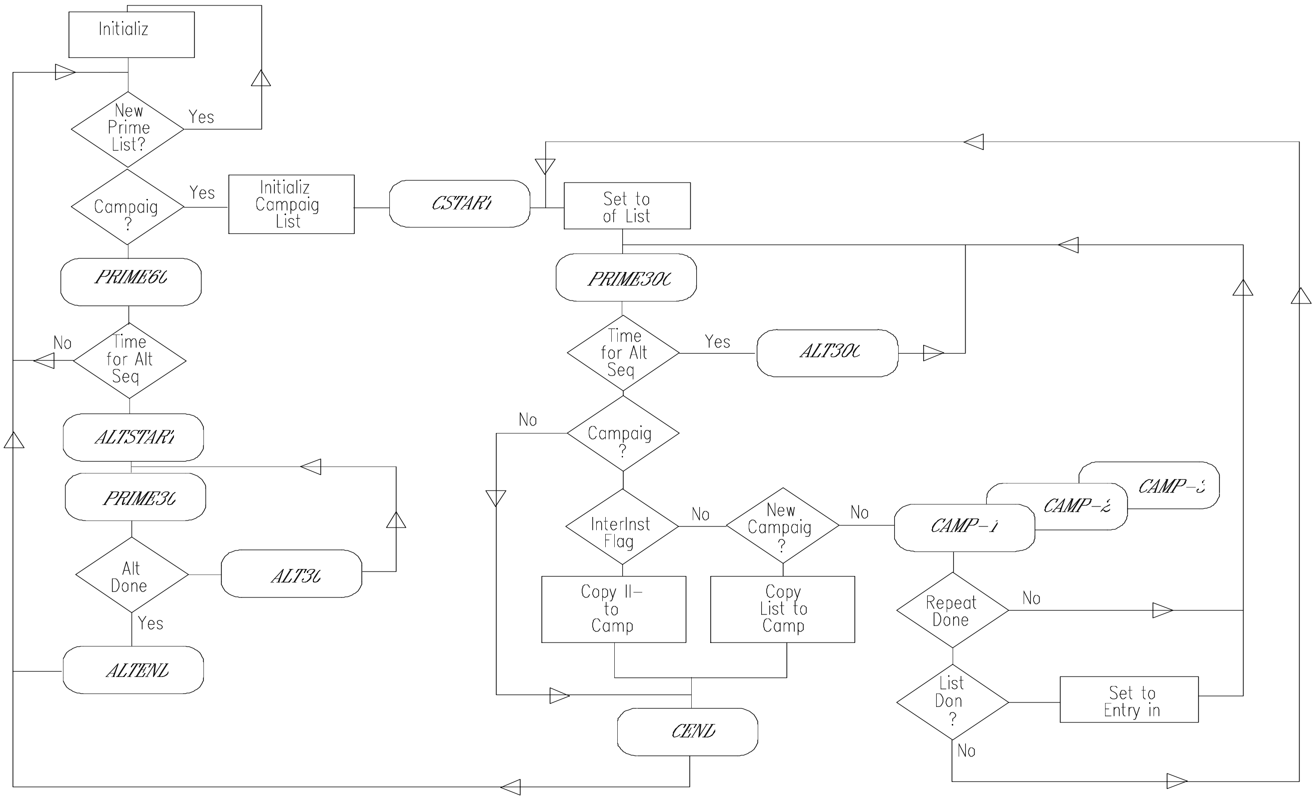

Figure 6: Logic Flow Diagram of the Main DEP Observing Sequence

Pieces of DEP Observation Specification		
Item	*Description*	*Location*
PRIME60	60 sec Prime Observation	R57 (load to R48)
PRIME30	30 sec Prime Observation	R58 (load to R49)
ALT30	30 sec Alternate Observation	R59 (load to R50)
ALT_START	15 sec alternate "head"	R60 (load to R51)
ALT_END	15 sec alternate "tail"	R61 (load to R52)
ALT_REP_COUNT	Repeate count (how many time to run)	R62 (load to R53)
ALT_CADENCE	How often to run ALT observation	R63 (load to R54)
CSTART	15 sec campaign Start	Campaign List
PRIME30C	30 sec Prime Obs during Campaign	Campaign List
OBS_CAMP-1	30 sec campaign	Campaign List
OBS_CAMP-2	30 sec campaign	Campaign List
OBS_CAMP-N	30 sec campaign	Campaign List
ALT30C	30 sec Alternate for Campaign	Campaign List
CEND	15 sec campaign End	Campaign List

Other Pieces to DEP Specifications			
Item	*Description*	*Type*	*Location*
??	Alternate Observation Enabled	Flag	R65
??	Alternate observation cadence	Value	R63
??	Alternate Observation Repeat Count	Value	R62
CAM_LIST	Campaign List Running	Pointer to table entry	R67
CHAIN_LIST	Campaign List to Run When Done	Pointer to table entry	R73
II_LIST	Campaign List to Run on II Flag	Pointer to table entry	R71
NEW_LIST	Campaign List to Run Now	Pointer to table entry	R69
CHAIN_FLAG	New list available when finished current	Flag	R72
II_FLAG	Inter-Instrument Flag, Interupt Now	Flag	R70
NEW_FLAG	New Campaign Available, Intrupt Now	Flag	R68

2.3 Timing Relative to the Minute Mark

2.4 Memory Page General Assignments

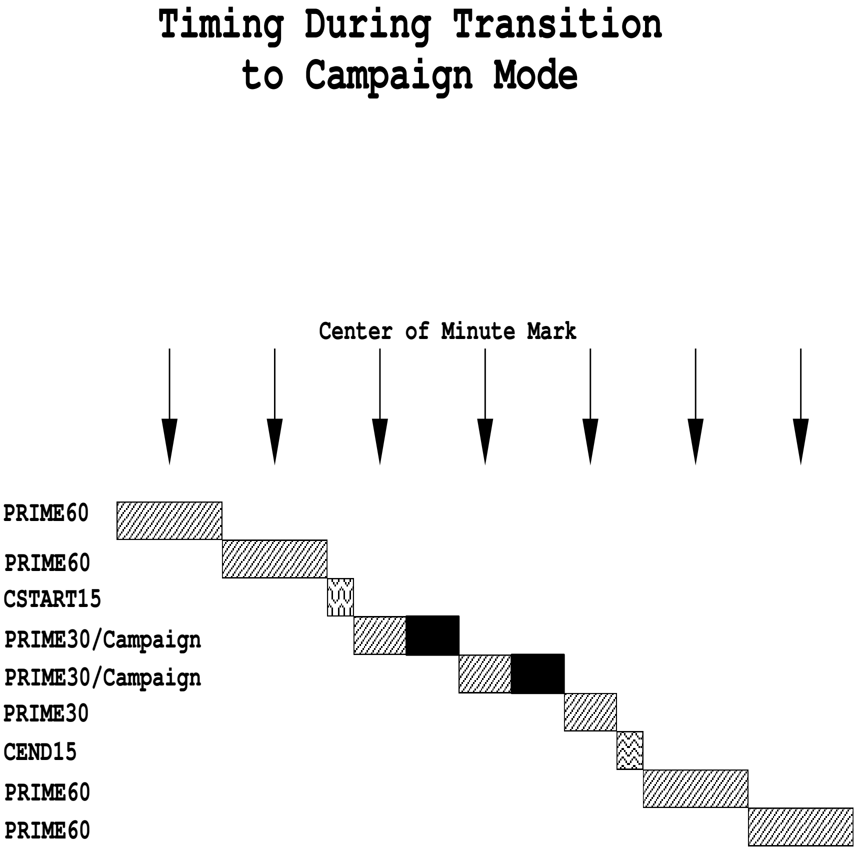

Figure 7: Minute Mark Timeline of a Campaign Transition

General Memory Page Usage			
Page	*Always*	*During Structure*	*During Campaign/Dynamics*
0	Camera Image	Sa	Sa
1	Camera Image	Sc	Sc
2	Camera Image	Sd	Sd
3	Camera Image	Si	Si
4		Copy of Si	Intermediate Product
5		Vel	Intermediate Product
6		LineDepth	Intermediate Product
7		Continuum	Intermediate Product
8	Telemetering	Telemetering	Telemetering
9	Telemeterimg	Telemeterimg	Telemeterimg
10	Flat Field	N/A	N/A
11		???????????????	???????????????
12	Additional Bin Lists(?)	N/A	N/A
13	Time Weight Averages	N/A	N/A
14	Bin Lists	N/A	N/A
15		Stored Magnetogram #4?	???????????????
16	IP Registers/Lookups	N/A	N/A
17		Stored Magnetogram #3	???????????????
18		Stored Magnetogram #2	???????????????
19		Stored Magnetogram #1	???????????????

