Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the G28 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the G28 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.

The cruise portion of G28 was much longer than that of previous GEM orbits. Some of the I27 data were not recorded over during the G28 Encounter. Some of this I27 data was played back with the G28 data.

There were thirty autonomous reloads of the NIMS RAM code from CDS during the G28 encounter, one just before each science observation. Two software halts were inferred during G28. The approach that we are taking to avoid data loss due to processor halts has proven to be very successful.

The NIMS grating became stuck some time between C22 and I24. NIMS can now return only 17 (of 408) wavelengths. This has caused a drastic change in NIMS science capabilities. Detectors 1, 2 and 7 now have very low sensitivity. Detectors 3 and 8 are still not functioning. NIMS now returns only 12 useful wavelengths. Interesting science can still be carried out given the current condition of the insturment.

The plots on the pages 3 and 4 show the geometry of the NIMS G28 observations using a north trajectory pole projection. The ’returned’ observations are in Bold characters and the ’non-returned’ in gray. The observations with an asterix were taken with the NIMS software halted.

The spreadsheets on pages 5 through 10 summarize the ’final’ playback model for the G28 data returned and also the I27 data returned during G28 cruise.

The text on page 11 gives a ’recap’ of the G28 playback events which affected which observations were returned.

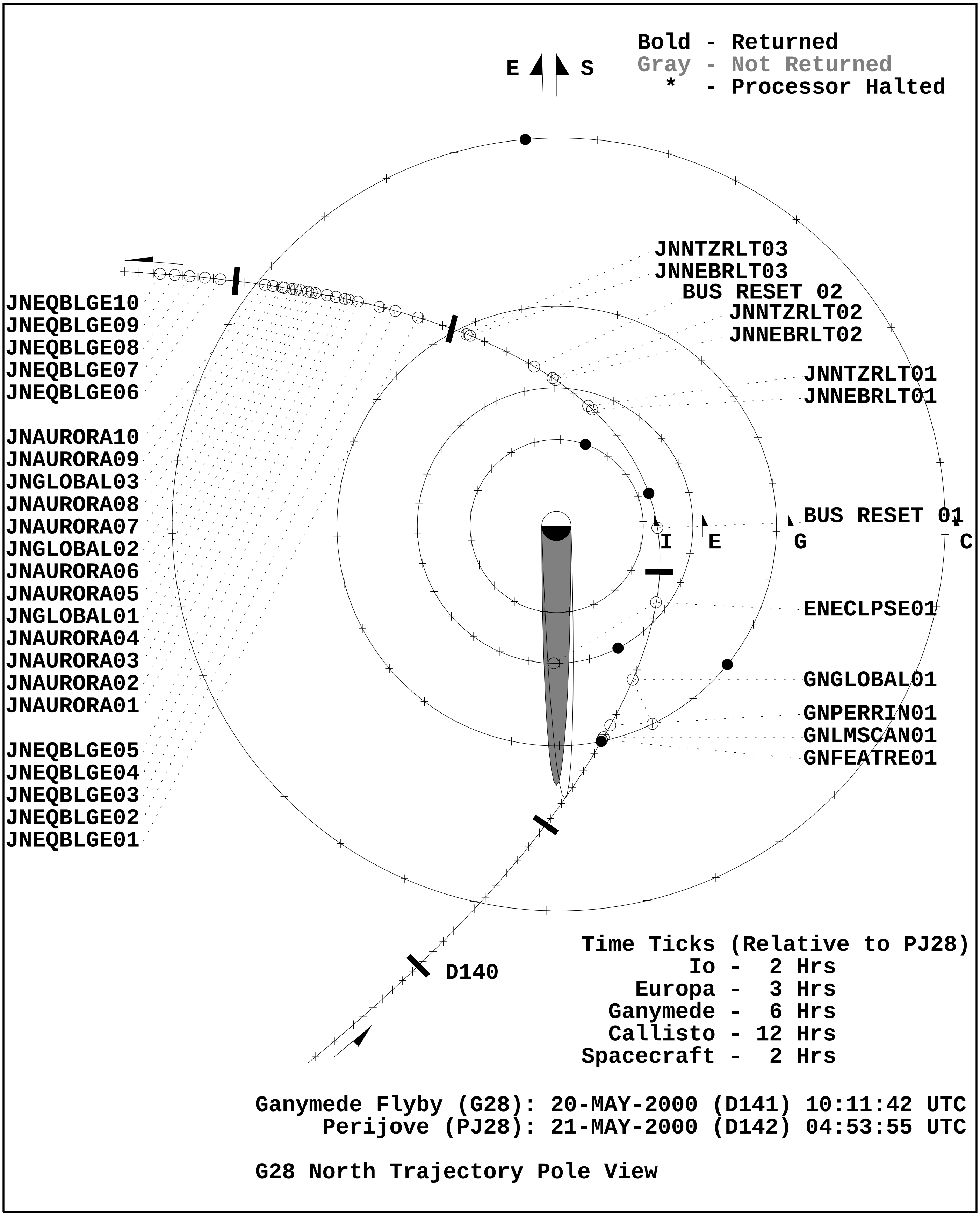
A Timeline of G28 playback events is on pages 11 through 18.

The text on pages 19 and 20 describes the I27 NIMS and Spacecraft Anomalies.

