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ACS Post-Flash Measurements

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ABSTRACT

The ACS CCDs are equipped with LEDs that can illuminate the chips with a controllable short exposure added to an image. The purpose of this is to counteract the loss of efficiency due to charge traps which develop from exposure to ionizing radiation causing a readout loss or redistribution of charge in science images. The LED post-flash exposure fills these traps but adds statistical noise. Mainly because of this noise, the mechanism has not been used yet on science data, but might come into play as radiation damage accumulates. Once a year the procedure has been tested to confirm that it is in working order and to measure its stability. Over a four year period the mechanism has continued to function and shows no variation in output.

Introduction

The ACS CCD Post-flash system incorporates LEDs which illuminate the WFC and HRC detectors. The LEDs may be actuated after an image has been accumulated but before it is read out, thus adding a background level to the image. The purpose of this is to fill in charge traps which are mainly caused by radiation damage to the CCDs and interfere with the charge transfer during the readout. The effect on charge transfer efficiency (CTE) has been the topic of much study (Riess and Mack, 2004, Mutchler and Sirianni, 2005). For the most part the CTE effects can be corrected by modeling. Over the first four years of the active life of ACS this approach has been preferred rather than adding artificial background with its attendant statistical noise. Nevertheless, in anticipation of a possible need to use the post-flash method, we have been testing it annually. This report gives the results of those tests.

The Post-Flash System

The post flash system is capable of illuminating the CCDs over a large flux range. There are three exposure currents available labeled LOW MEDIUM and HIGH and the exposure time may be varied between 1 and 400 seconds. The LOW and MEDIUM settings provide rates of about 12% and 75% of the HIGH value. There are two shutter positions labeled A and B.

Measurements

Each May in the years 2003 to 2006, a set of post-flash exposures were made. The exposures exercised both shutter sides with a post-flash exposure time of 400 seconds. High, medium and low rates were used on one side with only one of these rates being exercised with the other shutter. Additionally a series of eight one-second exposures was made at the high current rate to measure repeatability. The following tables summarize the four years' results.

	400 second exposure			1second	Ratios	
YEAR	LOW	MEDIUM	HIGH	HIGH	L/H	M/H
2003	4.0	25.0	32.6	35.9	12%	77%
2004	4.0	25.7	33.2	34.8	12%	77%
2005	4.2	25.7	33.5	35.0	12%	77%
2006	4.2	25.9	33.9	35.9	12%	76%

Table 1: HRC flash count rates in electrons per second. Ratios of low and medium to high are given in the last two columns

	400 second exposure			1 second	Ratios	
YEAR	LOW	MEDIUM	HIGH A	HIGH B	L/H	M/H
2003	12.6	79.3	80.7	103.2	16%	77%
2004	9.6	61.9	80.5	105.0	12%	77%
2005	12.7	62.1	80.9			77%
2006	9.8	62.4	81.0	106.0	12%	77%

Table 2: WFC1 flash count rates in electrons per second..

	400 second exposure			1 second	Ratios	
YEAR	LOW	MEDIUM	HIGH A	HIGH B	L/H	M/H
2003	11.9	79.3	80.7	103.2	12%	77%
2004	8.8	56.4	73.3	99.2	12%	77%
2005	12.0	56.6	73.6			77%
2006	9.0	57.2	74.4	100.6	12%	77%

Table 3: WFC2 flash counts in electrons per second. In the 2005 data set there was no HIGH exposure on the B side and so the Low/High ratio can not be given.

The images were taken with a minimum science exposure of 0.1 seconds and 0.5 seconds for the WFC so as to measure just the LED illumination, Crossed filters F775W with F330W for the HRC and F503N with F660N for the WFC were chosen to minimize any real exposure to incoming light. Since this facility is designed to be applied to normal exposures the system would not allow us to use a pure dark exposure.

Conclusion

The post-flash system remains operable and stable and ready for use if it becomes necessary. We would need to perform a moderate amount of calibration before actual use so that we know exact counts for a larger range of flash durations.

