Venus Express ASPERA-4

Description of L1 VEX data files

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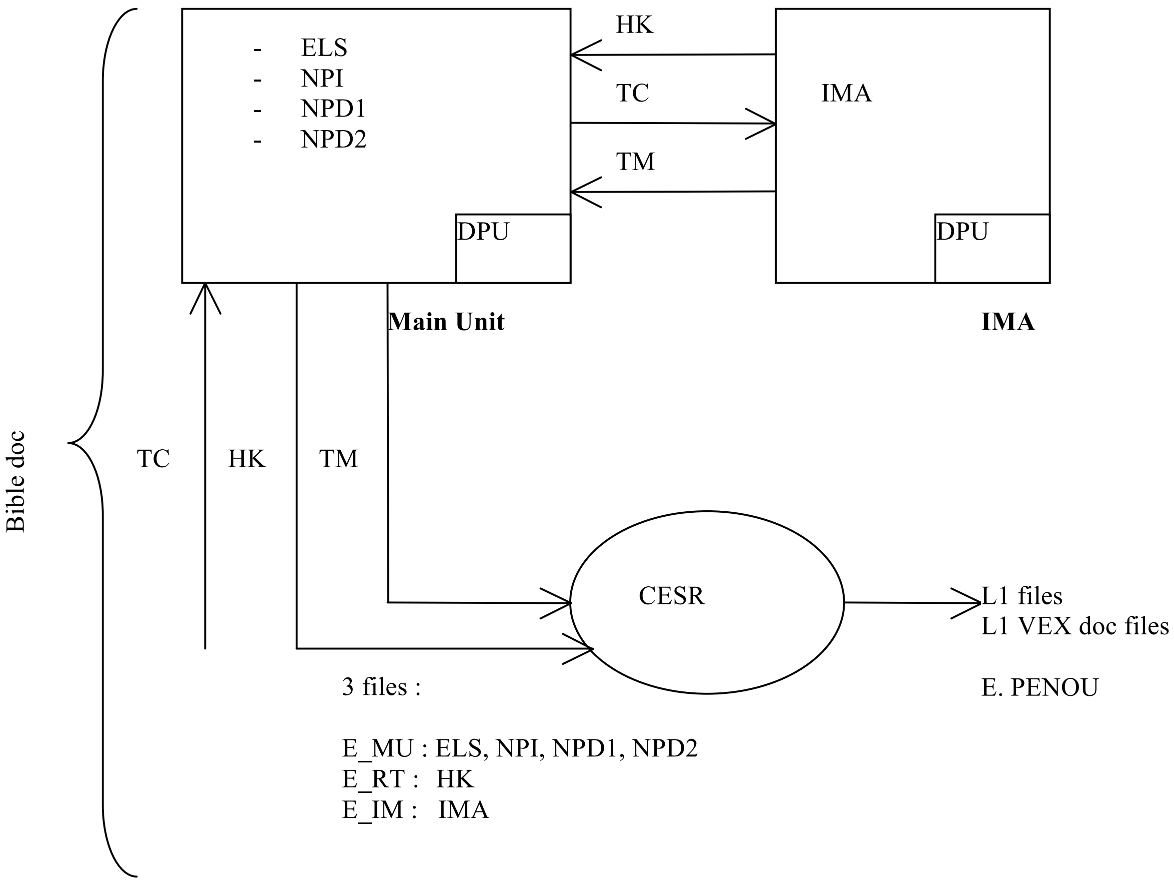
Schematic of the data processing :



This document describes the content of the L1 data files that are created after decommutating the ASPERA-4 telemetry data files.

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1- L0 telemetry data files

The level-0 telemetry data files are collected at IRF and distributed to the CoI team. Both ground tests data and on-board data files are available at http://aspera-4.irf.se/archive/raw.

This directory as posted at the time of the 30/11/2005 contained :

```
E_CMDPF20050427140000.txt 11-May-2005 15:15   26M
E_CMDPF20050610000000.txt 14-Jun-2005 10:41  936K
E_CMDPF20050831100000.txt 31-Aug-2005 14:56   54K

E_IM20050427140000.sfduZ  11-May-2005 15:05  9.9K
E_IM20050610000000.sfduZ  14-Jun-2005 10:05  227K
E_IM20050831100000.sfduZ  31-Aug-2005 13:18   13K
E_IM20050831110000.sfduZ  31-Aug-2005 14:51  839
E_MU20050427140000.sfduZ  11-May-2005 15:05   53K
E_MU20050610000000.sfduZ  14-Jun-2005 10:05  581K
E_MU20050831100000.sfduZ  31-Aug-2005 13:18   89K
E_MU20050831110000.sfduZ  31-Aug-2005 14:51  839
E_RT20050224230000.sfduZ  25-Feb-2005 12:55  1.5K
E_RT20050427140000.sfduZ  11-May-2005 15:05   17K
E_RT20050610000000.sfduZ  14-Jun-2005 10:05  138K
E_RT20050629150000.sfduZ  30-Jun-2005 13:26  2.3K
E_RT20050831100000.sfduZ  31-Aug-2005 13:18   12K
E_RT20050831110000.sfduZ  31-Aug-2005 14:51  1.9K

time-corr-LATEST          29-Nov-2005 00:50  432
time-corr-LATEST.sfduZ    30-Nov-2005 00:50  1.3K
```

E_IM*, E_MU* and E_RT* are the L0 telemetry data files. They are named according to the following naming convention:

- `E_IMYYYYMMDDhhmmss` (IMA data)
- `E_MUYYYYMMDDhhmmss` (ELS, NPI, NPD1 and NPD2 data)
- `E_RTYYYYMMDDhhmmss` (data HKxx de IMA and Main Unit)

where

`YYYYMMDDhhmmss` is the beginning date/time of data (year, month, day, hour, minute, seconde).

