Chapter 7 - Data Return

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Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E17 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E17 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.

There were thirteen autonomous reloads of the NIMS RAM code from CDS during the E17 encounter, one just before each science observation. No observations in E17 were lost due to NIMS 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 spacecraft suffered an AACS fault trip early in the encounter which put the spacecraft into cruise mode. As a result, the entire E17 encounter was executed in cruise mode. No other AACS upsets occurred during the encounter.

Spacecraft safing during the E18 encounter caused a good portion of E17 data not to be recorded over in E18. Thus, additional E17 data were returned during E18 playback.

The plots on the pages 3 and 4 show the geometry of the NIMS E17 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 and 6 summarize the 'final' playback model for the 'returned' E17 data during E17 and E18 cruise.

The text on page 7 gives a 'recap' of the E17 playback events which affected which observations were returned.

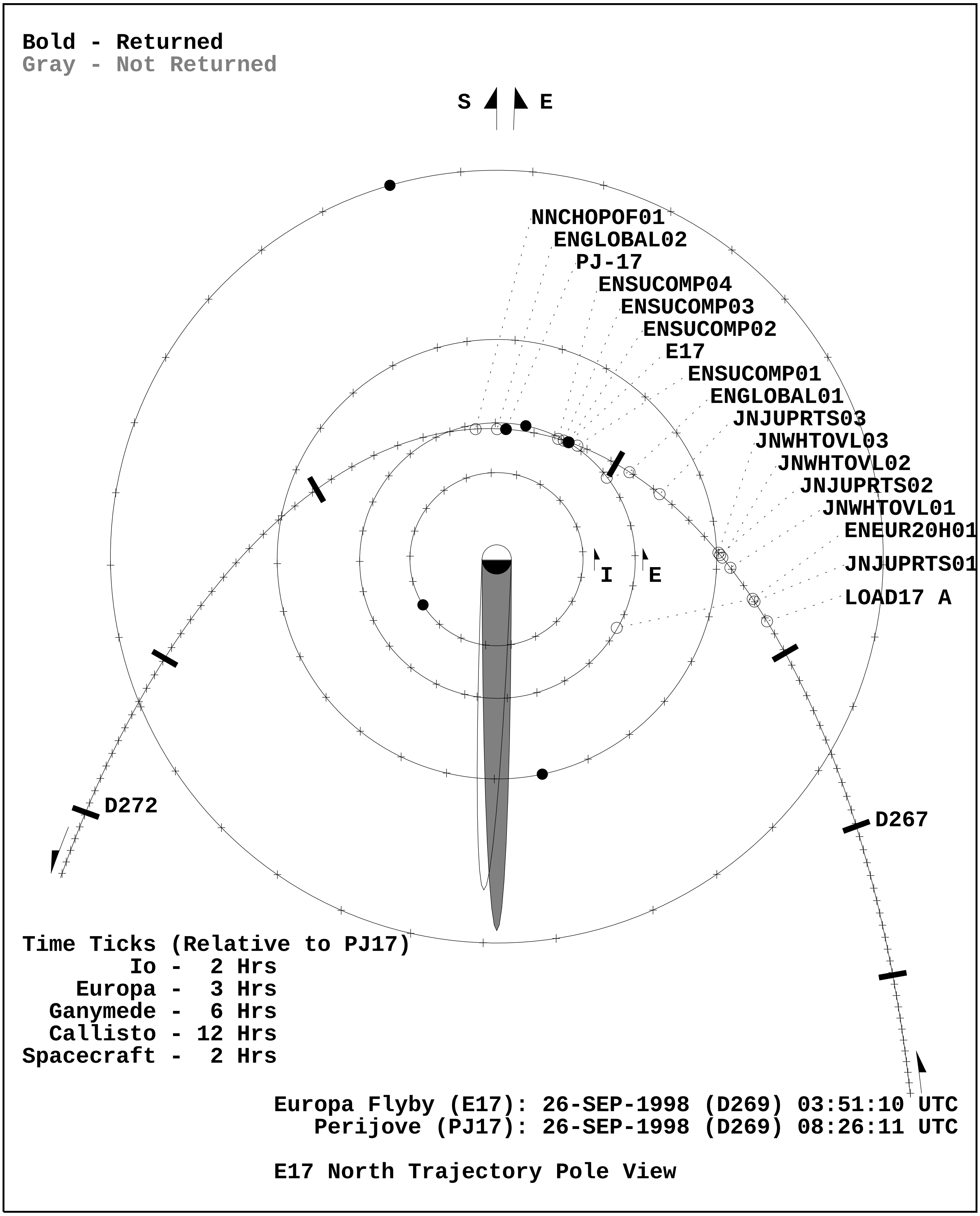
A Timeline of E17 playback events is on pages 8 through 14.

