Chapter 7 - Data Return

Contents

Introduction to Chapter 7

This chapter is a report on the NIMS data return for the C20 orbit. Due to the low downlink data rates available for Galileo Jupiter Operations and other unforeseen and unpredictable events during the C20 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 fourteen autonomous reloads of the NIMS RAM code from CDS during the C20 encounter, one just before each science observation. No observations were lost due to a NIMS processor halt. The approach that we are taking to avoid data loss due to processor halts has proven to be very successful.

Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

The spacecraft successfully survived two CDS Bus Resets using the new CDS Bus Upset Reset Patch (BURP). Each BURP event caused the NIMS software to halt. NIMS was halted for about 28 hours, from just after C20 perijove until the start of the Callisto flyby.

AACS dropped into Cruise mode at the start of the Callisto flyby in response to errors in the gyro rates. All Callisto observatiions were performed in Cruise mode.

The plots on the pages 3 and 4 show the geometry of the NIMS C20 observations using a north trajectory pole projection. The 'returned' observations are in Bold characters and the 'non-returned' in gray. The observations with an asterix were taken with the NIMS software halted.

The spreadsheets on pages 5 and 6 summarize the 'final' playback model for the 'returned' C20 and E17 data returned during C20 cruise.

The text on page 7 gives a 'recap' of the C20 playback events which affected which observations were returned.

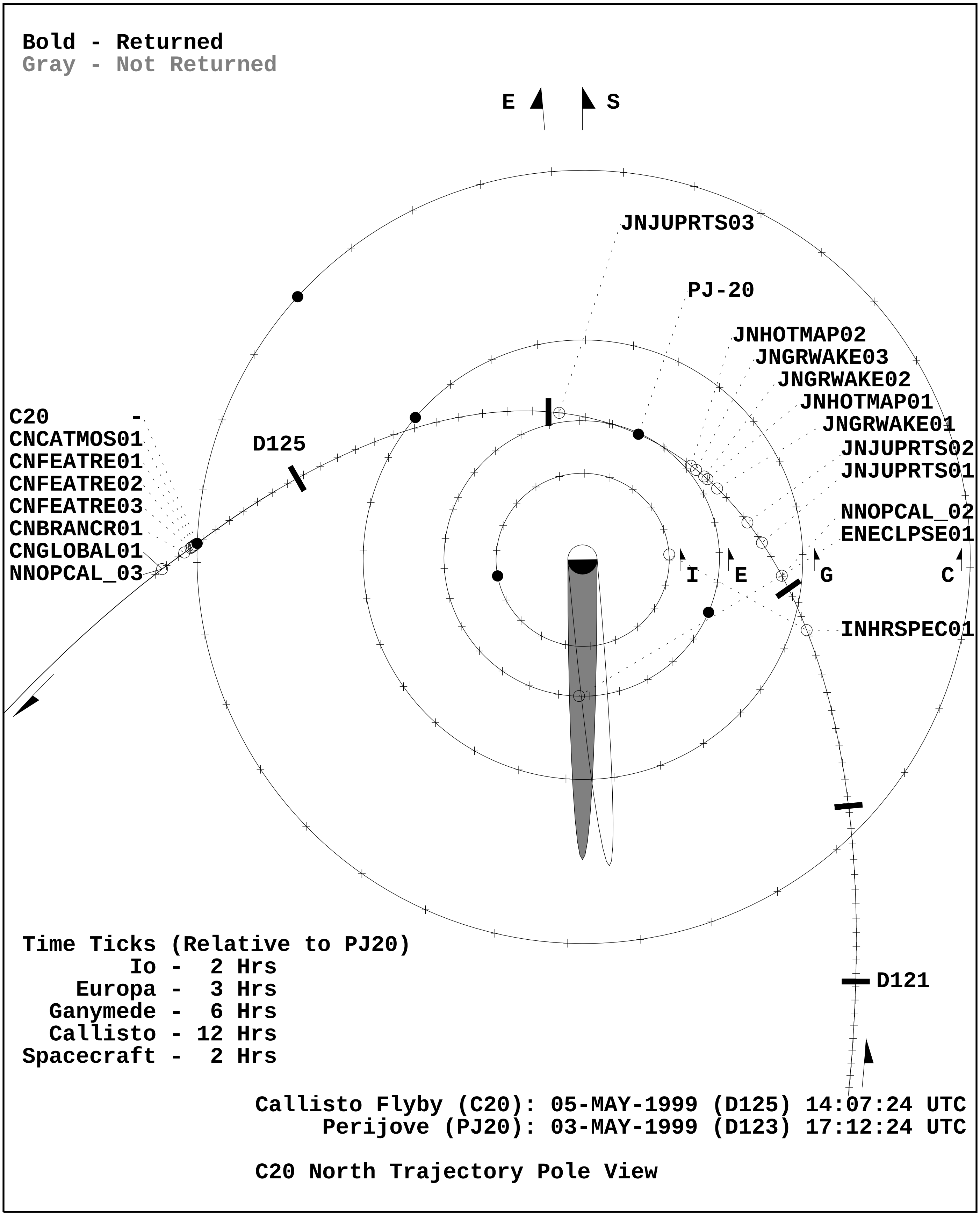
A Timeline of C20 playback events is on pages 7 through 12.