Typically a set of 3 data files (E_IM*, E_MU* and E_RT*) are produced at each start date/time observation. However, for un-processed or missing L0 telemetry data files, a data file set may have to contain fewer one.

These files are daily retrieved from the web IRF server then stored into the /DATA/ASPERA4/DATA/L0 directory of the aspera.cesr.fr restricted access server.

2- L1 data files

Each received E_IM, E_MU or E_RT packet is passed through the VEX data processing software for disassembling them into a collection of data set records, sorted by object type (ELS, IMA, NPI, NPD1, NPD2 and HK) and written in a format easily understandable by a human. All generated level-1 data files are placed in the /DATA/ASPERA4/DATA/L1 directory of the CESR database, that is accessible to the authorized ASPERA-4 team through the aspera.cesr.fr server.

For example, the processsing of the packets of the 20050610000000 time occurrence generated the following L1 data files :

```
CODE_E_IM20050610000000
CODE_E_MU20050610000000 (a)
CODE_E_RT20050610000000

LIST_E_IM20050610000000
LIST_E_MU20050610000000 (b)
LIST_E_RT20050610000000

VEX_ASP4_JDBx_E_IM20050610000000
VEX_ASP4_JDBx_E_MU20050610000000 (c)
VEX_ASP4_JDBx_E_RT20050610000000

VEX_ASP4_ELSx_E_MU20050610000000.gz
VEX_ASP4_HKxx_E_RT20050610000000.gz
VEX_ASP4_IMAx_E_IM20050610000000.gz (d)
VEX_ASP4_NPD1_E_MU20050610000000.gz
VEX_ASP4_NPD2_E_MU20050610000000.gz
VEX_ASP4_NPIx_E_MU20050610000000.gz

VEX_ASP4_OTHx_E_RT20050610000000.gz (e)
```

(a) CODE files contain the error code processing :

- 0 : OK
- 1 : WARNING
- 2 : ERREUR

(b) LIST files contain the list of generated L1 data files. For example,

LIST_E_IM20050610000000 contains:

```
VEX_ASP4_IMAx_E_IM20050610000000
```

LIST_E_MU20050610000000 contains:

```
VEX_ASP4_ELSx_E_MU20050610000000
VEX_ASP4_NPIx_E_MU20050610000000
VEX_ASP4_NPD1_E_MU20050610000000
VEX_ASP4_NPD2_E_MU20050610000000
```

LIST_E_RT20050610000000 contains:
VEX_ASP4_HKxx_E_RT20050610000000
VEX_ASP4_OTHx_E_RT20050610000000

(c) JDB files are the log files of the related processings.

(d) ELSx, IMAx, NPD1, NPD2 and NPIx files contain respectively ELS, IMA, NPD1, NPD2 and NPI science data. HK file contains « Housekeeping » data from IMA and the Main Unit.

(e) OTHx files contain additional data that are not referring to sensor observations.

Only ELSx, NPIx, NPD1, NPD2, IMAx and HKxx files are considered for achive. The naming convention is as following:

VEX_ASP4_expe_typeYYYYMMDDhhmmss.gz

where

expe:	ELSx, IMAx, NPD1, NPD2, IMAx or HKxx
type :	E_IM or E_MU or E_RT
YYYYMMDDhhmmss :	year month day hour minute second

Finally 6 types of L1 data file will be generated (in some cases, however, some data types may be not present) :

- VEX_ASP4_IMAx_E_IMYYYYMMDDhhmmss.gz
- VEX_ASP4_ELSx_E_MUYYYYMMDDhhmmss.gz
- VEX_ASP4_NPIx_E_MUYYYYMMDDhhmmss.gz
- VEX_ASP4_NPD1_E_MUYYYYMMDDhhmmss.gz
- VEX_ASP4_NPD2_E_MUYYYYMMDDhhmmss.gz
- VEX_ASP4_HKxx_E_RTYYYYMMDDhhmmss.gz

All ASPERA-4 telemetry data files collected at IRF are in binary format. Related technical documents describe these files format in detail. The L1 file products are written in ASCII format and designed in a telemetry-alike format with no data reprocessing for preserving the raw high-resolution data. This format similarity allows us the use of the description of the telemetry format for interpreting the L1 data files.

2-1 DESCRIPTION OF HKxx FILE

This file contains uncalibrated Housekeeping data incoming from two systems: the Main Unit (MU) and the IMA Data Processing Unit. HK MU data are identified by the first line `MU Housekeeping packet`. Each data block of HK IMA begins with the sentence marker `IMA Housekeeping packet`. The 12 subsequent lines will be treated as following :

Line	Name of the field	Type	Format
2			
3	`Version_Number`	3 bits	%d
4	`Type`	1 bit	%d
5	`Data_field_header_flag`	1 bit	%d
6	`ProcessID`	7 bits	%d
7	`Packet_Category`	4 bits	%d
8	`Header_SEQ_CNT`	16 bits	0x%x
9	`Header_SIZE_bytes`	16 bits	%d
10	**`Header_TIME`**	48 bits	%f
11	`Header_TYPE`	8 bits	%d
12	`Header_SUBTYPE`	8 bits	%d
13			

Succeding lines are the values of the housekeeping.

Housekeeping data marked in green are converted into physical unit as defined in the table of the ASPERA4 Bible, APPENDIX 6 (« HK channel conversion factor »). Housekeeping data marked in black are not intended to be converted to physical value.

Fields highlighted **in blue and bold font** indicate those values that are converted into physical unit for being plotted with the cl tool at the CESR.

The **`Header_TIME`** is converted to UT time by using the correlation/correction coefficients provided within the « time-corre-LATEST » file (see section 3).

2-1-1 MU Housekeeping data

A telemetry data description of the MU housekeeping is given in the ASPERA4 bible, APPENDIX 4 (« Main Unit TM/TC description »), page 64.

