SPACE TELESCOPE SCIENCE INSTITUTE

INSTRUMENT SCIENCE REPORT

CAL/FOS-006

TITLE: FOS Flat Field Calibration (FOS Calibration #15)

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ABSTRACT

The FOS photocathodes have a granularity of less than one percent. Eleven blemishes, with sensitivity variations greater than 5 percent, were found on the red tube in regions illuminated by aperture A3. One blemish is a "hot spot" and has an increased sensitivity of approximately 10%. The spatial extent of the blemishes in the direction of the diode array range from 50 to 250 microns. No data was available for the blue tube in air because of schedule constraints. In vacuum, only a minimal amount of data was obtained from the one functioning Quantatec lamp (Krypton).

I. Introduction

The FOS contains two Digicon detector assemblies, designated as the red tube and blue tube. The Digicons operate by accelerating photoelectrons emitted by the transmissive photocathode onto a linear array of 512 silicon diodes. The charge pulse generated in each diode is amplified and counted by one of 512 independent channels. A flat field calibration source is used to measure the variation in sensitivity of the diodes and photocathodes. In this report, we present results for the sensitivity variations of the photocathode on the red tube.

DISTRIBUTION: Master File, Library
ISB D. Macchetto, C. Cox, J. Wheatley
CSC C. Grady
SDAS
SOGS L. Ripp, G. Strein, P. Hintzen, D. Leckrone, A. Boggess
IDT J. Ryan, L. Randall, K. Bilitch
R. Allen

II. Calibration data

Data analyzed in this report was obtained in air in March, 1983 using a tungsten continuum lamp as the calibration source. The data was quarter stepped (XSTEPS=4). Multiplexing over 5 diodes (OVRSCN=5) was used to reduce variations due to the sensitivities of the diodes. Each observation contained four independent sampling of the same spectra (SLICES=4). Data was taken using the upper and lower A3 apertures for all gratings. The upper and lower A4 apertures were used for the prism.

III. Reduction

All data was corrected for diode non-linearities (paired pulse correction). The counts in data points scanned by dead diodes were adjusted accordingly (i.e. multiplication of the data value by 5/(number of good diodes sampling the data). The upper plots in Figures 1 - 6 show the corrected counts for each slice. The upper three slices are offset incrementally by 2000 counts. The bottom plots show the deviation of the spectral data from the continuum after summing all four slices. The continuum was estimated by smoothing the data with a 15 point mean filter. Also shown are the deviations expected due to counting statistics. The plus and minus two sigma levels are plotted, where sigma equals the square root of the counts in the continuum divided by the counts in the continuum. The photocathode X-position in all plots is in 50 micron units (the separation between diodes). Since quarter stepping was used, the separation between data points is 12.5 microns.

IV. Analysis

Most of the deviation from the continuum is due to the counting statistics. Regions where a large number of counts are available indicate the photocathode granularity is less than 1%.

The following blemishes (deviations ~ 5%) have been identified in the red tube.

H40 A3 upper - 3 blemishes
H40 A3 lower - 4 blemishes
H57 A3 lower - 3 blemishes
H57 A3 upper - 1 blemish

These blemishes are shown in Figures 7 and 8. All blemishes except one show a decreased sensitivity. The second blemish in Figure 7 is a "hot spot" and shows approximately a 10% increase in sensitivity. The spatial extent of the blemishes along the diode array range from 50 to 250 microns.

If thermal drifts in the digicon deflection system are significant, the blemishes will be difficult to remove from astronomical spectra using calibration spectra. It would be advantageous to position the gratings on the new flight tubes so that the spectra fall on regions of the photocathode that do not contain any major blemishes.

V. Future Data Collection and Analysis

A complete set of Flat Field data is needed for both detectors. All aperture positions for each grating should be checked. To decrease the noise due to the counting statistics, exposure times should be increased to give 10^5 counts in each final spectrum. The stability (both sensitivity and position) of all blemishes should be investigated using continuum lamps in both air and vacuum. All dispersers need to be used, because each directs the light to a different part of the photocathode. All apertures are required on each grating, because the vertical extent or position of the spectra on the cathode is different for every aperture. This laboratory calibration is essential for reduction of flight data, because features in all astronomical calibration sources will complicate blemish analysis. For apertures larger than ~0.2 arcsec, the avoidance of blemishes is especially important, because lab calibration spectra are for full aperture illumination, which differs from the vertical extent of the point sources to be observed in flight.

FIGURE CAPTIONS

Figures 1 - 6

Upper plots show the reduced observations of the tungsten continuum lamp. The four slices of each observation are plotted with 2000 count offsets between slices. The lower plots show the deviation from continuum of the sum of the four slices where the continuum is computed by applying a 15 point mean filter to the data. Also shown in lower plots are the plus and minus two sigma counting statistics limits. Photocathode x-position is in 50 micron units.

Figures 7 - 8

These plots show the major blemishes with deviations greater than 5% from continuum on an expanded scale.

