Chapter 7 - Data Return

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Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E14 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E14 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 twelve autonomous reloads of the NIMS RAM code from CDS during the E12 encounter, one just before each science observation. A single NIMS processor halt was detected, but no NIMS observations were lost due to this halt. 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.

AACS was in Cruise Mode during the entire E14 encounter period. Spacecraft wobble compensation is not active in Cruise Mode. This state of uncompensated wobble makes it more difficult to reconstruct geometrically projected NIMS spectra. The decision to have AACS in Cruise Mode during E14 encounter was due to a conservative response to the AACS anomalies that occurred in E12.

The plots on the pages 3 and 4 show the geometry of the NIMS E14 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' data.

The text on page 7 gives a 'recap' of the E14 playback events which affected which observations were returned.

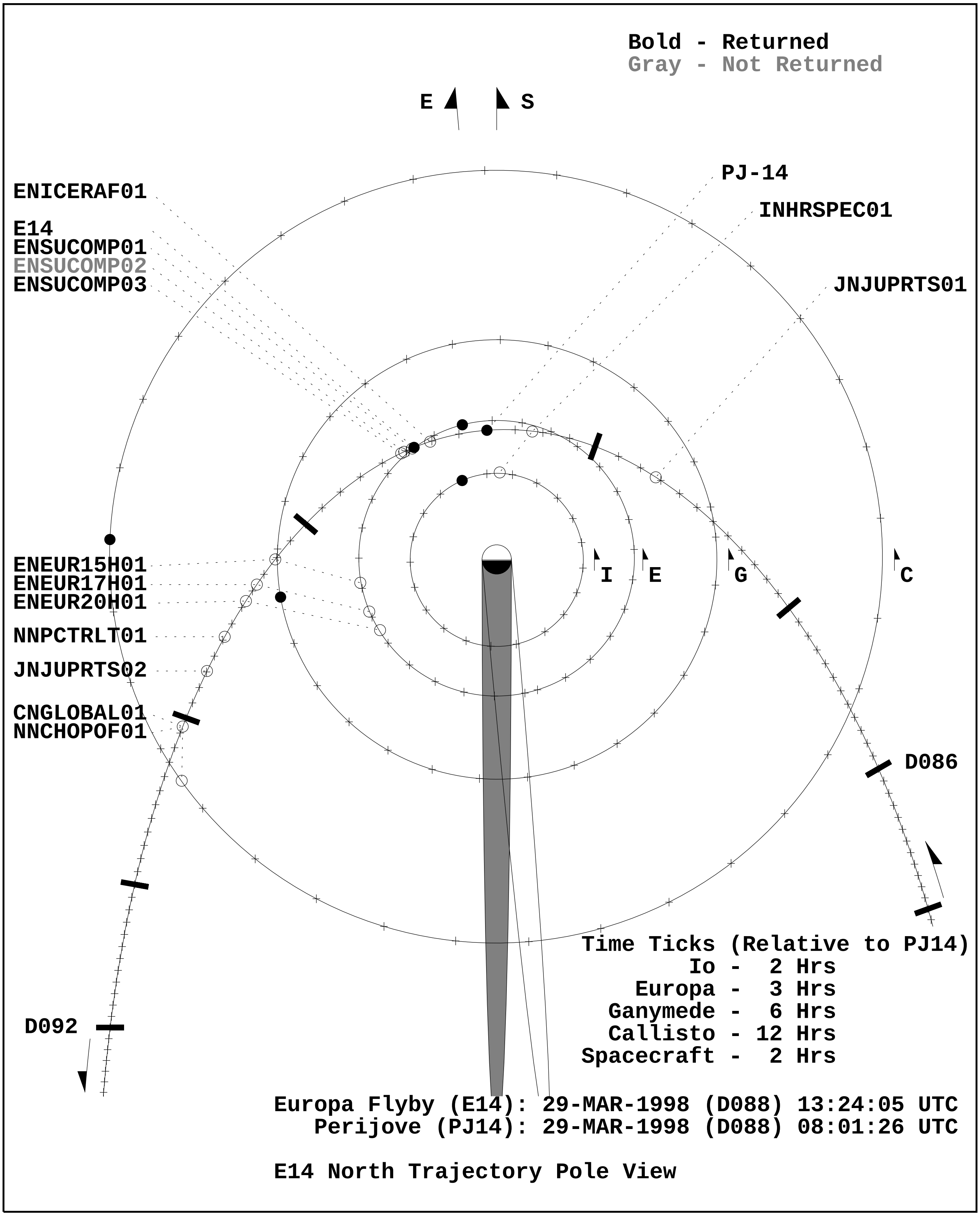
A Timeline of E14 playback events is on pages 8 through 11.

