Results of Target Acquisition Tests at LMSC; February, 1986

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ABSTRACT

Target acquisition tests at LMSC were carried out using the newly installed LEDs and the flight software version 3.7, which incorporates aperture acquisition with the LED. Binary Search and Firmware target acquisition were run on both the blue and the red sides. Although the tests were basically successful (i.e. the targets were found and estimates of accuracy could be made) there were several problems in the running of the command loads for target acquisition, and there were several errors in the flight software. Results and problems are discussed below.

I. INTRODUCTION

A target was simulated by illuminating an aperture with the LED, with the camera mirror in place. Both target acquisitions and fine maps were done using the smallest apertures (B2, the circular aperture, and A4L, the lower square paired aperture). Aperture acquisitions were done for B2, B1, and B3 ($0''.3$, $0''.5$, and $1''.0$ circular apertures) and for A4L, A3L, A2L, and C1L ($0''.1$, $0''.25$, $0''.5$, and $1''.0$ lower paired square apertures). As an additional consistancy check, some Firmware acquisitions were done using both the leading edge and the trailing edge of the diode. And as an additional test of accuracy, a series of Binary Search acquisitions was done in the A4L aperture with decreasing integration times.

II. PROCEDURAL PROBLEMS

Although the tests were basically successful, there were a number of problems in the running of the tests. Since the command loads will be similar to those used when HST is in orbit, it is worth summarizing these complications.

a) Wait Before Data Dump

The first problem concerned the amount of time alloted for dumping science data from the FOS microprocessor (CEA) to the NSSC-1. A time of 8 seconds was allocated, but a time of 13 or 14 seconds was needed. As a result, the interface between the CEA and the NSSC-1 was lost, and along with it some of the science data. This is corrected by allowing more time for the science data dump from the CEA.

b) Setting Event Flag 11

The next problem has to do with the setting of event flags (EF). Event flag 11, which indicates that FOS is no longer taking data and the proccessors can continue with the next task, can be set in two different places, as indicated by YTDFLOCK. For YTDFLOCK of 1, EF 11 is set by housekeeping (AP 30) when told by telemetry by the Rest In Peace telemetry point (RIP) that data taking is complete. For YTDFLOCK of 0, EF 11 is set instead in AP 32, the Applications Proccessor that controls Binary Search in the NSSC-1. At the beginning of the Firmware test, YTDFLOCK was set to 0, so that the event flag 11 could only be set in AP 32. But because Firmware has nothing to do with AP 32, EF 11 could not be set and the test halted after taking the first data. Once YTDFLOCK was reset to 1 the test could continue. To avoid this problem, YTDFLOCK should be explicitly set to 1 before Firmware acquisitions, before maps, and before science data acquisition.

c) Updating RIP

There was also a command block error involving Event Flag 11 and the RIP telemetry point. As mentioned before, EF 11 can be set either in housekeeping (AP 30) or in a take data flag RTCS (TDF RTCS). We ran into a timing problem with the setting of EF 11 during the Firmware test on the red side that caused the loss of an aperture map. When data acquisition on one test case was done, the RIP telemetry point was set. Then in the TDF RTCS, the event flag was cleared, and an acquisition was begun. RIP is not updated until the end of a major frame in the NSSC-1, at minor frame 119. But housekeeping checks RIP in minor frame 6, at the beginning of a major frame. So housekeeping looked at RIP, saw that it was still set to YES because it had not yet been updated, set event flag 11, and exited the TDF RTCS. The map was never completed.

One possible solution is to set a 61 second event wait after starting a TDF RTCS. The event we are waiting for is a major frame pulse, which tells us that we are at the beginning of a major frame. Then a 4 second wait would be inserted to ensure that we get past minor frame 6, where housekeeping looks at RIP to update event flag 11. This is a clumsy way to ensure that RIP is updated in minor frame 119 before being checked in minor frame 6.

This problem is still under consideration.

d) Setting YBASE

There were several problems with YBASE values. The first had to do with the YBASE values as output in the header packets in Binary Search. In the initial Relative Time Command Sequences (RTCSs) that are loaded for Binary Search, values for the start value of YBASE are loaded twice; first as a 12 bit number to the CEA (YBASE) and later as an 18 bit number to the NSSC-1 (YBASKP). As a short cut, YBASE was loaded into YBASKP, but because YBASE is 12 bit, the high order bit which indicates a negative sign, was misinterpreted in the 18 bit number. Because the FOS CEA took only the lower 12 bits of the 18 bit YBASKP, the YBASE values were set correctly in the test, and the test was executed correctly. The solution is to continue to load YBASE and YBASKP separately in the RTCS.

e) Setting YBASE

Finally, there was a problem with the intial YBASE values for Binary Search TA. Any time BS TA is run several times in a row, only the first time has the correct YBASE values. The sequential TAs always start with the last YBASE value from the previous test, as can be seen in Table 1.

