Operated for NASA by AURA

Instrument Science Report WFC3 2008-07

WFC3 TV3 Testing: UVIS Channel Glints

Thomas M. Brown
Apr 14, 2008

ABSTRACT

In the previous thermal vacuum (TV) campaign of 2007, it was discovered that the UVIS channel was subject to strong glints (containing ~1% to 30% of the source energy) due to reflections between the CCD surface and the CCD housing. The detector installed in WFC3 at the time was the spare detector, but the problem was due to a design flaw common to both the flight and spare detectors, so the flight detector was corrected to address this problem. In the current TV campaign, we have stepped a bright source across the detector and find no significant glints (i.e., none brighter than 0.1% of the source), confirming that the problem was solved.

Background

One of the tests performed in the current thermal vacuum (TV) campaign for WFC3 is a check for scattered light and glints in the UVIS channel. In the previous TV campaign of 2007, it was discovered that imaging a source on some regions of the detector resulted in strong glints covering large regions of the detector (Brown 2007, ISR WFC3 2007-21). These glints contained anywhere from 1% to 30% of the source energy and spanned thousands of pixels. The source of the glint turned out to be a reflection of the light from the surface of the CCD, to the CCD housing, and back to the CCD. During the 2007 TV campaign, the spare UVIS detector was in the instrument, but the problem was due to a design flaw common to both the spare and flight detectors. To address the problem, the part of the CCD housing causing this reflection was masked in the flight detector.

To confirm that this problem was fixed, we imaged a bright point source placed at 121 positions on the UVIS detector, with the positions spaced 400 pixels apart in X and Y (Figure 1). The point source was provided by the CASTLE optical stimulus, which illuminated WFC3 with its HeNe laser. A short (1 sec) exposure was taken to provide an unsaturated measure of the source intensity (~200,000 e-/s), and then a series of longer exposures (25 sec) were taken to saturate the source and thus provide enough counts to detect glints at the sub-1% level. With the low dark current (0.0005 e-/s/pix) and read noise (3 e-/read/pix) of the UVIS detector, a glint containing 0.1% of the source energy could be detected at a signal-to-noise ratio (SNR) exceeding 10 even if the scattered light from the glint spanned 10,000 pixels, and would be detected even more easily if the glint were more compact. To improve the detectability of extended glints even further, we obtained our saturated exposures using 3x3 binning on the detector, which also reduced the run time of the test by reducing the data volume. With 3x3 binning, each 3x3 binned pixel has the read noise of a single pixel (i.e., 3 e-/read/pix); because the glint detection is read noise limited, we would detect a glint at SNR > 10 if it contained only 0.03% of the source energy and spanned 10,000 pixels.

Results

The 121 saturated images were processed through a minimal pipeline (bias subtraction, overscan trimming), and then inspected by eye, given that the eye should be able to easily detect extended regions with elevated counts corresponding to SNR > 10. No glints were detected, confirming that the mask has addressed the problem seen in the previous TV campaign. The only features seen in these images were the donut-shaped optical ghosts from the CCD window (Figure 2). These ghosts contain a few tenths of a percent of the source energy, and are easily seen by eye, demonstrating that the test was sensitive to glints at these levels, too. Optical ghosts from the CCD window were already well-characterized by previous TV tests (e.g., Brown 2007, ISR WFC3 2004-04) and predicted from optical models of the instrument (e.g., Stiavelli et al. 2001, ISR WFC3 2001-17).

