Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E11 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E11 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.

Thirteen NIMS software reloads were inserted into the E11 Encounter sequence to protect against processor halts. During E11 no NIMS observations were 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.

Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

The plots on the pages 3 and 4 show the geometry of the NIMS E11 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 E11 playback events which affected which observations were returned.

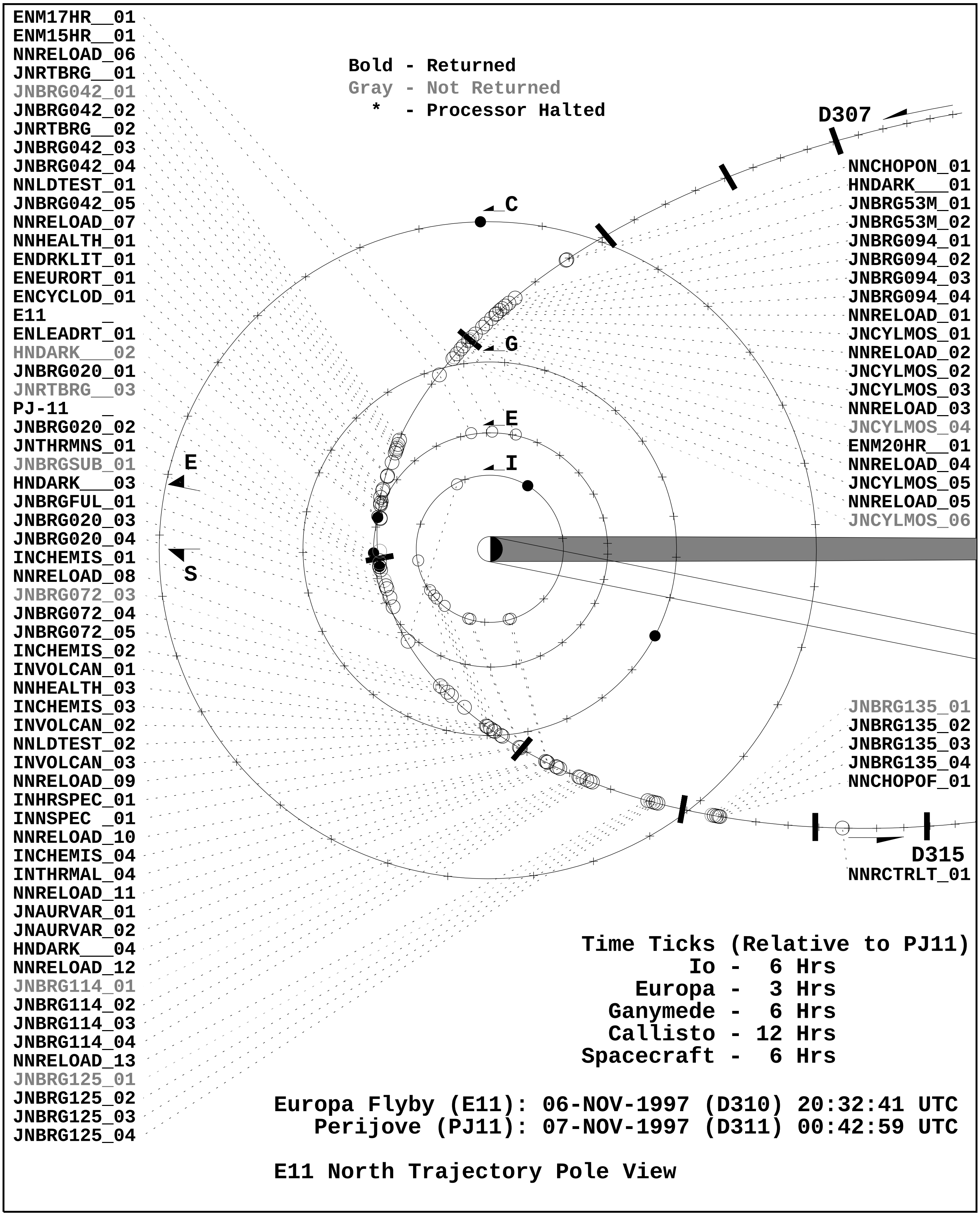
A Timeline of E11 playback events is on pages 10 through 14.

The text on page 15 describes the E11 NIMS Anomalies.

The text on page 16 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 17 and 18.

The text on page 19 is a guide to understanding the NIMS MASK.