MU housekeeping parameters are listed and detailed in the following fields table in the same order that they appear within the housekeeping file product :

Line	Name of the field	Type	Format	Calibration database	Unit
14	`PAD`	8 bits	%d	Useless	-
15	`SID`	8 bits	%d	Useless	-
16	**`ELS_temp`**	8 bits	%d	ELS Temp	°C

17	NPD1_temp	8 bits	%d	NPD1 Temp	°C
18	NPD2_temp	8 bits	%d	NPD2 Temp	°C
19	NPI_temp	8 bits	%d	NPI Temp	°C
20	Scanner_Temp_sensor	8 bits	%d	Scanner Temp	°C
21	SW_Version	16 bits	%d	-	-
22	ELS_minus_5v_screen_grid_reference	8 bits	%d	Digital 8 bits	digit
23	ELS_minus_5v_screen_grid_monitor	8 bits	%d	-0.0196*x	V
24	ELS_bia_mcp_reference	8 bits	%d	Digital 8 bits	digit
25	ELS_bia_mcp_monitor	8 bits	%d	ELS MCP bias	V
26	ELS_Range	1 bit	%d	0 low 1 high	digit
27	ELS_table_index	8 bits	%d	Number	digit
28	ELS_enable_hv	1 bit	%d	0=Off 1=On	-
29	ELS_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
30	HK_i_plus_30v	8 bits	%d	HK_I_+30V	V
31	HK_i_plus_5v	8 bits	%d	HK_I_+5V	V
32	HK_v_plus_12v	8 bits	%d	HK_V_+12V	V
33	HK_v_plus_30v	8 bits	%d	HK_V_+30V	V
34	HK_v_plus_5v	8 bits	%d	HK_V_+5V	V
35	HK_v_minus_12v	8 bits	%d	HK_V_-12V	V
36	HK_v_minus_5v	8 bits	%d	HK_V_-5V	V
37	NPD2_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
38	NPD1_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
39	NPD_heaters_on_off	1 bit	%d	0=Off 1=On	-
40	SUN_sensor_1	1 bit	%d	Sun sensor 1 output	-
41	SUN_sensor_2	1 bit	%d	Sun sensor 2 output	-
42	NPD2_defl_switch	1 bit	%d	Not in use	-
43	NPD1_defl_switch	1 bit	%d	Not in use	-
44					
45	NPD1_bias_monitor	8 bits	%d	NPD1 Bias	V
46	NPD1_bias_reference	8 bits	%d	Digital 8 bits	digit
47	NPD1_defl_monitor	8 bits	%d	NPD1 Defl	V
48	NPD1_defl_reference	8 bits	%d	Digital 8 bits	digit
49	NPD1_start_bias_monitor	8 bits	%d	NPD1 Start	V
50	NPD1_start_bias_reference	8 bits	%d	Digital 8 bits	digit
51	NPD1_stop_bias_monitor	8 bits	%d	NPD1 Stop	V
52	NPD1_stop_bias_reference	8 bits	%d	Digital 8 bits	digit
53	NPD1_frontctrl	8 bits	%d	See Append 5 P11 register	-
54	NPD1_mainctrl	8 bits	%d	See Append 5 P11 register	-
55	NPD1_stat	16 bits	%d	See Append 5 P11 register	-
56	NPD1_tdcrd	16 bits	%d	See Append 5 P11 register	-
57	NPD1_calib11	16 bits	%d	See Append 5	-

				P11 register	
58	NPD1_calib12	16 bits	%d	See Append 5 P11 register	-
59	NPD1_calib21	16 bits	%d	See Append 5 P11 register	-
60	NPD1_calib22	16 bits	%d	See Append 5 P11 register	-
61	NPD1_sefccnt	16 bits	%d	See Append 5 P11 register	-
62	NPD1_defccnt	16 bits	%d	See Append 5 P11 register	-
63					
64	**NPD2_bias_monitor**	8 bits	%d	NPD2 Bias	V
65	NPD2_bias_reference	8 bits	%d	Digital 8 bits	digit
66	**NPD2_defl_monitor**	8 bits	%d	NPD2 Defl	V
67	NPD2_defl_reference	8 bits	%d	Digital 8 bits	digit
68	**NPD2_start_bias_monitor**	8 bits	%d	NPD2 Start	V
69	NPD2_start_bias_reference	8 bits	%d	Digital 8 bits	digit
70	**NPD2_stop_bias_monitor**	8 bits	%d	NPD2 Stop	V
71	NPD2_stop_bias_reference	8 bits	%d	Digital 8 bits	digit
72	NPD2_frontctrl	8 bits	%d	See Append 5 P11 register	-
73	NPD2_mainctr	8 bits	%d	See Append 5 P11 register	-
74	NPD2_stat	16 bits	%d	See Append 5 P11 register	-
75	NPD2_tdcrd	16 bits	%d	See Append 5 P11 register	-
76	NPD2_calib11	16 bits	%d	See Append 5 P11 register	-
77	NPD2_calib12	16 bits	%d	See Append 5 P11 register	-
78	NPD2_calib21	16 bits	%d	See Append 5 P11 register	-
79	NPD2_calib22	16 bits	%d	See Append 5 P11 register	-
80	NPD2_sefccnt	16 bits	%d	See Append 5 P11 register	-
81	NPD2_defccnt	16 bits	%d	See Append 5 P11 register	-
82					
83	NPI_bias_reference	8 bit	%d	Digital 8 bits	digit
84	**NPI_bias_monitor**	8 bit	%d	NPI Bias	V
85	NPI_defl_reference	8 bit	%d	Digital 8 bits	digit
86	**NPI_defl_monitor**	8 bit	%d	NPI Defl	V
87					
88	IMA_plus_minus_5v_on_off	1 bit	%d	0=Off 1=On	-
89	IMA_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
90	IMA_plus_minus_12v_on_off	1 bit	%d	0=Off 1=On	-

