THE FOS DARK COUNT-RATE: PRELIMINARY ANALYSIS OF CYCLES 1 THROUGH 4

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Abstract.
This document gives a preliminary analysis of all FOS dark observations taken on-orbit from Cycle 1 through Cycle 4. We find that overall, the FOS/RED dark count-rate is 0.0086 $\pm$ 0.0046 cts s^{-1} $diode^{-1}$, while for the FOS/BLUE, the count-rate is 0.0036 $\pm$ 0.00079 cts s^{-1} $diode^{-1}$. We also confirm the finding of Rosenblatt *et al.* (1992) of the correlation between dark count-rate and geo-magnetic latitude.

Key words: FOS, HST Instruments, Dark countrates

1. Introduction

We have undertaken a study of the FOS dark count-rate from time of launch in 1990 to the present epoch. In order to do this, we have obtained from the HST data archive 1460 datasets, covering all of the observation cycles to date. There are 657 observations taken with the FOS/BL and 803 observations taken with the FOS/RED. The break down of datasets by Proposal ID, cycle, and detector are shown in Table 1, below.

All the datasets used in the present analysis were taken in IMAGE mode, and used the default values for both REJLIM and the High Voltage. As mentioned above, they were pulled from the HST archive, then converted to GEIS format, and occupy roughly 512MB.

2. Data Analysis

All of the datasets were analysed using the IRAF/STSDAS package. The dark count-rates were calculated using the STSDAS task "`parthity`", which used the C1H datasets. The task determines the average count rate per diode, using all the frames in the dataset. Points determined to be particle hits are not used in the average. Noisy diodes are identified as those having a dark count-rate greater than a given threshold (in our case, we chose 3σ) above the average for all diodes.

We then used the STSDAS task "`hstpos`" and the SHH files for find the geographic position of HST at the start of the integration for each frame (or more properly group) in the dataset. From there the output from this step was sent through the STSDAS task "`geo2mag`", where the geographic co-ordinates are converted to geo-magnetic co-

TABLE I
FOS Dark datasets by cycle and detector.

Proposal ID	Detector	No. Datasets	Cycle
1316	FOS/RED	592	1
1316	FOS/BLUE	497	1
1533	FOS/RED	32	1
1533	FOS/BLUE	32	1
2748	FOS/RED	62	2
2748	FOS/BLUE	94	2
4698	FOS/RED	35	3
4698	FOS/BLUE	19	3
4773	FOS/RED	2	SMOV
5532	FOS/RED	50	4
5532	FOS/BLUE	49	4

ordinates. This latter step is a simple spherical rotation from the geocentric coordinate system where the north pole is located at 90° latitude, 0° longitude, to the geo-magnetic co-ordinate system where the geo-magnetic north pole is located at 78.6° latitude, 289.3° longitude. There is no physics involved in this co-ordinate transform.

The last step used a specially coded task from J. Eisenhamer and the SHH files that calculated the great-circle distance between the (α, δ) of the pointing of HST's V1 axis, and the (α, δ) of the Sun at the start of each frame in each dataset. We call this final quantity the solar angle.

All these data (count-rates, positions, times, solar angles) were collated, and various correlations between variables explored.

3. Results

It is immediately apparent that the count-rates found from all the datasets in proposal 2748 were anomalously high – one order of magnitude larger on the RED side and two orders of magnitude larger on the BLUE side. On investigation, it was found that proposal 2748 was used for map the outline of the South Atlantic Anomaly (SAA). These datasets were therefore omitted from the calculations for the overall dark count-rates, and any of the correlations found between the variables. The average dark count-rates for each cycle by detector are given in Table 2.

TABLE II
Dark count-rates by Cycle and detector

Cycle Number (Proposal)	Detector	Dark Count-rate (cts/sec/diode)
1 (1316)	RED	0.00174 ± 0.0021
1 (1316)	BLUE	0.00395 ± 0.0011
1 (1533)	RED	0.0104 ± 0.0027
1 (1533)	BLUE	0.00049 ± 0.0001
2 (2748)	RED	0.1614 ± 0.126
2 (2748)	BLUE	0.1087 ± 0.16
3 (4698)	RED	0.00644 ± 0.0042
3 (4698)	BLUE	0.00353 ± 0.0024
SMOV (4773)	RED	0.0186 ± 0.0057
4 (5532)	RED	0.0102 ± 0.0039
4 (5532)	BLUE	0.00554 ± 0.0028

The overall dark count-rate is 0.0086 ± 0.0046 cts s^{-1} diode^{-1} for the FOS/RED, and 0.0036 ± 0.00079 cts s^{-1} diode^{-1} for the FOS/BLUE.

