Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the E26 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the E26 Encounter and Cruise, not all NIMS data recorded on the tape recorder or selected in real-time were returned. The previous 6 chapters nominally describe the planning and intention of the NIMS observations for this orbit, except the obstab section in chapter 4 which was updated to give the latest parameters for the data that were actually returned.

The cruise portion of I25 was too short in duration to return all of the data recorded during the I25 encounter. Some of the I25 data were not recorded over during the E26 encounter and were returned during E26 cruise.

There were five autonomous reloads of the NIMS RAM code from CDS during the E26 encounter, one just before each science observation. The NIMS processor halted once during E26 encounter, but well after the Io observation. NIMS was reloaded by the end-of-encounter reload. The approach that we are taking to avoid data loss due to processor halts has proven to be very successful.

The spacecraft suffered two 'standard' CDS bus reset and recovered without any ill effects.

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

The plots on the pages 3 and 4 show the geometry of the NIMS E26 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 both the I25 and E26 data returned during E26 cruise.

The text on page 7 gives a 'recap' of the E26 playback events which affected which observations were returned.

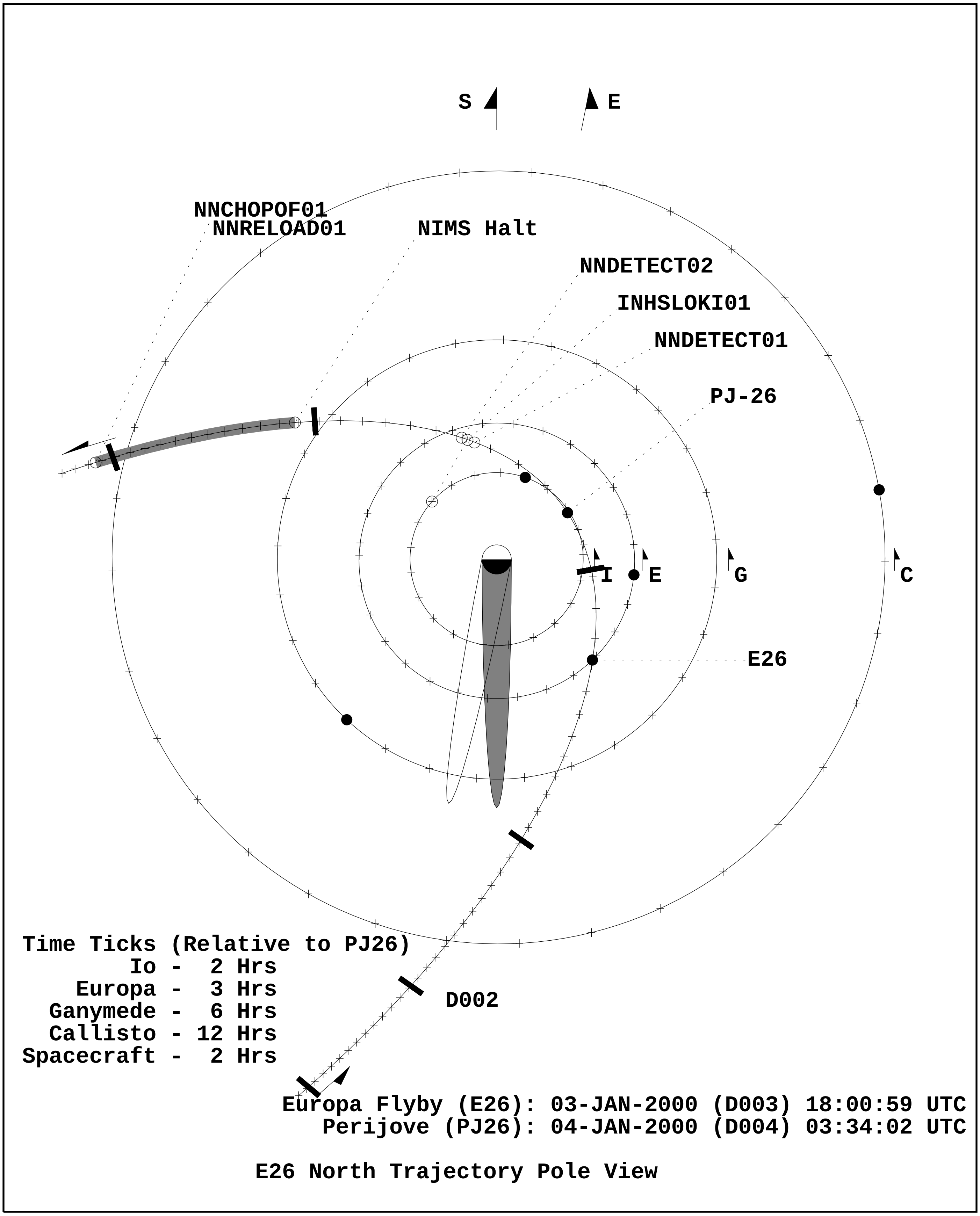
A Timeline of E26 playback events is on pages 7 through 14.