A new YBASE value is entered in an RTCS before each TA. When AP 32 is entered, it asks if YBASE has been previously set. If TA has just been done, the answer is yes, and the old value, YBASE, is used. For the second step, YBASKP is used instead of YBASE. Since YBASKP also has been set in the initial RTCS, it has the correct value, and the BS proceeds as planned.

On the blue side, TA was able to recover from this error because by chance one of the offsets had most of the target in the diode and the total counts in the target was updated to a reasonable number. On the first time through the red side this was not the case, and most examples failed to find the correct position. The soluction is to force the loading of YBASE by loading it in the YS32TA command block.

f) A Bug in Flight Software; Updating YBASE

Two bugs that will require changes in the Flight Software, hopefully to go into the 3.9 version, were found. The first has to do with updating the Engineering Header Data (EHD); the second has to do with the slews computed in Binary Search after the target is found.

Engineering Header Data in the FOS microprocessor (CEA) is updated continually, the entire update taking 60 seconds. To avoid a 60 second wait, there are two ways to jump ahead of the 64 word EHD sequence. The NSSC-1 uses a telemetry interupt for specific words; the CEA uses an EFILL command. To update YBASE, which is made up of 2 words, telemetry interupt 55 (TLM55) will send the high order word to EHD and save the low order word in a temporary word, 8TEMP. Then TLM56 gets 8TEMP and puts it in the EHD so that the 2 words for YBASE are updated. EFILL, on the other hand, updated the 64 word EHD instantaneously. Now, if TLM55 was initiated and it put the high YBASE word into EHD and the low YBASE word in 8TEMP, and then YBASE was updated and EFILL was executed before TLM56 could be initiated, then TLM56 would update the low YBASE value in EHD with the low YBASE word. In the case of interest (Table 1, case 4) the YBASE value is composed of the new high order YBASE and the old low order YBASE. (In hextadecimal this is FFFFFF07 combined with FFFFFEE7, to make FFFFFE07. Here the highest order FFFF is used to designate negative sign.)

To avoid this error, no YEFILL command can be sent closer than 2 seconds after an FOS Serial Magnitude Command. This is further discussed in a memo by R. Hier. This error must be written up in a non-conformance report.

g) A Second Bug in Flight Software; Binary Search Slew

The slew problem is a design error, not a mistake. After Binary Search finds the Y position of the target it then calculates a slew to a Y postition of 0 in base units. Instead it should calculate a slew to the Y position used in the first aperture map of BS. This is a straight forward change that should be easy to implement and should not take appreciatiable space. It requires a program trouble report (PRT).

III. RESULTS

An example of results are summarized in Table 1 for Binary Search, and final results for both Binary Search and Firmware are in Tables 2, 3, 4, and 5. The conventions for X positions are as follows. The Firmware produces a number (YTARXCTR) which is the distance from the target to the middle of diode 256 in XBASE units. The Binary Search produces a number that is the distance from the target to the middle of the diodes used in TA in XBASE units. On the red side the middle is (247-224)/2+224 or 235.5; on the blue side it is (279-256)/2+256 or 267.5. As a comparison, the X positions on the maps are also quoted in these units. Tables 2 and 3 show the X positions for the blue and the red side, respectively. The TA results are in good agreement with the maps, with a scatter on the order of a few XBASE units. Some of the procedural problems discussed above show up as notes to the Tables.

The Y positions can be seen in Tables 4 and 5 for the blue and red sides, respectively. Firmware used both the leading edge and the trailing edge of the diode to locate the target for some apertures. On the blue side this revealed that we did not have the whole aperture in the map, and the trailing edge gave a result that was too negative. This was corrected on the red side, and the differences in the positions using the two edges were 259, 252, and 255 for apertures B2, A3L, and A4L, respectively. These differences are very close to the diode height of 256.

The option to stop binary search aperture map after finding the target should be used very conservatively. The binary search test on the red side used that option, but because the target was not completely on the diode to start, YNMAX, the total number of counts in the target, was incorrect, and BS could never recover. When the whole aperture is mapped, BS is clever enough to add counts from adjacent maps to get a correct value for YNMAX.

