Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E6 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E6 Encounter and Cruise, not all NIMS data recorded on the tape recorder or selected in real-time were returned. The previous 6 chapters nominally describe the planning and intention of the NIMS observations for this orbit, except the obstab section in chapter 4 which was updated to give the latest parameters for the data that were actually returned.

Ten NIMS software reloads were inserted into the E6 Encounter sequence to protect against processor halts. During E6 only one NIMS observation, E6INCHEMIS03, was lost due to processor halts. The approach that we are taking to avoid data loss due to processor halts has proven to be very successful.

Unforturnately, Detector 3 failed unexpectantly during E6. It was never recovered.

The plots on the pages 3 and 4 show the geometry of the NIMS E6 observations using a north trajectory pole projection. The 'returned' observations are in Bold characters and the 'non-returned' in gray.

The spreadsheets on pages 5 through 8 summarize the 'final' playback model for the 'returned' data.

The text on page 9 gives a 'recap' of the E6 playback events which affected which observations were returned.

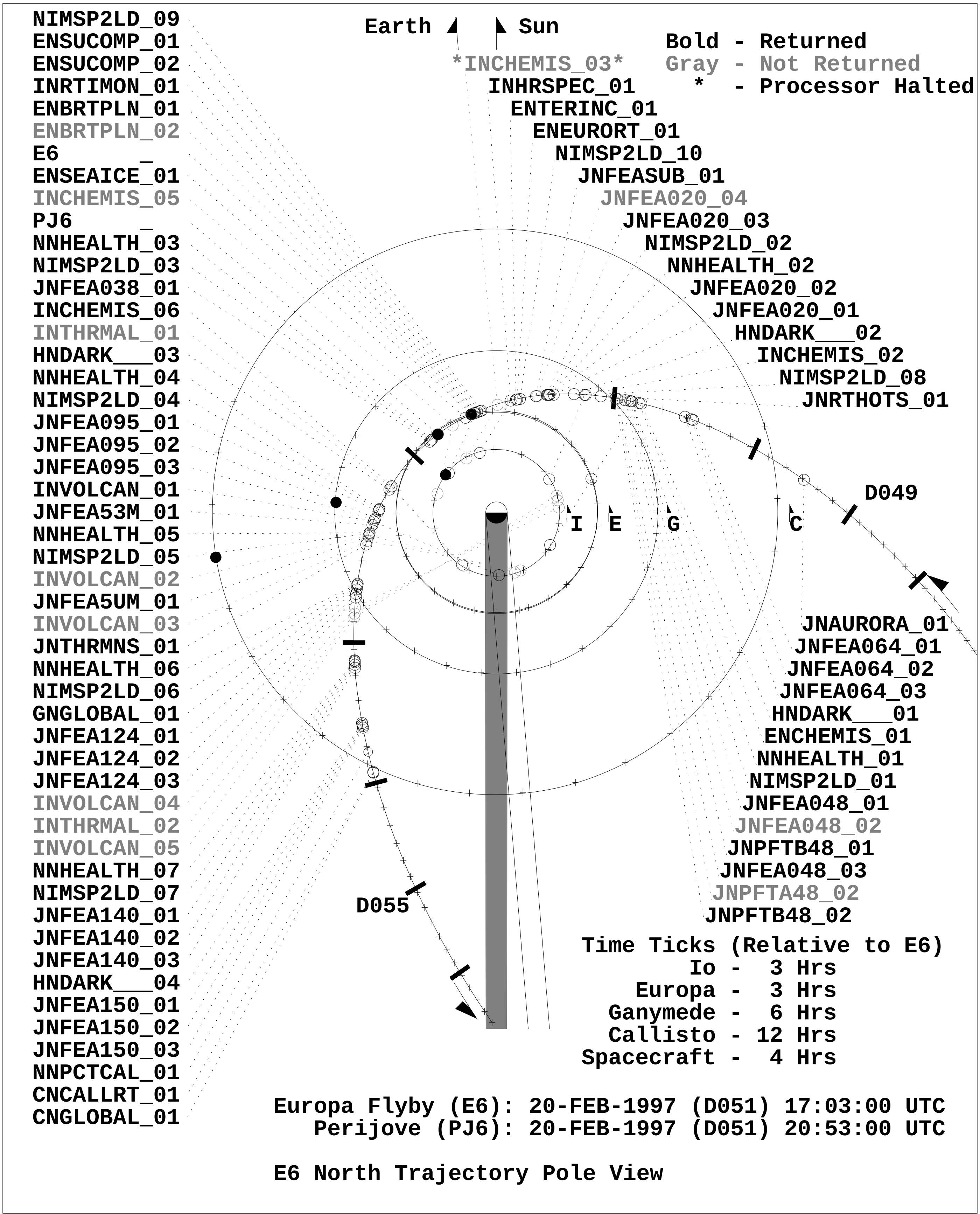
A Timeline of E6 playback events is on pages 10 and 11.

The text on pages 12 and 13 describes the E6 NIMS Anomalies, both Processor Halts and Detector failure.