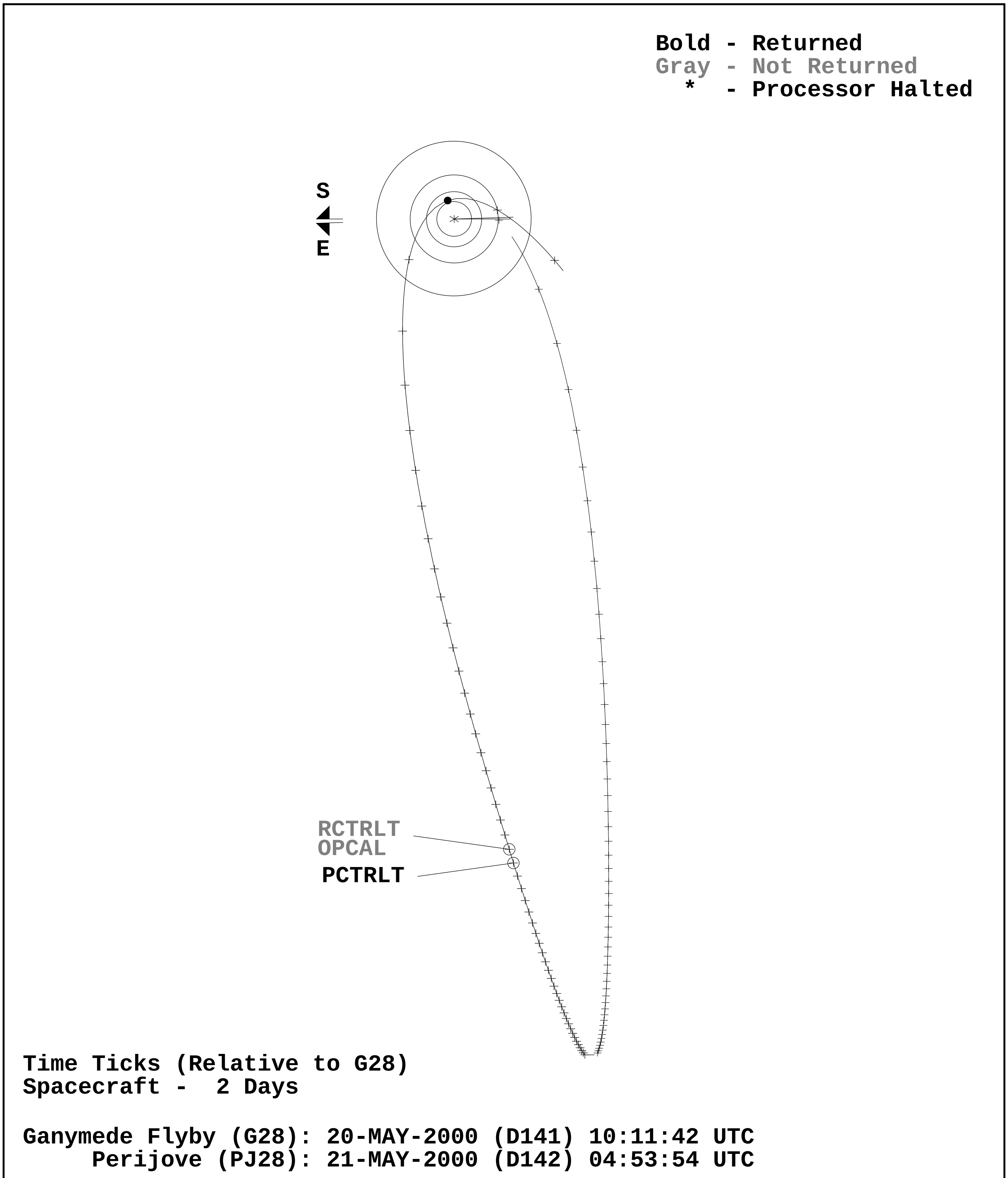
The text on page 21 gives a brief discussion of the NIMS data files. Additional information about NIMS data formats, data types, data labels and data access is given on pages 22 and 23.

The text on page 24 is a guide to understanding the NIMS MASK.

NIMS G28 OBSERVATIONS



NIMS G28 CALIBRATIONS



G28 North Trajectory Pole View

NIMS - FEL - 06/19/01

NIMS G28 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
27INICHAAC01-		I27ILM442	G28ILM144Comp	LM	2	0	0	MPW	
27INMOSAIC01-		I27ILM442	G28ILM144Comp	LM	2	0	0	MPW	
27INPROMTH01-		I27ILM442	G28ILM360	LM	2	0	0	MPW	
27INTOHIL_01+		I27ILM442	G28ILM360	LM	2	0	0	MPW	
27INPROMTH02+		I27ILM442	G28ILM360	LM	2	0	0	MPW	
27INCAMAXT01+		I27ILM442	G28ILM360	LM	2	0	0	MPW	
27INCAMAXT01-		I27ILM442	G28ILM360	LM	2	0	0	MPW	
27INAMRANI01-		I27ILM442	G28ILM360	LM	2	0	0	MPW	
28GNCALDRA01+		G28GLM442	G28GLM360		2				
28GNFEATRE01	Ganymede Hi-Res Feature	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28GNSMOOTH02+		G28GLM442	G28GLM360		2				
28GNBRTDRK02+		G28GLM442	G28GLM360		2				
28GNNICHOL02+		G28GLM442	G28GLM360		2				
28GNARBELA02+		G28GLM442	G28GLM360		2				
28GNLMSCAN01	Ganymede Limb Scan	G28GLM442	G28GLM360	LM	4	0	4	MPW	
28GNGLOBAL01	Ganymede Global Composition Map	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28ENECLPSE01	Europa Eclipse Obs	G28ELM442	G28ELM360	LM	4	0	4	MPW	
28JNNEBRLT01	Jupiter NEB R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNNTZRLT01	Jupiter NTZ R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNNEBRLT02	Jupiter NEB R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNNTZRLT02	Jupiter NTZ R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNNEBRLT03	Jupiter NEB R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNNTZRLT03	Jupiter NTZ R/T OBS	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE01	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE02	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE03	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE04	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE05	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNAURORA02	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA04	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA05	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNFEATRK01+		G28JLM442	G28JLM360		2				
28JNGLOBAL02	Jupiter Global Observation	G28JGM17A	G28JXM15	XM	2	0	4	MPW	
28JNFEATRK02+		G28JLM442	G28JLM360		2				