The text on page 12 describes the E14 NIMS Anomalies.

The text on page 13 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 14 and 15.

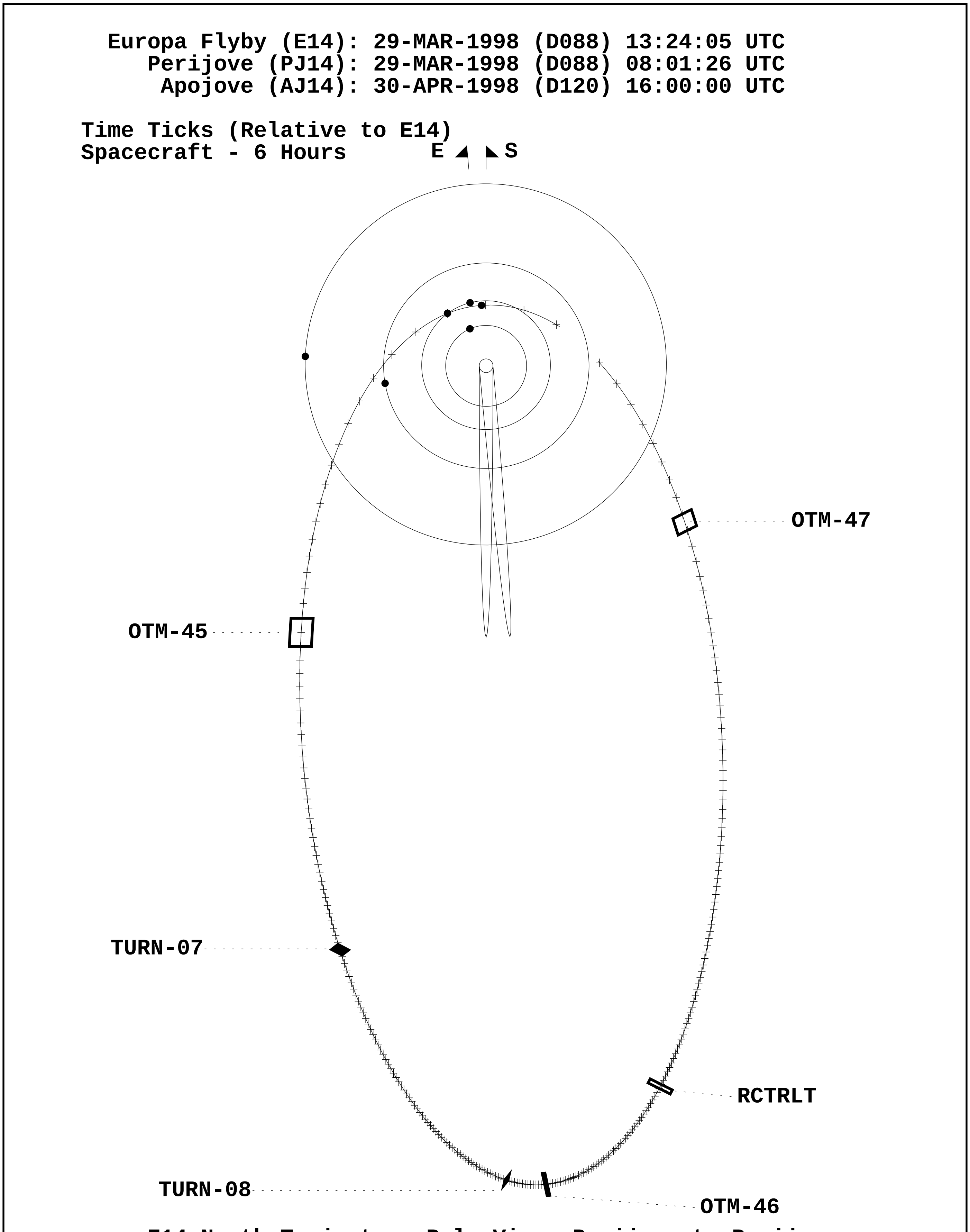
The text on page 16 is a guide to understanding the NIMS MASK.