2.5 Filtergram List and IP Queue Program

```
------------------------------------------------------------------------------------------
Name: Dynamics - A prototype dynamics observation
         Time    CAL1     CAL2      PAW      Dir       IP
 N   ID   Fr1   Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
23, AAA, -456,  CW,  1,  CCW,  2,   CW, 3,    -,  -,   0000

     MTM1 MTM2 CAL1 CAL2 PAW                          DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP    0   1   2   3
-456,  26,  52,  0,   0,  0,    F,     5,   0,   3                  Fc
-408,  44,  61,  0,   0,  0,    F,     5,   0,   0                  F1
-360,  62,  70,  0,   0,  0,    F,     5,   0,   1,2                F2
-312,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
-264,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
-216,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
-168,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
-120,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 -72,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 -24,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
  24,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
  72,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 120,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 168,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
 216,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
 264,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
 312,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
 360,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 408,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 456,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
```

2.6 Campaign Lists

A sample campaign List is:

```
OBSListID
OBSListSize
CHead
CTail
PrimeSeqAddress
AltSeqAddress
AltSeqRepeatCount
AltSeqCadence
Seq #1 Address:        7       (7 campaigns to follow)
Seq #1 Rep Count:      1       (one repeat)
Seq #1 IP Prog:        xx
Seq #1 OTP:            xx
  Seq #2 Address:      0100    (FDVEL)
  Seq #2 Rep Count:    1       (one repeat)
  Seq #2 IP Prog:      0       (use prog defined in observation)
  Seq #2 OTP:          xx
  Seq #3 Address:      0101    (FDCALVEL)
  Seq #3 Rep Count:    1
  Seq #3 IP Prog:      0
  Seq #3 OTP:          xx
  Seq #4 Address:      0102    (FDINTEN)
  Seq #4 Rep Count:    1
  Seq #4 IP Prog:      0
  Seq #4 OTP:          xx
  Seq #5 Address:      0103    (HRMAG)
  Seq #5 Rep Count:    1
  Seq #5 IP Prog:      0
  Seq #5 OTP:          xx
  Seq #6 Address:      0105    (HRINTEN)
  Seq #6 Rep Count:    1
  Seq #6 IP Prog:      0
  Seq #6 OTP:          xx
  Seq #7 Address:      0106    (HRVEL)
  Seq #7 Rep Count:    1
  Seq #7 IP Prog:      0
  Seq #7 OTP:          xx
  Seq #8 Address:      0107    (FDMAG)
  Seq #8 Rep Count:    1
  Seq #8 IP Prog:      0
```

```
  Seq #8 OTP:            xx
Seq #9 Address:          0223    (PLAGE)
Seq #9 Rep Count:        240     (4 hours)
Seq #9 IP Prog:          0
Seq #9 OTP:              xx
Seq #10 Address:         0225    (ARSEISMO)
Seq #10 Rep Count:       0       (continuous)
Seq #10 IP Prog:         0
Seq #10 OTP:             xx
```

The list can contain one level of nesting. A pair of words identify nested lists. The first word contains size of the group. The repeat count of the group is specified as a negative number. OTP is the pointer to the offset table. This table contains image co-ordinates indicate the region of interest. The size of the region is chosen by the IP program.

TODO?? Change "Seq" in the above list to "Obs"

2.6.1 Standard VC2 Campaign List Contents

A possibility for the VC2 campaign list is (each item is an observation so it is a filtergram list and IP program):

- 1 minute of downlinking two magnetograms (not images taken)
- 1 minute of downlinking another two magnetograms
- 1 minute to make FD_VEL
- 1 minute to make FD_CALVEL
- 1 minute to make FD_INTEN
- 1 minute to make HR_MAG
- 1 minute to make HR_INTEN
- 1 minute to make HR_VEL
- N minutes of campaign observation #1

2.6.2 Chaining Campaign Lists

2.6.3 Operational Use of Campaign List Addresses

During the "Prime Sequence" various DEP registers carry information on the state of the sequencer. The full register list is shown on 52. Of particular interest are the Control Registers because they indicate when specific action regarding campaign observations is to be taken. The registers of interest are R0-R15 and R64-R73.

The New Prime Table Flag indicates when the Prime60 or Prime30 observations have been updated; the flag is cleared after Prime Table is updated. The ALT Enable Flag indicates whether the Alternate Observation should be performed. The Campaign Flag indicates whether the Observations identified by the Campaign List Address shoud be performed.

- If the New List Flag is set, the New List Address is copied to the Campaign List Address at the start of the next campaign observation, and the New List Flag is cleared.
- If the Chain List Flag is set, the Chain List Address is copied to the Campaign List address at the completion of the original Campaign List, and the Chain List Flag is cleared.
- The II Flag is set by the reception of an Intra-Instrument command, and the II List Address is copied to the Campaign List Address at the start of the next campaign observation.

Nominal Observation Address Use	
Address	*Use*
Campaign List Address	The 5 minute VC2 observation
Chain List Address	The 8 hour campaign list of the day
New List Address	Manually set and run the campaign to be run

2.7 Tables and Lists Available in DEP Memory

DEP Tables Available		
Table	*# of Parameters*	*# of Different Sets*
MTM Lookup	1	76
MTM Offset	2	1
Exposure	1	64
Focus Position	1?	4
PAW Position	1?	4
Offset Coordinates	1 (both X and Y)	20

DEP Lists Available			
List	*Size*	*One Entry*	*Typical Entry*
Observations	4K bytes	(#frames+1)*12 bytes per observation	252 (or 132)
Observation Lists (Campaigns)	4K bytes	8*2 + (#observations*4*2) bytes per list	-
Optics Configuration Block	4 bytes	-	-
DMA Control Blocks	4 bytes	-	-
APU Control Blocks	6 bytes	-	-

With 4K bytes of space there is space for approximately 30 different 10 filtergram observations.

2.7.1 The Position to Extract from an Image

TODO - how many entries
See database chapter
what else is there?

2.8 How Extract Location and Image Shape is Specified

IP Fixed Register Use for Standard Extract Image		
Register	*Contents*	*How Updated*
83-84	Extract Source Page	Set within IP program ?
85-86	Extract Destination Page	Set within IP program ?
87	X-size	Ground upload (shape of day)
88	Y-size	Ground upload (shape of day)
89	Row Length (=1040)	Fixed?
90	Offset pointer (=91)	Fixed?
91-92	Offset (x,y corner to extract)	DEP Reg 5,6 from cam hdr. IP program copies (OR) Ground upload ?
93-94	DPC	Ground upload

TODO - Is the DPC unique for each different image shape/size TODO - Levay recommends that the DPC "format" portion has a value which is equal to 1 to mean "extract using offset and shape of the day via DEP, 2 to mean inter instrament offsets and II Shape of the Day (SOD), or 3 for other. What are the different extract options:

- A different total number of pixels. This should be a unique DPC under any plan and should have a register list set for each one?
- A different nx and ny but the same number of pixels.
- A different location
- The same extraction but different observables. Definiately needs to be different DPCs.
- Extraction from an un-binned image versus from a binned image?

2.9 Possible Alternate Sequences

It may be possible to create an alternate sequence which could be run to perform a flat field calibration observation. A separate sequence is needed because the capability to command the leg offsets is needed (the ISS mirror offsets cannot be commanded from any sequence). The alternate sequence and the Prime sequence can reside in DEP memory at the same time (a pointer to the start of the sequence code is overwritten).

3 List of Planned Observations

Basic Observations	
Name	*Description*
STRUCT60	60 second Structure Program
STRUCT30	30 second Structure Program
MAG30	30 second full disk magnetogram, to use with STRUCT30
MAG30START	transition sequence to run before MAG30
MAG30END	transition sequence to run after MAG30
DYNAMICS	Dynamics Program
VC2START	transition sequence to run before VC2OBS
VC2END	transition sequence to run after VC2OBS
CAMSTART	transition sequence to run before any campaign
CAMEND	transition sequence to run after any campaign
ALT30D	Alternate 30 sec during dynamics
PRIME30D	Prime 30 sec during dynamics

Scientific Campaign Observations	
Name	*Description*
FDVEL	full disk velocity (V) & continuum intensity (Ic)
FDMAG	full disk magnetogram (M)
FDINTEN	full disk Ic & line depth (L)
HRVEL	high resolution V
HRMAG	high resolution M
HRINTEN	high resolution Ic & L
ARSEISMO	active region seismology: Hi Res V, 2x2 binned M
PLAGE	high resolution plage: V, M, Ic sub-images
PLAGEFD	full disk plage: V, M, Ic sub-images
FDHIFREQ	sub-image of full disk V, 30 second cadence
FLOWS	high resolution Ic & 2x2 binned V

Test & Calibration Campaign Observations	
Name	*Description*
FDPIC	full disk filtergram
FDLSCAN	full disk lambda scan, rebinned to 256 x 256
FDFOCUS	full disk focus series, 256 x 256 sub-images
HRPIC	high resolution filtergram
HRLSCAN	high resolution lambda scan, 256 x 256 sub-images
HRFOCUS	high resolution focus series, 256 x 256 sub-images
LTC	light transfer series, 256 x 256 sub-images
DARKS	average of 9 dark frames
FDCALPIC	full disk cal mode filtergram
FDCALVEL	full disk cal mode V
CAL1...CAL10	ten sets of full disk cal mode detuned filtergrams, rebinned to 256 x 256
OBSDETUNE	ten full disk obs mode detuned filtergrams, rebinned to 256 x 256
FDSTUTTER	normal & wavelength-shifted full disk obs mode V's
HRCALPIC	high resolution cal mode filtergram
HRCALVEL	high resolution cal mode velocity

Observing Series	
Name	*Description*
VC2OBS*	standard 7 minute series to run during tape-dump VC2 periods: FDVEL, FDCALVEL, FDINTEN, HRMAG, HRINTEN, HRVEL, FDMAG (may not finish)
FDCONTEXT	3 minute context set: FDVEL, FDMAG, FDINTEN
HRCONTEXT	3 minute context set: HRVEL, HRMAG, HRINTEN
MAGFLOWS	large-scale network evolution: 10 x FLOWS, HRMAG
CALMODE1	standard Michelson calibration set: FDCALVEL, CAL1, CAL2, ... CAL10

Alternate Prime Observations (incompatible with Structure Program)	
Name	*Description*
FDFAST	full disk V sub-images, 12 second cadence
HRFAST	high resolution V sub-images, 12 second cadence