The text on page 15 describes the E17 NIMS and Spacecraft 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 E17 OBSERVATIONS

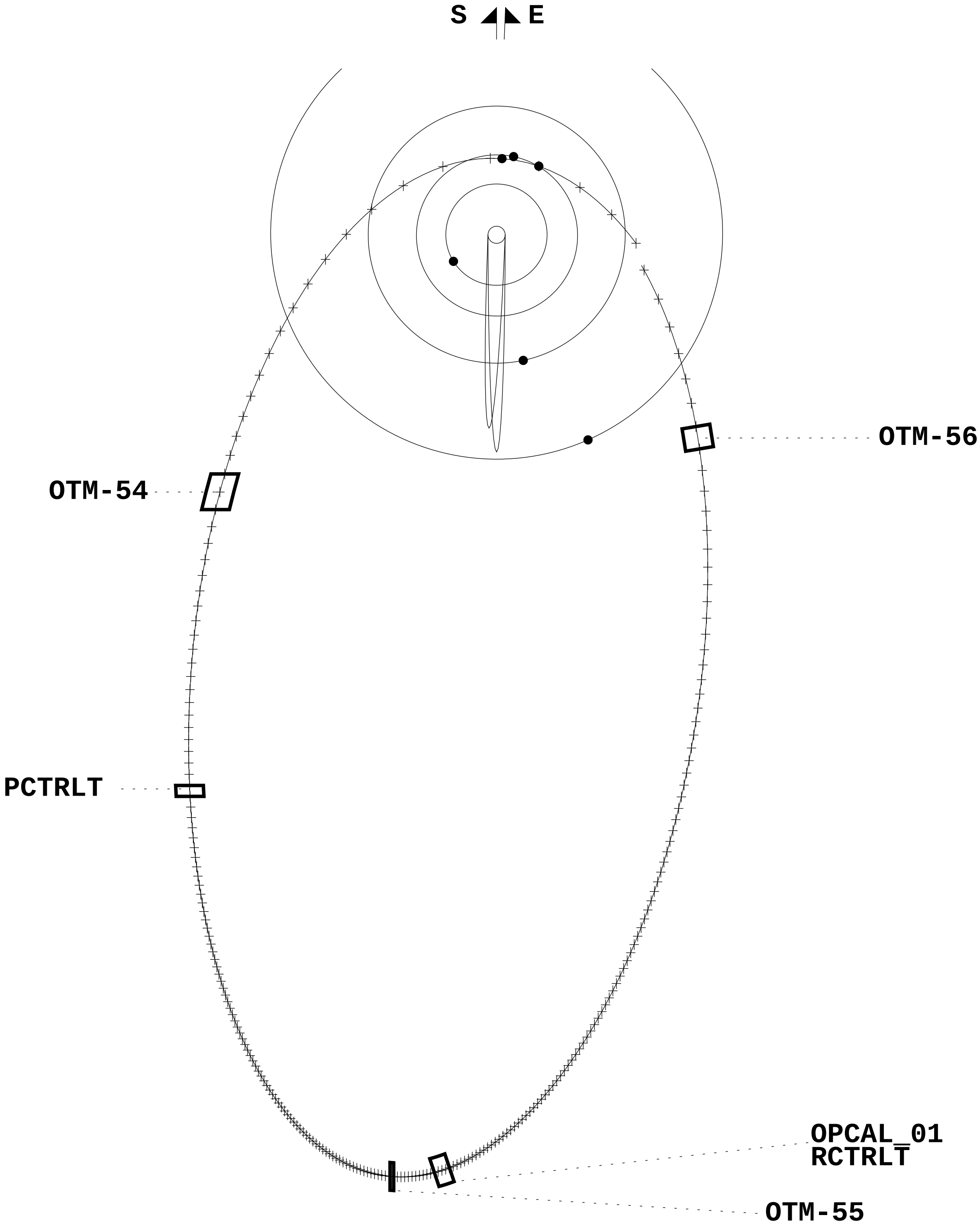


NIMS - FEL - 12/06/99

NIMS E17 CRUISE CALIBRATIONS

Europa Flyby (E17): 26-SEP-1998 (D269) 03:51:10 UTC
Perijove (PJ17): 26-SEP-1998 (D269) 08:26:11 UTC
Apojove (AJ17): 24-OCT-1998 (D297) 16:00:00 UTC

Time Ticks (Relative to E17)
Spacecraft - 6 Hours



E17 North Trajectory Pole View, Perijove to Perijove

NIMS E17 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
17JNJUPRTS01*	Jupiter Realtime Observation	E17JLM408/MB	R/T	LM	2	0	4	R/T	
17ENEUR20H01	Europa 20 Hour Map	E17B_ELM240T	E17B_ELM240T	LM	4	0	4	LPU	
17JNWHTOVL01-	Jupiter White Oval	E17JSB253B	E17JSB66B	LM	4	0	4	LPU	
17JNJUPRTS02*	Jupiter Realtime Observation	E17JLM408/MB	R/T	LM	2	0	4	R/T	
17JNWHTOVL03-	Jupiter White Oval	E17JSB253B	E17JSB253B	LM	2	0	4	LPU	
17JNJUPRTS03*	Jupiter Realtime Observation	E17JLM408/MB	R/T	LM	2	0	4	R/T	
17ENGLOBAL01-	Europa Global Observation	E17ELM442	E17B_ELM228C_1	LM	3	0	4	MPW	
17ENSUCOMP02-	Europa Surface Composition	E17ELM442	E17ELM360	LS	4	0	4	MPW	