NIMS E14 OBSERVATIONS



NIMS - FEL - 12/06/99

NIMS E14 CRUISE CALIBRATIONS



E14 North Trajectory Pole View, Perijove to Perijove

NIMS E14 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
14JNJUPRTS01*	Jupiter Realtime Observation	E14JLM442/MB	R/T	LM	2	0	4	R/T	DA
14INHRSPEC01-	Io Monitoring at High Spectral Resolution	E14ILM442	E14B_ILM324	LM	2	0	4	MPW	DB
14INHRSPEC01_B-	Io Monitoring at High Spectral Resolution	E14ILM442	E14B_ILM36	LM	2	0	4	MPW	DB
14INHRSPEC01_C-	Io Monitoring at High Spectral Resolution	E14ILM442	E14ILM360	LM	2	0	4	MPW	DB
14ENICERAF01-	Europa Ice Rift	E14ELM442	E14ELM360	LM	2	0	4	MPW	DC
14ENSUCOMP01-	Europa Surface Composition	E14ELM442	E14ELM360	LM	2	0	4	MPW	DD
14ENSUCOMP01_B-	Europa Surface Composition	E14ELM442	E14ELM360	LM	2	0	4	MPW	DD
14ENSUCOMP03-	Europa Surface Composition	E14B_ELS442	E14B_ELS360	LS	2	0	4	MPW	DF
14ENEUR15H01-	Europa Obs at Plus 15 Hours	E14B_ELM240V	E14B_ELM168V	LM	3	0	4	LPU	DI
14ENEUR15H01-	Europa Obs at Plus 15 Hours	E14ELM442	E14B_ELM240T	LM	4	0	4	MPW	EI
14ENEUR17H01-	Europa Obs beyond 17 Hours	E14B_ELM240T	E14B_ELM240T	LM	4	0	4	LPU	EJ
14ENEUR20H01-	Europa Obs beyond 20 Hours	E14B_ELM240T	E14B_ELM240T	LM	4	0	4	LPU	EK
14NNPCTRLT01-	NIMS PCT Real-Time Calibration	E14PCT252	R/T	LM	1	0	4	R/T	XE
14JNJUPRTS02*	Jupiter Realtime Observation	E14JLM442/MB	R/T	LM	2	0	4	R/T	DG
14CNGLOBAL01_A*	Callisto Global Map	E14CLM243C	E14B_CLM15C	LM	4	0	4	LPU	DH
14CNGLOBAL01_B*	Callisto Global Map	E14CLM243C	E14CLM228C	LM	4	0	4	LPU	DH
14CNGLOBAL01_C*	Callisto Global Map	E14CLM243C	E14 CLM228C	LM	4	0	4	LPU	DH
14CNGLOBAL01_D*	Callisto Global Map	E14CLM243C	E14CLM228C	LM	4	0	4	LPU	DH
14CNGLOBAL01_E*	Callisto Global Map	E14CLM243C	E14B_CLM15C	LM	4	0	4	LPU	DH
14NNRCTRLT01-	NIMS RCT Real-Time Calibration	E14RCT252	R/T	LM	1	0	4	R/T	XE

