Ambient QE Measurements of the FOS Red Side

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Abstract

A series of measurements were made at LMSC on October 1-2 to determine the current sensitivity of the FOS red side. Tests performed with the ambient ST optical simulator confirm the continuing degradation of the F-8 red response seen with the internal calibration lamp measurements included in the YMONTHLY test procedure.

I. *Introduction*

The recent removal of the FOS from the HST spacecraft has afforded an opportunity to make additional performance tests at LMSC. This report describes several measurements aimed at better determining the current sensitivity of the red side of the FOS, compared with its sensitivity immediately following the F-8 detector installation.

The FOS was located in the R&I room, mounted vertically in its test stand, and was operated with the FOS GSE. A translation of the YMONTHLY red tube monitor SATS test procedure, incorporating more Y-steps and longer exposure times (to improve statistics), was successfully performed on Oct. 1. The ambient ST optical simulator (ASTOS) was then utilized to obtain calibration spectra which may be directly compared with measurements made in the same manner in December, 1985.

II. *YMONTHLY Results*

A STOL version of YMONTHLY (called YMONTH) was created which increases the number of Y-steps to 5 (to assure registration of the spectrum with the diode array, given the uncertainty in the correct Y-base value) and extends the exposure time from 2s to 20s per quarter-step. The results of the 1 Oct. test are compared with those from the previous run of YMONTHLY, on 20 Aug., in Figure 1. Spectra at each of the Y-steps that are properly registered with the array, through both the upper and lower 0.1-PAIR aperture, have been co-added. Some wavelength-dependent degradation since August is present, with about 5% lower count rates seen at 6300Åand a 20% loss at 7500Å. However, the internal cal lamps are not particularly stable sources, and variations of 5-10% between operation cycles are to be expected. It is the wavelength dependence of the loss in signal that indicates continued loss of red response.

A similar comparison with spectra obtained on 18 Dec 85 (Figure 2.) shows the same trend, indicating a loss of red sensitivity amounting to about 50% at 7500Å, over the intervening 41 weeks. It should be noted that the red response decay was arrested and apparently reversed during the thermal-vacuum testing from May to July, so that the decay rate that would likely be seen if the detector remained in ambient is somewhat greater than observed here.

III. *ASTOS Test Results*

The ASTOS tests were made with FEL lamp #180 and diffusing screen #2. The Dec 85 ASTOS measurements were made with lamp #179, but this lamp now produces about 5-10% less flux, with weak wavelength dependence, compared to lamp #180. At each of the ASTOS calibrations at the NBS (in Dec 82 and Sept 84) these two lamps produced ASTOS irradiances that overlapped within the several percent measurement error. The FOS measurements at short wavelengths show excellent agreement between the spectra obtained with lamp #180 and those obtained in December, while the lamp #179 results fall about 8% below the December values. We can only surmise that lamp #179 has degraded in some fashion since December, necessitating the use of lamp #180.

The obscuration aperture of the ASTOS was removed for one set of measurements, thereby allowing the FOS collimator to define the beam (and thus rendering the test insensitive to ASTOS misalignment). A second set of measurements was made with an f/30 stop placed over the standard f/24 stop, to measure the FOS sensitivity away from the edges of the optics, again reducing the sensitivity to misalignment. The ASTOS was mounted on the FOS test stand in the same orientation as for the Dec 85 measurements, with the same set of alignment shims. The ASTOS alignment was crudely checked by occulting each of the four edges of the diffusing screen with a 25mm wide flat black slat (the outside edge of which was aligned with the screen edges) and noting no significant loss in signal. Three Y-steps, with $\sim 50\mu$ separation were used to assure registration of the spectra with the diode array.

Figures 3 through 6 show the results of the f/24 measurements, with gratings G270H, G400H, G570H and G780H, as compared with measurements made in the same manner in Dec 85. The operating parameters were identical with those used in December, with the exception of the Y-base values (an approximately 80μ drop in the Y-base values occured since Dec.), and substitution of the 0.5 aperture for the 0.5-PAIR aperture for the G400H spectra only (these results have been scaled by the measured aperture area ratio; see CAL/FOS-019).