NIMS G28 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
28JNAURORA08	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNFEATRK03+		G28JLM442	G28JXM15_NGM		2				
28JNFEATRK03+		G28JLM442	G28JXM15_NGM		2				
28JNAURORA09	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNEQBLGE06	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE07	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE08	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE09	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28JNEQBLGE10	Jupiter Equatorial Bulge	G28JLM442	R/T	LM	2	0	4	R/T	
28NNRCTRLT01-	RCT Calibration	G28RCT252	R/T	LM	1	0	4	R/T	
28NNROPCAL01	NIMS OPCAL	G28OPCAL48	R/T	LM	4	0	4	R/T	
28NNPCTRLT01-	PCT Calibration	G28PCT252	R/T	LM	4	0	4	R/T	
27INPROMTH01+		I27ILM442	G28ILM144Comp		2				
27INMOSAIC01-gf		I27ILM442	G28ILM144Comp		2				
27INMOSAIC01-		I27ILM442	G28ILM288		2				
27INMOSAIC01-gf		I27ILM442	G28ILM144Comp		2				
27INPROMTH01-gf		I27ILM442	G28ILM360		2				
27INCAMAXT01+gf		I27ILM442	G28ILM360		2				
27INAMRANI01-gf		I27ILM442	G28ILM360		2				
28GNFEATRE01-gf	Ganymede Hi-Res Feature	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28GNLMSCAN01	Ganymede Limb Scan	G28GLM442	G28GLM360	LM	4	0	4	MPW	
28GNPERRIN01	Ganymede Perrine Region	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28GNGLOBAL01-gf	Ganymede Global Composition Map	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28GNGLOBAL01	Ganymede Global Composition Map	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28ENECLPSE01-gf	Europa Eclipse Obs	G28ELM442	G28ELM360	LM	4	0	4	MPW	
28JNAURORA01	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA02-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA03	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA04-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNGLOBAL01	Jupiter Global Observation	G28JGM17A	G28JXM15	XM	2	0	4	MPW	
28JNAURORA05-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA06	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNFEATRK01+gf		G28JLM442	G28JLM360		2				

NIMS G28 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
28JNAURORA07	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNFEATRK02+gf		G28JLM442	G28JLM360		2				
28JNAURORA08-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNFEATRK03+gf		G28JLM442	G28JXM15_NGM		2				
28JNGLOBAL03	Jupiter Global Observation	G28JGM17A	G28JXM15	XM	2	0	4	MPW	
28JNAURORA10	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
27INMOSAIC01-gf		I27ILM442	G28ILM144Comp		2				
28GNLMSCAN01-gf	Ganymede Limb Scan	G28GLM442	G28GLM360	LM	4	0	4	MPW	
28GNGLOBAL01-gf	Ganymede Global Composition Map	G28GLM442	G28GLM360	LM	2	0	4	MPW	
28JNAURORA04-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNGLOBAL01-gf	Jupiter Global Observation	G28JGM17A	G28JXM15	XM	2	0	4	MPW	
28JNAURORA07-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
28JNAURORA10-gf	Jupiter Northern Aurora Mapping	G28JLM442	G28JLM360	LM	2	0	4	MPW	
gf = gap fill									
(+) = ridealong with SSI									

NIMS G28 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec)	Playback Time (sec)	Selected Bits to Tape sBOT (MBITS)	Bits to Tape BOT(Mbit)	Mode Cycle (sec)	AACS Mbits c 2.5	Comp	Total BTG Mbits (w/4% ohead)	Data Reduct. Factor (sBOT/BTG)	Pass
27INCHAAC01-	LM	MPW	144	122	117	1.35	1.41	8.667	0.01	1.29	0.313	4.30	1
27INMOSAIC01-	LM	MPW	144	842	842	9.70	9.70	8.667	0.05	1.23	2.366	4.10	1
27INPROMTH01-	LM	MPW	360	573	573	6.60	6.60	8.667	0.03	1.22	4.058	1.63	1
27ISTOHIL_01+	LM	MPW	360	102	27	0.31	1.18	8.667	0.00	1.28	0.182	1.71	1
27ISPROMTH02+	SAFE	MPW	15	102	45	0.52	1.18	0.333	0.00	1.30	0.324	1.60	1
27ISCAMAXT01+	LM	MPW	360	102	100	1.15	1.18	8.667	0.01	1.24	0.697	1.65	1
27INCAMAXT01-	LM	MPW	360	120	116	1.34	1.38	8.667	0.01	1.20	0.835	1.60	1
27INAMRANI01-	LM	MPW	360	1120	1120	12.90	12.90	8.667	0.06	1.18	8.200	1.57	1
28GSCALDRA01+	SAFE	MPW	15	102	28	0.32	1.18	0.333	0.00	3.03	0.087	3.73	1
28GNFEATRE01	LM	MPW	360	484	483	5.56	5.58	8.667	0.03	2.36	1.768	3.15	1
28GSSMOOTH02+	LM	MPW	360	102	10	0.12	1.18	8.667	0.00	2.54	0.034	3.39	1
28GSBRTDRK02+	LM	MPW	360	102	10	0.12	1.18	8.667	0.00	2.64	0.033	3.52	1
28GSNICHOL02+	LM	MPW	360	102	10	0.12	1.18	8.667	0.00	2.57	0.034	3.43	1
28GSARBELA02+	LM	MPW	360	102	44	0.51	1.18	8.667	0.00	2.41	0.158	3.21	1
28GNLMBSCN01	LM	MPW	360	720	360	4.15	8.29	8.667	0.02	2.27	1.370	3.03	1,2
28GNGLOBAL01	LM	MPW	360	720	360	4.15	8.29	8.667	0.02	1.82	1.709	2.43	1,2
28ENECLPSE01	LM	MPW	360	63	60	0.69	0.73	8.667	0.00	1.34	0.387	1.79	1
28JNNEBRLT01	LM	RT	360	480	480	0.00	0.00	8.667	0.03				
28JNNTZRLT01	LM	RT	360	420	420	0.00	0.00	8.667	0.02				
28JNNEBRLT02	LM	RT	360	480	480	0.00	0.00	8.667	0.03				
28JNNTZRLT02	LM	RT	360	420	420	0.00	0.00	8.667	0.02				
28JNNEBRLT03	LM	RT	360	480	480	0.00	0.00	8.667	0.03				
28JNNTZRLT03	LM	RT	360	420	420	0.00	0.00	8.667	0.02				
28JNEQBLGE01	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE02	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE03	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE04	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE05	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNAURORA02	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	1.10	1.233	1.47	1
28JNAURORA04	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.19	0.619	2.92	1
28JNAURORA05	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.25	0.603	3.00	1
28JSFEATRK01+	LM	MPW	360	102	219	2.52	1.18	8.667	0.01	2.27	0.834	3.03	1
28JNGLOBAL02	XM	MPW	15	343	340	3.92	3.95	0.333	0.02	2.52	1.264	3.10	1
28JSFEATRK02+	LM	MPW	360	357	355	4.09	4.11	8.667	0.02	2.41	1.273	3.21	1