The text on pages 15 through 17 describes the E26 NIMS and Spacecraft Anomalies.

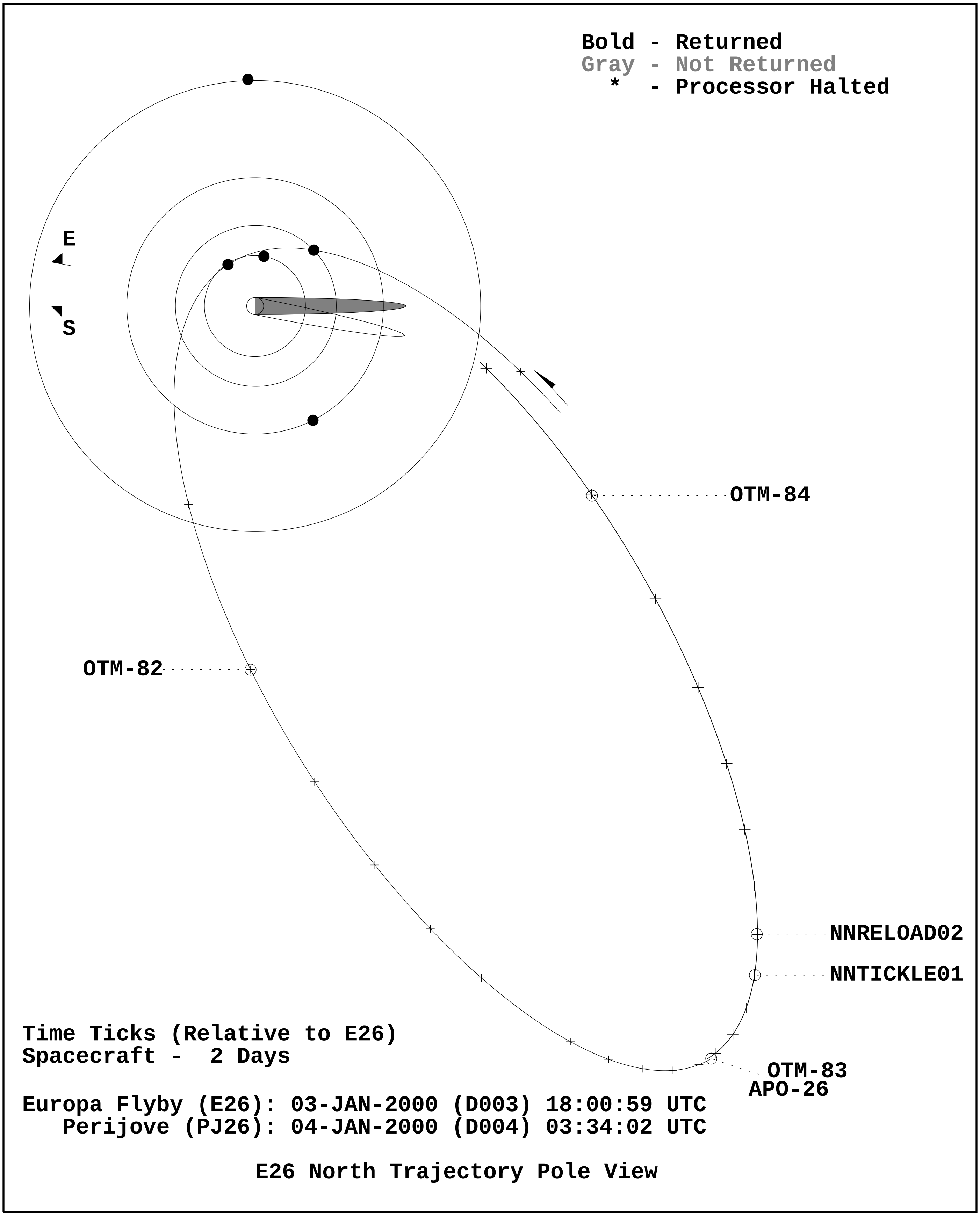
The text on page 18 gives a brief discussion of the NIMS data files. Additional information about NIMS data formats, data types, data labels and data access is given on pages 19 and 20.

