

An Investigation into the Guidance of FOC GTO 4073

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SUMMARY

An analysis of the guidance of the 1992 FOC GTO program 4073 was conducted at the request of the PI. Of the nine observations investigated, five were found to have motions detectable by the FOC/96. Magnitude and orientation of the predicted motions in the V2-V3 plane at the FOC/96 are provided. These are upper limits to possible spurious features detected in the images. In an effort to keep the evaluation objective, we did not look at the FOC images; our study was based solely on FGS and GYRO data.

INTRODUCTION

The Guidance data were obtained from B. Toth (of the Observatory Monitoring System) and reduced with new software derived for this study from the ST ScI FGS Team's POSition Mode data reduction software. X. Liu (of the Engineering Support Branch) independently examined the pointing stability of several of the observations, including both the Star Selector Encoder readings and GYRO data, in his evaluations. Pierre Bely (Engineering Support Branch) and R. Doxsey (Science and Engineering Systems Division) were extremely helpful in interpreting some of the data.

The mean (V2,V3) positions and the corresponding standard deviations for all nine files are listed in Table 1. As can be seen from Table 1, all of the dominant Guide Stars (GSs) were held very steady. The sub-dominant (or roll) GSs clearly show five cases for which the standard deviations are relatively large. These are: X14H0203T, X14H0204T, X14H0302T, X14H0303T, and X14H0304T.

GEOMETRY OF THE PROBLEM

In the five cases of interest, the observed GS motions are confined to the sub-dominant FGS resulting in a roll of the HST focal plane about the dominant Guide Star. See Figure 1 for the definition of the roll angle used here and the maximum motion of the target as seen at the FOC. Figures 2 and 3 show the actual geometry of two observations, X14H0203T and X14H0304T respectively.

Table 1
Mean (V2,V3) and Standard Deviation

Dominant Guide Stars					
Filename	FGS	V2 Mean(")	V2 SD(")	V3 Mean(")	V3 SD(")
X14H0201T	1	-570.5314	0.0036	-284.9414	0.0023
X14H0202T	1	-570.5322	0.0036	-284.9412	0.0025
X14H0203T	1	-570.5323	0.0049	-284.9415	0.0030
X14H0204T	1	-570.5318	0.0050	-284.9412	0.0029
X14H0301T	3	661.4880	0.0028	-150.7638	0.0026
X14H0302T	3	661.4882	0.0083	-150.7638	0.0032
X14H0303T	3	661.4876	0.0092	-150.7637	0.0035
X14H0304T	3	665.1971	0.0049	-154.8696	0.0029
X14H0305T	3	665.1973	0.0031	-154.8694	0.0021
Sub-Dominant Guide Stars					
Filename	FGS	V2 Mean(")	V2 SD(")	V3 Mean(")	V3 SD(")
X14H0201T	2	335.4271	0.0041	677.0972	0.0031
*X14H0202T	2	344.2480	0.0043	673.7371	0.0031
*X14H0203T	2	344.2269	0.0225	673.7160	0.0226
X14H0204T	2	335.4212	0.0087	677.0907	0.0079
X14H0301T	1	-635.2774	0.0045	-120.4415	0.0035
X14H0302T	1	-636.5714	0.6223	-120.4173	0.0125
X14H0303T	1	-636.1168	0.7309	-120.4263	0.0148
X14H0304T	1	-632.9821	0.4893	-124.5157	0.0102
X14H0305T	1	-631.5370	0.0035	-124.5433	0.0023
<p>*Position and standard deviation computed without a Fine Error Signal; only Star Selector encoder readings were used. There was apparently a transient problem with the hardware which reports the number of counts in channel A of the X-axis of FGS #2 which resulted in erroneous counts being returned via telemetry. Errors in the GS position are introduced if these positions are calculated using the Fine Error Signal obtained from faulty PMT counts.</p>					

RESULTS

The roll angle, the (maximum) predicted motion of the target at the FOC/96 as a result of the uncompensated roll, and the orientation of this motion with respect to V3 (measured positive counter-clockwise from V3 through -V2) are given in Table 2 for each of the five observations under consideration. Suspicious fine structures in the FOC images should be checked against the values in this table. Each case is discussed in more detail in the following sections.

Table 2			
(Maximum) Predicted Motions at FOC/96 Due to Guiding			
Filename	Roll Angle at Dom. GS (")	Max. Motion at FOC/96 (")	Orient. of Motion at FOC wrt V3 (°)
X14H0203T	1.056	0.0013	-159.0165
X14H0204T	4.856	0.0058	-159.0165
X14H0302T	12.463	0.0607	-357.3549
X14H0303T	11.740	0.0572	-357.3549
X14H0304T	12.518	0.0612	-357.5979

X14H0203T

A disturbance at about 650 seconds into the observation X14H0203T resulted in a 0.070" offset of the sub-dominant GS (see Fig. 4). The displacement in position of the GS was not instantaneous in FGS #2; rather, there was a very fast (on the order of 10 seconds) shift followed by a slow (roughly 100 seconds) over-damped oscillation. The rather slow response to this disturbance suggests that the FGS was thrown from the central region of the GS's interferometric signal (Transfer Function) and recovered by locking onto a secondary lobe with a slope less steep than the main lobe. We do not have a reference Transfer Function closer than 56" to the location of the GS; however, this theory is plausible given the rather severe deformations of the Transfer Function observed about an arc-minute away (see Fig. 5).

X14H0204T

During the initial 200 seconds of X14H0204T, the sub-dominant GS's position in FGS #2 exhibits an over-damped oscillation of magnitude 0.12" (see Fig. 6). Again, this is compatible with the explanation provided for X14H0203T.

X14H0302T, X14H0303T, and X14H0304T

At roughly 220 seconds into the observation X14H0302T, a disturbance resulted in a $\sim 1.65''$ shift of the sub-dominant GS (see Fig. 7). Given the size of the offset and the response of the system after the offset, we conclude that the disturbance caused the FGS to jump out of the central portion of the GS's signal and lock onto the noisier slope created by the misalignment of field-stops [see ST ScI Memo of 22 Jan., 1992 from P. Bely and X. Liu titled "Autopsy of the guiding problem (double image) in Proposal FOC 3105"].

Both X14H0303T and X14H0304T are very similar to X14H0302T. At about 160 seconds into X14H0303T, a $1.63''$ offset occurred (see Fig. 8). A $1.67''$ shift in the GS position occurred at roughly 125 seconds into X14H0304T (see Fig. 9). The above explanation is believed to apply.