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To: MIT XIS Team
From: Mark Bautz & Steve Kissel
Subject: Search for radioactivity in XIS substrate samples

Summary

We searched for enhanced background due to radioactivity in samples of the ceramic material slated for use with XIS2 flight CCD detectors and found none. We find no reason not to use this material for the flight detector package.

Measurements

A 1/4-inch-by 2-inch sample of the proposed ceramic was provided by Al Pillsbury. This strip was placed in close proximity to ACIS detector w163c1 so that the ceramic "covered" the 256 rows of the detector imaging area that are farthest from the framestore. The detector was operated at nominal temperature (-120C) using XIS-1 test electronics, and was read in timed exposure mode. Two runs were made: 1999 frames were acquired with a frame time of 8 seconds (the XIS standard) and 1570 frames were acquired with a frametime of 60 seconds (to reduce the effect of the framestore dwell). No X-ray source illuminated the detector during these runs. The data may be found at CSR in `/nfs/ota/d3/data/w163c1-xis/31Jul02/dark`.

The data were reduced to event lists using standard CCD lab procedures. The "RV" format event lists were first filtered to include only g02346 events, and then all event lists were converted to FITS format for subsequent filtering on exposure number (to remove frames at the beginning of each run that were acquired before the temperature had settled) and to remove bad columns.

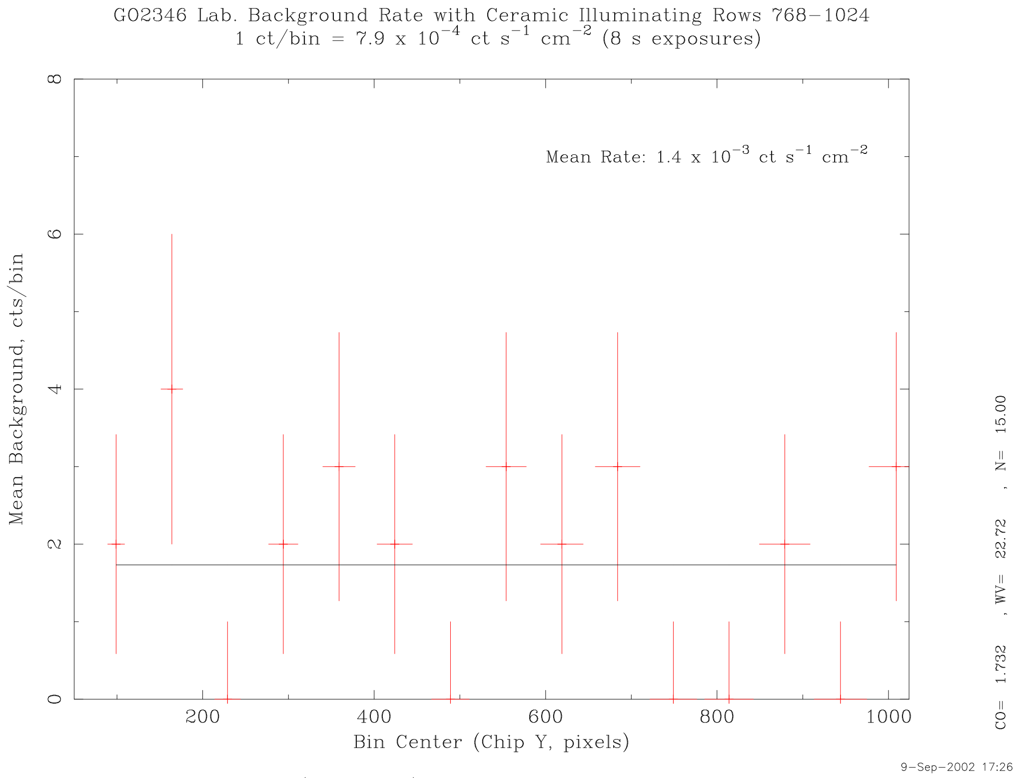
In fact, quadrant A of this device is non-functional and quadrants C and D show large numbers of hot columns which would greatly complicate the analysis, so attention was further restricted to the data obtained from quadrant B. Even quadrant B shows a fair number of hot pixels, and, at this writing, we have not been able to obtain useful results from the 60s exposures.