NIMS G28 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec)	Playback Time (sec)	Selected Bits to Tape sBOT (MBITS)	Bits to Tape BOT(Mbit)	Mode Cycle (sec)	AACS Mbits c 2.5	Comp	Total BTG Mbits (w/4% ohead)	Data Reduct. Factor (sBOT/BTG)	Pass
28JNAURORA08	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.21	0.614	2.95	1
28JSFEATRK03+	XS	MPW	15	357	173	1.99	4.11	0.1667	0.01	3.37	0.961	2.07	1
28JSFEATRK03+	XM	MPW	15	357	182	2.10	4.11	0.333	0.01	2.63	0.648	3.23	1
28JNAURORA09	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.21	0.614	2.95	1
28JNEQBLGE06	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE07	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE08	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE09	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28JNEQBLGE10	LM	RT	360	300	300	0.00	0.00	8.667	0.02				
28NNRCTRLT01	LM	RT	252					8.667					
	LM	RT	48					8.667					
28NNPCTRLT01	LM	RT	252					8.667					
27ISPROMTH02+	LM	MPW	144	67	33	0.38	0.77	8.667	0.00	1.30	0.088	4.33	2
27INMOSAIC01-	LM	MPW	144	842	45	0.52	9.70	8.667	0.00	1.20	0.130	4.00	2
27INMOSAIC01-	LM	MPW	288	842	93	1.07	9.70	8.667	0.01	1.20	0.536	2.00	2
27INMOSAIC01-	LM	MPW	144	842	19	0.22	9.70	8.667	0.00	1.20	0.055	4.00	2
27INPROMTH01-	LM	MPW	360	573	26	0.30	6.60	8.667	0.00	1.20	0.187	1.60	2
27ISCAMAXT01+	LM	MPW	360	102	8	0.09	1.18	8.667	0.00	1.20	0.058	1.60	2
27INAMRANI01-	LM	MPW	360	1120	179	2.06	12.90	8.667	0.01	1.18	1.311	1.57	2
28GNFEATRE01	LM	MPW	360	484	16	0.18	5.58	8.667	0.00	2.36	0.059	3.15	2
28GNLMBSCN01	LM	MPW	360	720	369	4.25	8.29	8.667	0.02	2.32	1.374	3.09	1,2
28GNPERRIN01	LM	MPW	360	483	480	5.53	5.56	8.667	0.03	2.16	1.920	2.88	2
28GNGLOBAL01	LM	MPW	360	720	10	0.12	8.29	8.667	0.00	1.83	0.047	2.44	1,2
28GNGLOBAL01	LM	MPW	360	720	368	4.24	8.29	8.667	0.02	1.83	1.737	2.44	1,2
28ENECLPSE01	LM	MPW	360	63	7	0.08	0.73	8.667	0.00	1.34	0.045	1.79	2
28JNAURORA01	LM	MPW	360	160	154	1.77	1.84	8.667	0.01	2.22	0.599	2.96	2
28JNAURORA02	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.14	0.634	2.85	2
28JNAURORA03	LM	MPW	360	160	160	1.84	1.84	8.667	0.01	2.16	0.640	2.88	2
28JNAURORA04	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.31	0.587	3.08	2
28JNGLOBAL01	XM	MPW	15	303	300	3.46	3.49	0.333	0.02	2.44	1.152	3.00	2
28JNAURORA05	LM	MPW	360	160	10	0.12	1.84	8.667	0.00	2.25	0.038	3.00	2
28JNAURORA06	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.25	0.603	3.00	2
28JSFEATRK01+	LM	MPW	360	102	18	0.21	1.18	8.667	0.00	2.27	0.069	3.03	2

