Re-analysis of SXT Entrance Filter Failures

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Abstract

Analysis of SXT images reveal the increase of stray visible light in the instrument which resulted from periodic failures of the thin-film entrance filters. The magnitude of the steps of straylight-increase with each failure help to estimate the fraction of entrance filter open area. This re-analysis of the SXT entrance filter failures makes use of non-x-ray signals in the corner of raw x-ray exposures to better define the sequence of entrance filter ruptures.

1 Introduction

Visible light began to enter the SXT on 27 October 1992 as a result of ruptures of the thin-film entrance filters. On 13 November 1992 two sectors of the second layer of the duplex entrance filters failed and the inside of the telescope was thereafter flooded with visible light. Aspect sensor images could no longer be acquired, even the shortest exposure were totally saturated.

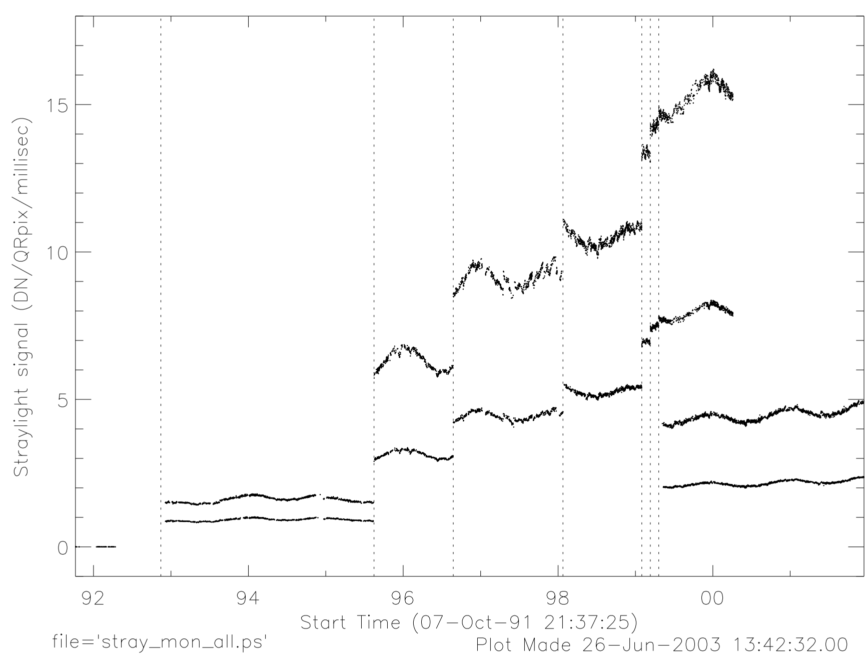

Figure 1: Signal rates from straylight monitor exposures. The vertical dotted lines denote the times of entrance filter failures. The two lower curves starting in 1999 are from the wide band optical filter.

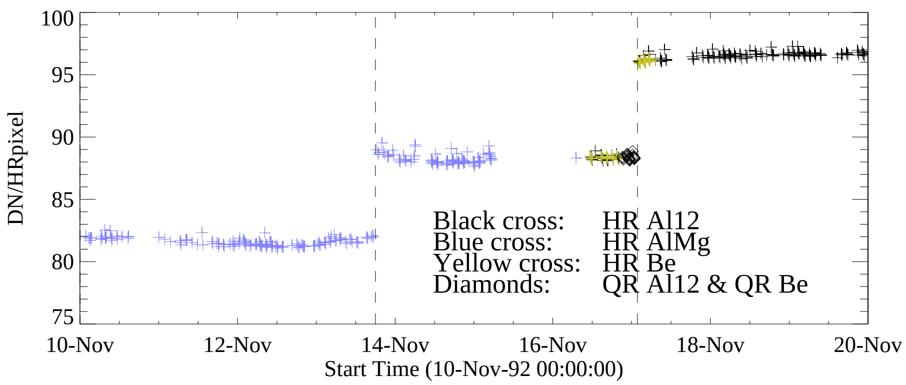

Figure 2: This figure reveals that the inner-filter ruptures of November 1992 took place in 2 events separated by about 3.3 days. Vertical units refer to the HR AlMg signals. Other data are normalized to these.

