Y LOCATION OF FOS SPECTRA

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Abstract. The optimal Y-locations of the FOS spectra were determined for all detector/grating combinations using calibration maps obtained during April 1994 - May 1995 (proposal ID 5530). The analysis shows that the spatial drift with time continues for all FOS/BL gratings while the locations of the spectra for all FOS/RD gratings are still scattered. The uncertainties in the locations of the spectra have affected both ACQ/BINARY pointing accuracy, ACQ images, and FOS photometric accuracy. The photometric quality of the data, especially for FOS/RD and the 1.0″ aperture for extended sources, are compromised due to the large fluctuations in the location of the spectrum. Further, this is not a simple matter of losing light, but the effect is also wavelength dependent.

Key words: FOS – Location of Spectra

1. Introduction

The ability to acquire FOS spectra and the accuracy of the FOS binary acquisition (ACQ/BINARY) depend on knowledge of where the spectrum is located on the photocathode. Previous observations show that there is a spatial drift with time of the position of the spectra on the photocathode for all gratings observed with the FOS/BL detector, while the location of the spectra for all gratings and the FOS/RD detector are scattered [see CAL/FOS - 133, CAL/FOS - 110, CAL/FOS - 96, CAL/FOS - 12]. The uncertainty requires us to monitor the location of the spectra frequently, as both the binary target acquisition ability and the photometric accuracy of the FOS are affected. The Y-location of the spectrum on the photocathode is specified by using a basic FOS unit called the YBASE. More precisely, the YBASE is a measure of the amount of magnetic deflection required to project the ejected photoelectrons onto the Digicon diode array.

2. Data Analysis

Observations using all FOS gratings and both the FOS/BL and FOS/RD detectors were obtained approximately once a month during the Cycle 4 calibration program 5530 to determine the Y-location of the FOS spectra. The internal wavelength calibration lamp was observed using the 0.3″ aperture. Each observation was in the FOS IMAGE mode and used all 512 diodes, with NXSTEPS=1, OVERSCAN=1 and YSTEPS=24. Thus, each observation can be considered to be a map of 512 x 24 pixels each. The exposure times for each single exposure are given in Table I. The observations used the optimum YBASE values determined from previous cycles for each grating/detector combination as a preliminary guess for the location of the spectrum on the photocathode.

TABLE I
Spearman Correlation Coefficients for the single apertures (May 1995)

Disperser	Blueside	Blueside Exposure Times (s)	Redside	Redside Exposure Times (s)
G130H	0.91	90	N/A	N/A
G190H	0.87	36	0.13	54
G270H	0.88	6	0.42	24
G400H	0.86	6	0.62	6
G570H	0.88	18	0.41	6
G780H	N/A	N/A	0.57	6
G160L	0.86	18	0.60	72
G650L	0.76	6	0.46	18
PRISM	0.93	6	0.50	6

The FOS spectra are curved due to the small imperfections of the Digicon magnetic field. Thus, the center of the spectrum is defined to be the mean of the maximum and minimum YBASE values attained by the specrum. For each map the optimal YBASE, which represents the center of the spectrum in the direction perpendicular to the diode array is determined [see CAL/FOS-96, CAL/FOS-110, CAL/FOS-133 for details of previous cycles and methodology].

Figures 1 through 4 show the distribution of the YBASE values determined for typical gratings on the Blue and Red sides, including SV, cycles 1, 2, 3 and 4 data.

3. Results

In the case of the FOS/BL detector, the data are correlated (see Table I) and show that there is a spatial drift with time of the positions of the spectra for all gratings. The drift can be characterized well by a straight line fit. In general, the locations of the spectra have shifted by about 113 YBASES. In the case of the FOS/RD detector, the data are not correlated (see Table I), and the locations of the spectra for all gratings show no obvious trend with time. The cumulative temporal range in the locations of spectra for the FOS/RED detector is about 78 YBASE units.

Both FOS/BL and FOS/RD detectors data show a change in the amount of standard deviation if the data are divided into two groups, prior to 1993.3 and after 1993.3. The change in scatter is more pronounced for the FOS/RD detector than it is for the FOS/BL detector. This change in scatter seems to be closely associated with the time that onboard GIM correction was implemented (5 April 1993; i.e. 1993.3).