Results

After visual inspection of the spatial distribution of events, the number of detected events in the 8-second exposures, in each contiguous 64-row-by-252-column region of the detctor (i.e., quadrant B less 4 bad columns) was computed. Results for all event grades and for the "useful" grade set (g02346) are shown in the accompanying figures. No signficant variation in the g02346 event rate with row number is seen, which suggests that the ceramic contributed nothing measurable to the detector background after background rejection filters were applied. The mean observed g02346 background (1.4×10^{-3} ct s^{-1} cm^{-2}, broadband) is no more 1/5 that observed on-orbit with ASCA (see Keith Gendreau's thesis.) Therefore, even if the ceramic were responsible for all of the observed residual background, (which, given the lab background flux of cosmic rays and gamma rays, cannot be true), the ceramic's contribution to the background is acceptable.

It is interesting to note that the total (all grades) event rate appears to be somewhat lower in the detector region shielded by the ceramic. It is not clear whether this is a real effect or some unexplained artifact. It may be that the ceramic shields the detector from some of the gamma-induced lab. background believed to originate in ^{40}K in its concrete-block walls. Note also that the "efficiency" of the grade rejection is just over 99%, as expected from previous work.

Finally, we report that visual examination of a small (40-frames x 1 quadrant) subsample of the data revealed 15 large, particle-induced blobs. This implies a "blob-rate" of roughly 2 blobs cm^{-2} minute^{-1}, which about about twice the cosmic-ray rate at sea-level.



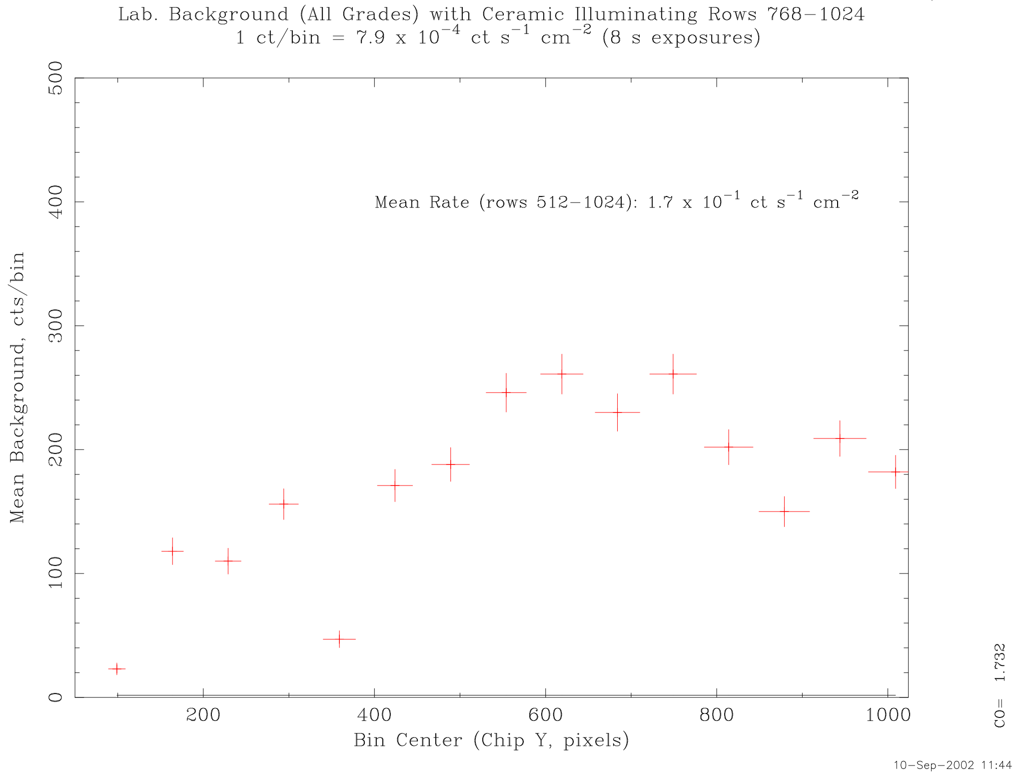


Figure 1: **Top:** Observed grade 02346 background rate vs. detector row with ceramic covering (approximately) rows 768-1024. No evidence for enhanced background due to the ceramic is seen. **Bottom:** Observed total background rate (all event grades) vs. detector row with ceramic covering (approximately) rows 768-1024. The increase in background with row number at low row number may be due to background events occurringin the framestore. The rate levels off (and even falls slightly) in the part of the detector covered by the ceramic sample.