Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the I31 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the I31 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 I31 encounter, one just before each science observation. Two software halts were detected during I31. The approach that we are taking to avoid data loss due to processor halts has proven to be very successful.

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

The plots on the pages 3 through 5 show the geometry of the NIMS I31 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 6 and 7 summarize the 'final' playback model for the I31 data returned.

The text on page 8 gives a 'recap' of the I31 playback events which affected which observations were returned.

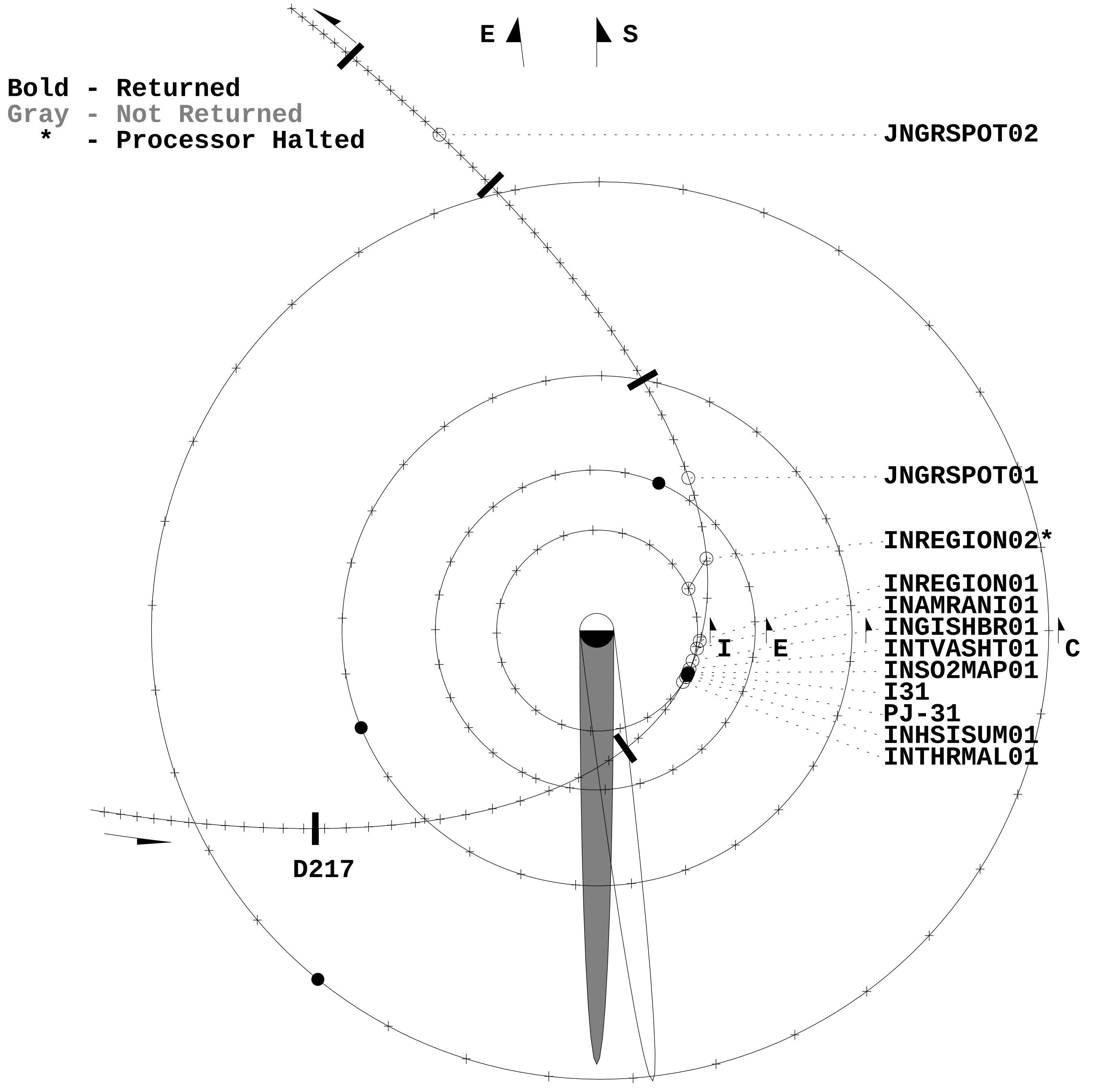
A Timeline of I31 playback events is on pages 8 through 25.

The text on pages 26 and 27 describes the I31 NIMS and Spacecraft Anomalies.

The text on page 28 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 29 and 30.

The text on page 31 is a guide to understanding the NIMS MASK.

NIMS I31 OBSERVATIONS



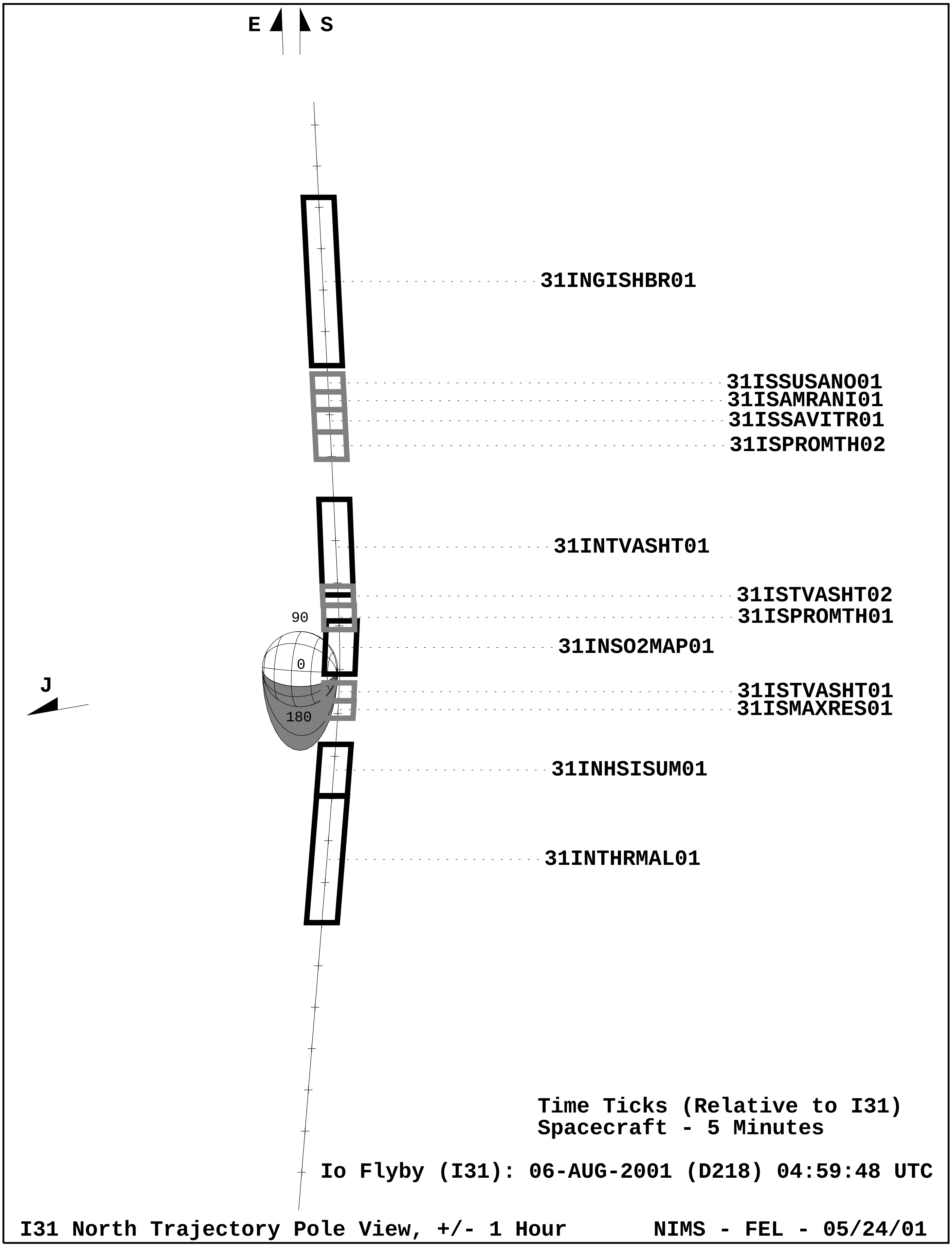
Time Ticks (Relative to PJ31)
Io - 2 Hrs
Europa - 3 Hrs
Ganymede - 6 Hrs
Callisto - 12 Hrs
Spacecraft - 2 Hrs

