SPACE TELESCOPE SCIENCE INSTITUTE

INSTRUMENT SCIENCE REPORT
CAL/FOS-024

TITLE: Results of Binary Search Target Acquisition Tests of August, 1985

AUTHOR: A.L. Kinney and H.C. Ford

DATE: 26 November 1985

ABSTRACT

The binary search target acquisition tests at Lockheed Missiles and Space Company were run under the new flight software, version 3.6. The final run of the TA tests was completely successful, with the target placed on the Y edge of the aperture when it was appropriate, and with the software branching when it was appropriate. The correct positions are found to within ±2μ in X and Y for a source with counts of about 1500. Considering that the dimension of the smallest FOS aperture (0".1), is 14μ in the image plane, this is a very acceptable accuracy.

DISTRIBUTION:

ISB
CSC
SDAS
SOGS
IDT

Introduction

The binary search target acquisition tests at Lockheed Missiles and Space Company were run under the new flight software, version 3.6. Several important changes had been made in the 3.6 software as well as a number of smaller, more technical changes. 1) The maximum number of binary search steps is now eight rather than five. 2) Finding more than four sources in one Y strip in the new version causes an exit and an error message to be written rather than causing an abort. 3) An integer overflow (counts in excess of $2^{16} - 1$) is flaged by setting the counters to the maximum value rather than simply letting the counters reset to zero.

As with the target acquisition tests of February, 1985 (see FOS/CAL-020), a star field was simulated by using a platinum lamp in the 0.″3 aperture with the G190H grating. This was done on the blue side because the red tube had been removed for replacement. By processing diodes 214 through 238 this configuration resulted in a pseudo-star field with three stars which are made up of the lines at 1907.493, 1911.702, and 1916.083 Å. The NSSC-1 FOS Binary Search Flight Software test searched for a specified source and measured its Y position by deflecting it on the Y edge of the diode array. A fine map in both X and Y was done before and after the test in order to have an independent measure of the correct position. These maps are shown in Figures 1, 2, and 3. Twenty-one test cases were run using various settings of the binary search parameters (see FOS/CAL-023) and testing various alternative branches.

Discussion

The test cases were run three times, with a high fail rate the first two times due to a timing problem with the turn on of the calibration lamp. The final run of the twenty-one test cases was done with the lamp left on through each test case, and this run was

completely successful. The results of the final run of August 20, 1985 are summarized in Tables 1 and 2 and discussed in more detail below. The first fourteen cases are completely described in Table 3, with the Y-BASE values of each Y strip, the total counts in the source (YNMAX), the total counts in the source at any binary step (YNTARG), the final result in microns at the photocathode (YFXCTR and YFYCTR), and difference between that and the value we calculate by hand from the fine maps in X and Y (ΔX and ΔY).

We tested the binary search algorithms by changing the settings of Y-BASE, the settings of the tolerances for putting an object on the edge of the diode array, and the settings for YNBRT. Binary search succeeded for all values of Y-BASE, including Y-BASE such that the star started on the edge between two Y strips (case 5). Although some of the tolerances for putting the star on the edge were more stringent than others, there was no significant difference in the accuracy achieved. Cases 1 through 3, 4 through 6, and 7 through 9 had different tolerance settings, yet there is little indication that the most stringent setting (cases 4 through 6) resulted in a higher accuracy. However, as soon as a dimmer star is used as the acquisition object, as with YNBRT of 2 or 3 in cases 10 through 15, the accuracy goes down appreciably.

We also tested the option to have a raster scan and a pre-planned branch by causing the binary search to fail. Both options worked as expected.

As can be seen in Table 2, the changes to flight software have been made correctly. The number of binary search steps exceeds 5 in most cases and in at least one case goes up to the maximum value of 8. Also, case 18 was set with a very broad window for finding peaks, so that too many peaks would be found in any Y strip. This case resulted in a YGIVUP value of 5, indicating that more than 4 peaks had been found. The more technical changes to the flight software were verified to have been made correctly, with the exception of integer overflow, which still remains to be tested.

