

A Preliminary Calibration of the Fine Error Sensor

An accurate estimate of the visual magnitude of variable stars at the time of the IUE observation can be a valuable aid in the interpretation of the UV observations. Such an estimate can also aid the observer in obtaining accurate exposure times. The Fine Error Sensor (FES) has the potential for providing an estimate of the visual magnitude. A calibration of the FES that has an accuracy of 0.06 mag is given here.

On the IUE there are two FESes, each an unfiltered image dissector tube with a S-20 photocathode. FES2, the more sensitive of the two, has been used exclusively since 18 February 1978. An FES can be used in a raster scan mode to build up an image of the star field at which the telescope is pointed or in a track mode. In the track mode, the FES provides a count rate which is related to the stellar magnitude. This relationship is dependent on the FES integration time (fast or slow), on the track pattern size (overlap or underlap), and on the location of the target in the field. Pre-launch tests showed that the pulse counter would begin to saturate for bright stars.

To enable observers to interpret the FES response in terms of a visual magnitude we are investigating the photometric properties of the FES2. In-orbit data confirms that for the brighter stars a correction is required for pulse counter dead time. We have used a function that includes a color term and a dead time correction of the form suggested by Fernie (1976). From 113 observations of 60 stars in the overlap, fast track mode, we find

$$(1) \quad V = -2.5 \log \left[\frac{C}{1-aC^b} \right] - 0.24 (B-V) + 16.59$$

with a sigma of 0.055 mag and where

C = FES count rate for stars near FES reference point
 $X=300, Y=144$. (This number is recorded on the
 observing scripts as "FES COUNTS OUT" along with
 the integration time and pattern size mode
 information.)

$$a = 1.60E-4$$

and $b = 0.781$

The stars for which this relationship was derived have B-V colors from -0.37 to +0.86. The relationship fails for very cool stars because of the long red response of the tube. Figure 1 shows the dependence of the error on V magnitude. Figure 2 shows the dependence of the error on the B-V color. To aid in the interpretation of these magnitudes for emission line sources, table 1 gives the normalized pre-launch sensitivity of FES2. These measurements, from the Ball Brothers Research Corporation, refer to the image dissector tube alone; the reflections from the telescope optics and the aperture plate have not been included. On 1 August 1979, the operational procedures were modified so that the FES counts are now measured at a new reference point. The FES calibration may be changed slightly thereby. Data to test for such a change is being collected.

Table 1
Normalized Sensitivity of FES2

wavelength (Å)	S/S max	wavelength (Å)	S/S max
4080	0.76	6530	0.46
4550	1.00	6940	0.40
5130	0.86	7190	0.35
5530	0.71	7920	0.21
6130	0.55	8880	0.03

Stars having magnitudes brighter than 4.7 are too bright for the overlap mode. In this case the tracking is done far out in the wings of the stellar image. Having less data (46 observations of 30 stars), we assumed that the dead time correction and the color term are the same in underlap as in overlap. We find

$$(2) \quad V = -2.5 \log \left[\frac{C}{1-aC^b} \right] - 0.24 (B-V) + 11.10$$

with a sigma of 0.20 mag.

Stars fainter than 11.5 mag are usually measured in the slow track mode. Equation (1) can be used if the slow track count rates are divided by 4 to

the dark and sky count levels may make a significant contribution to the observed count rate and should be subtracted for accuracy. The number recorded as the FES COUNTS IN usually gives a good estimate of dark and sky. It is usually on the order of 10 or less. If it is significantly larger than that, the FES may have accidentally picked up a faint field star during the slew to place the target in the aperture. If the target is in the small aperture, there may also be a contribution to FES COUNTS IN from light spilling over the edges of the aperture.

Work is continuing to refine the relationships given here. More observations will be added to the set used. Dependences of the FES sensitivity on temperature, telescope focus, and time will be looked for.

Albert V. Holm

William G. Crabb

Reference: Fernie, J. D. 1976, PASP, 88, 969.