We explored any possible correlations in the various quantities we had compiled (*i.e.* position, solar angle, and time). We found the following relationships to be true:

1. using singular value decomposition (SVD), there is **no** time dependence for the dark count-rates. To within 1σ, for both the FOS/RED and FOS/BLUE, the count-rates are flat (See Figure 1);
2. using SVD, there is **no** correlation between the solar angle and the dark count-rate, for either detector;
3. using SVD, there is **no** correlation between geo-magnetic longitude and dark count-rate, for either detector;
4. again, using SVD, we confirm the findings of Rosenblatt *et al.* of the relation between geo-magnetic latitude and dark count-rate. We find parabolic relationship for the geo-magnetic latitude *vs* dark count-rate, for both sides. The relationship for the FOS/RED is (in cts s^{-1} diode^{-1})

$$\mathrm{Rate}_{\mathrm{Red}} = 8.8 \times 10^{-3} - 8.0 \times 10^{-6} \lambda_{gm} + 5.2 \times 10^{-6} \lambda_{gm}^2,$$

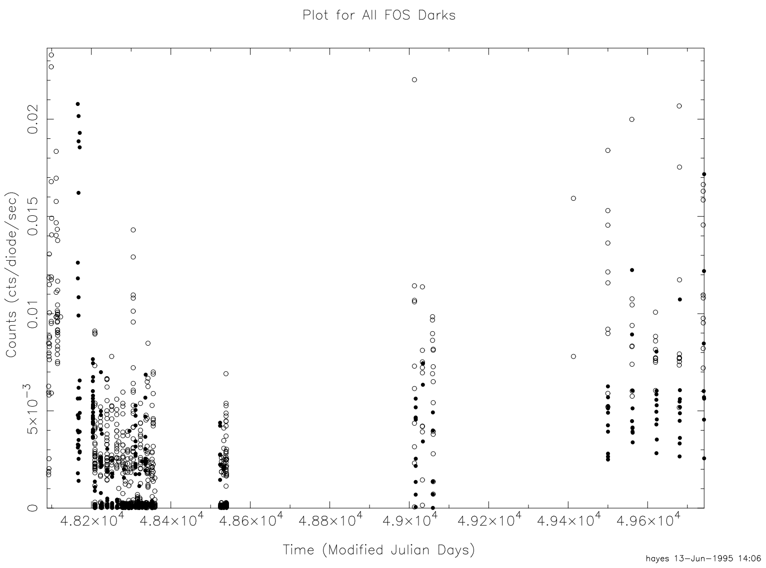

Fig. 1. Plot of dark count-rate *vs* Modified Julian Day (MJD). Open symbols are FOS/RED datasets and filled symbols are FOS/BLUE datasets.

and for the FOS/BLUE (in cts s^{-1} diode^{-1}) is

$$\mathrm{Rate}_{\mathrm{Blue}} = 4.3 \times 10^{-3} + 3.0 \times 10^{-5} \lambda_{gm} + 3.0 \times 10^{-6} \lambda_{gm}^2 .$$

The plot of the data, and the above relations are found in Figure 2. We note that our relations differ from that of Rosenblatt *et al.* , partly due to the fact that their units are in cts s^{-1} cm^{-2} while ours are in cts s^{-1} diode^{-1} .

In addition, we have plotted the 1 degree square contours of the dark count-rate in geo-magnetic position space (omitting data from 2748) in Figure 3. We note that there is a large "hole" in the data centred on latitude $-30°$ and longitude $-100°$: the position of the SAA. There does not appear to be a correlation in the density of contours with geo-magnetic position.