NIMS E14 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths ret.	Record Time (sec)	PB Time (sec)	Sel Bits of Tape sBOT (Mbits)	Total Bits of Tape BOT (Mbits)	Mode Cycle Time	Thold	Comp	Total BTG Mbits (4% ohead)	Data Reduct Factor	Pass
14JNJUPRTS01	LM	R/T	360										
14INHRSPEC01	LM	MPW	324	1113.3	481	5.54	12.83	8.667	2	1.27	2.9450	1.88	1
14INHRSPEC01	LM	MPW	36	1113.3	481	5.54	12.83	8.667	2	1.32	0.3148	17.60	1
14INHRSPEC01	LM	MPW	360	1113.3	484.3	5.58	12.83	8.667	2	1.23	3.4020	1.64	2
14ENICERAF01	LM	MPW	360	1886.7	121	1.39	21.73	8.667	0	1.52	0.6878	2.03	1
14ENSUCOMP01	LM	MPW	360	1140	460	5.30	13.13	8.667	0	1.50	2.6495	2.00	1
14ENSUCOMP01	LM	MPW	360	1140	467	5.38	13.13	8.667	0	1.53	2.6371	2.04	2
14ENSUCOMP03	LS	MPW	360	1140	182	2.10	13.13	8.667	0	1.62	0.9706	2.16	1
14ENEUR15H01	LM	LPU	168	290.0	285.4	1.76	1.79	8.667	0	1.61	0.7146	2.46	1
14ENEUR15H01	LM	MPW	240	284.0	283.3	3.26	3.27	8.667	0	1.84	0.8869	3.68	1
14ENEUR17H01	LM	LPU	240	242.7	242.7	1.50	1.50	8.667	0	2.02	0.6919	2.16	2
14ENEUR20H01	LM	LPU	240	205.3	196.7	1.21	1.27	8.667	0	2.00	0.5664	2.14	1
14NNRCTRLT01	LM	R/T	252										
14JNJUPRTS02	LM	R/T	360					8.667					
14CNGLOBAL01	LM	LPU	15	2239.3	868	5.35	13.81	8.667	0	1.57			1
14CNGLOBAL01	LM	LPU	228	2239.3	334	2.06	13.81	8.667	2	1.39	1.3148	1.57	2
14CNGLOBAL01	LM	LPU	228	2239.3	495.3	3.06	13.81	8.667	0	1.82	1.4892	2.05	1
14CNGLOBAL01	LM	LPU	228	2239.3	334	2.06	13.81	8.667	2	1.63	1.1212	1.84	2
14CNGLOBAL01	LM	LPU	15	2239.3	850.7	5.25	13.81	8.667	0	1.66	0.1845	28.44	1
14NNRCTRLT01	LM	R/T	252								0.1700		
											2.6940	Delay	
											23.6393	Total	
											23.3360	Alocation	
											0.3033	Over/Under	

2/22/00

RECAP OF E14 PLAYBACK EVENTS

E14 downlink was severely bit-limited, which is unfortunate because of the remarkably low noise levels encountered and the correspondingly excellent quality of the observations returned.

Due to concerns regarding spacecraft safety and the desire to have a successful encounter, the Project decided to fly the E14 encounter in "cruise mode." In this mode instrument pointing may be somewhat degraded. In all prior orbits, observations were obtained in "inertial mode," which includes an automatic compensation for the spacecraft's rotational wobble. This compensation does not occur in cruise mode. The reason for the change to cruise mode involved changes in the performance of one of the spacecraft's two gyros, which began reporting incorrect positional data in E12. The gyros are not employed in cruise mode.

NIMS experienced one software crash during E14, but no observations were affected. The instrument software was reloaded from CDS memory prior to the following observations, as usual. Near the end of playback, a sequencing error caused the spacecraft to go into safe mode, resulting in the loss of the final 3% of the data commanded for playback in E14.

An unusual strategy was employed for the large observation 14CNGLOBAL01. In the first playback pass, the central portion of the center (of 3) scans was returned with 228 wavelengths. In addition, also in pass 1, the balance of the observation was played back, but with only 15 wavelengths selected. This was to obtain the best possible pointing information (employing limb fitting). In pass 2 the central disk portions of the upper and lower scans were also returned in 228 wavelengths.

