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INSTRUMENT SCIENCE REPORT

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TITLE: IMPROVEMENTS IN FILTER/GRATING WHEEL REPEATABILITY

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ABSTRACT

The filter/grating wheel repeatability can be significantly improved by applying an additional motor step after the initial, standard positioning of the wheel. Because of uncertainties in the degree to which this remedy will operate in actual flight conditions, especially for the camera mirror, and the expected thermal drifts of the entrance aperture images, previously suggested modifications to the FOS to permit direct location of the images remain highly desireable.

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IMPROVEMENTS IN FILTER/GRATING WHEEL REPEATABILITY

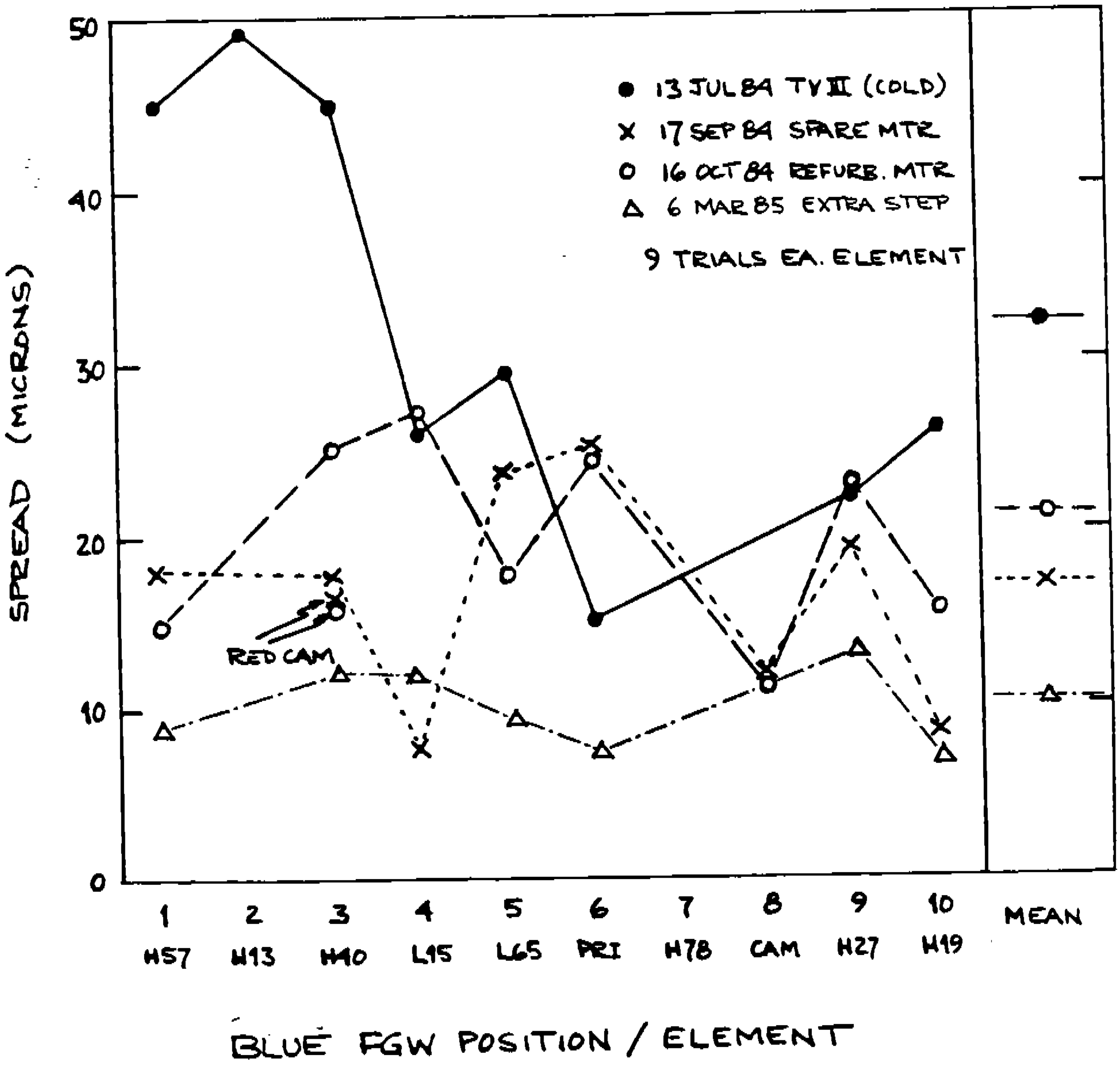
An attempt has recently been made to improve the FGWA repeatability (see Hartig, et al. CAL/FOS-010, Dec. 1984) by applying a small offset force to the wheel after it has been nominally positioned at the desired disperser (or camera mirror) and then allowing it to relax into that position. This was accomplished by commanding one additional step of the FGWA stepper motor in the forward direction after performing standard positioning (also in the forward direction). Power to the motor is removed immediately after the motor is phased for this step for the usual (200 ms) duration, allowing the detent roller to perform the final positioning adjustment from a more repeatable initial condition than is likely without this extra step.

