Some Thoughts on the Buildup of Material on the ACIS Filter

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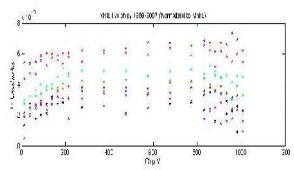
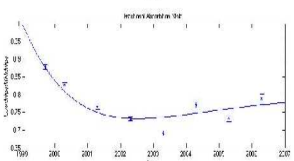
Abstract

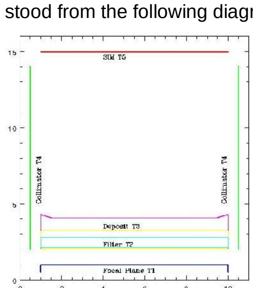
The buildup of material on the ACIS filters has been continuing now for eight years. However, the build up at the edge of the filters next to the frame has leveled off compared to the center of the filter. The change in the ratio of edge to center stopped increasing in 2003. The implications of this change will be discussed with regards to the thermal properties of the material. The continuing decrease in the strength of the Mn L_α line is making the measurement of the deposition on the filters more and more difficult.. We suggest that the Al K_α line can be used for this monitoring by combining many calibration sessions to improve the statistics. Some results of this approach will be presented.

Using the Mn L_α line divided by the Mn K_α Line from the calibration data, it is possible to construct a map of the layer of material that is accumulating on the surface of the ACIS filters. The results of this analysis for each year of data is shown below.





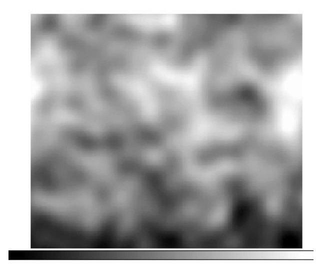
The edge absorption clearly levels out compared to the center of the CCD S3 after 2003. The implication of this is that the temperature of the surface of the contaminant has become uniform, so that any new buildup is distributed evenly over the surface of the CCD. The reason for the initial more rapid edge buildup is easily under stood from the following diagram.



The temperature T5 is a warm surface near 0C, while T4 is -60C. It is the extra heat from T5 that raises the temperature of the center portion of the filter and causes less material to deposit there compared to the edge next r\to the Collimator which is at T4. The heat from the filter flows out to the collimator and cools the filter near the edge leading to the buildup of extra contamination.

The fact that the edge buildup has leveled off relative to the center of the filter implies that the contamination is acting like an insulator, since the underlying filter aluminum is still a good conductor and will carry heat away from the center of the filter. The contamination may also affect the absorptivity of the filter as a whole since it is approaching the thickness of a wavelength of light, but the degree of change is hard to estimate. If the material is of low density, containing a large amount of voids, it could act as a very good insulator Once the surface of the contaminant is nearly isothermal the buildup of new material will become uniform.. A more detailed analysis might give some clues as to the physical nature of the buildup.

Using the calibration data from 2007 August and September and combining these data into a single file containing seventeen calibration sessions, 269055 counts were collected from the Al Kα line an 822,057 counts from the Mn Kα line. These data files were turned into image files and bin by 4, then each file was smoothed using aconvolve. Next the Aluminum image was divided by the Mn image to form an absorption plot as shown below.



It is clear that there are large variations in the absorption across the S3 CCD. The brightest regions have a value of 0.35 and the darkest regions have a value of 0.29. There is a clear trend toward excess absorption along the bottom of the image, but it is not symmetric with the top of the image. This effect is also seen in the first figure using the Mn L lines. More data can be combined to improve the statistical precision of this result, but it does serve to illustrate the power of using the Al line to monitor the absorption of the filter plus contamination.

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