Due to the limited downlink bits available, 14INHRSPEC01 was returned with a non-standard playback wavelength table which selected 324 (instead of the usual 360) wavelengths. The complimentary 36 wavelengths were eventually returned when the playback reserve was released.

The following timeline details the most signifigant events of the E14 playback period. Most of the text is taken directly from reports generated at the time.

E14 Playback Events Timeline (02-11-1998 to 05-29-1998)

02-11-98: Here are the initial E14 Playback allocations, and a few comments about them:

1) Relative to the OPG allocations, the total number of bits available in E14 has increased by about 10 MB.
2) To avoid the situation we had in E12, in which allocations have had to be cut during ops because of SEQ's AACS test sequences, we have increased the amount of margin being held in reserve. The 2-pass inefficiency margin remains at 4%, but the Office margin (aka "Paczkowski margin") has increased from 2.0 MB to 5.0 MB. This increase reflects the approximate worst-case cost of doing 2 separate gyro test sequences.
3) The NIMS RTS Usage below reflects a 2.694 MB charge for delaying the start of playback until after the completion of CNGLOBAL01, as called for in the OPG.
(NIMS Playback Allocation = 20.086 Mb).

02-18-98: We have about 10.2 Mbits to spend on Europa. Here is the present strategy, observation by observation:
14ENSUCOMP01: We will get about 2/3 of this highest-resolution observation near -30 latitude and 165-190 W longitude (cost about 4 Mb).
14ENSUCOMP02: Not planned for playback as it is similar to and partially overlaps 14ENICEBRG01.
14ENSUCOMP03: Long spectrometer mode. Spatial coverage cut to the most interesting 3 of 18 Rims recorded. Cost 1.2 Mb
14ENICERAF01: Formerly deselected. Now we plan to retarget this to see the dark linea at 10 N 275 W that was lost due to instrument stoppage in E12. Only 2 Rims planned for return, cost 0.8 Mb.
14ENEUR15H01: Will receive all of both the visible end and thermal range scans. Cost about 2 Mb.
14ENEUR17H01: Will receive only the thermal range scan (detectors 9-17). Cost about .8 Mb.
14ENEUR20H01: Will receive only the thermal range scan (dets 9-17 as above). Cost about .8 Mb.

02-03-98: I've (J. Gross) just finished modeling the MBTG available in the new E14BGA products, and I've got some bad news. Our total capability has gone down by 5.0 MB. Here's a list of reasons why, in no particular order:

1) We lost approx. 24 hrs. of 43 coverage in negotiations with other DSN users,
2) All 3 SITURNs and all 3 OTMs in E14B are now correctly in the sequence at RTE 10, the new rule we have to follow because of the AACS problem, and
3) several stations were converted from 1-way to 2-way.

<u>E14 Playback Events Timeline</u> (02-11-1998 to 05-29-1998)

03-04-98: The playback table delivered today includes all of the modifications to the Europa plan mentioned in the last message. Unfortunately we are forced to make additional cuts of about 1 Mb this time, since E14 science downlink capability went down. The total allocation for NIMS is 21.9 Mb. The following outlines the current status by target, along with our strategy in 2-pass playback.
Io: The full spatial area of 14INHRSPEC01 will be played back, half in pass 1 and half in pass 2. The wavelength table has 324 wavelengths: half-density (Full Map) resolution for detectors 2, 4, and 5, and Long Map (full resolution) for the rest.
Callisto: Some trimming of spatial coverage near the east and west limb resulted in saving enough bits to increase wavelength coverage to the maximum (228 wavelengths in this case).
Europa: The addition of the distant observations (14ENEUR15H01, 17H01, 20H01) has necessitated cutbacks in spatial coverage for the balance of the observations. All of the Europa observations return 360 wavelengths.
14ENICERAF01: Retargeted to see the area of dark linea at 12 N 277 W. Only 2 Rims are planned for return, all in pass 1.
14ENSUCOMP01: The pass 1 portion sees the fresh dark spots / cracks at -29 latitude, 177-185 W longitude. The pass 2 part includes the dark wedge near 171 W. 3.05 and 0.8 Mb respectively.
14ENSUCOMP02: deleted from the plan.
14ENSUCOMP03: Only 3 Rims of this, testing the long spectrometer mode over a dark linea, will come down- all in pass 1.
14ENEUR15H01: Both the visible (168 wavelengths, gain state 3) and thermal (gain 4, 240 wavelengths) scans will come down in pass 1.
14ENEUR17H01: Only the gain state 4 scan will come down, in pass 2.
14ENEUR20H01: Only the gain state 4 scan will be returned, likewise in pass 1.