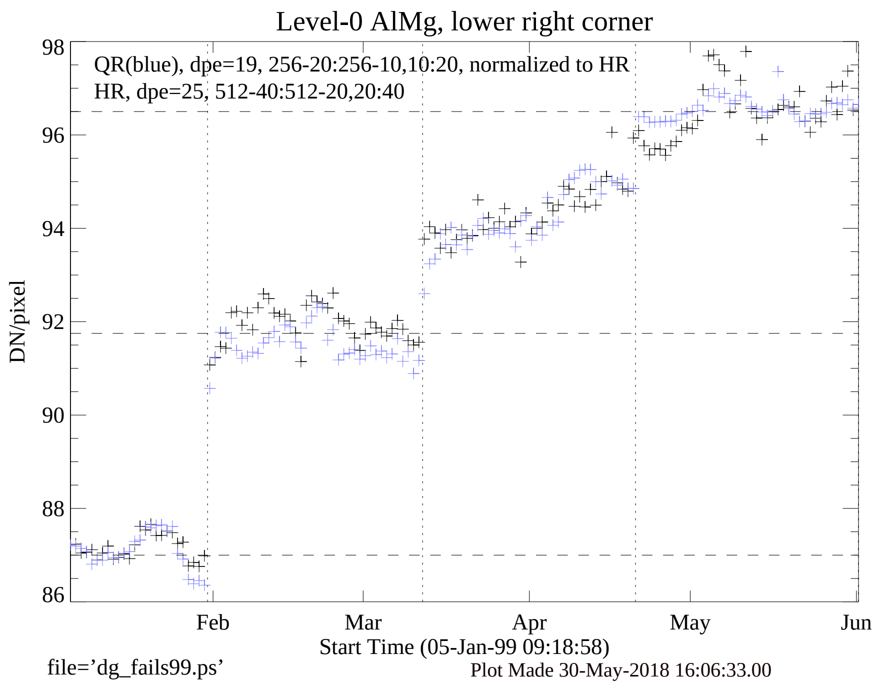

Figure 3: Daily averages of the raw signal from the lower left corner of AlMg images for the first half of 1999. Details are discussed in the text.

In early December 1992 a routine straylight monitor image was made a part of the standard FFI table. These were 1 ms (DPE=2) QR dark exposures (i.e., shutter closed) with filter A in position 2 (NB) and filter B in position 1 (open). In 1999, after the 3 entrance failures early in the year, the standard straylight monitor exposure was approaching saturation so that we began to take straylight monitor exposures using filter A position 5 (WB). Both NB and WB exposures were taken for about a year for cross calibration. The conversion is NB=3.8*WB for background corrected images. NB images ceased to be routinely taken on 4 April 2000.

Figure 1 displays the total dark-corrected signal from 11,751 SXT straylight monitor images. The data points prior to 13 November 1992 were exposures equivalent to the straylight monitors that were

Table 1: Re-evaluation of SXT Entrance Filter Failures

	Date	Outer Sectors	Inner Sectors
1.	27-Oct-92 05:41	1.0	0.0
2.	27-Oct-92 07:18	2.0	0.0
3.	13-Nov-92 18:00	2.0	1.0
4.	17-Nov-92 01:47	2.0	2.0
5.	16-Aug-95 08:04	4.0	4.0
6.	24-Aug-96 07:00	5.0	5.0
7.	24-Jan-98 00:00	6.0	6.0
8.	30-Jan-99 23:17	8.0	7.0
9.	12-Mar-99 02:00	8.0	7.5
10.	20-Apr-99 19:02	8.0	8.0

obtained as darkframe candidates. They average to zero, i.e., there was no visible straylight reaching the CCD prior to the entrance filter failures. Previous to this analysis the time and circumstances of the failures were determined primarily from these stray light monitor data. I recently published an exhaustive description of the analysis and interpretation of these data (Acton, 2016).

As noted in Acton (2016) a mystery remained as to why the signal from the SXT aspect sensor declined by 90% during the first 15 months of the mission. It has now been demonstrated that this decline is probably due to the deposit of some absorbing material on the entrance apertures of the SXT, including the entrance filters (Acton, 2018). In the course of this SXT re-calibration the times and details of entrance filter failures were re-evaluated, using the raw signal in the lower left corner (HR pixels 472:492,20:40) of long x-ray exposures. These exposures were much more frequent than the straylight monitor images and clarified details of the entrance filter ruptures in 1992 and 1999 as illustrated in Figures 2 and 3.

The straylight jumps of 1992 and the first 1999 rupture show the straylight increase of 5-6 DN/HRpixel, presumably due to the rupture of an entire 30° entrance filter sector. The rupture of 12 March 1999 appears to have opened about half of a sector and tore slowly thereafter up until the completed rupture on 20 April 1999. The first two failures on 27 October 1992 involved only the outer layer of the duplex entrance filters so that the increase in straylight was insufficient to show up in darkframes. Note that after November 1992, when both inner and outer filters failed, the straylight was so intense that additional outer filter failures, without corresponding failures of inner filters, could not be recognized.

Table 1 lists SXT entrance filter failures with the rupture of 12 March 1999 approximated as failure of half of a 30 degree sector. These data are used in the SXT sensitivity calibration published by Acton (2018) and has been incorporated in SXT analysis programs that derive physical units from instrumental data.

References

Acton, L.W.: 2016, On-Orbit Performance and Calibration of the Soft X-Ray Telescope on Yohkoh. *Solar Phys.* **291**, 643. DOI. ADS.

Acton, L.W.: 2018, Recalibration of the Soft X-ray Telescope on Yohkoh. *Submitted to Solar Physics.*