91	NPI_defl_mode	1 bit	%d	0=Off 1=On	-
92	NPI_defl_switch	1 bit	%d	?	?
93	NPI_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
94	SCANNER_vrefmc	8 bit	%d	Digital 8 bits	digit
95	SCANNER_init	1 bit	%d	?	?
96	lost_step	1 bit	%d	?	?
97	SCANNER_status_state	2 bits	%d	?	?
98	SCANNER_status_direction	1 bit	%d	?	?
99	SCANNER_status_pos_clock	1 bit	%d	?	?
100	SCANNER_status_cw_end_pos	1 bit	%d	1 – Scanner in cw end position 0 – Scanner not in cw end position	-
101	SCANNER_status_ccw_end_pos	1 bit	%d	1 - Scanner in ccw end position 0 – Scanner not in ccw end position	-
102	SCANNER_speed	2 bit	%d	?	?
103	SCANNER_setup_direction	1 bit	%d	?	?
104	SCANNER_setup_mode	1 bit	%d	?	?
105	SCANNER_plus_30v_on_off	1 bit	%d	0=Off 1=On	-
106	SCANNER_coast_current_ref	8 bits	%d	Digital 8 bits	digit
107	SCANNER_ramp_current_ref	8 bits	%d	Digital 8 bits	digit
108	SCANNER_treshold_cw_ref	8 bits	%d	Digital 8 bits	digit
109	SCANNER_treshold_ccw_ref	8 bits	%d	Digital 8 bits	digit
110	SCANNER_treshold_wheel_ref	8 bits	%d	Digital 8 bits	digit
111	SCANNER_position	8 bits	%d	Scanner Position	deg
112	SW_mode	8 bits	%d	?	?
113	cpu_load	8 bits	%d	?	?
114	ELS_sector_mask	16 bits	%d	16 sector mask 0 – Sector disabled 1 – Sector enabled	-
115	ELS_compression_scheme	8 bits	%d	?	?
116	IMA_link_status	8 bits	%d	?	?
117	NPI_sector_mask	32 bits	%d	32 sector mask 0 – Sector disabled 1 – Sector enabled	-
118	NPI_RICE_compression_enable	1 bit	%d	0=No 1=Yes	-
119	NPI_LOG_compression_enable	1 bit	%d	0=No 1=Yes	-
120	NPI_Accumulation_Time	4 bits	%d	Accumulation period 31.25 ms * (2^n)	s
121	NPI_mode	2 bits	%d	?	-

122	NPD_Accumulation_Time	5 bits	%d	Accumulation period 31.25ms*(2^n)	s
123	NPD_RICE_compression_enable	1 bit	%d	0=Off 1=On	-
124	NPD_LOG_compression_enable	1 bit	%d	0=Off 1=On	-
125	NPD1_mode	4 bits	%d	?	-
126	NPD2_mode	4 bits	%d	?	-

2-1-2 IMA Housekeeping data

A telemetry data description of the IMA housekeeping is given in the ASPERA4 bible, APPENDIX 9 (« IMA TM/TC description »), section 6.

IMA housekeeping parameters are listed and detailed in the following fields table in the same order that they appear within the housekeeping file product :

Line	Name of the field	Type	For mat	Calibration database	Unit
14	Last_command_status	2 bits	%d	Cmd status	-
15	Current_data_reduction_mode	6 bits	%d	Mode	-
16	HV_switch_status	8 bits	%d	bitit0=Mcp 28V On/Off bit1=Opto 28V On/Off bit2=Main 28V On/Off bit3=Pacc.ref On/Off bit4=Grid.ref On/Off bit5=Entr.HV.ref On/Off bit6=EnyDfl.HV.ref On/Off bit7=EnyDfl.LV.ref On/Off 0=Off 1=On	
17	+28V_MCP_HV_present	1 bit	%d	Mcp 28V switch 0=No 1=Yes	-
18	+28V_Opto_HV_present	1 bit	%d	Opto 28V switch 0=No 1=Yes	-
19	+28V_main_HV_present	1 bit	%d	Main 28V switch 0=No 1=Yes	-
20	Post_acceleration_mode	1 bit	%d	0=Fixed 1=Alternating	-
21	Current_SID_number	3 bits	%d	IMA Internal Sid type	-
22	New_command_received_toggle_bit	1 bit	%d	Toggles 0/1 for each new command returned in Line 24	-
23	FIFO_filling_in_terms_of_internal_packets_in_F8	8 bits	%d	The number of 6 byte packets held in the TM-fifo in F8 representation	-
24	First_word_command_return	16 bits	%d	The 1:st word of the last command received	-
25	**Opto_HV_monitor**	8 bits	%d	x*(-0.0131) - 0.006	kV