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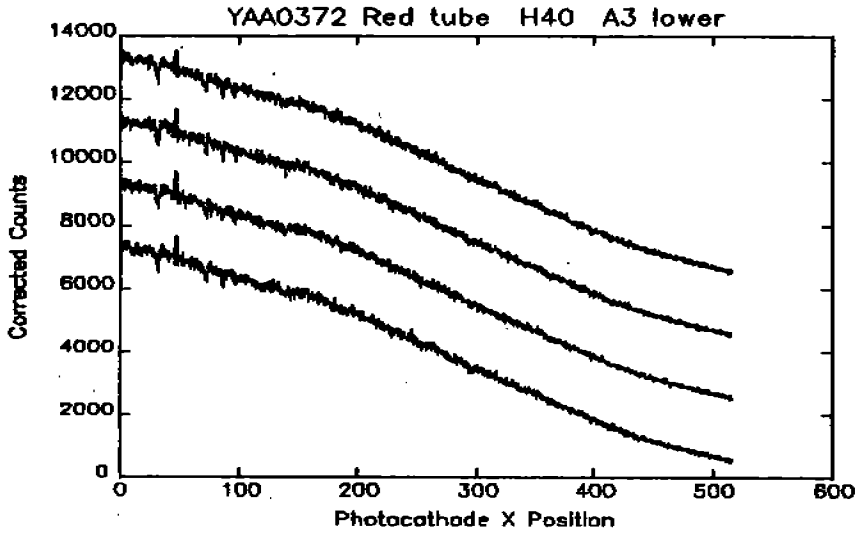
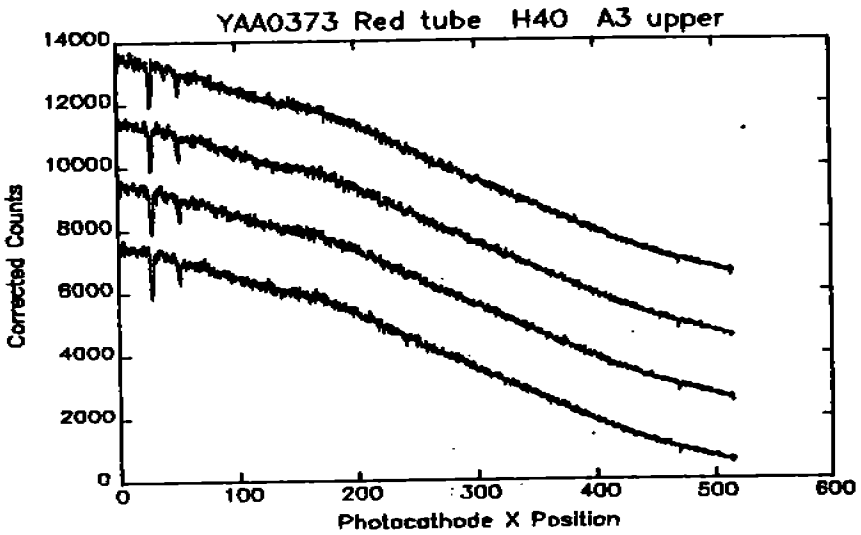
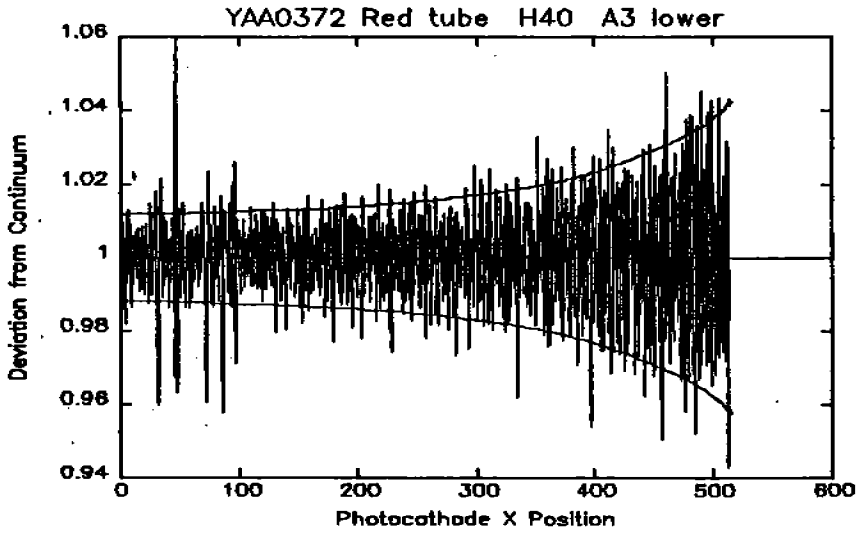
RCB-P-16

Figure 1


YAA0372 Red tube H40 A3 lower
Corrected Counts
Photocathode X Position


YAA0373 Red tube H40 A3 upper
Corrected Counts
Photocathode X Position


YAA0372 Red tube H40 A3 lower
Deviation from Continuum
Photocathode X Position

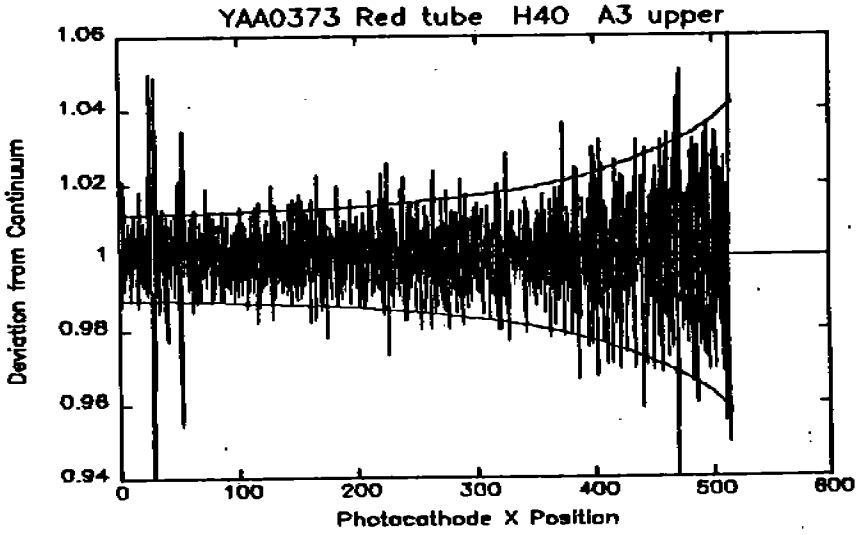
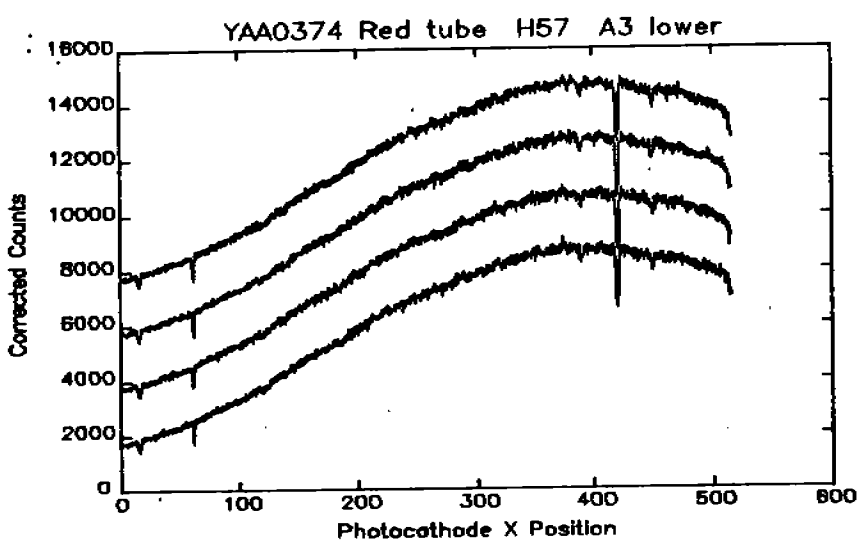
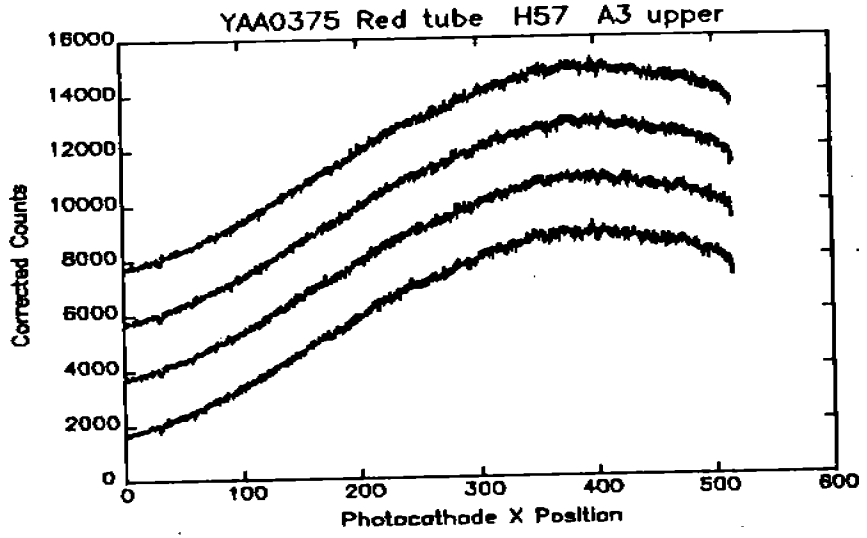
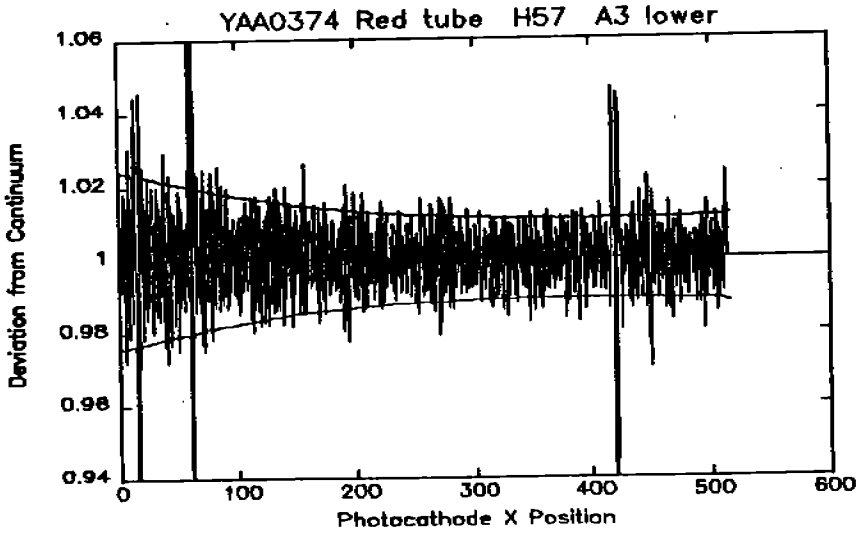