The text on page 21 is a guide to understanding the NIMS MASK.

NIMS E26 OBSERVATIONS



NIMS E26 CALIBRATIONS



NIMS - FEL - 12/12/00

NIMS E26 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Ofset	Record Format	PSID
26NNDETECT01-	Grating Step Test P2								
26NNDETECT02-	Grating Step Test Copy								
26INHSLOKI01-	Io Loki Observation	I26ILM442	I26ILM360	LM	2	0	4	MPW	
26NNDETECT03-	Grating Step Test P2								
26NNDETECT04-	Grating Step Test Copy								
26INRELOAD01-	NIMS Software Reload								
26NNCHOPOF01-	NIMS Chopper Off								
26NNMROGRT01-	Grating MRO								
25INCULANN01-gf	Io Culann Obs	I25ILM442	I25ILM288	LM	2	0	4	MPW	
25INREGION01-gf	Io Regional Observation	I25ILM442	I25ILM288	LM	2	0	4	MPW	
25ENNOPOLE01-gf	Europa North Polar Meridional Obs.	I25ELM442	I25ELM360	LM	4	0	4	MPW	
25ENNOPOLE01-gf	Europa North Polar Meridional Obs.	I25ELM442	I25ELM144	LM	4	0	4	MPW	
25ENEQUATR01-gf	Europa Equatorial Band	I25ELM442	I25ELM360	LM	3,4	0	4	MPW	
25ENGLOBAL01-	Europa Jupiter-Facing Hemisphere Global	I25ELM442	I25ELM144	LM	3	0	4	MPW	
25ENGLOBAL01-	Europa Jupiter-Facing Hemisphere Global	I25ELM442	I25ELM216	LM	3	0	4	MPW	
26INHSLOKI01-gf	Io Loki Observation	I26ILM442	I26ILM360	LM	2	0	4	MPW	
26INHSLOKI01-	Io Loki Observation	I26ILM442	I26ILM360	LM	2	0	4	MPW	
25INREGION01-gf	Io Regional Observation	I25ILM442	I25ILM288	LM	2	0	4	MPW	

NIMS E26 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengtrhs Returned	Record Time (sec)	PB Time (sec)	Selected Bits to Tape sBOT (MBITS)	Total Bits of Tpae BOT (Mbit)	Mode Cycle (sec)	Comp	Thold	RT	Total BTG Mbits (4% ohead)	Data Reduction Factor	Pass
26NNDETECT01-														
26NNDETECT02-														
26INHSLOKI01-	LM	MPW	360	400.00	207.00	2.38	4.61	8.67	1.29			1.3864	1.72	1
26NNDETECT03-														
26NNDETECT04-														
26INRELOAD01-														
26NNCHOPOF01-														
26NNMROGRT01-														
25INCULANN01-gf	LM	MPW	288	52	29	0.33	0.60	8.67	1.18			0.1699	1.97	2
25INREGION01-gf	LM	MPW	288	2,702	408	4.70	31.13	8.67	1.24			2.2742	2.07	2
25ENNOPOLE01-gf	LM	MPW	360	660	60	0.69	7.60	8.67	1.24			0.4180	1.65	3
25ENNOPOLE01-gf	LM	MPW	144	660	41	0.47	7.60	8.67	1.24			0.1143	4.13	3
25ENEQUATR01-gf	LM	MPW	360	790	15	0.17	9.10	8.67	1.19			0.1089	1.59	3
25ENGLOBAL01-	LM	MPW	144	503	99	1.14	5.79	8.67	1.20			0.2851	4.00	3
25ENGLOBAL01-	LM	MPW	216	503	110	1.27	5.79	8.67	1.20			0.4752	2.67	3
26INHSLOKI01-gf	LM	MPW	360	400.00	36.00	0.41	4.61	8.67	1.29			0.2411	1.72	3
26INHSLOKI01-	LM	MPW	360	400.00	223.00	2.57	4.61	8.67	1.29			1.4935	1.72	3
25INREGION01-gf	LM	MPW	288	2,702	21	0.24	31.13	8.67	1.24			0.1171	2.07	4
												7.0836	**Total**	
												6.935	**Allocation**	
												0.1486	**Over/Under**	

12/31/00

RECAP OF E26 PLAYBACK EVENTS

E26 was an extremely short and therefore bit-limited orbit; only 46 days elapsed between perijove and the end of the playback (cruise) period. NIMS recorded only a single distant observation of Io (26INHSLOKI01). Our allocation reached only about 7 Megabits. With this we were able to return additional data recorded in I25, primarily gap fills but also some new spatial coverage for 25ENGLOBAL01.