Io Flyby (I31): 06-AUG-2001 (D218) 05:00:21 UTC
Perijove (PJ31): 06-AUG-2001 (D218) 04:53:14 UTC

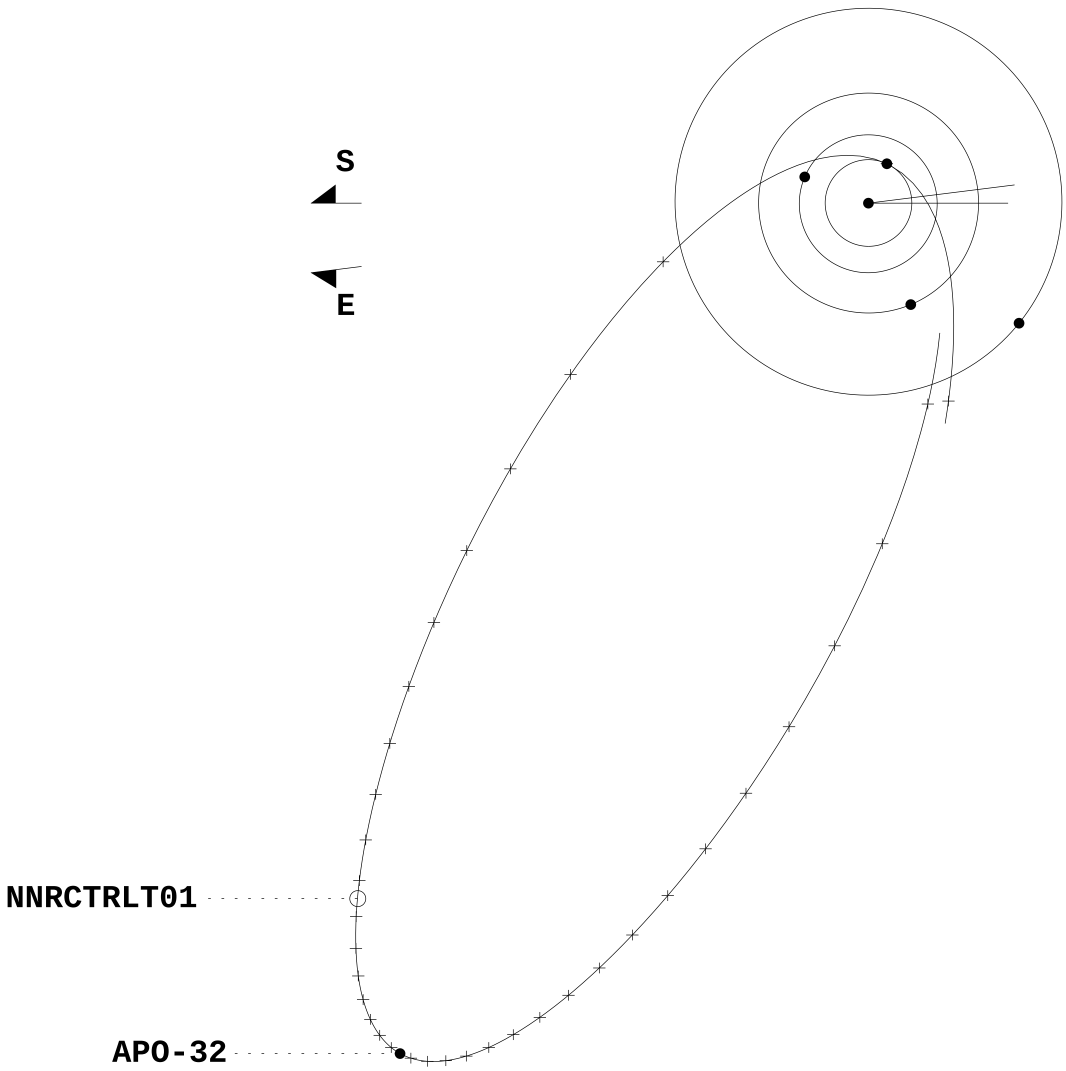
I31 North Trajectory Pole View

NIMS - FEL - 01/18/02

NIMS & SSI I31 IO FLYBY OBSERVATIONS



NIMS I31 CALIBRATIONS



Time Ticks (Relative to I31)
Spacecraft - 2 Days

Io Flyby (I31): 06-AUG-2001 (D218) 05:00:21 UTC
Perijove (PJ31): 06-AUG-2001 (D218) 04:53:14 UTC
Apojove (A32): 09-SEP-2001 (D252) 23:46:40 UTC

I31 North Trajectory Pole View

NIMS - FEL - 10/31/01

NIMS I31 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
31INTHERML01	Io Thermal Map	I31ILM442	I31ILM144	LM	1	0	4	MPW	DA
31INHSISUM01	Io Isum Obs	I31ILM442	I31ILM144	LM	1	0	4	MPW	DB
31INSO2MAP01	Io SO2 Map	I31ILM442	I31ILMFG96	LM	2	0	4	MPW	DC
31INTVASHT03+	Io Tvashtar SSI ride-along	I31ILM442	I31ILMFG96	LM	2	0	4	IM8	IC
31INTVASHT01	Io Tvashtar region	I31ILM442	I31ILM144	LM	2	0	4	MPW	DD
31INGISHBR01	Io Gishbar Mosaic	I31ILM442	I31ILM144	LM	2	0	4	MPW	DE
31INAMRANI01	Io Amirani Mosaic	I31ILM442	I31ILMFG36	LM	2	0	4	MPW	DF
31INREGION01	Io Regional Map	I31ILMFG252	I31ILMFG36B	LM	2	0	4	LPU	DG
31INREGION02	Io Regional Map	I31ILMFG252	I31ILMFG36B	LM	2	0	4	LPU	DH
31JNGRSPOT01	Jupiter Great Red Spot	I31JSMFG60	I31JSMFG54	SM	2	0	4	LPU	DK
31JNGRSPOT02	Jupiter Great Red Spot	I31JLMFG240	I31JLMFG54	LM	2	0	4	LPU	DL
31INTHERML01	Io Thermal Map	I31ILM442	I31ILM144comp	LM	1	0	4	MPW	DA
31INHSISUM01	Io Isum Obs	I31ILM442	I31ILM144comp	LM	1	0	4	MPW	DB
31INTVASHT01-gf	Io Tvashtar region	I31ILM442	I31ILM144	LM	2	0	4	MPW	DD
31INAMRANI02+	Io Amirani SSI ride-along	I31ILM442	I31ILM144	LM	2	0	4	IM8	IE
31INGISHBR01	Io Gishbar Mosaic	I31ILM442	I31ILM144	LM	2	0	4	MPW	DE
31INAMRANI01	Io Amirani Mosaic	I31ILM442	I31ILMFG108	LM	2	0	4	MPW	DF
31INREGION01	Io Regional Map	I31ILMFG252	I31ILMFG48comp	LM	2	0	4	LPU	DG
31INREGION02	Io Regional Map	I31ILMFG252	I31ILMFG36C	LM	2	0	4	LPU	DH
31JNGRSPOT01	Jupiter Great Red Spot	I31JSMFG60	I31JSMFG54	SM	2	0	4	LPU	DK
31JNGRSPOT01-gf	Jupiter Great Red Spot	I31JSMFG60	I31JSMFG54	SM	2	0	4	LPU	DK

