This memo investigates the incidence of the background flares that were first observed in ACIS data soon after opening the HRMA door. Some characteristics of these flares are included on the CXC Calibration web pages (http://asc.harvard.edu/cal - follow links for ACIS Background). XMM has observed similar background flares and has determined that they are caused by an increase in low energy protons. It is believed that the ACIS flares are also caused by low energy protons. This memo is an attempt to correlate the frequency and strength of background flares with orbital altitude, position relative to the Earth’s magnetosphere.

Studying light curves of telemetered events is complicated by interference from astrophysical X-ray sources which may be extended or variable. We are instead using count rates of events rejected by the on-board software for high amplitude pulseheights of greater than 3750 ADU or about 15 keV. S3 amp_rej rates are preferred because the BI CCD is unaffected by changing CTI and radiation damage. Figure 1 is presented for comparison of S3 amp_rej rates to similar plots in Plucinsky & Virani (2000) of the ACIS S3 total event rate and the E150 channel of the EPHIN detector. In general the telemetered event rate and the amp_rej rate appear to be correlated.

Figure 2 is a light curve of the S3 amplitude reject rate in 5 minute bins from 23 August 1999 when the amp_rej filter was first activated until 10 January 2001. These are observations with ACIS in the focal plane, both gratings retracted, taken in standard faint mode (no window filters or subarrays). The quiescent count rate has been declining since launch. This is also seen in the telemetered event background rate (see CXC Cal web pages) and is correlated with protons with energies of order 10 MeV as measured by ACE (C. Grant, poster at HEAD 2000). The very strongest flare is from ObsID 303 and the large increase in count rate may be attributable to entry into the radiation belts. The mechanism for this ‘flare’ may then be quite different than that seen at other times outside of the belts so this observation has been removed from further analysis.

Figure 3 compares the S3 amp_rej count rate to Chandra’s altitude. There seems to be some correlation between flaring and altitude with more flares occurring around 90,000 km, however the difference between the highest and lowest flaring probability is small. Altitude does not appear to be the only factor in causing flares since flares are still seen in all parts of the orbit. Other studies (both Maxim Markovitch/CXC Cal and Paul Plucinsky/CXC SOT) have come to the same conclusion but with less data and therefore less orbital coverage.

Looking back at Figure 2, clearly the strongest background flares seem to occur in two groups spaced nearly a year apart. This suggests that the flares may be associated with Chandra’s position with respect to the Earth’s geomagnetic field. Figure 4 compares the S3 amp_rej light curve with
Chandra’s geomagnetic location (magnetosphere, magnetosheath, or solar wind) at apogee provided by Shanil Virani. The flaring periods do not neatly align with any particular region. Further work may need to include the level of geomagnetic activity, measured as the Kp index, as well as Chandra’s orientation.

References

Figure 1: Light curve of S3 amp rej rates averaged over 64.8 s intervals for ObsIDs 303, 965 and 804 for comparison with Plucinsky & Virani (2000) Fig. 2, 4, and 5. The units of time are seconds from the first exposure of the observation.
Figure 2: Light curve of S3 amp_rej rates from 23 August 1999 to 10 January 2001 in linear (top) and logarithmic (bottom) plots. The color coding indicates time bins in which the count rate is 1-, 3- and 5-sigma above a second order polynomial fit to the quiescent data (ObsID 303 is not included in the statistical analysis).
Figure 3: S3 amp_rej count rate versus altitude. The top plot uses the same 5 minute binning as Figure 2. The bottom plot bins the data into 8000 km altitude bins and shows the fraction of time at each altitude spent over 1-, 3- and 5-sigma above the same polynomial trend as Figure 2.
Figure 4: S3 amp.rej count rate versus Chandra’s geomagnetic position at apogee. Color coding is the same as Figures 2 and 3.