26	MCP_HV_monitor	8 bits	%d	x*(-0.0132) – 0.005	kV
27	Energy_deflection_HV_monitor	8 bits	%d	x*(-0.0227) – 0.009	kV
28	Energy_deflection_LV_monitor	8 bits	%d	x*(-0.048) – 0.018	V
29	Post_acceleration_HV_monitor	8 bits	%d	x*(-0.0189) – 0.035	kV
30	Grid_LV_monitor	8 bits	%d	N.A Grid grounded	-
31	Sensor_unit_temperature	8 bits	%d	x*0.47 – 60	°C
32	DPU_temperature	8 bits	%d	x*0.47 – 60	°C
33	Energy_deflection_HV_reference	12 bits	%d	Deflection HV ref.	V
34	Post_acceleration_low_level_reference	3 bits	%d	Pacc low ref.	V
35	Direct_command_switch	1 bit	%d	Direct cmd sw.	-
36	Energy_deflect_LV_reference	12 bits	%d	Deflection LV ref.	-
37	Post_acceleration_high_level_reference	3 bits	%d	Pacc high ref.	-
38	TM_FIFO_overflow	1 bit	%d	0=No overflow 1=Overflow	-
39	Entrance_HV_reference	12 bits	%d	Entrance ref.	-
40	Grid_LV_reference	3 bits	%d	Grid reference	-
41	Post_acceleration_level	1 bit	%d	0=low 1=high	-
42	Entrance_upper_HV_monitor	9 bits	%d	x*0.0195 – 5.0	kV
43	MCP_HV_default_reference	4 bits	%d	Mcp reference	-
44	Opto_HV_default_reference	3 bits	%d	Opto reference	-
45	Entrance_lower_HV_monitor	9 bits	%d	x*0.0195 – 5.0	kV
46	MCP_HV_current_reference	4 bits	%d	Mcp reference	-
47	Opto_HV_current_reference	3 bits	%d	Opto reference	-

2-2 DESCRIPTION OF IMAx FILE

The IMA telemetry data description is given in the ASPERA4 bible, APPENDIX 9 (« IMA TM/TC description »).

This file is a series of data block related to the IMA sensor measurements, wherein each block contains a sequence of data whose size varies with respect to the applied operation mode. Typically a data block consists of several lines, with the sentence `Sync_Pattern 0xE3 0x31 0xCA` as the first line marker. The content of the 25 first header lines are displayed below:

Line	Field	Type	Format
1	Sync_Pattern 0xE3 0x31 0xCA	-	-
2	Unit	2 bits	%d
3	Mode_index	6 bits	%d
4	Experiment_data_format_counter	8 bits	%d
5	Number_of_sets_in_minimum_mode	4 bits	%d
6	Checksum_1_failure	1 bit	%d
7	Checksum_0_failure	1 bit	%d
8	TM_FIFO_emptied	1 bit	%d
9	HV_ramping_in_progress	1 bit	%d
10	Test_pattern	4 bits	%d
11	Post_acc_level	1 bit	%d
12	Alternating_post_acc_switch	1 bit	%d
13	Auto_reduc_change_switch	1 bit	%d
14	Compression_switch	1 bit	%d
15	FIFO_filling	8 bits	%d
16	PROM_EEPROM_section_1_16_loaded	5 bits	%d
17	Sample_processing_overrun	1 bit	%d
18	Sweep_processing_overrun	1 bit	%d
19	Post_processing_overrun	1 bit	%d
20	Solar_wind_energy_start_index	7 bits	%d
21	Reset_due_to_watchdog_or_machine_error	1 bit	%d
22	Format_start_time_in_units_of_31.25ms	24 bits	%u
23	Format_length_in_words	20 bits	%d
24	Shadow_masking_switch	1 bit	%d
25	Bad_HV_masking_switch	1 bit	%d

`Unit` takes one of the following values: 1 (ICA), 2 (IMA from MEX) or 3 (IMA from VEX)
`Mode_index` indicates the data mode index that may take one of the following values: 0, 2, 4, 5, or any values included in the range 8 to 35.

`Format_start_time_in_units_of_31.25ms` is converted to UT time by using the correlation/correction coefficients provided within the « time-corre-LATEST » (see section 3).

2-2-1 Modes 0, 2, 4 and 5

Next to the header lines mentioned above, we can read:

- Mode 0: no data are produced

- Mode 2, 4 and 5:

Line number	Field	Type	Format
26	`Error`	8 bits	%x

If `Error` is not equal to 0, the data decompression process is invalid.

Subsequent lines represent the particle count values as an array [mass, energy, set], where the mass (the first) is the fastest varying parameter. Each line consists of a series of 16 particle count values that are written in a 16-bit hexadecimal format.

set varies between 1 and `Number_of_sets_in_minimum_mode` that is defined at line 5 .
The following table indicates the data contents for each science operation mode and their representation in the resolved parametric space azimuth x mass x energy x polar-angles.

Mode	Index	Masses	Azimuthal angles	Energies	Polar angles	Max sets
Mspo	2	2	1	32	1	15
Msis	4	6	1	96	1	5
Mexm	5	32	1	96	1	5

Note that, till the 26th july of 2006, these operation modes have never happened on MEX, neither on VEX. Their description is specified in the decommutation of the data pipeline.

2-2-2 Modes 8 to 31

Next to the header lines mentioned above, we can read:

Line number	Field	Type	Format
26	`Error`	8 bits	%x

If `Error` is not equal to 0, the data decompression process is invalid.

Subsequent lines represent the particle count values as an array [azimuth, mass, energy, polar angle], where azimuth (the first) is the fastest varying parameter. Each line consists of a series of 16 particle count values that are written in a 16-bit hexadecimal format.

The following table indicates the data contents for each science operation mode and their representation in the resolved parametric space azimuth x mass x energy x polar-angles.

Mode	Index	Masses	Azimuth angles	Energies	Polar angles
Nrm-0	8	6	16	96	16
Nrm-1	9	6	16	96	8
Nrm-2	10	6	16	96	4
Nrm-3	11	6	16	96	2
Nrm-4	12	6	8	96	2
Nrm-5	13	6	4	96	2
Nrm-6	14	3	4	96	2
Nrm-7	15	3	4	96	1
Har-0	16	16	16	96	16
Har-1	17	16	16	96	8
Har-2	18	16	16	96	4
Har-3	19	8	16	96	4
Har-4	20	4	16	96	4
Har-5	21	2	16	96	4
Har-6	22	2	8	96	4
Har-7	23	2	8	96	2
Exm-0	24	32	16	96	16
Exm-1	25	32	16	96	8
Exm-2	26	32	16	96	4
Exm-3	27	32	16	96	2
Exm-4	28	32	8	96	2
Exm-5	29	32	4	96	2
Exm-6	30	32	2	96	2
Exm-7	31	32	2	96	1

The IMA post-acceleration high voltage `Post_acceleration_high_level_reference` is not delivered in telemetry packets. It is extracted from the telecommand packets and stored in the CESR database as « PAHLR.asc » ASCII file (see section 4) for allowing the intrepretation of IMA scientific data.