The text on pages 13 and 14 describes the C20 NIMS and Spacecraft Anomalies.

The text on page 15 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 16 and 17.

The text on page 18 is a guide to understanding the NIMS MASK.

NIMS C20 OBSERVATIONS

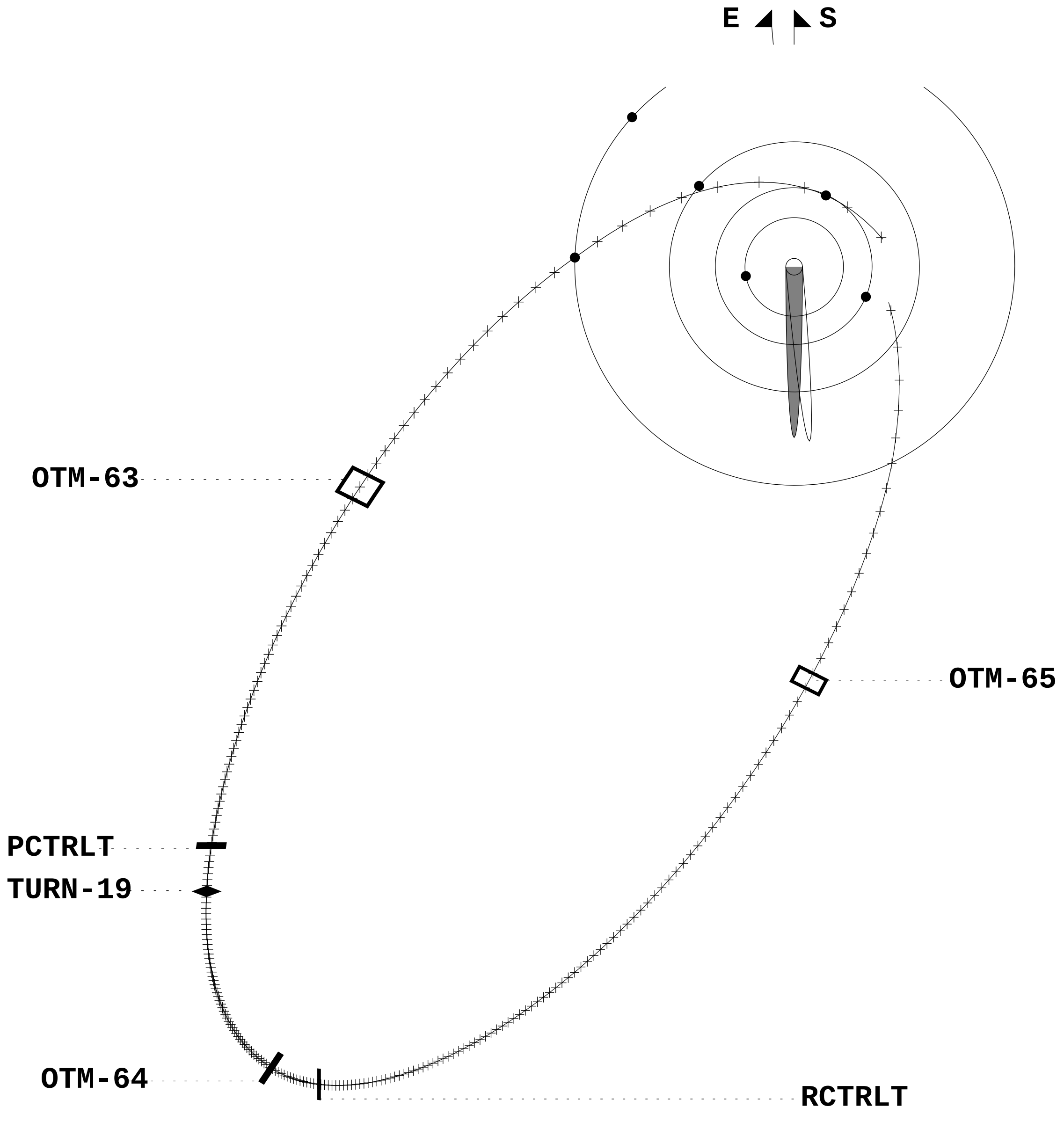


NIMS - FEL - 12/06/99

NIMS C20 CRUISE CALIBRATIONS

Callisto Flyby (C20): 05-MAY-1999 (D125) 14:07:24 UTC
Perijove (PJ20): 03-MAY-1999 (D123) 17:12:24 UTC
Apojove (AJ20): 02-JUN-1999 (D153) 16:00:00 UTC