4 Creation of a New Observation (Filtergram List and Program)

4.1 Sample Observation Specifications

```
---------------------------------------------------------------------------------------
Name: Dynamics - A prototype dynamics observation
         Time    CAL1     CAL2      PAW      Dir       IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
23, AAA, -456,  CW,  1,  CCW,  2,   CW, 3,    -,  -,   0000

     MTM1 MTM2 CAL1 CAL2 PAW                         DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP    0   1   2   3
-456,  26,  52,  0,   0,  0,    F,     5,   0,   3                  Fc
-408,  44,  61,  0,   0,  0,    F,     5,   0,   0                  F1
-360,  62,  70,  0,   0,  0,    F,     5,   0,   1,2                F2
-312,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
-264,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
-216,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
-168,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
-120,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 -72,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 -24,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
  24,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
  72,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 120,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 168,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
 216,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
 264,  98,  88,  0,   0,  0,    F,     5,   0,  -1                  F4
 312,  80,  79,  0,   0,  0,    F,     5,   0,  -0,+2               F3
 360,  62,  70,  0,   0,  0,    F,     5,   0,  +1,+2               F2
 408,  44,  61,  0,   0,  0,    F,     5,   0,  +0                  F1
 456,  26,  52,  0,   0,  0,    F,     5,   0,  +3                  Fc
```

```
-------------------------------------------------------------------------------------------
Name: PRIME30 (30 sec structure)
         Time    CAL1     CAL2       PAW      Dir       IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
23, AAA, -456,  CW,  1,  CCW,  2,   CW, 3,    -,  -,   0000

     MTM1 MTM2 CAL1 CAL2 PAW                         DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP    0   1   2   3    Label Img#  IP
 Commands
-456,  26,  52,  0,   0,  0,    F,     5,  0,   3                  Fca    1
-408,  44,  61,  0,   0,  0,    F,     5,  0,   0,2                F1a    2
-360,  62,  70,  0,   0,  0,    F,     5,  0,   1,2                F2a    3
-312,  80,  79,  0,   0,  0,    F,     5,  0,  -0,+2               F3a    4
-264,  98,  88,  0,   0,  0,    F,     5,  0,  -1,+2               F4a    5
-216,  98,  88,  0,   0,  0,    F,     5,  0,  -1,+2               F4b    6
-168,  80,  79,  0,   0,  0,    F,     5,  0,  -0,+2               F3b    7
-120,  62,  70,  0,   0,  0,    F,     5,  0,  +1,+2               F2b    8
 -72,  44,  61,  0,   0,  0,    F,     5,  0,  +0,+2               F1b    9  DOP
   .,   .,   .,  .,   .,  .,    .,     .,  .,  .                   .      .  LINEDEP
 -24,  26,  52,  0,   0,  0,    F,     5,  0,  +3                  Fcb   10  COPY 03 04
   .,   .,   .,  .,   .,  .,    .,     .,  .,  .                   .      .  COPY 02 01
   .,   .,   .,  .,   .,  .,    .,     .,  .,  .                   .      .  CONT
   .,   .,   .,  .,   .,  .,    .,     .,  .,  .                   .      .  STRUCT

Note I have removed the dummy tunings from the 30 and 60 second prime
observations.  Only F4 suffers any hysteresis from this, and it is
on the order of 1-2 m/s in wavelength shift.  It is exactly the same
in the 30 and 60 second observations.  The solution with no hysteresis
and no dummy tunings had the disadvantages of offsetting the continuum
image in time from the velocity and of using a wider tuning range for
continuum, introducing greater MTM image motion.  Though neither of
these effects is particularly bad, they seem worse than the "disease"
we were trying to cure.
```

```
-------------------------------------------------------------------------------------
Name: Plage Region Campaign (30 sec campaign)
         Time    CAL1     CAL2      PAW      Dir       IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
??, ???,  288,  CW,  1,  CCW,  2,   -,   2,   -,  -,   ????

    MTM1 MTM2 CAL1 CAL2 PAW                         DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP   0   1   2   3
 288,  26,  52,  0,   0,  2,    H,    6,   1,  3                 FcR    1
 336,  44,  61,  0,   0,  2,    H,    6,   1,  0,2               F1R    2
 384,  62,  70,  0,   0,  1,    H,    6,   1,  4                 F1L    3
 432,  80,  79,  0,   0,  1,    H,    6,   1,  6                 F2L    4  DL8 MAG EXTRACT01
 480,  98,  88,  0,   0,  2,    H,    6,   1,  1,+2              F2R    5
 528,  98,  88,  0,   0,  2,    H,    6,   1,  -0,+2             F3R    6
 576,  80,  79,  0,   0,  1,    H,    6,   1,  -4                F3L    7
 624,  62,  70,  0,   0,  2,    H,    6,   1,  -6                F4L    8  DOP_LCP_HR
 672,  44,  61,  0,   0,  2,    H,    6,   1,  -1,+2             F4R    9  DOP_RCP_HR
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  LINEDEP
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  COPY 03 04
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  COPY 02 01
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  CONT
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  SHIFT_RCP_CONT_HR
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  SHIFT_LCP_HR
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  SHIFT_RCP_HR
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C1  MAG
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  DOP_AVG
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  DL89 CONT EXTRACT01
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .     .  AVGDOP EXTRACT01
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C2
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C3
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C4
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C5
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C6
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C7
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C8
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .    C9
   .,   .,   .,  .,   .,  .,    .,    .,  .,  .                   .   C10

Notes:
1)  PAW Pos 2 = RCP, 1 = LCP; - = use shortest direction
2)  Only RCP is used for line depth & continuum
3)  Both RCP & LCP results are shifted, but by different amounts
4)  Continuum is also shifted, using the RCP offset
5)  Extract #1 is used (default shape?) with OFP #1:  region of the day
6)  Only 9 frames are taken:  extra time is put at beginning & end
    (Is this the best way to ensure no interference with PRIME30?)
7)  Uses different exposure entry from full disk sequences
8)  The M1 & M2 tunings and directions need to be verified by me
9)  Are the lines for C1 - C10 necessary?  Why not only include those
    with callbacks?
10) The choices of RCP 1st and continuum in RCP are arbitrary.  Are there
    any differences worth considering?
11) The SHIFT and DOP_xCP subroutines have different parameters for HR & FD
12) Many of these comments also apply to the ALT30 frame list
```

```
-------------------------------------------------------------------------------------------
Name: ALT30 (30 second Full Disk Magnetograms)
         Time    CAL1     CAL2      PAW      Dir       IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
??, ???,  312,  CW,  1,  CCW,  2,   -,   2,   -,  -,   ????

     MTM1 MTM2 CAL1 CAL2 PAW                            DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP    0   1   2   3
 312,  44,  61,  0,   0,  2,    F,     5,   0,  0,2                 F1R    1
 360,  62,  70,  0,   0,  1,    F,     5,   0,  4                   F1L    2
 408,  80,  79,  0,   0,  1,    F,     5,   0,  6                   F2L    3
 456,  98,  88,  0,   0,  2,    F,     5,   0,  1,+2                F2R    4
 504,  98,  88,  0,   0,  2,    F,     5,   0,  -0,+2               F3R    5
 552,  80,  79,  0,   0,  1,    F,     5,   0,  -4                  F3L    6
 600,  62,  70,  0,   0,  2,    F,     5,   0,  -6                  F4L    7  DOP_LCP_FD
 648,  44,  61,  0,   0,  2,    F,     5,   0,  -1,+2               F4R    8  DOP_RCP_FD
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  SHIFT_LCP_FD
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  SHIFT_RCP_FD
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  MAG
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  AVG_ALT30
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  FDCROP
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .      .  STORE_ALT30
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C1
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C2
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C3
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C4
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C5
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C6
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C7
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C8
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .     C9
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                   .    C10
```

```
-----------------------------------------------------------------------------------------
Name: 10 Full Disk 4x4 Filtergram Campaign (30 sec campaign)
         Time    CAL1     CAL2      PAW      Dir      IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
23, AAA, -456,  CW,  1,  CCW,  2,   CW, 3,    -,  -,   0000

 264,  26,  52,  0,   0,  0,    F,     5,   0,  0                 Flt1   1
 312,  44,  61,  0,   0,  0,    F,     5,   0,  1                 Flt2   2  DL89 PAGE00 4x4 SQRT_COMP PAGE01 4x4 SQRT_COMP
 360,  62,  70,  0,   0,  0,    F,     5,   0,  2                 Flt3   3
 408,  80,  79,  0,   0,  0,    F,     5,   0,  3                 Flt4   4
 456,  98,  88,  0,   0,  0,    F,     5,   0,  4                 Flt5   5
 504,  98,  88,  0,   0,  0,    F,     5,   0,  0                 Flt6   6  DL89 PAGE02 4x4 SQRT_COMP PAGE03 4x4 SQRT_COMP
 552,  80,  79,  0,   0,  0,    F,     5,   0,  1                 Flt7   7
 600,  62,  70,  0,   0,  0,    F,     5,   0,  5                 Flt8   8
 648,  44,  61,  0,   0,  0,    F,     5,   0,  6                 Flt9   9
 696,  26,  52,  0,   0,  0,    F,     5,   0,  7                 Flt0  10  DL89 PAGE04 4x4 SQRT_COMP PAGE00 4x4 SQRT_COMP
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C1
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C2
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C3
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C4  DL89 PAGE01 4x4 SQRT_COMP PAGE05 4x4 SQRT_COMP
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C5
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C6
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C7
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C8  DL89 PAGE06 4x4 SQRT_COMP PAGE07 4x4 SQRT_COMP
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .     C9
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                 .    C10

NOTES:
1) I can live with 9 filtergrams if there is timing risk with 10
2) Other 10 (9) filtergram campaigns are:
     FD NxN Extract (where N ~ 350)
     HR NxN Extract
     HR 4x4 Summed
3) All filtergrams are square-root compressed before downlink:  need
   multiple tables or scaling to handle both extracts and 4x4 summing
```

```
-----------------------------------------------------------------------------------------
Name: 10 Extracted Filtergram Campaign (30 sec campaign)
         Time    CAL1     CAL2      PAW      Dir       IP
 N   ID   Fr1  Dir  Pos  Dir  Pos  Dir  Pos  M1  M2    Addr
23, AAA,   80,  CW,  1,  CCW,  2,   CW, 3,    -,  -,   0000

     MTM1 MTM2 CAL1 CAL2 PAW                           DMA
Time  Pos  Pos  Pos  Pos Pos  IType  Exp  OFP    0   1   2   3
 264,  26,  52,  0,   0,  0,    F,     5,   0,  3                 Flt1   1  EXT PAGE03 PAGE10-0/FOURTH
 312,  44,  61,  0,   0,  0,    F,     5,   0,  3                 Flt2   2  EXT PAGE03 PAGE10-1/FOURTH
                                                                             DL89 PAGE10-0/FOURTH ALL PAGE10-1/FOURTH ALL
 360,  62,  70,  0,   0,  0,    F,     5,   0,  3                 Flt3   3  EXT PAGE03 PAGE10-2/FOURTH
 408,  80,  79,  0,   0,  0,    F,     5,   0,  3                 Flt4   4  EXT PAGE03 PAGE10-3/FOURTH
 456,  98,  88,  0,   0,  0,    F,     5,   0,  3                 Flt5   5  EXT PAGE03 PAGE11-0/FOURTH
 504,  98,  88,  0,   0,  0,    F,     5,   0,  3                 Flt6   6  EXT PAGE03 PAGE11-1/FOURTH
                                                                             DL89 PAGE10-2/FOURTH ALL PAGE10-3/FOURTH ALL
 552,  80,  79,  0,   0,  0,    F,     5,   0,  3                 Flt7   7  EXT PAGE03 PAGE11-2/FOURTH
 600,  62,  70,  0,   0,  0,    F,     5,   0,  3                 Flt8   8  EXT PAGE03 PAGE11-3/FOURTH
 648,  44,  61,  0,   0,  0,    F,     5,   0,  3                 Flt9   9  EXT PAGE03 PAGE10-0/FOURTH
 696,  26,  52,  0,   0,  0,    F,     5,   0,  3                 Flt0  10  EXT PAGE03 PAGE10-1/FOURTH
                                                                             DL89 PAGE11-0/FOURTH ALL PAGE11-1/FOURTH ALL
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C1
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C2
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C3
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C4  DL89 PAGE11-2/FOURTH ALL PAGE11-3/FOURTH ALL
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C5
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C6
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C7
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C8  DL89 PAGE10-0/FOURTH ALL PAGE10-1/FOURTH ALL
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .     C9
   .,   .,   .,  .,   .,  .,    .,     .,   .,  .                  .    C10

NOTE: The size and location of the extract are set in IP regsiters
```