Summary

The tests of binary search target acquistion with version 3.6 of the flight software, done at LMSC in August of 1985 were completely successful. They verified not only that the changes to the flight software had been made correctly but also that target acquistion worked in the way that was originally envisioned and all the options were operating correctly. The bright targets were acquired within ± 2 μ in X and Y. Considering that the dimension of the smallest FOS aperture ($0''.1$), is 14 μ in the image plane, this is a very acceptable accuracy.

Table 1

Parameters for Binary Search TA Tests; LMSC, August, 1985

Case	YBASE	YTOLER	YSTAT	YNMAX	YNMIN	YNBRT	YPPB
1	-1121	3	200	2000	64	1	2
2	-993	3	200	2000	64	1	2
3	-1200	3	200	2000	64	1	2
4	-1100	3	0	2000	64	1	2
5	-1050	3	0	2000	64	1	2
6	-1249	3	0	2000	64	1	2
7	-1140	6	0	2000	64	1	2
8	-1020	6	0	2000	64	1	2
9	-1170	6	0	2000	64	1	2
10	-1080	3	200	2000	64	2	2
11	-1070	3	200	2000	64	2	2
12	-1235	3	200	2000	64	2	2
13	-1110	3	200	2000	64	3	2
14	-1040	3	200	2000	64	3	2
15	-1180	3	200	2000	64	3	2
16	-1102	3	200	60000	50000	1	2
17	-910	3	200	2000	100	1	2
18	-1358	3	200	2000	3	1	2
19	-1102	3	200	2000	1997	1	1
20	-910	3	200	2000	1997	1	1
21	-1102	-	-	-	-	-	-

Notes: The numbers are quoted in decimal but inserted in procs in octal.

Table 2

Results of Binary Search TA Tests; LMSC, August, 1985

Case	YGIVUP	BS Steps	YFXCTR	YFYCTR	Result
1	0	5	113.313	-185.625	**Succeeded**
2	0	5	114.094	-185.625	**Succeeded**
3	0	5	113.719	-185.844	**Succeeded**
4	0	7	113.313	-183.281	**Succeeded**
5	0	8	112.531	-185.625	**Succeeded**
6	0	7	113.313	-184.063	**Succeeded**
7	0	6	112.938	-184.844	**Succeeded**
8	0	6	114.094	-184.844	**Succeeded**
9	0	6	113.313	-183.281	**Succeeded**
10	0	4	-32.375	-184.844	**Succeeded**
11	0	4	-30.031	-177.031	**Succeeded**
12	0	4	-20.281	-180.938	**Succeeded**
13	0	4	-177.281	-183.281	**Succeeded**
14	0	5	-175.719	-184.844	**Succeeded**
15	0	4	-176.906	-187.969	**Succeeded**
16	10	-	-	-	**Failed correctly**
17	0	5	NA	-183.281	**Succeeded**
18	5	-	-	-	**Failed correctly**
19	9	-	-	-	**Raster scan enabled**
20	-	-	-	-	**Pre-planned branch**
21	-	-	-	-	**Peak-up**

Notes: YGIVUP is set upon completion of BS TA. 0 means the source was successfully placed on the edge of the aperture. 5 means that more than 4 stars were found in a Y strip. 9 means that AP 32 ran out of moves for a raster scan without finding the target and 10 means that nothing was found.

Table 3

Summary of Test Cases

Case 1	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-300			6670
	-556			
	-44			
BS	-172	515	NO	
	-236	5707	YES	
	-204	2711	NO	
	-220	4084	YES	
	-212	3347	ON EDGE	
Results:	YFXCTR=113.313	ΔX=1.06	YFYCTR=-185.625	ΔY=1.80

Case 2	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-172			
	-428			6826
	-84			
BS	-300	6791	YES	
	-236	5912	YES	
	-204	3626	NO	
	-220	4341	YES	
	-212	3449	ON EDGE	
Results:	YFXCTR=114.094	ΔX=0.28	YFYCTR=-185.625	ΔY=1.80

Note: X and Y postions are given in units of microns at the photocathode.