The ASTOS measurements are in near perfect agreement with the Dec 85 values at the short wavelengths; the ratio of the measurements made at each epoch with grating G270H and G400H is nearly unity. Some departure from this agreement becomes apparent at the longest wavelengths of the G400H spectra, and this trend is continued in the G570H and G780H measurements. The strong wavelength dependence of the signal ratio seen with G780H closely mimics the YMONTHLY results, obtained with the internal, cross-strapped cal lamp. Both techniques indicate that a loss of about 50% in the F-8 detector sensitivity at 7500Åhas occurred since the Dec 85 installation.

The ratio of the f/30 measurements to those of Dec 85 is in excellent agreement with the f/24 results, confirming the loss of red sensitivity. The ratio of the f/30 measurements to those at f/24 (at either epoch) is of considerable interest, however. After correction for diffraction losses, which are non-negligible for the f/30 beam at long wavelengths through the smallest apertures (even though it avoids the periphery of the collimator), the f/30 measurements indicate an FOS QT that is approximately 20% greater than the QT measured with the ASTOS aperture plate removed, allowing the collimator to define the beam (nominally f/24). ASTOS measurements made in the same way on the blue side indicate that a similar loss of efficiency at the edges of the f/24 beam is also present on that side. This loss of efficiency appears to be essentially independent of the disperser selection and wavelength, and may be indicative of an optical misalignment or a misplaced or undersized baffle internal to the FOS. Such vignetting of the beam would offer at least a partial explanation for the fact that the end-to-end absolute QE measurements, made at f/24 with the VSTOS and ASTOS in July-August 84, yielded throughput values that averaged only about 70% of the individual component efficiencies (Hartig and Bohlin, 1985). This matter clearly deserves closer scrutiny, and will be the subject of a future calibration report.

References

Hartig, G.F. 1986, *Thermal-Vacuum Monitoring of the F8 Detector Red Sensitivity*, CAL/FOS-036, August, 1986, STScI.

Hartig, G.F. and Bohlin, R.C. 1985, *The Laboratory Absolute Photometric Calibration of the FOS*, CAL/FOS-016, June, 1985, STScI.

Lindler, D.J., Bohlin, R.C. and Hartig, G.F. 1985, *FOS Entrance Aperture Sizes*, CAL/FOS-019, July, 1985, STScI.

