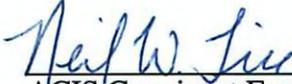


ACIS Verification Summary Report

Specification:	AXAF Observatory to Science Instrument ICD (IF1-20)
Requirement Number/Title:	3.1.1.2 Aspect Determination System (VRSD 3.1.1.2-2)
Requirement Statement: Except during the +/- 3 hour period around perigee, the SI shall ensure the angular motion of operating Fiducial light centroids does not exceed 0.030 arcsec over any consecutive 48 hr observation period. Reference ICD table 3.1-1.	
Verification Method:	Analysis
Procedure Number: ACIS Memo ACIS-1994-013 (Attachment 1)	
Configuration: ACIS Instrument Mounted in ISIM	
Cycle Time: N/A	
Verification Discussion/Results:	
<p>The verification of this requirement has been documented in the attached memo. The analysis shows that the angular motion of the Fiducial Light Centroids is ± 0.016 arc seconds (single axis) for any 48 hour period except for ± 3 hours around perigee. This meets the requirements of paragraph 3.1.1.2 and no further discussion is required.</p>	


 ACIS Cognizant Engineer

5/29/97
 Date

Program Memo

MARTIN MARIETTA

TO: Phil Gray
FROM: Neil Tice
SUBJECT: ACIS-Fiducial Light Location and Analysis Close-out
CC: G. Lang, E. Sedivy, B. Kast, B. Cunningham, R. Simon

DATE: Mon, Mar 14, 1994
MEMO NO.: ACIS-1994-013
DISK FILE: ACIS_fid_anal2
EXT: 1-9089 M/S: B0560

Introduction

This memo is being written to document the current fiducial light locations based on the new focal plane layout received from Penn. State University (Version 5). This memo is similar to one presented on 12/2/93 and documents the current fid light locations with the imaging and spectrometer arrays moved apart by 8 mm. The thermal movements of 3 aim points on the imaging array and 3 aim points on the spectrometer array have been analyzed relative to the centroid of 7 different fiducial light configurations. Only the worst case aim point location and fiducial light combination is discussed in this memo. Figure 1 shows the current fiducial light locations based on the PSU analysis. This analysis shows that the +/- .030 arc sec requirement for thermal stability can be met.

Analysis

The analysis was performed using the predicted temperatures from the current ACIS thermal math model for each of the fiducial light locations and focal plane aim points and calculating the thermal movement for each relative to the mounting center for the focal plane support paddle in an Excel spreadsheet. The camera housing was assumed to be aluminum and the focal plane support paddle was assumed to be beryllium. Beryllium is a good choice since its Coefficient of Thermal Expansion (CTE) is half that of aluminum. The focal plane and camera housing were assumed to be controlled to $-120\pm 1^\circ\text{C}$ and $-60\pm 1^\circ\text{C}$, respectively. The analysis was ran for 10 hours to make sure that the worst case conditions occur between the focal plane and camera housing since the heater control circuits have different time constants.

Seven different fiducial light combinations were analyzed per a fax from TRW on 11/17/93. The thermal movements of the center of gravity (CG) of each fiducial light configuration was calculated by averaging the Y and Z movements of each of the 3 fiducial lights assuming the focal plane mounting center point remains fixed. The thermal movement of the aim points was calculated in the same manner. Table 1 shows each of the configurations shown by TRW.

The effects of earth albedo and Infrared (IR) heating at perigee were not analyzed. The +/- .030 arc second thermal stability requirement will be exceeded during this time period. However, ACIS will not be operating in the +/- 4 hour time period around perigee because the excessive electron and proton radiation levels. The temperatures will be back under the control of the heater control circuitry by the time ACIS begins normal operations.

Results

Figures 2 show the analysis results for the worst case aimpoints on the Imaging array with fid lights 1,2 and 6. The figure is created by calculating the thermal movements of each fid light relative to aim points A, B, and C from Figure 1. The worst case errors occur when both heater control circuits are at their max or min limit simultaneously. For clarity, only the worst case 2 hour period was plotted where the peak relative deflections between the focal plane and camera housing occur simultaneously resulting in a +.030 micro inch difference. It should be noted that since the focal plane and camera housing have different time constants, the relative deflections could be at a minimum of -.030 micro inch at a different time in the orbit. Therefore

Attachment 1 - Verif. Rpt. 36-01520.002
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configuration 1, with fiducial light 1, 2, and 6 and aim point A, gives the highest error of +/- 30 micro inches (+/- .016 arc seconds). Due to the location of the three fiducial lights (1, 2, and 6), the relative deflection between the fid light CG is primarily in the +/- Z direction and as a result should be considered a single axis error. Table 1 shows the results for the rest of the fiducial light combinations.

Conclusions

The fiducial light thermal stability analysis has been updated for the current CCD locations and fid light position. The maximum peak to peak deflection of the fiducial light cg relative to the aimpoints on the focal plane is +/- 30 μ inches single axis in the +/- Z direction. This is equivalent to +/- .016 arc seconds. The analysis assumes that all movement of the focal plane is symmetrical about the mounting cg. The +/- .030 arc seconds which was agreed upon some time back will leave a reasonable margin for analysis uncertainty pertaining to non-symmetrical movement of the focal plane and possible changes in the focal plane materials. A large margin of error is required since you are talking about predicting something that you can't even measure. Analysis of this type is not an exact science and here are just a few items which could account for additional error.