The text on page 14 gives a brief discussion of the NIMS data files. Additional information about NIMS data formats, data types, data labels and data access is given on pages 15 and 16.

The text on page 17 is a guide to understanding the NIMS MASK.

NIMS E6 OBSERVATIONS



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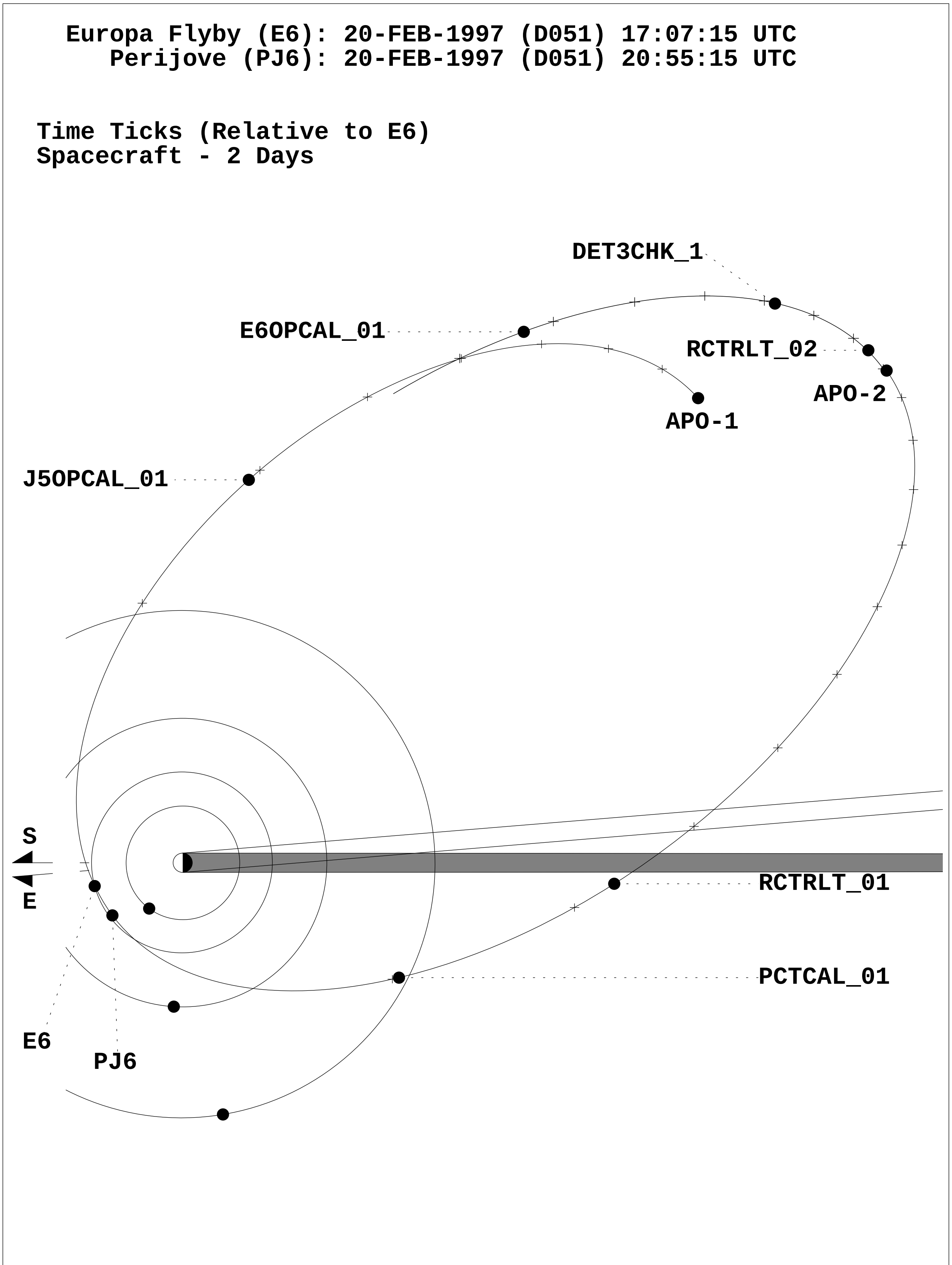
NIMS E6 CALIBRATIONS