Sets of commands designed to exercise the instrument and hopefully free the stuck grating were performed in E26, without the desired result. These involved pausing playback for a period of some hours, at the cost of about 1.1 Mbits of playback allocation, on 4 February. This followed an initial test performed during I25 cruise on 12-16-99:. Descriptions of both tests are included below.

NIMS experienced one software halt late in the encounter, at approximately 15 Rj outbound. E26 was otherwise uneventful, with onboard software handling two "despun bus resets" without incident.

The following timeline details the most signifigant events of the I24 playback period. Most of the text below is excerpted from messages issued at the time.

E26 Playback Events Timeline (11-23-99 to 02-19-00)

11-23-99: (J. Gross) Here are your allocations, based on your OPG percentages, and your old OPG allocations for comparison:

TEAM	OPG %	ALLOC	ALLOC
SSI	30.0	18.632	11.4
NIMS	9.5	5.884	3.6
PPR	0.0	0.0	0.0
UVS	1.3	0.817	0.5
MWG	59.2	36.774	22.5

Bruce feels that, at least in an order-of-magnitude sense, the telecom profile is probably pretty stable, so enjoy your extra bits!
As you are well aware, in addition to the new track of E26 data, there are also three tracks of I25 data available for playback (Tracks 2,3,and 4). In general it is up to each team decide how they want to divide their E26 playback allocation between E26 and I25 data. There are no technical issues that arise from playing back both datasets.
Playback will proceed in the following order:
Track 2 (I25 MWG Torus),
Track 3 (I25 C/A),
Track 4 (I25 C/A cont.),
Track 1 (E26).
That puts the data in time-order beginning with Track 2, so there are no games we have to play with the pass numbers.
Note that E26 will be the last data off the tape.

<u>E26 Playback Events Timeline</u> (11-23-99 to 02-19-00)

11-29-99: **(J. Gross) Let's wait on the E26 PBT delivery 'til we know exactly what we're going to do with E26 in the wake of I25. For example, moving the E26 records from Track 1 to Track 3 would preserve the I25 Europa data for further playback during E26 cruise. I'm sure we'll have conversations along these lines at tomorrow's SPOT meeting and tomorrow's E26 integration meeting.**

12-07-99: **(J. Gross) Well, I've got good news and bad news about our allocations. The bad news is that when I sent out the first allocations, I had a typo in my spreadsheet. The good news is, the typo works in our favor. Instead of about 66 MB of capability in E26, we have about 86! So, Merry Christmas!**
Here are your PB Allocations after subtracting off any R/T usage:

Team	PB Alloc	
SSI	24.334	
NIMS	7.684	
PPR	------	
UVS	0.957	(after 0.04 MB EUV and 0.07 MB UVS)
MWG	47.657	(after 0.37 MB DDS)

As decided in the 12/7 SPOT meeting, we're going to change the order of E26 playback in order to insure that we have time to get bested data for all the I25 data. So here is the order of playback and the pass numbers you should use:
Pass 1 - Track 2 (I25 Torus) and Track 3 (E26)
Pass 2 - Track 4 (I25 Io)
Pass 3 - Track 1 (I25 Europa), Track 2 (I25 Torus), and Track 3 (E26)
Pass 4 - Track 4 (I25 Io) [if necessary]
Note that this plan only allows one opportunity in E26 cruise to playback the I25 Europa data.

12-16-99: **(J. Gross) Based on the E26AFC product, there is a small negative change to your playback allocations. The total capability decreased by <1.0 MB, so it's nothing to get too worried about. Here are the usage v. capability numbers with the latest PB allocations and the usage from the Dec 9th PBT delivery:**
NIMS 7.684

12-16-99: **(M. Segura) The NIMS grating warming began this afternoon around 2 pm. Approximately one hour into the test the phase 2 software crashed. Big surprise - the software doesn't enjoy heat any better than radiation.**
A discussion with Bill brought about a plan to recover part of the test. Run in Phase 0 software. The commands were uplinked to power cycle the instrument and set the instrument in the same configuration as previously commanded in the sequence. We got the commands generated and uplinked to the spacecraft in time to recover the last 3 hours of the test. The temperatures just prior the end of the warming cycle of 10 hours was: Chopper: -62.6 C, Telescope: -25.0 C, and Grating: -82 C with optics heater 1 on.