YAA0373 Red tube H40 A3 upper
Deviation from Continuum
Photocathode X Position

Figure 2


YAA0374 Red tube H57 A3 lower
Corrected Counts
Photocathode X Position


YAA0375 Red tube H57 A3 upper
Corrected Counts
Photocathode X Position


YAA0374 Red tube H57 A3 lower
Deviation from Continuum
Photocathode X Position

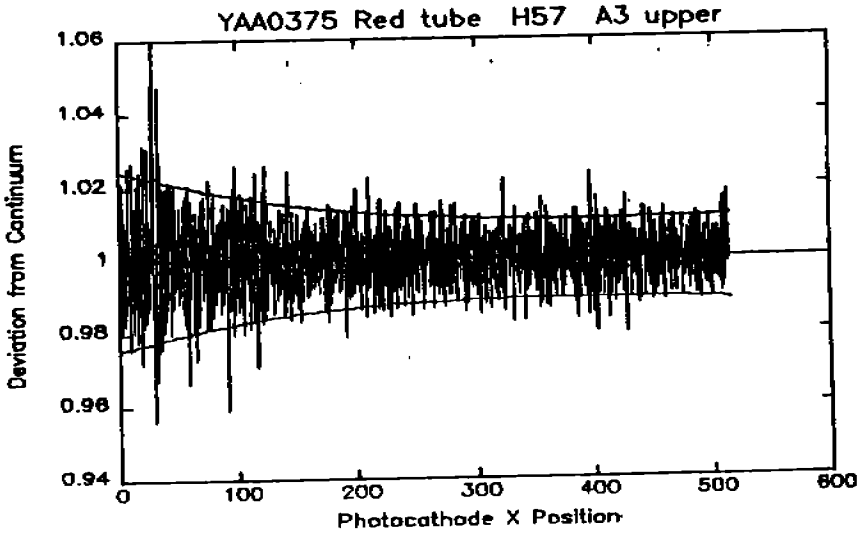
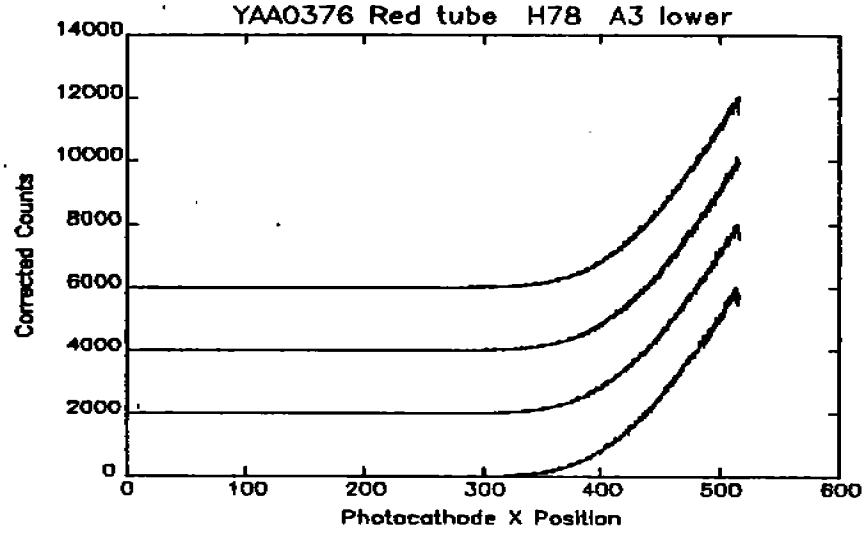
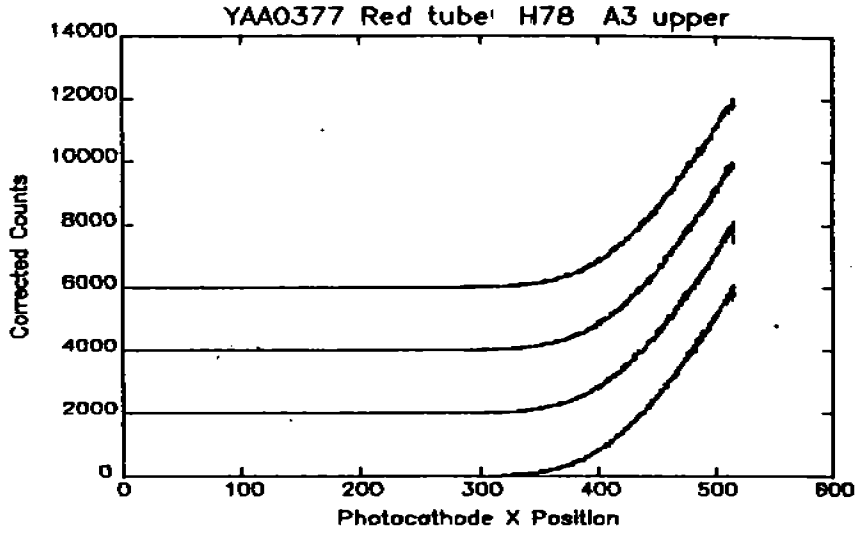
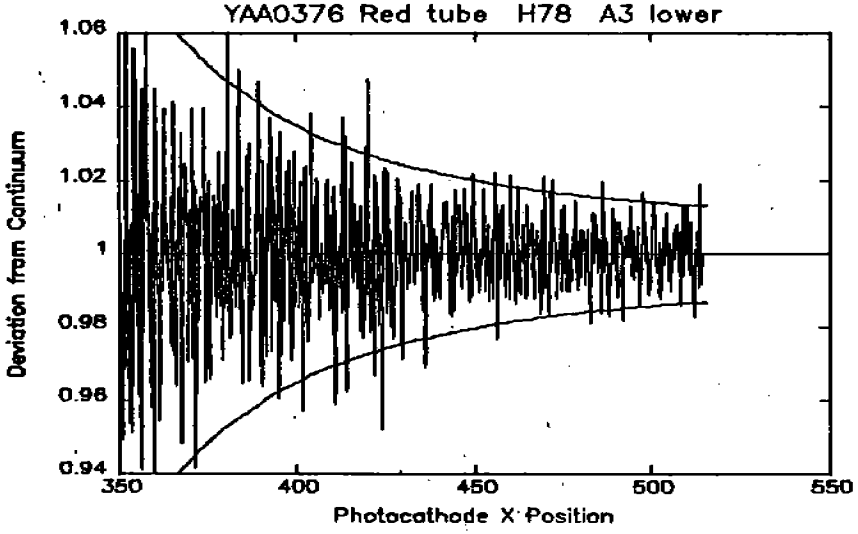

