Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E16 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E16 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 E16 encounter, one just before each science observation. One observation, 16JNHOTMAP01, was lost due to a NIMS processor halt, but that was due to an error in the planned reload sequence. 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 a Despun Bus Reset Error that safed the spacecraft about 6 hours before E16 perijove. The perijove and outbound portions of the E16 encounter were lost.

Spacecraft safing during the E16 encounter caused a good portion of E15 data not to be recorded over in E16. Thus, additional E15 data were returned during E16 playback.

The plots on the pages 3 and 4 show the geometry of the NIMS E16 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 8 summarize the 'final' playback model for the 'returned' E16 and E15 data returned during E16 cruise.

The text on page 9 gives a 'recap' of the E16 playback events which affected which observations were returned.

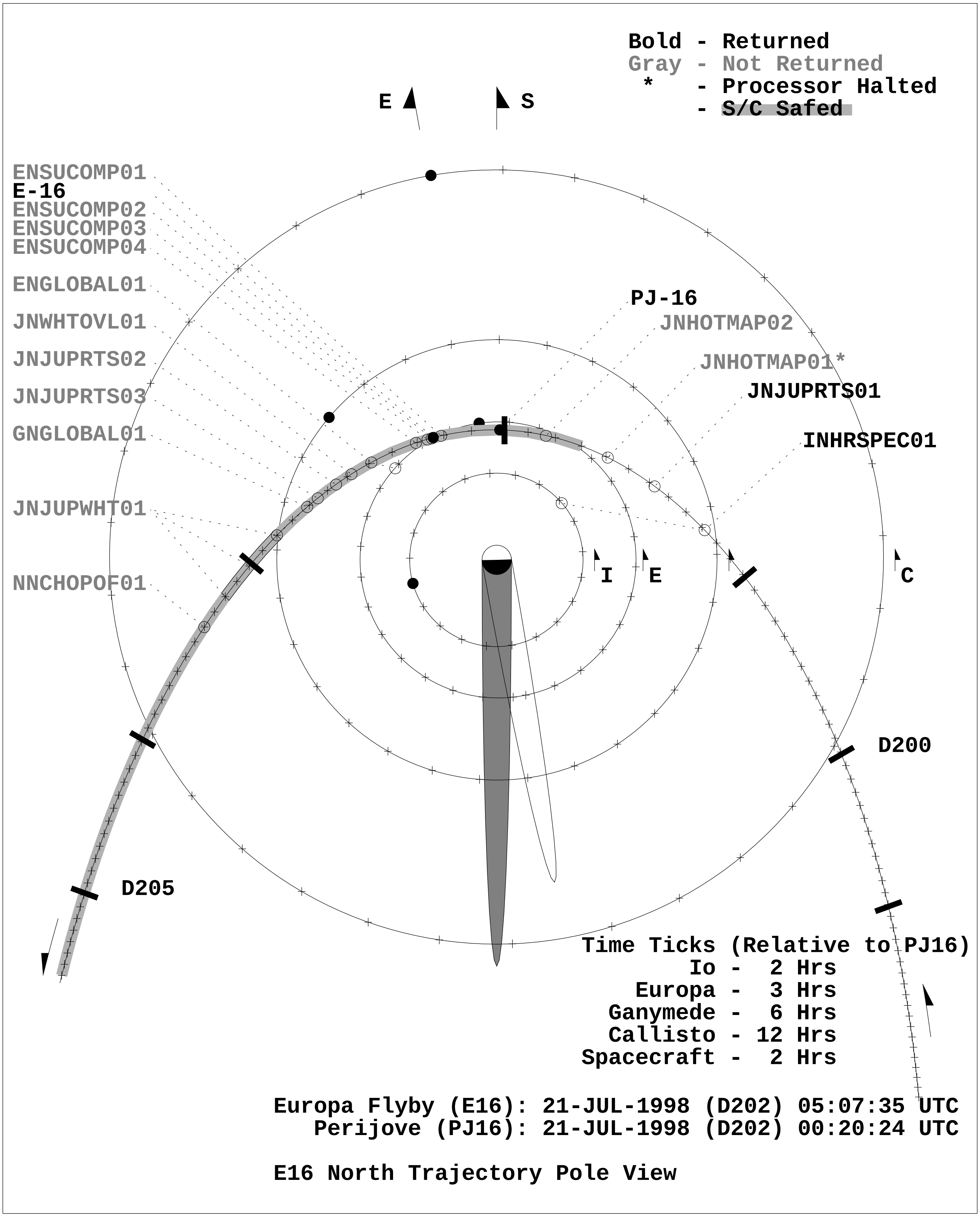
A Timeline of E16 playback events is on pages 10 through 15.