NIMS I31 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec)	PB Time (sec)	Selected Bits to Tape sBOT (MBITS)	Bits to Tape BOT (Mbit)	Mode Cycle (sec)	AACS Mbits c 2.5	Comp	Total BTG (Mbits) w/ 4% O'head	Data Reduct. Factor (sBOT/BTG)	Pass
31INTHERML01	LM	MPW	144	604	600	6.91	6.96	8.667	0.03	1.33	1.56	4.43	2
31INHSISUM01	LM	MPW	144	241	236	2.72	2.78	8.667	0.01	1.36	0.60	4.53	2
31INSO2MAP01	LM	MPW	96	301	40	0.46	3.47	8.667	0.00	1.35	0.07	6.75	2
31INTVASHT03+	LM	IM8	96	50	44	0.00	0.00	8.667	0.00	1.31	0.08	0.00	2
31INTVASHT01	LM	MPW	144	596	593	6.83	6.87	8.667	0.03	1.12	1.83	3.73	2
31INGISHBR01	LM	MPW	144	967	500	5.76	11.14	8.667	0.03	1.18	1.46	3.93	2
31INAMRANI01	LM	MPW	36	920	907	10.45	10.60	8.667	0.05	1.16	0.68	15.47	2
31INREGION01	LM	LPU	36	7311	6882	42.45	45.09	8.667	0.40	1.16	5.13	8.28	2
31INREGION02	LM	LPU	36	4370	404	2.49	26.95	8.667	0.02	1.27	0.27	9.07	2
31JNGRSPOT01	SM	LPU	54	2500	1700	10.49	15.42	2.33	0.10	1.42	5.77	1.82	2
31JNGRSPOT02	LM	LPU	54	2650	2632	16.23	16.35	8.667	0.15	1.74	1.96	8.28	2
31INTHERML01	LM	MPW	144	604	443	5.10	6.96	8.667	0.03	1.22	1.25	4.07	3
31INHSISUM01	LM	MPW	144	241	180	2.07	2.78	8.667	0.01	1.31	0.47	4.37	3
31INTVASHT01-gf	LM	MPW	144	596	153	1.76	6.87	8.667	0.01	1.2	0.44	4.00	3
31INAMRANI02+	LM	IM8	144	50	43	0.00	0.00	8.667		1.2	0.12	0.00	3
31INGISHBR01	LM	MPW	144	967	475	5.47	11.14	8.667	0.03	1.18	1.39	3.93	3
31INAMRANI01	LM	MPW	108	920	907	10.45	10.60	8.667	0.05	1.16	2.03	5.16	3
31INREGION01	LM	LPU	48	7311	6882	42.45	45.09	8.667	0.40	1.16	6.83	6.21	3
31INREGION02	LM	LPU	36	4370	404	2.49	26.95	8.667	0.02	1.28	0.27	9.14	3
31JNGRSPOT01	SM	LPU	54	2500	825	5.09	15.42	2.33	0.05	1.41	2.82	1.80	3
31JNGRSPOT01-gf	SM	LPU	54	2500	51	0.31	15.42	2.33	0.00	1.41	0.17	1.80	3
											35.22	**Total**	
											35.06	**Allocation**	
											0.1598	**Over/Under**	

01/18/02

<u>RECAP OF I31 PLAYBACK EVENTS</u>

I31 was marred by the loss of many of SSI's recorded Io observations due to an instrument anomaly. This occurrence resulted in a significant windfall of downlink resources for NIMS. The increased allocation permitted us to return a healthy proportion of our recorded data. We were able to return 7 samples per detector for the large observation 31INREGION01, amounting to some 12 Mbits by itself. A new, large, extremely hot volcanic outburst was observed on Io in I31, which was imaged in that observation.

Although there were at least two spacecraft safings due to despun bus resets, only one NIMS observation was severely impacted (31INREGION02). Late changes made to the sequence prior to uplink also severely impacted the plan for 31INSO2MAP01; only a small portion of this observation could be salvaged.

The following timeline details the most signifigant events of the C30 playback period. Most of the text below is excerpted from messages issued at the time.

<u>I31 Playback Events Timeline</u> (06-18-01 to 10-25-01)

06-18-01: **The first-cut playback table for I31 has been delivered to donatello. We will have several additional input ports for this pbt (June 26, July 5, July 16, July 27).**

06-22-01: **(Y. Anderson) The allocations are based on the 1st OP ORPROs: I31ABA and I31BBA. We initiate I31 playback at 01-221/12:00:00.000, 9 hrs before the end of the A-load, and terminate at 01-286/09:50:00.266.**
NIMS allocation: 22.422 Mbits
We have a total 90.34 MB downlink capability, and SPOT holds 3.00 MB margin and 2.71 MB inefficiency. Thus, 84.63 MB is allocated to the teams, which is more than a 30% increase from OPG.

07-03-01: **(Y. Anderson) I31 Playback Allocation Update (7/3)-- Initiation of I31 playback in ADA has been moved 14 hours earlier. As a result we gain 1 MB more downlink capability. Currently, I31 playback initiates at 01-220/20:00:00.000, and terminates at 01-286/09:50:00.266. Total MTG is 91.224 MB. SPOT holds 3.00 MB margin and 2.737 MB inefficiency. 85.487 MB (vs. 84.63 MB previously) is allocated to the teams.**
NIMS: 21.651 MB

I31 Playback Events Timeline (06-18-01 to 10-25-01)

07-16-01: There is one additional update cycle before the I31 table is uplinked to the spacecraft. The current table has times adjusted to align with the latest SEF. Data reduction factors are now realistic, but not all singles have correct wavelength edit table entries.

Our allocation in I31 is currently 21.6 Mbits, about 3 times larger than that for C30. Nonetheless we are recording much more data than can be brought down. To deliver this table I made some assumptions about the magnitude of data editing. These will need to be reviewed and fine-tuned for the next update cycle. Below are percentage values (of data recorded) planned for return in the current table.

All Io high-resolution observations:	50%
Io REGION01, REGION02:	15%
Jupiter Great Red Spot observations:	25-50%

As noted, we can bring these in line with science priorities in the next cycle.

07-22-01: (D. Bindschadler) This is to update you with regard to the situation surrounding the planned SEQID hibernation period at I31 C/A. The hibernation period is required due to the geometry of the planned flyby. During a period of approximately 15 minutes near Io c/a, there is a bright body vector (necessitated by Io itself) which also blocks our OSAD star. A similar situation occurred at both I25 and E26 flybys.