NIMS E11 OBSERVATIONS

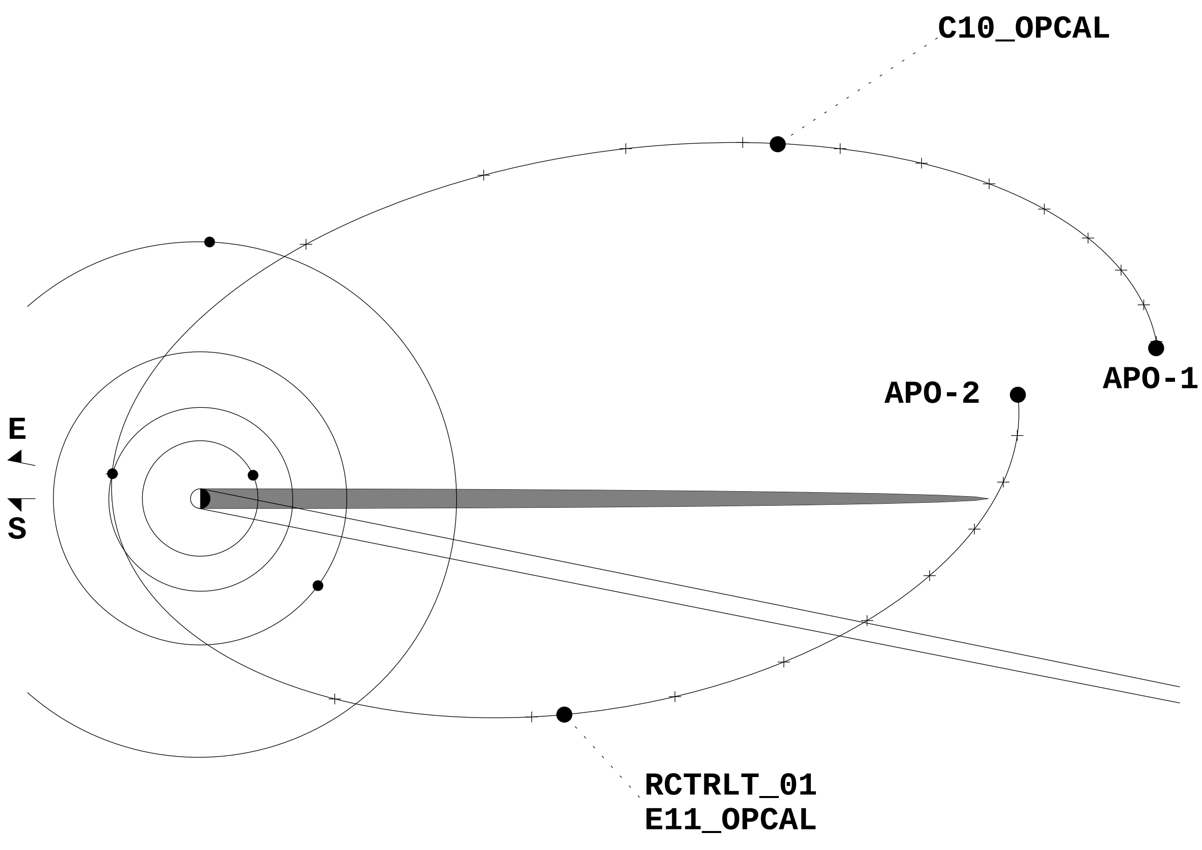


NIMS - FEL - 12/01/98

NIMS E11 CALIBRATIONS

Europa Flyby (E11): 06-NOV-1997 (D310) 20:32:41 UTC
Perijove (PJ11): 07-NOV-1997 (D311) 00:42:59 UTC

