SWIFT-UVOT-CALDB-15-01
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SWIFT UVOT CALDB RELEASE NOTE

SWIFT-UVOT-CALDB-15: Sensitivity loss

0. Summary:

This CALDB product gives a correction for the gradual decline in sensitivity for each filter.

1. Component Files:

FILE NAME	VALID DATE	RELEASE DATE	VERSION

2. Scope of Document:

This document includes a description of the product, expected future updates, warnings for the user, a list of data the product is based on and finally the analysis methods used to create the product.

3. Changes:

This is the first release of the on-orbit calibration for this product. There were previous versions but they were not released (this is v5). The sensitivity loss is now at a level where it can affect photometry and hence a correction needs to be made.

4. Reason For Update:

5. Expected Updates:

The throughput is tested annually and may be updated if changes are seen.

6. Caveat Emptor:

7. Data Used:

Several photometric standard sources (see Table 1) have been observed from time to time throughput the mission to check for any changes in throughput. For this report all data up to and including February 2010 have been used.

source	RA	Dec	v	b	u	uvw1	uvm2	uvw2	white
WD1026+453	10 29 45.3	+45 07 03.0	✓	✓	✓	✓	✓	✓	
WD1121+145	11 24 15.9	+14 13 49.0	✓	✓	✓	✓	✓	✓	✓
WD1657+343	16 58 51.3	+34 18 51.0	✓	✓	✓	✓	✓	✓	✓
SA95–42	03 53 43.66	–00 04 33.9	✓	✓	✓				
SA95–102	03 53 07.58	+00 01 10.3	✓	✓	✓				
SA98–646	06 52 02.23	–00 21 16.6	✓	✓	✓				
SA101–278	09 56 54.50	–00 29 39.0	✓	✓	✓				✓
SA101–L3	09 56 54.99	–00 30 24.8	✓	✓	✓				✓
SA104–244	12 42 34.3	–00 45 47.0	✓	✓	✓				✓
SA104–338	12 42 30.3	–00 38 33.0	✓	✓	✓				✓
SA104–367	12 43 59.0	–00 33 30.0	✓	✓	✓				✓
SA104–443	12 42 20.0	–00 25 22.0	✓	✓	✓				✓
SA104–457	12 42 54.2	–00 28 49.0	✓	✓	✓				✓
PG1525–071	15 28 11.60	–07 16 27.0	✓	✓	✓				
PG1633+099	16 35 24.0	+09 47 47.0	✓	✓	✓				
G24–9	20 13 55.68	+06 42 44.9	✓	✓					

Table 1 Standard sources for monitoring throughput.

All the relevant data on these sources were downloaded from the Swift archive at HEASARC. Important keywords in each sky file and also the *uct.hk files were checked for any problems like ‘shift and toss’ loss, which could affect exposure times. However, not all the data had been processed with the same version of uvot2fits and the keywords were not all available for the earlier versions. The oldest reprocessing of data used here was uvot2fits 3.8 and the most up-to-date was uvot2fits 3.30.

8. Description of Analysis:

For each star, we made region and background files using the 5" aperture for the stars and 27.5 – 35" annulus for the background. We checked each exposure visually for any problems e.g. aspect correction not being applied correctly, or the images being smudged by drift. Where necessary the aspect correction was redone, or where unsuccessful, a special set of region files devised for that particular exposure.

Using UVOTMAGHIST (with LSSfile=CALDB), the fully corrected count rates (and errors) of the sources were extracted for each exposure and written into an excel spreadsheet. Both the co-incidence corrected count rates and those with LSS correction were recorded. Weighted means were calculated for those cases where there was more than one extension, i.e. when several exposures were taken on the same day. The LSS corrected count rates were used in the fits and plots.

The count rates were normalised using the mean count rate for each star in each filter in exposures taken within the first 500 days. For one star which was not observed until day ~800, a factor taken from the fit was used to correct the starting value. This allows all stars to be plotted and fitted together, with the expected value for the beginning of the mission for each star being 1.0. Standard stars only observed at the beginning on the mission, and not re-visited, have not been included.