Table 3 continued

Case 3	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-379			6728
	-635			
	-123			
BS	-251	6434	YES	
	-187	1266	NO	
	-219	4250	YES	
	-203	2596	NO	
	-211	3330	ON EDGE	
Results:	YFXCTR=113.719	ΔX=0.66	YFYCTR=-185.844	ΔY=2.01

Case 4	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-279			
	-535			6599
	-23			
BS	-151	183	NO	
	-215	3820	YES	
	-183	1055	NO	
	-199	2292	NO	
	-207	2851	NO	
	-211	3403	YES	
	-209	3237	ON EDGE	
Results:	YFXCTR=113.313	ΔX=1.06	YFYCTR=-183.281	ΔY=-0.55

Table 3 continued

Case 5	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-299			7038
	-485			
	27			
BS	-101	57	NO	
	-165	378	NO	
	-197	1952	NO	
	-213	3627	YES	
	-205	2803	NO	
	-209	3182	NO	
	-211	3287	NO	
	-212	3575	ON EDGE	
Results:	YFXCTR=112.531	ΔX=1.84	YFYCTR=-185.625	ΔY=1.80

Case 6	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-428			6710
	-684			
	-172			
BS	-300	6854	YES	
	-236	5810	YES	
	-204	2676	NO	
	-220	4274	YES	
	-212	3572	YES	
	-208	3125	NO	
	-210	3340	ON EDGE	
Results:	YFXCTR=113.313	ΔX=1.06	YFYCTR=-184.063	ΔY=0.23

Table 3 continued

Case 7	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-319			6617
	-575			
	-63			
BS	-191	1548	NO	
	-255	6544	YES	
	-223	4674	YES	
	-207	2968	NO	
	-215	3925	YES	
	-211	3410	ON EDGE	
Results:	YFXCTR=112.938	ΔX=1.44	YFYCTR=-184.844	ΔY=1.01

Case 8	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-199			
	-455			6998
	57			
BS	-327	6698	YES	
	-263	6769	YES	
	-231	5376	YES	
	-215	3844	YES	
	-207	3127	NO	
	-211	3373	NO EDGE	
Results:	YFXCTR=114.094	ΔX=0.28	YFYCTR=-184.844	ΔY=1.01

Table 3 continued

Case 9	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-349			6681
	-605			
	-93			
BS	-221	4459	YES	
	-157	233	NO	
	-189	1468	NO	
	-205	2847	NO	
	-213	3675	YES	
	-209	3242	ON EDGE	
Results:	YFXCTR=113.313	ΔX=1.06	YFYCTR=-183.281	ΔY=-0.55

Case 10	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-259			722
	-515			
	-3			
BS	-131	50	NO	
	-195	243	NO	
	-227	590	YES	
	-211	408	ON EDGE	
Results:	YFXCTR=-32.375	ΔX=-0.13	YFYCTR=-184.844	ΔY=1.01

Table 3 continued

Case 11	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-249			657
	-505			
	7			
BS	-121	34	NO	
	-185	177	NO	
	-217	416	YES	
	-201	289	ON EDGE	
Results:	YFXCTR=-30.031	ΔX=-2.47	YFYCTR=-177.031	ΔY=-6.80

Case 12	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-414			727
	-670			
	-158			
BS	-286	758	YES	
	-222	528	YES	
	-190	216	NO	
	-206	380	ON EDGE	
Results:	YFXCTR=-20.281	ΔX=-12.22	YFYCTR=-180.938	ΔY=-2.89

Table 3 continued

Case 13	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-289			643
	-545			
	-33			
BS	-161	35	NO	
	-225	429	YES	
	-193	161	NO	
	-209	329	ON EDGE	
Results:	YFXCTR=-177.281	ΔX=-0.72	YFYCTR=-183.281	ΔY=-0.55

Case 14	Y-BASE	YNTARG	ON ARRAY	YNMAX
Ap Map	-219			761
	-475			
	37			
BS	-91	24	NO	
	-155	15	NO	
	-187	119	NO	
	-203	251	N0	
	-211	354	ON EDGE	
Results:	YFXCTR=-175.719	ΔX=-2.28	YFYCTR=-184.844	ΔY=1.01