YAA0375 Red tube H57 A3 upper
Deviation from Continuum
Photocathode X Position

Figure 3


YAA0376 Red tube H78 A3 lower
Corrected Counts
Photocathode X Position
0
2000
4000
6000
8000
10000
12000
14000
0
100
200
300
400
500
600


YAA0377 Red tube H78 A3 upper
Corrected Counts
Photocathode X Position
0
2000
4000
6000
8000
10000
12000
14000
0
100
200
300
400
500
600


YAA0376 Red tube H78 A3 lower
Deviation from Continuum
Photocathode X Position
0.94
0.96
0.98
1
1.02
1.04
1.06
350
400
450
500
550

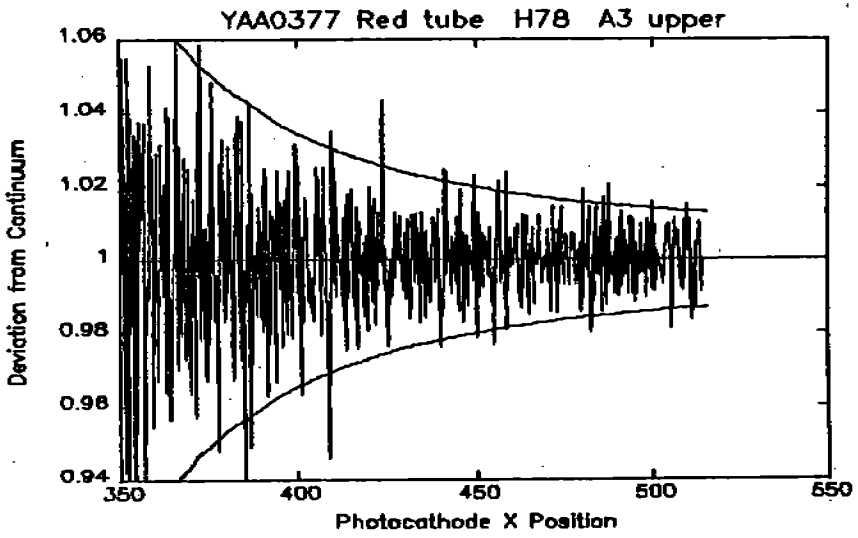
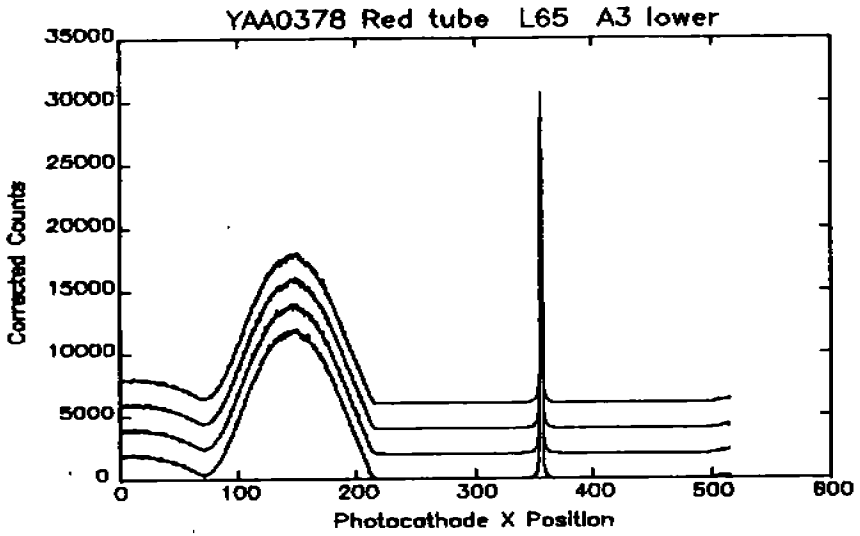
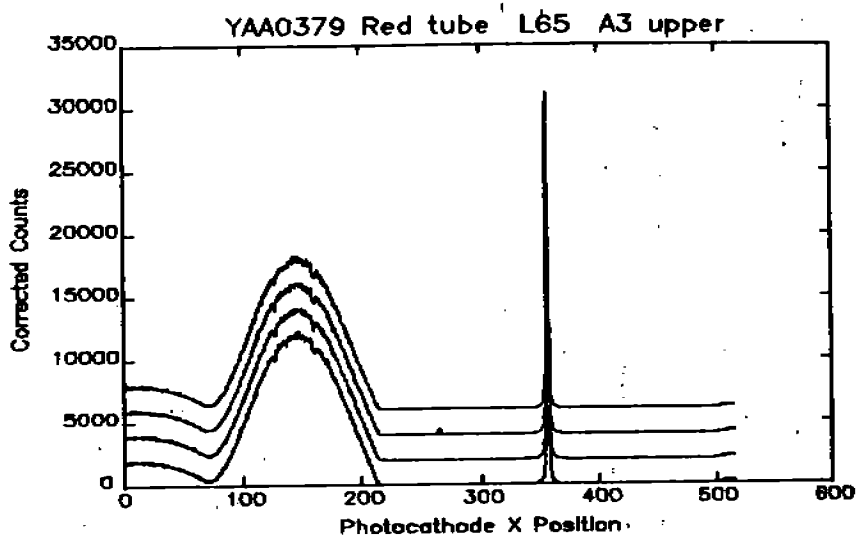
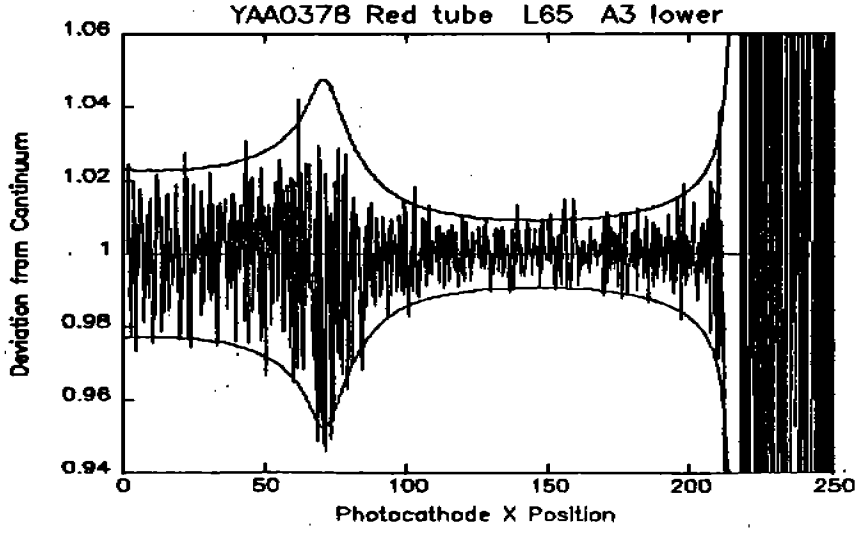