Time Ticks (Relative to E11)
Spacecraft - 2 Days



E11 North Trajectory Pole View, Apoapsis to Apoapsis

NIMS - FEL - 03/20/98

NIMS E11 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
11HNDARK__01-	NIMS Dark Observation	E11DRK252	E11DRK32	LM	3	0	4	LPU	EF
11JNBRG53M01-	Brown Barge Observation	E11J35157	E11J35083	LM	4	0	4	LPU	DC
11JNBRG53M02-	Brown Barge Observation	E11J35157	E11J35083	LM	4	0	4	LPU	DD
11JNBRG53M02-	Brown Barge Observation	E11J35157	E11J35083	LM	4	0	4	LPU	DD
11JNBRG09402-	Brown Barge Observation 94 deg phase	E11JFT68C	E11JFT04B	SM	2	1	4	LPU	DF
11JNBRG09403-	Brown Barge Observation 94 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	DG
11JNBRG09404-	Brown Barge Observation 94 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	DH
11JNCYLMOS01-	Jupiter Cylindrical Mosaic Part 1	E11JGM10A	E11JGM05A	XM	2	5	4	LPU	DL
11JNCYLMOS03-	Jupiter Cylindrical Mosaic Part 3	E11JGM10A	E11JGM05A	XM	2	5	4	LPU	DO
11ENM20HR_01-	Europa Obs Beyond 15 Rj	E11ELM442	E11ELM360	LM	4	0	4	MPW	DS
11JNCYLMOS05-	Jupiter Cylindrical Mosaic Part 5	E11JGM10A	E11JGM05A	XM	2	5	4	LPU	DU
11ENM17HR_01-	Europa Obs Beyond 15 Rj	E11ELM442	E11ELM360	LM	4	0	4	MPW	DX
11ENM17HR_01-	Europa Obs Beyond 15 Rj	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	DB
11ENM15HR_01	Europa Observation at Minus 15 Hours	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	EF
11JNRTBRG_01-	NIMS Real-Time Brown Barge Obs	E11JLM442/MB	R/T	LM	2	0	4	R/T	KH
11JNBRG04202-	Brown Barge Observation 42 deg phase	E11JFT68C	E11JFT04B	SM	2	1	4	LPU	EB
11JNRTBRG_02-	NIMS Real-Time Brown Barge Obs	E11JLM442/MB	R/T	LM	2	0	4	R/T	KI
11JNBRG04203-	Brown Barge Observation 42 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	EC
11NNHEALTH01-	NIMS Real-Time Health Observation	E11RCVY3	R/T	LM	2	0	4	R/T	KJ
11ENEURORT01-	NIMS Europa Real-Time Observation	E11ELM442/MB	R/T	LM	4	0	4	R/T	EI
11ENCYCLOD01-	EUROPA CYCLODIAL OBSERVATION	E11ELM243C	E11B_ELM228C_0	LM	4	0	4	LPU	EK
11ENLEADRT01+	Europa Leading Hemisphere Observation Ride-Along with UVS	E11ELM442/MB	R/T	LM	4	0	4	R/T	EM
11JNRTBRG_03-	NIMS Real-Time Brown Barge Obs	E11JLM442/MB	R/T	LM	2	0	4	R/T	KM
11JNTHRMNS01-	Jupiter Thermal North-South Stripe	E11J5M253A	E11J5M80A	LM	4	0	4	LPU	EQ
11HNDARK__03-	NIMS Dark Observation	E11DRK252	E11DRK32	LM	4	0	4	MPW	EF
11JNBRGFUL01-	Brown Barge Obs	E11JFE253A	E11JFE253A	LM	2	0	4	LPU	ES
11JNBRGFUL01-	Brown Barge Obs	E11JFE253A	E11JFE253A	LM	2	0	4	LPU	ES
11JNBRG07205-	Brown Barge Obs 72 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FB
11INCHEMIS02-	MONITORING OF IO'S DAYSIDE	E11ILM243C	E11ILM228C	LM	2	0	4	LPU	FC
11NNHEALTH03-	NIMS Real-Time Health Observation	E11RCVY3	R/T	LM	2	0	4	R/T	KJ
11INCHEMIS03-	MONITORING OF IO'S DAYSIDE	E11ILM442	E11ILM360	LM	2	0	4	MPW	FE
11INVOLCAN02-	MONITORING OF SELECTED VOLCANIC REGIONS	E11ILMDK243D	E11ILMDK228D	LM	4	0	4	LPU	FF
11INVOLCAN03-	MONITORING OF SELECTED VOLCANIC REGIONS	E11ILMDK243D	E11ILMDK228D	LM	4	0	4	LPU	FG
11INHRSPEC01-	MONITORING OF IO'S DAYSIDE	E11ILM442	E11ILM360	LM	2	0	4	MPW	FI
11INNSPEC 01-	NIGHTSIDE SPECTRA AT HIGH RESOLUTION	E11ILM442	E11ILM360	LM	4	0	4	MPW	FJ
11JNAURVAR01+	NIMS Ride-Along Aurora Obs. with UVS	E11B_JAU243	E11JAU40A	LM	4	0	4	LPU	
11JNAURVAR02+	NIMS Ride-Along Aurora Obs. with UVS	E11B_JAU243	E11JAU40A	LM	4	0	4	LPU	
11HNDARK__04-	NIMS Dark Observation	E11DRK252	E11DRK32	LM	4	0	4	LPU	EF
11JNBRG11402-	Brown Barge Obs 114 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FQ
11JNBRG12504-	Brown Barge Obs 125 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FX
11JNBRG13502-	Brown Barge Obs 135 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	KA
11NNRCTRLT01-	NIMS Real-Time RCT Calibration	E11RCT252	R/T	LM	1	0	4	R/T	KE
11NNOPCAL_01-	NIMS Real-Time OPCAL	E11OPCAL48	R/T	LM	4	0	4	R/T	KE