<u>E26 Playback Events Timeline</u> (11-23-99 to 02-19-00)

The grating current prior to the software crash was 134 DN after power cycle it was and continues to be in the 114 DN range. The MROs of the actual grating position still show hex "00" after 10 hours of warming.
The NIMS instrument state at the end of the test will be: chopper off, safe mode, with phase 0 software in place. I would like to leave the instrument in this state until E26 at which time the encounter sequence will reload the Phase 2 software just before the Io observation we have planned.
There are two reasons for doing this - we could more easily convince the project to repeat the activity with optics heater 2 before E26 if the only work required by the SST is a simple parameter edit to an existing file. The second reason is to reload the instrument, it will require the same people to do the work as supported this activity and I suspect there will be some resistance to doing both....
The downside of this is that any data SSI is taking in E26 prior to our IO observation will have no NIMS data embedded.

12-17-99: Due to holiday schedules, today's update is expected to be the final update before uplink and the start of E26 playback. The new table includes, in addition to the two sets of commands to return 26INHSLOKI01, 12 additional sets for filling gaps in our I25 observations. There are single sets for 25INCULANN01, 25ENEQUATR01, and 25ENGLOBAL01, together with 6 sets of singles for 25INREGION01 and 3 for 25ENNOPOLE01. In all cases all 15 detectors are commanded for playback.
It is my understanding that playback begins with the E26 data on Track 3. The pass numbers assigned are 1 and 3 for 26INHSLOKI01, 2 for the I25 Io gap fills on track 4, and 3 for the I25 Europa recordings on track 1.
NIMS currently has a surplus of E26 downlink bits, but I25 playback is only about 60% completed at this point, and additional gaps are likely to appear. It will be critical to have gaps information for the last observations in the I25 table (i.e., Europa) early next year. We have only one pass over track 1 during E26 playback.

12-20-99: (J. Gross) The order-of-playback during E26 cruise will be a little different than we're used to seeing. Pass 1 will consist of the I25 MWG Torus data on Track 2, followed by the E26 data on Track 3. Pass 2 will be the I25 Io data on Track 4. Pass 3 will be the I25 Europa data on Track 1, plus the I25 Torus data on Track 2, plus the E26 data on Track 3. Pass 4 will be the I25 Io data on Track 4.
Note that this strategy results in only one pass through the I25 Europa data on Track 1. The unusual pass number strategy is a result of having I25 data on Tracks 1,2,4 and having E26 data on Track 3.
Our playback capability in E26 is nearly 2X what was predicted in the GMM OPG. This is due to a) continued use of the ultra-cone, which was originally thought to be gone by E26, and b) a significant increase in the number of stations.

E26 Playback Events Timeline (11-23-99 to 02-19-00)

The increase in allocations will allow the MWG to fully play back the I25 Torus from Track 2 by the end of E26 playback. Originally this track was to be carried over and played back during I27 cruise. This frees up the constraints on the I27 DMS plan and will allow the science teams an opportunity in that sequence to recover some lost science from I24 and I25.
NIMS 7.668
What If There's an E26 Anomaly? Segment 1 from E26PBB contains ONLY I25 Torus data, which is already on the tape. Even in the event of an E26 anomaly, Segment 1 from this table is perfectly valid and usable. The only requirement is that the tape be positioned somewhere on Track 1 before the Initiate Playback.

01-01-00: E26 encounter begins at 23:30 UTC.

01-03-00: Europa close approach occurs at 18:00 UTC.

01-03-00: (J. Erickson) The Galileo spacecraft is operating normally. Remote sensing observations of the small satellites Amalthea, Thebe, and Metis appear to have been recorded as planned at approximately 7:30 pm PST ground receipt time. Observations of Io will commence on 1/4/2000 at approximately 4:00 am PST ground receipt time. The Galileo spacecraft passed perijove (Jupiter close approach) at approximately 8:12 pm PST ground receipt time. So far, radiation levels have appeared nominal, with no problems identified.

01-04-00: Perijove occurs at 03:34 UTC. A NIMS software crash occurs later in the day as the spacecraft is outbound from the encounter.

01-04-00: (J. Erickson) The Galileo spacecraft is operating normally. Remote sensing observations of Io appear to have been recorded as planned on 1/4/2000 at approximately 4:00 am PST ground receipt time. This completes all of the planned recording for the encounter. Playback is scheduled to begin 1/5/2000 at approximately 1:34 pm PST ground receipt time. So far, radiation levels have appeared about average, with no problems identified. The peak radiation level was around 600 (measured by the star scanner in pulse counts), significantly lower than the maximum of 1400 seen in previous GEM orbits. The only identified radiation related effects so far were a pair of standard bus resets, handled normally by the on-board recovery software without any effect on the planned sequence. These occurred at approximately 7:31 pm on 1/3/2000, and at approximately 3:49 am on 1/4/2000 PST ground receipt time.