YAA0377 Red tube H78 A3 upper
Deviation from Continuum
Photocathode X Position
0.94
0.96
0.98
1
1.02
1.04
1.06
350
400
450
500
550

Figure 4


YAA0378 Red tube L65 A3 lower
Corrected Counts
Photocathode X Position


YAA0379 Red tube L65 A3 upper
Corrected Counts
Photocathode X Position


YAA0378 Red tube L65 A3 lower
Deviation from Continuum
Photocathode X Position

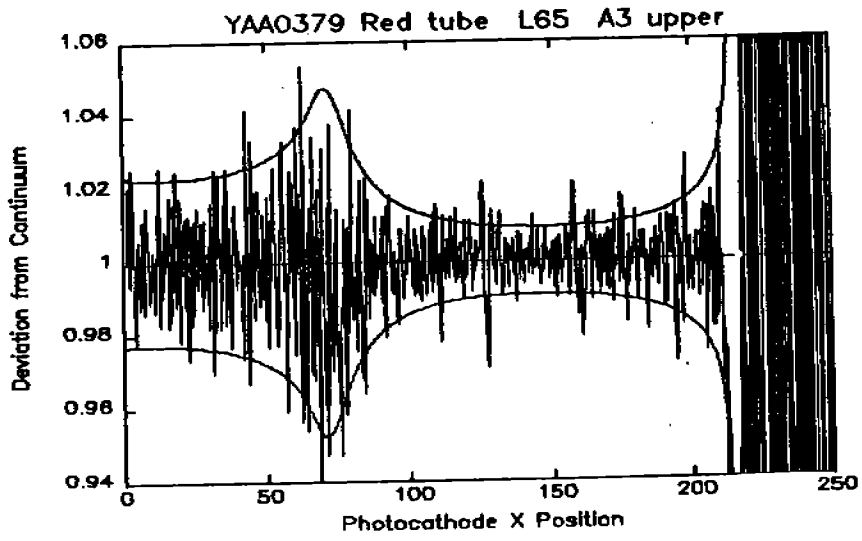
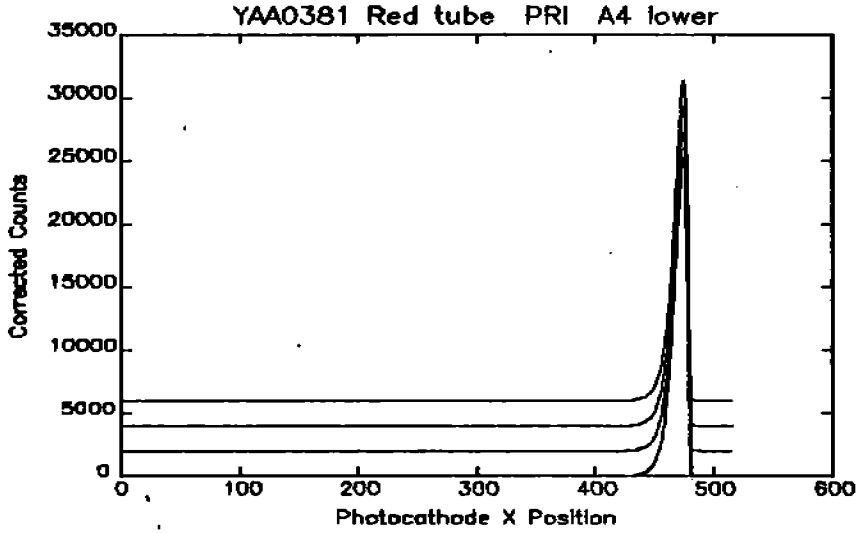
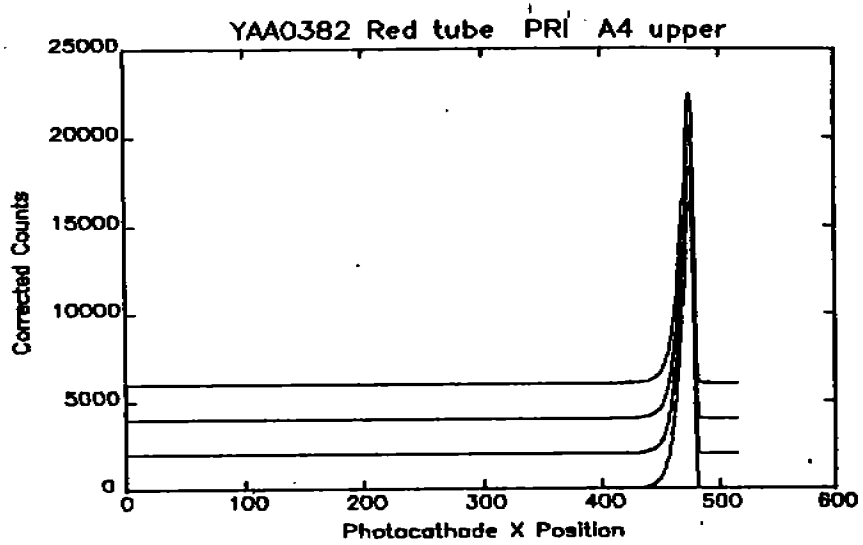
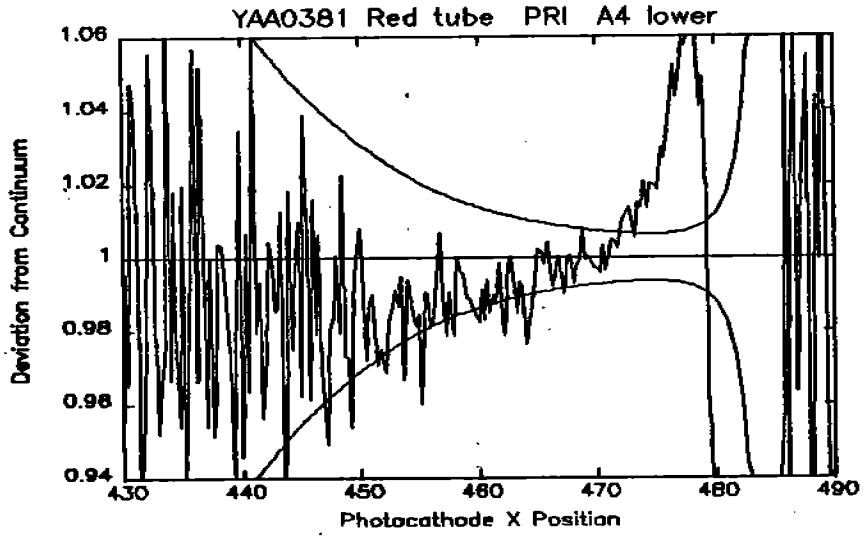

