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The FGS Astrometry in the Feb 2005 On-orbit Two Gyro Mode Test

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ABSTRACT

FGS1r Astrometry was tested under the Two-Gyro Mode (TGM) pointing control law during the February 2005 on-orbit test. Three orbits were dedicated to FGS Position mode observations and one orbit was allocated to Transfer mode observations. In each of these orbits the visit contained a single (long) exposure that observed the visit's particular target star for the remainder of the visibility period. The Transfer mode visit suffered a guide star acquisition failure and therefore provided no useful data for evaluating TGM pointing performance under FGS control. Nonetheless, the observed jitter and drift from three Position mode visits indicate that TGM pointing performance with the FGS guiding in Fine Lock is essentially the same as with FGS guidance in three-gyro mode.

1. Introduction

In February 2005 a special on orbit test was executed to evaluate the performance of the HST pointing control system under two-gyro mode (TGM). The bulk of the test consisted of observations by ACS/HRC and NICMOS to evaluate image quality and coronagraphy in TGM. However, the test also included four orbits to evaluate FGS1r Astrometry; three orbits for Position mode observations and one for Transfer mode observations. These FGS1r data provide an independent assessment of the TGM line of sight pointing performance at 40 Hz that can readily be compared to data from the guiding FGSs.

2. Observations

The FGS1r test was composed of four single-orbit visits containing a single, long exposure to observe the target selected for the visit. Three of the visits employed Position mode to observe a bright star (using different a star for each visit), but with different guide stars pairs that spanned a range of brightness (Table 1). For the first Position mode visit, a guide star that had failed to be acquired in a previous attempt (during execution of an unassociated science proposal) was *intentionally* chosen in order to test the new control law's ability to "fail-over" to single FGS guiding.

	FGS1	FGS2	FGS3
Visit 01	11.35	13.14	-
Visit 02	12.52	9.90	13.38
Visit 03	10.39	14.20	14.26
Visit 04	10.31	-	-

Table 1. The observed V-band magnitudes of the FGS1r targets and the guide stars in the guiding FGS units. Visit 01 successfully "failed-over" to single FGS guidance. Visit 04 failed due to a guide star acquisition failure; the FGS1 target was not observed (its predicted magnitude is listed).

3. Results

Visit 01:

As expected (and hoped for), HST failed to acquire the guide star in FGS3. The guide star acquisition process successfully (and autonomously) "failed-over" to single FGS guidance with FGS2 providing the "Observer" data for the TGM control law. FGS1r successfully acquired and tracked its target (in open loop, i.e., the FGS1r data were not used by the pointing control system) for the duration of the visit, approximately 19.26 minutes. The (1-sigma) standard deviation (or jitter) of the centroid of FSG1r target star was observed to be 0.0031" and 0.0034" along the instrument's X and Y-axis, respectively. The drift of the target across the FGS1r FOV was approximately 0.003", which is consistent with what is nominally observed under three-gyro control with a guider in Fine Lock. Thus, no excessive roll of the Observatory was observed with this gyro-pair configuration under single FGS guidance.

Visit 02:

Visit 02 employed a bright (V=9.9) dominant guide star. FGS1r observed its target in Fine Lock for 20.78 minutes. The observed jitter in the FGS1r target star was 0.0034" and 0.0030" in X and Y respectively. The drift of the target across the FGS FOV was observed to be ~0.003", consistent with