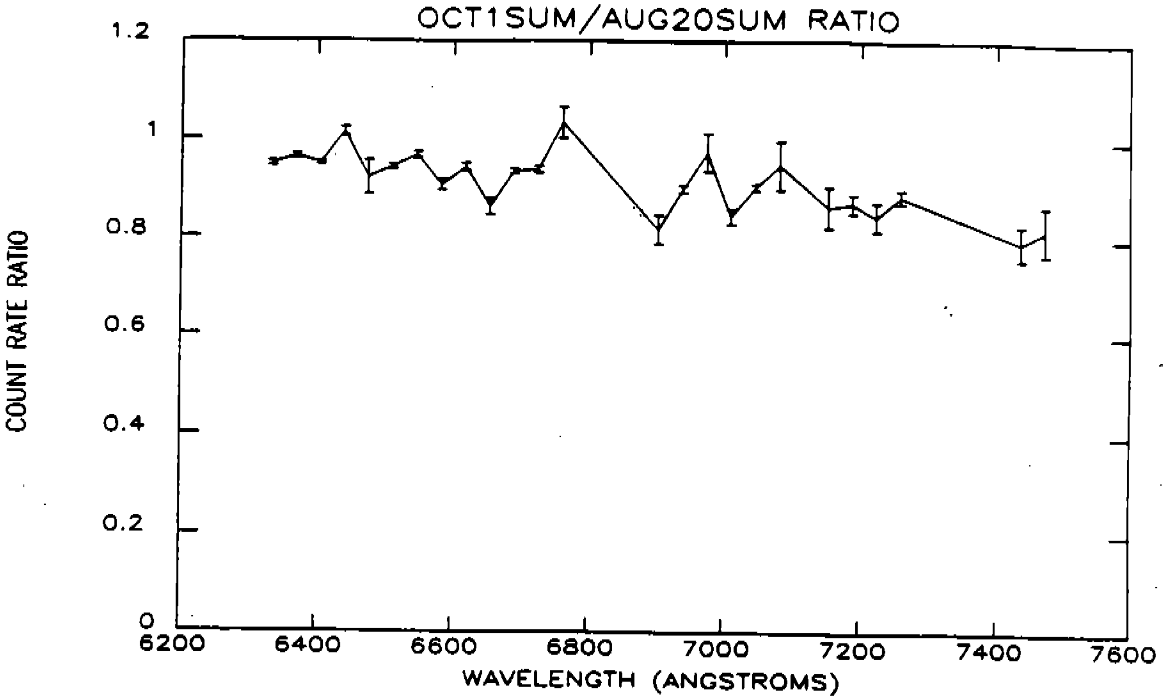

Figure 1. Comparison of the YMONTHLY spectra obtained on 1 October 86 with those from 20 August 86. All Y-steps fully registered with the diode array, from both the upper and lower 0.1-PAIR aperture, have been co-added. Error bars are the 1σ uncertainties due to photon noise.

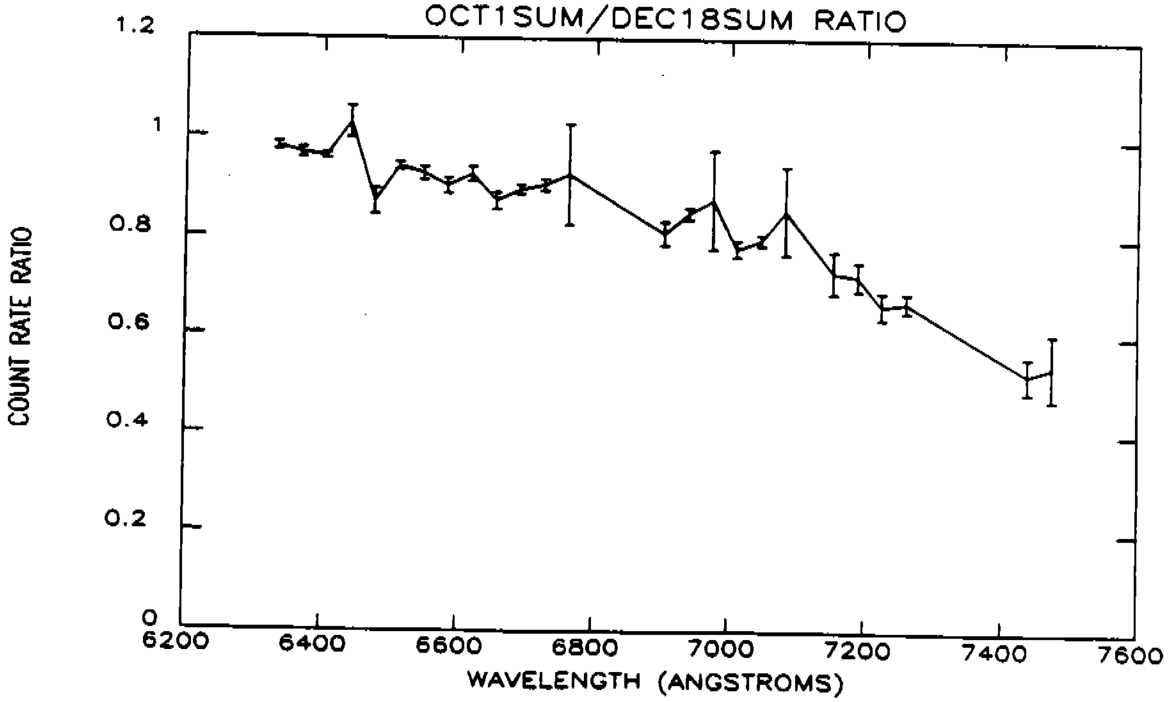

Figure 2. Comparison of the summed YMONTHLY spectra from 1 October 86 with the baseline spectra obtained on 18 December 85. A drop in sensitivity of 50% at 7500Åis indicated.