- 1) The heater input was assumed to be uniform on the bottom surface of the focal plane which may not be possible and will cause additional temperature gradients which were not accounted for. The dissipation in the CCDs was also assumed uniform for all 10 CCDs. In reality, all CCDs will probably not be dissipating heat at the same time.
- 2) The analysis assumes identical thermal resistances for the thermal stand-offs and thermal straps. If the actual thermal resistances are not identical (i.e. cross sectional area, length, material properties, contact resistances, etc), additional thermal gradients will be imparted on the focal plane.
- 3) Non-symmetrical movement of the focal plane due to thermal stresses imparted by the thermal straps.
- 4) The CG of the focal plane was also assumed to be perfect with respect to camera housing CG which is unlikely.

In summary, MMA feels comfortable with the current allocation of +/- .030 arc seconds for fiducial light stability and would like to keep it going into PDR.

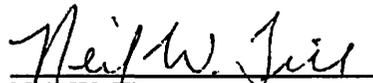

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Table 1-Analysis Results for Aluminum Camera and Beryllium Focal Plane Support

CONFIG. NUMBER	USAGE	LIGHTS	FIDUCIAL LIGHT CG RELATIVE TO AIM POINT (ARC SECONDS)					
			A	B	C	D	E	F
1	Imaging - Primary Config.	1,2,6	0.016	0.003	0.008			
2	Imaging - Redundant Config. (Use if 2 or 6 fails)	1,3,5	0.009	0.014	0.012			
3	Imaging - Redundant Config. (Use if 1 fails)	2,3,4	0.014	0.012	0.008			
4	Spectroscopy - Primary Config.	3,4,5				0.004	0.006	0.009
5	Spectroscopy - Redundant Config. (Use if 3 fails)	2,4,5				0.004	0.006	0.008
6	Spectroscopy - Redundant Config. (Use if 4 fails)	1,5,6				0.003	0.006	0.010
7	Spectroscopy - Redundant Config. (Use if 5 fails)	2,4,6				0.010	0.009	0.010

FIGURE 1-CURRENT Y-Z LOCATIONS FOR FIDUCIAL LIGHTS

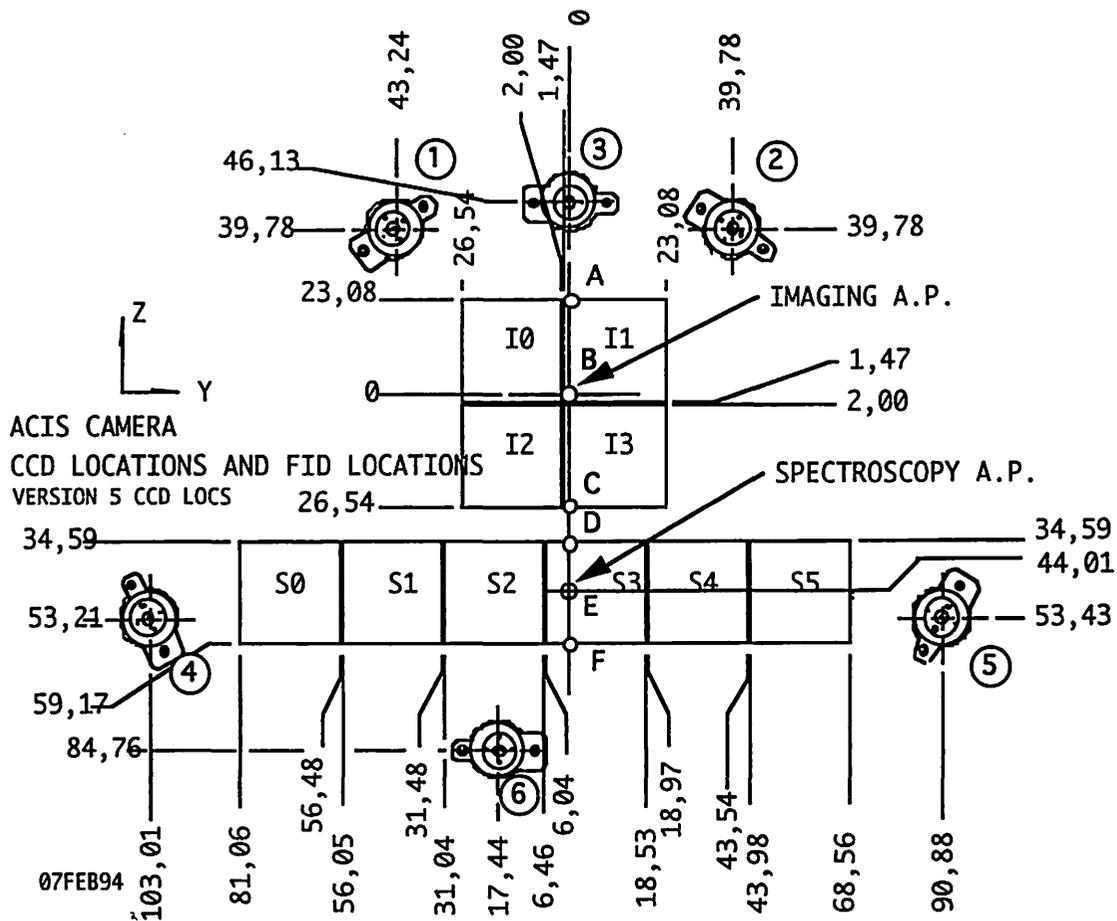


FIGURE 2-FIDUCIAL LIGHT CG MOVEMENT RELATIVE TO AIMPOINTS A,B, & C