References

Rosenblatt, E.I. *et al.*: 1992,'An Analysis of FOS Background dark noise', *CalFOS* **71**

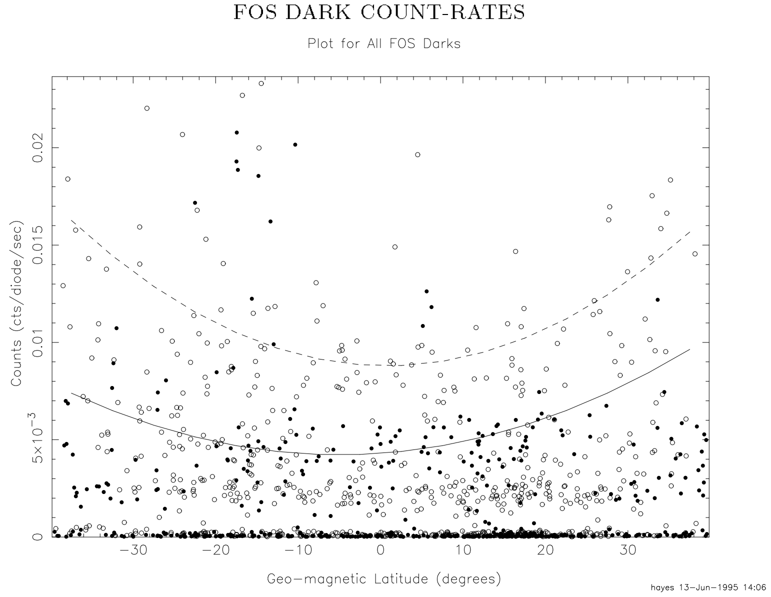

Fig. 2. Plot of dark count-rate *vs* geo-magnetic latitude. The open symbols are the FOS/RED data and the filled symbols are the FOS/BLUE data. The dashed curve is the model for the FOS/RED, and the solid curve is the model for the FOS/BLUE.

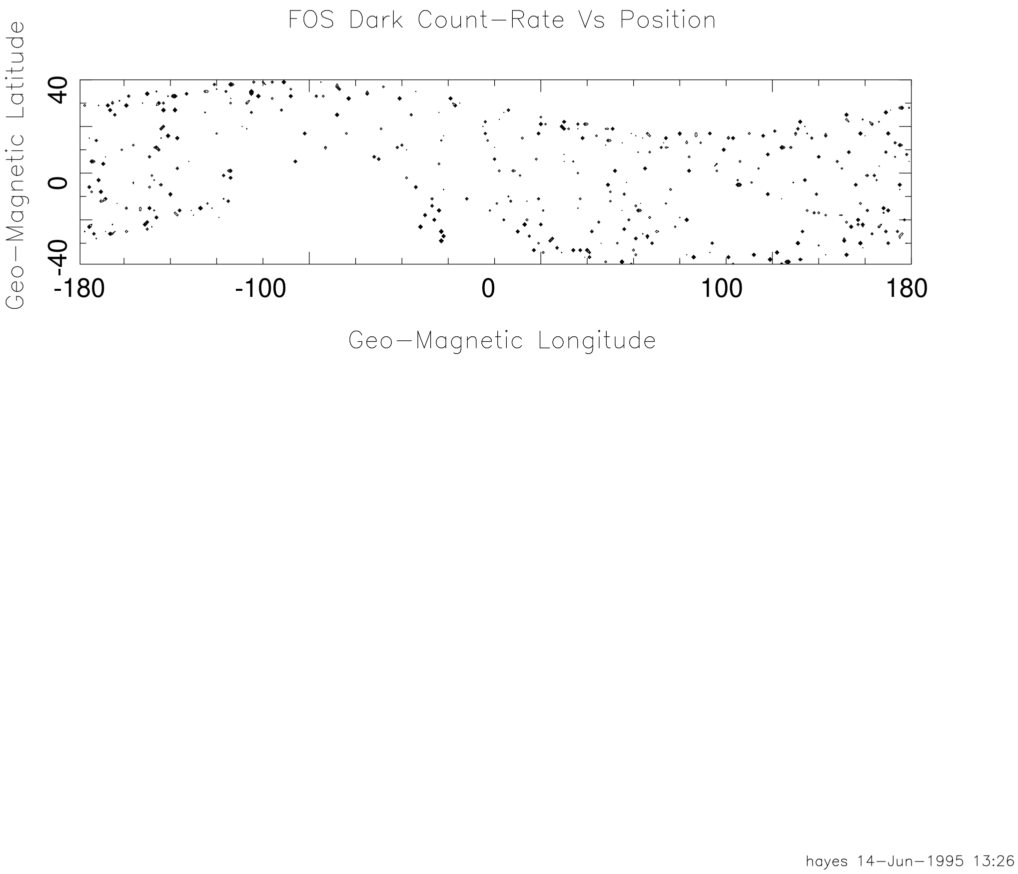

Fig. 3. Contours of dark count-rate in geo-magnetic position space.