17ENSUCOMP04-	Europa Surface Composition	E17ELM442	E17ELM360	LM	4	0	4	MPW	
17ENGLOBAL02-	Europa Global Observation	E17ELM442	E17ELM360	LM	3	0	4	MPW	
17NNPCTRLT01-	NIMS Real-Time PCT Claibration	E17PCT252	R/T	LM	4	0	4	R/T	
17NNRCTRLT01-	NIMS RCT Real-Time Calibration	E17RCT252	R/T	LM	1	0	4	R/T	
17NNROPCAL01-	NIMS OPCAL	E17OPCAL48	R/T	LM	4	0	4	R/T	
17ENEUR20H01	Europa 20 Hour Map	E17B_ELM240V	E17B_ELM240V	LM	3	0	4	LPU	
17JNWHTOVL02-	Jupiter White Oval	E17JSB253B	E17JSB66B	LM	4	0	4	LPU	
17ENGLOBAL01-	Europa Global Observation	E17ELM442	E17B_ELM228C_1	LM	3	0	4	MPW	
17ENSUCOMP01-	Europa Surface Composition	E17ELM442	E17ELM360	LM	4	0	4	MPW	
17ENSUCOMP02-gf	Europa Surface Composition	E17ELM442	E17ELM360	LS	4	0	4	MPW	
17ENSUCOMP03-	Europa Surface Composition	E17ELM442	E17ELM360	LM	4	0	4	MPW	
17ENGLOBAL02-	Europa Global Observation	E17ELM442	E17ELM360	LM	4,3,4	0	4	MPW	
gf = gap fill									
E18 Playback Period									
17ENSUCOMP01-gf	Europa Surface Composition	E17ELM442	E17ELM360	LM	4	0	4	MPW	
17ENSUCOMP02-gf	Europa Surface Composition	E17ELM442	E17ELM360	LS	4	0	4	MPW	
17ENSUCOMP03-gf	Europa Surface Composition	E17ELM442	E17ELM360	LM	4	0	4	MPW	