Time Ticks (Relative to C20)
Spacecraft - 6 Hours



C20 North Trajectory Pole View, Perijove to Perijove

NIMS C20 DATA RETURN

Activity ID	Observation Title	NIMS Edit Table	NIMS PB Table	Mode	Gain	Grating Start	Grating Offset	Record Format	PSID
20INHRSPEC01*	Io Monitoring at High Spectral Resolutio	C20ILMDK243D	C20ILMDK228D	LM	4	0	4	LPU	
20ENECLPSE01_O	Europa Eclipse Obs(O)	C20PCT252	C20OPCAL48	LM	4	0	4	MPW	
20JNJUPRTS01*	Jupiter Realtime Observation	C20JLM442/MB	R/T	LM	2	0	4	R/T	
20JNJUPRTS02*	Jupiter Realtime Observation	C20JRT204A/MB	R/T	LM	2	0	4	R/T	
20JNHOTMAP01-	NIMS Jupiter HotMap	C20JHT253A	C20JHT100A	LM	4	0	4	LPU	
20JNGRWAKE03-	GRWAKE03	C20JSB253C	C20JSB140C	LM	2	0	4	LPU	
20JNJUPRTS03*	Jupiter Realtime Observation	C20JLM442/MB	R/T	LM	2	0	4	R/T	
20CNCATMOS01-	Callisto Limb Scan	C20CLM247L	C20CLM228L	LM	4	0	4	LPU	
20CNFEATRE01-	Callisto Feature	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNFEATRE02-	Callisto Feature	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNFEATRE03-	Callisto Feature Observation	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNBRANCR01-	Bran Crater	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNGLOBAL01-	Callisto Global Map	C20CLM243D	C20CLM228D_0	LM	4	0	4	LPU	
20CNGLOBAL01_O	Callisto Global Map(O)	C20PCT252	C20OPCAL48	LM	4	0	4	LPU	
20NNRCTRLT01-	NIMS RCT Real Time Calibration	C20RCT252	R/T	LM	1	0	4	R/T	
20NNROPCAL01	NIMS OPCAL	C20OPCAL48	R/T	LM	4	0	4	R/T	
20NNPCTRLT01-	NIMS Real-Time PCT Calibration	C20PCT252	R/T	LM	4	0	4	R/T	
20INHRSPEC01* gf	Io Monitoring at High Spectral Resolutio	C20ILMDK243D	C20ILMDK228D	LM	4	0	4	LPU	
20ENECLPSE01*	Europa Eclipse Obs	C20ELM442	C20ELM360	LM	4	0	4	MPW	
20JNGRWAKE01-	GRWAKE01	C20JHT253A	C20JHT100A	LM	4	0	4	LPU	
20JNHOTMAP01-gf	NIMS Jupiter HotMap	C20JHT253A	C20JHT100A	LM	4	0	4	LPU	
20JNGRWAKE02-	GRWAKE02	C20JSB253C	C20JSB140C	LM	2	0	4	LPU	
20JNGRWAKE03- gf	GRWAKE03	C20JSB253C	C20JSB140C	LM	2	0	4	LPU	
20JNHOTMAP02-	NIMS Jupiter HotMap	C20JSB253C	C20JSB140C	LM	2	0	4	LPU	
20CNCATMOS01-gf	Callisto Limb Scan	C20CLM247L	C20CLM228L	LM	4	0	4	LPU	
20CNFEATRE01-	Callisto Feature	C20CLM442	C20CLM132D	LM	4	0	4	MPW	
20CNFEATRE01-	Callisto Feature	C20CLM442	C20CLM360	LM	4	0	4	MPW	
20CNFEATRE02-	Callisto Feature	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNFEATRE03-	Callisto Feature Observation	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNBRANCR01-gf	Bran Crater	C20CLM442	C20CLM228D_1	LM	4	0	4	MPW	
20CNGLOBAL01-gf	Callisto Global Map	C20CLM243D	C20CLM228D_0	LM	4	0	4	LPU	
20CNGLOBAL01-	Callisto Global Map	C20CLM243D	C20CLM228D_0	LM	4	0	4	LPU	