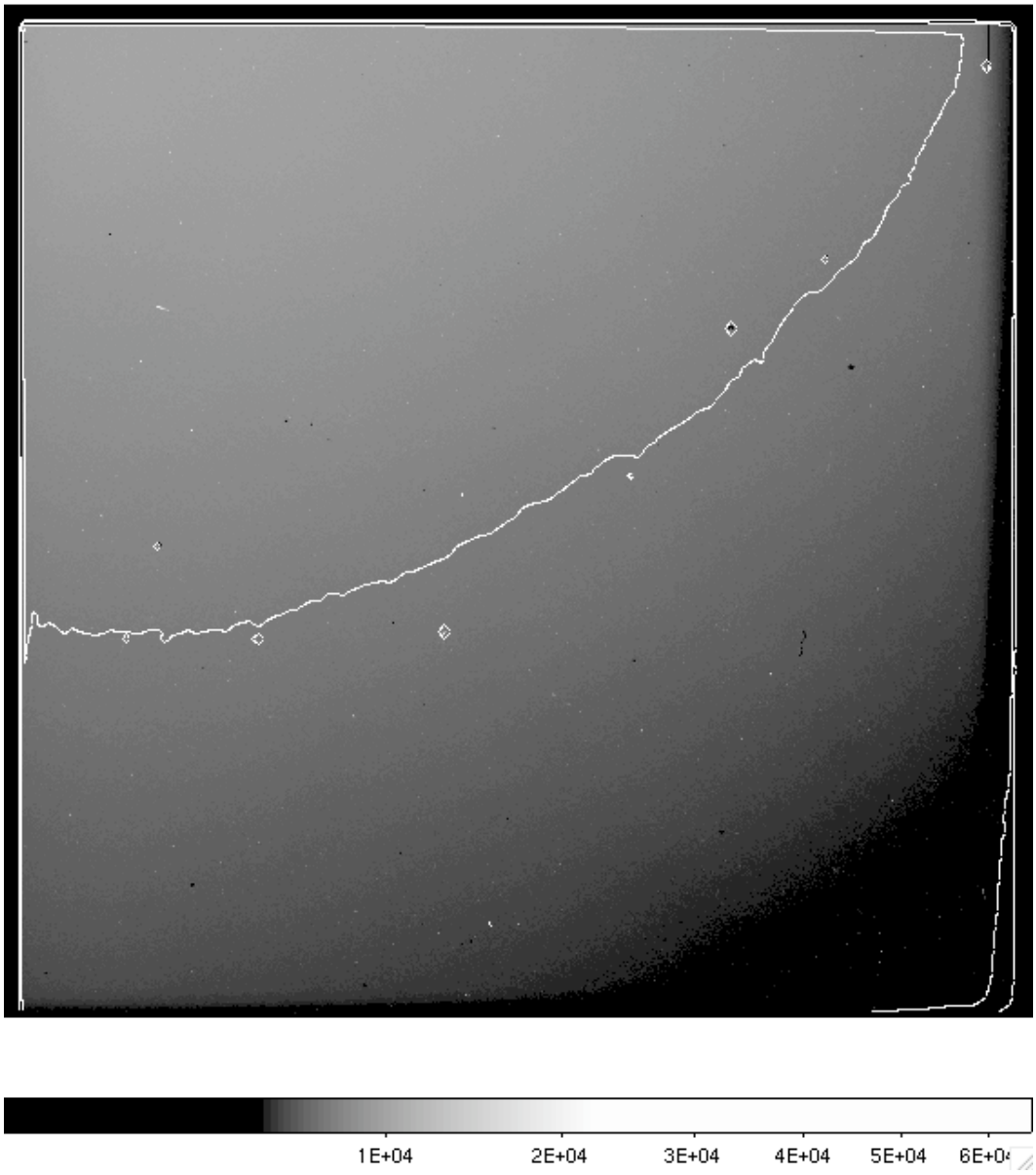

Figure 1: HRC Post-flash image shown with a square-root stretch. The intensity is not uniform. The peak intensity is near the upper left corner. Contours are shown at approximately 75%, 50% and 25% of the peak intensity. Only a small section in the lower right corner receives less than 50% of the peak intensity.