<u>E26 Playback Events Timeline</u> **(11-23-99 to 02-19-00)**

01-12-00: **Although we recorded only one observation in E26, the playback table delivered today has 23 sets of commands. All but 2 of these will bring down data recorded in I25. There were many gaps in 25INREGION01 that will hopefully be filled during E26. We are also recovering about 1.3 Mbits of gap fills and new data for the I25 Europa observations.**
We are somewhat below our allocation of 7.68 Mbits for E26. However, we may be required to pay part of the cost of pausing playback in order to perform another grating test at the end of this week. There should be ample time to adjust playback commands following that test. To come in under our allocation this time, I cut back on our wavelength coverage for 25ENGLOBAL01. In the current plan we will get all detectors for the center scan, but only 9 of 15 for the upper and lower scans. And, there is additional data that was recorded after the end of the last slew for this observation that would also be worth returning. There is only one pass over this data in E26. Hopefully we will receive some additional downlink bits in time to let us recover some of this data.

01-13-00: **(J. Gross) Re: Playback bits required for NIMS grating test: Pausing from 2000-035/11:00 to 2000-035/21:00 costs 1.11 Mb. We are currently in Segment 1 on Track 2, playing back MWG Torus data from I25. Thanks to the predictable nature of this data, we are right on schedule, as of Thursday afternoon. To date we have received 13.55 MB of data and have suffered losses of 0.54 MB.**

01-14-00: **(J. Erickson) Europa 26 is behind us, with a much less stressful passing than normal (it's a little strange to think of normal as being "the usual new anomaly"). Io 27 is coming up quick, along with the official passing of the GEM mission (on 1/31/2000).**
In addition to the regular encounter cleanup commanding for AACS and CDS, the gyro scale factors were updated to account for further degradation from the E26 flyby. The bad axes, -1y, -1x, and -2x are now at 23.05%, 65.55% and 18.09% error, respectively. The good axes have not changed significantly. The scale factors are adjusted to remove the error with the exception of the -1x axis which is biased to decrease the pointing error during maneuvers. The next gyro test is February 7, in preparation for I27.
Realtime commands were sent to protect playback from a partial station loss as the front end of DSS-14 on Friday, January 14 was given to DS-1 for part of their recovery.
NIMS suffered one processor stoppage during E26, at roughly 15 Rj outbound. This is unusually far from Jupiter for such events to occur. A sequenced memory reload occurred in the E26 sequence after the stoppage, so no further commanding was required.

E26 Playback Events Timeline (11-23-99 to 02-19-00)

NIMS is pursuing a redo of their "Warm Tickle" exercise. This time they will use their Optics Heater #2 (rather than #1) in an attempt to heat up the grating and free it. Work is ongoing to adapt the existing RBS for this exercise to the current conditions. The sequence is tentatively planned to execute on Friday, Feb 4th.

01-19-00: We are faced with some hard choices for the playback table update that occurs next week (January 26). Below is a statement of the problem and a proposed strategy. My solution may cause problems on the downlink data processing side. Other suggestions are welcome.

Our allocation is about 7.7 Mbits. Our current usage is 7.5 Mbits. Our grating test (warm and tickle) on February 4 will cost 1.1 Mbits. Thus we need to make cuts amounting to .9 Mbits.

There are 3 categories of recorded data planned for playback:

1. 26INHSLOKI01: New data from E26, about 3 Mbits with all 15 detectors selected.
2. I25 Io gapfills, principally 25INREGION01, also about 3 Mbits with all 15 detectors selected.
3. I25 Europa observations, both new coverage and gap fills, about 1.5 Mbits. This has previously been cut to the bone, with most of 25ENGLOBAL01 coming down with 9 detectors only.

The Europa data is unique, our only view of the Jupiter facing hemisphere. In my opinion it should not be cut further.

We can achieve the needed reductions by NOT returning data from detectors 1, 2, and 7 for the I25 Io gap fills and for the second half (all that we can affect) of 26INHSLOKI01. There is little or no signal present for these due to the position of the grating. The down side of this approach is the added work it will cause in assembling the merged final products. (There are nearly two dozen gaps in 25INREGION01). The existing gaps will be unfilled only in detectors 1, 2, and 7. However, to my knowledge, we have not yet produced any products in which the wavelength coverage varies from place to place (correct me if I'm wrong). Is this an insurmountable problem? We can discuss these questions Thursday and next Tuesday morning.

01-26-00: The cost of pausing playback while we perform our next grating exercise (February 4) is about 1.1 Mbits. In this update we trimmed our wavelength coverage for the remaining Io observations in order to come up with the bits to pay for the grating test. No timing changes were made.