Similar to I25, we planned to increase the persistences on several AACS variables, which would allow SEQID to continue to provide attitude reference during the period when the OSAD star was blocked out. During testbed testing (AACS subsystem mode), the hibernation period worked fine, but SEQID crashed at the point it should have required the OSAD star. SEQID quickly recovered, but the crash caused us to investigate further. We found that scan platform movement during the hibernation period causes changes in rotor motion that are not as accurately modeled by SEQID as we might wish. In particular, investigations during I25 development suggested that the spacecraft mass properties (in particular the Izz moment of inertia) is not correctly modeled in AACS software. The result is that any net scan platform motion between the start of the hibernation period and the end creates an error in SEQID’s estimate of clock angle. In the case of the testbed test, once the BBV hiding our OSAD star expired, SEQID began "looking" for the star at the wrong time and in the wrong part of the sky. Once it crashed it was able to quickly re-acquire the OSAD star, since the incorrect positional information was discarded.

<u>I31 Playback Events Timeline</u> (06-18-01 to 10-25-01)

There are four options for dealing with this issue. Below is my description and my recommendation with regard to each one.

Option 0:	Do nothing. Allow SEQID to crash upon exiting the hibernation period.
Impact:	This will likely impact the INSO2MAP01 observation (NIMS) and could impact the ISPROMTH01 (SSI) observation. Shadan may be able to better estimate the impact.
Testing:	This option has been tested in the testbed.
Option 1:	Add a post-position slew to the sequence.
Impact:	This will impact the INSO2MAP01 observation (NIMS). From Shadan's and my inspection, this appeared to allow the 1st minute of the observation, but not the subsequent ~2 minutes. The post-position slew needs to begin at 05:03:20 in order to have the required 160 seconds to reach its target clock angle position. There appears to be time in the sequence for the subsequent slew (for ISPROMTH01) to execute.
Testing:	This option has already been mostly tested in the testbed. The only remaining aspect (does s/p motion subsequent to post-positioning slew execute wi/out misslews?) will be done by Monday am.
Option 2:	Add a pre-position slew to the sequence.
Impact:	This will impact INHSISUM01 (NIMS) and *probably* IPHIRES_01 (PPR). Because of the required 160 sec slew time, INHSISUM01 appears to be completely gutted -- the preposition slew has to begin by 04:48:20, and the MPW 6TMREC isn't until 04:49:36. In addition, there doesn't appear to be time to slew from the pre-position point to the beginning of the IPHIRES_01 observation, meaning that this PPR observation would also be compromised.
Testing:	This option has been tested but is unsuccessful in the testbed. Would require pointer work (to create a hole for the pre-position slew), and testing of the new s/p sequence in testbed.
Option 3:	Increase the duration of the BBV, and thus the hibernation period by 4 minutes. Add a pre-position slew (but earlier than in #2).
Impact:	In this option, we would begin the BBV 4 minutes earlier and place it prior to the INHSISUM01 (NIMS) observation. However, there is not time in the timeline for this option either. At the very least INHSISUM01 would be compromised and possibly the previous one (INTHRMAL01) would also be affected. In addition, we would be operating further outside our range of experience. For I25, the BBV was 13 minutes long with persistences set to 17 min. Current I31 situation is 15/17. This would become 19 minutes with 21 minutes persistences.

<u>I31 Playback Events Timeline</u> **(06-18-01 to 10-25-01)**

Testing: Not yet tested.
RECOMMENDATION:
Option 1 (post-position slew)
Recommend implementation. This option works, with the only remaining detail left being to see if it affects the subsequent SSI observation. Impacts only one observation. Appears to be straightforward to implement in pointer and is not expected to cause SCANOPS problems.

07-23-01: The "final" (pre-uplink) I31 pbt must be delivered by Thursday, and there are still several questions about the overall Io plan. Here is the situation.

1. We are currently near our allocation, doing the following :

Returning 12 of 24 wavelengths recorded for
31INTHERML01
31INHSISUM01
31INSO2MAP01
31INTVASHT01
31INGISHBR01
31INAMRANI01

Returning 3 of 24 wavelengths for
31INREGION01
31INREGION02,
(however, not all of REGION01 is selected, see below).

2. Additions wanted: I understand the SSI ridealong data is wanted for 31ISTVASHT01-02. This will cost about 0.5-0.6 Mbits all together. And, in the current table, I did not include the second part of 31INREGION01, which has an instrument reload in the middle. Getting all of this will require another 1.7 Mbits.

SST is messing about with the sequence, and a good part of 31INSO2MAP01 may be lost as a result. We may involuntarily gain some bits here but it will be less than a Mbit.

The current distribution is about 10.3 Mbits to the higher resolution observations, and 4.6 to the two REGIONS, not counting the needed 1.7 Mbits to complete REGION01.

Thus it seems we have to prioritize.

Question: should the ridealongs take priority over any of the NIMS data?

Question: Did you want to bring down any other SSI ridealong data?

Question: are you happy with the S/N for 30INGLOBAL01? (This came down with 3 of 24 recorded wavelengths. If it is not good enough then we should increase the sampling for the REGIONs. If it is better than adequate, perhaps we should consider dropping to 2 samples per detector for the I31 REGIONS).

If we drop from 12 to 8 or 9 samples returned for the higher resolution data, we can bring down the full area of both REGIONs and the ride-along data. Alternatively if we drop from 3 to 2 samples on the REGIONS, we can get everything else without changing the sampling (12/24).

07-24-01: (R. Lopes) Tough call. I suggest we drop from 12 to 8 or 9 samples for the higher resolution data, EXCEPT the nightside observation. We need the full sampling to derive the highest temperatures, so we need to get all we can for THRMAL01 and INHSISUM. Let's try to bring all SSI ridealongs back, we have found those very useful in the past. It's hard to assign a priority. These can also be 8 or 9 samples. Let's see what we can do with this plan, I would like the full coverage of the REGIONS and no less than 3 samples. I'd be very worried to go down to 2.

07-25-01: (F. Leader) Due to the s/c hibernation period near Io C/A, the NIMS observation 31INSO2MAP01 took a big hit. Only the first 55 mf are pointing at the spot on Io where we want to collect SO2 spectra. At that time, a scan platform TARGET command is issued to put the scan platform in a 'nice' place causing the NIMS FOV to slew all about Io's disk and out into space.
So, the nice 5 Rim record has turned into a 55 mf record. The rest is recorded but not worth returning (only for curiosity).

07-27-01: Today's is the final update prior to uplink of the I31 playback table to the spacecraft. A very large number of changes were required this time in order to optimize the science data return (as discussed in yesterday's team meeting). In particular, new playback wavelength tables were generated for all observations with the exception of 31INTHERML01 and 31INHSISUM01.
For better playback efficiency, portions of the following observations were placed in pass 3 (the first playback pass will assess the quality of SSI data recording only, as in C30):
31INTHERML01
31INHSISUM01
31INGISHBR01
31INREGION01
31JNGRSPOT01
Two SSI ridealong observations were added, one in each pass, designated 31INTVASHT02+ and 31INTVASHT03+. If allocation allows, more SSI Io ridealong data return will be added in pass 3.

I31 Playback Events Timeline (06-18-01 to 10-25-01)

Io Strategy:
31INTHERML01 and 31INHSISUM01 (dark side, gain state 1, for temperature determination) will be previewed in the first pass with 12x sampling, with additional samples for the hot spot areas planned for return in the last pass.
31INREGION01-02 will come down with 3 samples per detector. The ridealongs, and 31INTVASHT01, 31INAMRANI01, 31INGISHBR01, and 31INSO2MAP01 will come down with 8 samples per detector (of 24 recorded). We will only return the first 40 seconds of the latter, as it's design was altered at the last minute for sequence safety reasons.
Jupiter Strategy:
This orbit has two nice GRS observations obtained close in, one in short map and one in long map. The record table selects 10 detectors but we will not bring down the data from detector 7 (low to nonexistent signal). We are commanding 3 samples / detector for 31JNGRSPOT01 (of 6 recorded) and 6 of 24 for 31JNGRSPOT02.