gf = gap fill

NIMS C20 DATA RETURN

Activity ID	Mode	Record Format	Wave-lengths Returned	Record Time (sec)	PB Time (sec)	Selected Bits of Tape sBOT (MBITS)	Total Bits of Tape BOT (Mbit)	Mode Cycle (sec)	Comp	Thold	RT BTG MBits	Total BTG (Mbits) (4% ohead)	Data Reduct Factor (sBOT/BTG)	Pass
20INHRSPEC01	LM	LPU	228	240	180	1.11	1.48	8.667	1.65	0		0.597	1.86	1
20ENECLPSE01_O	LM	MPW	48	120	61	0.70	1.38	8.667	2.06	0		0.034	20.60	1
20JNJUPRTS01	LM	R/T	360								0.16			
20JNJUPRTS02	LM	R/T	204								0.16			
20JNHOTMAP01	LM	LPU	100	885	423	2.61	5.46	8.667	1.19	0		0.853	3.06	1
20JNGRWAKE03	LM	LPU	140	585	585	3.61	3.61	8.667	1.53	0		1.285	2.81	1
20JNJUPRTS03	LM	R/T	360								0.16			1
20CNCATMOS01	LM	LPU	228	600	600	3.70	3.70	8.667	2.33	0		1.409	2.63	1
20CNFEATRE01	LM	MPW	228	600	269	3.10	6.91	8.667	2.03	0		0.725	4.27	1
20CNFEATRE02	LM	MPW	228	1102	512	5.90	12.70	8.667	1.98	0		1.415	4.17	1
20CNFEATRE03	LM	MPW	228	600	298	3.43	6.91	8.667	2.07	0		0.788	4.36	1
20CNBRANCR01	LM	MPW	228	819	747	8.61	9.43	8.667	2.08	0		1.965	4.38	1
20CNGLOBAL01	LM	LPU	228	1700	434	2.68	10.49	8.667	1.74	0		1.365	1.96	1
20CNGLOBAL01_O	LM	LPU	48	120	120	0.74	0.74	8.667	2.00	0		0.069	10.71	1
20INHRSPEC01	LM	LPU	228	240	57	0.35	1.48	8.667	1.65	0		0.189	1.86	2
20ENECLPSE01	LM	MPW	360	300	182	2.10	3.46	8.667	1.77	0		0.888	2.36	2
20JNGRWAKE01	LM	LPU	100	585	446	2.75	3.61	8.667	1.15	0		0.931	2.96	2
20JNHOTMAP01	LM	LPU	100	885	22	0.14	5.46	8.667	1.19	0		0.044	3.06	2
20JNGRWAKE02	LM	LPU	140	585	427	2.63	3.61	8.667	1.57	0		0.914	2.88	2
20JNGRWAKE03	LM	LPU	140	585	170	1.05	3.61	8.667	1.53	0		0.373	2.81	2
20JNHOTMAP02	LM	LPU	140	885	423	2.61	5.46	8.667	1.58	0		0.900	2.90	2
20CNCATMOS01	LM	LPU	228	600	140	0.86	3.70	8.667	2.30	0		0.333	2.59	2
20CNFEATRE01	LM	MPW	132	600	270	3.11	6.91	8.667	2.10	0		0.407	7.64	2
20CNFEATRE01	LM	MPW	360	600	270	3.11	6.91	8.667	2.01	0		1.161	2.68	2
20CNFEATRE02	LM	MPW	228	1102	586	6.75	12.70	8.667	2.01	0		1.595	4.23	2
20CNFEATRE03	LM	MPW	228	600	311	3.58	6.91	8.667	2.09	0		0.814	4.40	2
20CNBRANCR01	LM	MPW	228	819	106	1.22	9.43	8.667	2.08	0		0.279	4.38	2
20CNGLOBAL01	LM	LPU	228	1700	209	1.29	10.49	8.667	1.92	0		0.596	2.16	2
20CNGLOBAL01	LM	LPU	228	1700	1210	7.46	10.49	8.667	1.92	0		3.448	2.16	2
Total												23.377	**Total**	
Allocated												24.054	**Allocation**	
												-0.677	**Over/Under**	

RECAP OF C20 PLAYBACK EVENTS

C20 was highly successful, both in terms of the quality of the data returned (for Callisto, and for Jupiter), and for the successful adaptations to circumstances accomplished by the Galileo flight team. C20 was the first of the "perijove reduction campaign" orbits of GEM, and downlink bits were relatively scarce. Nonetheless, thanks to good compression, a very nice set of Callisto observations was obtained.

Although Galileo twice experienced "bus reset" faults during the encounter, similar to the one which safed the spacecraft in E16, in both cases a new software patch enabled an immediate recovery. The second of these corresponded in time to a NIMS software crash, which likewise led to no adverse consequences because of a following standard software reload. Late in the encounter Galileo was commanded to inertial mode, in order for NIMS to obtain the best possible Callisto data. However, shortly thereafter the spacecraft dropped back into cruise mode, due to gyro problems, and stayed there for the Callisto encounter.

The following timeline details the most signifigant events of the C20 playback period. Most of the text below is excerpted from messages issued at the time.

C20 Playback Events Timeline (03-10-99: to 06-28-99:)

03-10-99: This is a summary of our actions taken to bring C20 playback into line with our allocation. As you know the allocation is only about 20 Mbits and we are recording much more data than that. Based on Bob Carlson's priority list we gave lowest priority to the Jupiter HOTMAP observations. Spatial coverage for these was cut in half (lower scan of two, in each case, centered over latitude 5 North). The cuts in wavelength coverage from Kevin Baines were implemented and we increased the dayside compression estimates to conform with E19 experience.
The JNGRWAKE observations are retained with full spatial coverage and with wavelengths as specified by Kevin Baines. Only the third (dayside) will come down in pass 1 so that we can identify the locations of key features, and possibly trim spatial coverage for the two remaining in pass 2.
By projecting less conservative compression estimates for Callisto we were able to increase spatial coverage for all of the observations. Only CNFEATRE02 is not fully selected. 20ENCLIPSE01 has two full scans over the target and so the first scan was deleted. 20INHRSPEC01 is only 3 Rims in duration and was retained unchanged (228 wavelengths).
"Stealth" OPCALS are to be appended to 20ENCLIPSE01 and to 20CNGLOBAL01. We estimated that these would have 1 Rim of recording, using a 252 band table, and would return 48 wavelengths in playback.

C20 Playback Events Timeline (03-10-99: to 06-28-99:)

The Callisto limb scan with highest priority will be returned in full with 228 wavelengths using the table created for the E19 Ganymede aurora observations.
The above changes bring us into line with allocation and will permit the playback coordinators to model playback events with some confidence.