The new detectors selection for 25INCULANN01 gap fills, 25INREGION01 gap fills, and 26INHSLOKI01 pass 2 data includes 12 detectors, all but 1, 2, and 7, which have extremely low signal levels at the present time. It is expected that this will involve some new programming on the downlink data side, in order to merge data files with overlapping times that have different detectors selected.

E26 Playback Events Timeline (11-23-99 to 02-19-00)

In response to Frank's request (below), I can move the NIMPBK for the pass 2 26INHSLOKI earlier by about 15 seconds, to catch the RIM rollover. This will cost about .1 Mbit and we will have about that much redundant data.
(FEL:) I noticed that 26INHSLOKI01 is being played back in two sections with two separate edit tables. It would make downlink alot easier if the two playback segments were broken at RIM roll-over. With the latest PBT, we must deliver two separate Obstabs to MIPL and break the playback processing at an as yet unknown ERT time to separate the use of the two playback edit tables (obstabs)

01-27-00: (J. Gross) As of Thursday morning we are currently in Segment 2, playing back the E26 NIMS Io Loki observation from Track 3. To date we have received 42.5 MB of data, and have suffered 1.7 MB of losses.
NIMS added gap fills and reduced their wavelength coverage for their remaining Io observations to come up with 1.1 MB cost of pausing playback for their grating test on Feb. 4. The NIMS playback allocation has been reduced to reflect this. The schedule currently does not finish by ~16 hours. This will be addressed with the next update.
Looking ahead on the schedule, Segments 7 and 8 are extremely short (numerous gap fill SINGLEs returning a small amount of data). The timing for uplinking these segments will need to be closely watched, although at the present time there is no danger of not getting the segments up.

02-02-00: (J. Gross) After examining our position in playback, I am able to release 3.0 MB of SPOT margin back to the teams. The 3.0 MB are being given to SSI, NIMS, and MWG, according to their relative OPG percentages. The increase in allocation, the new total PB allocation, and the updated unused MBTG are shown below:

	NEW MBTG	NEW PB ALLOC	UNUSED MBTG
SSI	0.912	25.238	4.216
NIMS	0.288	6.935	0.343
MWG	1.800	47.654	0.568

We're still retaining 2.4 MB of 2-pass inefficiency margin, which should be more than sufficient to see us thru to the end of playback. A decision about releasing the rest of the 2-pass margin will be made next week.

02-03-00: We received a small increase in our allocation due to the release of 3 Mb of office margin this week. Together with some small savings due to good compression, this was

sufficient to cover our gap-filling requirements for the first pass data for 26INHSLOKI01. In addition we bumped our detectors/wavelengths coverage for the pass 2 portion back up to 15/360. This will make it easier to merge the pass 1 and 2 portions. As previously noted we could not get all detectors for our I25 Io gap fills. If there is a major windfall of new bits (unlikely), it is theoretically possible that we could retrieve them at the end of E26 playback.
Gap fills for 25INREGION01 should be finished soon, and we should see those for 25ENNOPOLE01 on Saturday. The balance of the I25 Europa data should hit the ground about the middle of next week.

02-03-00: (J. Gross) Segments 7, 8, and 9 will be clocking out rather quickly next week, due to the large number of SINGLEs but relatively small amount of data selected. And due to the small number of uplink passes next week, we will be sending Segment 9 earlier than usual to avoid the risk of an autonomous pause. There is no risk in sending Segment 9 once we've seen NIMS from Segment 6.
There will most likely be only one uplink pass (Thursday's 43-pass) between the first NIMS data of Segment 7 on Wednesday morning and the start of Segment 10 Saturday night. If we miss Thursday's pass, the next uplink pass isn't until Sunday afternoon.

02-04-00: (M. Segura) The optics heater was turned off just a few minutes ago. The highest temperature on the grating was - 54 C. The final MRO just came in. I am sorry to report there was no change to the physical grating position value - still hex "00".
The instrument is currently in "safe" mode with phase 0 software enabled. The chopper is off. NIMS will stay in that state until early Sunday morning at which time the Phase 2 software will be reloaded.

02-08-00: (J. Gross) After analyzing the situation, I am releasing 1.8 MB of 2-pass margin for the final playback table update. NIMS has indicated that they have no need for their share of the 1.8 MB. MWG requests only 0.4 MB for new gap-fills, so the remaining 1.4 MB goes to SSI.