NIMS E17 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec.)	PB Time (sec.)	Selected Bits of Tape sBOT (MBITS)	Total Bits of Tape (Mbit)	Mode Cycle (sec)	Comp	Thold	RT BTG Mbits	Total BTG Mbits (4% ohead)	Data Reduct Factor (sBOT/BTG)	Pass
17JNJUPRTS01	LM	R/T	408								0.16			
17ENEUR20H01	LM	LPU	240	219	219	1.35	1.35	8.667	1.65	0		0.764	1.77	1
17JNWHTOVL01	LM	LPU	66	602	600	3.70	3.71	8.667	1.91	0		0.498	7.44	1
17JNJUPRTS02	LM	R/T	408					8.667			0.16			
17JNWHTOVL03	LM	LPU	253	602	600	3.70	3.71	8.667	2.71	0		1.344	2.75	1
17JNJUPRTS03	LM	R/T	408					8.667			0.16			
17ENGLOBAL01	LM	MPW	228	2700	1321	15.22	31.10	8.667	1.53	0		4.724	3.22	1
17ENSUCOMP02	LM	MPW	360	1020	1018	11.73	11.75	8.667	1.46	0		6.024	1.95	1
17ENSUCOMP04	LM	MPW	360	600	590	6.80	6.91	8.667	1.61	0		3.166	2.15	1
17ENGLOBAL02	LM	MPW	360	1800	437	5.03	20.74	8.667	1.37	0		2.756	1.83	1
17NNPCTRLT01	LM	R/T	252								0.2			
17NNRCTRLT01	LM	R/T	252								0.14			
17NNOPCAL01-	LM	R/T	48											
17ENEUR20H01	LM	LPU	240	271	271	1.67	1.67	8.667	1.63	0		0.958	1.75	2
17JNWHTOVL02	LM	LPU	66	602	600	3.70	3.71	8.667	1.98	0		0.480	7.71	2
17ENGLOBAL01	LM	MPW	228	2700	1360	15.67	31.10	8.667	1.98	0		3.758	4.17	2
17ENSUCOMP01	LM	MPW	360	1200	1160	13.36	13.82	8.667	1.28	0		7.830	1.71	2
17ENSUCOMP02	LM	MPW	360	1020	66	0.76	11.75	8.667	1.46	0		0.391	1.95	2
17ENSUCOMP03	LM	MPW	360	1320	1313	15.13	15.21	8.667	1.29	0		8.794	1.72	2
17ENGLOBAL02	LM	MPW	360	1800	1310	15.09	20.74	8.667	1.4	0		8.084	1.87	2
Total Resources												49.57	Total	
												52.91	Allocated	
												-3.339	Over/Under	
17ENSUCOMP01	LM	MPW	360	1200	217	2.50	13.82	8.667	1.3	0		1.442	1.73	2
17ENSUCOMP02	LM	MPW	360	1020	66	0.76	11.75	8.667	1.46	0		0.391	1.95	2
17ENSUCOMP03	LM	MPW	360	1320	283	3.26	15.21	8.667	1.3	0		1.881	1.73	2
												3.714	E18 Total	

RECAP OF E17 PLAYBACK EVENTS

NIMS Data return in E17 was greater than for any other orbit of the Galileo Europa Mission (GEM). Just under 50 Megabits were brought down during the E17 cruise period, with an additional 3 Mbits coming down during E18 (see the E18 NIMS Guide).

At the beginning of the encounter sequence, a fault monitor tripped, indicating a problem with the spacecraft gyros. This caused the spacecraft to transition from inertial mode (preferred, for NIMS, since spacecraft wobble is compensated), to cruise mode. The sequence thereafter executed as planned.

Early in the sequence we received information that the NIMS software had crashed. No recorded observations were affected, as a routine software reload preceded our next observation.

