HRC Update

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Another year has passed and the HRC continues to operate normally. There have been no significant changes or performance anomalies since the last *Chandra* newsletter. However, as described in detail in Jeremy Drake's article on LETG, the CXC calibration team felt that the gain loss, and therefore quantum efficiency loss (40% or more at some locations), due to charge extraction in the wing plates of the HRC-S was sufficiently large that it would start to impact science observations. This slow decay in instrument gain and QE is a well-known effect in microchannel plate (MCP) detectors, and the HRC was designed with the capability to raise the high voltage to recover the gain.

Accordingly, a plan was developed (principally by Mike Juda and the CXC Calibration team with the support of the HRC instrument team) to evaluate the effect of a progressive increase of the high voltage on both the top and bottom MCPs and determine how much of the lost QE in the wing plates could be recovered by a small increase to the HV. This plan was implemented during a realtime contact on the morning of January 9th, 2012. A Command Action Procedure was developed in which the HV on the HRC-S would be raised above the nominal operating voltage one digital step at a time while observing HZ 43 with the LETG inserted (30 cts s^{-1} in the dispersed spectrum in the wing plates). The voltages were to be raised by 3 steps on each plate, or roughly 50 volts above the nominal 1250 V operating voltage. Roughly 10 minutes of data would be taken at each voltage step so that the progressive change could be evaluated. This would occur during a realtime telemetry contact so that the instrument team could continuously monitor the performance and safety of the instrument. The HV would be returned to its nominal operating setting at the end of the experiment.

At the time of writing this article, we are just receiving the processed data from this experiment. Quick look realtime analysis at the OCC showed that the detector performed as expected at the higher voltages and that there were no problems with increased background or hot spots in the detector during the operation. The HRC was returned to its default configuration and seen to be operating normally at the end of experiment. Preliminary analysis of the processed data from the first few voltage steps shows that the source rate did increase by roughly 10% per voltage step. A more careful analysis is underway by both the CXC Cal and HRC instrument teams to evaluate the effect on gain and QE. If the data shows that we recover most or all

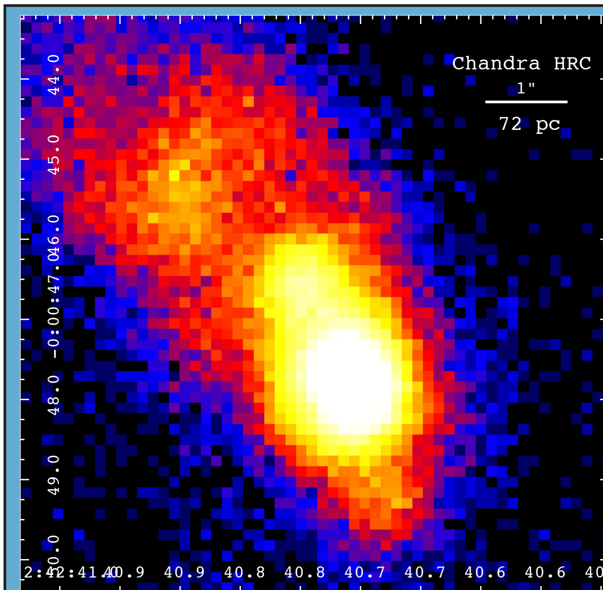

Fig. 1. - The ~7" x 7" (500 pc across) HRC image of NGC 1068 obtained in ObsID 12705.

of the QE by increasing the gain, the HV on the HRC-S may be permanently increased. A similar procedure eventually may be needed to increase the voltage on the HRC-I plates, but charge extraction monitoring shows a smaller gain loss in the imager to date.

The HRC continues to be used for a wide range of scientific investigations. Junfeng Wang, Margarita Karovska, Pepi Fabbiano and collaborators used the HRC plus image deconvolution to resolve structures on sub-arcsecond scales near the nucleus in the Seyfert 2 AGN NGC 1068. As described in detail in Pepi Fabbiano's contribution, the HRC is being used in a number of investigations to resolve sub-arcsecond structure in the vicinity of bright AGN. The HRC is particularly useful in these observations because the pixel scale closely matches the telescope PSF and the HRC does not suffer from pileup due to the bright AGN.

Motivated by the HRC discovery of the jet-gas cloud interaction in the nuclear region of NGC 4151 (Wang et al. 2009ApJ 704,1195), the first HRC image of the prototype Compton-thick Seyfert 2 galaxy NGC 1068 (1"~72 pc) was recently obtained (Fig. 1, 40 ks exposure, PI: Fabbiano). The HRC image clearly resolves the subarcsecond structures associated with the narrow line region clouds, which cannot be studied in previous ACIS imaging observations due to the overwhelming pileup of the bright X-ray nucleus. The PSF-deconvolved HRC image using the EMC2 algorithm (see Karovska et al. 2005, ApJL 623, 137 and references therein) provides an unprecedented morphological comparison between the X-ray emission and the radio jet in the innermost 100 pc of this galaxy (Fig. 2), allowing us to study in detail the disruption of the collimated inner radio jet (Wang, Fabbiano, Karovska et al. 2012 in prep.). The overlay shows X-ray emission "blobs" at the locations where the radio jet (green contours) changes direction and where the highly collimated jet terminates, implying possible interactions with the gas clouds.

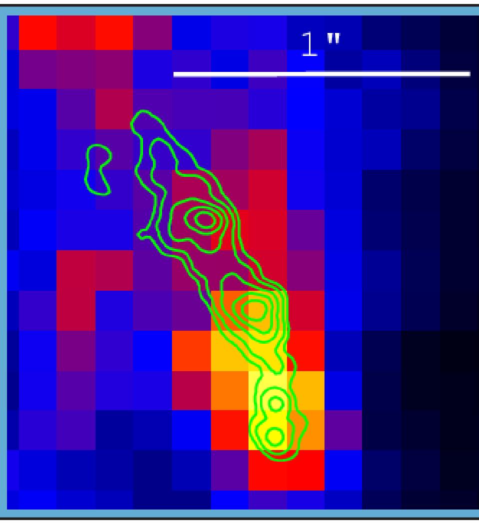

Fig. 2 - X-ray emission structure in the innermost 100 pc region of NGC 1068, revealed by the HRC image with EMC2 deconvolution. Superposed are contours from 5 GHz MERLIN radio image (courtesy of J. Gallimore).