NIMS G28 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec)	Playback Time (sec)	Selected Bits to Tape sBOT (MBITS)	Bits to Tape BOT(Mbit)	Mode Cycle (sec)	AACS Mbits c 2.5	Comp	Total BTG Mbits (w/4% ohead)	Data Reduct. Factor (sBOT/BTG)	Pass
28JNAURORA07	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.37	0.572	3.16	2
28JSFEATRK02+	LM	MPW	360	357	16	0.18	4.11	8.667	0.00	2.41	0.057	3.21	2
28JNAURORA08	LM	MPW	360	160	16	0.18	1.84	8.667	0.00	2.21	0.063	2.95	2
28JSFEATRK03+	XS	MPW	15	357	96	1.11	4.11	0.1667	0.01	3.37	0.533	2.07	2
28JNGLOBAL03	XM	MPW	15	320	317	3.65	3.69	0.333	0.02	2.68	1.108	3.30	2
28JNAURORA10	LM	MPW	360	160	157	1.81	1.84	8.667	0.01	2.21	0.614	2.95	2
27INMOSAIC01-	LM	MPW	144	842	198	2.28	9.70	8.667	0.01	1.20	0.570	4.00	3
28GNLMBSCN01	LM	MPW	360	720	36	0.41	8.29	8.667	0.00	2.32	0.134	3.09	3
28GNGLOBAL01	LM	MPW	360	720	12	0.14	8.29	8.667	0.00	1.83	0.057	2.44	3
28JNAURORA04	LM	MPW	360	160	11	0.13	1.84	8.667	0.00	2.31	0.041	3.08	3
28JNGLOBAL01	XM	MPW	15	303	17	0.20	3.49	0.333	0.00	2.44	0.065	3.00	3
28JNAURORA07	LM	MPW	360	160	10	0.12	1.84	8.667	0.00	2.37	0.036	3.16	3
28JNAURORA10	LM	MPW	360	160	10	0.12	1.84	8.667	0.00	2.21	0.039	2.95	3
											46.975	Total	
											51.760	Allocatation	
											-4.785	Over/Under	

RECAP OF G28 PLAYBACK EVENTS

G28 encounter data return extended over four months, and was characterized by a highly unusual abundance of downlink capability. Nearly 100% of the NIMS data recorded in G28 was successfully returned, together with about 20 Mbits of I27 encounter data that was deliberately retained on the tape through the G28 encounter. Over the course of time NIMS donated a total of 55 Mbits of downlink allocation back to the Science Planning and Operations Team (SPOT); most of this was reallocated to SSI.

Spacecraft "despun bus reset" events occurred during the encounter, but onboard software handled them flawlessly. The NIMS software halted at least once during the encounter, but routine software reloads prevented the loss of any observations.

A considerable number of Jupiter observations were recorded and returned, among them a very successful series of auroral observations.

The following timeline details the most signifigant events of the G28 playback period. Most of the text below is excerpted from messages issued at the time.

G28 Playback Events Timeline (02-01-00 to 05-05-00)

01-19-00: (A. McEwen to M. Belton) I would like to initiate a discussion within the SSI team about our position with respect to how much G28 data we *want* to record. The bulk of the I27 data will remain on tape by G28, if all is successfully recorded. Based on the success of E26 and the project’s understanding of safing events in 24-25, it seems like there is a good chance all of the I27 data will be recorded. We expect to be able to play back only ~25% of the I27 data before G28. Obviously this data will be highly unique--we may not get back to Io in any of our lifetimes. The G28 Ganymede data will also be unique, although only 2 tracks of data are possible at better-than-Voyager resolution. It seems to me that the best solution would be to reduce the G28 recording to something like 2.5 tracks and leave 1.5 tracks from I27.

02-04-00: (D. Bindschadler) On Wednesday, 2/9, 9:30-10:30 am, we will have a meeting in the SWAMP to discuss changes proposed to G28A plans in order to support carryover of I27 data.

G28 Playback Events Timeline (02-01-00 to 05-05-00)

02-09-00: (D. Bindschadler) Proposed Revisions to G28
The SSI proposal is to record only 3 tracks of data during the G28 encounter period (approximately DOY 140 through 165), allowing Track 4 of the I27 record sequence (the post C/A track) to be carried over into G28. The primary rationale for this change is the science value of the I27 SSI and NIMS data, coupled with the relatively small amount of bits to ground (~88 MBTG) available for all I27 playback.

05-17-00: Start of G28 encounter sequence.

05-19-00: (J. Erickson) In the last two weeks, the spacecraft came through solar conjunction, with the first telemetry received 5/13 as expected. Some data is still being lost due to solar scintillation as the SEC angle is still under 9 degrees.
The G28A sequence has begun executing. G28 is a more extended encounter than recent orbits. Remote sensing observations begin on Saturday, 5/20 (PDT) and continue until Wednesday, 5/24. The Fields and Particles survey will continue through June 13th, allowing them to collect nearly 4 weeks of continuous RTS data as Galileo moves from the inner magnetosphere, through the magnetopause and bowshock and into the solar wind. Playback of recorded data initates on June 15, local time.

05-20-00: Ganymede close approach occurs at 10:11:42 UTC.

05-21-00: Perijove occurs at 04:53:55 UTC.

05-21-00: (R. Mehlman) No sign of NIMS Jupiter realtime packets yet, though our first observation (JNNEBRLT01) should have occurred 9 hours ago. (It may have gone to tape via BDT.) No new SCLKs. However a hardware status word transmitted 5 hours after Jupiter closest approach and 2 hours before JNNEBRLT01 shows a peculiar value value (x18), probably due to a reported bus reset 2 hours before closest approach. According to the MCT summary: A bus reset was experienced on the spacecraft, SCET for the event was 142/02:45:19.3z. The spacecraft handled it as programmed and no impact to the encounter activities has occurred.