We lost a significant quantity of our downlink capability late in the playback (cruise) period, as anomaly recovery activities on the Deep Space 1 and Voyager spacecraft required tracking by DSN stations during times that had been previously allocated to Galileo.

The following timeline details the most signifigant events of the E17 playback period. Most of the text below is excerpted from messages issued at the time.

<u>E17 Playback Events Timeline</u> (07-22-98: to 11-21-98:)

07-22-98: In light of the loss of E16 observations of Europa, SSI is considering reconfiguring some of their E17 observations to cover targets lost in E16. NIMS could do the same. There is not a great deal of time available to accomplish this, if we wish to. If you favor some particular lat/lon(s) as high priority target(s) here please let us know.

08-13-98: (J. Gross) NIMS playback allocation is 50.613 Mbits.

08-14-98: This is the first delivery of the E17 playback table. NIMS has four Europa surface composition observations and two large Europa global observations in this orbit. As a result of some brilliant negotiations by Marcia Segura we were able to add a pair of distant, leading side Europa observations, and three new observations of the newly-merged Jupiter white oval. In addition we have RCT and PCT calibrations and three Jupiter realtime observations.

08-20-98: The subject of the pointer designs and NIMS mode for 17ENSUCOMP02 and 03 was discussed in today's NIMS team meeting at noon. The decisions regarding pending design changes were:
17ENSUCOMP02: Retain current pointer design (8/6/98 version) but change mode to long spectrometer.
17ENSUCOMP03: We will NOT change from 1 scan to two scans for this observation; that is, the pointer design from 8/6/98 will be employed.
The reasons for these decisions are intertwined. The as-is, 1-scan design for 17ENSUCOMP03 includes brighter territory at longitudes 120-150 that encompasses the area imaged by 17ENSUCOMP02 (centered at 120 W, 65 S). This makes the two observations complementary, a benefit that would be lost in the 2-scan plan.

09-09-98: The NIMS E17 PBT is ready to fly. We have one more update (next week) before uplink.
A number of minor timing changes were made to complete the fine-tuning of the table, and correct playback wavelength tables were entered/verified.
17ENGLOBAL02 will be recorded at the end of the sequence, near perijove. To get information on compression for this observation we are bringing back the second scan (of 4) in the first pass over the tape. The pointer plot for this observation shows several scans of dark sky. We are retaining these to obtain dark values.
We presently have about 1 Mb of unused downlink allocation, after increasing playback of the visible part of 17ENEUR20HR01 to the full 240 wavelengths. The unused portion is being held to cover compression uncertainties.

<u>E17 Playback Events Timeline</u> (07-22-98: to 11-21-98:)

09-16-98: **E17 playback will initiate in less than 2 weeks. The only significant change this week involved a modification to the plan for the two large Europa global observations. 17ENGLOBAL01 views longitudes we have already seen but will provide polar coverage we lack. 17ENGLOBAL02 views leading-side longitudes only seen in E15.**
Unfortunately 17ENGLOBAL02 will have booms (cone angles about 75 degrees) and is taken near perijove in what may be a noisy environment. Compression for both is somewhat optimistically estimated at 1.5. If either compresses poorly, significant revisions to the playback plan will be required.
Logistically there is the potential problem that pass 1 17ENGLOBAL02 may not be down before decisions about pass 2 17ENGLOBAL01 have to be finalized. On the plus side, 17ENGLOBAL02 should be the last observation to be played back in pass 2, and may benefit from the release of margin bits.
The current strategy is to play back the two polar scans of 17ENGLOBAL01 in pass 1 (since these have highest priority).
The two equatorial scans remain in the playback plan in pass 2. For 17ENGLOBAL02, we will return a single scan in pass 1 to evaluate the data quality and get compression values. Since we have sufficient allocation, we will command 360 wavelengths (rather than the standard 228) for this scan.
The balance of the observation (pass 2) is currently planned with 228 wavelengths, but this is mutable.