08-04-01: I31 sequence begins at 11:00 GMT (day 216).

08-05-01: (R. Lineaweaver)
A Bus reset occurred at 217/22:54:36 SCET. (218/01:24:17 ERT)

08-06-01: Perijove occurs at 04:53 GMT.

08-06-01: Io close approach occurs at 05:00 GMT.

08-06-01: (E. Theilig) The Galileo spacecraft is operating normally with the exception of the SSI camera as discussed below, and all activities appear to be as planned. Close approach to Jupiter was at 10:41 p.m. PDT on 8/5 (Earth-received time) at an altitude of 4.9 Jupiter radii. Closest approach to Io was a few minutes later at 10:48 p.m. PDT at a targeted altitude of 200 km.
All planned atmospheric and Io observations to date appear to have been recorded successfully using over three quarters of the tape recorder. The DSN successfully recorded the Radio Science Jupiter Occultation using the RSR and DSP over DSS-43 (Canberra, Australia), between 3:39 p.m. and 6:15 p.m. (8/5) PDT.
The spacecraft has now passed Jupiter close approach and the peak radiation level was around 590 (measured by the star scanner in pulse counts), significantly lower than the maximum of 1400 seen in previous extended mission orbits. The only identified radiation related effects so far have been a standard bus reset, handled normally by the on-board recovery software without any effect on the planned sequence, a NIMS memory upset, handled by instrument memory reloads in the science sequence, and possibly the SSI issue discussed below. All observation recording is proceeding according to plan. The expected end of the radiation danger is shortly after 9:00 a.m. PDT, Monday morning.

<u>I31 Playback Events Timeline</u> **(06-18-01 to 10-25-01)**

As anticipated, the SSI camera baseline voltage anomaly is recurring in association either with instrument commanding or the radiation environment or both. The anomaly was triggered during a planned instrument power cycle preceding the closest approach observations and a subsequent power cycle failed to clear the problem. Results of a third cycle are unknown because of a telemetry outage; however, there is no change in the camera state after telemetry resumed. Most of the closest approach imaging is probably lost. Three more SSI observations and one OPNAV are planned over the next two days.

08-06-01: (R. Mehlman) Only spotty engineering data is available from the I31 encounter. We have two bad SCLKs which probably indicate NIMS software halts. The first is about an hour after the bus reset reported in the MCT summary, which is to be expected. (Our software was reloaded before our first observation.) The second is 2 1/3 hours after the start of the hour-long Io REGION02 observation indicating that our software crashed either during or after that observation. (Fairly close to even odds that it's OK.) Good SCLK values are reported between the GISHBR01 and AMRANI01 observations, and between the AMRANI01 and REGION01 observations, indicating that we hadn't crashed during GISHBR01 and AMRANI01.
We got only two hardware status words near the Io encounter, both with zero values (gain state 2, 63-hertz chopper). The first is between the Io AMRANI01 and REGION01 observation. But we should *not* be in 63-hertz chopper mode at this point. The second is just before the bad SCLK after the REGION02 observation and confirms that something was wrong at that point.
More engineering data might show up after besting, but there are already several observations whose success is questionable, and many more about which we know nothing. Perhaps we should consider sampling some of the longer ones, such as REGION02, during the second pass, before playing back the bulk of the data during the third.

08-07-01: (R. Mehlman) A conversation this afternoon with the Galileo ACE yielded two additional (but unofficial) bus reset times: SCETs 218/05:27 and 218/15:34. The first of these is 3 RIMs past the end of our INTVASHT01 observation, but well before INGISHBR01, which was preceded by a software reload. The second bus reset was well after INREGION02 and 35 RIMs before JNGRSPOT01, which also had a software reload.

This latter bus reset is several hours after another NIMS halt we infer from the trashed SCLK value CDS returned at 218/13:28, but which must have happened earlier. There's also a hardware status word at 218/13:21 indicating an unreasonable 63-hertz chopper mode, which often accompanies a NIMS halt. This halt must have occurred sometime during or after INREGION02, which was preceded by a reload. The observation is an hour long, and over an hour elapsed afterwards before we have evidence of the halt, so the odds are fairly even on whether the observation was affected. So we we might want to sample it before playing it back.

08-07-01: (K. Schimmels) We will be discussing updates to allocations due to SSI's anomaly during Io later this week / early next week, as that may fold into your PBT updates. I've had a request from the MWG to put BTG into dayside RTS inbound to I32, and we are looking at the possibility and cost of doing so. All depends on what SSI has on tape, what they realistically will maintain to play it back, and what the various science priorities are for the remaining observations vs. the RTS request.

08-07-01: (F. Leader) I31 NIMS halts and CDS Bus Resets:
Summary: CDS reported 2 Bus Resets which halted NIMS due to loss of RTI synch. The sparse NIMS engineering seem to agree with the timing of these halts.
31INREGION02 took a big hit - we recorded the first 6 of 58 Rims before the second CDS bus reset, which halted NIMS ... big impact on playback.
The first CDS Bus reset took place before we were in data taking mode. So, no loss of data.
31INAMRANI01 may be in Chopper 63Hz mode, but we don't know why.
BURP #1 between D217 22:21 and 22:47
anomalous engr at 217/23:27:56 - NIMS currents
anomalous engr at 217/23:34:36 - grating current and Hardware status block
anomalous engr at 217/23:41:16 - NIMS SCLK read 06101510 instead of 06154718
NIMS RELOAD at 218/04:27:38 - 31NNTHRMAL01 - first NIMS reload ... NIMS seems to have recovered form the first BURP without loss of data.
anomalous engr at 218/06:34:35 - hardware status block indicates 63Hz chopper mode
standard engr at 218/06:41:15 - NIMS SCLK reading OK.
... NIMS is reported to be in Chopper 63Hz mode in the middle of 31INAMRANI01. There oden't seem to be any problem in the NIMS software reload prior to this Observation.

BURP #2 at 218/11:11:46 in the middle of 31INREGION02 !!!!!! (SCLK 6155403.28)
anomalous engr at 218/13:14:35 - NIMS currents
anomalous engr at 218/13:21:55 - grating current and Hardware status block
anomalous engr at 218/13:27:55 - NIMS SCLK read 061444322 instead of 06155535
NIMS RELOAD at 218/16:04:56 - 31NNGRSPOT01
... If NIMS halted at the time of the second BURP due to loss of RTI synch at 6155403.28, then a good portion of 31INREGION02 is lost. 31INREGION02 ran from 6155397.00 to 6155456.13 So, only the first 6 RIMS out of 58 are good !!! The spatial coverage of these 6 Rims is the upper section of the first of three swaths making a global map. This little piece DOES cover the ISUM region and will give context for the High-spatial-res obs 31INHSISUM01.
Bob Mehlman thinks we should play back some of the halted stuff to verify that NIMS was indeed halted. I agree. Playback of 31INREGION02 is in the first NIMS pass (Pass 2) so a decision needs to be made soon.