These normalised plots, for each filter, are shown in Figure 1 to Figure 7.

In each case the data have been fitted with a weighted straight line fit, shown in the plots. The slopes for all filters are similar to each other except the white filter, but the white filter suffers from more scatter than the other filters. The numbers are shown in Table 2.

Filter	**% loss per year**
V	1.24 ± 0.19
B	0.99 ± 0.18
U	0.83 ± 0.22
UVW1	0.90 ± 0.30
UVM2	1.10 ± 0.30
UVW2	1.07± 0.30
White	1.94 ± 0.27
White (bkgnd corrected, see section 8.1)	1.20+/-0.25

Table 2 The observed change in throughput per year for each filter.

8.1.White filter:

There is a large scatter in the white plot (Figure 7), some of which can be attributed to high background count rates, i.e. the failure of the coincidence correction to cope with high backgrounds. This is illustrated in Figure 8 where the measured count rate of WD1121 is plotted against background count rate. Only the white filter suffers from backgrounds high enough to cause a problem.

Fitting a straight line to the data in Figure 8 gives a correction factor for the high background. A ‘normal’ background count rate of 0.04 c/s was assumed, to which the higher backgrounds are corrected using the formula:

$$corrcts = cts - m(bkgnd - 0.4)$$

For WD1121 I found the gradient m to be –126 (for WD1657, with more scattered points, it was –151). If I correct the count rates using this formula and $m = -126$, then the result is Figure 9, and the rate of sensitivity loss is –1.20 ± 0.25% per year. The scatter is still high compared with the other filters, but the gradient is now consistent with the other filters.

8.2. Choice of parameter values:

It is likely that the sensitivity of all filters will decline at the same rate, as most of the decline will be due to the MCPs. In Table 2 all the optical and UV loss rates are consistent with –1.0% per year, and indeed if all the values are averaged the result is –1.02 ± 0.13 % per year . With the background correction, the decline in white is also consistent with –1.0% per year. Thus we chose to set all the values to –1.0% per year for this product.

9. Figures:

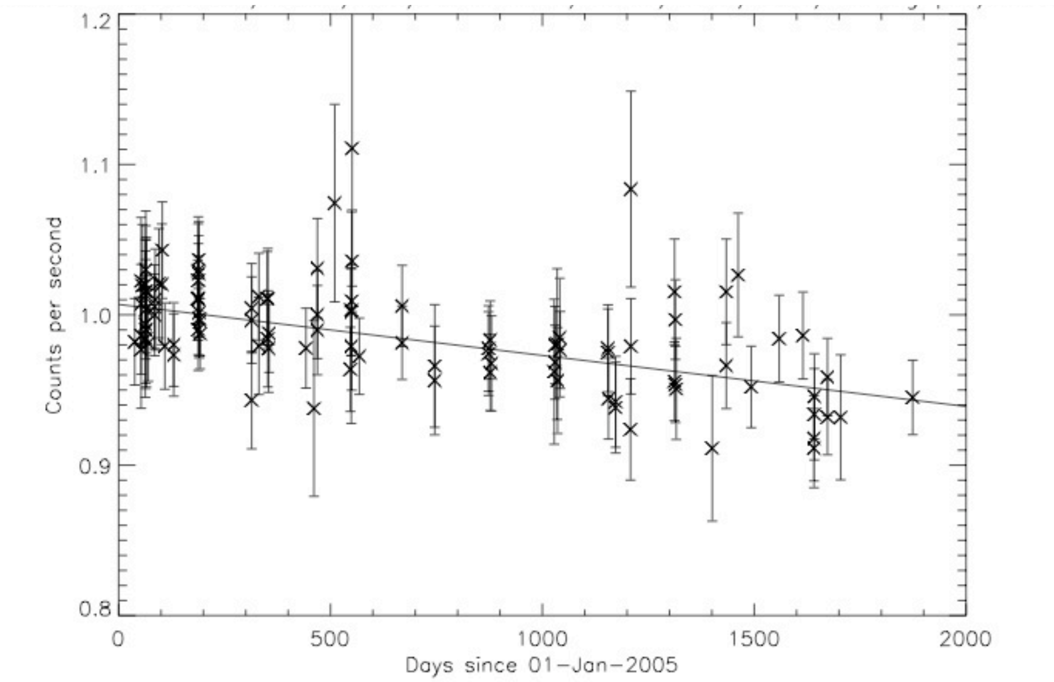

Figure 1 Count rates of standard stars in v filter, normalised to the count rates within the first 500 days post launch, against days since launch.