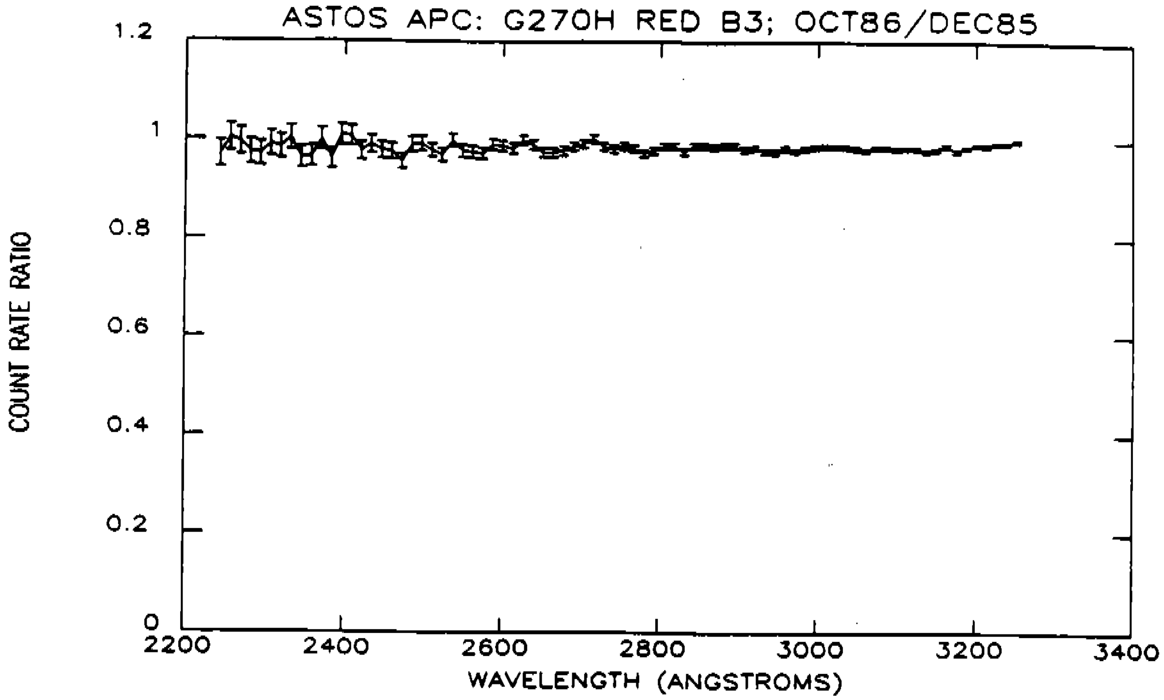

Figure 3. Comparison of the f/24 ASTOS measurements obtained with the G270H grating on 2 October 86 with those obtained on 18 December 85.