08-10-01: (A. McEwen) I strongly urge that NIMS and PPR recieve as much of our excess BTG as they need for their unique high-resolution observations of Io, before we release any bits for MWG cruise science data. Our difficulties only serve to make close observations of Io by other experiments more valuable. NIMS and PPR may have modest requirements so that a portion can still go to MWG.
(appended message from: H Herbert Breneman <H.H.Breneman@jpl.nasa.gov>)
In view of the loss of a major fraction of SSI's data, it is likely that SSI will be "asked" (read "forced") to give up a portion of its 41-Mbit downlink allocation to support "high-priority" MWG cruise science data collection. I estimate that if we return all of the good non-Jupiter data (PLUMES, JOVHEM and both GLOCOLs) losslessly compressed and the Jupiter data ICT-compressed at 10:1, all in pass 2, and hold a 10% margin to cover compression uncertainty and gapfilling in pass 3, we would need about a 20-Mbit allocation. If the Jupiter data is compressed less, that total would go up, but AWG has said in the past that they are completely satisfied with 10:1 compression. Does the above sound like a good playback strategy ? Does the Team have an opinion about how much of our BTG allocation I should fight to retain or offer to give up? The Project expects to make a decision on this by Friday.

I31 Playback Events Timeline (06-18-01 to 10-25-01)

08-14-01: (K. Schimmels) I wanted to send out a quick email to fill everyone in on the status of the I31 BTG situation due to the SSI anomaly in the I31 encounter. This message has two purposes. To document the decision process and status of the BTG, and to comment on the way this was handled.
SSI has agreed initially to release approximately 15 MB from their 41 MB allocation. The agreement between Herb, Marcia, and Claudia was the following:
NIMS: 5.0 MB for addt'l Io playback
MWG: 10.0 MB for I31B RTS,
and any "negligible" request from PPR would come from MWG.
In addition, if SSI determines they do not need this amount of BTG for playback of their Io observations based on pass 1/2 playback, they agreed that such addtl BTG would go to NIMS on the understanding that (1) PPR's needs were negligible and (2) the nature of MWG's use of the downlink is such that their share had to be finalized up front, so they could not benefit from any later releases. It should be noted also that this entire plan is also contingent on a survey of the pass-1 images showing that all of the frames we are assuming to be bad based on engineering telemetry actually are bad.
What was not included in this discussion was the fact that PPR had already requested an addt'l 2.0 MB. Had this been factored in, the decision may have been different by the MWG.
Here is how we've left things:
NIMS: 5.0 MB
MWG: 8.0 MB
PPR: 2.0 MB
If SSI determines that they can release addt'l MB prior to the development of I31B part 2 (early next month) then I am requesting that the first 2.0 MB be restored to MWG, and then the addt'l go to NIMS. This retains the intention of the agreement between NIMS, MWG, and SSI.

08-15-01: Frank reported an engineering value near the end of 31INAMRANI01 indicating the chopper was in 63 Hz mode. Since we don't know when this happened I propose to play back the entire observation during our first pass over the data, but with wavelengths cut back to 36 (3 samples/detector) from 96. This will cost .65 Mbits, and we can go back in pass 3 to obtain more if there is good data on the tape. Let me know if you have objections/suggestions/redirections..

08-15-01: I have added several new sets of singles to pick up NIMS data embedded in the SSI Io observations. The PSIDs are DJ, DU, DV, DW, DY, DZ, EA, EB, EC, ED, EE. Yanhua mentioned when we worked out the original AACS requirements that MWG was paying for a large chunk that may overlap several of the above playback requests. All the new singles are in pass 3 so there is no great rush, but we do want all of the AACS for them, one way or another

I31 Playback Events Timeline (06-18-01 to 10-25-01)

08-15-01: This is the first update following the I31 encounter. Due to a despun bus reset during 31INREGION02, we believe that about 90% of that observation did not record correctly. We have redistributed the downlink bits allocated to that observation. In addition, we received a windfall of 5.0 Mbits from SSI due to the loss of their Io close-approach observations. As a result we have expanded our I31 playback plan significantly.
Jupiter: The relatively high-resolution, short map observation 31JNGRSPOT01 will now come down with all 6 grating steps of the 9 detectors selected.
31JNGRSPOT02 is unchanged (6 samples of 24 recorded).
Io: We added 9 sets of commands to return SSI-ridealong data for Io. These will come down with 12 (of 24) samples for each of the 12 detectors. We also increased sampling density of our own 31INTVASHT01 and 31INGISHBR01 to 12 samples (from 8). We will now return the whole of 31INREGION01 in the first pass (pass 2), with 3 samples. In the final pass we should be able to fill gaps, and return another 2-3 samples / detector.
We are returning the first 6 1/2 RIMS of 31INREGION02 (prior to the bus reset). As an experiment we are also requesting a snippet of data from the period following the reset. This will most likely be corrupted, based on past experience, but it is possible that the instrument software survived the reset.
Engineering data indicates the chopper may have been in 63Hz mode near the end of 31INAMRANI01. We cut back our sampling density from 8 to 3 but will return the entire observation in the first pass (2) to check this out.

08-28-01: (K. Schimmels) The MWG, after much discussion and deliberation, has determined that the MAG team has the priority of bow shock RTS data, and the rest of the MWG does not choose to participate in this activity, due both to complexity involved with getting it, and given the amount of good Io data still on the tape (as these bits were originally intended for Io science). Therefore, they have decided to let MAG do their own bow shock RTS at a cost of 1.0 MB, without the need for buffer dumps. They currently plant to release 4.0 MB back to SPOT this week. I believe that PPR has received all that they requested, and if this is the case, then the release is as follows:
For Engineering data (0.37 MB):
  0.072 Star Scanner data
  0.298 SSI Engineering Data
  NIMS: 4.0 MB

IF PPR still has data on the tape and requires more BTG, they should let me and NIMS know ASAP - the 4.0 MB to NIMS is contingent on PPR not needing any.
The remainder of the BTG (2.63 MB) is being held by the MWG to cover gaps in Io Closest Approach data until next week, at which time they will have an idea of their gap totals and can possibly release the remainder back to SPOT.

08-29-01: Several significant changes to the table were implemented this week, and there are a number of issues that need to be addressed by science team members in tomorrow's team meeting. These relate to the prioritization of downlink bits for Io observations. The good news is that we received an additional 4 Mbits of playback allocation from MWG, which was derived from an earlier release of bit from SSI. There were no changes to the playback plan for Jupiter observations.
The following changes were made to the Io playback commands.

1. SSI ride-alongs: We added commands to retrieve their 31INSPROMTH01, although NIMS was in SAFE mode. We deleted the GLOCOL01-02 ridealongs because of the small size of the target in our field of view. We are requesting all of the AACS data for all the SSI ridealongs.
2. 31INAMRANI01 wavelengths: We got 3x sampling (36 wavelengths) in our first pass (note, this observation is thought to have been recorded in chopper 63 Hz mode). Since the data looks good we will go after an additional 9 samples per detector (total=12 x or 144 bands), as we are doing for our other high resolution observations. A new wavelength table was generated. This expanded playback costs 1.96 Mbits.
3. Gap fill: There were 2 gaps in 31INTVASHT01 which will be filled in the next pass over the tape. There was also a small gap in 31INAMRANI01 (1/2 RIM). Since we will be getting 9x sampling over this observation (see 2 above), this gap will be ignored.
4. 31INREGION01-02: We are now requesting all the AACS data for our playback time intervals for both observations, to aid with pointing corrections during these LONG observations. Our 31INREGION02 playback has been extended to include 26 seconds of data AFTER the despun bus reset. Also pass 3 playback of 31INREGION01 was increased from 24 to 36 wavelengths. We may wish to reallocate some of these bits (see below).

Open issues:

1. Io dark side observations: 31INTHRMAL01 and 31INHSISUM01 are already down with 12x sampling. If we want more samples, or more samples for portions of these observations, we may need to take bits away from some other observation (such as 31INREGION01, pass 3).