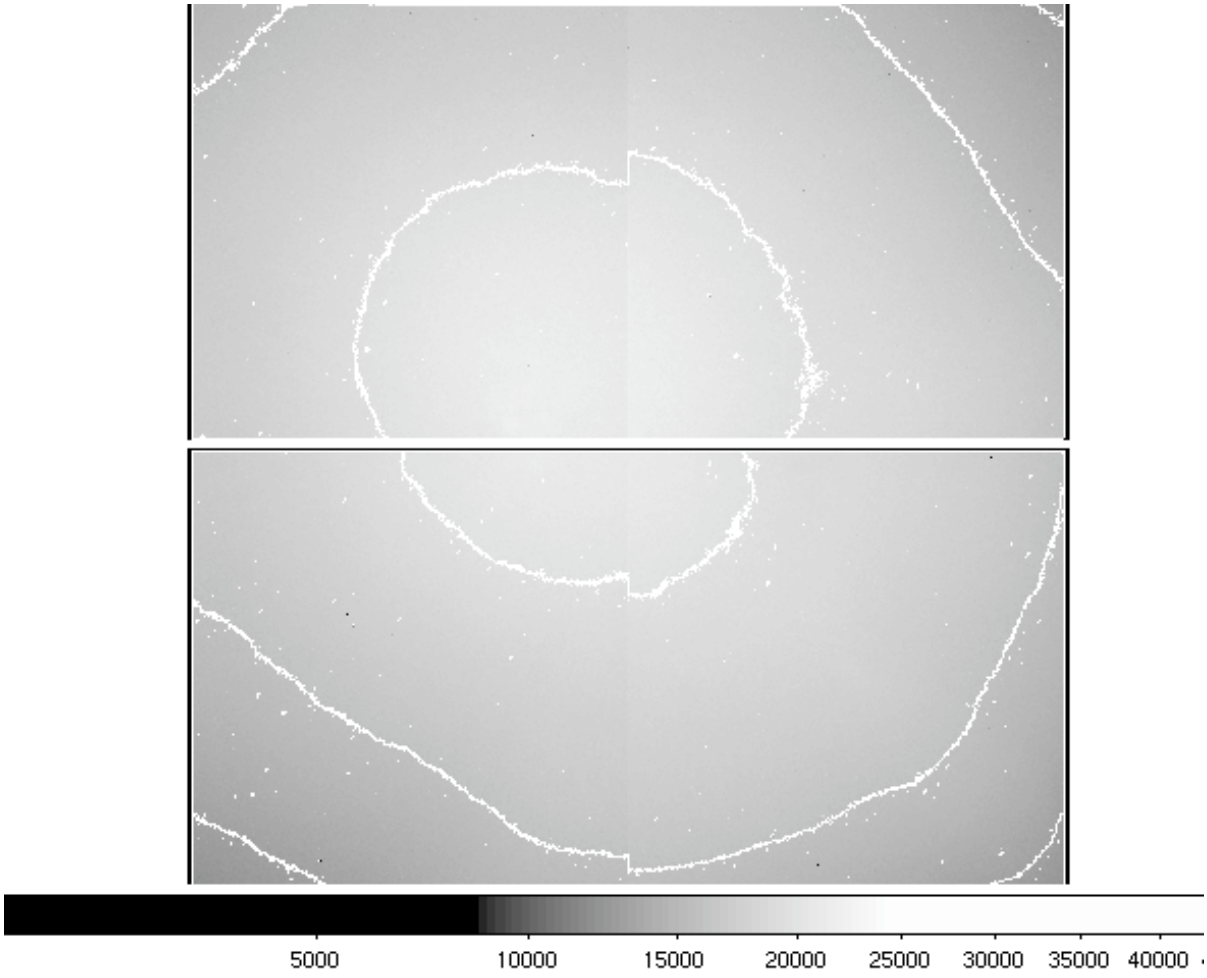

Figure 2: The WFC post-flash exposure. This is much more uniform than the HRC distribution. The contours are at 90%, 80% and 70% of the maximum intensity. No part of the image receives less than 60% of the maximum intensity

References

Adam Riess, Jennifer Mack, Time Dependence of ACS WFC CTE Corrections for Photometry and Future Predictions, Instrument Science Report ACS 2004-006, May 2004

Max Mutchler and Marco Sirianni, Internal monitoring of ACS charge transfer efficiency, Instrument Science Report, ACS 2005-03, April 2005