On the red side, under Binary Search, a series of 4 target acquisitions was done with decreasing total counts in the peak. This was meant as a rough check of accuracy as a function of peak count. The peak counts were approximately 1400, 750, 375, and 188. The detected positions for the 4 succesive acquisitions did not vary much. However, because an aperture, which is relatively extended, is used to simulate a point source, the value of this test is limited.

The direction of a slew changes sign according to whether it is a target acquisition (YTAMIN=0) or an aperture acquisition (YTAINV=1). This sign change has been verified.

Table 1

Summary of Binary Search Test Cases YTAFUN6A

Run on March 5, 1986

Case 5	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-441			19680
BS	-313	10111	YES	
	-249	1229	NO	
	-281	7014	NO	
	-297	11591	YES	
	-297*	9221	NO	
	-293	10395	YES	
	-291	7894	ON EDGE	
Results:	YFXCTR=-1704		YFYCTR=-91925	YTAINV=1

Case 4	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-441			14231
BS	-313	12179	YES	
	-249	407	NO	
	-505*	3815	NO	
	-297	8213	YES	
	-289	6043	NO	
	-293	7058	YES	
Results:	YFXCTR=-1616		YFYCTR=-91875	YTAINV=1

Note: X postions are given in units of 32 microns at the photocathode. To convert to XBASE units, divide by 50. Y positions reflect the error described in section III. To put them in YBASE units, divide by 25, convert to octal, add 7777770000, and convert back to decimal.

Table 1 continued

Case 7	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-293**			7074
BS	-313	12325	YES	
	-249	388	NO	
	-281	3965	NO	
	-297	8211	YES	
	-289	6055	ON EDGE	
Results:	YFXCTR=1604		YFYCTR=91975	YTAINV=0

Case 6	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-289			22716
BS	-313	20957	YES	
	-249	7088	NO	
	-281	13857	YES	
	-265	10271	ON EDGE	
Results:	YFXCTR=-1579		YFYCTR=-92575	YTAINV=1

Table 1 continued

Case 9	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-709			22716
BS	-581	16642	YES	
	-517	1300	NO	
	-549	8009	NO	
	-565	12299	YES	
	-557	10297	NO	
	-561	11385	ON EDGE	
Results:	YFXCTR=-1354		YFYCTR=-85175	YTAINV=1

Case 8	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-561**			5788
BS	-581	12123	YES	
	-517	232	NO	
	-549	2760	NO	
	-565	7133	YES	
	-557	4815	NO	
	-561	5948	ON EDGE	
Results:	YFXCTR=-1316		YFYCTR=-85175	YTAINV=1

Table 1 continued

Case 2	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-709			6371
BS	-581	5566	YES	
	-517	137	NO	
	-549	1436	NO	
	-565	3634	YES	
	-557	2473	NO	
	-561	3072	ON EDGE	
Results:	YFXCTR=1441		YFYCTR=85175	YTAINV=0

Case 10	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-561**			21043
BS	-581	25522	YES	
	-517	9812	NO	
	-549	17197	YES	
	-533	13233	ON EDGE	
Results:	YFXCTR=-1316		YFYCTR=-85875	YTAINV=1

Table 1 continued

Case 21	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-441			15154
BS	-313	13414	YES	
	-249	597	NO	
	-281	4631	NO	
	-297	9099	YES	
	-289	6906	NO	
	-293	8027	YES	
	-291	7772	ON EDGE	
Results:	YFXCTR=1329		YFYCTR=91925	YTAINV=0

Case 22	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-291**			7017
BS	-313	12310	YES	
	-249	399	NO	
	-281	4199	NO	
	-297	8641	YES	
	-289	6361	ON EDGE	
Results:	YFXCTR=1579		YFYCTR=91975	YTAINV=0

Table 1 continued

Case 23	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-289**			6398
BS	-313	12542	YES	
	-249	442	NO	
	-281	4230	NO	
	-297	8482	YES	
	-289	6055	ON EDGE	
Results:	YFXCTR=2565		YFYCTR=92999	Y=0

Steps marked by * denote cases when the engineering header data did not have a correctly updated value of YBASE due to the problem with EFILL discussed in the text. Steps marked by a ** denote cases when AP 32 rejected a new value for YBASE because it already had a value from the previous target (or aperture) acquisition.