The text on page 16 describes the E16 NIMS and Spacecraft Anomalies.

The text on page 17 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 18 and 19.

The text on page 20 is a guide to understanding the NIMS MASK.

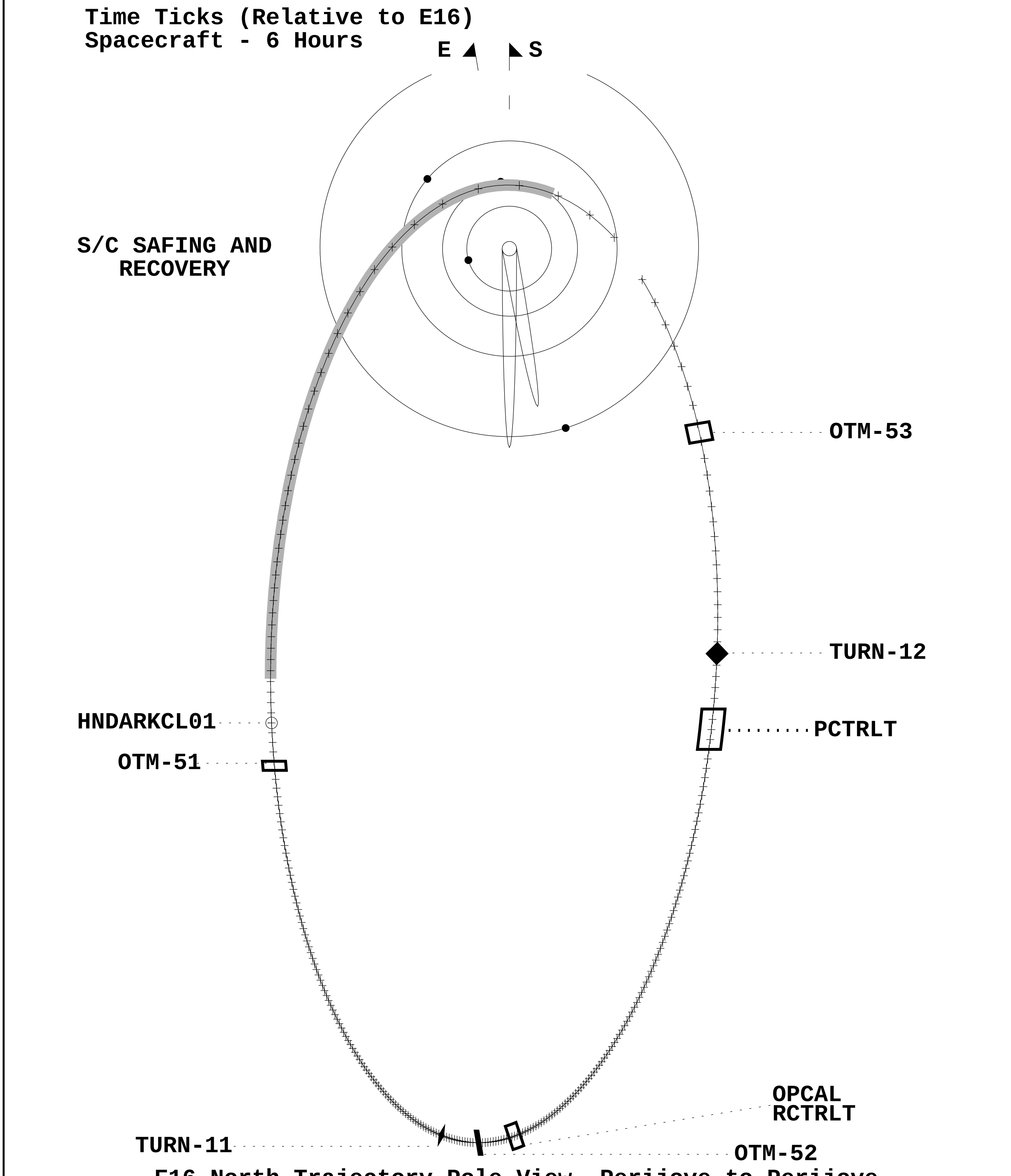
NIMS E16 OBSERVATIONS



NIMS - FEL - 12/06/99

NIMS E16 CRUISE CALIBRATIONS

Europa Flyby (E16): 21-JUL-1998 (D202) 05:07:35 UTC
Perijove (PJ16): 21-JUL-1998 (D202) 00:20:24 UTC
Apojove (AJ16): 23-Aug-1998 (D235) 16:00:00 UTC