4.2 "Super" Command Set

Commands used to Create Observables or to Process Observables

MDM 19-Apr-95 Ver 1.0

Cmd	Filtergram List:	Input Memory	Output Memory	Number of Writes 0 1 2 3 4 5 6
DOP-4	F1 F2 F3 F4	0:Sa, 1:Sc (2:Sd,3:Si)	5:Vel	2 2 4 1 0 0 0
DOP-8	F1a F2a F3a F4a F4b F3b F2b F1b	0:Sa, 1:Sc (2:Sd,3:Si)	5:Vel	4 4 8 2 0 0 0
DOP-R	F1R F2R F3R F4R	0:SaR, 1:ScR (2:SdR,3:SiR)	11:Vel_R	2 2 4 1 0 0 0
DOP-L	F1L F2L F3L F4L	4:SaL, 6:ScL, N/A	10:Vel_L	0 0 0 0 2 0 2
LINEDEP-4	F1 F2 F3 F4	0:Sa, 1:Sc	6:Idep	
LINEDEP-8	F1a F2a F3a F4a F4b F3b F2b F1b	0:Sa, 1:Sc	6:Idep	
LINEDEP-R	F1R F2R F3R F4R	0:SaR, 1:ScR	6:Idep	
LINEDEP-L	F1L F2L F3L F4L	4:SaL, 6:ScL	6:Idep	
CONT-4	F1 F2 F3 F4 Fc	1:Sd, 4:Si, 6:Idep	7:Ic	
CONT-8	Fca F1a F2a F3a F4a F4b F3b F2b F1b Fcb	1:Sd, 4:Si, 6:Idep	7:Ic	
CONT-R	F1R F2R F3R F4R FcR	1:SdR, 4:SiR, 6:Idep	7:Ic	
CONT-L	N/A [1]	N/A	N/A	
SHIFT-DOP-R	F1R F2R F3R F4R	11:Vel_R	6:Vel*R	
SHIFT-DOP-L	F1L F2L F3L F4L	10:Vel_L	5:Vel*L	
MAG	F1L F2L F3L F4L F1R F2R F3R F4R	5:Vel*L, 6:Vel*R	10:Mag	
MAG-NOSHIFT	F1L F2L F3L F4L F1R F2R F3R F4R	10:Vel_L, 11:Vel_R	10:Mag	
AVGDOP	F1L F2L F3L F4L F1R F2R F3R F4R	5:Vel*L, 6:Vel*R	5:AVel	
AVGDOP-NOSHIFT	F1L F2L F3L F4L F1R F2R F3R F4R	10:Vel_L, 11:Vel_R	5:AVel	

NOTES:
[1] CONT cannot work for LCP currently since SdL and SiL have no pages to go to?
[2] CONT works from copies of Sd and Si

Manual Commands
===============

MAN-DOP	<Sa Page> <Sc Page>
MAN-LINEDEP	<Sa Page> <Sc Page>
MAN-CONT	<Sd Page> <Si Page> <Idep Page>
MAN-SHIFT	<Input Page> <Output Page>
MAN-MAG	<Vel_R Page> <Vel_L Page>

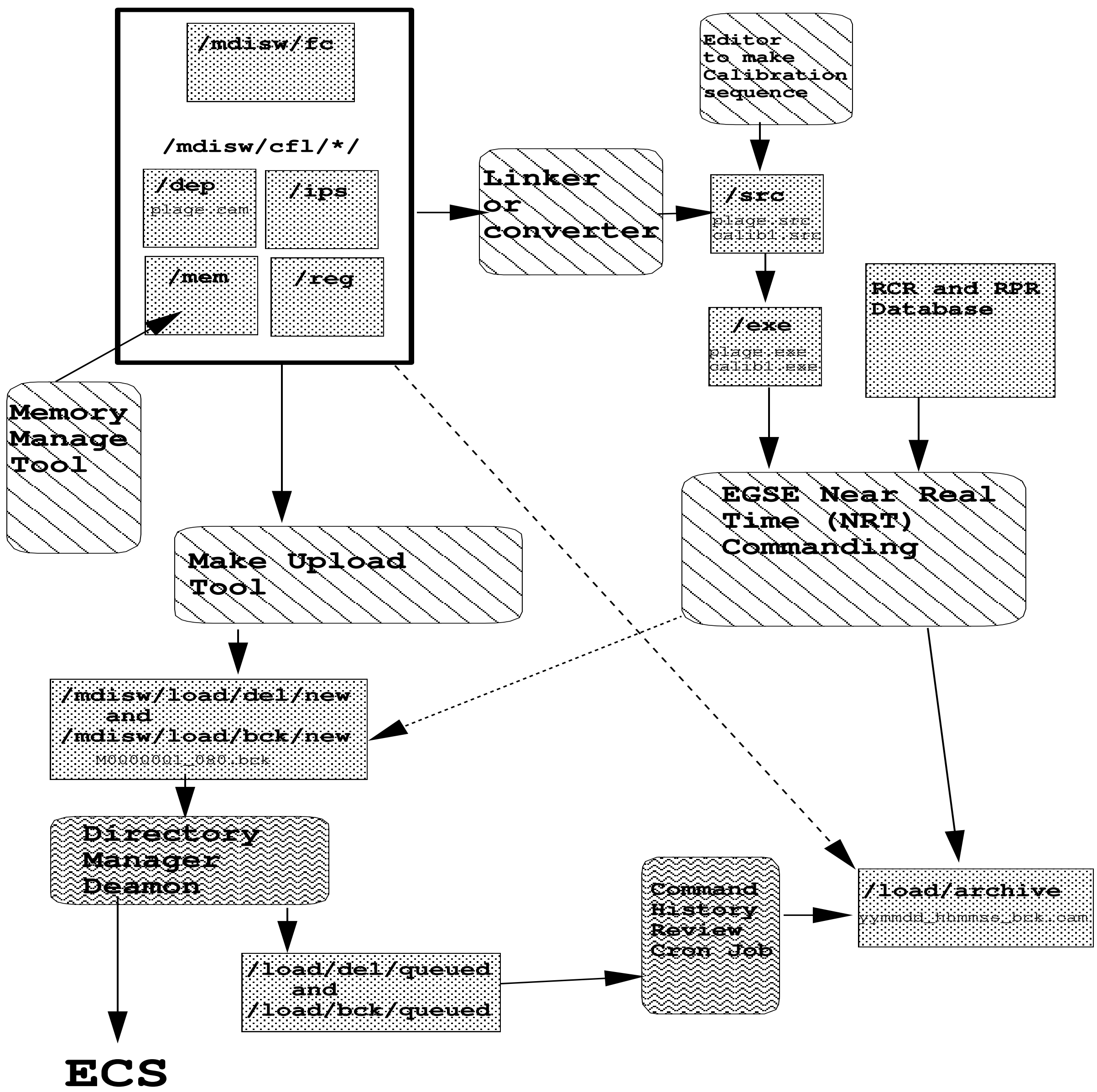

Figure 8: Flow of the control files through loading and archiving

5 Databases

5.1 Different Databases Available

Campaign List Table (or Observing Series?)	
Item	*Sample Value*
Label:	IPC_Standard_VC2_V001
Campain ID:	0005
Observation Series?:	Yes
IAP Label [#2]:	VC2OBS_SER
IAP Images:	FD_VEL, FD_CALVEL, FD_INTEN, HR_MAG, HR_INTEN, HR_VEL, FD_MAG
File Name of Source:	xyz.src
Originally Created:	1-Jan-95 11:05
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

Observation and IP Queue Program Table	
Item	*Sample Value*
Label:	IPQ_DOP_V003
IAP Label [#1]:	FDVEL
IAP Images:	FD_VEL, FD_INTEN
Observation ID:	0002
Description:	Used to make a dopplergram
Is this a subroutine?:	No
IP Subroutines Used:	IPSR_DOP
IP Registers used:	IPR_DOP_V001
IP Reg of HRDINIT:	IPR_HINIT_xxx?
IP Bin Lists used:	IPL_DOP_V001
On Board Address:	00f2
File Name of Source:	xyz.src
Originally Created:	1-Jan-95 11:05
Date Validated:	10-Jan-95 17:00
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

IP Register Table	
Item	*Sample Value*
Label:	IPR_DOP_V001
Description:	Used to make a dopplergram
# of Words:	4
Register Values:	ffff0011, 001, 022, 00
On Board Address:	00f2
IP Program Class:	DOP
IP Programs Using It:	IPQ_DOP_V003
Originally Created:	1-Jan-95 11:05
Date Validated:	10-Jan-95 17:00
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

Optimal Michelson Tuning Values	
Item	*Sample Value*
Label:	MTUNE_Intial_Value
Tuning ID:	0005
FC:	M1: 26 M2: 52
F1:	M1: 44 M2: 61
F2:	M1: 62 M2: 70
F3:	M1: 98 M2: 88
Originally Created:	1-Jan-95 11:05
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