E6 North Trajectory Pole View, Apoapsis to Apoapsis

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NIMS E6 DATA RETURN

Activity ID	Observation Title	Mode	Gain	Record Mode	NIMS Edit Table	NIMS PB Table	Grating Start	Grating Offset
E6JNAURORA01+	Jupiter Aurora observation	LM	4	R/T	E6JLM408		0	4
E6JNFEA06401-	Jupiter Feature Track 64 deg phase pt 1	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6JNFEA06402-	Jupiter Feature Track 64 deg phase pt 2	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6JNFEA06403-	Jupiter Feature Track 64 deg phase pt 3	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6NNHNDARK01-	Dark Observation	LM	2	LPU	E6DRK34	E6DRK32	0	4
E6ENCHEMIS01-	Monitoring of IO's Dayside - EUROPA-	LM	2	MPW	E6ELM245	E6ELM96	0	4
E6NNHEALTH01-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA04801-	Jupiter Feature Track 48 deg phase pt 1	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6JNPFTB4801-	Jupiter Feature Track B 48 deg part 1	SM	2	LPU	E6JFT68C	E6JFT04A	1	4
E6JNFEA04803-	Jupiter Feature Track 48 deg phase pt 3	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6JNPFTB4802-	Jupiter Feature Track B 48 deg part 2	SM	2	LPU	E6JFT68C	E6JFT20A	1	4
E6JNRTHOTS01-	Jupiter Real-time Hotspot	LM	2	R/T	E6JLM408		0	4
E6INCHEMIS02-	Monitoring of IO's Dayside	LM	2	MPW	E6ILM442	E6ILM384	0	4
E6NNHNDARK02-	Dark Observation	LM	2	LPU	E6DRK34	E6DRK32	0	4
E6JNFEA02001-	Jupiter Feature Track 20 deg phase pt 1	SM	2	LPU	E6JFT68C	E6JFT20A	1	4
E6JNFEA02001-	Jupiter Feature Track 20 deg phase pt 1	SM	2	LPU	E6JFT68C	E6JFT20A	1	4
E6JNFEA02002-	Jupiter Feature Track 20 deg phase pt 2	SM	2	LPU	E6JFT68C	E6JFT25A	1	4
E6NNHEALTH02-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA02003-	Jupiter Feature Track 20 deg phase pt 3	SM	2	LPU	E6JFT68C	E6JFT25A	1	4
E6JNFEA02003-	Jupiter Feature Track 20 deg phase pt 3	SM	2	LPU	E6JFT68C	E6JFT25A	1	4
E6JNFEASUB01-	Jupiter Campaign Feature sub-spectra	LM	2	LPU	E6JSB253A	E6JSB80A	0	4
E6ENEURORT01-	Europa Real-Time Observation	LM	2	R/T	E6ELM408		0	4
E6ENTERINC01-	Europa Terra Incognito	FM	2,3	MPW	E6EFM221	E6EFM192	0	4
E6ENTERINC01-	Europa Terra Incognito	FM	2	MPW	E6EFM221	E6EFM192	0	4
E6INHRSPEC01-	High spatial and spectral Obs of IO	LM	2	MPW	E6ILM245	E6ILM216	0	4
E6INHRSPEC01-	High spatial and spectral Obs of IO	LM	2	MPW	E6ILM245	E6ILM216	0	4
E6ENSUCOMP01-	Europa Surface Composition	LM	3	MPW	E6ELM442	E6ELM192	0	4
E6ENSUCOMP01-	Europa Surface Composition	LM	3	MPW	E6ELM442	E6ELM192	0	4
E6ENSUCOMP02-	Europa Surface Composition A	LM	3	MPW	E6ELM442	E6ELM192	0	4
E6ENSUCOMP02-	Europa Surface Composition B	LM	3	MPW	E6ELM442	E6ELM96	0	4
E6INRTIMON01-	NIMS Io Real-Time Observation	XM	2	R/T	E6IXM8RTB		21	4
E6ENBRTPLN01+	BRTPLN Ride-Along with SSI	LM	2	MPW	E6ELM442	E6ELM384	0	4
E6ENSEAICE01-	Europa Hexangonal Ice	XM	3	LPU	E6EXM10B	E6EXM10B	0	4
E6ENSEAICE01-	Europa Hexangonal Ice	XM	3	LPU	E6EXM10B	E6EXM10B	0	4
E6NNHEALTH03-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA03801-	Jupiter Feature Track 38 deg phase pt 1	SM	2	LPU	E6JFT68C	E6JFT25A	1	4