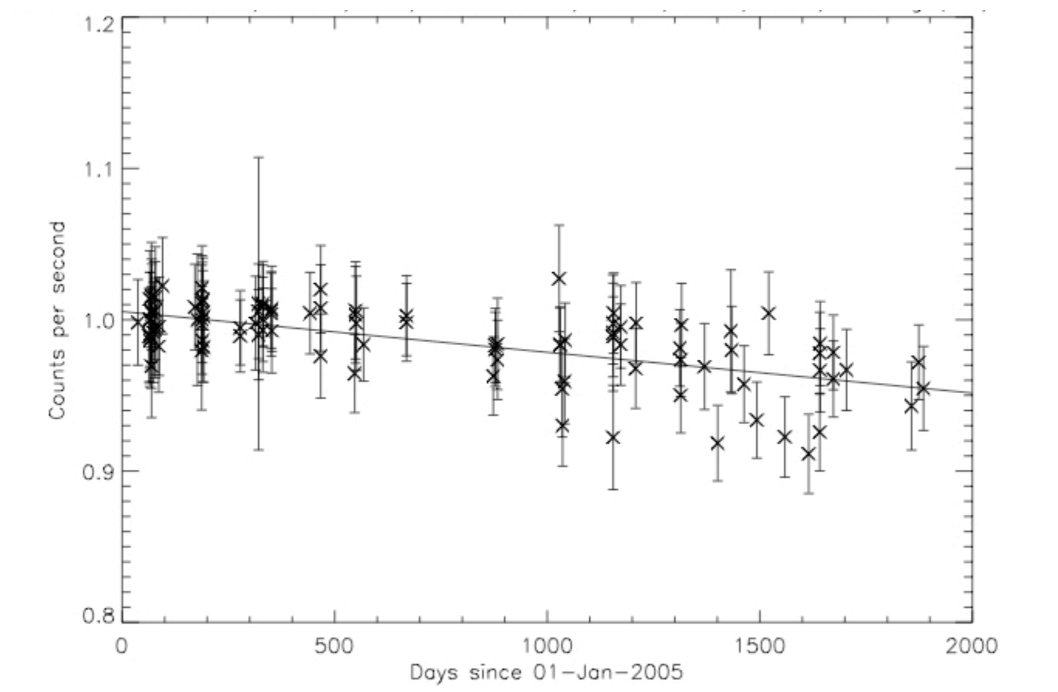

Figure 2 Count rates of standard stars in b filter, normalised to the count rates within the first 500 days post launch, against days since launch.