2. Increased sampling for ridealongs (with rapid scan rates): It would require another .9 Mbits to go from 12x to 24x sampling for these. How should we rank this in comparison with the value of (1), or of more samples for 31INREGION01?
3. The cost of our expanded AACS data requests is not known, but it may exceed 1 Mbit. I will know before next week. These issues will be discussed tomorrow and need to be resolved by Tuesday (possibly the last chance to modify start of pass 3 playback).

09-04-01: The table delivered today has relatively few changes. Pass 3 playback of 31INTHRMAL01 and 31INHSISUM01 was extended to return the full spatial coverage, with the "other" 12 samples, so that we will have full recorded wavelengths density on these night side observations. A few changes to data reduction factors were made to reflect actual compressions from pass 2.
31INREGION01 is "undercompressing" by about 23% (1.16 actual versus 1.5 predicted). The predicted value was overly optimistic. Pass 2 playback of REGION01 will cost about 1.2 Mbits more than budgeted. We have plenty of time to adjust, and will most likely have to reduce our sampling density for this in pass 3. We do not have any Jupiter data down at present, and there may be some adjustments needed here also, after we know the actual compression figures.

09-06-01: (Y. Anderson) We are about 0.5 days ahead of schedule. We are near the end of Pass 2. Next week we'll start updating the Pass-3's segments. Playback is currently 37% complete.

09-06-01: (L. Kamp) Looking at the tubes, I think that for 31INHSISUM01A, I would say that we can probably omit the extra GPs over the first quarter of the observation, i.e., up to about SCLK 6155025:84.
For 31INTHRMAL01A, we can trim the first 115 MFs and the last 120, i.e. SCLK < 6155014:33 and SCLK > 6155021:41.
Thus, we will save 0.14 MB on ISUM and 0.45 MB on THRMAL. Together with the 0.77 MB obtained by deleting all the ridealongs except for AMRANI02, that makes 1.36 MB, which may be enough, if other things go well.

09-11-01: (K. Schimmels) Let me start by saying what an awful tragedy has occurred today, and although so many americans were affected closely by the events that unfolded, I dearly hope none of you had family or close friends involved in the various terrorist attacks that occurred. If you did, please let me know so we can all be here for you if you need us! Let us all hope that this horrific activity will cease after today.

<u>I31 Playback Events Timeline</u> (06-18-01 to 10-25-01)

09-14-01: The playback table delivered today has a number of changes. Although we received an additional 2.6 Mbits of downlink allocation courtesy of MWG, we were forced to cut back the number of observations planned for return. The following SSI-ridealong observations were deleted (Yanhua, please delete the corresponding AACS playback commands):

- 31INTVASHT02+
- 31INPROMTH01+
- 31INSAVITR01+
- 31INMASUBI01+
- 31INLEIZI_01+
- 31INKANEHE01+
- 31INTERMIN01+
- 31INTERMIN02+

We will return 31INAMRANI02+ to aid in the interpretation of 31INAMRANI01 which may have been recorded in 63 Hz chopper mode.
The cutbacks were necessitated by the lower than expected compression performance for 31INREGION01 and 31JNGRSPOT01. On the plus side, both observations are superb.
Three gap-fill singles for 31JNGRSPOT01 were added this week. In addition pass 3 playback durations for 31INTHERML01 and 31HSISUM01 were reduced to save bits following Lucas' recommendations. Finally, we will return 3 more samples for the observation 31INREGION01, which includes pole-to-pole coverage and at least one major new hot spot.
The current table models at 32.98 Mbits, slightly over our allocation. We have not received any data for 31JNGRSPOT02 so far; I expect this will overcompress relative to predicts. We have time to adapt by trimming back pass 3 playback commands if that becomes necessary.

09-24-01: (Y. Anderson) Most recent changes/trades reflected in the allocations are:
...PPR released their remaining bits (0.594MB).
Since it seems only NIMS needs additional bits, the PPR bits goes to NIMS.
...MWG released their remaining bits (3.872MB). 3.372MB goes to NIMS, and 0.5 MB was hold for SPOT margin.
...All buffer dumps are on the ground. 2.005 MB was received for 5 BDTs. I don't know if there is any gap in the buffer dumps. At present, the remaining BDT bits (originally come from MWG), 0.757MB, also goes to NIMS.
We are currently more than 2-day (about 1.7 MB) behind the schedule. The update this week is nominal. Please deliver the files by Wed 3PM. If nothing urgent coming up, this is the last update we have for I31.

09-26-01: We received various donations of I31 downlink bits from MWG, PPR, etc and now have 2 Mbits to spend. However, we can only affect segment 14 of playback, which starts with 31INREGION01. I have asked for permission to put in commands for a 4th tape pass but have not heard back from Kathy. Herb has not put in his pass 3 selects, so it is unclear who will be last on the tape.
If there is no 4th pass, the logical thing to do is return another 6 grating positions for 31JNGRSPOT02. This would require 2 Mbits or so.
The choices for Io are less exciting. We could get 1 more grating step for REGION01 (3 down now, 3 more planned), but it would break the symmetry of spacing of samples (I don't know if that is anything more than an aesthetic issue). Cost for that would be 1.7 Mbits. We could get 3 more samples (in addition to the 3 already down) for 31INREGION02 (but was there anything dramatic there?), with lots of bits left over (this would cost .3 Mbits).
If Kathy approves a 4th pass, I was planning to reinstate all our SSI ridealongs, just to soak up any bits remaining after getting the GRSPOT02 down. This is a pain for me and Yanhua, but nothing unmanageable. However: Would it be of scientific value to go after data from detectors 1, 2, and/or 7 for the over-saturated 31INTHERML01 and 31INHSISUM01..?

09-26-01: (R. Lopes) I agree with Lucas that playing back dets 1,2, and 7 is probably not worth spending our bits on. If we can get the 4th pass, let's go for the SSI ride-alongs. The REGION02 data are very interesting, but look clean. If we don't get the 4th pass, I'd say let's get that, it's worth 0.3 Mbits. Of course I would like more sampling for REGION01, but 7 rather than 6 would probably not increase our science significantly.
The reason REGION 02 is interesting is that it shows the Isum hot spot in darkness at lower spatial resolution than our observation near closest approach. It will be very interesting to do a comparison between the spectra and see what effect resolution has in what temperatures we can determine. Since the observations are close together in time, chances are the eruption did not change much.

09-26-01: Today's update may or may not be the final update for I31. We received additional downlink bits from PPR and MWG, giving us an additional 2 Mbits for science data return. After polling team members this morning it became clear that the best use for these bits was to expand playback of 31INREGION01 in the final pass from 3 to 4 samples, for a two-pass total of 7 (of 21 recorded). We can also bring down an additional 3 samples for REGION02. Both of these required new wavelength edit tables.

One additional set of gap-fill singles for 31JNGRSPOT01 was entered (PSID=EK).
I requested a 4th tape pass, in order to go after the 8 SSI ridealong observations that we were forced to delete (due to insufficient allocation) in the September 14 delivery. MWG also wants to get another shot at a buffer dump recording from the early part of the sequence. And, SSI wants to fill gaps in early Callisto data. Thus there will be a 4th pass, but none of us are assured of getting the data selected there. SSI added 13 Mbits in pass 3 today so prior schedules are now out the window. Herb can't make a delivery of pass 4 singles today so there may be another update (worst case) next week.