09-25-98: **(R. Lineaweaver) ** E17 encounter activities ****
Gyros tripped off, aborted to cruise 6 seconds after first 7SCAN command in E17A. Scan Platform safed at that time but since sequence continues, subsequent scan platform cmds executed. Commands were sent to MRO the gyro data and AACS fault max counter array, re-enable data compression for PWS, and Clear the fault code & sysfault. Unless AACS sees something obvious in the MRO's that explains the anomaly, we will not transition back to inertial mode.

09-25-98: **(J. Erickson) Late in the evening of September 24, an AACS fault changed the spacecraft configuration from operating the scan platform in inertial mode (which allows gyro correction of any spacecraft wobble present) to a mode where the star scanner is the primary attitude reference.**
The cause of this anomaly is under investigation, and it is expected that the encounter will be performed with the star scanner as the primary attitude reference. The lack of gyro correction will primarily affect the Near Infrared Mapping Spectrometer's observations, degrading their resolution.

E17 Playback Events Timeline (07-22-98: to 11-21-98:)

09-25-98: (R. Mehlman) According to SCLK monitor data returned at 16:09 today (268/23:09 ERT) the NIMS instrument software halted at SCLK 4666170 (~268/19:00 SCET, reported to CDS at 4666390, 22:35 SCET).
The halt is 4 hours before the beginning of the 17ENGLOBAL01 observation, which is preceded by a software reload. It is also 9 hours before Europa closest approach and 13 1/2 hours before Jupiter closest approach, which makes it perhaps the earliest halt yet, and therefore not a particularly good sign.

09-26-98: Europa close approach occurs at 03:51:10 UTC.

09-26-98: (R. Mehlman) Three samples of the NIMS SCLK monitor have been received since the observed (but harmless) halt. Two of these were between 17ENGLOBAL01 and 17ENSUCOMP01, the third was right after 17ENSUCOMP04. All that remains in the NIMS encounter is 17ENGLOBAL02, immediately following the closest approach to Jupiter.

09-26-98: Perijove occurs at 08:26:11 UTC, followed at 09:12:03 by 17ENGLOBAL02.

10-06-98: E17 playback is progressing as planned. For the next 2+ weeks only SSI data will be played back. The newest schedule shows our next observation, 17ENSUCOMP02, coming down on 22 October (Thursday). Compression has been somewhat better than predicted, suggesting a relatively low noise environment for the inbound observations. A first look at the polar scans of 17ENGLOBAL01 reveals no obvious "torque spikes". These were painfully plentiful in the global observation in E15. As anticipated we will not receive data from 17ENGLOBAL02 early enough to enable us to make changes to our pass 2 playback of 17ENGLOBAL01, should we wish to. This means that if 17ENGLOBAL02 is ratty or noisy, we cannot shift resources to the other observation. Currently we expect to get all of 17ENGLOBAL01 at 228 wavelengths (nothing wrong with that), and we should get most or all of 17ENGLOBAL02 at 360 wavelengths.

10-23-98: (J. Gross) After analyzing the inefficiency we've received and what we expect from here 'til Terminate, we have decided to release 4.0 MB of inefficiency margin. This leaves us 5.24 MB to cover our worst-case inefficiency the rest of the way. Since MWG has no recorded data, the 4.0 MB was divided up among remote-sensing teams. The increases by team, according to OPG percentages, are:

SSI	2.98 MB
NIMS	0.90 MB
PPR	0.06 MB
UVS	0.06 MB

Additionally, we are releasing the remaining office margin to the team with the last observation on the tape, NIMS. Since we only have about 3.5 weeks of PB left, and at most three updates, we decided this was the appropriate time to give NIMS these bits. Originally there 2.0 MB of office margin being held. The addition of the AACS slew-test on DOY 311 and the early Resume Playback after OTM-55 result in a net loss of 0.3 MB. That leaves 1.7 MB of office margin for NIMS. Therefore the new allocations by teams are:

TEAM	NEW PB ALLOC	OLD PB ALLOC
SSI	173.182	170.202
NIMS	52.848	50.248
PPR	3.442	3.382
UVS	2.891	2.831

10-26-98: (J. Gross) As you're probably aware of by now, we entered a limited search yesterday morning after resuming PB following the scheduled DMS Conditioning. The total period of time for which we were without playback was 20.5 hours.