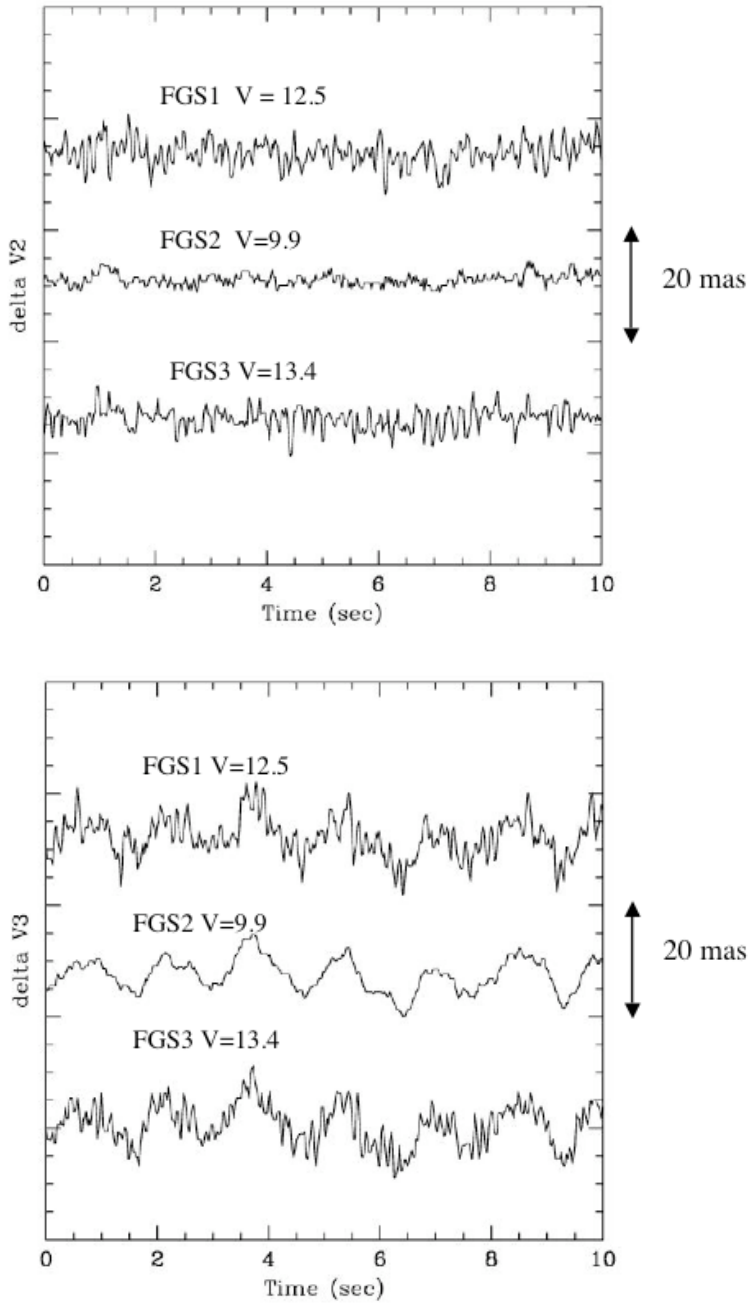

Figure 1. The correlation in V2 (top) and V3 (bottom) of the motion of the stars observed by the 3 FGSs over an (arbitrary) 10 second interval in TGM during visit 02. The curves in each plot correspond to tracking data from FGS1r, FGS2, and FGS3, with the V magnitude of the star in each FGS denoted.

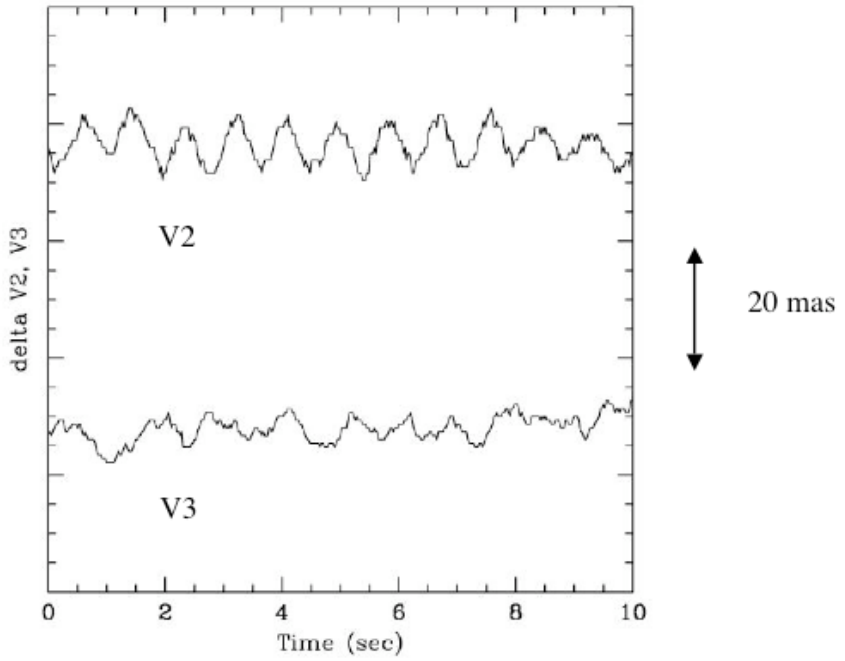

Figure 2. The oscillations in V2, V3 observed by FGS1r under the nominal three-gyro pointing control law. These data are taken from a Position mode observation of a V=9.6 star from a science proposal.

three-gyro operations. As shown in Figure 1, the data from all three FGSs along V2 and V3 correlate very well (albeit the small V2 motion is dominated by photon noise). This supports an assertion that FGS1r served as a reliable witness to the pointing performance of the HST in TGM. Moreover, the amplitude and periodicity of the oscillations are similar to what is nominally observed in three-gyro mode (Figure 2).

Visit 03:

Visit 03 employed a pair of faint guide stars. FGS1r observed its target in Fine Lock for 20.60 minutes. The observed jitter in the centroids of the FGS1r target star was 0.0036" and 0.0033" in X and Y, respectively. The drift of the target across the FGS FOV was observed to be ~0.004", consistent with three-gyro operations.

Visit 04:

The guide stars were not acquired for visit 04, and subsequently the target in FGS1r was not acquired. Therefore no useful data for accessing TGM pointing under FGS control were obtained from this visit.

4. Summary

Based upon the data gathered by the FGS1r observations during the February 2005 on-orbit TGM test, there appears to be no degradation of HST pointing characteristics that would adversely affect the astrometric performance of FGS1r in Position mode. The Transfer mode test failed due to a guide star acquisition failure. However, the pointing performance observed in the three successful Position mode visits supports the expectation that Transfer mode observations in TGM will also not be degraded relative to three-gyro operations.