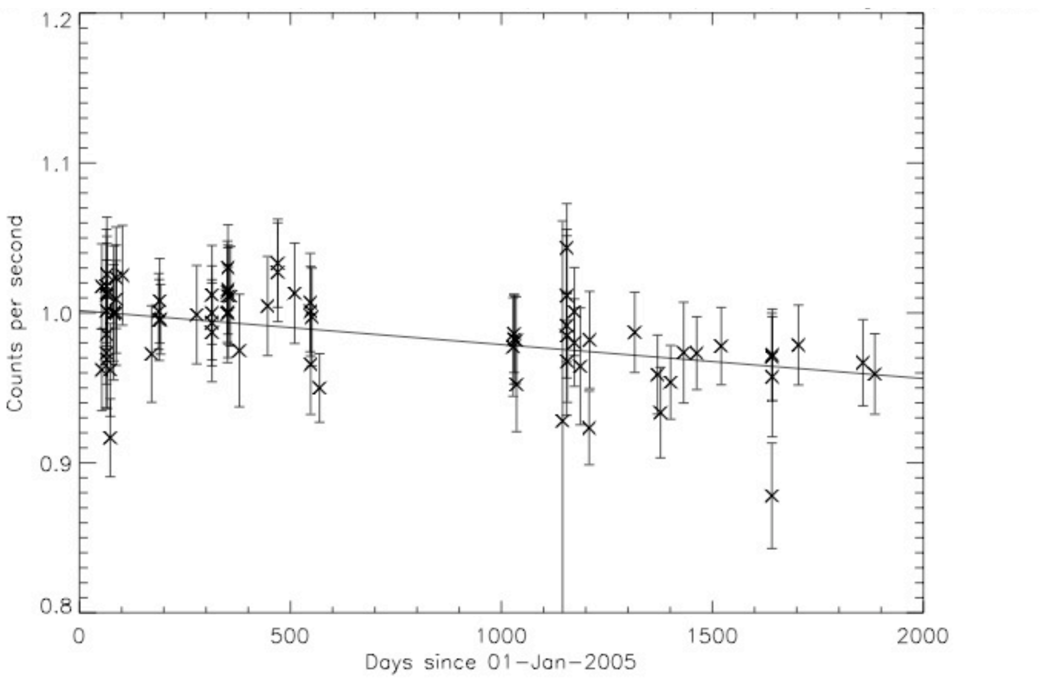

Figure 3 Count rates of standard stars in u filter, normalised to the count rates within the first 500 days post launch, against days since launch.

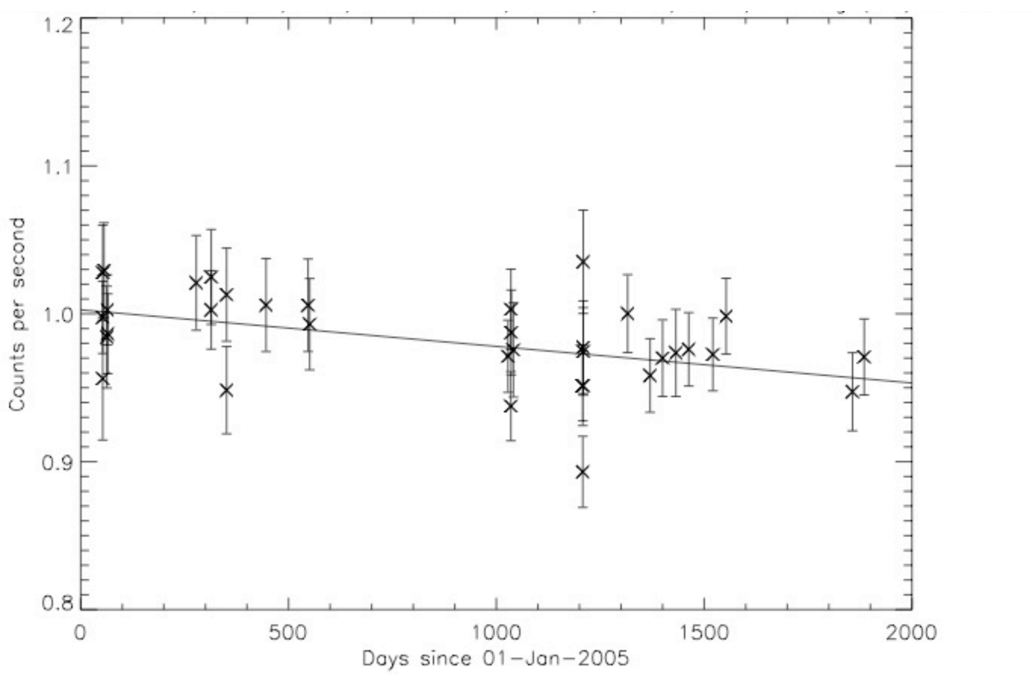

Figure 4 Count rates of standard stars in uvw1 filter, normalised to the count rates within the first 500 days post launch, against days since launch.