09-26-01: (Y. Anderson) Just wanted to update all the teams that there is pass 4 for I31 playback.
NIMS requested pass 4 to playback the SSI ride-alongs, which were deleted earlier so that they are under their allocation. After receiving bits from PPR and MWG last week, they would now like to add these back. MWG's buffer dump #2 is completely missing. It's too late to fill the gap in pass 3 because BDT#2 was recorded before the c/a. It can only be played back in pass 4. SSI saw the opportunity and would like to add gap fills for their Callisto observation in pass 4. They have ~2MB available in their allocation even after pass 3.
To accommodate this late change, we slip this week's update by half day. All file including pass 4 PBT are due tomorrow noon. Reasons for the slip? 1. SST cannot support a playback table update on Thursday (i.e. tomorrow) because of all the existing activities for I31B and I32A&B. 2. Teams will have time to work on pass 4 PBT (particularly for SSI), so that all the inputs can be put in for this week's update. Otherwise, if we stick to our regular schedule, we could not have all the inputs in this week. And we'll have to do another update next week.

09-27-01: (Y. Anderson) Nice catch. That's exactly what the problem was. I've changed all your SSI ridealongs in pass 4 to what you suggested. Now all singles in pass 4 can be fit into one segment. No worry about uplinks!
At 9/27/2001 03:03 PM, you wrote:
One other thing, if there are too many segments that will run out too fast, we / you can replace (at your option) any of the sets of edit groups (24,0239ff,020000,...060000;) with the following 2,3039FF,040000;
This will just pick up more wavelengths (not an issue since we are not worrying about allocations in pass 4).
(technically, if you do this, you should also replace the preceding field value 03309000 with 03052000) (this bit does not go to the spacecraft, it is just "accounting")

09-27-01: (E. Theilig) The Galileo spacecraft is operating normally. Playback of data recorded during the Io 32 encounter is 64% complete and is scheduled to terminate on 10/13.
On 9/28, a new flight software patch will be loaded to further attempt to mitigate science losses due to the ongoing camera anomaly. The new patch permanently disables both the light flood and the erase mode, features added pre-launch to minimize "ghosting" or residual images. Images acquired with both disabled were acquired at Io 31 with negligible impact to image interpretation. Both the light flood and erase mode stress the video signal from the CCD and are considered to aggravate the problem. In addition to disabling these functions, a conditional check is being added to the camera power-cycling and memory reload process such that it will execute only if the camera is in its anomalous state.

09-27-01: While modeling the I31 playback table today, Yanhua ran into a problem that we have experienced before. There are only so many slots in CDS memory for NIMS edit groups. If we specify 24 edit groups for one observation playback, then only 3 of our observations can fit in one playback segment. Only 4 segments can exist on the s/c at once. New segments can only be uplinked during two-way passes. Bottom line, playback would probably run through segments with our ridealongs in a short period, and playback would pause or fill would be generated, until new segments were uplinked.
The fix is easy. Yanhua edited our table so we are now selecting 24 samples instead of 12, for our ridealongs. Only 2 edit groups are required per observation, and there will only have to be 1 segment in pass 4.

10-02-01: I notice on the schedule I31PDL that no pass 4 entries are shown (on the graphic). Is this due to conservatism of the model, or some other problem?
IF circumstances (running ahead?) warrant, NIMS would support one more update of I31 this week. We have experienced some gaps in "new territory" playback of 31INGISHBR01, and we would add singles to go after that, IF other teams or SPOT also have/has some incentive to do an update. Given work loads and schedules this week, we understand that this is unlikely. But let me know if that changes..

10-02-01: We have some gaps in our pass 3, including a 1 RIM gap in GISHBR, on territory not yet seen. MWG likewise has gaps. Thus we can do an early update this week. Does gap fill take precedence over ride-along data? (my gut says yes).

10-02-01: (R. Lopes) My gut agrees with yours - we should get the gap fill in preference to ride-alongs.

I31 Playback Events Timeline (06-18-01 to 10-25-01)

10-03-01: Data return during the 3rd tape pass has been afflicted with gaps. Although last week's version of the playback table was to have been the last, SPOT and the Project approved another update cycle, with files due at 10 am this morning.
The table delivered today has 8 new sets of pass 4 gap-filling playback commands (PSIDs FA-FH). Thanks to Bob Mehlman for generating a list of gap times.
The largest gaps are found in 31INGISHBR01 (new territory), in 31INAMRANI01, and in 31INREGION01. The NIMS team unanimously gave higher priority to gap fills than to new SSI ridealong data return, so all of the commands added last week to return ridalongs have been deleted from this table (including these would have reduced the chances of receiving the data to fill the above large gaps). The total pass 4 data requested is down from last week's .78 Mbits to .52 Mbits. It is unknown whether there will be sufficient downlink resource to return any of these bits. MWG has likewise experienced gaps, and added gap-fill singles ahead of ours.

10-15-01: (R. Mehlman) As you may already know, none of our pass 4 gap-fill for I31 came down, even though the MCT summary shows the tape at a tic mark beyond the 31INTHRMAL01 gap-fill.

10-25-01: None of the NIMS data selected for return in pass 4 was received on the ground due to insufficient downlink resources. Late in playback one of our DSN passes was changed from 1-way to 2-way, with a consequent loss of about 2 Mbits of downlink. This change was not noticed and was not entered correctly in the modeling software.

NIMS Anomaly Report - I31 Sequence

The NIMS grating became stuck prior to the I24 encounter. The grating continued to be stuck for the I31 encounter. This development caused a drastic change in NIMS operations. Detectors 1, 2 and 7 now have very low sensitivity. Detectors 3 and 8 are still not functioning. NIMS now returns only 12 useful wavelengths.

The NIMS processor halted twice during the C30 Encounter as a result of CDS Bus Reset (BURP) events. The first CDS Bus Reset took place well before the first NIMS observation, so no data were lost. The second bus reset occurred during the NIMS observation 31INREGION02. Only 6 of 58 Rims were recorded.

The spacecraft did not safe during the I31 Encounter but did suffer two Bus Resets which precipitated the NIMS halts.

Stuck Grating (from the I24 NIMS Guide)

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

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

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

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

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

Response to Stuck Grating Anomaly (I31)

At I31 the cause of the stuck grating was not known (and is still not clearly understood). No attempts were made during I31 to unstick the grating.

Processor Halts

There were two NIMS processor halts during I31. The halts were detected by the NIMS engineering and were coincident in time with the reported CDS Bus Reset events. The first Bus Reset occurred before the first NIMS observation. The NIMS software reload prior to the first NIMS observation restarted the software without any data loss. The second Bus Reset induced halt occurred 6 RIMS into the 58 RIM record of the NIMS observation 31INREGION02.

A hardware status word 0 was returned during the encounter, indicating chopper 63Hz mode, at RIM 6155128. This occurred near the end of the 31INAMRANI01 observation. The data were compared to other observations of the Amirani region and were found to agree with the instrument being in Chopper Reference mode. At this time we do not understand how or why the hardware status word got set to zero. The engineering value could have been 'zeroed out'. There was a similar event in C30.

Spacecraft Anomaly

During the I31 encounter two standard CDS bus resets occurred and were handled normally by the on-board recovery software without any effects on the planned sequence. The BURP events occurred at about D217/22:21 and D218/11:11.

Anomaly Timing:

6154641	01-217/22:21:00	CDS Bus Reset 01
6154720	01-217/23:41:16	6101510 SCLK reported (anomalous)
6155002	01-218/04:26:37	NIMS Software Reload (31INTHRMAL01)
6155128	01-218/06:34:35	Chopper 63Hz HW Status Word
6155397	01-218/11:05:46	Start Record for 31INREGION02
6155403	01-218/11:11:46	CDS Bus Reset 02
6155537	01-218/13:27:55	6144432 SCLK reported (anomalous)
6155691	01-218/16:03:26	NIMS Software Reload (31JNGRSPOT01)

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.