02-09-00: Only one change to the prior table was included in today's new file. This new set of singles is to fill a gap in our I25 gap fill requests. The PSID is ER, the pass number is 4, and the estimated additional BTG is 0.11 Mbits.
Today's is the final update for E26. Playback terminates on 19 February.

02-09-00: (J. Gross) There is only one uplink pass to get Segment 11 to the spacecraft before it's scheduled to go active. Missing this pass would cause an autonomous pause, putting the last few observations at risk of not being returned.

02-19-00: Playback terminated.

NIMS Anomaly Report - E26 Sequence

The NIMS grating became stuck prior to the I24 encounter. The grating continued to be stuck for the E26 encounter. This development caused a drastic change in NIMS operations. Detectors 1, 2 and 7 now have very low sensitivity. Detectors 3 and 8 are still not functioning. NIMS now returns only 12 useful wavelengths.

There was one NIMS processor halt detected during the E26 Encounter. This occurred outbound past Ganymede's orbit.

The spacecraft experienced two of the usual radiation-induced bus resets that were handled by the on-board recovery software. NIMS did not appear to halt because of these bus resets.

Stuck Grating (from the I24 NIMS Guide)

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

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

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

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

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

Response to Stuck Grating Anomaly (E26)

Optics Heater 2

At E26 the cause of the stuck grating was not known (and is still not clearly understood). An attempt was made during E26 cruise to unstick the grating by heating up the NIMS instrument by turning on the NIMS Optics heaters. This attempt was not successful in freeing up the stuck grating.

During I25 cruise, NIMS Optics Heater 1 was turned on in an attempt to warm up the NIMS grating mechanism. This heater did not warm up the NIMS mechanisms, only the NIMS telescope. During E26 cruise Optics Heater 2, which is located in a different part of the NIMS instrument than heater 1, was turned on. The grating test was conducted with NIMS running Phase 0 code. Phase 2 code crashed during the I25 grating test when Optics Heater 1 was turned on.

On Day 035 NIMS Optics Heater 2 was turned for about 9 hours. The NIMS engineering telemetry showed a rise in the FPA, Shield, Telescope, Grating and Chopper temperatures, and no change in the Electronics temperature. NIMS Optics Heater 2 did indeed heat up the NIMS instrument differently that Optics Heater 1 during I25 cruise.

NIMS was commanded to band edge mode (as in I24 and I25) to have the grating jump between grating positions 11 and 23 every minor frame. MROs were commanded once per hour during this 9 hour period to return the NIMS grating position engineering to test if the grating was moving (unstuck). Analysis of the grating position engineering showed the values remaining 00x as before.

After NIMS Optic Heater 2 was turned off, real time commands were sent to reload and run the NIMS Phase 2 software.

Grating Position Engineering MROs

NIMS grating position engineering values were copied from NIMS RAM to CDS RAM to verify the lack of movement of the NIMS grating. This was done twice during the E26 encounter, once 20 minutes before the 26INHSLOKI01 observations and the other 20 minutes after. This monitoring activity is similar to the grating position monitoring started during C22. In the current test, a segment of NIMS memory containing the grating position engineering DN was copied to CDS via 6MCOPY commands for every minor frame over a long map grating cycle, sampling every other grating position. The CDS memory locations containing the NIMS engineering DN were then sent to ground via MRO. Analysis of the grating position engineering showed the values remaining 00x as before.

NIMS Anomaly Report - E26 Sequence

Processor Halts

NIMS suffered one processor halt during the E26 Encounter. This halt occurred in the oubound portion of the encounter when the spacecraft was outside of Ganymede's orbit well about 12 hours after the last NIMS observation. NIMS remained halted for about 24 hours until the NIMS software was reloaded during the scheduled reload at the end of encounter when the spacecraft was outside of Callisto's orbit.

The halt was detected by analysis of the NIMS SCLK engineering values. The SCLK values continued to indicate a halt until the time of the planned reload. After the that time the SCLK values resumed reporting correct values.

Timing:

SCLK	Comments
5329408:11	Software reload after 26INHSLOKI01
5329635:58	Good SCLK 5329633 reported
5330400:48	Anomalous SCLK 5330237 reported
5331218:05	Anomalous SCLK 5330237 reported
5331360:43	Anomalous SCLK 5330237 reported
5331713:61	Software reload 26NNRELOAD01
5331993:40	Good SCLK 5331991 reported

Spacecraft Anomaly

During the E26 encounter CDS suffered 2 'standard' despun bus reset errors. These bus resets happen at least once every encounter. These bus resets were handled by the on-board recovery software without any effect on the planned sequence. NIMS did not appear to have halted due to loss of RTI synch.

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.