E16 North Trajectory Pole View, Perijove to Perijove

NIMS E16 DATA RETURN

Activity ID	Observation Title	NIMS EDIT Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
16INHRSPEC01	Io Monitoring at High Spectral Resolution	E16ILM243C	E16ILM228C	LM	2	0	4	LPU	
16JNJUPRTS01	Jupiter Realtime Observation	E16JLM442		LM	2	0	4	R/T	
16JNHOTMAP01	NIMS Jupiter Hotmap	E16JHT238A	E16JHT238A	LM	2	0	4	LPU	
16HNDARKCL01		E16HN442	E16HN408	LM	1,2,3,4			MPW	
	NIMS Software Reload								
15ENSUCOMP02-gf	Europa Surface Composition	E15ELM442	E15ELM360	LM	3	0	4	MPW	DG
15ENSUCOMP02-	Europa Surface Composition	E15ELM442	E15ELM360	LM	3	0	4	MPW	DG
15ENGLOBAL01-gf	Europa Global	E15ELM442	E15B_ELM228C	LM	4,3	0	4	MPW	DI
15ENGLOBAL01-	Europa Global	E15ELM442	E15B_ELM228C	LM	4,3	0	4	MPW	DI
15ENEUR16H01C-	Europa 16 Hour Map	E15ELM442	E15ELM120T	LM	4	0	4	MPW	DK
15ENEUR16H01D-	Europa 16 Hour Map	E15ELM240V	E15ELM72V	LM	3	0	4	LPU	EK
15JNJPDARK01A-	Jupiter Dark Observation	E15J5M253B	E15J5M80B	LM	4	0	4	LPU	DN
15JNJPDARK02A-gf	Jupiter Dark Observation	E15J5M253B	E15J5M80B	LM	4	0	4	LPU	DO
15JNJPDARK02A-	Jupiter Dark Observation	E15J5M253B	E15J5M80B	LM	4	0	4	LPU	DO
15ENEUR20H01B-gf	Europa 20 Hour Map	E15ELM240V	E15ELM168V	LM	3	0	4	LPU	EL
15JNJPDARK03A-	Jupiter Dark Observation	E15J5M253B	E15J5M80B	LM	4	0	4	LPU	DP
15JNJPDARK03A-gf	Jupiter Dark Observation	E15J5M253B	E15J5M80B	LM	4	0	4	LPU	DP
15ENEUR22H01C-	Europa 22 Hour Map	E15ELM442	E15ELM120T	LM	4	0	4	MPW	DM
15ENEUR22H01D-	Europa 22 Hour Map	E15ELM240V	E15ELM72V	LM	3	0	4	LPU	EM
15INHRSPEC01-	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DB
15INHRSPEC01-	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LS	2	0	4	MPW	DB
15INHRSPEC02-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DD
15INHRSPEC02-	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DD
16INHRSPEC01	Io Monitoring at High Spectral Resolution	E16ILM243C	E16ILM228C	LM	2	0	4	LPU	
16HNDARKCL01		E15HN442	E15HN408	LM	1,2,3,4			MPW	
15ENREGION01-gf	Europa Regional Observation	E15ELM442	E15ELM360	LM	3	0	4	MPW	DE
15ENSUCOMP02-gf	Europa Surface Composition	E15ELM442	E15ELM360	LM	3	0	4	MPW	DG
15ENSUCOMP02-gf	Europa Surface Composition	E15ELM442	E15ELM360	LM	3	0	4	MPW	DG
15ENSUCOMP03CD-	Europa Surface Composition	E15ELM442	E15ELM132C	LM	4,3	0	4	MPW	DH
15ENGLOBAL01J-Q-	Europa Global	E15ELM442	E15ELM132C	LM	4,3	0	4	MPW	DI