Lookup Tables	
Item	*Sample Value*
Label:	LOOKUP_FD_Velocity_V001
Description:	Standard velocity lookup for FD calculation
On Board Address:	00f2
File Name of Source:	xyz.src
Originally Created:	1-Jan-95 11:05
Date Validated:	10-Jan-95 17:00
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

Bin Lists	
Item	*Sample Value*
Label:	BINLIST_CROP_FD_V001
Description:	Standard full disk circular crop
On Board Address:	00f2
File Name of Source:	xyz.src
Originally Created:	1-Jan-95 11:05
Date Validated:	10-Jan-95 17:00
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

LRDXFR Lists	
Item	*Sample Value*
Label:	LRDXFR_???
Description:	????
Other Info????	????
On Board Address:	00f2
File Name of Source:	xyz.src
Originally Created:	1-Jan-95 11:05
Date Validated:	10-Jan-95 17:00
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

Offset Values for Image Extraction	
Item	*Sample Value*
Label:	OFFSET_Intial_Value
Offset ID:	0005
Description:	Near center extraction for size ...?
X Corner (0-1039):	300
Y Corner (0-1039):	500
On Board Location (0-19):	0
Originally Created:	1-Jan-95 11:05
Last Modified:	1-Jan-95 11:05
Date Loaded:	2-Feb-95 23:23
Date Last Used:	28-Apr-95 16:56

5.2 Management of the Databases

5.2.1 Where is the Master

5.2.2 How and When Databases are Updated

6 Selection and Uploading New Observations

7 Selection and Uploading Campaigns

8 Creation of an Instrument Activity Plan (IAP)

8.1 Sample MDI IAP

```
DATATYPE = INSTRUMENTER INPUT TO THE ACTIVITY PLAN
FILENAME = MDI19950504004.IAP
INSTRUME = MDI
ORIG_ID  = mdi@mdisas.nascom.nasa.gov
OBSERVER = todd
DATE_CRE =  3-May-1995 18:52:35.00
STARTIME = 1995/05/04 00:00:00
ENDTIME  = 1995/05/05 00:00:00
COMMENT  = Simulation test input
END

SCIPLAN_Struc_Prog
        STARTIME = 1995/05/04 00:00:00
        ENDTIME  = 1995/05/05 00:00:00
        INSTRUME = MDI
        SCI_OBJ  = Regular Structures Program
        OBJECT   = FS

SCIPLAN_Std_VC2
        STARTIME = 1995/05/04 13:30:00
        ENDTIME  = 1995/05/04 13:35:00
        INSTRUME = MDI
        SCI_OBJ  = Standard VC2 Observations
        OBJECT   = FS
        NOTES    = IMAGES: FD_VEL, FD_CALVEL, FD_INTEN
        NOTES    = IMAGES: HR_MAG, HR_INTEN, HR_VEL, FD_MAG

SCIPLAN_Std_VC2
        STARTIME = 1995/05/04 17:30:00
        ENDTIME  = 1995/05/04 17:35:00
        INSTRUME = MDI
        SCI_OBJ  = Standard VC2 Observations
        OBJECT   = FS
        NOTES    = IMAGES: FD_VEL, FD_CALVEL, FD_INTEN
        NOTES    = IMAGES: HR_MAG, HR_INTEN, HR_VEL, FD_MAG

SCIPLAN_Std_VC2
        STARTIME = 1995/05/04 20:30:00
```

```
        ENDTIME  = 1995/05/04 20:35:00
        INSTRUME = MDI
        SCI_OBJ  = Standard VC2 Observations
        OBJECT   = FS
        NOTES    = IMAGES: FD_VEL, FD_CALVEL, FD_INTEN
        NOTES    = IMAGES: HR_MAG, HR_INTEN, HR_VEL, FD_MAG

SCIPLAN_CALMODE1
        STARTIME = 1995/05/04 13:35:00
        ENDTIME  = 1995/05/04 13:46:00
        INSTRUME = MDI
        SCI_OBJ  = CALMODE1
        OBJECT   = FS

SCIPLAN_HRCONTEXT
        STARTIME = 1995/05/04 13:46:00
        ENDTIME  = 1995/05/04 13:49:00
        INSTRUME = MDI
        SCI_OBJ  = HRCONTEXT
        OBJECT   = DC

SCIPLAN_PLAGE
        STARTIME = 1995/05/04 13:49:00
        ENDTIME  = 1995/05/04 20:53:00
        INSTRUME = MDI
        SCI_OBJ  = PLAGE
        SCI_SPEC = 015
        OBJECT   = DC
        NOTES    = MDI PLAGE CAMPAIGN SUBFIELD IS NW PART OF HR FOV

PROGRAM_PLAGE
        STARTIME = 1995/05/04 13:49:00
        ENDTIME  = 1995/05/04 17:30:00
        INSTRUME = MDI
        OBS_PROG = PLAGE
        SCI_OBJ  = QS
        XCEN     = 160
        YCEN     = 180
        ANGLE    = 0
        IXWIDTH  = 320
        IYWIDTH  = 600
        CMP_NO   = 015
```

```
        OBJECT   = DC

PROGRAM_PLAGE
        STARTIME = 1995/05/04 17:35:00
        ENDTIME  = 1995/05/04 20:30:00
        INSTRUME = MDI
        OBS_PROG = PLAGE
        SCI_OBJ  = QS
        XCEN     = 160
        YCEN     = 180
        ANGLE    = 0
        IXWIDTH  = 320
        IYWIDTH  = 600
        CMP_NO   = 015
        OBJECT   = DC

PROGRAM_PLAGE
        STARTIME = 1995/05/04 20:35:00
        ENDTIME  = 1995/05/04 20:53:00
        INSTRUME = MDI
        OBS_PROG = PLAGE
        SCI_OBJ  = QS
        XCEN     = 160
        YCEN     = 180
        ANGLE    = 0
        IXWIDTH  = 320
        IYWIDTH  = 600
        CMP_NO   = 015
        OBJECT   = DC

SCIPLAN_FDCONTEXT
        STARTIME = 1995/05/04 20:53:00
        ENDTIME  = 1995/05/04 20:55:00
        INSTRUME = MDI
        SCI_OBJ  = FDCONTEXT
        OBJECT   = FD

SCIPLAN_FDVEL
        STARTIME = 1995/05/04 20:55:00
        ENDTIME  = 1995/05/04 20:56:00
        INSTRUME = MDI
        SCI_OBJ  = FDVEL
```

```
        OBJECT   = FD

SCIPLAN_FDCALVEL
        STARTIME = 1995/05/04 20:56:00
        ENDTIME  = 1995/05/04 20:57:00
        INSTRUME = MDI
        SCI_OBJ  = FDCALVEL
        OBJECT   = FD

SCIPLAN_HRCONTEXT
        STARTIME = 1995/05/04 20:57:00
        ENDTIME  = 1995/05/04 21:00:00
        INSTRUME = MDI
        SCI_OBJ  = HRCONTEXT
        OBJECT   = DC

SCIPLAN_FD_Mag
        STARTIME = 1995/05/04 00:00:00
        ENDTIME  = 1995/05/05 00:00:00
        INSTRUME = MDI
        SCI_OBJ  = Regular Full Disk Magnetogram
        OBJECT   = FS
        NOTES    = NIMAGES  = 16
        NOTES    = ITIME01  = 1995/05/04 00:00:00
        NOTES    = ITIME02  = 1995/05/04 01:30:00
        NOTES    = ITIME03  = 1995/05/04 03:00:00
        NOTES    = ITIME04  = 1995/05/04 04:30:00
        NOTES    = ITIME05  = 1995/05/04 06:00:00
        NOTES    = ITIME06  = 1995/05/04 07:30:00
        NOTES    = ITIME07  = 1995/05/04 09:00:00
        NOTES    = ITIME08  = 1995/05/04 10:30:00
        NOTES    = ITIME09  = 1995/05/04 12:00:00
        NOTES    = ITIME10  = 1995/05/04 13:30:00
        NOTES    = ITIME11  = 1995/05/04 15:00:00
        NOTES    = ITIME12  = 1995/05/04 16:30:00
        NOTES    = ITIME13  = 1995/05/04 18:00:00
        NOTES    = ITIME14  = 1995/05/04 19:30:00
        NOTES    = ITIME15  = 1995/05/04 21:00:00
        NOTES    = ITIME16  = 1995/05/04 22:30:00
```

9 On Board Memory Management (Observations/IP Programs/Register

9.1 DEP Register Dumps

The DEP registers can be dumped into the SCI5K telemetry by means of a telecommand. This command does not interfer with the structure program (as long as there is margin in the SCI5K telemetry stream).

9.2 Managing the IP Register Contents

9.3 Removing Unsused Portions, Resorting, Re-pointing

10 How to Contribute/Suggest a Campaign

TODO?? Phil's 12 step 2 page writeup?