03-19-99: NIMS playback allocation is 21.972 Megabits.

04-21-99: (K. Schimmels) C20 Allocations have been reduced due to station losses - total capability loss was 5.65 MB between the last cruise product (C20BFA) and the upcoming (C20BFE) product. We were holding an additional 3.5 MB to cover these anticipated losses, so 2.15 MB will need to be reduced from your allocations. The new allocations are below.
NIMS 21.758

04-22-99: The C20 encounter begins on 2 May. The final pre-uplink playback table delivery happened today.
The 20CNCATMOS01 (limb scan) observation was moved from the second tape pass to the first to permit gap filling. Otherwise there were only minor changes (to data reduction factors).
A software patch to prevent spacecraft safing due to despun bus resets will be employed this time to help avoid the safing condition that impacted us in E16. We hope for the best since our Callisto observations come on the outbound portion of the encounter. In the current plan we will return nearly all of our spatial coverage for all targets (we will get only 50% for the two Jupiter HOTMAP observations). We will leave behind a substantial number of wavelengths for many observations, however. Our total bits allocation is only 21.4 Mb for this orbit.
Calibration fans will be happy to know that two OPCALs are included, at the start and end of the encounter period. These are tacked on to the ends of other NIMS recorded observations.

05-02-99: C20 encounter begins at 17:00 UTC.

05-03-99: Perijove occurs at 17:12:24. Between 17:57 and 18:51, a despun bus reset occurs. CDS software handles this as planned and the encounter continues.

05-04-99: A second bus reset occurs at about 00:08:05 UTC. CDS handles this one as well.

05-05-99: (M. Segura) Here is an update on the spacecraft activities for C20. The CDS "Burp" patch designed to protect us from Bus RESET safing occurrences executed twice in the early part of C20 Encounter. Once at 123/17:57ish (SCET) and again at 124/00:08. As a result - the spacecraft reverted to Cruise mode from inertial.

There was a decision made yesterday afternoon to attempt to return the spacecraft to inertial mode for Callisto observing to provide NIMS with the best data possible. AACS supported this based on knowledge at hand. The commands were sent to the spacecraft last evening. At the first SSI slew of Callisto C/A, the spacecraft dropped into cruise mode again. So.... all our observations will be executed in cruise mode. As a result of our attempt, SSI has probably lost their highest resolution observation at worst and mispointed at best.
Bob Mehlman reported one inconsequential reset at rim 4979800. While it didn't impact our data (we do have a reload prior our first Callisto observation), it does have great significance. That was at the exact time that the second Burp patch executed to protect us from safing. We were to expect up to a 5 minor frame loss of CDS timing pulses whenever the patch executed. There were two possible scenarios for NIMS - that we would have a momentary lapse in data or that the software would crash. We now know what will happen.
This knowledge will be factored into our sequence development. Now we not only have radiation to contend with for reloads but this as well.

05-07-99: (J. Erickson) The gyros did not behave well this encounter, so we have spent most of the time in cruise mode. We had a gyro high rate trip early in the sequence which hasd only minimal impact. After we returned to inertial mode for the beginning of the Callisto observations, we tripped out of inertial again (at 99-125/14:08 SCET). This was due to a Y-axis mismatch. The spacecraft has fully redundant gyro capability in the Y axis, and the Attitude Control System has fault protection checks that both of the Y asis gyros are reporting consistent values.
Subsequent gyro tests have indicated that the -1 Y gyro axis error increased during the perijove pass to almost 10%. This would almost guarantee a fault trip. The gyro test has also shown that the -1 X gyro axis has now increased to a 60% mismatch.

05-26-99: The first Callisto data will be coming down about June 6 or so. We have several large observations and a relatively tight budget for downlink bits. Four changes to the playback table were made this week to enable us to adapt to possible undercompression of the Callisto data.
Marcia Segura gave highest priority to 20CNGLOBAL01 which sees new territory and completes our global mapping. One of 3 scans will be returned in pass 1, giving us an accurate value for compression. Second priority is the Bran crater observation. This was moved from pass 2 to pass 1 to enable later filling of any gaps.

C20 Playback Events Timeline (03-10-99: to 06-28-99:)

The three 20CNFEATRE0n observations were planned for playback in pass 1. All of these are now split between the two tape passes. If compression is lower than expected, or if one observation turns out to be very interesting, we will be able to shift our bits around to adapt to conditions in pass 2. There are large gaps in 20INHRSPEC01 and 20JNGRWAKE03. Next week we will need to enter our gap-fill commands for these, possibly (temporarily) stealing bits from pass 2 Callisto observations to get this done.

06-02-99: The second pass over the C20 recorded observations begins next week. The current update represents the last chance to fill gaps in our Io and Jupiter observations. We have not received any Callisto data so far, and the compression values for those observations are unknown at the moment. For this update we made no changes to the Callisto plan, other than moving one playback command earlier by 3 seconds. Six new sets of commands were added to the table this week to fill gaps in the observations that have reached the ground.
Since we have not received any additional downlink bits, the addition of the new commands required some trimming of other observations. Kevin Baines spent some time reviewing the Jupiter observations and came up with the following strategy:

1. Bit savings were accomplished by trimming spatial coverage of 20JNGRWAKE01 (dark side, longitudes >= 270), and 20JNGRWAKE02 (easternmost scans that do not overlap with 20JNGRWAKE03).
2. Large gaps in 20JNGRWAKE03 will all be filled, and the most significant 70% of 20JNGRWAKE02 will come down. No changes to the coverage of the two HOTMAPs were implemented. One gap in 20JNHOTMAP01 will be filled. In addition we are filling the significant gap in 20INHRSPEC01.