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15ENEUR16H01A-gf	Europa 16 Hour Map	E15ELM442	E15ELM360	LM	4	0	4	LPU	EK
15JNJPDARK01B-	Jupiter Dark Observation	E15J5M253B	E15J5M149B	LM	4	0	4	LPU	DN
15JNJPDARK02B-	Jupiter Dark Observation	E15J5M253B	E15J5M149B	LM	4	0	4	LPU	DO
15ENEUR20H01C-	Europa 20 Hour Map	E15ELM442	E15ELM120T	LM	4	0	4	MPW	DL
15ENEUR20H01D-	Europa 20 Hour Map	E15ELM240V	E15ELM72V	LM	3	0	4	LPU	EL
15JNJPDARK03B-	Jupiter Dark Observation	E15J5M253B	E15J5M149B	LM	4	0	4	LPU	DP
Extended Playback Required Pass Number Reset to 1									
15INHRSPEC01-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DB
15INHRSPEC01-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DB
15INHRSPEC01-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DB
15INHRSPEC02-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DD
15INHRSPEC02-gf	Io Monitoring at High Spectral Resolutio	E15ILM442	E15ILM360	LM	2	0	4	MPW	DD

NOTES: The complexity of E16 playback resulted in the use of several schemes for numbering the separate portions of the observations. Final data product nomenclature will differ from that employed here. This spreadsheet is a record of the separate parts commanded to be played back, in time order of playback.

gf= Gap fill

NIMS E16 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 BOT (Mbits)	Mode Cycle (sec)	Thold	Comp	Total BTG Mbits (4% OHEAD)	Data Reduct Factor (sBOT/BTG)	Pass
16INHRSPEC01	LM	LPU	228	184.00	181.00	1.110	1.13	8.667	0	2.32	0.43	2.60	1
16JNJUPRTS01	LM		360										
16JNHOTMAP01	LM	LPU	238	1468.0	70.00	5.180	9.06	8.667	0	99.00	0.00	1.35	1
16HNDARKCL01	LM	MPW	408	667	485	5.59		8.667	0	2.71	1.75	3.19	1
15ENSUCOMP02-gf	LM	MPW	360	1200	212.2	2.44	13.82	8.667	0	1.33	1.38	1.77	2
15ENSUCOMP02-	LM	MPW	360	1200	88	1.01	13.82	8.667	0	1.33	0.57	1.77	2
15ENGLOBAL01-gf	LM	MPW	228	1800	195	2.25	20.74	8.667	0	1.20	0.89	2.53	2
15ENGLOBAL01-	LM	MPW	228	1800	204.6	2.36	20.74	8.667	0	1.26	0.89	2.65	2
15ENEUR16H01C-	LM	MPW	120	290	286	3.29	3.34	8.667	0	1.40	0.59	5.60	2
15ENEUR16H01D-	LM	LPU	72	290	282	1.74	1.79	8.667	0	1.25	0.39	4.46	2
15JNJPDARK01A-	LM	LPU	80	600	306	1.89	3.70	8.667	0	1.30	0.45	4.18	2
15JNJPDARK02A-gf	LM	LPU	80	600	20	0.12	3.70	8.667	0	1.26	0.03	4.05	2
15JNJPDARK02A-	LM	LPU	80	600	316	1.95	3.70	8.667	0	1.26	0.48	4.05	2
15ENEUR20H01B-gf	LM	LPU	168	266	20	0.12	1.64	8.667	0	1.50	0.05	2.29	2
15JNJPDARK03A-	LM	LPU	80	600	86	0.53	3.70	8.667	0	1.27	0.13	4.08	2
15JNJPDARK03A-gf	LM	LPU	80	600	30	0.19	3.70	8.667	0	1.27	0.05	4.08	2
15ENEUR22H01C-	LM	MPW	120	245	234	2.70	2.82	8.667	0	1.50	0.45	6.00	2
15ENEUR22H01D-	LM	LPU	72	245	234	1.44	1.51	8.667	0	1.53	0.26	5.46	2
15INHRSPEC01-	LM	MPW	360	1260	636	7.33	14.52	8.667	0	1.30	4.23	1.73	3
15INHRSPEC01-	LM	MPW	360	1260	146	1.68	14.52	8.667	0	1.40	0.90	1.87	3
15INHRSPEC02-gf	LM	MPW	360	1260	40	0.46	14.52	8.667	2	1.30	0.27	1.73	3
15INHRSPEC02-	LM	MPW	360	1260	303.3	3.49	14.52	8.667	0	1.30	2.02	1.73	3
16INHRSPEC01	LPU	MPW	228	184.00	180.00	1.110	1.13	8.667	0	1.60	0.62	1.80	3
16HNDARKCL01	LM	MPW	408	667	242	2.79		8.667	0	2.70	0.88	2.35	3
15ENREGION01-gf	LM	MPW	360	1140	20	0.23	13.13	8.667	0	1.25	0.14	1.67	4
15ENSUCOMP02-gf	LM	MPW	360	1200	30	0.35	13.82	8.667	0	1.33	0.19	1.77	4
15ENSUCOMP02-gf	LM	MPW	360	1200	30	0.35	13.82	8.667	0	1.33	0.19	1.77	4
15ENSUCOMP03CD-	LM	MPW	132	600	598	6.89	6.91	8.667	0	1.25	1.52	4.55	4
15ENGLOBAL01J-Q-	LM	MPW	132	1800	1092	12.58	20.74	8.667	0	1.25	2.77	4.55	4

