A Reexamination of the Accuracy of Two-Gyro Fixed-Rate Slews

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IUE commonly acquires a very faint target by performing a two-axis fixed-rate slew (i.e., a PYSLEW) from a nearby offset star. The reliability of such a slew is thus very important. Sonneborn (1985) concludes from examining a large number of test slews that maneuver errors of 2" or less can reasonably be expected for slews of 15' or less. However, PYSLEWs use the gyros to control the pitch and yaw axes and the Fine Sun Sensor to control the roll axis, and these devices may have deteriorated in the intervening years. Below, the results of a recent test of the accuracy of fixed-rate slews are presented.

The results are based on thirty two fixed-rate maneuvers done between SAO stars in two fields on August 17 and 18/19, 1990. The stellar coordinates are taken from the SAO catalog, and are corrected for proper motion using the SAO data. The beta angles represented by the fields are 78 and 84 degrees; it is important to note that these betas are higher than the maximum value (62 degrees) in the Sonneborn (1985) data. All slews use the default slew rate (10 "/sec), except for three of the longer maneuvers (each in excess of 38'). The latter maneuvers use a higher rate of 20 "/sec, consistent with actual operating procedures.

The yaw components of the slews and slew errors are plotted in Figure 1. The accompanying line is the least squares fit to the equally weighted data points; the fitting algorithm and determination of the fitted parameter uncertainties follow Bevington (1986). The relationship between the yaw leg length and yaw error is

$$\Delta Y'' = (0.10 \pm 0.01) Y' - (0.2 \pm 0.2). \qquad (1)$$

The correlation coefficient for this fit is R=0.83; there is much less than a 0.1% probability of obtaining a coefficient as large or larger than 0.83 from a sample of 32 uncorrelated points (Bevington 1969).

The pitch leg lengths and pitch errors are shown in Figure 2. Assessing the characteristic pitch error is particularly important, since the pitch direction lies roughly along the direction of the minor axes of the large apertures. The least squares fit to this data is

$$\Delta P'' = (0.04 \pm 0.01) P' - (0.1 \pm 0.2). \qquad (2)$$

The correlation coefficient is R=0.36, corresponding to a 95% probability of a true correlation. This lower probability relative to the yaw result is not surprising, since a comparison of Figures 1 and 2 shows that the pitch error is generally much smaller than the yaw error for slew legs of similar length.

The data for the total slew distances and total slew errors are presented in Figure 3. The fit to all the data points yields

$$\Delta S'' = (0.07 \pm 0.01)S' + (0.6 \pm 0.3), \qquad (3a)$$

where R=0.57, indicating a 99.9% probability of a correlation. However, there is a hint of nonlinear behavior in the errors for large slews. If the two points representing slew lengths of greater than 50′ are omitted from the fit, the result is

$$\Delta S'' = (0.05 \pm 0.01)S' + (0.9 \pm 0.3). \qquad (3b)$$

The correlation coefficient for this fit is R=0.40, giving approximately a 97% correlation probability. It should be noted that Log-Log and Ln-Ln (where Ln is the natural logarithm) fits can also be applied to the data to partially test for the presence of a nonlinear correlation (power law and exponential relationships, respectively) between the slew distance and error, but these fits are highly inadequate, i.e. they have very low correlation coefficients. Similarly, the significant y-intercept terms present in eqs 3a and 3b may result simply from small errors in the stellar coordinates rather than the choice of a linear fitting function.

If the one sigma uncertainties are added to the parameters of eqs 3a and 3b, forming a crude "upper limit" to these parameters, the equations predict a 2" error for a slew of 15′ (see also figure 3), similar to Sonneborn's (1985) result. Thus, there is no compelling evidence in this data that the accuracy of IUE fixed-rate slews, at least at these betas, has deteriorated since 1985.

References

Bevington, P.R. 1969, Data Reduction and Error Analysis for the Physical Sciences (New York: McGraw-Hill).
Sonneborn, G. 1985, NASA IUE Newsletter No. 28, p. 154.