A Data Product Code (DPC) Encoding

The Data Product Code (DPC) is a 4 byte parameter that defines the type of data produced by the MDI instrument. It is suggested that the DPC be split into the following fields:

```
        bit 31   0 indicates flight data product
                 1 indicates ground data product

        bit 30   0 indicates 5 kbps science telemetry data product
                 1 indicates 160 kbps science telemetry data product

    bits 28-29  00 indicates standard science data products
                01 indicates limb figure science data products
                10 indicates tables and lists
                11 indicates other data products including
                   memory dumps, ISS mode etc.

    bits 16-27     indicate science observable or type of acquisition

    bits 00-15     indicate data format and parameters or identifier
```

The Data Product Code described above seen as bit fields:

```
    byte 1   byte 2   byte 3   byte 4
   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX

   X                                      = Ground or flight
   0                                        *** Flight ***
   1                                        *** Ground ***

    X                                     = 5 kbps or 160 kbps
    0                                       *** 5kbps telemetry ***
    1                                       *** 160kbps telemetry ***

     XX                                   = Type of data product
     00                                      *** Standard Science Products ***
     01                                      *** Limb Figure Products ***
     10                                      *** Lists and Table Products ***
     11                                      *** Other Products ***

       XXXX XXXXXXXX                      = Science observable, table/list type,
```

or other identifier

XXXXXXXX XXXXXXXX = Data format & parameters

For standard science and limb figure data products bits 16-27 indicates science observables. At a minimum, the science observables include full disk and high resolution image and calibration mode for each of the following:

filtergram
Sa - 4 summed filtergrams
Sa - 8 summed filtergrams
Sc - 4 summed filtergrams
Sc - 8 summed filtergrams
Sd - 8 summed filtergrams
Sd - 16 summed filtergrams
Si - 2 summed filtergrams
Si - 4 summed filtergrams
dopplergram - 4 filtergram
dopplergram - 8 filtergram
dopplergram - 16 filtergram
line depth - 8 filtergram
line depth - 16 filtergram
continuum intensity - 10 filtergram
continuum intensity - 20 filtergram
magnetogram - 8 filtergram
magnetogram - 16 filtergram

For standard science data products, bits 00-15 indicate the data format and any parameters necessary to fully describe the image. Data format descriptions include normal, IP compressed, and time weighted averages for each of the following:

cropped image with a crop radius identifier
nxm extract with an extract parameter identifier
nxm binning with a rebin list identifier
rectangular weighted binning with a rwbin list identifier
vector weighted binning with a vwbin list identifier
irregular binning with a irregular list identifier

For limb figure data products, bits 00-15 provide the limb figure radius and thickness, with bits 00-11 indicating the inner crop radius in 1/8 pixels and bits 12-15 indicating the delta crop radius. A suggested formula for the outer radius is:

outer_radius = inner_radius + delta_radius + offset

If the delta_radius is given in 1/8 pixel values, then the offset should be 40 in order to provide a 5 pixel baseline for the limb figure radius. For an inner radius of 480 pixels, bits 00-15 would then be 8F00 (hex) for a 6 pixels delta radius and the outer radius would be 486.

For lists and tables bits, 16-27 indicate the type of list or table and bits 00-15 are an identifying index. Typical list/table types are velocity, square root, and reciprocal look up tables, and binning, crop list and flat field tables. The available index space is sufficient that a unique index identifier could be associated with each list or table and that they could be associated with the corresponding data format.

For other data products, bits 16-27 indicates the type of acquisition and bits 00-15 provide a data identifier. "Other" data products include ground calibration data, IP memory dumps, ISS high rate sampled data, and simulated test data.

The ground calibration data that has been collected over the past two years falls into the "other" data product category with an acquisition type of xFFF with data identifiers from x0000 to xFFFF.

B Sequence ID Encoding

The "Observation ID" is associated with the list of frames that makes up an individual observation, while the "Campaign List ID" is associated with a list of observations and their associated parameters (including repeats).

```
Here's how sequence ID is being implemented:

        xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx
        x                                      = Ground or Flight
         x                                     = Telecommand or Sequence
          x                                    = Standard or "other" sequence
           xxx                                 = Sequencer version
              xx x                             = Part of sequence executing
                  xxxxxxx xxxx                 = Campaign List ID
                              xxxx xxxxxxxx    = Observation ID


Bit 31: 0:        Ground Test
        1:        Flight

Bit 30: 0:        Telecommand
        1:        Sequence

Bit 29: 0:        Standard Sequencer
        1:        Some other sequence

Remaining bits are meaningful only for standard sequencer

Bits 28-26:       Era, i.e. version of the standard sequencer
Bits 25-22:       Where am I, i.e. which part of the sequence is
                  executing:
                0:        prime60
                1:        Head transistion on the left
                2:        Prime 30 on the left
                3:        Alt observation on the left
                4:        Tail transition on the left
                8:        Head transition on the right
                9:        Prime 30 on the right
                A:        Campaign
                B:        Alt observation on the right
                C:        Tail transition on the right
```

```
Bits 21-12:       Campaign List ID
Bits 11-0:        Observation ID
```

C List of Observables

List of Observables		
Type	*Source*	*1st Obs*
Filtergram	Campaign	Yes
Dopplergram	Campaign	Yes
Line Depth	Campaign	Yes
Continuum	Campaign	Yes
Magnetogram	Campaign	No
Line Center	Campaign	No
Medium-L	Structure	No
LOI-?	Structure	No (TWA?)
LOI-?	Structure	No (TWA?)
Limb Figure	Structure	No (TWA)

NOTE: *TWA* means Time Weighted Average.

C.1 IP Instructions Used to Make the Observable

C.2 Parameters Used to Make the Observable

IP shift/scale parameter values for each case of the observable (ie 4,8,16 frame measurement, FD/HR, OBS/CAL, ...)

Scale of Lookup table / which lookuptable to use

What N and K values to use for each observable.

C.3 Different Calibration Processes Need for Each Observable

D List of Register Assignments

D.1 DEP Register Assignments

DEP Register Usage

Range	Usage
0-7	IP-DEP Communication
8-15	Main Sequence Parameters
16-23	DEP Flags
24-31	SCR implicit operands
32-47	SCR List Processing Instructions
48-63	Normal Sequence Table
64-72	Main Sequence Control Flags

IP_DEP Commnunications Registers:

Register #	Usage	
R0	Frame Number	
R1	Ticks w.r.t. Reference Time	
R2	Cycle # (Interval Count)	
R3	Telemetry Virtual Channel	
R4	Campaign Mode Flag	
R5	Dynamics Mode Flag	
R6	Image X Offset	
R7	Image Y Offset	
R8	Number of Observations	(Reserved)
R9	Observation Repeat Count	(Reserved)
R10	Duration in Mode	(Reserved)
R11	Frame in Observation	(Reserved)
R12-R15	Spare	

DEP Flags:

R16	IP Interrupt Code
R17	IP Interrupt Count
R18	Intra Instrument Command flag
R26	MTM1 Offset Register
R27	MTM2 Offset Register
R28	DMB address auto incr/decr flag

```
      R29         Hidden DMB Address
      R30         OCB Address auto incr/decr flag
      R31         Hidden OCB Address

Frame List Processing
      R32         Sequence ID (LS word)
      R33         Sequence ID (MS word)
      R34         Time of 1st Frame
      R35         Exposure
      R36         CAL1 Device Fucntion
      R37         CAL1 Position
      R38         CAL2 Device Function
      R39         CAL2 Position
      R40         PAW Device Function
      R41         PAW Position
      R42         CAL Move Flag
      R43         Image Type
      R44         Time

      R45         Address of Frame List
      R47         ALT Seq Address (Temporary)

Normal Sequence Table (Load Registers):
      R48         Prime60 Address
      R49         Prime30 Address
      R50         ALT Address
      R51         ALT Header Sequence
      R52         ALT Tail Sequence
      R53         ALT Repeat Count
      R54         ALT Cadence

ALT Observation Control:
      R55         Cycle Time (Cadence + ALT repeat count)
      R56         # ALT repeats remaining

Normal Sequence Table (Working Registers):
      R57         Prime60 Address
      R58         Prime30 Address
      R59         ALT Address
      R60         ALT Header Sequence
      R61         ALT Tail Sequence
      R62         ALT Repeat Count
```

```
      R63        ALT Cadence

Control Flags:
      R64        New Prime Table Flag
      R65        ALT Enable Flag
      R66        Campaign Flag
      R67        Campaign List Address
      R68        New List Flag
      R69        New List Address
      R70        II Flag
      R71        II List Address
      R72        Chain List Enable Flag
      R73        Chain List Address

Miscellaneous Register Usage:
      R81        Campaign Header Seq
      R82        Prime30C
      R83        Campaign Seq
      R84        Campaign Tail Seq
```

D.2 IP Register Assignments

IP Register Assignments		
Registers	*Description*	*Details*
0-63	IP Built-in's	These register are updated directly by certain IP instructions.
64-68	Geometry parameters	Set By Load Geometry Telecommand
69-70	Sun Center Offset	Used to change nominal central pixel
71-72	Pixels in Cropped Image	Set by DEP
73-75	Intra-Instrument Data	Set By DEP Telecommand
81-127	RESERVED	
128-159	EDAC Correction Control and Status	EDAC control and Status information for 4 pages of error corrected memory
160-167	Reserved for an additional EDAC page	
168-255	Uncommitted	Could be used for program controls
256-511	Temporary Register List	For programs that use reentrant instructions.
512-720	Register lists used for dynamics	
720-799	Reserved for dynamics	
800-3071	For additional register Lists	Will be partitioned into structure, magnetogram, and campaign sections.
3072-3087	DEP Registers	Written here automatically by IP with each camera header.
3088-3103	Place to save DEP registers	3072-3087 get overwritten with each new frame. If need in long programs, save registers here.
3104-3583	Uncommitted	
3584-4095	Low Rate Data Product Directory	Built into the IP's Low Rate Data Product generation scheme.

D.3 IP/DEP Registers in High Rate Data Product

The following defines the contents and usage of the first 294 IP/DEP registers. These registers appear in the high rate data product header (refer to MD340011).