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15ENEUR16H01A-gf	LM	MPW	360	290	50	0.58	3.34	8.667	0	1.25	0.35	1.67	4
15JNJPDARK01B-	LM	LPU	149	600	595	3.67	3.70	8.667	0	1.37	1.55	2.36	4
15JNJPDARK02B-	LM	LPU	149	600	605	3.73	3.70	8.667	0	1.43	1.51	2.47	4
15ENEUR20H01C-	LM	MPW	120	266	262	3.02	3.06	8.667	0	1.45	0.52	5.80	4
15ENEUR20H01D-	LM	LPU	72	266	263	1.62	1.64	8.667	0	1.53	0.30	5.46	4
15JNJPDARK03B-	LM	LPU	149	600	595	3.67	3.70	8.667	0	1.49	1.43	2.57	4
										Total	28.17	(MBTG)	
15INHRSPEC01-gf	LM	MPW	360	1260	50	0.58	14.52	8.667	0	1.30	0.33	1.73	1
15INHRSPEC01-gf	LM	MPW	360	1260	18	0.21	14.52	8.667	0	1.30	0.12	1.73	1
15INHRSPEC01-gf	LM	MPW	360	1260	52	0.60	14.52	8.667	0	1.30	0.35	1.73	1
15INHRSPEC02-gf	LM	MPW	360	1260	73	0.84	14.52	8.667	0	1.30	0.49	1.73	1
15INHRSPEC02-gf	LM	MPW	360	1260	44	0.51	14.52	8.667	0	1.30	0.29	1.73	1
										Total	1.58	(MBTG)	
gf= Gap fill													

RECAP OF E16 PLAYBACK EVENTS

E16 in its original form was the most downlink-bit-rich orbit of the Galileo Europa Mission (GEM), with total capability of greater than 290 Megabits. Early in the E16 encounter, a spacecraft fault occurred, placing the spacecraft in safe mode. It was not possible to diagnose and respond to the condition in time to record any of the scheduled observations later in the sequence. Thus, the E16 encounter was nearly a total loss.

The E16 cruise period was occupied with the recording and playback of calibrations, and the playback of a considerable quantity of E15 data that remained on the tape from the prior encounter. The successfully recorded 16INHRSPEC01 was also retrieved. All in all NIMS received well over 90% of the NIMS data recorded to tape for E15, producing one of the finest data sets of the entire mission. In many cases, where only a portion of the recorded wavelengths had been returned earlier, it was necessary to generate new wavelength tables to "fill in" the missing wavelenghts. As a result, there were multiple data files for many observations, which had to be merged together to produce the final products. This involved significant extra work in processing by NIMS team members and at MIPS.

In addition to the spacecraft safing, one halt of the NIMS software occurred, at the start of 16JNHOTMAP01, which was to have been recorded prior to the time of the safing. It was later determined that this was the result of an error in commanding the instrument.