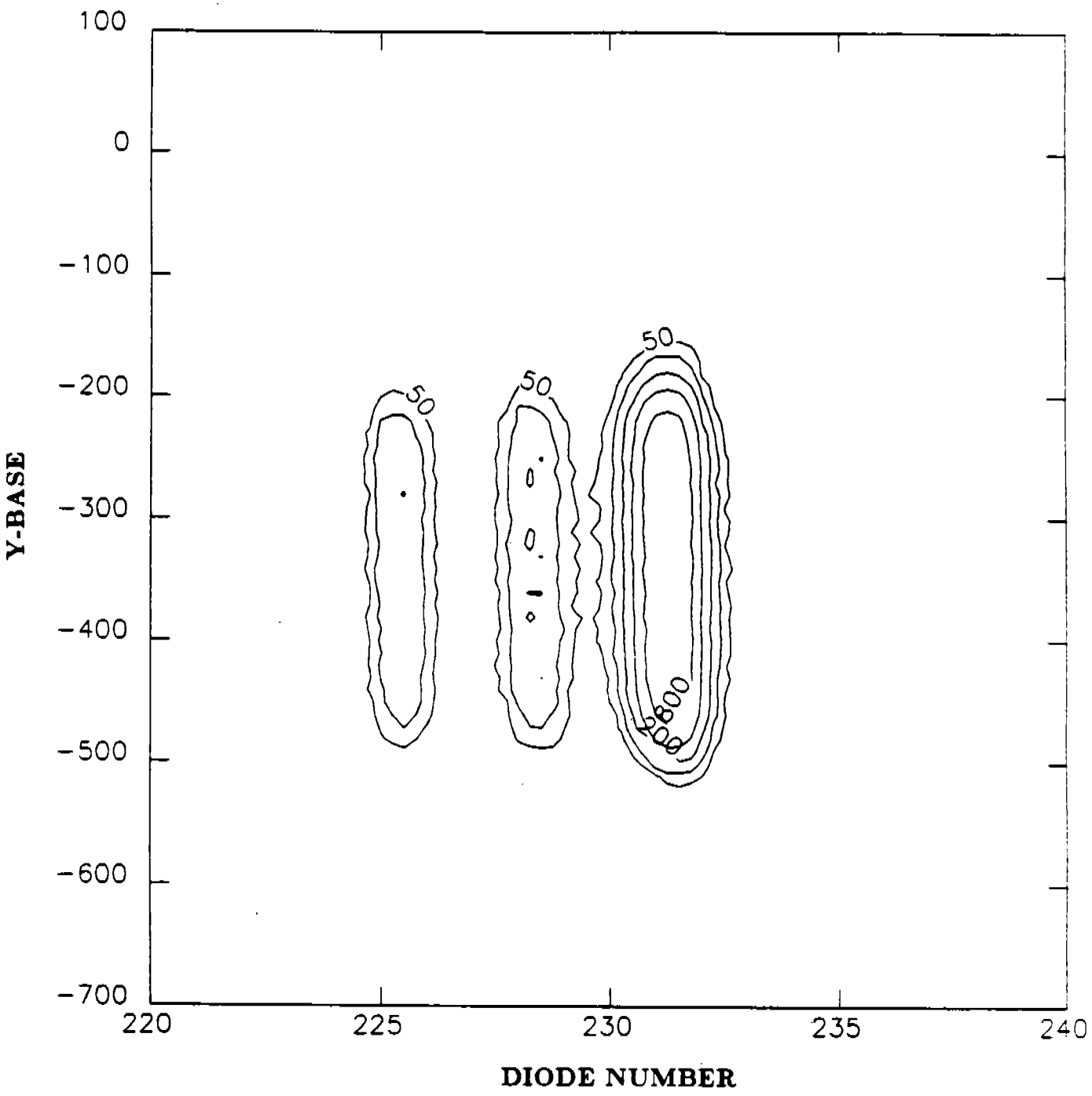

Figure 1: Simulated 4″.3 star field using platinum lamp through 0″.3 aperture.