06-07-99: (K. Schimmels) There will be bits released this week based on lower inefficiencies than expected. 2.6 MB of unused inefficiency margin will be released by relative OPG percentage to those teams that still have playback left to affect in Segments 13 on. If this includes anyone other than SSI and NIMS, please let me know before Wednesday.

06-09-99: (K. Schimmels) Unused bits (inefficiency 2.6 MB and PPR 0.325 MB) release for C20 is as follows:
SSI: 1.886 MB
NIMS: 1.038 MB
Total: 2.924 MB

06-10-99: MWG has decided to release their 3.0 MB by OPG percentage to SSI and NIMS, as well as help UVS out. UVS has been undercompressing and needs 0.3 MB to solve their overage and fill 2 small gaps. The remainder (2.7 MB) will be split between SSI and NIMS as follows:
1.74 SSI
0.96 NIMS

06-10-99: Playback is currently running about half a day behind schedule, apparently due to SSI undercompression. NIMS Callisto data is compressing slightly better than predicted, yielding bit savings of approximately 0.6 Mbits to this point. We should start the second pass over the tape tonight if all goes as planned. We received 1 Mb from office margin this week. There may or may not be an additional release for the final update cycle next week. Also this week, the MWG found that they had some 3.3 Mbits of downlink allocation that they could not use. Of this, we received nearly 1 Mbit. SSI and UVS also received needed bits.
Two changes to the table were made this week. We are requesting gap fill for 20CNCATMOS01; there was a 2-Rim gap in our pass 1 playback. This requires 0.4 Mbits. In addition, we are extending the playback time for our pass 2 20CNGLOBAL01 to return an additional 4.3 Rims of recorded data. A portion of this consists of off-limb scans that will be very valuable for determining detector dark values for this orbit. This requires about .7 Mbits using our assumed compression of 2.0 for this observation.
We have 1.5 Mbits available for use in the final update cycle next week. The only place we can apply the bits are to the pass 2 Callisto observations. If there are major gaps to be filled, we will use the bits for that purpose. If we have a significant quantity of bits left, we could use them to increase wavelength coverage of one or possibly more of the high-resolution Callisto observations (20CNBRANC01, 20CNFEATRE01-03).

06-15-99: (K. Schimmels) The cost of the BURP early enable / early TPB is 1.35 MB, of which we have retained 2.0 MB to protect. Therefore, we have 0.65 MB remaining to release from this, and an additional .24 MB of MWG unused bits. Therefore, the btg released this week for C20 is as follows:
SSI: 0.22
NIMS: 0.66
Total: 0.88
This was done by relative percentage of playback remaining in the affectable segments (15 and 16), as per discussion in today's SPOT meeting.

06-14-99: (R. Mehlman) 1. There was an error in the playback request for 20NNOPCAL_03 (the last pass 1 request for 20CNGLOBAL01). The request is for two RIMs, but should only have been for one RIM, the second one. The first RIM contains GLOBAL01 data, probably off-limb, but it was played back with an OPCAL WET table. The result would contain only 24 wavelengths of the 228 recorded for GLOBAL01. I have set the SCLK for those (five) packets to zero, so MIPS will not process them. If you want that RIM of data, you can ask for it in the 2nd pass.

C20 Playback Events Timeline (03-10-99: to 06-28-99:)

06-16-99: Playback of C20 data will end on about 28 June. Today's update is the final opportunity to modify the playback table. C20 is developing nicely for Callisto afficionados. Compression performance is good with all of the high-resolution observations at about 2.0 or better. 100% of spatial coverage of all observations is planned for return, with the uncertainty centering on the possibility of gaps in data yet to be received as a result of DSN problems. Today's update includes 5 new sets of playback commands to fill gaps in the pass 1 playback of 20CNBRANCR01, along with an additional set to fill a long gap at the start of 20CNGLOBAL01. Thanks to an earlier release of margin bits and a windfall from MWG we were also able to significantly improve on 20CNFEATRE01. This is the highest resolution observation. We will be returning an additional 132 bands for the upper scan, which came down in pass 1, and in addition have commanded all 360 bands of the second scan. The finished product will therefore have full (LM) wavelength resolution for the complete observation. 20CNGLOBAL01 has high priority since it fills significant gaps in our longitudinal coverage. It is the last thing to be played back, and may be at some risk if SSI undercompresses on an observation or two. At present we have a small margin (0.37 Mbits) of our own allocation remaining to protect it.

06-28-99: Playback terminates at 06:24:59.933 UTC.

NIMS Anomaly Report - C20 Sequence

There were two NIMS processor halts detected during the C20 Encounter. Detectors 3 and 8 are still not functioning and are expected to be lost for the rest of the mission.

