SPACE TELESCOPE SCIENCE INSTITUTE

INSTRUMENT SCIENCE REPORT

CAL/FOS - 003

TITLE: Recent FOS Calibration at GSFC

AUTHOR: J. M. Wheatley and R. C. Bohlin

DATE: 11 November 1983

ABSTRACT

No abstract

DISTRIBUTION: Master File, Library

ISB

CSC

SDAS

SOGS

IDT - FOS

CAL/FOS-005

Jean This should be given an FOS #XX number & put in the files & on your master title list. (No general ISB distribution)
Thanks, Ralph

SPACE TELESCOPE SCIENCE INSTITUTE

(No Abstract)

TO: Distribution DATE: 7 November 1983

FROM: J. Wheatley and R. Bohlin

SUBJECT: Recent FOS Calibration at GSFC

I. Photometric Calibration

The photometric calibration was repeated on 28-29 October 1983 at Goddard Space Flight Center. This new data resolves the problems described in the previous calibration report. The quantum efficiency of the blue detector with gratings H27, H40 and H57, as measured with the ambient ST optical simulator (STOS), has changed less than 2% since the previous photometric calibration of 14 June 1983. Also, the October spectrum of the deuterium lamp with grating H19 agrees to within 10% of the June air spectrum at wavelengths above 1900Å, where the increased atmospheric absorption at sea level is small. The June data agrees to about the same accuracy with the few spectra obtained in March after the STOS vignetting problem was solved.

Therefore, the low count-rates in the 22 July vacuum spectra must be due to the improperly calibrated or misaligned vacuum STOS, which contains two mirrors whose reflectance is not accurately known. Furthermore, the vacuum lamps are not fully calibrated in terms of uniformity in angle over f/24, or in area over the required size.

II. Entrance Aperture Sizes

We discovered that the neutral density filters used for the March aperture maps contain pin holes and scratches which may have caused small-scale variations in illumination across the apertures. This is the most likely cause of the spurious results in the March aperture maps. For the GSFC measurements, the neutral density filters were removed and the tungsten lamp operated at a reduced voltage of 4.00 amps.

The new aperture maps agree with those of 8 August to within 10% for all except the 0.1 arcsec aperture (A4), for which the light transmittance is 20% less than in August. However, the ratio of the upper to lower halves of A4 remains unity. The August maps were made with a polarizing element in the vacuum STOS. This, combined with the alignment problems in the STOS, may account for the difference between the two sets of aperture maps. Furthermore, the aperture map technique may not be repeatable to an accuracy greater

than 10% when the aperture size is small compared with the diode size, because small scale variations in the cathode sensitivity, diode uniformity and diode size all contribute to the error in the count rate. The image of the 0.1 arcsec aperture is only 14 microns square, compared with the diode size of 50x200 microns.

We also considered the effects of the STOS output beam angle on the measurement of the 0.1 arcsec aperture. The f/24 beam produces a 4% vignetting due to the substrate thickness of this small aperture but less than 1% for the 0.25 arcsec aperture (A3). We believe the vacuum STOS might have an even slower (~f/40) beam, further reducing the vignetting to 2%. Thus, the angle of the STOS output beam can not be responsible for the small 0.1 arcsec aperture size inconsistency.

The October aperture map results give sizes that are 3-10% smaller than the microscope measurements for most of the apertures, but the 0.1 arcsec aperture is 30% smaller. There is a few percent uncertainty in the magnification used in the microscope measurements, and the difficulty in measuring the very rough outline of the smaller apertures with a planimeter is considerable. These errors, combined with those in the aperture map technique may well be enough to explain the 5-10% difference between the two measurement techniques for the larger apertures and the 30% difference in the smallest aperture.

III. Scattered light from an isolated spectral line.

To determine whether the FOS meets its scattered light specifications, we obtained line profiles of two isolated mercury lines at 2537 and 4357A. The scattered light intensity at various distances from the center of each line is shown in table 2. These values are an upper limit to the scattered light intensity because the digicon non-linearity correction is not known for the 60Hz pulsed output of the Hg lamp. The actual intensity at the line center may be higher than that measured. Nevertheless, the uncorrected scattered light intensities are better than the specifications at more than 10 pixels from the line center, and close to the specifications at distances of 2-10 pixels. Future reductions of this data will include examination of the isolated line profiles for saturation effects in the peak. The scattered light calibration next summer will have a check for non-linearity effects by doing one grating at a peak apparent counting rate of 1000 instead of the routine 10,000.

TABLE 1 FOS Entrance Aperture Sizes

Aperture	Dimensions (arcsec)	Specifications ($arcsec^2$)	Microscope ($arcsec^2$)	Aperture Maps October* ($arcsec^2$)	Aperture Maps August* ($arcsec^2$)
A 4 L	0.1 X 0.1	.010	.00905	.0060	.0074
A 4 U		.010	.00855	.0061	.0078
A 3 L	0.25 X 0.25	.063	.0575	.050	.055
A 3 U		.063	.0575	.051	.055
B 2	0.3 Circular	.071	.0629	.056	.062
B 1	0.5 Circular	.196	.184	.180	.187
A 2 L	0.5 x 0.5	.250	.243	.228	.235
A 2 U		.250	.246	.236	.244
C 2	0.25 x 2.0	.500	.475	.444	.447
B 3	1.0 Circular	.785	.738	.759	.769
C 1 L	1.0 x 1.0	1.0	.981	.952	.940
C 1 U		1.0	.989	.986	.963
C 4	0.7 x 2.0	1.19	1.18	1.13	1.10
C 3	2.0 x 2.0	3.46	3.36	3.34	3.23
A 1	4.3 x 4.3	18.5	18.6	18.5	18.5

* Normalized to A1 = 18.5 $arcsec^2$.

L = lower, U = upper

Table 2. Scattered Light from an isolated spectral line.

Distance from line center (diodes).	Scattered light intensity normalized to line peak. Observed*	Specifications
2537A		
10	6×10^{-4}	5×10^{-4}
50	1×10^{-4}	2×10^{-4}
100	1×10^{-5}	1×10^{-4}
4357A		
2	1.1×10^{-2}	1×10^{-2}
6	1×10^{-4}	1×10^{-3}
10	5×10^{-5}	5×10^{-4}
50	7×10^{-6}	2×10^{-4}
100	5×10^{-6}	1×10^{-4}

*These values represent an upper limit to the scattered light intensities, because the digicon non-linearity correction for a pulsed light source is not well known.

Figure 1. Aperture map of 0.1 arcsec aperture (A4), October 1983. The count rate in each x-step and y-step is plotted on the vertical axis.