2-2-3 Modes 32 to 35

These modes have not to be considered. It is required to skip all lines untill a next data mode is found. No PDS data archival are planned for these modes.

2-3 DESCRIPTION OF ELSxx FILE

The ELS telemetry data description is given in the ASPERA4 bible, APPENDIX 4 (« Main Unit TM/TC description »), page 64.

This file is a series of data block related to the ELS sensor measurements, wherein each block contains a sequence of data whose size varies with respect to the applied operation mode. Typically 4 modes may exist. Each related data block begins with one of the following lines:

```
SCI Type : ELS data, engineering information
SCI Type : ELS data, complete sweep
SCI Type : ELS data, steps number 0-63
SCI Type : ELS data, steps number 64-127
```

The content of the 24 next header lines are displayed below:

Line	Field	Type	Format
2			
3	`Version_Number`	3 bits	%d
4	`Type`	1 bit	%d
5	`Data_field_header_flag`	1 bit	%d
6	`ProcessID`	7 bits	%d
7	`Packet_Category`	4 bits	%d
8	`Header_SEQ_CNT`	16 bits	0x%x
9	`Header_SIZE_bytes`	16 bits	%d
10	`Header_TIME`	48 bits	%f
11	`Header_TYPE`	8 bits	%d
12	`Header_SUBTYPE`	8 bits	%d
13			
14	`SW_VERSION`	16 bits	%X
15	`SW_version`	String	-
16	**`Time`**	48 bits	%f
17	`Sector_Mask`	16 bits	0x%x
18	`Time_Compression`	3 bits	1,2,4,8,16 ou -1 sweeps
19	`Energy_Compression`	2 bits	1,2,4 ou -1 steps
20	`Log_Compression`	1 bit	%d
21	`Rice_Compression`	1 bit	%d then OK or Pb
22	`Scanner_Direction`	1 bit	%d
23	`Scanner_Speed`	2 bits	0,32,64 or 128
24	`Scanner_Position`	8 bits	%d
25			

The **`Time`** is converted to UT time by using the correlation/correction coefficients provided within the « time-corre-LATEST » file (see section 3).

2-3-1 Engineering information mode

Next to the 25 header lines mentioned above, we can read:

Ligne	Nom de variable	Type	Format
26	ELS_status	8 bits	%d
27	Temperature	8 bits	%d
28	ELS_MCP_reference	8 bits	%d
29	ELS_MCP_monitor	8 bits	%d
30	ELS_screen_grid_reference	8 bits	%d
31	ELS_screen_grid_monitor	8 bits	%d
32			
33	ELS Deflection reference - ELS Deflection monitor		

Then 256 values written in 16-bit hexadecimal format are displayed along a line as followings: els_deflection_reference_step1, els_deflection_monitor_step1, els_deflection_reference_step2, els_deflection_monitor_step2, …, els_deflection_reference_step128, els_deflection_monitor_step128.

2-3-2 Complete sweep mode

Next to the 25 header lines mentioned above, particle count values are displayed as table [sector, energy] over several lines, where the angular sector is the fastest varying parameter. Each line consists of a series of 16 values written in 16-bit hexadecimal format.

Number of energy bins = 128 / Energy_Compression
Number of angular sectors = number of bit set to 1 in Sector_Mask

2-3-3 Steps mode

These 2 following modes alternately appear one by one. Adding these 2 modes will allow to reconstruct a particle counts table of 128 energy levels.

<u>- Steps number 0-63 mode</u>

Next to the 25 header lines, particle count values are displayed as table [sector, energy] over several lines, where the angular sector is the fastest varying parameter. Each line consists of a series of 16 values written in 16-bit hexadecimal format.
Finaly the table may contain nb_sectors * nb_energies counts, where :

- nb_energies = 64
- nb_sectors = number of bit set to 1 in Sector_Mask

<u>Note</u> : the Energy_Compression field has to contain 128 (with no energy compression). This mode contains data from first 64 energy steps of a complete 128 energy levels mode

- Steps number 64-127 mode

Next to the 25 header lines, particle count values are displayed as table `[sector, energy]` over several lines, where the angular sector is the fastest varying parameter. Each line consists of a series of 16 values written in 16-bit hexadecimal format.
Finaly the table may contain `nb_sectors` * `nb_energies` counts, where :
- `nb_energies` = 64
- `nb_sectors` = number of bit set to 1 in `Sector_Mask`

Note : the `Energy_Compression` field has to contain 128 (with no energy compression). This mode contains data from latter 64 energy steps of a complete 128 energy levels mode.

2-4 DESCRIPTION OF NPIx FILE

The NPI telemetry data description is given in the ASPERA4 bible, APPENDIX 4 (« Main Unit TM/TC description »), page 69.