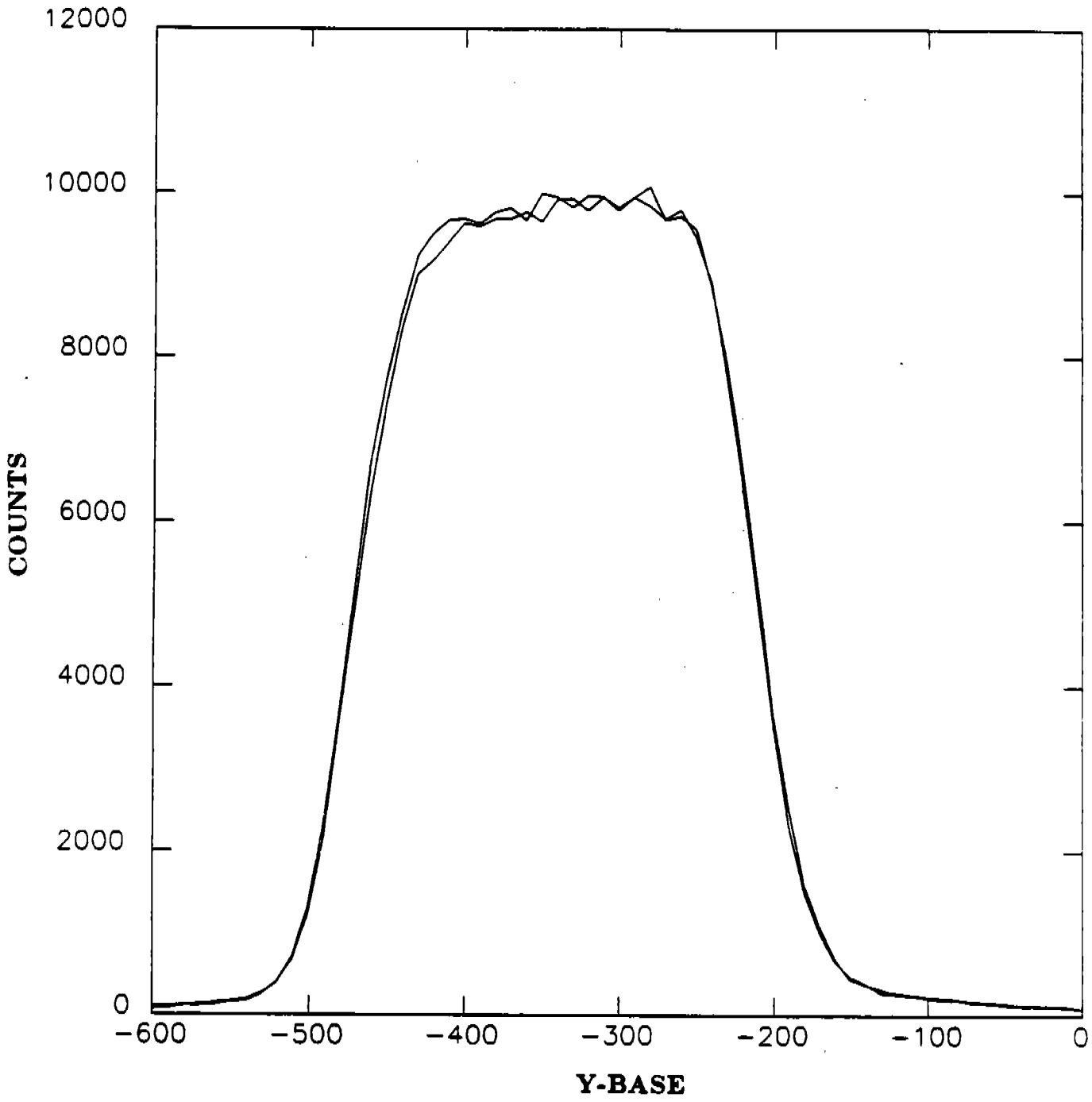

Figure 2: Profile of Y scan before and after target acquisition.