NIMS E6 DATA RETURN

ACTID	Obs Cost Tics	Wave-lengths ret	Record Time (sec)	PB Time (sec)	Sel Bits of Tape sBOT (Mbits)	Total Bits of Tape BOT (Mbits)	Mode cycle time (sec)	Thold	Comp	Total BTG BTG (Mbits) (4% Ohead)	Data Reduct Factor (sBOT/BTG)	Pass
E6TNAURORA01+		408										
E6JNFEA06401-	25.3776	4	104	100	0.62	0.64	2.33	0	2.08	0.017	35.93	1
E6JNFEA06402-	25.3776	20	104	100	0.62	0.64	2.33	0	2.36	0.076	8.15	1
E6JNFEA06403-	25.3776	4	104	100	0.62	0.64	2.33	0	1.61	0.022	27.81	1
E6NNHNDARK01-	16.2360	32	65	61	0.38	0.40	8.667	0	3.01	0.016	24.17	1
E6INCHEMIS01-	97.9212	96	108	104	1.20	1.24	8.667	2	2.30	0.104	11.50	1
E6NNHEALTH01-		3										
E6JNFEA04801-	25.3776	4	104	100	0.62	0.64	2.33	0	2.14	0.017	36.97	1
E6JNPFTB4801-	98.8222	4	417.33	413.33	2.55	2.57	2.33	0	1.77	0.083	30.57	1
E6JNFEA04803-	25.3776	4	104	100	0.62	0.64	2.33	0	1.55	0.023	26.77	1
E6JNPFTB4802-	98.8222	20	417.33	413.33	2.55	2.57	2.33	0	1.99	0.371	6.87	2
E6JNRTHOTS01-		408										
E6INCHEMIS02-	191.0846	384	214	98	1.13	2.47	8.667	2	1.45	0.623	1.81	2
E6NNHNDARK02-	16.2360	32	65	61	0.38	0.40	8.667	0	2.12	0.022	17.03	1
E6JNFEA02001-	203.5216	20	864	648	4.00	5.33	2.33	0	2.14	0.541	7.39	1
E6JNFEA02001-	203.5216	20	864	216	1.33	5.33	2.33	0	2.15	0.179	7.43	2
E6JNFEA02002-	25.3776	25	104	100	0.62	0.64	2.33	0	1.77	0.126	4.89	1
E6NNHEALTH02-		3										1
E6JNFEA02003-	203.5216	25	864	212	1.31	5.33	2.33	0	1.86	0.254	5.14	1
E6JNFEA02003-	203.5216	25	864	620	3.82	5.33	2.33	0	1.88	0.736	5.20	2
E6JNFEASUB01-	87.2592	80	368	364	2.25	2.27	8.667	0	1.71	0.409	5.49	1
E6ENEURORT01-		408										
E6ENTERINC01-	1729.1596	192	1964	251	2.89	22.63	4.333	0	1.49	1.553	1.86	1
E6ENTERINC01-	1729.1596	192	1964	627	7.22	22.63	4.333	0	1.50	3.853	1.87	2
E6INHRSPEC01-	258.4962	216	290.7	130	1.50	3.35	8.667	2	1.20	0.562	2.67	1
E6INHRSPEC01-	258.4962	216	290.7	165	1.90	3.35	8.667	2	1.13	0.757	2.51	2
E6ENSUCOMP01-	433.0458	192	489.3	253	2.91	5.64	8.667	0	1.37	0.851	3.43	1
E6ENSUCOMP01-	433.0458	192	489.3	241	2.78	5.64	8.667	0	1.37	0.811	3.43	2
E6ENSUCOMP02-	433.0458	192	489.3	486	5.60	5.64	8.667	0	1.28	1.750	3.20	1
E6ENSUCOMP02-	433.0458	96	489.3	486	5.60	5.64	8.667	0	1.32	0.848	6.60	2
E6INRTIMON01-		8					8.667	0	1.30			
E6ENBRTPLN01+	31.7251	384	32.683	32	0.37	0.38	8.667	0	1.51	0.195	1.89	1
E6ENSEAICE01-	113.5120	10	480	63.4	0.39	2.96	0.333	0	1.53	0.259	1.51	1
E6ENSEAICE01-	113.5120	10	480	63.39	0.39	2.96	0.333	0	1.53	0.259	1.51	2
E6NNHEALTH03-		3										
E6JNFEA03801-	203.5216	25	864	650	4.01	5.33	2.33	0	1.51	0.961	4.17	2

NIMS E6 DATA RETURN

Activity ID	Observation Title	Mode	Gain	Record Mode	NIMS Edit Table	NIMS PB Table	Grating Start	Grating Offset
E6INCHEMIS06-	Monitoring of IO's Dayside	LM	2	LPU	E6ILM245	E6ILM216	0	4
E6NNHNDARK03-	Dark Observation	LM	4	LPU	E6DRK34	E6DRK32	0	4
E6NNHEALTH04-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA09501-	Jupiter Feature Track 95 deg phase pt 1	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6JNFEA09502-	Jupiter Feature Track 95 deg phase pt 2	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6JNFEA09503-	Jupiter Feature Track 95 deg phase pt 3	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6INVOLCAN01-	Monitoring of Selected Volcanic Regions	LM	4	LPU	E6ILMDK245	E6ILMDK67	0	4
E6JNFEA53M01-	Jupiter Campaign Feature 5 and 3 um Map	LM	4	LPU	E6J35160	E6J35160	0	4
E6NNHEALTH05-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA5UM01-	Jupiter Feature Track 5 Micron Map 2	LM	4	LPU	E6J5M253B	E6J5M80B	0	4
E6JNTHRMNS01-	Jupiter Thermal North South Stripe	LM	4	LPU	E6J5M253A	E6J5M80A	0	4
E6JNTHRMNS01-	Jupiter Thermal North South Stripe	LM	4	LPU	E6J5M253A	E6J5M80A	0	4
E6NNHEALTH06-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6GNGLOBAL01-	NIMS Ganymede Global	LM	3	LPU	E6GLM245D	E6GLM192	0	4
E6JNFEA12401-	Jupiter Feature Track 124 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6JNFEA12402-	Jupiter Feature Track 124 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6JNFEA12403-	Jupiter Feature Track 124 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT04A	1	4
E6NNHEALTH07-	Health Observation	LM	2	R/T	E6RCVY3		0	4
E6JNFEA14001-	Jupiter Feature Track 140 deg phase pt	SM	2	LPU	E6JFT68B	E6JFT19D	1	4
E6JNFEA14002-	Jupiter Feature Track 140 deg phase pt	SM	2	LPU	E6JFT68B	E6JFT19D	1	4
E6JNFEA14003-	Jupiter Feature Track 140 deg phase pt	SM	2	LPU	E6JFT68B	E6JFT19D	1	4
E6NNHNDARK04-	Dark Observation	LM	2	LPU	E6DRK34	E6DRK32	0	4
E6JNFEA15001-	Jupiter Feature Track 150 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6JNFEA15002-	Jupiter Feature Track 150 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6JNFEA15003-	Jupiter Feature Track 150 deg phase pt	SM	2	LPU	E6JFT68A	E6JFT20A	1	4
E6NNPCTCAL01	PCT Recorded Calibration	LM	4	LPU	E6PCT252	E6PCT228	0	4
E6CNCALLRT01-	Callisto Real-Time Observation	LM	4	R/T	E6CLM442		0	4
E6CNGLOBAL01-	Callisto Global Observation	LM	4	MPW	E6CLM442	E6CLM270	0	4
E6NNRCTRLT01	RCT R/T Calibration	LM	1	R/T	E6RCT252		0	4
E6NNRCTRLT02	RCT R/T Calibration	LM	1	R/T	E6RCT252		0	4
E6NNOPCAL_01	R/T OPCAL	LM	4	R/T	E6OPCAL120		0	4