YAA0379 Red tube L65 A3 upper
Deviation from Continuum
Photocathode X Position

Figure 5


YAA0381 Red tube PRI A4 lower
Corrected Counts
Photocathode X Position


YAA0382 Red tube PRI A4 upper
Corrected Counts
Photocathode X Position


YAA0381 Red tube PRI A4 lower
Deviation from Continuum
Photocathode X Position

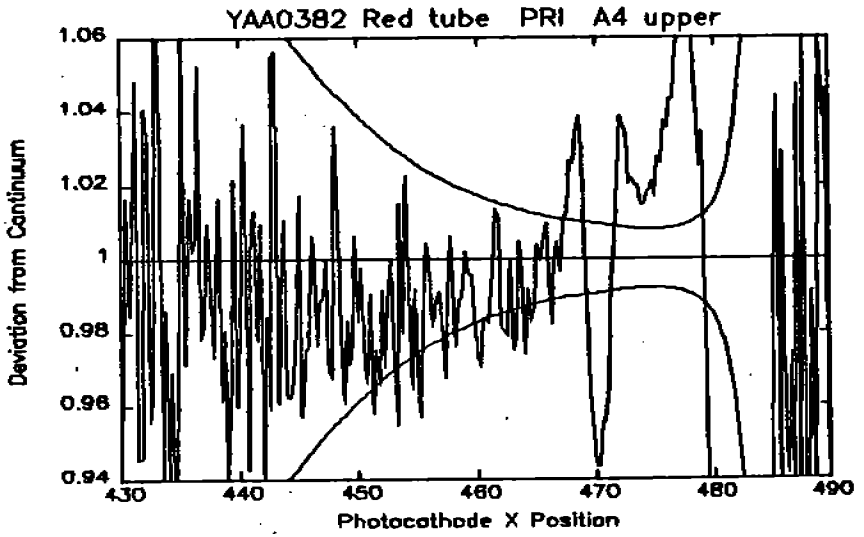
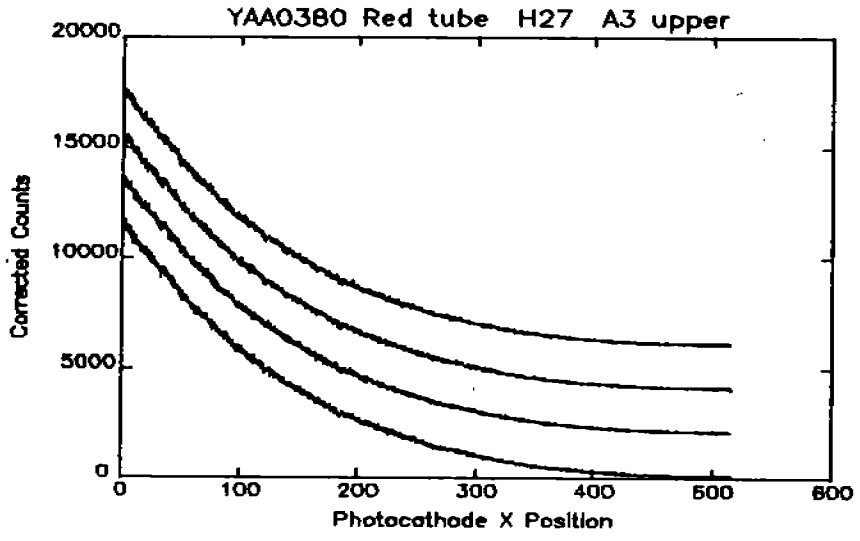
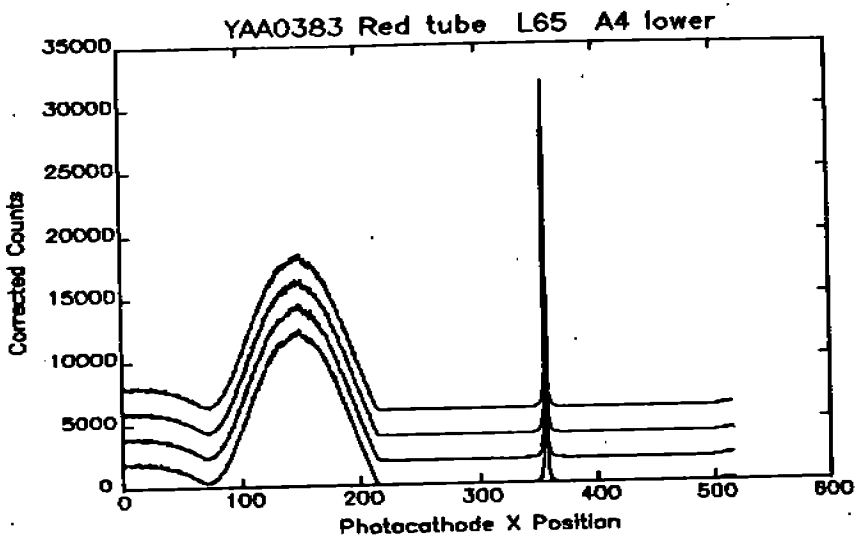
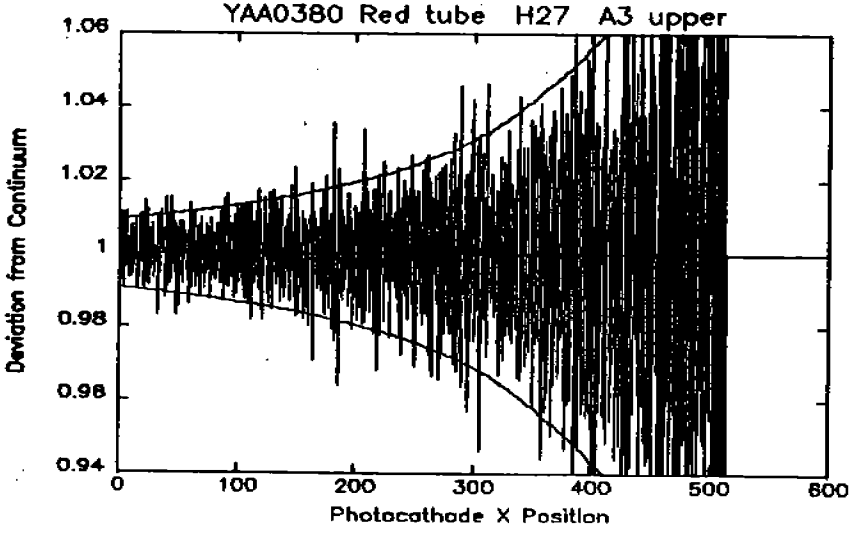