03-19-98: A new E14 playback table was delivered today. With the exception of Callisto, it contains the plan described by by Jim Shirley in his message on March 4. For Callisto the approach (requested by Marcia Segura and Frank Leader) is to return 1.67 MB in pass 1 and 1.34 MB in pass 2.

03-20-98: (R. Mitchell) The decision has been made that the encounter sequence for the Europa-14 encounter on March 29 will be done without use of the gyros. The consequence of this is that there will be no compensation for spacecraft wobble and nutation, and therefore some degradation of instrument pointing and stability, with the NIMS instrument data being the most affected. SSI data, particularly the high resolution data with short exposures, should see only minimal effects.

<u>E14 Playback Events Timeline</u> (02-11-1998 to 05-29-1998)

03-25-98: NIMS downlink allocation drops to 18.436 Mb.

03-28-98: E14 encounter begins at 13:00 UTC.

03-29-98: Perijove occurs at 08:01 UTC.
Europa encounter occurs at 13:24 UTC.

03-29-98: (R. Mehlman) According to the last SCLK received, the NIMS software halted at ~ 7:36 this morning, local time (day 88, hour 15:36 UTC, SCLK 4409622). This is about an hour after the last data from ENSUCOMP03 was recorded, and half a day before ENEUR15H01.

04-08-98: A new E14 playback table was delivered today. The only difference from the playback table delivered on 03-19-98 is that the NIMPBK time for 14INHRSPEC01 in pass 2 was backed up by 3.333 seconds in order to begin data selection at the start of the grating cycle. Also, the WET ID for 14ENSUCOMP03 was corrected. In the previous delivery we were oversubscribed by 0.161 MB. In this delivery we are undersubscribed by ~0.1 MB since the actual compression of 14INHRSPEC01 in pass 1 (1.29), was higher than the predicted compression (1.20).

04-21-98: NIMS downlink allocation rises to 19.153 Mb

04-22-98: E14 playback has been uneventful so far. Half of 14INHRSPEC01 has come down, along with 2 Rims of 14ENICERAF01 and most of the 8 selected Rims of 14ENSUCOMP01. Radiation noise was relatively low during recording of the Europa encounter observations, and compression is running at about 1.5 versus the 1.3 predicted.
The only changes to the playback table in this update involved removing thresholding for the top and bottom scans of 14CNGLOBAL01. This will provide more wavelengths for limb-fitting (all 15 selected, versus 1 if thresholded). Also, revised compression estimates for remaining Europa observations were entered to permit accurate modeling by the Playback Coordinator.
We received about 0.5 Mb of new downlink allocation as a result of early office margin release and reduced requirements for gyro testing. In addition, savings from good Europa compression, including data down and still to come, amounts to about 1 Mb. Thus we have a total of about 1.5 Mb to spend in this orbit.

05-06-98: Minor changes to the playback table were made to reflect new information on actual compression ratios for Callisto and for the distant Europa observations. The most significant modification involves an increase in the playback of 14ENSUCOMP01, at the expense of 14CNGLOBAL01. 14ENSUCOMP01 is a nice observation with good s/n. By adding just over

2 Rims to the existing playback plan we are able to close a significant gap between the data for the two highest-priority dark features, resulting in a spatially-continuous, single scan observation. To do so we cut a corresponding amount of data from the final playback commands for 14CNGLOBAL01. We will almost certainly be able to reinstate the data affected in a later revision of the playback table; a total of nearly 6 Mb is still being held by the office to support possible gyro anomaly fixes and protect the final observation in E14 playback, which is 14CNGLOBAL01.