Table 2

Red Side X Positions, March 5, 1986

Type of Acquisition	Aperture	Firmware Position	Binary Search Position
AA	B1 0″.5	350	-13.92
Map	B2 0″.3	348.8	-16.00
AA	B2 0″.3	349	-15.16
TA	B2 0″.3	350	-15.42
other edge	B2 0″.3	345	NA
AA	B3 1″.0	352	****
AA	A2L 0″.5	355	-10.42
AA	A3L 0″.25	353	-11.42
other edge	A3L 0″.25	352	NA
Map	A4L 0″.1	*	-11.49
TA	A4L 0″.1	355	-10.42**
other edge	A4L 0″.1	354	NA
TA	A4L 0″.1	NA	-10.16
TA	A4L 0″.1	NA	-10.16
TA	A4L 0″.1	NA	-10.16
AA	C1L 1″.0	***	-4.92
Map	B2 0″.3	****	****

Positions are in units of XBASE and can be compared to the position of aperture maps. *RTCS error caused loss of map. ** This series of 4 BS TA's was an attempt to check accuracy as a function of total counts, which decreased by a factor of 2 each succesive TA. *** Firmware mapped so far up the image that it began to map the upper aperture, saw two targets, and bombed. **** Aperture wheel was not turned, acquisition was lost.

Table 3

Blue Side X Positions, February 21 and 22, 1986

Type of Acquisition	Aperture	Firmware Position	Binary Search Position
AA	B1 $0\farcs5$	-623	34.08
other edge	B1 $0\farcs5$	-625	NA
Map	B2 $0\farcs3$	-624	34.88
AA	B2 $0\farcs3$	-625	32.32
other edge	B2 $0\farcs3$	-626	NA
TA	B2 $0\farcs3$	-625	32.08
other edge	B2 $0\farcs3$	-626	NA
AA	B3 $1\farcs0$	-628	31.58
AA	B3 $1\farcs0$	-628	NA
AA	A2L $0\farcs5$	-631	27.08
AA	A3L $0\farcs25$	-629	26.32
Map	A4L $0\farcs1$	*	32.32
TA	A4L $0\farcs1$	-628	28.82
AA	C1L $1\farcs0$	-632	26.32

Positions are in units of XBASE and can be compared to the position of aperture maps.
* Lost interface. Not enough time alloted for data dump.

Table 4

Red Side Y Positions, March 5, 1986

Type of Acquisition	Aperture	Firmware Position	Binary Search Position
AA	B1 0.″5	415	440
Map	B2 0.″3	424±3	433±3
AA	B2 0.″3	415	436
TA	B2 0.″3	415	436
other edge	B2 0.″3	418	NA
AA	B3 1.″0	422	****
AA	A2L 0.″5	161	183
AA	A3L 0.″25	163	179
other edge	A3L 0.″25	159	NA
Map	A4L 0.″1	*	159±3
TA	A4L 0.″1	161	175**
other edge	A4L 0.″1	160	NA
TA	A4L 0.″1	NA	171
TA	A4L 0.″1	NA	175
TA	A4L 0.″1	NA	171
AA	C1L 1.″0	***	***
Map	B2 0.″3	****	****

Positions are in units of YBASE and can be compared with the positions in the aperture maps. *RTCS error caused loss of map. ** This series of 4 BS TA's was an attempt to check accuracy as a function of total counts, which decreased by a factor of each succesuve TA. *** Firmware mapped so far up the image that it began to map the upper aperture, saw two targets, and bombed. **** Aperture wheel was not turned, acquisition was lost.

Table 5

Blue Side Y Positions, February 21 and 22, 1986

Type of Acquisition	Aperture	Firmware Position	Binary Search Position
AA	B1 0.″5	-431	-419
other edge	B1 0.″5	-426	NA
Map	B2 0.″3	-426	-420
AA	B2 0.″3	-427	-421
other edge	B2 0.″3	–443*	NA
TA	B2 0.″3	-426	-417
other edge	B2 0.″3	-442*	NA
AA	B3 1.″0	-437	-393
other edge	B3 1.″0	-421	NA
AA	A2L 0.″5	-701	-689
AA	A3L 0.″25	-698	-689
Map	A4L 0.″1	**	-686
TA	A4L 0.″1	-697	-689
AA	C1L 1.″0	-6706	-661

Positions are in units of YBASE and can be compared with the positions in the aperture maps. * The difference between leading and trailing edge is not 256, as expected. In this case the map was not large enough to completely reach off the aperture, so that the trailing edge was in effect the edge of the map. **Lost interface. Not enough time alloted for map.