NIMS E6 DATA RETURN

ACTID	Obs Cost Tics	Wave- lengths ret	Record Time (sec)	PB Time (sec)	Sel Bits of Tape sBOT (Mbits)	Total Bits of Tape BOT (Mbits)	Mode cycle time (sec)	Thold	Comp	Total BTG BTG (Mbits) (4% Ohead)	Data Reduct Factor (sBOT/BTG)	Pass
E6INCHEMIS06-	40.3792	216	168	164	1.01	1.04	8.667	2	1.42	0.599	1.69	1
E6NNHNDARK03-	16.2360	32	65	61	0.38	0.40	8.667	0	1.37	0.034	11.00	1
E6NNHEALTH04-		3										
E6JNFEA09501-	25.3776	4	104	100	0.62	0.64	2.33	0	1.61	0.022	27.81	1
E6JNFEA09502-	25.3776	20	104	100	0.62	0.64	2.33	0	1.88	0.095	6.49	1
E6JNFEA09503-	25.3776	4	104	100	0.62	0.64	2.33	0	1.93	0.019	33.34	1
E6INVOLCAN01-	19.7520	67	80	76	0.47	0.49	8.667	2	2.06	0.059	7.90	2
E6JNFEA53M01-	87.2592	160	368	364	2.25	2.27	8.667	0	1.22	1.146	1.96	1
E6NNHEALTH05-		3										
E6JNFEA5UM01-	87.2592	80	368	364	2.25	2.27	8.667	0	1.20	0.582	3.86	1
E6JNTHRMNS01-	421.3566	80	1793.33	1040	6.41	11.06	8.667	0	1.31	1.524	4.21	1
E6JNTHRMNS01-	421.3566	80	1793.33	258	1.59	11.06	8.667	0	1.33	0.372	4.27	2
E6NNHEALTH06-		3										
E6GNGLOBAL01-	336.3561	192	1430.7	580	3.58	8.82	8.667	0	1.69	1.581	2.26	1
E6JNFEA12401-	25.3776	4	104	100	0.62	0.64	2.33	0	1.67	0.021	28.85	1
E6JNFEA12402-	25.3776	20	104	100	0.62	0.64	2.33	0	2.10	0.085	7.25	1
E6JNFEA12403-	25.3776	4	104	100	0.62	0.64	2.33	0	2.26	0.016	39.04	1
E6NNHEALTH07-		3										
E6JNFEA14001-	25.3776	19	104	100	0.62	0.64	2.33	0	1.87	0.091	6.80	1
E6JNFEA14002-	25.3776	19	104	100	0.62	0.64	2.33	0	1.89	0.090	6.87	1
E6JNFEA14003-	25.3776	19	104	100	0.62	0.64	2.33	0	2.02	0.084	7.35	1
E6NNHNDARK04-	16.2360	32	65	61	0.38	0.40	8.667	0	2.96	0.016	23.77	1
E6JNFEA15001-	23.9009	20	97.7	93.667	0.58	0.60	2.33	0	2.19	0.076	7.57	1
E6JNFEA15002-	23.9009	20	97.7	93.667	0.58	0.60	2.33	0	2.11	0.079	7.29	1
E6JNFEA15003-	23.9712	20	98	94	0.58	0.60	2.33	0	2.26	0.074	7.81	1
E6NNPCTCAL01-	132.9672	228	563	97	0.60	3.47	8.667	0	2.26	0.235	2.55	1
E6CNCALLRT01-		384										
E6CNGLOBAL01-	443.0389	270	500.67	121	1.39	5.77	8.667	2	1.86	0.422	3.31	1
E6NNRCTRLT01-		252										
E6NNRCTRLT02-		252										
E6NNOPCAL_01-		120										
Total						177.86				23.598	Planned BTG	
Allocated										23.229	Allocation	
Oversubscribed										0.369	Over/under	

Recap of E6 Playback Events

There were a number of significant events and new adaptations during E6 recording and data playback. Perhaps most significant for NIMS was the failure of detector 3, which occurred about 3/4 of the way through the encounter sequence, after recording of E6GNGLOBAL01. There was one NIMS software crash, which prevented the recording of one Io observation. A planned software reload enabled us to successfully record the subsequent observations.