Preliminary tests were conducted on 20 February 1985 during which the image position (in the dispersion (x) direction only) of a line near the center of the H40 grating (red side) spectrum of the internal calibration lamp was noted, both directly after normal positioning of the FGWA and after application of the additional motor step. Thirteen trials were made, with the FGW rotated 360 degrees between each trial. It was readily apparent that the repeatability could be improved with this process; in every case for which the wheel initially settled to a position with large deviation from the mean, application of the extra step reduced the discrepancy markedly. The standard deviation was reduced from about 9μ (before motor step) to just over 5μ. Trials were also made with 2 additional forward steps applied, which sometimes drove the wheel far enough that the detent roller moved entirely out of the detent, so that the positioning was lost, and with one step in each direction applied consecutively, which appeared to make no additional improvement.

In order to test the effectiveness of this method further, for other FGW positions, the standard repeatability test procedure was performed on 6 March 1985, on the blue side. The results of this test can be directly compared to those of the 16 October 1984 evaluation, which yielded a mean standard deviation of 6.9μ in the X direction for 9 trials of each of 7 dispersers. With the additional motor step, the standard deviation was found to be 3.2μ, indicating an average improvement of more than a factor of 2! The improvement ranged from ~20% to a factor of nearly 3.5, depending on the disperser selected. The spread in X positioning for each of the tested dispersers is plotted in Figure 1, along with some previous measurements made in the same manner. The mean spread has been reduced by approximately a factor of 2, from 21μ for the October 1984 measurements to 10.2μ.

Although these data indicate that a noticeable improvement in the FGW repeatability is likely to result from the simple addition of a single step command following each wheel positioning, we note that even the performance level measured in the 6 March test is not entirely satisfactory, particularly for target acquisition into the smallest, .1 arcsecond (A4) apertures. The ~10μ spread in the (camera mirror) aperture image location, inferred from the average behavior of the 7 dispersers tested, remains a large fraction of the (14μ) A4 aperture image size. For a substantial percentage of A4 acquisitions, the target will suffer significant decentering. Thermal drifts, which may now dominate the non-repeatability, will aggravate the situation. Furthermore, we have no assurance that the behavior demonstrated in our tests is applicable to the camera mirror, which was not actually measured (especially in view of the large variation in relative improvement depending on FGW element), or that the improvement noted in the X direction will be reflected in the Y axis. An additional concern is that these measurements were made in ambient, whereas the previous data indicate that the repeatability may be significantly worse when the FGW is operated under flight conditions.

We conclude that, if possible, a direct evaluation of the FGWA repeatability for the camera mirror, on both red and blue sides and in both X and Y axes, should be made during thermal-vacuum testing. Furthermore, the addition of a means of illuminating the entrance apertures (LEDs) and the minor modifications to the NSSC-1 software required to determine the aperture image positions will significantly aid our ability to perform accurate target acquisitions, whether or not the improvements to the FGWA repeatabilty suggested by our recent tests will indeed be realized on orbit.



50
40
30
20
10
0
SPREAD (MICRONS)
● 13 JUL 84 TV III (COLD)
X 17 SEP 84 SPARE MTR
O 16 OCT 84 REFURB. MTR
Δ 6 MAR 85 EXTRA STEP
9 TRIALS EA. ELEMENT
RED CAM
1 H57
2 H13
3 H40
4 L15
5 L65
6 PRI
7 H78
8 CAM
9 H27
10 H19
MEAN
BLUE FGW POSITION / ELEMENT

FIGURE 1.