The first 6.5 hours is how long it would have taken the DMS to slew from Track 1, Tinc 200 (the normal post-DMS conditioning location) to Track 3, Tinc 5636 (the location of the DMS when we paused for the conditioning). There is nothing we could do about losing this 6.5 hours. There is also no way to account for it ahead of time because it is impossible to know where the tape will be located when we pause playback.

The next 14 hours is the amount of time the DMS slewed while looking for data in the active time window. We slewed to the end of track 3, all the way down track 4, transitioned back up to track 3, and slewed down to Tinc 5636 before PB resumed. The cost of this 20.5 hours of slewing is 2.75 MB. So, remember that 4.0 MB of inefficiency margin that I released on Friday? Well, I'm taking back 2.75 MB of it. The new PB allocations by team are as follows:

TEAM	NEW ALLOC	OLD ALLOC
SSI	171.133	173.182
NIMS	52.229	52.848
PPR	3.401	3.442
UVS	2.850	2.891

10-28-98: Today's update affects data to be played back in the second pass over the tape. Several new developments have contributed to the changes made. First, the office decided to release margin held for slewing inefficiency. Over the weekend, however, following the DMS (tape recorder) conditioning exercise, the recorder failed to find the data it expected, and went into limited search mode. After 20.5 hours of slewing, it arrived at the proper time /observation, and began playing back data.

This event cost us about 2.75 Mb of capability, consuming a large part of the 4.0 Mb that had been released. We received a small increase in allocation as a result of these events. More significantly, the playback coordinator released the 1.7 Mb of margin that was being held to protect our last observation (17ENGLOBAL02) to us.
As a result we have been able to increase playback wavelengths for the remaining 3/4 of 17ENGLOBAL02 from 228 to 360. (We had previously hoped to do so, and the first portion of the observation is presently coming down with 360 wavelengths as well).
In addition we have added commands to fill a gap in 17ENSUCOMP02. This amounts to about .25 Mb. Following these changes, we still have about 0.7 Mb of unused capability to act as insurance that all of our data will come down.

10-28-98: The cause of the limited search was a buildup of uncertainty in the tape position estimate used by CDS. An unusually large number of data "gulps" (230) were commanded on Track 3, resulting in a large accumulated error in calculated tape position.

11-04-98: E17 playback was proceeding smoothly until our second pass playback of 17ENGLOBAL01. There are 7 significant gaps in the portion that has come down this week, some on the order of 20 packets in size. This is particularly unfortunate because 17ENGLOBAL01 was obtained under relatively low noise conditions, and is one of our few global observations where we are obtaining complete pole-to-pole coverage.
Two large higher-resolution Europa observations have come down with better-than-expected compression. These are 17ENSUCOMP02 and 04. Our present situation is that we have fully selected the NIMS data remaining on the tape through the end of pass 2, and we have > 1 Mbit of unused downlink allocation at the present time. This may grow a bit since we have two additional high-resolution SUCOMPs to come down soon. These may also overcompress.
As a result we are proposing a third pass over the tape to retrieve the data that was lost this week (17ENGLOBAL01). This would be quite painless to implement since the start of our 17ENGLOBAL01 data is only 1500 tics from the end of our current pass 2 playback, on the same track. Thus less than 2 hours of slewing will be required to position the tape for the pass 3 playback.
Changes to the playback table this week include a few changes in data reduction factors, to reflect our pass 1 knowledge of compressions, and the addition of 3 additional gap-fill singles pairs to complete our spatial and wavelength coverage of 17ENSUCOMP02. This long-spectrometer mode observation of high southern latitudes has good signal to noise. However, since we were in cruise mode while it was obtained, there is some spatial smearing of features due to the less-accurate pointing.