About two weeks before termination of playback, a CDS software bug caused the tape recorder to go into limited search mode, resulting in the generation and downlink of 1.8 Mbits of useless fill packets. Despite these problems, E6 data return was quite successful; low levels of radiation noise for Io and Europa observations resulted in high-quality data sets.

We adopted a new strategy for AACS (attitude and articulation) data return in E6. For observations not affected by booms (cone angles between 105 and 165 degrees), we commanded the return of only a portion of the AACS data (20-40%). This resulted in bit savings that were applied to bring down more coverage of the target bodies.

<u>E6 Playback Events Timeline</u> (10-04-96 to 3-30-97)

10-04-96: **Evolution of new DMS (tape recorder) rules forces the abandonment of OPG tape allocation and generation of new allocations. New allocations represent a 25% reduction in the amount of tape available for recording, for the balance of the mission.**

01-07-97: **Playback table delivered commands return of 16.6 Megabits of data (one of the smallest totals of the mission). As a result most NIMS observations are planned to come down with fewer wavelengths than recorded, and/or with less spatial coverage than was recorded.**

01-31-98: **NIMS downlink allocation increases by 3.8 Mbits (1.9 AWG, 2.9 SWG) due to improvements in telemetry (downlink bit rates) and due to a strategy of sending down engineering data during low data rate DSN passes. New allocation is 21.34 Mb distributed approximately as follows: Jupiter 7.5, Io 3.2, Europa 8.7, Ganymede 1.3, Callisto 0.5, Calibration 0.23.**

02-07-97: **NIMS allocation reduced by 1 Mb to reflect new knowledge of the cost of "inefficiency," which results when the tape is running but no data is being read. This is a consequence of 2-pass playback.**

02-12-97: **Cuts to spatial coverage of Europa, Ganymede, and Callisto, and to wavelengths returned for E6JNPFTB4801 (20 bands to 4) are made to match new allocation of 20.6 Mb.**

02-18-97: **NIMS E6 recording begins with E6JNAURORA_01.**

02-19-97: **An observation of Io (E6INCHEMIS01) instead sees Europa, which was occulting Io at the time. This is the only instance of this sort during the mission; positions of satellites other than Io were not considered when generating the design.**

02-20-97: **NIMS software halts at about 12:50 UTC, and the observation E6INCHEMIS03 is not successfully recorded. A planned software reload about 3 hours later prevents the loss of any later observations. Europa close approach is at 17:03; Jupiter perijove is at 20:53.**

E6 Playback Events Timeline (10-04-96 to 3-30-97)

02-21-97: Detector 3 apparently fails after the observation E6GNGLOBAL01 (ending at 16:43).

03-05-97: Playback table update. Good compression for Io and Europa observations (indicating low levels of radiation noise during recording) and a small (0.3 Mb) increase in allocation permitted us to increase spatial and wavelength coverage on several observations, including E6GNGLOBAL01, E6INCHEMIS06, and the PCTCAL.

03-12-97: 50% of E6 playback has been completed. Inefficiency has been smaller than expected. We convinced the Project to release 2 Mbits to NIMS (and 1.5 to SSI) from the 5 Mbit reserve (office margin), in order to get more spatial coverage of E6ENTERINC01. Playback for that observation is increased by 6 Rims.

03-17-97: A previously-unsuspected bug in CDS software relating to PPR playback causes the tape recorder to go into "limited search" mode, slewing over 2 tracks of the tape, and costing 1.8 Mbits. This consumes the remaining margin, placing the last observation planned for return (E6INVOLCAN01) at some risk.

03-19-97: The final playback table update. A proposal from the Project to reduce our allocation to protect E6INVOLCAN01 was forestalled by decisions by NIMS and SSI to command playback of data from later in the sequence, thereby protecting the "last" observation. We received 0.4 Mbits from UVS and placed this on E6JNTHRMNS01. In order to ensure that no downlink bits were wasted, SSI was allowed to add additional playback commands to the end of the table to sop up any remaining bits. This practice would become standard in later orbits.

03-30-97: Playback is terminated. All commanded bits were received successfully, with about 0.2 Mb of downlink capability remaining (on the order of a couple of hours of capability). Total Mbits to ground for NIMS is 24.25.

<u>NIMS Anomaly Report - E6 Sequence</u>

Two types of anomalies occurred during the E6 Encounter: The NIMS processor halted once and NIMS detector 3 failed. The processor Halt was recoverable, but the detector 3 failure turned out to be permanent.

<u>Processor Halts</u>

Facts:

0. Between the start of the E6 Encounter and the single Halt NIMS returned 5 realtime observations and successfully reloaded NIMS from CDS 4 times. The NIMS SCLK engineering channels were continuously monitored for detecting a NIMS processor halt.