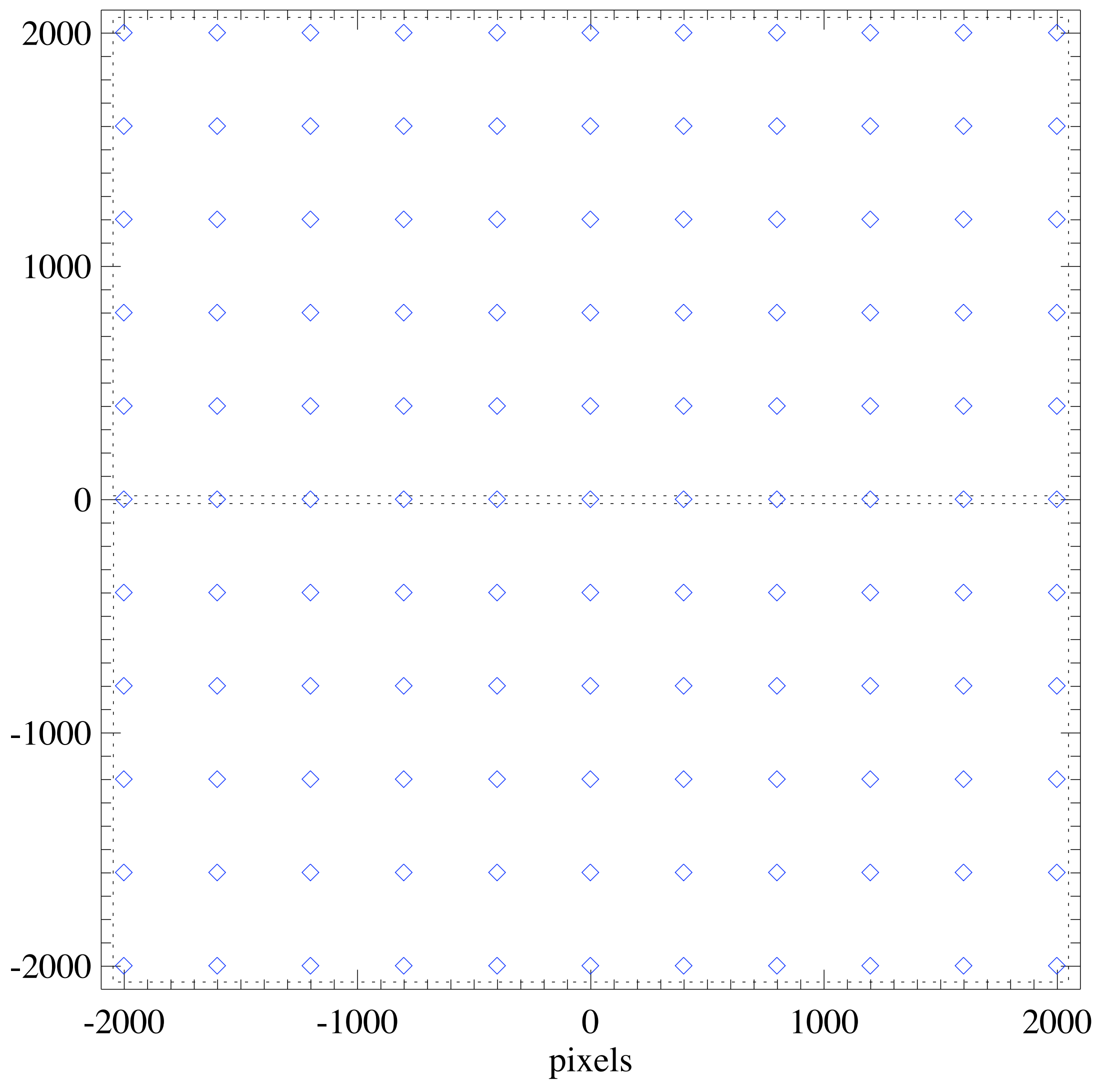

Figure 1: The positions on the UVIS detector, relative to field center, where a saturated point source was imaged for 25 seconds. The edges of the two detector halves are shown by dotted lines. A small gap (equivalent to ~34 pixels in width) exists between the detector chips.