05-22-00: (J. Erickson) The Galileo spacecraft is operating normally, and all activities appear to be as planned. The current status is from the end of the DSS 63 pass at 4:45 a.m. PDT on 5/22. The spacecraft has now passed the peak of the radiation expected for this encounter. Observations are continuing, primarily remote sensing of Jupiter’s atmosphere, as well as fields and particles monitoring of the inner magnetosphere.
Two spurious despun bus resets occurred during the encounter. They were at 7:45 p.m. PDT on 5/20, and 9:23 a.m. PDT on 5/21. These are expected during the high radiation period, and were handled perfectly by the on-board software.

<u>G28 Playback Events Timeline</u> (02-01-00 to 05-05-00)

05-22-00: (M. Segura) I have looked at the weekend's engineering data and have determined that NIMS software did experience one crash. The first indication was at 142/05:33:38 (rim 5525582) about 40 minutes after Jupiter closest approach. The instrument stayed in the crashed state until 142/23:00:18 (rim 5526617) according to telemetry. However - there was a "reload" of the software prior to our first NEB realtime observation which executed at 142/11:10:56 (rim 5525916) and I have no reason to assume that the instrument did not fully recover at that time.

05-23-00: (J. Shirley) I delivered a new version of the NIMS G28 playback table today. This table selects nearly all of our recorded G28 data along with a significant amount (over 20 Mbits) of data carried over from I27.

05-26-00: (J. Erickson) Playback will begin 6/15/00. Playback is delayed to allow an opportunity for a cross sectional mapping of Jupiter's magnetosphere. This is important both in preparation for the dual spacecraft observations with Cassini at the end of this year, and because the spacecraft is now in the dusk region of the magnetosphere for the first time. Radiation levels were significantly below average, with no problems identified. The peak radiation level was around 300 (measured by the star scanner in pulse counts), significantly lower than the maximum of 1400 seen in previous GEM orbits.

05-26-00: Our wealth of downlink bits in G28 makes it possible to think new thoughts. We could go after ALL the embedded NIMS data in ALL the SSI recordings where our data exists.

06-01-00: NIMS allocation is 95.7 Mbits, SSI's is 125.4. The earliest time within the observation 27ISPROMTH01 where we can begin returning data is is 00-053/13:51:31.800. This is 622 tics into the observation. This condition is due to G28 data recording over the first portion.

06-07-00: Playback will begin on the 15th of June. In this update we added commands to return NIMS data that is embedded in SSI record frames, and made some other changes.
I27 carryover data: Since a portion of track 3 was not recorded over in G28, we were able to go after additional wavelengths for the observations 27INICHAAC01 and 21INMOSAIC01. We will now have 288 wavlengths for these.
In addition to our track 4 observations, coming down with all detectors, we will get some SSI ridealong data that we could not return in I27 (27ISPROMTH02, 27ISTOHIL__01).

G28 Playback Events Timeline (02-01-00 to 05-05-00)

G28: The NIMS Ganymede observations were unchanged with the exception of an adjustment to the data reduction factor. We added 5 sets of commands to return SSI ridealong data for the observations: 27GSCALDRA01, 27GSSMOOTH02, 27GSBRTDRK02, 27GSNICHOL02 and 27GSARBELA02.
Five other SSI observations could not be selected due to NIMS instrument activities (reloads) or status (chopper off).
No changes to the Jupiter observations were made. The Jupiter realtime observations will come down when the various buffer dump to tape recordings are played back.
We have a surplus of downlink allocation bits at present. We will hold on to a good portion of these to insure against DSN problems or other gap-creating events, and to account for compression uncertainties and the potential need for returning additional I27 observation wavelengths. I anticipate we will release some of our allocation back to other teams at some point. The next update will not occur until the second week of July.

06-12-00: (K. Schimmels) Playback initiates Thursday June 14 at 9:19 PM PDT. (00-166/04:19 SCET-UTC). Playback terminates at the end of the C-load, around DOY 00-300 (TBD). Playback is being done in a first-in/first-out fashion this orbit, but spans data from I27 and G28. We are starting pass 1 mid-track 3 with I27 data, and will get thru some of the early G28 data on track 1 during the B-load.

06-22-00: (E. Theilig) On Sunday 6/18, the spacecraft struggled for about 9 hours to maintain lock on celestial reference. It re-established lock about mid-day on Monday and remains stable. The outage may be related to an apparent drop in intensity of one of the stars but the investigation is ongoing.
Playback initiated on the spacecraft last night and the first frames have been obtained.
The first five weeks of playback contain I27 data carried over into G28. Data from the Ganymede closest approach period begin playing back sometime around July 22nd and continue into at least the first two weeks of August

07-22-00: (K. Schimmels) SSI Anomaly Status: On 7/19, the Baseline Correction Stabilization Voltage measurement on the SSI camera went into alarm. At roughly the same time the camera began drawing approximately one-watt additional power. Memory readouts of other SSI engineering measurements reveal no other indications of problems. The Baseline measurement is used to adjust processing of images from the camera. No change was expected in this measurement during this cruise period.

G28 Playback Events Timeline (02-01-00 to 05-05-00)

Since the initial anomaly was detected, the readings on the voltage channels appear to be toggling between normal and anomalous readings. Several possiblities exist for the cause, including either bad measurement circuitry (for measuring the voltage), or bad circuitry elsewhere in the system. The effect is a change to the background level in the images.