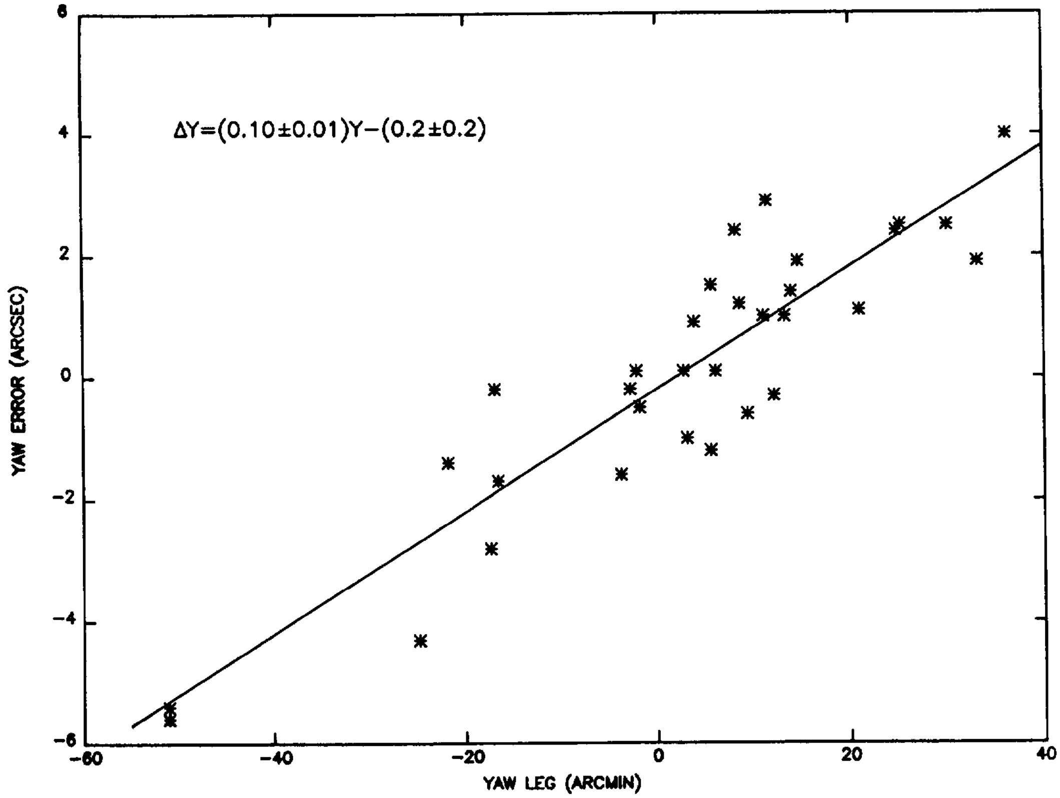

Figure 1. Yaw component of the slew error vs. yaw slew leg. The line is a least squares fit to the equally weighted data points.