1. A NIMS processor halt was detected at SCLK 03836981 from the analysis of the NIMS SCLK engineering telemetry channels S-1931 and S-1932. This occurred about 7 hours before E6 perijove. A fifth NIMS reload occurred about 2 hours and 10 minutes later. No more Halts occurred during the rest of the encounter. A table of the NIMS engineering SCLK values near the time of the Halt follows (Note that the NIMS engineering SCLK value is normally 2 Rims behind the CDS SCLK Rim when it is reported):

NIMS SCLK	CDS SCLK	CDS SCET	GROUND ERT
03836800	03836802.58	1997-051T10:30:36.704	1997-051T11:26:20.746
03836981	03837000.40	1997-051T13:50:36.697	1997-051T15:05:44.027
03837183	03837185.05	1997-051T16:57:16.690	1997-051T19:02:43.972

2. Only one NIMS observation was lost due to this Halt: E6INCHEMIS03.

<u>Timing:</u>

SCLK	Comments
03837000.40	Anomalous 03836981 SCLK reported
03837017:84	Start of NIMS observation E6INCHEMIS03
03837023:79	END of NIMS observation E6INCHEMIS03
03837128:06	Start of NIMS CDS Reload09 (#5)
03837429:00	E6 Perijove

NIMS Anomaly Report - E6 Sequence

Summary:

1. One NIMS processor halt occurred during the E6 Encounter.

2. Continous monitoring of the NIMS SCLK channels led to a rapid identification that NIMS processor halts had occurred.

3. The 10 NIMS software reloads from CDS greatly lessened the potentially disastrous effects of the E6 Halt and protected the NIMS observations in the encounter.

4. Checksums of NIMS memory space verified that NIMS had reloaded properly.

5. Frequent NIMS realtime observations, both science observations and instrument health monitoring observations, verified that NIMS was functioning normally at various time points throughout the encounter.

6. The error avoidance measures applied to the E6 Encounter as determined in the analysis of the processor halts that occurred in earlier orbits were shown to be the proper response for dealing with the inevitable occurrence of radiation-induced NIMS processor halts.

Detector 3 Failure

0. Detector 3 failed sometime during E6 outbound. Its response is random, independent of what NIMS is looking at.

1. Detector 3 was first observed to have unusual behavior in the E6 RealTime observation E6CNCALLRT01. Analysis of playback data found that detector 3 had failed after E6GNGLOBAL01 and before E6NNHNDARK04. The observations between these two did not return any detector 3 data.

2. Detector 3 DN seems to vary randomly, bouncing between 0 and 1023. This behavior is similar to that of detector 8.

3. It is not ascertainable whether Detector 3 failed abruptly or over a period of hours since NIMS data returned after E6GNGLOBAL01 for about 20 hours did not include detector 3 data.

4. Detector 3 never recovered. Both detector 3 and 8 are no longer functioning.

NIMS Archived EDRs and CUBEs

The NIMS data are stored in EDRs (Experimental Data Records) produced by JPL-MIPS (Multi-mission Image Processing System). The NIMS Phase2 EDR is described in the NIMS EDR SIS (Software Interface Specification) Number 232-08. The same information is available in both human and machine-readable form in the PDS (Planetary Data System) structure files EDRHDR.FMT and EDRDATA.FMT in the LABEL directory of the NIMS EDR CD-ROM. Each observation has at least one EDR. The EDR file name is derived from the 12 character observation name plus a single character which allows an observation to be broken up into multiple EDRs. The EDRs have a Vicar label, followed by a PDS/ISIS label, binary header records and the data records. For archiving on CD-ROM, the Vicar labels are detached from the EDR (but kept separately on CD) and the file is renamed so as to conform to the 8.3 DOS file-naming convention. The 8.3 EDR name consists of a 2 character orbit identifier, a single character target identifier, a 3 digit counter and the suffix EDR. For example, the MIPS EDR G1GNGLOBAL01A.1 becomes G1G001.EDR. More information about NIMS EDRs can be found in the VOLINFO.TXT file on the EDR CD-ROM.

NIMS EDR data typically require considerable processing before they are readily amenable to science analysis. Normally, the EDRs are processed into spectral image cubes by one of several sets of software. MIPS systematically processes the EDRs into CUBEs (band sequential image files) and MASKs (spatial/spectral summary images) which are distributed on the NIMS CUBE CD-ROMs. Information about the structure of the NIMS CUBEs can be found in the VOLINFO.TXT file on the CUBE CD-ROM. The name of the CUBE file is derived from the input EDR filename. For archiving on CD-ROM, the CUBE files are renamed so as to conform to the 8.3 DOS file-naming convention. The 8.3 CUBE name consists of a 2 character orbit identifier, a single character target identifier, a 3 digit counter, a single character cube-type identifier, a single character data unit-type (DN, radiance or IOF) and the suffix QUB. For example, the MIPS IOF radiance cube for the observation G1GNGLOBAL01A.1 (G1G001) becomes G1G001CR.EDR. The summary MASKs on the CD-ROM have the same 6 character name as the EDR name with the suffix JPG or GIF to denote its graphics format.