The following timeline covers two quite different intervals of time, that prior to the spacecraft safing, which occurred on 20 July, and that which followed. Only minimal information is provided here for the pre-safing period, since only one of the planned observations was successfully recorded. Most of the text below is excerpted from messages issued at the time.

<u>E16 Playback Events Timeline</u> (06-30-98: to 09-24-98:)

06-30-98: The E16 encounter begins on 20 July. Following today's update there is one more opportunity to modify the table before uplink.
This orbit includes 4 Europa surface composition observations and one Europa global. There is a very large Ganymede global observation that will fill in a significant gap in our longitudinal coverage. Io is de-emphasized this time with only a single low resolution HRSPEC.
The original Jupiter plan called for two HOTMAPs and 3 realtime spectra. Observation of the merging of two white ovals observed previously prompted requests for new observations of the merged feature. In this update we added 16JNWHTOVL01, which is 11.5 Rims in length and which will return 253 wavelengths using table JSB253B.
In addition we will obtain spectra from some of SSI's observations of the white oval taken late in the encounter. At this point commands to cover one of the SSI mosaics that extends for about 5 minutes of time has been included

07-02-98: (J. Gross) NIMS playback allocation is 49.598 Mbits.

07-20-98: E16 encounter begins at 05:00 UTC.
16INHRSPEC01 occurs at 06:06, followed by 16JNJUPRTS01 at 11:53.

07-20-98: (M. Segura) At rim 4570588 roughly 201/16:58 scet, NIMS software halted. It appears that we have lost 16JNHOTMAP01. The next observation is ~ 30 minutes away with the usual reload just before so we should recover nicely for HOTMAP02.

07-21-98: (Report to Team) The spacecraft went into safe mode very early in the record sequence, approximately between our two JNHOTMAP observations. The balance of the sequence did not execute as planned, and therefore we have lost nearly all of E16. The apparent cause is a hardware bus parity error. Long term consequences for the spacecraft and the NIMS instrument are not known but we are receiving telemetry, and there are some similarities to events that have occurred previously. The next three weeks will be devoted to diagnosing the problem. If the problem is understood, it is likely that we will be able to make use of our E16 downlink capability for 1) returning data that was recorded but not played back in E15, 2) playing back the E16 data that was recorded, and 3) obtaining realtime data, mainly for MWG but also hopefully including NIMS dark calibrations.

07-21-98: (Report to Galileo Project) NIMS has several candidate observations that will make good use of E16 downlink. There are 3 categories of data: Data recorded successfully during E16, data recorded but not played back in E15, and realtime calibrations.

E16 Playback Events Timeline (06-30-98: to 09-24-98:)

During E16 we recorded 16INHRSPEC01, and may have completed recording of 16JNHOTMAP01. Complete playback of the former will require about 0.9 Mb, and complete playback of the latter, assuming it recorded successfully, would require approximately 6.7 Mb.
Due to insufficient downlink allocation in E15, the following observations were returned with partial spatial coverage, partial wavelength coverage, or both:

15INHRSPEC01
15ENSUCOMP02
15ENSUCOMP03
15ENGLOBAL01
15JNJPDARK01
15JNJPDARK02
15JNJPDARK03
15ENEUR16H01 (MPW and LPU)
15ENEUR20H01 (MPW and LPU)
15ENEUR22H01 (MPW and LPU)

To bring down the spatial areas and wavelengths not returned in E15 will require approximately 21.5 Mb.
No allowance for gap fills has been made here, because of insufficient time to identify them and estimate downlink requirements. Therefore it is likely that if we are able to replay E15 data, we will request additional bits for gap filling.
Realtime calibration data: Marcia Segura estimates that we can obtain excellent dark values at a cost of 5.0 Mb or possibly less. These will be representative of all 4 NIMS gain states. These data are needed for optimal processing of all other NIMS data obtained.
Total:

E16	7.6 Mb
E15	21.5 Mb
RTS	5.0 Mb
	34.1 Mb

07-21-98: (R. Mehlman) 16JNHOTMAP01 is almost certainly lost, due to a sequencing error in the NIMS software reload, which caused it to halt. I believe we want to return a RIM or so just to make sure, but probably no more.