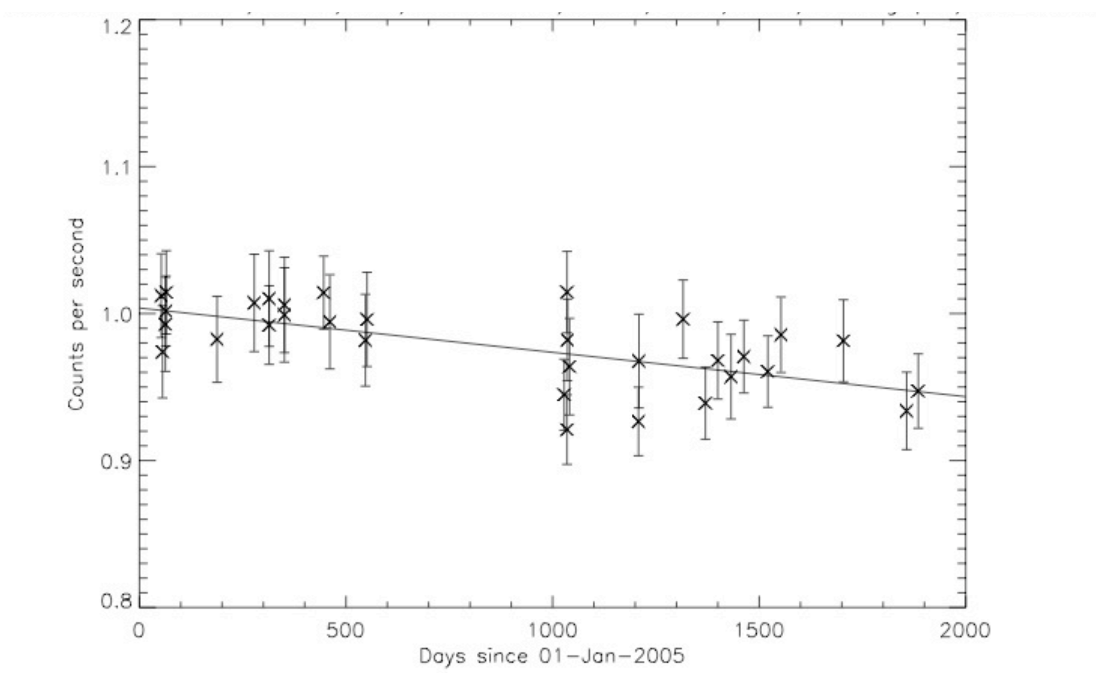

Figure 5 Count rates of standard stars in uvm2 filter, normalised to the count rates within the first 500 days post launch, against days since launch.