NIMS E11 DATA RETURN

ACTID	Mode	Record Format	Wave-lengths ret	Record Time (sec.)	PB Time (sec.)	Sel Bits of Tape sBOT (MBITS)	Total Bits of Tape BOT (Mbit)	Mode Cycle time	Thold	Comp	Total BTG (Mbits) (4% ohead)	Data Reduct Factor (sBOT/BTG)	Pass
11HNDARK__01-	LM	LPU	32	60.67	60.67	0.37	0.37	8.667	0	2.72	0.0171	21.85	1
11JNBRG53M01-	LM	LPU	83	182	182	1.12	1.12	8.667	0	1.21	0.2996	3.75	1
11JNBRG53M02-	LM	LPU	83	1200	420	2.59	7.40	8.667	0	1.27	0.6587	3.93	1
11JNBRG53M02-	LM	LPU	83	1200	378	2.33	7.40	8.667	0	1.23	0.6122	3.81	1
11JNBRG09402-	SM	LPU	4	300	300	1.85	1.85	2.33	0	2.22	0.0483	38.35	1
11JNBRG09403-	SM	LPU	25	300	300	1.85	1.85	2.33	0	2.11	0.3173	5.83	1
11JNBRG09404-	SM	LPU	25	200	200	1.23	1.23	2.33	0	1.94	0.2301	5.36	1
11JNCYLMOS01-	XM	LPU	5	600	600	3.70	3.70	0.333	0	1.95	0.9610	3.85	1
11JNCYLMOS03-	XM	LPU	5	600	600	3.70	3.70	0.333	0	1.86	1.0075	3.67	1
11ENM20HR_01-	LM	MPW	360	411.34	411.34	4.74	4.74	8.667	0	1.52	2.3381	2.03	1
11JNCYLMOS05-	XM	LPU	5	600	600	3.70	3.70	0.333	0	1.86	1.0075	3.67	1
11ENM17HR_01-	LM	MPW	360	542	529	6.09	6.24	8.667	0	1.66	2.7532	2.21	1
11ENM17HR_01-	LM	LPU	228	538	538	3.32	3.32	8.667	0	1.67	1.7628	1.88	1
11ENM15HR_01-	LM	LPU	228	591	591	3.65	3.65	8.667	0	1.50	2.1559	1.69	1
11JNRTBRG_01-	LM	R/T	408						0				
11JNBRG04202-	SM	LPU	4	400	400	2.47	2.47	2.33	0	2.11	0.0677	36.45	1
11JNRTBRG_02-	LM	R/T	408						0	1.70			
11JNBRG04203-	SM	LPU	25	400	400	2.47	2.47	2.33	0	1.90	0.4698	5.25	1
11NNHEALTH01-	LM	R/T	3						0				
11ENEURORT01-	LM	R/T	408						0				
11ENCYCLOD01-	LM	LPU	228	720	100	0.62	4.44	8.667	0	1.25	0.4377	1.41	1
11ENLEADRT01+	LM	R/T	408						0				
11JNRTBRG_03-	LM	R/T	408						0				
11JNTHRMNS01	LM	LPU	80	2775	1205	7.43	17.12	8.667	0	1.15	2.0117	3.69	1
11HNDARK__03	LM	LPU	32	60.67	61	0.38	0.37	8.667	0	1.30	0.0360	10.44	1
11JNBRGFUL01-	LM	LPU	253	1200	153	0.94	7.40	8.667	0	1.44	0.6451	1.46	1
11JNBRGFUL01-	LM	LPU	253	1200	153	0.94	7.40	8.667	0	1.53	0.6072	1.55	1
11JNBRG07205-	SM	LPU	25	400	400	2.47	2.47	2.33	0	2.15	0.4152	5.94	1
11INCHEMIS02-	LM	LPU	228	170.67	170.67	1.05	1.05	8.667	2	2.74	0.3408	3.09	1
11NNHEALTH03-	LM	R/T	3						2				
11INCHEMIS03-	LM	MPW	360	121	121	1.39	1.39	8.667	2	2.54	0.4116	3.39	1
11INVOLCAN02-	LM	LPU	228	170.67	170.67	1.05	1.05	8.667	2	1.70	0.5493	1.92	1
11INVOLCAN03-	LM	LPU	228	170.67	170.67	1.05	1.05	8.667	2	2.55	0.3662	2.87	1
11INHRSPEC01-	LM	MPW	360	170.67	84	0.97	1.97	8.667	2	2.42	0.2999	3.23	1
11INNSPEC 01-	LM	MPW	360	170.67	84	0.97	1.97	8.667	2	1.75	0.4147	2.33	1
11JNAURVAR01+	LM	LPU	37	616.68	122	0.75	3.80	8.667	0	2.00	0.0542	13.89	1
11JNAURVAR02+	LM	LPU	37	2436.68	864	5.33	15.03	8.667	0	1.97	0.3894	13.68	1
11HNDARK__04-	LM	LPU	32	60.67	60.67	0.37	0.37	8.667	0	2.38	0.0196	19.12	1
11JNBRG11402-	SM	LPU	25	300	150	0.93	1.85	2.33	0	2.00	0.1674	5.53	1
11JNBRG12504-	SM	LPU	25	200	200	1.23	1.23	2.33	0	2.35	0.1899	6.49	1
11JNBRG13502-	SM	LPU	25	152	102	0.63	0.94	2.33	0	2.25	0.1012	6.22	1
11NNRCTRLT01-	LM	R/T	252										
11NNOPCAL_01-	LM	R/T	48										

NIMS E11 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
11JNBRG53M02-	Brown Barge Observation	E11J35157	E11J35083	LM	4	0	4	LPU	DD
11JNBRG09401-	Brown Barge Observation 94 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	DE
11ENM20HR_01-	Europa Obs Beyond 15 Rj	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	DT
11ENM17HR_01-	Europa Obs Beyond 15 Rj	E11ELM442	E11ELM360	LM	4	0	4	MPW	DX
11ENM17HR_01-	Europa Obs Beyond 15 Rj	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	DB
11ENM15HR_01-	Europa Observation at Minus 15 Hours	E11ELM442	E11ELM360	LM	4	0	4	MPW	DY
11ENM15HR_01-	Europa Observation at Minus 15 Hours	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	EF
11ENM15HR_01-	Europa Observation at Minus 15 Hours	E11ELM243C	E11B_ELM228C_0	LM	3	0	4	LPU	EF
11JNBRG04204-	Brown Barge Observation 42 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	ED
11JNBRG04205-	Brown Barge Observation 42 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	EE
11ENDRKLIT01-	EUROPA Dark Mosaic	E11ELM243C	E11B_ELM228C_0	LM	4	0	4	LPU	EJ
11ENCYCLOD01-	EUROPA CYCLODIAL OBSERVATION	E11ELM243C	E11B_ELM228C_0	LM	4	0	4	LPU	EK
11ENCYCLOD01-	EUROPA CYCLODIAL OBSERVATION	E11ELM243C	E11B_ELM228C_0	LM	4	0	4	LPU	EK
11JNBRG02001-	Brown Barge Obs 20 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	EO
11JNBRG02002-	Brown Barge Obs 20 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	EP
11JNTHRMNS01-	Jupiter Thermal North-South Stripe	E11J5M253A	E11J5M80A	LM	4	0	4	LPU	EQ
11JNBRGFUL01-	Brown Barge Obs	E11JFE253A	E11JFE253A	LM	2	0	4	LPU	ES
11JNBRG02003-	Brown Barge Obs 20 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	ET
11JNBRG02004-	Brown Barge Obs 20 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	EU
11INCHEMIS01-	MONITORING OF IO'S DAYSIDE	E11ILM442	E11ILM360	LM	2	0	4	MPW	EV
11JNBRG07204-	Brown Barge Obs 72 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FA
11INVOLCAN01-	MONITORING OF SELECTED VOLCANIC REGIONS	E11ILMDK243D	E11ILMDK228D	LM	4	0	4	LPU	FD
11INVOLCAN02-	MONITORING OF SELECTED VOLCANIC REGIONS	E11ILMDK243D	E11ILMDK228D	LM	4	0	4	LPU	FF
11INHRSPEC01-	MONITORING OF IO'S DAYSIDE	E11ILM442	E11ILM360	LM	2	0	4	MPW	FI
	NIGHTSIDE SPECTRA AT HIGH RESOLUTION	E11ILM442	E11ILM360	LM	4	0	4	MPW	FJ
11INCHEMIS04-	MONITORING OF IO'S DAYSIDE	E11ILM243C	E11ILM228C	LM	2	0	4	LPU	FL
11INTHRMAL04-	MONITORING OF IO'S NIGHTSIDE	E11ILMDK243D	E11ILMDK228D	LM	4	0	4	LPU	FM
11JNAURVAR02+	NIMS Ride-Along Aurora Obs. with UVS	E11B_JAU243	E11B_JAU228	LM	4	0	4	LPU	
11JNBRG11403-	Brown Barge Obs 114 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FR
11JNBRG11404-	Brown Barge Obs 114 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FS
11JNBRG12502-	Brown Barge Obs 125 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FV
11JNBRG12503-	Brown Barge Obs 125 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	FW
11JNBRG13503-	Brown Barge Obs 135 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	KB
11JNBRG13504-	Brown Barge Obs 135 deg phase	E11JFT68C	E11JFT25A	SM	2	1	4	LPU	KC
11JNCYLMOS02-	Jupiter Cylindrical Mosaic Part 1	E11JGM10A	E11JGM05A	XM	2	5	4	LPU	DL