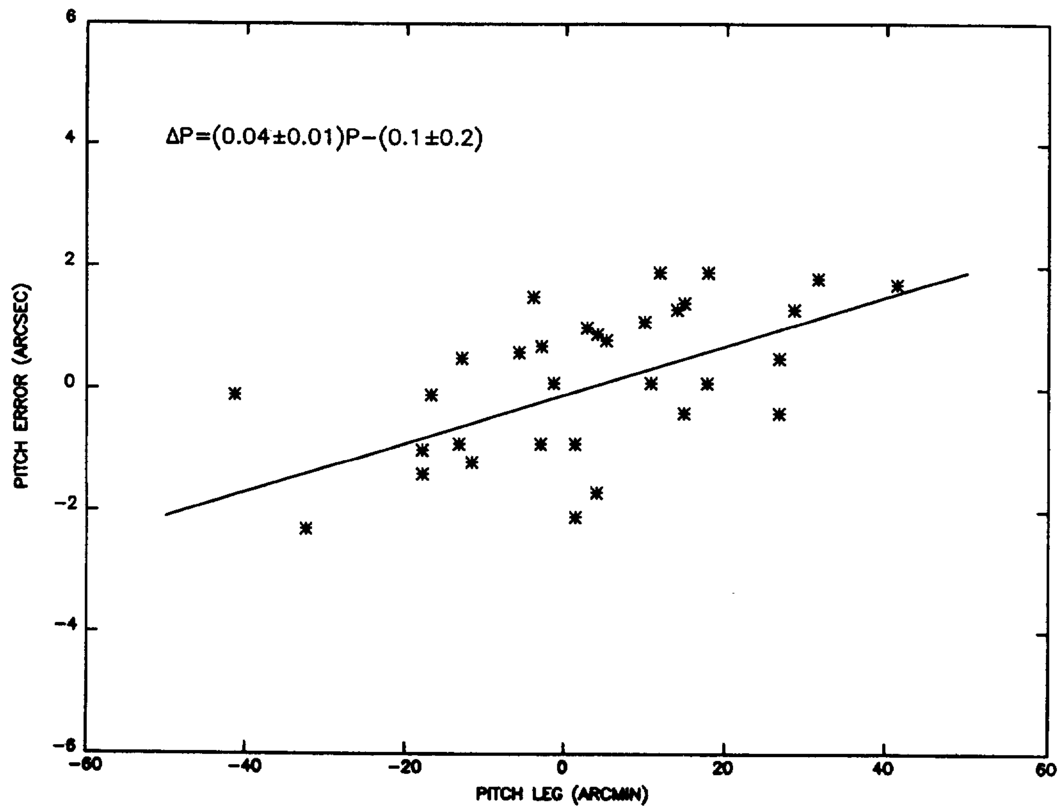

Figure 2. Pitch component of the slew error vs. pitch leg. The line is a least squares fit to the equally weighted data points.

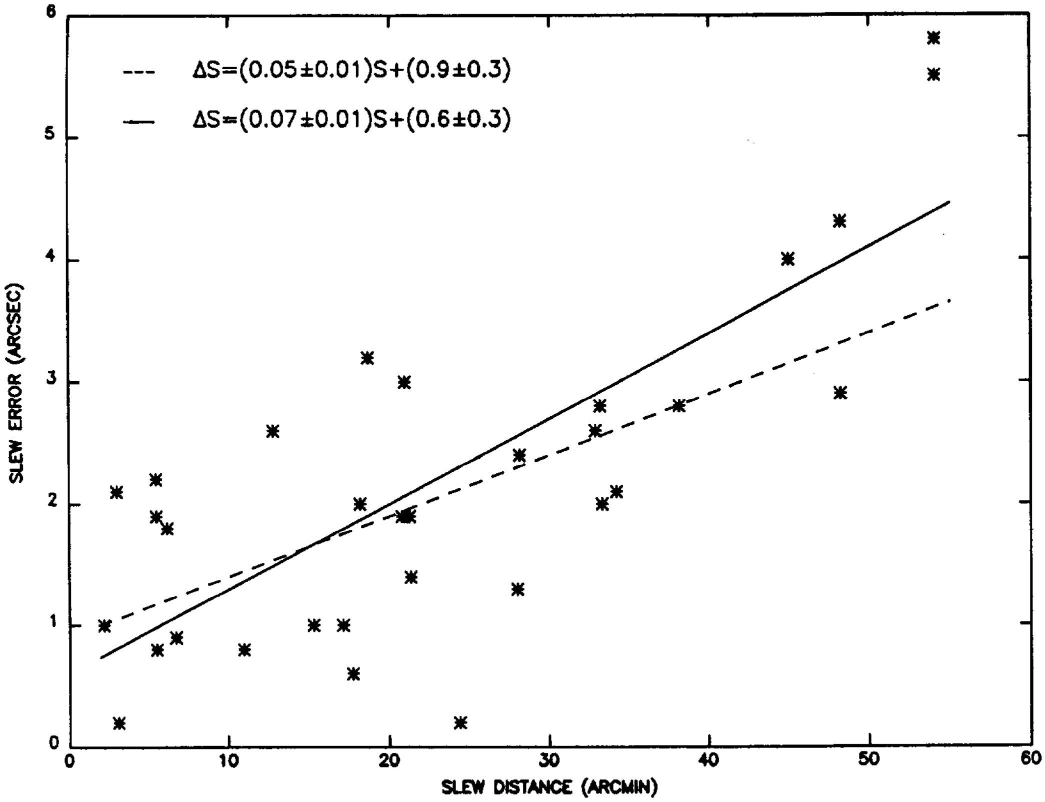

Figure 3. Total slew error vs. total slew distance. The solid line is a least squares to all of the equally weighted data points. The dashed line is a simimlar fit omitting the two points representing slew distances greater than 50′.