IP/DEP Register Assignments		
Registers	*Description*	*Details*
0-19	CCD Temperatures	Generated by AVGTEMPS
20	CCD Temperature Handshake	Incremented by AVGTEMPS
21	Programmed Interrupt Code	Set by parameter in SETIRPT
22	Interrupt Handshake	Incremented by SETIRPT
23	IP Error Interrupt Code	Set by IP on certain errors
24-25	Total Data Products	Incremented by HRDINIT
26	High TM Board Recovery Flag	Set by High Rate Program (s)
27	Number of High Rate Errors	Incremented by High Rate Program(s)
28	High Rate Recovery Enable	Set by telecommand
29	High Rate Recovery Delay	Set by telecommand
30	High Rate Recovery Delay Counter	Dynamic copy of 29
31	Spare	
32	Heritage Program Number	Set by DEP on MBIPLBIC
33	Heritage Program Prime/Redundant Flag	Set by telecommand
34-35	Error Log Address	Set by telecommand
36	Error Log Count	Set by IP copylog
37-63	Spare	
64	Maximum Solar Radius (1/8 Pixels)	Set by DEP when geometry loaded
65	Minimum Solar Radius (1/8 Pixels)	Set by DEP when geometry loaded
66	Suncenter X (1/8 Pixels)	Set by DEP when geometry loaded
67	Suncenter Y (1/8 Pixels)	Set by DEP when geometry loaded
68	Line Length	Set by DEP when geometry loaded
69	Sun Center Offset (Lower)	Set by Telecommand
70	Sun Center Offset (Upper)	Set by Telecommand
71	Pixels in the Cropped Image (Lower)	Set by DEP when crop list loaded
72	Pixels in the Cropped Image (Upper)	Set by DEP when crop list loaded
73	II Valid Event	Set by DEP When Valid Event Occurs
74-75	II Offset	Set by DEP When Valid Event Occurs
76	II Extraction X-Size	Set by telecommand
77	II Extraction Y-Size	Set by telecommand
76-80	Spare	
81	Virtual Channel Number	0, 2, or 3
82	Dynamics Flag	0, 1
83-128	UNUSED	
128	page_address (of lookup table page)	EDAC Error status as generated by
129	multi-bit_error_sum	a purge instruction. This set (registers
130	single-bit_error_sum	128-135) is reserved for the lookup
131	multi-bit_error_count	table page (2 byte EDAC), which has
132	single-bit_error_count	been initially assigned to page 16. The
133	start_address_low	3 (8 long) register groups are for 3
134	start_address_high	pages of list memory which have been
135	number_blocks	defined as pages 12, 13, and 14.
136-143	EDAC Error results for a list page	See Registers 128 - 135
144-151	EDAC Error results for list page	See Registers 128 - 135
152-159	EDAC Error results for list page	See Registers 128 - 135
160-293	SPARE	

E List of IP Instructions

TODO?? List of a subset of the IP instructions and their mathmatical equivalent?

The following sets of tables shows the IP instructions available. The letter in the second column is R if the instruction can only be executed by the DEP, Q if the instruction can only be executed by the IP queue program, and B if it can be exectuted by either (Both). The parameter "v" means the instruction takes a value, and "r[8]" means the instruction points to a register address where it reads 8 values.

IP Instructions – Program & Instruction Queue Control			
Instruction		*Params*	*Description*
ABORTMAC	R		Abort instruction queue processing.
ADDADR	B	r[2],r[2],r[2]	Add main memory addresses.
BEGINMAC	B	v	Begin instruction queue macro.
BRANCHEQ	B	r[1],v,v	Branch if register contents equal to value.
BRANCHGT	B	r[1],v,v	Branch if register contents greater than value.
BRANCHIF	B	r[1],v	Branch if register contents equal zero.
BRANCHLT	B	r[1],v,v	Branch if register contents less than value.
BRANCHNE	B	r[1],v,v	Branch if register contents not equal to value.
BRANCHNR	B	v,v	Branch if memory page not ready.
BRANCHWR	B	v	Branch if purge warning bit not set.
CALLQUE	Q	v	Call queue subroutine.
CLRIRPT	R		Clear DEP interrupt.
DSBIRPT	R		Disable subsequent DEP interrupt instructions.
DSBQUE	B		Disable instruction queue processing.
ENBIRPT	R		Enable subsequent DEP interrupt instructions.
ENBQUE	R		Enable instruction queue processing.
ENDMAC	Q		Pop hardware stack and resume previous instruction queue macro.
GOTO	B	v	Transfer queue processing to new address (direct).
GOTOREG	B	r[1]	Transfer queue processing to new address (indirect).
NOOP	B		No operation.
RTNQUE	Q		Return from queue subroutine.
SETIRPT	B	v	Interrupt DEP if enabled.
SUBINIT	R		Initialize queue subroutine stack.
SWAPTOS	Q		Swap current queue address with top of hardware stack and branch.

IP Instructions – DEP/IP Register Operations			
Instruction		*Params*	*Description*
ADDREGD	B	r[1],v	Add value to contents of register.
COPYRD2D	B	r[n],r[n],v	Copy a series of registers to another series of registers (direct to direct).
COPYRD2I	B	r[n],r[r[n]],v	Copy a series of registers to another series of registers (direct to indirect).
COPYREG	B	r[1],r[1]	Copy contents of one register to another.
COPYRI2D	B	r[r[n]],r[n],v	Copy a series of registers to another series of registers (indirect to direct).
COPYRI2I	B	r[r[n]],r[r[n]],v	Copy a series of registers to another series of registers (indirect to indirect).
GETREG	R	r[1]	Copy register contents to DEP data register.
LOADRLST	B	r[n],v,v,v	Copy words from main memory to registers.
PCKL2REG	B	v,v,v,v	Copy low byte of words from main memory to registers.
REGLOGOP	B	r[1],r[1],r[1]	Register logical operations (and, or, xor, invert).
REGNUMOP	B	r[1],r[1],r[1]	Register numerical operations (add, subtract, complement, multiply).
SAVERLST	B	r[n],v,v,v	Copy a series of registers to main memory.
SETREG	B	r[1],v	Set register to a value.
SETREGS	B	r[n],v,v...	Set a series of registers to a series of values.
SETRPG	R	v	Set location of lookup page in main memory.

IP Instructions – Main Memory Operations			
Instruction		*Params*	*Description*
COPYLST	B	r[6]	Copy list to new location.
COPYTAB	B	r[5]	Copy table to new location.
DAT2LST	B	r[6]	Copy data from main memory to list.
FILLBLK	B	v,v,v,v,v	Writes fill word to a block of main memory addresses (direct).
FILLSTD	B	v,v,r[3]	Write fill word to a block of main memory addresses (indirect).
LST2DAT	B	r[6]	Copy main memory list to main memory data.
MOVBLK	B	v,v,v,v,v,v	Copy main memory data to data (direct).
MOVBLKI	B	r[6]	Copy main memory data to data (indirect).
MOVSBLKI	B	r[6]	Copy main memory data to data (indirect, same page).

IP Instructions – Science Support			
Instruction		*Params*	*Description*
AWBIN	B	r[8]	Arbitrary weighted binning.
BADPIX	B	r[8]	Remove bad pixels from image.
CNTNM	B	r[10]	Calculate Ic = (Sd/8)+(Id/4)+(Si/2)-Cadc (continuum intensity).
COPYCB	B	r[8]	Copy data to circular buffer.
CROP	B	r[8]	Extract an arbitrarily shaped subimage.
EXTRACT	B	r[8]	Extract a rectangular subimage.
FLATFLD	B	r[9]	Perform flat field correction on an image.
IRBIN	B	r[8]	Perform irregular weighted binning of source image.
LDEPTH	B	r[9]	Calculate line depth from summing buffers Sa and Sc.
LOOKUP	B	r[8]	Perform generic lookup.
LRBIN	B	r[8]	Performs linear rebinning of source data.
ROWBIN	B	r[11]	Bin rectangular subimage to a single row.
RWBIN	B	r[8]	Perform rectangular weighted binning of source image.
SCALE	B	r[8]	Perform scaling of main memory data.
SCALESUM	B	r[11]	Calculate sum of independently scaled images.
TWAVG	B	r[12]	Perform time weighted average of source data.
VELOCITY			Calculate velocity from summing buffers Sa and Sc.
VWBIN	B	r[8]	Perform vector weighted binning of source image.
XALIGN	B	r[8]	Move image fraction of a pixel in x.
YALIGN	B	r[8]	Move image fraction of a pixel in y.

IP Instructions – Telemetry Support			
Instruction		*Params*	*Description*
AVGTEMPS	B	v,v,v	Average CCD Camera temperatures to registers.
BUF2DAT	R	v,v,v,v	Copy data from double buffer to main memory (normal format).
BUF2LST	R	v,v,v,v	Copy data from double buffer to main memory (list format).
BUF2TAB	R	v,v,v,v	Copy data from double buffer to main memory (table format).
DAT2BUF	B	v,v,v,v	Copy data from main memory to double buffer.
HRDINIT	B	r[6]	Initialize a buffer for high rate telemetry.
LRDEND	B		Copy low rate data product directory to buffer and finialize.
LRDINIT	B	v	Initialize low rate data product directory header.
LRDXFR	B	r[14]	Copy a low rate data product to the DEP/IP interface buffer.
START1HR	B	v,v,r[2]	Start high rate telemetry transfer (one page).
START2HR	B	v,v,v,r[2],r[2]	Start high rate telemetry transfer (two pages).

IP Instructions – Error Control			
Instruction		*Params*	*Description*
CLRWARN	R		Clear purge warning flag to DEP.
COPYELOG	B	r[3]	Copy error log to main memory.
ERRDUMP	R		Clear fatal error condition, return error code and parameters.
INITLST	R	v,r[8]	Initialize a main memory page to use 8 byte error detection and correction.
INITTAB	R	v,r[8]	Initialize a main memory page to use 2 byte error detection and correction.
LOADMODE	B		Restore operating mode.
PURGELST	B	r[8]	Remove single bit errors from main memory page in 8 byte edac mode.
PURGETAB	B	r[8]	Remove single bit errors from main memory page in 2 byte edac mode.
SAVEMODE	B		Save current operating mode.
THROW	B	v	Generate error.

IP Instructions – Debug & Diagnostic Support			
Instruction		*Params*	*Description*
COPYQUE	R		Copy instruction queue to double buffer.
GETAUX	R		Return contents of DEP/IP interface auxillary register.
GETHEADR	B	r[10]	Get CCD camera header commands.
GETIPARM	R		Returns contents of APU instruction parameter registers.
GETQADR	B	r[1]	Copy current instruction queue address to register.
GETQVAL	B	r[1],r[1]	Copy instruction queue data to register.
MEM2DEP	R	v,v,v	Copy main memory data to DEP.
MEMDIAG	R	v	Returns error status registers from addressed page of main memory.
MSLFTEST	R	v,v,v	Perform self test of three main memory pages and all local memories.
TLMFILL	R	v,v	Fill page with standard telemetry test pattern.
TLMTEST	R	v,v,v,v	Start high rate telemetry transfer (test).
VERSION	B		Returns microcode version number to DEP data register.

F List of IP Register List Sets

G List of IP Subroutines (Macros?)