NIMS Data Format - Data types - Data Labels - Data Access

Data Format

All data files have PDS labels. The raw data (EDR) file contains time-sequential, 16 bit integers. Reduced data files (TUBES and CUBES) may be viewed as images or spectra. They contain VAX real numbers, are band sequential (BSQ - the images are stacked in band order) and have geometry information appended as backplanes after the last NIMS band.

Data Types

Mask files contain summary images (3 band BSQ) and spectra of up to six selected regions that provide a quick indication of data location, data quality and spectral content. A Guide to understanding the NIMS mask is available.

Cube files contain data that have been projected and resampled. The core data are BSQ - spatial in the first two dimensions, and spectral in the third. Cubes of the satellites are projected in point-of-view, and, with few exceptions have no photometric correction applied. Cubes of Jupiter are (generally) projected as simple cylindrical. Cubes of Europa, Ganymede, and Callisto have been despiked. The cubes are available both in radiance and I/F (intensity divided by flux) form.

Tube files contain data in (almost) time order and normally have a NIMS-related 20 pixel spatial dimension (20 x n or n x 20). Projection coordinates are contained in backplanes, but the data have not been resampled. The data are in units of radiance and no despiking has been applied. All data in cubes are also available in tube form. Some data (such as spatially undersampled data) appear in tube form only.

A spike file contains a list of pixels that have been identified as spikes, but not replaced, in the tube. Spike files can be used to remove spikes from both tube and EDR files.

EDR files contain the most primitive form of the data available. They should be used only for advanced data analysis. The format is complex and the files do not form images or spectra without prior processing.

Data Labels

A data label (PDS form) is attached to the front of each file (except masks, which have an attached VICAR label and a detached PDS label). The labels are in ASCII keyword=value format and contain pointers to various data objects in the file, descriptions of the data objects and descriptions of the observation associated with the file. A history object in similar format follows and describes the processing steps that produced the file. Much of this information is necessary for understanding and viewing the cube. In particular, the label contains the offset to the cube, the dimensions of the cube, axes labels, and explicit wavelength information.

Data Access

Software for processing this data is called ISIS and is available for DEC VAX VMS, SUN Solaris, DEC Alpha Digital Unix, Silicon Graphics Unix and PC LINUX systems. The Unix versions are available from the USGS Astrogeology team. Images from NIMS cubes and tubes can be viewed with any image display program which allows an offset from the beginning of the file to the selected image. Packages tested include ISIS, VICAR, ENVI, SAO IMAGE, and NASAVIEW. ISIS and ENVI (and soon NASAVIEW) additionally display spectra. The ISIS viewer is named CV (UNIX) or QL3 (VMS).

Labels may be displayed with some editors (eg DOS edit), and with most "type" and "search" functions. Some editors do not recognize the PDS line termination conventions. The label may be listed by the ISIS function LHLIST (VMS) or LABEL (UNIX).

Software for converting EDRs to cubes exist in both ISIS (DEC VAX VMS) and VICAR (DEC Alpha VMS) versions only. A primitive list of values in an EDR may be obtained with the program EDRDMP2.

Understanding the NIMS Mask

The NIMS mask is designed to provide a quick summary of the contents of a NIMS data cube (or tube). It displays a view of both the spatial and spectral content of the data.

The mask has four regions. Starting from the upper left and proceeding clockwise: a spatial display; six or fewer representative spectra; annotation; and a spectral histogram.

The spatial display of an observation which has been projected and resampled (a cube) has a maximum size of 600x600 pixels. This is overlaid with surface coordinates and is embedded in a 700x700 grid of pixel coordinates. It is accompanied by two 1-dimensional histograms describing the raw image and the image stretched for display. The data image can range from a simple combination of up to 3 NIMS bands displayed in the RGB planes, to complicated arithmetic functions of NIMS bands displayed in the RGB planes. (The formulas appear as annotation below the histograms.) The graphics directly below the image show the input and output data histograms for the three color planes. The "shortest" color for each bin displays in front. The image also contains from one to six numbered rectangles, which show the from which averaged spectra (displayed on the right) were taken.

The spatial display of an observation in time sequence (a tube) is a graphic showing a footprint of the observation over a grid of surface coordinates on the target body. Numerals 1-6 on the graphic mark the locations of the average spectra displayed on the right.

The spectra to the right of the image may display either BDRF or radiance (or both). If both are displayed, then a vertical "radiance fence" line will appear where the breakpoint occurs. This permits display of both atmospheric data, which have significant reflectance and thermal components, and I/F satellite surface data which have strong absorptions at longer wavelengths (such as water spectra.) The spectra are labelled with wavelength in microns and location in both pixel and latitude-longitude space.

The annotation provides information about the observation, including its name, a brief description, its geometry, instrument and projection parameters. TCA is the time from Galileo's closest approach to the target body.

The 2-dimensional spectral histogram in the lower left corner shows the number of pixels at a given radiance for each wavelength. If a surface contains spatial mixtures with significantly different spatial fractions for several components, the spectra of the components will be evident in this display.