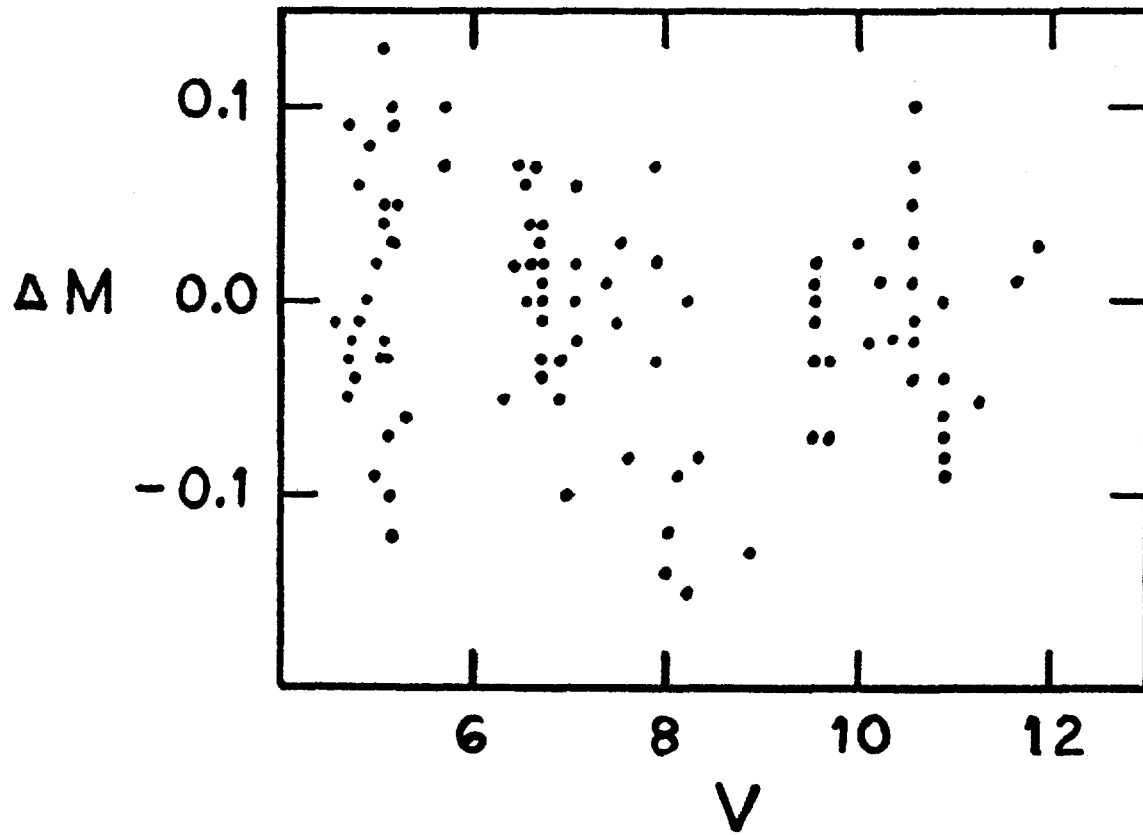


Fig. 1 -- The difference between the V magnitude and the predicted V derived from the FES counts plotted as a function of V.

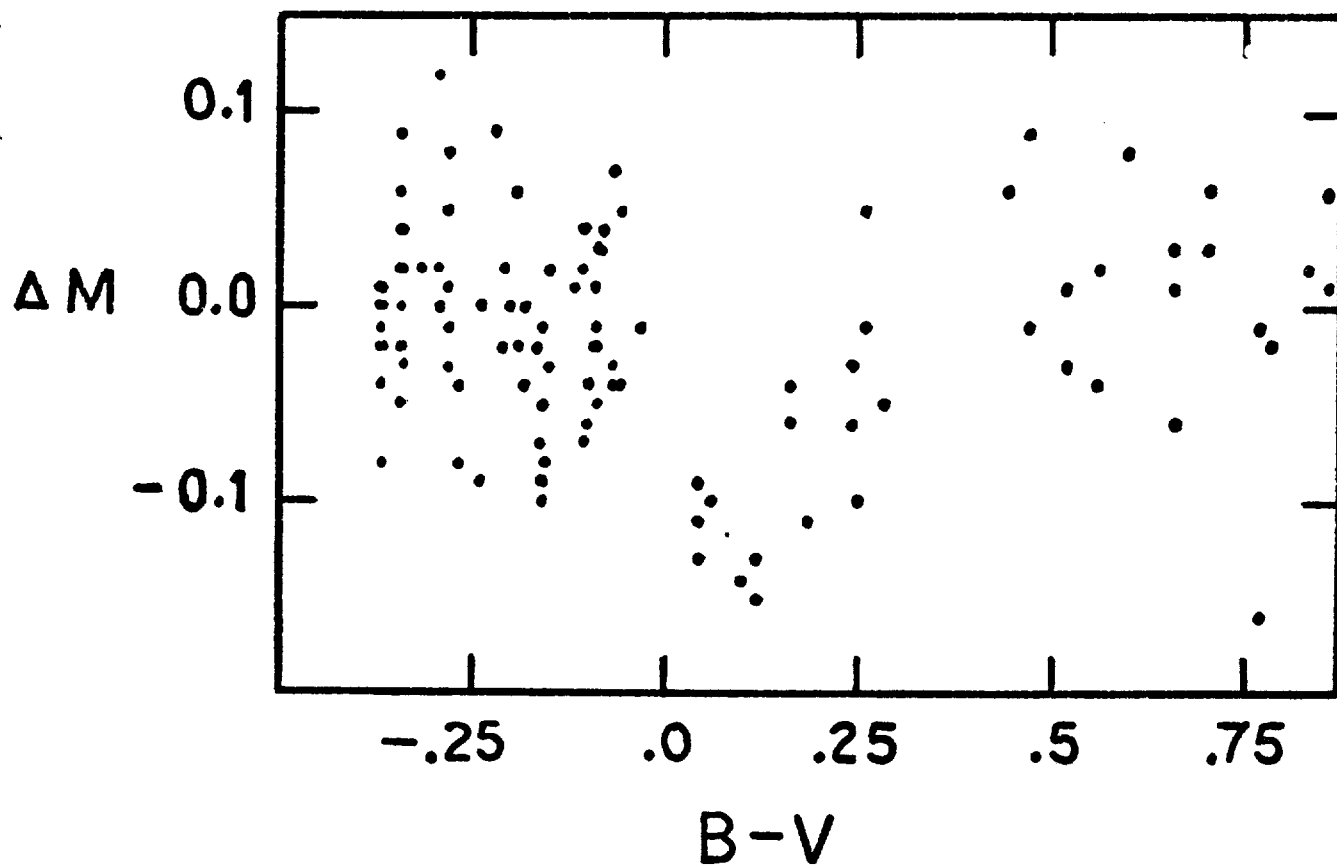


Fig. 2 -- The difference between the V magnitude and the predicted V derived from the FES counts plotted as a function of $B-V$.