H Details on the Telemetry Mode Transition TSTOLs

```
Detailed below is my understanding of the actions taken during the
SOHO spacecraft high rate telemetry transitions. The nomenclature and
command details are to be finalized.

Setup for daily observations
Action:         Update new list and chain list addresses
Delay Commands: Set MDI DEP REG R69 to address of 8-hr campaign list
                Set MDI DEP REG R73 to address of 8-hr campaign list


IDLE => VC2
Action:         Initiate magnetogram dump campaign and enable chain list.
TSTOL Proc:     K_IDTOMM
TSTOL Commands: Set MDI DEP Reg R66 to 1; set campaign flag
                Set MDI DEP Reg R72 to 1; set chain list flag
                Set MDI DEP Reg  R3 to 2; set VC id to 2
                Transition S/C telemetry to MDI-M mode.

IDLE => VC3
Action:         Initiate new list campaign.
TSTOL Proc:     K_IDTOMH
TSTOL Commands: Set MDI DEP Reg R66 to 1; set campaign flag
                Set MDI DEP Reg R28 to 1; set new list flag
                Set MDI DEP Reg  R3 to 3; set VC id to 3
                Transition S/C telemetry to MDI-H mode.

VC2 => IDLE
Action:         Flag termination of H/R downlink and transition to prime 60.
TSTOL Proc:     K_MMTOID
TSTOL Commands: Set MDI DEP Reg  R3 to 0; set VC id to 0
                Set MDI DEP Reg R5  to 0; clear dynamics flag
                Set MDI DEP Reg R66 to 0; clear campaign flag
                Set MDI DEP Reg R72 to 0; clear chain list flag
                Wait 60 seconds
                Set MDI DEP REG R67 to address of VC2OBS campaign list
                Transition S/C telemetry to high rate idle mode.

VC3 => IDLE
Action:         Flag termination of H/R downlink and transition to prime 60.
TSTOL Proc:     K_MHTOID
```

```
TSTOL Commands: Set MDI DEP Reg  R3 to 0; set VC id to 0
                Set MDI DEP Reg R5  to 0; clear dynamics flag
                Set MDI DEP Reg R66 to 0; clear campaign flag
                Set MDI DEP Reg R72 to 0; clear chain list flag
                Wait 60 seconds
                Set MDI DEP REG R67 to address of VC2OBS campaign list
                Transition S/C telemetry to high rate idle mode.

VC2 => VC3
Action:         Identify transition from VC2 to VC3
TSTOL Proc:     K_MMTOHM
TSTOL Commands: Set MDI DEP Reg  R3 to 3; set VC id to 3
                Transition S/C telemetry to MDI-H mode.

VC3 => VC2
Action:         Identify transition from VC3 to VC2
TSTOL Proc:     K_MHTOMM
TSTOL Commands: Set MDI DEP Reg  R3 to 2; set VC id to 2
                Transition S/C telemetry to MDI-M mode.
```

I Summary of Database Files and Data File Types

Data Files			
Type	*File*	*Source*	*Read/Write*
Operations	ECS KAP	??	Read
	IAP of other Instruments	??	Read
	IAP for MDI	MDI/OPS	Write
	Upload Files	MDI/OPS	Write
	Delayed Command Files	MDI/OPS	Write
	Ground based images	??	Read
	Planning Images (within minutes)	??	Read/Write?
	Summary Data (Daily)	??	Write
	EGSE History	MDI/EGSE	Write
	Command History	ECS	Read
	Command Verification	ECS?	Read
Ancillary	S/C Orbital Solutions	ECS?	Read
	S/C Attitude	ECS?	Read
Telemetry	SCI160K (real time)	Socket	Write
	SCI5K (real time)	Socket	Write
	SCI5K QCK (real time playback)	FTP	Write
	SCI5K REL (tape playback)	FTP	Write
Reformatted	FITS file per SCI160K DPC	MDI	Write
	FITS file per SCI5K DPC	MDI	Write
Software	/mdisw	MDI	Write
	/solar_soft	NFS	Read
	Other instrument databases	NFS	Read
	Other instrument documentation	NFS	Read
Databases	Bin List	??	??
	Observation (Filtergram list)	??	??
	IP Queue Program	??	??
	IP Registers	??	??

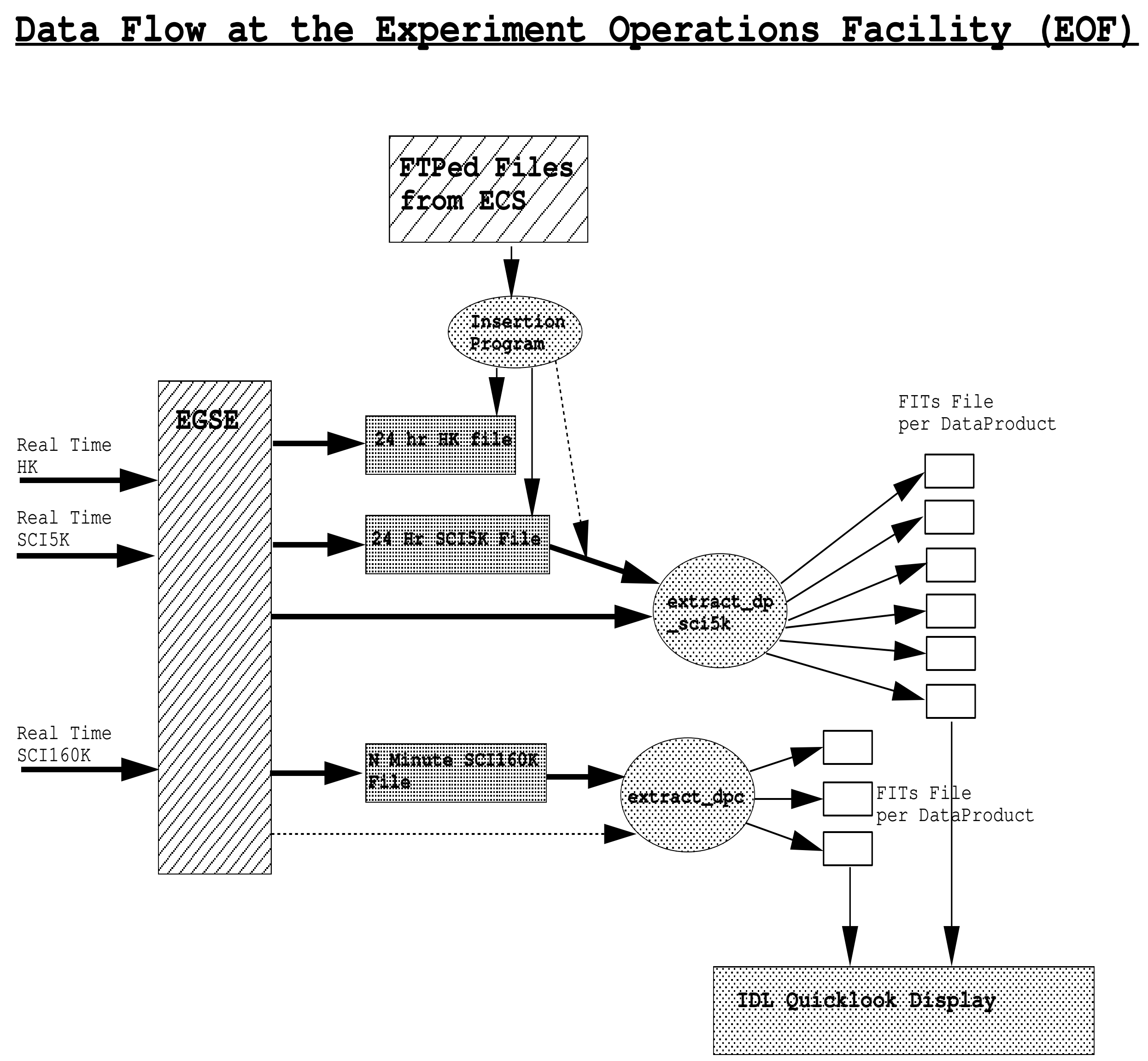

Figure 9: Data Flow at the EOF

J TO RESOLVE / PUT SOMEWHERE / DELETED

- ALT sequence cannot be interupted, so if ALT is running and we start a VC2 session, it does not enter campaign mode. The high rate is idle until the ALT sequence is finished (up to 5 minutes). Is this a scheduling problem, or do we need to look at the logic.
- Does a camera image need to be taken every 3 seconds whether it is needed or not (residual image/bulk damage/dark signal/CTE/ghost image)
- What about when going from FD to HR. The pixels off the limb have not been exposed to light in a long time. Is there a trap/ghost problem with those pixels now that they are being illuminated? What action is needed? Flag those data products as questionable.
- Do we have dummy moves? 0 1 2 3 4 4 3 2 1 0 OR 1 2 3 4 5 4 3 2 1 0 or what?
- How do we handle VC2. Rock: At start of VC2, set telemetry mode and campaign flag. Mike: Set telemetry mode, let PRIME60 telemeter the magnetograms down the SCI160K, TSTOL wait 2 minutes, then set campaign flag.
- How are campaign loads done? When is the campaign address updated? Hours before the campaign flag gets set? Part of the TSTOL?
- What is this saving of the last 8+ hours of LOI and resending it at VC2?
- Do we encode the image shape in the DPC? If not, Katie/Jim have to be brought up to date for the reformatter. Is there a new DPC when
  - There is a different image shape
  - There is a slight change to frame list (ie: shutter duration or memory pages used)
  - Slightly different IP program
  - New velocity table?
  - New reciprocal table?
  - ??

  Where are the DPC values specified? All in the register list space? or some inside an IP queue program?
- Do we need a new code which encompasses (1) SeqID, (2) DPC, and (3) some shape AND LOCATION parameters?
- How to dump DEP register/memory contents? How often? What impacts to the structure program.
- How to process the memory dump packets? Have a dummy header created by ground software and treat it like a data product from then on? Is there a memory address in each sci5k packet?
- WE NEED TO START MANAGING THE BIN/LOOKUP/CROP LISTS. We need a file per list. We'll want a file per data product which contains the names of the lists used (there will be several for some products ie: recip, vel, crop for a cropped dopplergram)
- We need to manage/define the observation ID setting. We need the capability to go from a SeqID (ObsID + CampaignID) to a known .OBS and .IPS file so that we can analyze and interpret the data. There are only 12 bits (4096 values). Remove some bits from the campaign ID (or remove it completely - manage that by date/time of load?). Do we manage it separately for SIM system and FLIGHT? Have the number set when going

from .IPS and .CAM files to load or .SRC files?