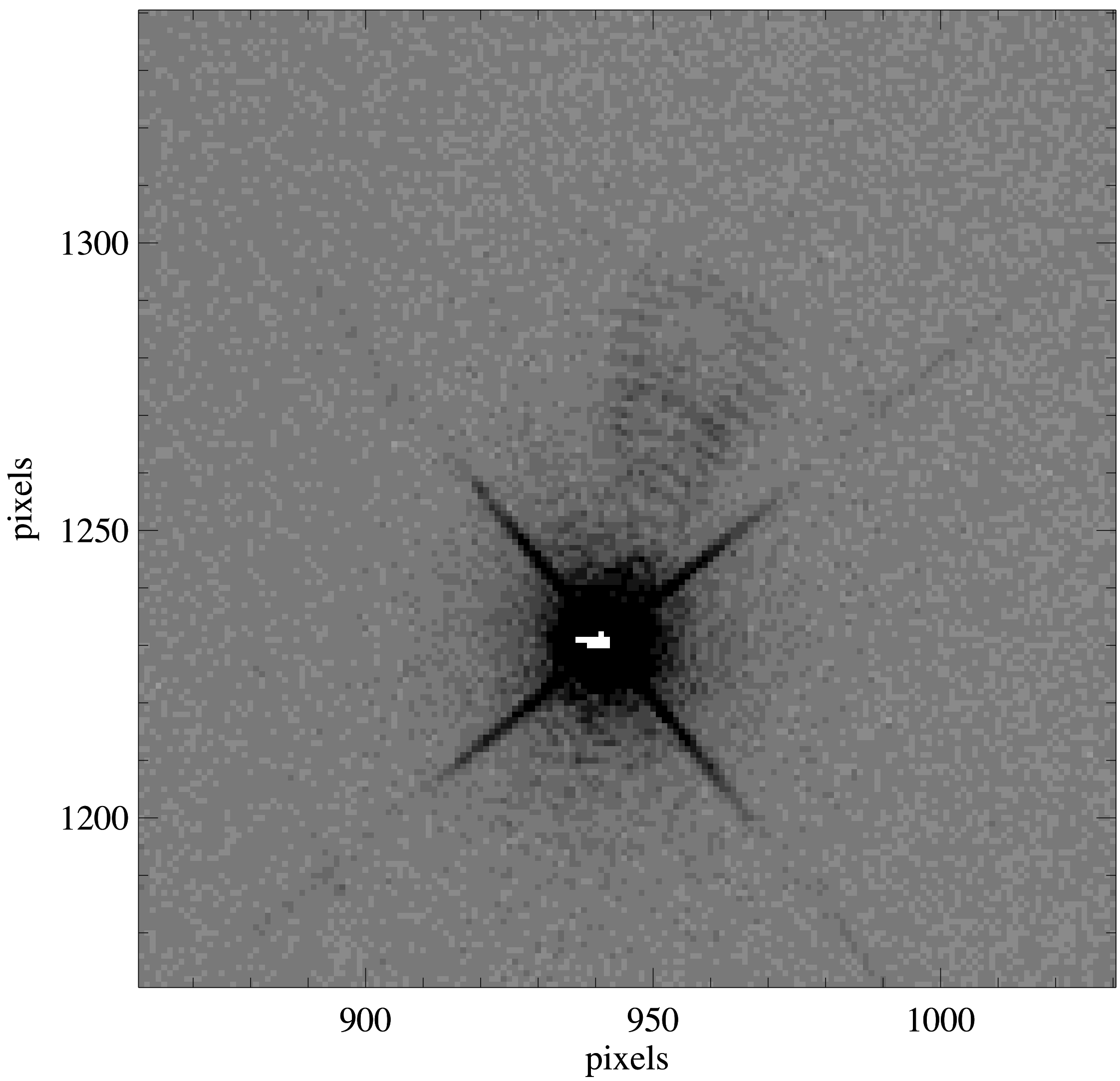

Figure 2: A cutout from one of the saturated images, showing the donut-shaped optical ghosts from CCD window reflections. Although these ghosts contain ~0.3% of the source energy, they are easily seen by eye, even in the vicinity of the saturated source. Note that the pixel coordinates here reflect the 3x3 on-chip binning used in these exposures. Such CCD window reflections were the only illumination patterns seen in these saturated images, aside from the source itself. The glints seen in the previous TV campaign were not present.