The spacecraft survived two CDS bus resets. The new CDS bus reset patch (BURP) executed properly so that the spacecraft did not safe itself. AACS went into Cruise mode just before the C20 Callisto flyby. All Callisto observations were performed in Cruise mode.

Unfortunately, each BURP event caused the NIMS software to halt. A secondary effect of the BURP is that AACS went into Cruise mode after each BURP recovery. But, at least the sequence was not completely lost due to spacecraft safing.

Testing to better understand the ongoing changes to the NIMS grating mechanism started in C20.

Processor Halts

Facts:

0. There were two NIMS processor halts in C20. The NIMS flight software was successfully reloaded after each halt.

1. A NIMS processor halt was detected at SCLK 04979800 from the analysis of the NIMS SCLK engineering telemetry channels S-1931 and S-1932. This occurred about 5 hours after perijove, very close in time to the second CDS BURP recovery. In ground testing, it was determined that NIMS would lose RTI synch with CDS for about 5mf during the BURP, which causes the NIMS software to halt. NIMS remained halted for about 28 hours until the next NIMS software reload just before the Callisto flyby.

2. The first BURP event occurred 6 hours earlier. According to ground testing, NIMS should have halted at that time also. There were no NIMS SCLKs reported at the time, but the NIMS hardware status engineering channel, S-1929, went to zero near the time of the first BURP. From this it was inferred that NIMS had halted.

Timing:

SCLK	Comments
04979390.00	PJ-20 Jupiter Closest Approach
04979433.00	First CDS BURP
04979527.04	NIMS Hardware Status Zeroed.
04979731.16	NIMS Software Reload
04979800.00	Second CDS BURP
04980133.58	BAD SCLK reported: 04979800
04982069.16	NIMS Software Reload

NIMS Anomaly Report - C20 Sequence

Spacecraft Anomaly

AACS dropped into Cruise mode at the start of the C20 Callisto flyby. This was apparently in response to errors in the gyro rates.

Grating Anomaly

The NIMS grating mechanism developed a new degree of freedom sometime after the C3 encounter. The grating step size is no longer a fixed parameter anymore but is changing, mostly increasing, in size over time. This new grating 'parameter' has been dubbed Inflation. Now there are two grating parameters, pshift and inflation. Pshift, which gives the correction to the grating start position, is also changing with time. The grating parameters are determined using Opcals (Optics Calibration) and also by fitting spectral features in the NIMS data, such as SO2 absorption bands in the Io data.

The cause of this change in the grating mechanism is not well understood. Radiation damage to electronic components is the best candidate. The two grating parameters could be changing continuously or in a step-wise manner, most likely near perijove where radiation is highest. To test these models, two Opcals were inserted into the encounter sequence, one inbound and one outbound. These encounter Opcals were compared to Opcals taken at E19 perijove and C20 perijove. The result favors a model which has the grating parameters changing in a step-wise manner at or near perijove.

NIMS Archived EDRs and CUBEs

The NIMS data are stored in EDRs (Experimental Data Records) produced by JPL-MIPS (Multi-mission Image Processing System). The NIMS Phase2 EDR is described in the NIMS EDR SIS (Software Interface Specification) Number 232-08. The same information is available in both human and machine-readable form in the PDS (Planetary Data System) structure files EDRHDR.FMT and EDRDATA.FMT in the LABEL directory of the NIMS EDR CD-ROM. Each observation has at least one EDR. The EDR file name is derived from the 12 character observation name plus a single character which allows an observation to be broken up into multiple EDRs. The EDRs have a Vicar label, followed by a PDS/ISIS label, binary header records and the data records. For archiving on CD-ROM, the Vicar labels are detached from the EDR (but kept separately on CD) and the file is renamed so as to conform to the 8.3 DOS file-naming convention. The 8.3 EDR name consists of a 2 character orbit identifier, a single character target identifier, a 3 digit counter and the suffix EDR. For example, the MIPS EDR G1GNGLOBAL01A.1 becomes G1G001.EDR. More information about NIMS EDRs can be found in the VOLINFO.TXT file on the EDR CD-ROM.

NIMS EDR data typically require considerable processing before they are readily amenable to science analysis. Normally, the EDRs are processed into spectral image cubes by one of several sets of software. MIPS systematically processes the EDRs into CUBEs (band sequential image files) and MASKs (spatial/spectral summary images) which are distributed on the NIMS CUBE CD-ROMs. Information about the structure of the NIMS CUBEs can be found in the VOLINFO.TXT file on the CUBE CD-ROM. The name of the CUBE file is derived from the input EDR filename. For archiving on CD-ROM, the CUBE files are renamed so as to conform to the 8.3 DOS file-naming convention. The 8.3 CUBE name consists of a 2 character orbit identifier, a single character target identifier, a 3 digit counter, a single character cube-type identifier, a single character data unit-type (DN, radiance or IOF) and the suffix QUB. For example, the MIPS IOF radiance cube for the observation G1GNGLOBAL01A.1 (G1G001) becomes G1G001CR.EDR. The summary MASKs on the CD-ROM have the same 6 character name as the EDR name with the suffix JPG or GIF to denote its graphics format.

