In–flight calibration of the C edge fine–structure in the HRC UV/ion shield transmission models

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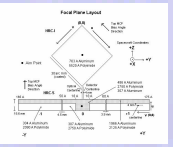
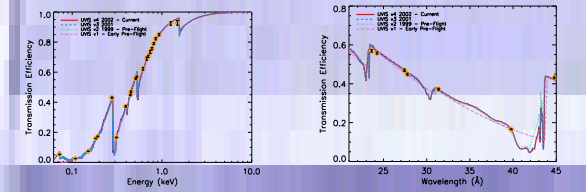


Abstract

We present details on the in-flight calibration of the HRC UV/ion shield transmission efficiency models. The broad shapes of the UV/ion shield models were derived from pre-flight measurements made at the HRC X-ray Test Facility at SAO. Further C,N,O,Al absorption edge structure measurements were made at the BESSY 1 synchrotron light source. However, during in-flight LETG/HRC-S calibration it became apparent that the HRC-S UVIS absorption fine structure was incompletely modeled, particularly the strong C-K edge. From in-flight observations of the AGN PKS 2155−304 and 3C 273, and the compact object RX J1856.5−3754, we have improved calibration of the HRC UV/ion shield transmission models, in 2 significant updates since launch.

The plots presented here focus on the C edge in the HRC-S UVIS transmission model. This is where the most work has been done. There have also been similar, though less significant, updates to N, O, and Al edges; and these improvements have been made to all HRC (-S & -I) UVIS models.



For those who prefer keV's to Å's, the left-hand plot shows the HRC-S UVIS transmission in terms of energy. Note that the overall general shape of the transmission has not changed throughout the updates. **Only edge fine-structure has changed with the improvements.**

The right-hand plot in terms of wavelength shows the evolution of the model around the C,N,O edges.

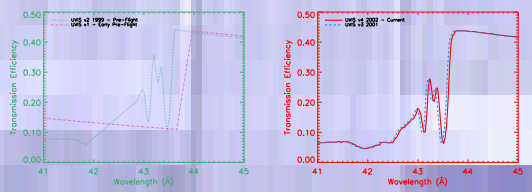
Note: on both plots the gold diamonds are the SAO monochrometer measurements.

Method

At launch, the model of the ACIS optical blocking filter (OBF) had more edge fine-structure than the HRC UVIS models. In-flight LETG/HRC-S observations of the calibration targets resolved much of the UVIS C,N,O,Al fine-structure that was lacking in the UVIS model, particularly that of the C edge. Since the ACIS OBF is made of the same material as the HRC UVIS, just in different amounts, we were able to simply decompose the OBF into component transmission functions (Al-L, C-K, N-K, O-K, AL-K) and adjust them independently to match the HRC UVIS model parameters. In this way we were able to scale and adjust the more detailed ACIS OBF fine-structure to fit in the overall shape of the HRC UVIS model. Thus, our first post-launch UVIS update (**v3**) primarily accounted for the inclusion of the more detailed C,N,O,Al edge fine-structure. For the most recent update (**v4**), a shift of ~ -0.25 eV was applied to the C edge region (only) to get a good match of the modeled with observed resonance structures.

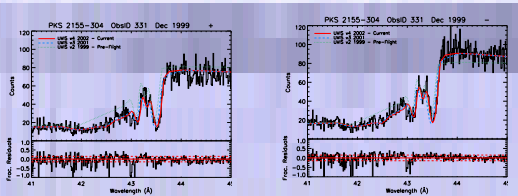
For further details on the decomposition of the ACIS OBF for improvements of both HRC and ACIS filters see Herman's page:

http://space.mit.edu/ASC/calib/letg_acis/



Evolution of the C edge in more detail. The left-hand plot shows the initial basic UVIS model (**v1** - purple) derived from SAO monochrometer measurements and the official pre-flight model (**v2** - green) which is a synthesis of SAO and BESSY models to include some of the edge fine-structure.

The right-hand plot shows the two in-flight updates: 1) the inclusion of the more detailed fine-structure (**v3** - blue), and 2) a shift applied to the C fine-structure of ~ -0.25 eV (**v4** - red).



Above we show the model-predicted counts compared with the December 1999 observation of PKS 2155−304. Counts models are produced with UVIS models v2 (green), v3 (blue) and v4 (red), respectively. Residuals are for UVIS model v4 only, and dashed lines are 15% error lines. Note the remaining mismatch at ~ 43Å. Positive (left) and negative (right) dispersions are shown separately.

Conclusions & Future Work

- HRC UV/ion shield models are much improved since launch
- Remaining C edge fine-structure discrepancy at ~ 43Å
- Future work planned for disentangling ISM effects from UVIS material
- O edge model needs improvement

http://asc.harvard.edu/cal/Hrc