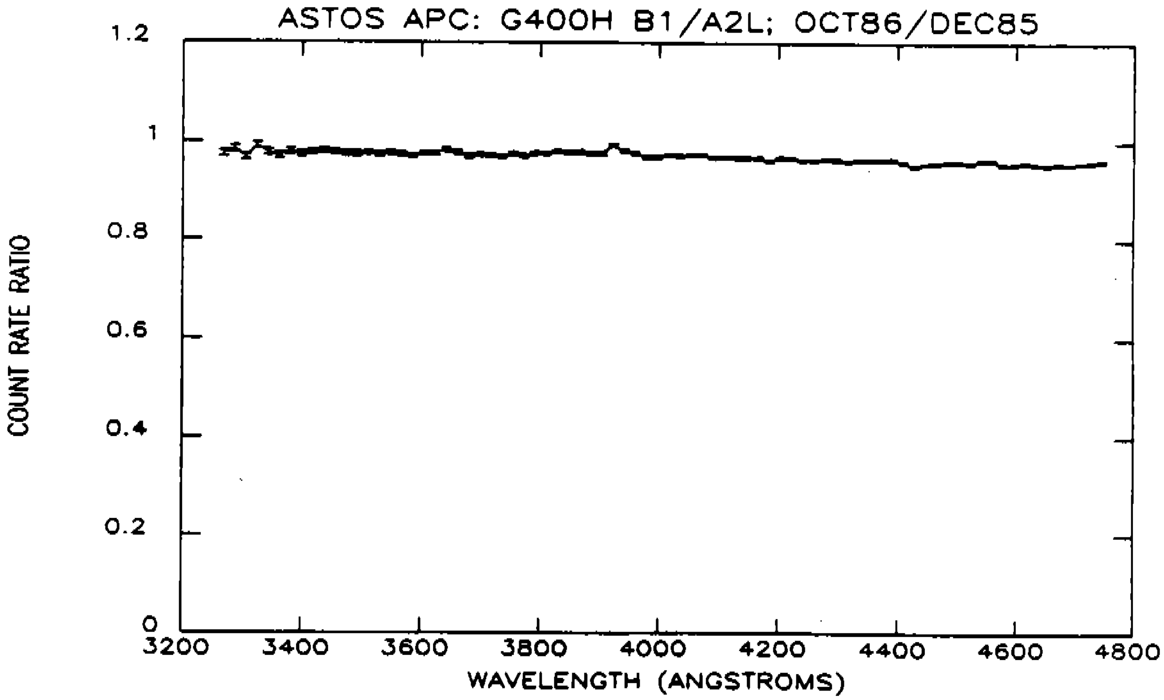

Figure 4. Comparison of the f/24 ASTOS measurements obtained with the G400H grating on 2 October 86 with those obtained on 18 December 85.