NIMS Data Format - Data types - Data Labels - Data Access

Data Format

All data files have PDS labels. The raw data (EDR) file contains time-sequential, 16 bit integers. Reduced data files (TUBES and CUBES) may be viewed as images or spectra. They contain VAX real numbers, are band sequential (BSQ - the images are stacked in band order) and have geometry information appended as backplanes after the last NIMS band.

Data Types

Mask files contain summary images (3 band BSQ) and spectra of up to six selected regions that provide a quick indication of data location, data quality and spectral content. A Guide to understanding the NIMS mask is available.

Cube files contain data that have been projected and resampled. The core data are BSQ - spatial in the first two dimensions, and spectral in the third. Cubes of the satellites are projected in point-of-view, and, with few exceptions have no photometric correction applied. Cubes of Jupiter are (generally) projected as simple cylindrical. Cubes of Europa, Ganymede, and Callisto have been despiked. The cubes are available both in radiance and I/F (intensity divided by flux) form.

Tube files contain data in (almost) time order and normally have a NIMS-related 20 pixel spatial dimension (20 x n or n x 20). Projection coordinates are contained in backplanes, but the data have not been resampled. The data are in units of radiance and no despiking has been applied. All data in cubes are also available in tube form. Some data (such as spatially undersampled data) appear in tube form only.

A spike file contains a list of pixels that have been identified as spikes, but not replaced, in the tube. Spike files can be used to remove spikes from both tube and EDR files.

EDR files contain the most primitive form of the data available. They should be used only for advanced data analysis. The format is complex and the files do not form images or spectra without prior processing.

NIMS Data Format - Data types - Data Labels - Data Access

Data Labels

A data label (PDS form) is attached to the front of each file (except masks, which have an attached VICAR label and a detached PDS label). The labels are in ASCII keyword=value format and contain pointers to various data objects in the file, descriptions of the data objects and descriptions of the observation associated with the file. A history object in similar format follows and describes the processing steps that produced the file. Much of this information is necessary for understanding and viewing the cube. In particular, the label contains the offset to the cube, the dimensions of the cube, axes labels, and explicit wavelength information.

Data Access

Software for processing this data is called ISIS and is available for DEC VAX VMS, SUN Solaris, DEC Alpha Digital Unix, Silicon Graphics Unix and PC LINUX systems. The Unix versions are available from the USGS Astrogeology team. Images from NIMS cubes and tubes can be viewed with any image display program which allows an offset from the beginning of the file to the selected image. Packages tested include ISIS, VICAR, ENVI, SAO IMAGE, and NASAVIEW. ISIS and ENVI (and soon NASAVIEW) additionally display spectra. The ISIS viewer is named CV (UNIX) or QL3 (VMS).

Labels may be displayed with some editors (eg DOS edit), and with most "type" and "search" functions. Some editors do not recognize the PDS line termination conventions. The label may be listed by the ISIS function LHLIST (VMS) or LABEL (UNIX).

Software for converting EDRs to cubes exist in both ISIS (DEC VAX VMS) and VICAR (DEC Alpha VMS) versions only. A primitive list of values in an EDR may be obtained with the program EDRDMP2.

Understanding the NIMS Mask

The NIMS mask is designed to provide a quick summary of the contents of a NIMS data cube (or tube). It displays a view of both the spatial and spectral content of the data.

The mask has four regions. Starting from the upper left and proceeding clockwise: a spatial display; six or fewer representative spectra; annotation; and a spectral histogram.

The spatial display of an observation which has been projected and resampled (a cube) has a maximum size of 600x600 pixels. This is overlaid with surface coordinates and is embedded in a 700x700 grid of pixel coordinates. It is accompanied by two 1-dimensional histograms describing the raw image and the image stretched for display. The data image can range from a simple combination of up to 3 NIMS bands displayed in the RGB planes, to complicated arithmetic functions of NIMS bands displayed in the RGB planes. (The formulas appear as annotation below the histograms.) The graphics directly below the image show the input and output data histograms for the three color planes. The "shortest" color for each bin displays in front. The image also contains from one to six numbered rectangles, which show the from which averaged spectra (displayed on the right) were taken.

The spatial display of an observation in time sequence (a tube) is a graphic showing a footprint of the observation over a grid of surface coordinates on the target body. Numerals 1-6 on the graphic mark the locations of the average spectra displayed on the right.

The spectra to the right of the image may display either BDRF or radiance (or both). If both are displayed, then a vertical "radiance fence" line will appear where the breakpoint occurs. This permits display of both atmospheric data, which have significant reflectance and thermal components, and I/F satellite surface data which have strong absorptions at longer wavelengths (such as water spectra.) The spectra are labelled with wavelength in microns and location in both pixel and latitude-longitude space.

The annotation provides information about the observation, including its name, a brief description, its geometry, instrument and projection parameters. TCA is the time from Galileo’s closest approach to the target body.

The 2-dimensional spectral histogram in the lower left corner shows the number of pixels at a given radiance for each wavelength. If a surface contains spatial mixtures with significantly different spatial fractions for several components, the spectra of the components will be evident in this display.