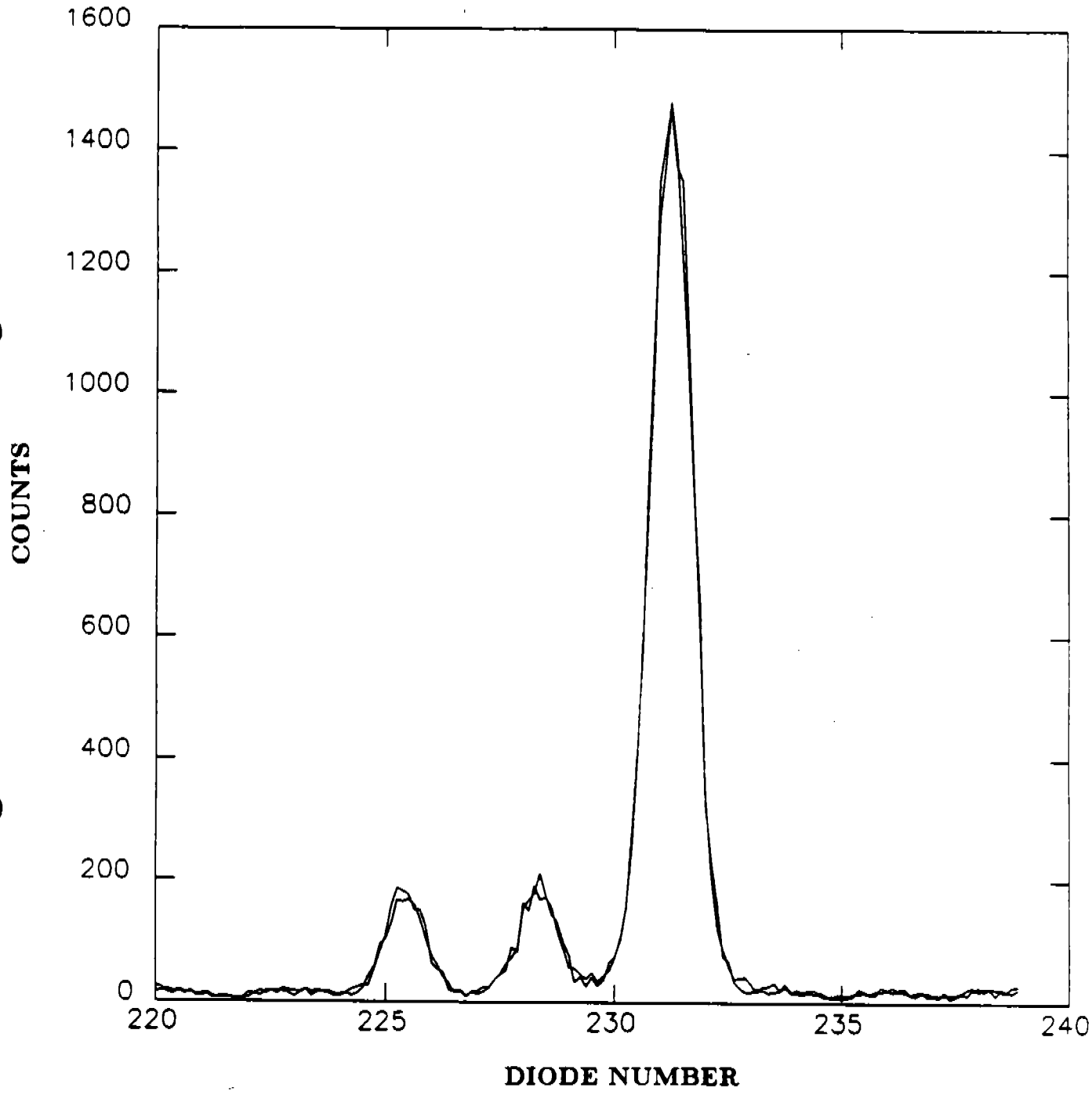

Figure 3: Profile of X scan before and after target acquisition.