07-31-00: (K. Schimmels) We've had a 31 MB increase in BTG released to the teams!! So, here's your new allocations:
NIMS 106.708

08-09-00: A large number of additions and a small number of corrections were made to the G28 playback table in this update. Much of the following documents relatively subtle tweaks made. This table is comparable in size and complexity to those of the main mission. The executive summary for today's delivery is that we added lots of commands to fill gaps in our pass 1 playback of the I27 data carried over into G28. At this level, it should also be noted that we are about 1/3 of the way through G28, measured by bits received. We have a very large cushion of downlink bits in our allocation.
Blow-by-blow descriptions follow:
27INPROMTH01+: We obtained 144 wavelengths for this ridealong observation in I27. In pass 2 we are going after another 144 ("complementary") wavelengths. HOWEVER, we cannot access the entire observation, because it was in effect partially overwritten by G28 data recording. Thus we will get 'complete' wavelengths coverage for about 2/3 of the spatial area, when the I27 and G28 datasets are merged.
27INMOSAIC01: During I27 playback of this observation we were not able to get the entire spatial area, and we received only 144 wavelengths. In pass 1 of G28 we commanded return of the entire area, with the complementary 144 wavelengths. Now for pass 2 we will get gap fills for this G28 portion, together with 'complete' (288 wavelengths) coverage for the portion we missed in I27. (It would have been logical to command only the missing 144 here, except that a large gap occurred over this data in G28 pass 1 playback. The only way to get continuous complete data over this gap is to command it all, about 1.5 RIMS).
Other gap fills: Those for 27INPROMTH01, 27INCAMAXT01, and 27INAMIRANI01 are straightforward.
Because we often reloaded the NIMS software during SSI recordings, we have ridealong data on tape for only a minority of their observations. In some cases we got partway through a reload, and took data, even though the command to shift from SAFE to LM mode had not taken effect. 27INPROMTH02+ and 28GNCALDRA01+ were obtained in SAFE mode, and 28GNFEATRK03+ began recording in SAFE mode, transitioning part way through to FIXED MAP. SAFE mode is equivalent to FIXED SPECTROMETER, with no mirror motion. New wavelength tables for these cases were generated. It was too late to implement these for 27INPROMTH02+ and 28GNCALDRA01+, but 28GNFEATRK03+ is commanded for return with the XM table (15 wavelengths).

Fortunately the LM table employed for the former two selects the recorded data and gets it into the downlink stream without problems. Finally, for 28GNFEATRK01+, the playback deselect was moved earlier in time to avoid a memory reload that occurred about 90% of the way into the SSI recording.

08-14-00: (K. Schimmels) Playback is Currently on schedule. We are playing back 28GSSMOOTH02, in Segment 3. Track 1, tic 3734 (as of 10 AM 8/14). We may continue to see a lag of up to a few days over time in this schedule due to modelling discrepancies in SSI BARC data. So far, this lag is only ~12 hours.
SSI and NIMS made adjustments to pass 2 data return, including some gap fill SINGLEs. A few compression parameters were adjusted in pass 1 as well. Additional AACS was selected to complete all of NIMS requests from I27 data. All AACS is selected for NIMS in I27/G28 now.

08-25-00: The NIMS team has determined that we have sufficient G28 internal downlink allocation margin to allow us to release a total of 20 Megabits back to SPOT for use by other teams, effective today (08-25-2000:).

08-25-00: (K. Schimmels) NIMS has donated 20 MB back to SPOT for G28 Playback. The breakdown is as follows:
SSI: 18 MB, MWG: 2 MB.

09-03-00: (R. Mehlman) NIMS pass 1 playback for G28 appears to be finished; pass 2 doesn't begin until mid-September.
We have received most packets (mainly small gaps) from requested recorded data through 28JNAURORA10. We also have buffer-dumped-to-tape packets for realtime observations through 28JNEQBLGE10, except for the observations 28JNEQBLGE02-05, which were entirely lost, presumably due to station problems.

09-05-00: G28 playback accelerated significantly over the weekend to the point where we are now about 5 days ahead of schedule.

09-05-00: (R. Mehlman) We now have:
28JNNEBRLT01-03: OK
28JNNTZRLT01-03: OK
JNEQBLGE01: OK
JNEQBLGE02: first 12 packets (3 RIMs) OK. Five packets missing, final three packets received. As it turns out, only the first three RIMs will be usable; we can't easily decipher incomplete sets of 4 packets (one RIM).
JNEQBLGE03: Only first packet received. Not very useful.

JNEQBLGE04: Nothing
JNEQBLGE05: Nothing
JNEQBLGE06-10: All OK
JNEQBLGE02-05 should be replayed if possible.

09-06-00: (K. Schimmels) If anyone is going to want to replay buffer dumps, please let me know so we can start tracking down the right ones (which I think is what your intentions were here...)

09-07-00: (K. Schimmels) We DID in fact have several gaps in buffer dump playback around those times, the software we use to track it had an idiosyncrasy in it for buffer dump gaps. So, I will track down which ones need to be replayed to recover all missing data.

09-08-00: (K. Schimmels) Here's your newest allocations based on some re-work of traded bits, DDS Realtime activities, and costs of the first opnav test. SSI, 157.849, NIMS 86.760.

09-13-00: The first pass over the tape has been completed, and we are well into the second pass over the I27 data. A considerable number of changes were made this week, to fill numerous gaps and refine our estimates of compressions for the remaining data. During orbit development we employed highly conservative compression estimates for Ganymede. Since we have a wealth of downlink allocation this orbit, the initial estimates were not revised until now. It turned out that in many cases, actual compression was twice as good as predicted. This led to an acceleration of playback, relative to the schedule, putting us several days ahead.
Ten new sets of playback commands were generated this time. DSN performance has not been as good as one might hope over the past several weeks. We lost essentially all of our 28JNAURORA02 and 28JNAURORA04, and a considerable portion of 28JNFEATRK03+ (SSI ridealong). In addition, two BDTs (buffer dump to tape) containing NIMS realtime data were not received and will have to be replayed. The cost of doing this is yet to be determined. The cost of doing this will not be an issue since due to our overcompression we still have on the order of 40 Mbits of allocation as margin.
We previously released 20 Mbits of downlink allocation back to the SPOT team, where it was divided between SSI and the MAG team. We will be releasing another substantial block of allocation as soon as we get a handle on the costs of BDTs and other data not presently in the playback plan.
I made one significant error in the specification of playback times for 27INMOSAIC01. As a result we did not receive about 3 RIMS of complementary wavelengths needed to complete playback of that observation. We will request a third tape pass to retrieve this. It is likely that SSI will be able to make good use of a third pass also.