07-21-98: (M. Segura) It has been confirmed that the spacecraft anomaly was caused by DESPUN bus resets on the A string which the B string saw and reacted to. There have been 3 resets in the last 24 hours.
Now that the problem is understood, recovery will begin. The first package will be uplinked tonight, followed by 4 others over the next few days. The science virtual machine will be commanded back on line early in the day on Thursday with state matching (instrument configurations and other stuff) occurring on Friday and beyond.
Based on this schedule and no further resets, we should be back on track by next week.

07-23-99 (K. Schimmels, Playback Strategy) It has been decided it would be better to pick up the E16 higher priority data prior to playing back more E15 data, so the playback strategy has changed slightly.

1) Pass 1: first time through E16 data, from tic 835, track 2, to tic 900, track 3.
   (includes NIMS Dark Calibration, which overwrites most of 15ESCILIXS01).
2) Pass 2: E15 data on tracks 3, 4, and 1, from tic 1011 on track 3, to end of track 1.
   (15ENREGION01 - 15ISKANEHI01)
3) Pass 3: E15 data on track 2, from tic 5946 to tic 984.
   (ISHIPHASE01 - ESREGMAP01) AND second time through all E16 data (tic 835, track 2 - tic 900, track 3)
4) Second time through E15 data on tracks 3, 4, and 1.
   Same locations as Pass 2.

7-23-98: The playback table delivered today will be sent up next week. It is largely devoted to recovering the rest of the NIMS E15 data that remains on the tape following the safing of the spacecraft early in the E16 encounter.
The loss of E16, GEM's most bit-rich orbit, was a blow, but there is a considerable silver lining developing. NIMS will bring down more than 25 Mb of NIMS data during the E16 playback period. This includes about 4 Mb for a new dark observation for calibration purposes. The 25 Mb total is larger than our total bits-to-ground for E14, and is twice as large as that for E12. Io is coming out ahead. With two chances to fill data gaps, the high-resolution 15INHRSPEC02 should be a complete observation. The additional equatorial scan recorded but not played back previously will be returned as well. Multiple looks at the same location will be extremely valuable for confirming the presence of particular spectral features. We will also bring down the first two scans of 15INHRSPEC01, which will be useful for the same reason. Lastly, 16INHRSPEC01 was successfully recorded before spacecraft safing.
Portions of the southern 2 scans of 15ENGLOBAL01 were written over. However, when all is said and done, we will have all recorded wavelengths and full spatial coverage for the remaining portion. All other Europa and Jupiter observations will likewise be available with full spectral and full spatial coverage, barring future problems in playback.
Generation of the new PBT on relatively short notice required substantial efforts. Thanks to Frank and Bob for gaps timing and to Elias for proofreading and generation of new wavelength edit tables.

07-24-98: (F. Leader) E16 and E15 playback hassles.
Well, the real fun is about to begin. We are playing back a lot of NIMS E15 data during E16 Cruise. Some of the observations will have the wavelength coverage expanded. This might give us some headaches if we do not procede carefully. The following table lists the observations with expanded wavelength coverage:

E16 Playback Events Timeline (06-30-98: to 09-24-98:)

OBS ID	EXT	WAVES	EXT	WAVES	TOTAL WAVES	NOTES
15ENSUCOMP03	A	228	C	132	360	MPW-NIMS5, GS 4
15ENSUCOMP03	B	228	D	132	360	MPW-NIMS5, GS 3
15ENGLOBAL01	A	228	B	132	360	MPW-NIMS5, GS 4
15ENGLOBAL03	A	228	B	132	360	MPW-NIMS5, GS 4
15ENGLOBAL04	A	228	B	132	360	MPW-NIMS5, GS 3
15ENGLOBAL05	A	228	B	132	360	MPW-NIMS5, GS 4
15ENGLOBAL06	A	228	B	132	360	MPW-NIMS5, GS 3
15ENGLOBAL07	A	228	B	132	360	MPW-NIMS5, GS 4
15ENGLOBAL08	A	228	B	132	360	MPW-NIMS5, GS 3
15ENEUR16H01	A	240	C	120	360	MPW-NIMS5
15ENEUR16H01	B	168	D	72	240	LPU-NIMS6
15ENEUR20H01	A	240	C	120	360	MPW-NIMS5
15ENEUR20H01	B	168	D	72	240	LPU-NIMS6
15ENEUR22H01	A	240	C	120	360	MPW-NIMS5
15ENEUR22H01	B	168	D	72	240	LPU-NIMS6
15JNJPDARK01	A	80	B	173	253	LPU-NIMS6
15JNJPDARK02	A	80	B	173	253	LPU-NIMS6
15JNJPDARK03	A	80	B	173	253	LPU-NIMS6

07-28-98: (K. Schimmels) Playback of E15/E16 data will start Thursday morning ~7:13 AM, with E16 data the first out the gate. We should be done with the E16 playback by Saturday AM, and on into E15 data we go.