YAA0382 Red tube PRI A4 upper
Deviation from Continuum
Photocathode X Position

Figure 6


YAA0380 Red tube H27 A3 upper
Corrected Counts
Photocathode X Position


YAA0383 Red tube L65 A4 lower
Corrected Counts
Photocathode X Position


YAA0380 Red tube H27 A3 upper
Deviation from Continuum
Photocathode X Position

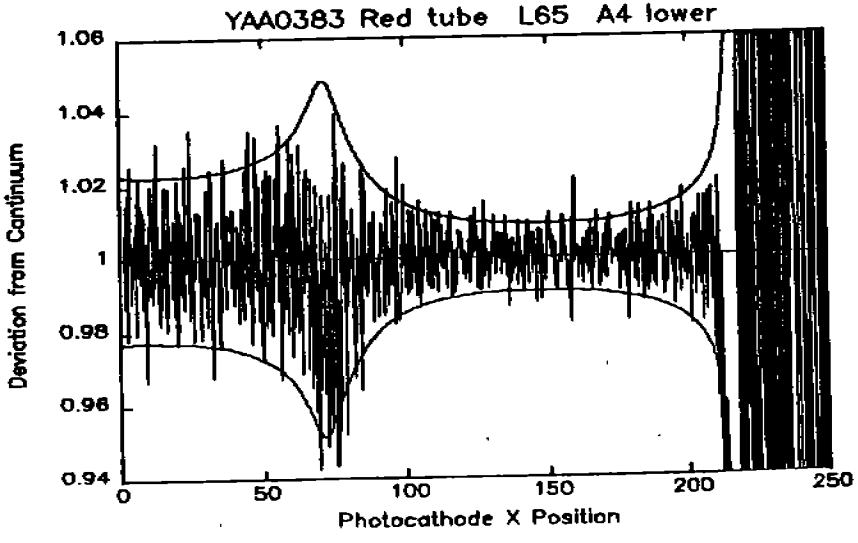
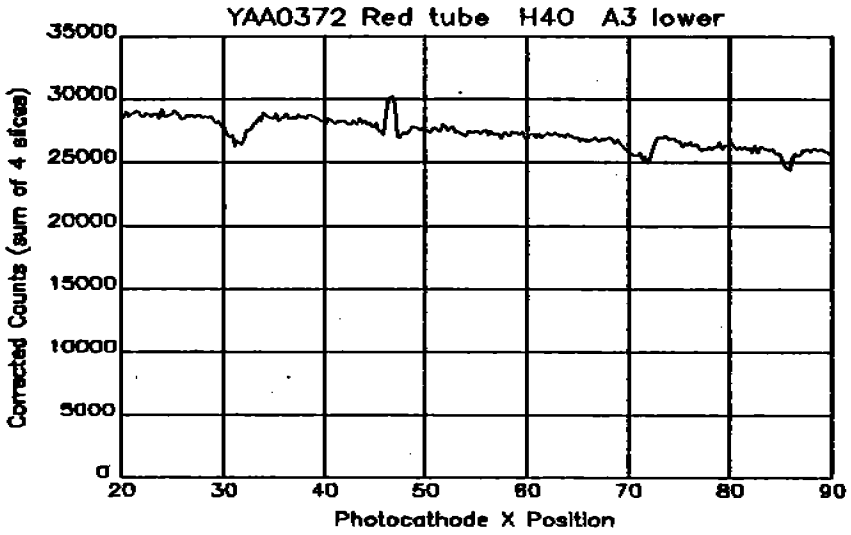
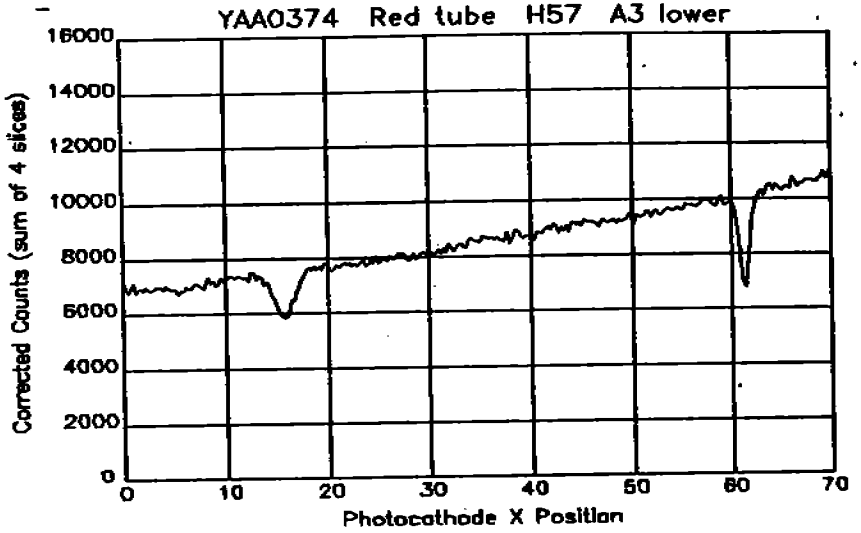
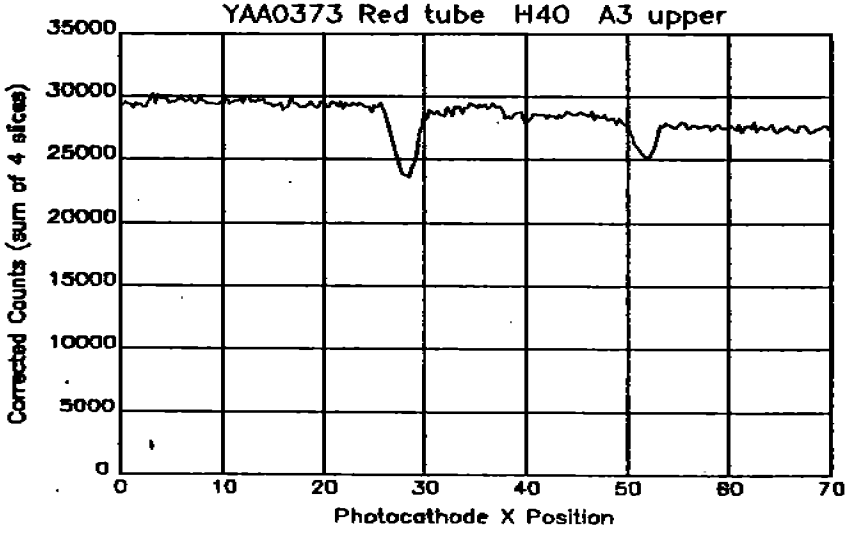