<u>E17 Playback Events Timeline</u> **(07-22-98: to 11-21-98:)**

11-08-98: **(W. Currie) The AACS Slew Test to recreate E17A executed nominally, E17A was successfully recreated. A gyro high rate fault trip caused FM 28 to trip 6 seconds into the slew. Analysis of the flood mode and high rate telemetry data is underway. Playback resumed after the test as expected since data compression was re-enabled in the RBS. Several cleanup commands will need to be sent real time in the next few days.**

11-09-98: **(J. Gross) Well, we're down to the very end of playback. We have less than two weeks to go, and our final update is this Wednesday. So this seems to be the right time to give out our remaining margin. Factored into this release is the amount of inefficiency we've received since the limited search on Oct 24-25, the undercompression of UVS data, and an estimate of our remaining inefficiency. That leaves 3.0 MB to give out today. PPR indicated that they have no need for more BTG, so the 3.0 gets split among SSI, NIMS, and UVS.**

11-11-98: **This is the final update for E17. Playback will terminate next Friday. The Project graciously agreed to let us have a 3rd pass over the tape in order to best utilize our downlink bits.**
The main problem addressed in this update derives from the many hardware problems currently being experienced by the DSN. Performance has been particularly bad this week. As a result ten new sets of playback commands were added to fill the 14 gaps in pass 2 playback of 17ENSUCOMP01. In addition, as noted last week, there are also 6 significant gaps in 17ENGLOBAL01, which are being handled with 4 new sets of playback singles.
We received an additional 0.68 Mb of downlink allocation with the release of the remaining margin. In our current model, we show about 1.0 Mb of downlink allocation remaining after we finish returning all our remaining observations and gap fills. In a perfect world we would be certain to get all our bits down. However, as of this afternoon, Deep Space 1 has taken over one of our DSN-63 passes to deal with an anomaly (reportedly with the ion engine). We do not know how much of our remaining downlink will be ceded to DS1. Thus there are no guarantees (not that there ever were).
I neglected to mention one additional category of new playback singles added to this week's table. The Playback Coordinator, Jerod Gross, and I think that the spacecraft is currently sending down our pass 2 gap fill singles for 17ENSUCOMP02, even though the DSN is listening elsewhere. Thus, at the end of the table, you will find a duplicate set of 4 playback singles commanding return of the same data selected in pass 2. (These have new PSIDs and pass numbers).

<u>E17 Playback Events Timeline</u> (07-22-98: to 11-21-98:)

11-20-98: **(J. Erickson) Playback will terminate on Friday afternoon. We have lost about 12.5 Mbits due to station reallocation to VGR2 and DS1. This represents about 5% of the total capability for this orbit. Even with these losses, we expect to just finish with Pass 2 playback by the time we terminate. Unfortunately, we will lose our Pass 3 playback to recover significant data gaps in our data.**
The spacecraft slew test was successful in recreating the E17A gyro high rate error. The telemetry gathered during the test is being analyzed but has not yet yielded a solution. Four seconds into the slew, the gyro rate accelerates quickly to greater than 2.5 degrees per second. The first conclusion from these data are that the problem is in the electronics and that the gyros are not physically seeing the high rates reported in the telemetry channels.

11-21-98: **Playback terminates prior to playback of pass 3 gap fills.**

NIMS Anomaly Report - E17 Sequence

There was no NIMS processor halts detected during the E17 Encounter. Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

Also, the spacecraft suffered an AACS gyro fault trip that put the spacecraft into Cruise mode. The entire E17 encounter was executed in Cruise mode, instead of Inertial mode.

E17 AACS Anomaly

Near the beginning of the E17 encounter, an AACS fault cause the spacecraft configuration to change from operating the scan platform in inertial mode (which compensates for spacecraft wobble) to Cruise mode where the star scanner is the primary attitude reference. Since the cause of the anomaly was unknown at the time, the project decided to let the entire E17 encounter execute in Cruise mode.

The gyros tripped off, safed the scan platform and aborted to Cruise mode 6 seconds after the first 7SCAN command in E17A. The rest of the encounter went smoothly without any more AACS upsets.

Analysis of the gryos during E17 cruise point to the gyro electronics as being the cause of the fault trip.

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.