07-30-98: A rare record-during-cruise begins at 13:39:50 UTC to obtain NIMS dark calibration data (16HNDARKCL01) in all four gain states. Playback initiates at 14:13.

08-12-98: The first pass over the E16 and E15 data is nearly complete. Today’s update was scheduled to enable us to make changes to our plan based on the first pass performance. Four changes to the table were implemented.
16INHRSPEC01 came down in pass 1 with thresholding enabled (as usual for Io observations). However in this case some data drop-outs on the target resulted due to the thresholding. In the next pass the entire observation will be replayed without thresholding.
Two data gaps in 15ENSUCOMP02 will be filled by new playback commands (PSIDs FB, FC).

A small gap in pass 1 playback of 15ENEUR16HR01 falls on top of a similar gap in E15 playback of this data. For our last shot, we are commanding playback of all 360 recorded wavelengths for this portion of the observation. Our additions to the playback plan amount to less than 1 Mb of downlink. SSI is adding about 17 Mb, to retrieve some images at lower compression ratios. Still a considerable amount of unused downlink capability remains. Some provisional trades of our present unused capability with other DSN users have been made; these may increase our downlink allocation in later orbits by a small amount.

09-03-98: (K. Schimmels) There is some discussion about doing another pass through some of the E15/E16 data before the end of the orbit. The idea would be to fill any gaps in E16 data (there is only one gap - in NIMS Dark Cal - that I know of) or possibly in E15 data, since track 2 got hit pretty hard by station problems and rain gaps in the first pass through. SSI and NIMS have the majority of the gaps, and UVS seems to have one as well. It would be a good idea if these three teams began to look at what they would like to do, given the opportunity to playback more data on track 2 or 3. We currently expect to have ~18 - 20 MB unused, and finish playback 5 days prior to the background sequence terminate playback command.

09-11-98: The current E16 playback plan will terminate a little over a week from now. There will be about 18 Mb of downlink capability remaining. In order to make use of this resource, the project has approved creation of a new table (not an extension of the current one, which has expended all possible pass numbers).
There are 5 gaps in 15INHRSPEC01 and 15INHRSPEC02 that we can fill using this opportunity. In addition, we will get the rest of the 16HNDARKCL01 (which will be the last thing played back). This is considerably padded to act as margin to ensure the return of the Io data. SSI has plans to use most of the available downlink. Our requests total just under 2.0 Mb.

09-11-98: (K. Schimmels) Playback is scheduled to be finished (run out of SINGLEs in the final Segment) on Friday, 9/18. Sunday’s 63-pass is the first uplink pass available after this, over which we plan to send a realtime TPB, IPB, and uplink a new, separate playback table Segment 1.

09-15-98: The current and final E16 pbt is to be found in LIVELY::[JSHIRLEY]E16ALL_980915.PBT. NIMPBK start times for two gap fills were moved earlier, and the threshold parameter for one of the two 15INHRSPEC02 gap fills was reset to zero. Thanks to F. Leader for catching the errors, and thanks to Kathy Schimmels for permitting us to make the changes after the delivery deadline.

09-24-98: Playback terminates at 08:26:57 UTC. 29.75 Mbits of NIMS data were received during the E16 playback period.

NIMS Anomaly Report - E16 Sequence

There was one NIMS processor halts detected during the E16 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 a despun bus reset about 6 hours before E16 perijove. The perijove and outbound portion of the E16 encounter were lost.

Processor Halts

The NIMS processor halted to the NIMS observation 16JNHOTMAP01. This halt was due to an error in the order of the command sequence to reload the NIMS software prior to the observation.

Spacecraft Anomaly

The spacecraft suffered a despun bus reset and safed about 6 hours before E16 perijove. The spacecraft did not recover autonomously due to multiple despun bus resets to both CDS strings A and B. The anomaly was not resolved in time to recover any of the E16 encounter.

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.