This file is a series of data block related to the NPI sensor measurements, wherein each block contains a sequence of data whose size varies with respect to the applied operation mode. Typically 2 modes may exist. Each related data block begins with one of the following lines:

```
SCI Type : NPI data, normal mode
SCI Type : NPI Stepping mode
```

The content of the 23 next header lines are displayed below:

Line	Field	Type	Format
2			
3	`Version_Number`	3 bits	%d
4	`Type`	1 bit	%d
5	`Data_field_header_flag`	1 bit	%d
6	`ProcessID`	7 bits	%d
7	`Packet_Category`	4 bits	%d
8	`Header_SEQ_CNT`	16 bits	0x%x
9	`Header_SIZE_bytes`	16 bits	%d
10	`Header_TIME`	-	%f
11	`Header_TYPE`	8 bits	%d
12	`Header_SUBTYPE`	8 bits	%d
13			
14	`SW_VERSION`	16 bits	%X
15	`SW_version`	String	-
16	**`Time`**	48 bits	%f
17	`Scanner_Position`	8 bits	%d
18	`Scanner_Direction`	1 bit	%d
19	`Scanner_Speed`	2 bits	0,32,64 ou 128
20	`Accumulation_Time`	4 bits	%d
21	`Number_of_sample`	8 bits	%d
22	`NPI_Sector_Mask`	32 bits	%02X%02X%02X%02X coreesponding to the bits sector order 24-31, 16-23, 8-15, 0-7
23	`Log_Compression`	1 bit	%d
24	`Rice_Compression`	1 bit	%d then OK or Pb

The **`Time`** is converted to UT time by using the correlation/correction coefficients provided within the « time-corre-LATEST » file (see section 3).

2-4-1 Stepping mode

Next to the 24 header lines mentioned above, we can read:

Line	Field	Type	Format
25	NPI_Deflection_Status_Mask	32 bits	%02X%02X%02X%02X corresponding to the bits sector order 24-31, 16-23 , 8-15, 0-7
26			
27	Anodes		
28	Sample 0		
	…		
28+n	Sample n		

Line 27 : `Anodes` is displayed then the numbering of the active angular sectors corresponding to `NPI_Sector_Mask` (the numbering starts at 0) or « `None working` » for `NPI_Sector_Mask` equals to 0.

Lines 28 to 28+n: `Sample n` is displayed then the particle number of counts accumulated in the sample n at different active angular sectors (contained within the `NPI_Sector_Mask`). Values are written in 16-bit hexadecimal format.

Note that, till the 26th july of 2006, this operation mode has never happened on MEX, neither on VEX. The IRF has no telemetry packets containing this mode. Its description is specified in the decommutation of the data pipeline.

2-4-2 Normal mode

Next to the 24 header lines mentioned above, we can read:

Line	Field	Type	Format
25			
26	Anodes		
27	Sample 0		
	…		
27+n	Sample n		

Line 26 : `same to line 27 from Stepping mode`

Lines 27 to 27+n: `same to lines 28 to 28+n from Stepping mode`

2-5 DESCRIPTION OF NPD1 et NPD2 FILES

These 2 files have exactly same data structure. There is one file per sensor.

The NPD telemetry data description is given in the ASPERA4 bible, APPENDIX 4 (« Main Unit TM/TC description »), page 66.

This file is a series of data block related to the NPD sensor measurements, wherein each block contains a sequence of data whose size varies with respect to the applied operation mode. Typically 4 modes may exist. Each related data block begins with one of the following lines:

```
SCI Type : NPD? raw data
SCI Type : NPD? binning data
SCI Type : NPD? TOF mode
SCI Type : NPD? PHD mode
```

Where `NPD?` may equal to `NPD1` or `NPD2`

The content of the 22 next header lines are displayed below:

Line	Field	Type	Format
2			
3			
4	`Version_Number`	3 bits	%d
5	`Type`	1 bit	%d
6	`Data_field_header_flag`	1 bit	%d
7	`ProcessID`	7 bits	%d
8	`Packet_Category`	4 bits	%d
9	`Header_SEQ_CNT`	16 bits	0x%x
10	`Header_SIZE_bytes`	16 bits	%d
11	`Header_TIME`	48 bits	%f
12	`Header_TYPE`	8 bits	%d
13	`Header_SUBTYPE`	8 bits	%d
14			
15	`SW_VERSION`	16 bits	%X
16	`SW_version`	String	-
17	**`Time`**	48 bits	%f
18	`Scanner_Position`	8 bits	%d
19	`Scanner_Direction`	1 bit	%d
20	`Scanner_Speed`	2 bits	0,32,64 or 128
21	`Accumulation_Time`	4 bits	%d
22	`Log_Compression`	1 bit	%d
23	`Rice_Compression`	1 bit	%d then OK or Pb

The **`Time`** is converted to UT time by using the correlation/correction coefficients provided within the « time-corre-LATEST » file (see section 3).

2-5-1 Raw mode

Next to the 23 header lines mentioned above, we can read:

Line	Field	Type	Format
24	FRONT_CTRL	8 bits	%X
25	MAIN_CTRL	8 bits	%X
26	STAT	16 bits	%X
27	TDCRD	16 bits	%X
28	CALIB11	16 bits	%X
29	CALIB12	16 bits	%X
30	CALIB21	16 bits	%X
31	CALIB22	16 bits	%X
32	STARTCNT	16 bits	%X
33	STOP0CNT	16 bits	%X
34	STOP1CNT	16 bits	%X
35	STOP2CNT	16 bits	%X
36	TOF_CNT	16 bits	%X
37	RAW_CNT	16 bits	%X
38			
39	Data :		
40	- StopPH TOF Direction Coincidence -		
41			

Immediately after the raw mode information comes the 512 quadruplet hexadecimal values (stop PH, TOF, Direction and Coincidence), split into 64 lines with 8 quadruplets per line. Each quadruplet is written in a - %X %X %X %X- format and contains data values as following:

- Stop PH : 8-bit hexadecimal
- TOF : 11-bit hexadecimal
- Direction : 2-bit hexadecimal
- Coincidence : 3-bit hexadecimal

2-5-2 Bin matrix mode

Next to the 23 header lines mentioned above, we can read:

Line	Field	Type	Format
24	TRESHOLD1	4 bits	%d
25	TRESHOLD2	4 bits	%d
26	TRESHOLD3	4 bits	%d
27	CALIB11	16 bits	%X
28	CALIB12	16 bits	%X
29	CALIB21	16 bits	%X
30	CALIB22	16 bits	%X

31	STARTCNT	16 bits	%X
32	STOP0CNT	16 bits	%X
33	STOP1CNT	16 bits	%X
34	STOP2CNT	16 bits	%X
35			
36	Data :		
37	Bin number 0 to 0x2FF		
38			

Immediately after the bin matrix mode information comes several lines of 16 values each for containing the 3 consecutive matrices (stop PH)x(TOF) of counter values. The first matrix refers to the direction 1, the last one referring to the direction 3. Within each matrix, counter values are written in a 16-bit hexadecimal format.