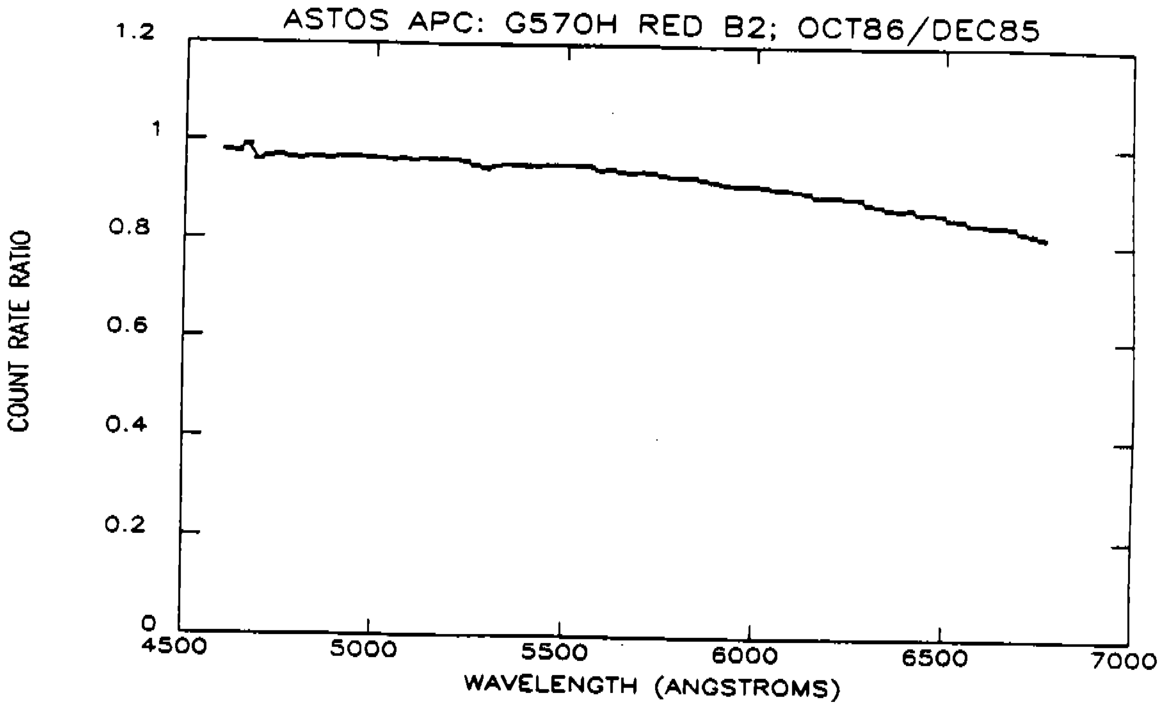

Figure 5. Comparison of the f/24 ASTOS measurements obtained with the G570H grating on 2 October 86 with those obtained on 18 December 85.

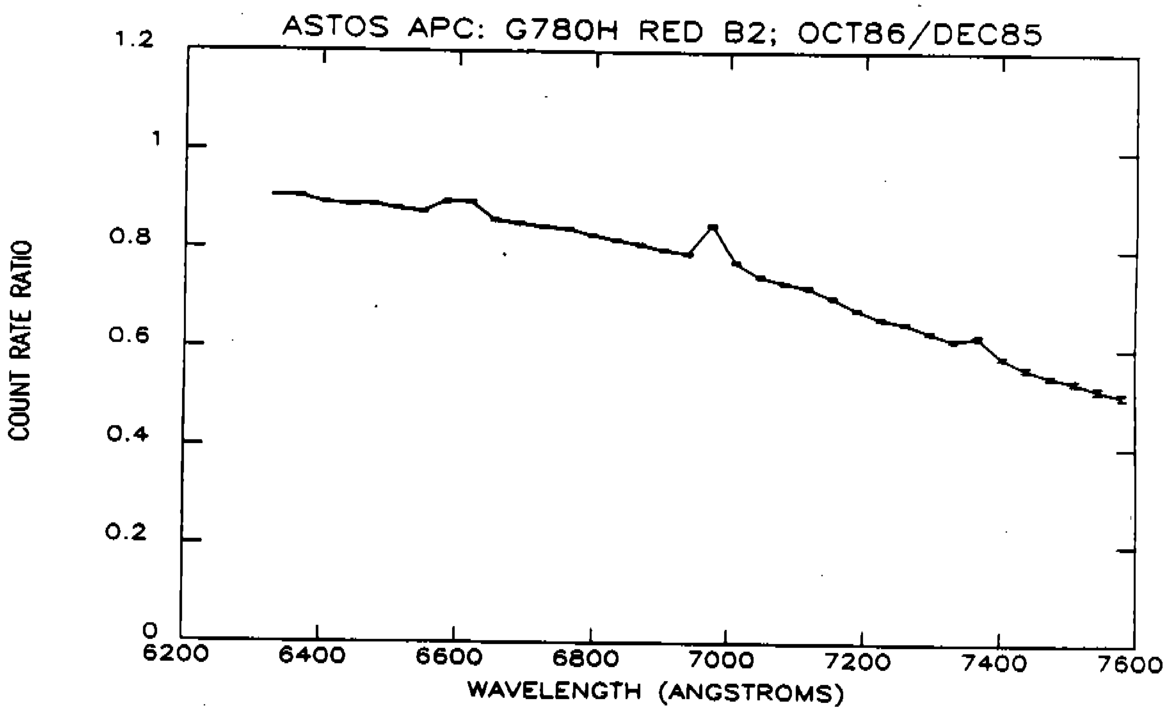

Figure 6. Comparison of the f/24 ASTOS measurements obtained with the G780H grating on 2 October 86 with those obtained on 18 December 85. The drop in efficiency at the red end of the spectrum closely matches that indicated by the internal calibration lamp (YMONTHLY) measurements.