NIMS E11 DATA RETURN

ACTID	Mode	Record Format	Wave-lengths ret	Record Time (sec.)	PB Time (sec.)	Sel Bits of Tape sBOT (MBITS)	Total Bits of Tape BOT (Mbit)	Mode Cycle time	Thold	Comp	Total BTG (Mbits) (4% ohead)	Data Reduct Factor (sBOT/BTG)	Pass
11JNBRG53M02-	LM	LPU	83	1200	420	2.59	7.40	8.667	0	1.24	0.6747	3.84	2
11JNBRG09401-	SM	LPU	25	300	150	0.93	1.85	2.33	0	2.70	0.1240	7.46	2
11ENM20HR_01-	LM	LPU	228	486	479	2.95	3.00	8.667	0	1.68	1.5601	1.89	2
11ENM17HR_01-	LM	MPW	360	542	14	0.16	6.24	8.667	0	1.66	0.0729	2.21	2
11ENM17HR_01-	LM	LPU	228	538	14	0.09	3.32	8.667	0	1.64	0.0467	1.85	2
11ENM15HR_01-	LM	MPW	360	604	591	6.81	6.96	8.667	0	1.50	3.4040	2.00	2
11ENM15HR_01-	LM	LPU	228	591	57	0.35	3.65	8.667	0	1.49	0.2093	1.68	2
11ENM15HR_01-	LM	LPU	228	591	20	0.12	3.65	8.667	0	1.49	0.0734	1.68	2
11JNBRG04204-	SM	LPU	25	400	400	2.47	2.47	2.33	0	1.71	0.5220	4.73	2
11JNBRG04205-	SM	LPU	25	400	400	2.47	2.47	2.33	0	1.55	0.5759	4.28	2
11ENDRKLIT01-	LM	LPU	228	720	364	2.25	4.44	8.667	0	1.29	1.5440	1.45	2
11ENCYCLOD01-	LM	LPU	228	720	20	0.12	4.44	8.667	0	1.24	0.0883	1.40	2
11ENCYCLOD01-	LM	LPU	228	720	620	3.82	4.44	8.667	0	1.25	2.7140	1.41	2
11JNBRG02001-	SM	LPU	25	300	150	0.93	1.85	2.33	0	1.57	0.2132	4.34	2
11JNBRG02002-	SM	LPU	25	400	267	1.65	2.47	2.33	0	1.59	0.3748	4.39	2
11JNTHRMNS01	LM	LPU	80	2775	1562	9.63	17.12	8.667	0	1.19	2.5201	3.82	2
11JNBRGFUL01-	LM	LPU	253	1200	275	1.70	7.40	8.667	0	1.50	1.1132	1.52	2
11JNBRG02003-	SM	LPU	25	300	300	1.85	1.85	2.33	0	1.55	0.4320	4.28	2
11JNBRG02004-	SM	LPU	25	300	300	1.85	1.85	2.33	0	1.57	0.4265	4.34	2
11INCHEMIS01-	LM	MPW	360	153.33	153.33	1.77	1.77	8.667	2	1.92	0.6900	2.56	2
11JNBRG07204-	SM	LPU	25	400	400	2.47	2.47	2.33	0	2.02	0.4419	5.58	2
11INVOLCAN01-	LM	LPU	228	170.67	170.67	1.05	1.05	8.667	2	2.15	0.4344	2.42	2
11INVOLCAN02-	LM	LPU	228	170.67	90	0.56	1.05	8.667	2	1.70	0.2897	1.92	2
11INHRSPEC01-	LM	MPW	360	170.67	95	1.09	1.97	8.667	2	3.07	0.2674	4.09	2
11INNSPEC 01-	LM	MPW	360	170.67	95	1.09	1.97	8.667	2	2.16	0.3800	2.88	2
11INCHEMIS04-	LM	LPU	228	169.33	169.33	1.04	1.04	8.667	2	2.56	0.3619	2.89	2
11INTHRMAL04-	LM	LPU	228	170.67	170.67	1.05	1.05	8.667	2	1.98	0.4717	2.23	2
11JNAURVAR02+	LM	LPU	228	2436.68	864	5.33	15.03	8.667	0	2.05	2.3062	2.31	2
11JNBRG11403-	SM	LPU	25	284	190	1.17	1.75	2.33	0	2.09	0.2029	5.78	2
11JNBRG11404-	SM	LPU	25	280	280	1.73	1.73	2.33	0	2.30	0.2717	6.36	2
11JNBRG12502-	SM	LPU	25	200	133	0.82	1.23	2.33	0	2.17	0.1368	6.00	2
11JNBRG12503-	SM	LPU	25	200	200	1.23	1.23	2.33	0	2.34	0.1907	6.47	2
11JNBRG13503-	SM	LPU	25	152	152	0.94	0.94	2.33	0	2.41	0.1408	6.66	2
11JNBRG13504-	SM	LPU	25	152	152	0.94	0.94	2.33	0	2.43	0.1396	6.72	2
11JNCYLMOS01-	XM	LPU	5	600	600	3.70	3.70	0.333	0	1.89	0.9915	3.73	2
Total						138.27	197.60				46.570	Total Mbtg	
Allocation											46.033	Allocation	
											0.537	Over/Under	

