Chandra Calibration Update

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The ACIS detector gain continues to be calibrated in six month intervals by co-adding observations of the ACIS external calibration source (ECS) to increase integration time. ACIS is exposed to the ECS whenever it is in the stowed position, which occurs during each radiation belt passage. The six month intervals, as opposed to three month intervals used prior to 2016, are necessitated by the declining flux of the ECS (a radioactive ^{55}Fe source with a half life of 2.7 years). Since the ACIS gain continues to decline by about 0.1–0.2% per six month interval, the gain is still being calibrated to within the requirement of 0.3%. At the present time, the ACIS gain can still be calibrated on the same spatial scale as before (16″ by 16″ regions), but it will become necessary within the next few years to increase the region over which the gain is calibrated. The calibration team has also completed studies of astronomical sources (e.g., Cas A and the Perseus cluster) for use as potential gain calibration targets once the ECS flux has faded even further.

Gain calibration only requires the measurement of line centroids, while quantum efficiency (QE) calibration requires the measurement of the total flux in a line, which requires considerably better photon statistics. Previously, QE maps were released every two years. Due to the fading of the ECS, the next set of ACIS QE maps, which are currently under development, will cover a four year interval.

The calibration team continues to monitor the build-up of molecular contamination onto the ACIS optical blocking filters through imaging observations of the rich cluster of galaxies Abell 1795 and the oxygen-rich supernova remnant E0102-72 and gratings observations of the blazar Mkn 421. These observations are designed to track the time-dependence of the condensation rate onto the ACIS filter, the chemical composition of the contaminant, and the spatial distribution of the contaminant on the ACIS filters. Abell 1795 is observed semi-annually at the ACIS-I and ACIS-S aim-points. In addition, a more extensive raster scan of Abell 1795 on ACIS-I and ACIS-S is performed annually to map out the spatial distribution of the contaminant. A set of LETG/ACIS-S observations of Mkn 421 are carried out semi-annually in “Big Dither” mode (i.e., with a large enough dither to cover approximately one-fourth of the ACIS-S array). All observations acquired during 2017 are consistent with the present version of the ACIS contamination model in the CALDB, which was released in December 2016. Based on the full set of Abell 1795 observation acquired since launch, the rms scatter in the 0.5–2.0 keV flux is less than 3% when analyzed with the CALDB version of the ACIS contamination model.

Both the HRC-I and HRC-S have undergone a continuous decline in detector gain since launch. In addition, the HRC-S has also shown a continuous QE decline. These effects are corrected by the calibration team with annual updates to the HRC-I and HRC-S detector gains and the HRC-S QE. CIAO default processing automatically corrects for the time-dependent gain and QE losses to HRC-S data and time-dependent gain losses to HRC-I data. Due to the continued QE and gain decline, the operating high voltage of the HRC-S was increased in 2012 to restore the gain and QE to near launch values. However, since 2012, the gain and QE of the HRC-S has declined even faster. The calibration team has increased the cadence of the HRC gain and QE monitoring observations to four month intervals. At present, the HRC-S QE is declining by about 2–3% per year. While the HRC-I QE was stable over most of the mission, periodic observation of HZ43, for which most of the flux is below the C-K edge, show that the low energy HRC-I QE has declined by about 10% since launch. The calibration team is presently developing a time-dependent HRC-I QE file that will correct this problem. There are currently no plans to further increase the HRC-S high voltage, since the last increase produced an acceleration in the gain decline and any adjustment to the high voltage involves some risk to the detector. The calibration team will continue to release updates to the QE and gain files and the HRC-I and HRC-S effective area files used by PIMMS prior to each cycle. ■