05-07-98: (T. Johnson) We have agreed to give up a DSS-43 Canberra tracking pass this Friday 5/8/98, for VLBI observations of a newly identified gamma ray burster. This event has been located in a relatively close galaxy, providing a unique opportunity to characterize the event. Essentially all southern hemisphere radio observatories are dropping their regular programs to observe this event, and VLBI with the DSN stations has unique capabilities. After discussion with Bob Preston, the PI of the VLBI experiment, Jim Erickson and I have agreed that the unique nature of the event justifies the loss to the playback (approx 2 megabits). This loss will be taken out of available margin.

05-27-98: (J. Gross) I forgot to mention - the reason that we're running so far ahead is a combination of continued SSI overcompression and high data-rates. We actually had 4 hours of 120 bps earlier today!
I've created a new playback schedule based on this week's bested data. Much to my surprise, it appears that we're going to make it most, if not all, of the way through our Pass 3 data! The schedule currently shows that we will terminate during the final Pass 3 observation, ESCRATER.
We also have a Pause Playback period tomorrow for OTM-47 that may add an additional 0.1-0.2 MB to our capability, based on the average amount of playback received during Pause Playback periods in E14. The only thing that would prevent us from getting all the way to the end of Pass 3 is if CNGLOBAL significantly undercompresses.

05-29-98: (J. Erickson) The Galileo spacecraft is presently in safing, due to an error in the construction of the Europa-15 approach maneuver sequence. On May 28 the spacecraft executed the majority of the maneuver, before the sequence error caused the spacecraft to abort the on-board sequence and safe itself. The flight team is presently reconfiguring the spacecraft to allow the uplink of the encounter sequence on the evening of May 29.
The navigation team has reviewed the trajectory resulting from the aborted maneuver, and the uncorrected errors will have a minimum impact on the flyby. It is expected that the encounter activities beginning on May 30 will be unaffected by the safing event. The other major activity over the past week was the continued playback of the Europa-14 recorded data. The playback process was halted by the maneuver anomaly, with 97% of the planned data returned.

NIMS Anomaly Report - E14 Sequence

The NIMS processor halted once during the E14 Encounter. Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

Also, due to problems with the gyros, the spacecraft was in AACS Cruise Mode for the entire E14 encounter time period.

Processor Halts

Facts:

0. Between the start of the E14 Encounter and the single Halt NIMS returned 1 realtime observations and successfully reloaded NIMS from CDS 6 times. The NIMS SCLK engineering channels were continuously monitored for detecting a NIMS processor halt.

1. A NIMS processor halt was detected at SCLK 04409622 from the analysis of the NIMS SCLK engineering telemetry channels S-1931 and S-1932. This occurred about 7 hours and 33 minutes after E14 perijove. The subsequent NIMS observation (14ENEUR15H01) had a reload that restarted the NIMS processor 12 hours and 37 minutes later. Although NIMS was halted for over 12 hours, no observations were lost.

No more Halts occurred during the rest of the encounter. A table of the NIMS engineering SCLK values near the time of the Halt follows (Note that the NIMS engineering SCLK value is normally 2 Rims behind the CDS SCLK Rim when it is reported):

NIMS SCLK	CDS SCLK	CDS SCET	GROUND ERT
04409608	04409610.40	1998-088T16:26:59.573	1998-088T15:22:34.993
04409622	04409795.05	1998-088T19:58:52.760	1998-088T18:29:14.986
04409622	04410012.58	1998-088T23:03:49.520	1998-088T22:09:14.979
04409622	04410177.43	1998-089T01:46:57.102	1998-089T00:55:54.973
04409622	04410210.40	1998-089T03:02:48.525	1998-089T01:29:14.971
04410393	04410395.05	1998-089T05:42:15.727	1998-089T04:35:54.965

2. No NIMS observations were lost due to this Halt.

Timing:

SCLK	Comments
04409622.00	NIMS HALTED
04410370.69	Start Reload 14NNEUR15H01
04410395.05	Good SCLK reported.

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.