RECAP OF NIMS E11 PLAYBACK EVENTS

E11 was a very successful orbit in terms of the completeness and quality of the NIMS data received. Highlights included the first distant Europa observations, which produced spectra with greatly reduced noise in thermal wavelengths, and the AWG brown barge campaign and cylindrical mosaics. There were no known software crashes during E11.

There were two significant errors by the NIMS development and playback staff. Neither was of any great consequence but both caused concern at the time. During development, an error in the instrument mode specification in a spreadsheet resulted in an estimated downlink bits requirement that was a factor of 7 too small for the 11JNCYLMOSnn observations. This caused playback to run behind. Later, a failure to update the wavelength editing commands for pass 1 playback of 11JNAURVAR01-02 caused playback to run ahead and pause, because only 37 wavelengths were commanded instead of the desired 228. The full wavelength coverage was subsequently returned in pass 2.

In order to understand the rationale for the use of the particular wavelength and spatial editing commands employed, it is useful to review the downlink-bits-allocation-driven evolution of the playback strategy with time, as presented in the accompanying timeline.

E11 Playback Events Timeline (08-12-97 to 12-14-97)

08-12-97: NIMS trades surplus downlink allocation bits during the C9 orbit to SSI in exchange for their initial 1.5 Megabits of E11 office margin to be received.

09-15-97: Playback table modeling reveals that NIMS is over allocation by 4.2 Mbits on the AWG side, and over by 2.5 Mbits on the SWG side. Total allocation is 40.13 Mbits (17.83 AWG, 22.299 SWG). 11ENCYCLOD01 wavelengths reduced from 228 to 10. 50% cuts in spatial coverage of JNBRGFUL01, JNBRGSUB01, JNBRG02002, JNBRG04201; JNAURVAR02 deleted from plan.

09-29-97: Playback table update with additional changes to the AWG plan. JNBRG53M01-02 will come down with 83 (instead of 157) wavelengths. JNBRGSUB01 is deleted since it is similar to JNBRGFUL01. Spatial coverage on the latter is increased from 50% to 67%.

10-10-97: Playback table update. The following text is excerpted from the playback memo of that date:
In order to get extensive wavelength coverage of the Io and Europa "footprints" in the Jovian auroral region, we made several changes to the AWG plan. We will bring down 2 Rims from the UVS sit-and-stare AURVAR01 observation, and one complete scan from AURVAR02, amounting to about 23 Rims, all with 228 wavelengths. In order to do this it was necessary to reduce wavelength coverage of 12 of the brown barge observations (25 wavelengths to 4).
The SWG subsidized part of the AURVAR01-02 data addback. In addition, however, we received a "new" 0.75 Mbits from the MWG as a result of a trade of (our) tape allocation for (their) downlink in this amount. As a result, the only SWG observation not currently fully selected, the Europa ENCYCLOD01, was increased from about .5 to about 3.5 Rims in duration (at 228 wavelengths). We could use an additional 2 Mb or so to get the rest of it.
The Io HRSPEC and NNSPEC observations were each split into two parts for 2-pass playback. We are predicting (aggressively) compression of 1.9-2.0 for these, and the 2 passes will let us adapt if actual performance is lower. All of the Io observations are thresholded. Thresholding is not employed in any other cases.

10-22-97: Playback table update. In order to improve playback efficiency, several observations are moved between passes or split between passes. Also new information from analyses of past Jupiter compression performance is incorporated, indicating that bits estimates for several observations are too low (by an aggregate total of 3 Mbits). 60% of JNTHRMNS01 is (temporarily) deleted from the playback plan.