TRESHOLD value indicates the size of the PH x TOF matrix for a given direction (3 possible azimuths):

- 0 : 16x16 matrix = 256 values (16 PHD, 16 TOF) with TOF the fastest varying parameter
- 15 : 1x16 matrix = 16 values (16 TOF)
- 1to 14: 2x16 matrix = 32 values (2 PHD, 16 TOF) of TOF distributed between the H^+ and O^+ counters

2-5-3 Tof mode

Next to the 23 header lines mentioned above, we can read:

Line	Field	Type	Format
24	Number of valid samples integrated to the matrix	8 bits	%d
25	CALIB11	16 bits	%X
26	CALIB12	16 bits	%X
27	CALIB21	16 bits	%X
28	CALIB22	16 bits	%X
29	STARTCNT	16 bits	%X
30	STOP0CNT	16 bits	%X
31	STOP1CNT	16 bits	%X
32	STOP2CNT	16 bits	%X
33	Data :		

Immediately after the Tof mode information comes 768 counter values, split into several lines of 16 values each and written in a 16-bit hexadecimal format.

The following algorithm is required to correct the time-tag data :

Initialisation :

`Last_Sn` = -2

Loop reading data :

```
- Data reading (Time included)
- If Header_SEQ_CNT is different to Last_Sn then
      S0 = Header_SEQ_CNT
      T0 = Time
Else
      Time = T0 + (Header_SEQ_CNT - S0)
Endif
- Convert Time into UT time
```

2-5-3 Phd mode

This mode has not to be considered. It is required to skip all lines untill a next data mode is found. No PDS data archival are planned for this mode.

3- Use of the time-corr-LATEST file

The file « time-corr-LATEST » is required to map the on-board time to UT time. This files is daily and automatically retrieved from the IRF server then stored into the /DATA/ASPERA4/DATA/AU directory of the aspera.cesr.fr restricted access server.

It is a binary file containing several records whose format is as follows:

Field	Type	Number of elements	Format
DDSHEADER	8 bits	18	Sun (and PC)
Gradient	double - 64 bits	1	Sun
Offset	double - 64 bits	1	Sun
Std	double - 64 bits	1	Sun
GenTime	8 bits	6	Sun (and PC)

The date_dds time is defined by:

- number of seconds past since the 01/01/1970 00:00:00 = `256*256*256*DDSHEADER[0] + 256*256*DDSHEADER[1] + 256*DDSHEADER[2] + DDSHEADER[3]`

- number of milliseconds = `256*256*256*DDSHEADER[4] + 256*256*DDSHEADER[5] + 256*DDSHEADER[6] + DDSHEADER[7]`

Each record indicates the time correlation coefficients, mainly the time offset `Offset` and the time gradient `Gradient`, to use for the computed time date_dds.

This file is sorted in increasing time order.

Note : to determine the appropriate record, it is recommended to read records of this file one by one, and identify this one for which the date_dds time is lower or equal to the day that we are processing.

3-1 Time processing for HKxx, ELSx, NPIx et NPDx files

The number of seconds past since 00:00:00 on January 1st 1970 from UT is `Offset + tb * gradient`, where `tb` is the on-board time to be converted into UT time.

3-2 Time processing for IMAx file

The on-board timer of IMA returns to 0 when it exceeds the value 0x7FFFF, This happens approximately every six days.

The number of seconds past since 00:00:00 on January 1st 1970 from UT is `Offset + (tb + no*0x80000) * gradient`, where `no` is the number of time the IMA on-board time is returned to 0 and `tb` is the on-board timer of IMA to be converted into UT time.

Note : to determine `no`,it is recommended to increment the variable `no` inside a loop (starting from 0) until the `UT` time corresponds to the day we are processing.

4- Use of the PAHLR.asc file

The PAHLR.asc file allows to determine the Post-Acceleration High voltage Reference value applied in-flight to the IMA sensor. These information are useful for the understanding of the IMA data scientific analysis.

These values being missing from the telemetry packets, the executed commands for stepping the in-flight IMA PAHLR are extracted from the telecommand packets and stored in the CESR database as PAHLR.asc file.

The PAHLR.asc file is automatically updated as soon as a new telecommand file is received at the CESR. This file is located in the /DATA/ASPERA4/DATA/AU directory of the aspera.cesr.fr server.

File format :

It is an ascii file, wherein each line represents a data record whose format is as follows:

Field number	Value	Format
1	Start year	%04d
2	Start month	%02d
3	Start day	%02d
4	Start hour	%02d
5	Start minute	%02d
6	Start second	%06.3f
7	Post Acceleration high level reference value	%f
8	End year	%04d
9	End month	%02d
10	End day	%02d
11	End hour	%02d
12	End minute	%02d
13	End second	%06.3f
14	Number of start orbit	%d
15	Number of end orbit	%d

Each line indicates the PAHLR value set to the IMA sensor in the time range when it is applied.

This file is sorted in increasing time order. No overlaping time may exist.

Note : The fields 14 and 15 contain -1.

Note : to determine the PAHLR value at a given time:

- identify the record with the time range where the given time is applicable. This record contains the appropriate PAHLR value.
- if not it is set by default to 6.0