The predicted YBASE values which best represent the locations of the spectra for each grating as of 1 July 1995 were determined for the Blueside by the value predicted

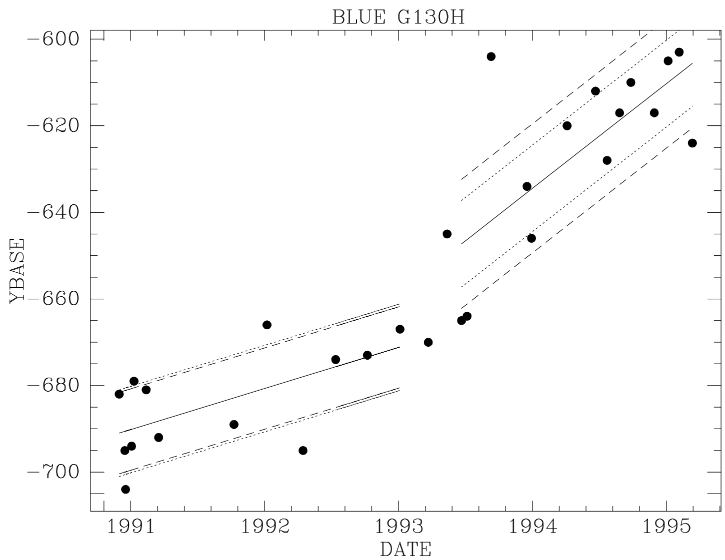

Fig. 1. The optimal YBASE values as a function of time for the location of spec tra for FOS/BL G160L grating. The best fit straight lines were calculated for the grating and the results of the analysis are shown in the figure. The dashed lines are +/- 1σ YBASE units from the best fit straight line to th e SV, Cycle 1, Cycle 2, Cycle 3, and Cycle 4 data when the data are divided into two halves (see text). The dotted lines ar e +/- 10 YBASE units from the two best fit straight lines. These represent the possible range in the YBASE values to account for filter-grating wheel non-repeatability. Most of the scatter in the data for the first half lies withi n the dotted lines indicating that the scatter is mostly due to filter-grating w heel non-repeatability. The scatter in the second half of the data is larger tha n can be accounted for by the filter-grating wheel non-repeatability. We hypothesize t hat the measured YBASE variations are most likely due to the impact of changes in the evolution of the residual ma gnetic field in the detector as a result of the introduction of the onboard GIM correction.

by the linear fit to the second half of the data (post 1993.3). For the Redside data, since the data are not correlated, only the average of the cycle 4 data was computed. Table II gives the predicted values.

The uncertainties in the location of the spectra have affected ACQ/BINARY pointing accuracy, ACQ images, and FOS photometric accuracy for extended objects. The 1σ Binary acquisition accuracy for the FOS/BL detector is 0.08″ while it is 0.12″ for the FOS/RD detector (50% larger than the FOS/BL detector). The size of these uncertainties with ACQ/BINARY has forced us to follow ACQ/BINARY with a time-consuming ACQ/PEAK to improve the target centering for science with all apertures smaller than 1.0″. This inefficiency is exacerbated for Redside acquisitions, which are more commonly utilized than Blueside acquisitions, because the poorer FOS/RD ACQ/BINARY accuracy requires an ACQ/PEAK sequence nearly twice as long as that for FOS/BL.

We find that the photometric quality of the data may be compromised due to the large fluctuations in the YBASES. especially on the Redside. In the case of extended