YAA0383 Red tube L65 A4 lower
Deviation from Continuum
Photocathode X Position

Figure 7


YAA0372 Red tube H40 A3 lower
Corrected Counts (sum of 4 slices)
35000
30000
25000
20000
15000
10000
5000
0
20
30
40
50
60
70
80
90
Photocathode X Position


YAA0374 Red tube H57 A3 lower
Corrected Counts (sum of 4 slices)
16000
14000
12000
10000
8000
6000
4000
2000
0
0
10
20
30
40
50
60
70
Photocathode X Position


YAA0373 Red tube H40 A3 upper
Corrected Counts (sum of 4 slices)
35000
30000
25000
20000
15000
10000
5000
0
0
10
20
30
40
50
60
70
Photocathode X Position

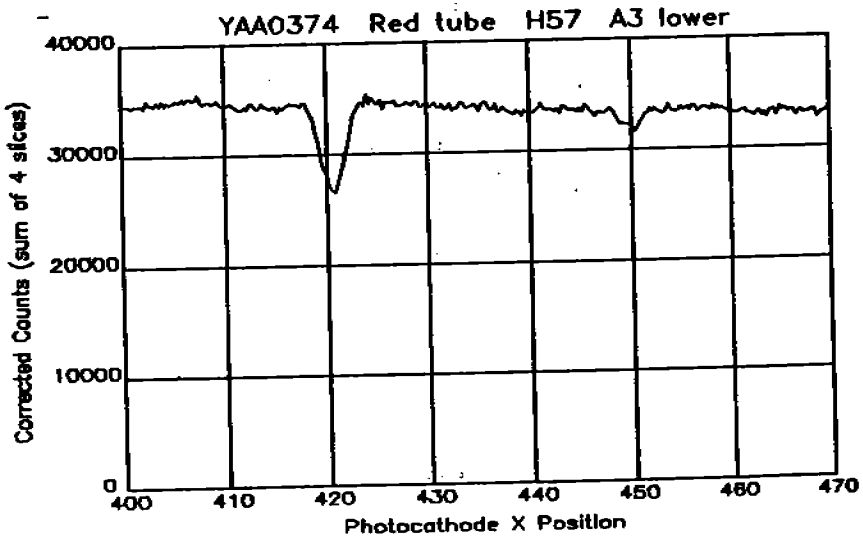
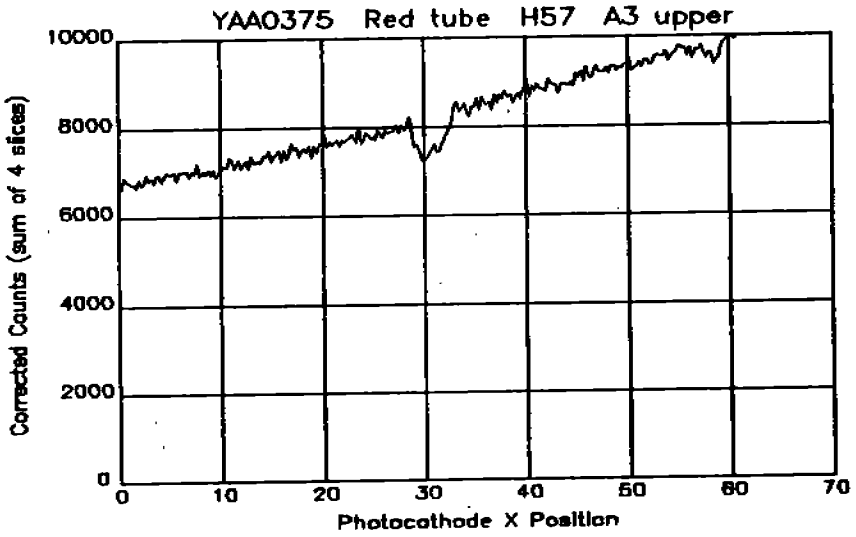

YAA0374 Red tube H57 A3 lower
Corrected Counts (sum of 4 slices)
40000
30000
20000
10000
0
400
410
420
430
440
450
460
470
Photocathode X Position

Figure 8


YAA0375 Red tube H57 A3 upper
Corrected Counts (sum of 4 slices)
10000
8000
6000
4000
2000
0
0
10
20
30
40
50
60
70
Photocathode X Position