10-30-97: Playback table update. Minor pre-uplink changes are implemented. JNTHRMNS01 is restored to 88% of recorded total by making cuts to JNBRGFUL01.

<u>E11 Playback Events Timeline</u> (08-12-97 to 12-14-97)

11-02-97: Start E11 encounter.

11-06-97: Europa close approach occurs at 20:32 GMT.

11-07-97: Perijove is reached at 00:42 GMT.

11-11-97: Playback is initiated.

11-12-97: Playback table update. Playback is already running 17 hours behind schedule due to undercompression of NIMS data. The following message recaps actions taken at that time:
We were over allocation last week by an acceptable .203 Mb. Our allocation was reduced due to new telemetry modeling by an additonal .2 Mb. And, JNBRG53M01-02 did not compress as well as expected, by about .4 Mb (total). Thus we started this update cycle "in the hole."

AWG: The two pressing issues can be discussed separately; first, the issue of wavelengths for the BRG observations: Brown barge observations recording 68 wavelengths and returning only 4 have a potential to create vast amounts of unwanted downlink fill bits. There were a dozen such observations in our prior plan. To relieve this problem Kevin looked at BRG09403 (processed rapidly by Bob Mehlman) and specified some cuts to spatial coverage for several observations. In addition several less-advantageous observations were cut. The observations cut were: JNBRG04201, JNBRG07203, JNBRG11401, JNBRG12501, JNBRG13501.
Reduced spatial coverage (via shorter playback times) was specified for: JNBRG02001, JNBRG02002, JNBRG09401, JNBRG11402, JNBRG11403, JNBRG12502, JNBRG13502.
The AWG plan still contains a few 4-wavelength selections but the first will not be coming down until the end of the month. To bring all of them down at 25 wavelengths will require another 1.2 Mb of allocation.
The second pressing AWG issue concerns an error found in the NIMS "Resources" spreadsheet generated during orbit development. The mode for JNCYLMOS01-06 was specified as short map when it should have been fixed map. As a result of this error downlink bits for the cylindrical mosaics were underestimated by a factor of 7.
JNCYLMOS01, 03, and 05 are down (01,03) or coming down (05) this week. They are consuming 2.5 Mb more than was estimated in the playback model. Unfortunately this means that we will have to make cuts of this magnitude later in order to be within our allocation of downlink bits. As an immediate, temporary partial fix I removed the remaining (center 1/3) portion of JNBRG53M02 from pass 2 playback. If desired this can be restored in next week's update, at the expense of some other observation.

SWG: Compression for ENM20HR_01 (MPW portion, gain state 4) is 1.52. The estimated compression for this observation was 1.9. The difference is attributable to not thresholding the observation, which has considerable dark sky. We are deliberately not thresholding the 20, 17, and 15 hour observations to obtain the best possible spectra. If all of these compress at 25% below estimates, we will be forced to make corresponding cuts to Europa playback in pass 2. In order for us to come in at our allocation this week, it was necessary to (temporarily, perhaps) cut 2 of the 12 Rims of ENDRKLIT_01. There is an estimated 5.6 Mb of additional Europa playback this week, which could grow to about 7 Mb if each compresses at about 1.5. It appears likely that some significant cuts to the Europa plan will be needed in the weeks to come.

11-19-97: Playback table update. The following message is extracted from the playback memo of that date:

AWG: To adapt to the bits crunch produced by the larger-than-expected cylindrical mosaics (JNCYLMOS01,03,05), we deleted the remaining pass 2 JNCYLMOS observations (02, 04, 06). In addition we were able to pare about 1.4 Mb from JNAURVAR02, the ride-along with UVS looking for the Io and Europa footprints on the Jovian high latitudes. We cut from the sunlit portion and also from the last part of the observation, which returned a large percentage of dark sky.

Several of the high phase observation playbacks were moved to the end of pass 2 where they will be the last thing to come down. In pass 1 we will see JNBRG11402, JNBRG12504, and JNBRG13502, all with 25 wavelengths. In pass 2 are 11403, 11404, 12502, 12503, 13503, and 13504. Of these only 12502 is at 25 wavelengths (the others are at 4). We should be able to increase wavelength coverage here in the final pbt update of this orbit.

As requested by Kevin, the central segment of JNBRG53M01 was restored, after being cut as a temporary expedient last week.

SWG: Lower-than-predicted compression for the Europa ENM20HR_01, ENM17HR_01, and ENM15HR_01 observations force us to make some cuts this week.

In this week’s update we needed to trim nearly 3 Mb from satellites, and so we have temporarily cut the remaining part of ENM15HR_01 down from 10 Rims to 2.

11-25-97: Playback table update. Below is an excerpt from the playback memo for that date:

The news is good this week. The office agreed to release 3.0 Mb of office margin at this time, along with an additional 1.0 Mb from the playback inefficiency bucket. Since SSI owed us 1.5 Mb as a result of a trade back in C9, we received their entire portion of the office margin, giving us a total of 3.5 Mb of additional downlink to spend.

All of the modifications this week affect satellites; no Jupiter observation playback commands were changed.

The compression estimates for the 42 degree phase JNBRG observations were revised slightly based on pass 1 performance.