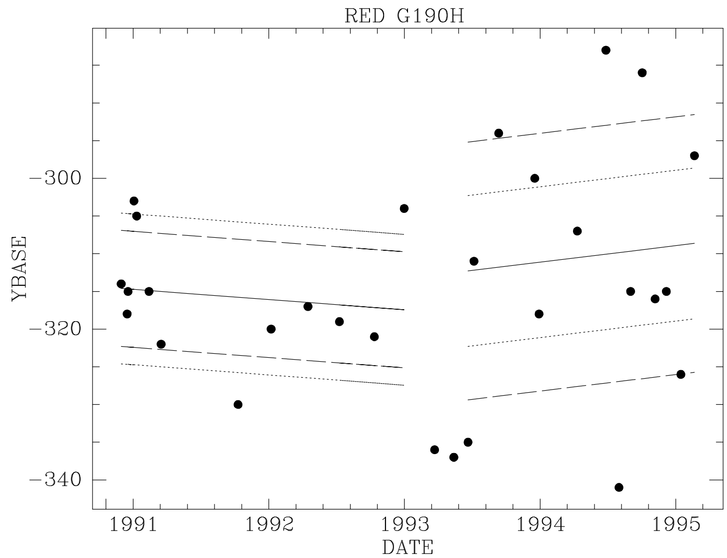

Fig. 2. As Fig. 1 but for the G190H grating and the FOS/RD detector.

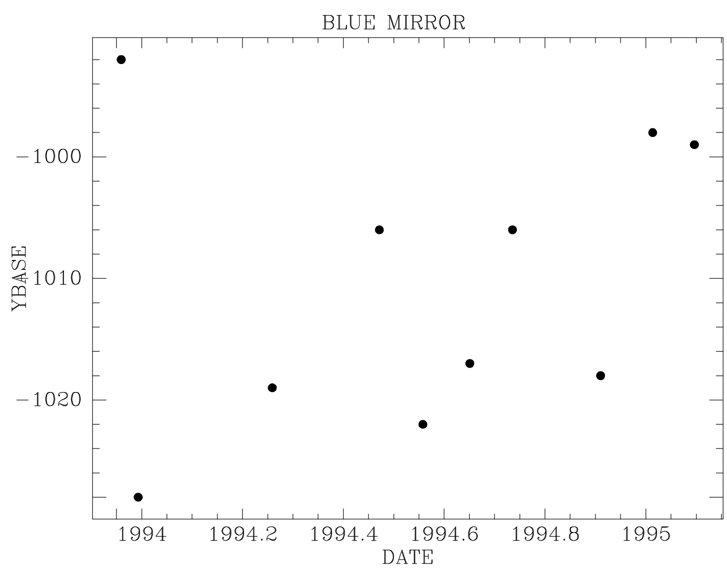

Fig. 3. A plot of YBASE vs. time for the MIRROR and the FOS/BL detector.

objects, the 1.0″ aperture, which is similar to the size of the FOS diode height, can be affected substantially because any uncertainty $\gtrsim$ 40 YBASES in the location of the spectrum means that we are not collecting all the photons in the point spread function.

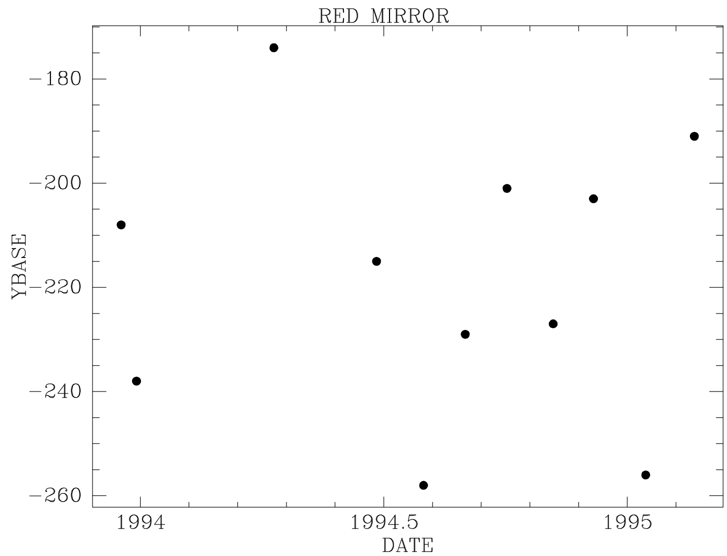

Fig. 4. A plot of YBASE vs. time for the MIRROR and the FOS/RD detector.

TABLE II

Predicted YBASE Values for July 1 1995 for the 0.3″ aperture

DISPERSER	Post 1993.3 BLUE	Avg Cycle 4 RED
MIRROR	-1015	-218
G130H	-598	N/A
G190H	-975	-309
G270H	-1615	323
G400H	316	-1387
G570H	266	-1496
G780H	N/A	264
G160L	-878	-216
G650L	-669	-344
PRISM	-720	-334

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