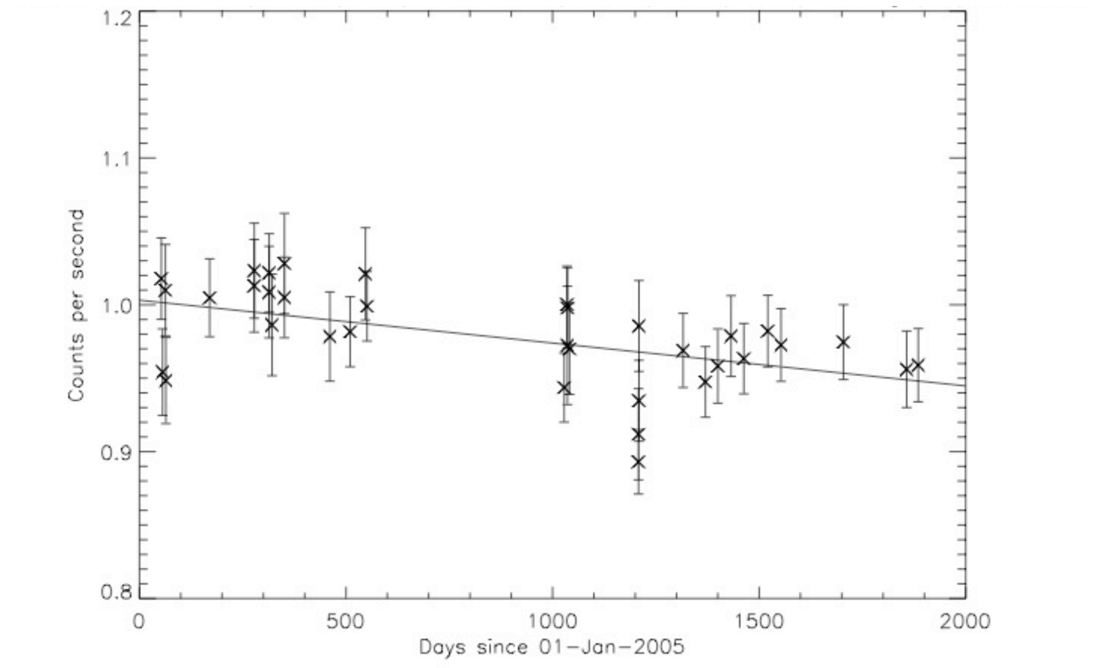

Figure 6 Count rates of standard stars in uvw2 filter, normalised to the count rates within the first 500 days post launch, against days since launch.

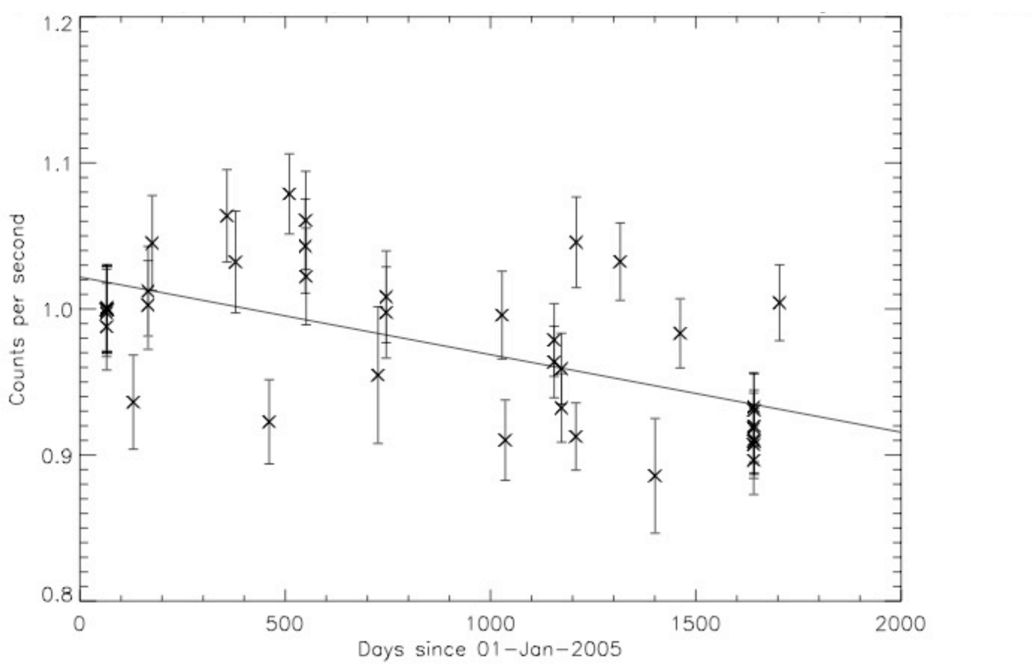

Figure 7 Count rates of standard stars in white filter, normalised to the count rates within the first 500 days post launch, against days since launch.