<u>G28 Playback Events Timeline</u> (02-01-00 to 05-05-00)

09-20-00: The newest playback table has three new sets of playback singles, which will bring down gap-filling data for 27INMOSAIC01. A third pass over the tape is being allowed this time to make the best use of the abundant downlink resource. Due to good compression of our Ganymede data and other factors we were able to release 30 Mbits of surplus downlink allocation back to the SPOT team. Almost all of this will go to SSI. We retain about 10 Mb of cushion to adapt to future gaps in data received.

09-21-00: (K. Schimmels) Playback is currently on schedule. We are playing back the very end of 27ISCAMAXT01 in Segment 12. Track 4, tic 1942 (as of 6 AM 9/21).
Playback is currently 61% complete.
NIMS released 30 MB of their allocation this week, 29 went to SSI and 1 went to the MWG for buffer dump gaps.
A "pass 3" was approved this week. NIMS allocation: 56.260

09-28-00: (K. Schimmels) Due to moving Terminate playback prior to the DOY 299 DMS conditioning, we lost ~2.26 MB of capability. This loss will be reflected in next week's allocations.

10-03-00: (M. Segura) We have determined that NIMS can make a final release of 5 mbits of our playback allocation. The rest will be held in reserve for pass 2 gap fill.

10-06-00: (K. Schimmels) Playback is currently running about half a day behind schedule. We are playing back 28JNAURORA03 in Segment 18. Playback is currently 77% complete, and will terminate on 00-299/21:57 (10/25/00, ~3 PM).
Current Margin: 5.0 MB (already all used by inefficiency costs).

10-11-00: Today's is the final update for G28. We are including 8 new sets of singles to fill gaps in our pass 2 Ganymede and Jupiter data. The gaps turned out to be fairly small, amounting to about .5 Mbits total. We are requesting that one buffer-dump-to-tape be replayed in hopes of recovering a missing RIM of data for 28JNEQBLGE03.
Having released all but about 5 Mbits of our internal margin previously, we are fairly confident that all of our data requested will be returned. The excess will cover the losses incurred during long tape slews in which no data is retrieved. SSI has one observation that follows our last one, and thus in a sense their allocation assigned to that observation provides added insurance for us.

12-08-00: (K. Schimmels) Below is the approval information for the G28D playback table update, G28PED. This playback table is for playing back the Buffer Dumps recorded in G28D, and does NOT include any playback data for I27 or G28A recorded data. Playback will Terminate on 12/24/00 at ~10:30 PM PST.

The NIMS grating became stuck prior to the I24 encounter. The grating continued to be stuck for the G28 encounter. This development caused a drastic change in NIMS operations. Detectors 1, 2 and 7 now have very low sensitivity. Detectors 3 and 8 are still not functioning. NIMS now returns only 12 useful wavelengths.

The NIMS processor halted twice during the G28 Encounter. No NIMS observations were lost due to these halts.

The spacecraft did not safe during the G28 Encounter but did suffer two Bus Resets which precipitated the two NIMS halts.

Stuck Grating (from the I24 NIMS Guide)

At I24, NIMS experienced a fundamental change in the way that it operates. Sometime between C22 and I24, the NIMS grating became stuck at a position corresponding to a pshift of about 14.5. This unusual grating position produces wavelengths for each detector far shorter than previously used. With the stuck grating, NIMS is permanently in a "fixed grating" mode. At this new grating position, Detectors 1, 2 and 7 return very low DN, as their new wavelengths are outside of the passband of their blocking filters and therefore are of minimal use. As before, detectors 3 and 8 are still not functioning.

There is no ground calibration for the wavelengths corresponding to this pshift. Flight calibration was derived from the I24 RCT and PCT calibrations. Details of this new flight calibration will be discussed in the as yet unpublished NIMS calibration report.

The spectral capability of the NIMS instrument shrank from 408 wavelengths to 17 wavelengths with the stuck grating. Now all commanded modes, Long Map, Full Map, Short Map or Fixed Map, select the same 17 wavelengths. Two effects of the stuck grating have been put to good use: spatial editing and noise reduction.

Even though the grating is stuck, the grating cycle still plays an important role. The playback edit table can now be used for spatial data editing. In Long Map mode, each mirror scan can be selected or deselected using the playback edit table. This allows a range of spatial density versus areal coverage choices.

If an observation is performed in Long Map mode at the Long Map scan rate, the 24 mirror scans over a single grating cycle can be averaged together to increase the signal to noise level. The adverse effects of the high levels of radiation-induced noise encountered close-in to Jupiter are greatly alleviated by this averaging.

Response to Stuck Grating Anomaly (G28)

At G28 the cause of the stuck grating was not known (and is still not clearly understood). No attempts were made during G28 to unstick the grating.

NIMS Anomaly Report - G28 Sequence

Processor Halts

There were two NIMS processor halts during G28. The halts were inferred from the occurance of two CDS Bus Resets. In the CDS recovery process from the bus interrupts, NIMS loses RTI synch with CDS, causing NIMS to halt. Both Bus Resets occurred outside of NIMS observations. Each NIMS observation was preceded by a NIMS Software reload so that no NIMS observations were lost due to the halts.

Spacecraft Anomaly

During the G28 encounter a pair of standard bus resets occurred and were handled normally by the on-board recovery software without any effects on the planned sequence. The first occurred at about D142/02:45 and the second at about D142/16:23.

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.