<u>E11 Playback Events Timeline</u> **(08-12-97 to 12-14-97)**

Bob Carlson placed highest priority on the distant Europa observations in this orbit (ENM20HR_01, ENM17HR_01, ENM15HR_01). Therefore in this update a large chunk of our bits was placed on the MPW portion of ENM15HR_01. As a result all of these distant observations are now being returned in full. It was also possible to fill in some gaps in the pass 1 playback of both 17HR records, and in the LPU portion of the 15HR record.
Preliminary inspection of the first 100 seconds of ENCYCLOD01 revealed some interesting features, so this observation was given next highest priority. We will return the balance (about 10.5 Rims) of this in pass 2. In addition, we are filling a gap near the start of the pass 1 portion.
Finally, we had sufficient allocation remaining to pick up 50% (6 Rims) of ENDRKLIT01.

12-01-97: Galileo data playback autonomously paused over the prior weekend, due to playback running ahead of schedule, and completing all the stored commands held in CDS memory. Reasons for the pause are detailed in the next entry in this timeline.

12-03-97: Playback table update. Events accompanying the autonomous pause are described below. In addition to the problems noted, another anomaly involving "buffer dump to tape" commanding was under investigation at the same time. A number of significant changes to the playback table were made this week. Several factors contributed to making this a difficult process. Most significantly we could not get reliable numbers on the numbers of bits received and the number of bits lost due to the abysmal performance of the data folks (Joe Gleason's troops). The servers that are supposed to provide current information (the RT, realtime, server) and bested information (opsana3) gave conflicting totals, sometimes with substantial subsets missing. Dave Schranck and I finally arrived at believable totals at 12:20 today, after multiple attempts beginning on Monday. The deadline for delivery of the NIMS table was 12:00. It was accomplished by 2:20.
Playback during the past week was characterized by anomalously high apparent compression of NIMS data. Observations of Io and Jupiter came in with significantly fewer bits than forecasted, by 50% in some cases and by 84% in one case. Part of the problem was caused by missing data, yielding low bits totals for observations. The biggest surprise was receiving only 1/6 of the predicted data for JNAURVAR02. This was due to an error in the playback table. The WETable JAU40A, which was originally specified for the observation by Kevin, was not changed over to B_JAU228 when Bob decided to go for full spectral coverage. As a result we received 37 wavelengths instead of the 228 desired. Fortunately this problem can be rectified in pass 2.

We received .35 Mb of surplus bits from UVS and .15 from PPR. Together with compression savings and the incorrect WET problem we had sufficient downlink allocation to make the following changes to the table:
JNBRG02001 and 02002 had wavelength coverage increased from 4 to 25 wavelengths. This will prevent any possible excess fill bits generation during playback of those observations.
JNTHRMNS01 playback in pass 2 was increased by 6 Rims to bring down the full observation, all the way to the south pole.
JNBRGFUL01 playback was previously in 3 2.5 Rim chunks. I expanded the remaining (middle) portion (which Kevin says contains the relevant feature) by 2 additional Rims.
INVOLCAN02 sustained the largest data loss during the past week's playback, amounting to about half of the on-body part of the observation. I added singles to fill this gap. Unfortunately I could not get precise gap start/stop times so the timing involved some guesswork.
JNAURVAR02: This is now selected for full wavelength coverage playback (using the correct WETable) in pass 2.

12-08-97: Final E11 playback table update. Details on the modifications made are discussed in the memo issued at the time:
E11 playback will finish next Sunday. Some additional downlink bits became available when other instruments and teams determined that they could not use the rest of their totals. MWG released .55 Mb, UVS released .85, PPR released .2, and the remaining 0.4 Mb of office margin was also thrown in, for a total of 2 Mb. We received half as did SSI. In addition we had a small unused balance from last week, and detailed accounting of AACS bits by Dave Schranck showed that we were due a rebate of .365 Mb there. As a result we had over 1.5 Mb to spend. SSI proposed a third partial pass through the tape in order to fill some gaps in their REGMAP. This involves losing downlink while slewing across tape. It places them last in the schedule, at maximum risk if anything goes wrong.
We could affect only NIMS AWG observations with this update. The bits were spent to 1) bring back all remaining high phase (114, 125, 135 degree) observations with 25 wavelengths instead of 4. Also 2) we were able to command playback of JNCYLMOS02 in its entirety. This fills the gap between CYLMOS01 and CYLMOS03, providing continuous coverage from longitude 90 to 235. This observation is at the start of the first tape track of playback, in "pass 3", well before the SSI REGMAP.
Once again, it was nearly impossible to get reliable information on bits received from the servers. This delayed delivery from the scheduled 11 am to 3 pm.

12-14-97: Playback is terminated. All of the commanded NIMS data is returned, along with nearly 4 Mbits of SSI data, before termination.

NIMS Anomaly Report - E11 Sequence

No halts of the NIMS processor were detected during the E11 Encounter. Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

Processor Halts

Facts:

0. No processor halts were detected during E11 Encounter.

Summary:

1. No NIMS processor halts occurred during the E11 Encounter.

2. Continous monitoring of the NIMS SCLK channels led to a rapid identification that no NIMS processor halts had occurred.

3. The 13 NIMS software reloads from CDS greatly lessened the potentially disastrous effects of processor halts and protected the NIMS observations in the encounter.

4. 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.

5. The error avoidance measures applied to the E11 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.

Detectors 3 and 8

Detectors 3 and 8 are still not functioning properly. These 2 detectors are still being monitored in the calibration observations as well as in the 408 wavelength realtime observations.

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.

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

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.