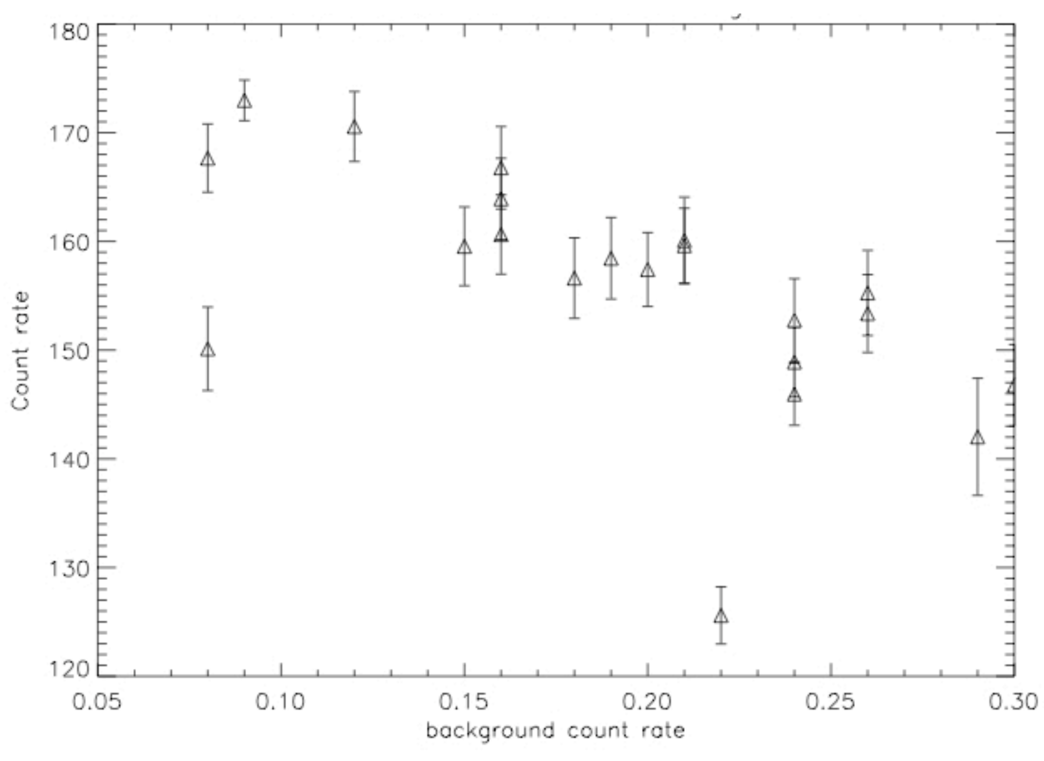

Figure 8 showing how count rates in the white filter are significantly affected by the background level.

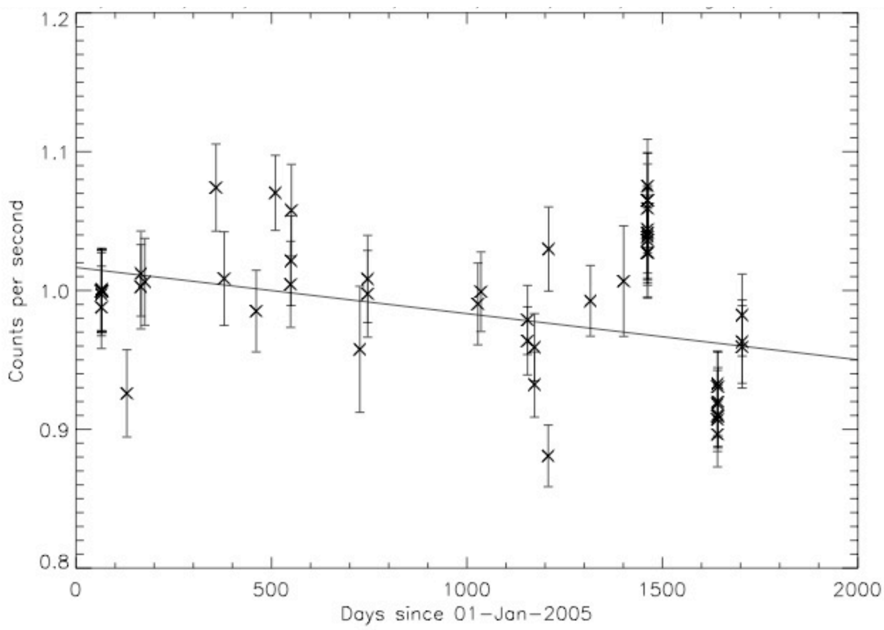

Figure 9 White data corrected for background count rate.