5.1.10.2 WAC FM ANTI-BLOOMING PIXEL PAIRS CALIBRATION RESULTS

As reported in Reference 5.1.10.2-1

Reference 5.1.10.2-1 - IOM 388-PAG-CCA98-9, "WAC FM CALIBRATION RESULTS: Anti-blooming Pixel Pairs", Bob West and Charlie Avis , April 16, 1998

Reference 5.1.10.2-2 - IOM 388-PAG-CCA98-1, "WAC FM Calibration Results: Sensor Blemishes", C. Avis, January 20, 1998

5.1.10.2.1 INTRODUCTION

Long exposures with anti-blooming ON will show bright/dark pairs of pixels scattered throughout the image. According to J. Janesic (private communication) these are caused by traps which preferentially accumulate electrons at the expense of the adjacent pixel under the action of the anti-blooming voltage forcing function. The bright pixel is one line higher than the dark pixel. The magnitude of the effect will depend on the size of the trap(s), a time constant for trap filling, and the exposure level.

Wide-angle Flight Model thermal/vacuum anti-blooming test images were used for characterization of this pixel pairing. These data were taken at Gain 2 in the 1x1 mode at chamber temperatures of -5° C. The CCD was maintained at about -90° C. Exposures were available up to 56 seconds with anti-blooming ON and OFF.

We are unable to formulate an accurate model for this process, but heuristically it should obey the following approximate form:

$$\frac{DN(line+1, sample) - DN(line, sample)}{DN(line+1, sample) + DN(line, sample)} = a\left(1 - e^{-bt}\right)$$

Equation 5.1.10.2-1

where t is the exposure time

a and b are positive constants to be determined by fitting images taken at different times

5.1.10.2.2 METHOD

The expectation is that at short exposure times the difference/sum should be approximately linear with time, and at long exposure times it should approach an asymptotic value. The calibration analysis consisted of finding the pixels which show bright/dark pair behavior from the longest flat-field frames with anti-blooming ON. For the NAC an additional step was to attempt to fit the difference/sum measured on images at a variety of exposure times to the formula above. The maximum exposure for the WAC with anti-blooming ON was 56s. That exposure time is too short to attempt to fit to Equation 5.1.10.2-1.

Pixel pairs showing the effect described above were identified in the 56s exposures. Three 56s exposures were averaged to improve signal to noise ratio. An averaged image with anti-blooming ON was compared to an averaged image with anti-blooming OFF. Pixel pairs having one pixel brighter than the local (21-point median filter) average along the line direction and the adjacent one dimmer were identified. To be identified as a trap pair, DN values for both pixels must depart from the median value by more than some threshold which was chosen to provide maximum sensitivity while excluding unaffected pixels with a confidence level near one part in 10,000. The threshold (DN-median DN)/median DN ratio for this process was 0.015. The algorithm operating on the image with anti-blooming ON identified 13932 pixel pairs. The same algorithm was performed on the average image having anti-blooming OFF. The algorithm identified 80 pixel pairs (false positives) out of a total of approximately one million pixels.

5.1.10.2.3 RESULTS

A small portion of the average image with anti-blooming ON is shown in Figure 5.1.10.2-1.

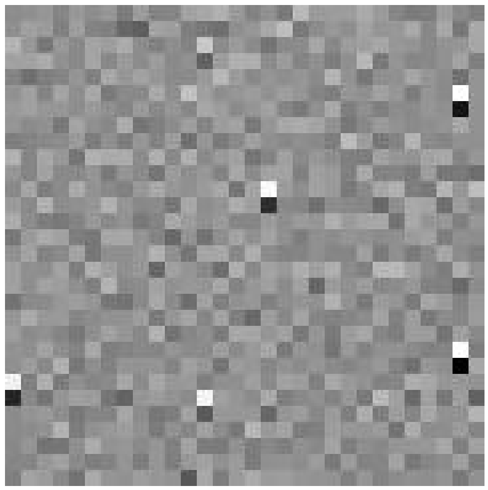

Figure 5.1.10.2-1

Five or six bright/dark pairs are obvious in Figure 5.1.10.2-1 (an average of three 56s images with anti-blooming ON). These and others less obvious were identified and stored in a digital image file ABPAIR_MASK.WA. The values in ABPAIR_MASK.WA are 100,000 times the DN ratio expressed in Equation 5.1.10.2-1 divided by the exposure time.

5.1.10.2.4 CONCLUSIONS

1. Bright/dark pixel pairs having ratios 0.015 in (DN-median DN)/median DN or higher have been identified in 56s exposures. An image file with non-zero values at the pixel locations of the bright component of the pair can be used to mask these pixels during the calibration of in-flight images.

2. For most exposure times to be used during the Cassini mission (e.g. 1s or less) the pixel pair differences can be ignored. Those pairs with large amplitudes, or images with long exposures need some calibration method which treats them as blemish pixels. A crude approach to deal with these pairs would be to replace their values with the mean for the two. A better approach would be to use adjacent and surrounding good pixels to interpolate for the locations of the bright/dark pairs. This latter method would better conform with intensity gradients in the image. In addition, this method would be easily implemented by adding these pixels to the Blemish File discussed in Reference 5.1.10.2-2.

5.1.10.2.5 IMAGES USED FOR ANALYSIS

image	observation	mode	expos	filt1	filt2	gain	ablm	temp
123933	ANTI-BLOOMING_502	FULL	56000	CL1	CL2	2 (100K)	ON	-5.
123934	ANTI-BLOOMING_502	FULL	56000	CL1	CL2	2 (100K)	ON	-5.
123935	ANTI-BLOOMING_502	FULL	56000	CL1	CL2	2 (100K)	ON	-5.
123945	ANTI-BLOOMING_503	FULL	56000	CL1	CL2	2 (100K)	OFF	-5.
123946	ANTI-BLOOMING_503	FULL	56000	CL1	CL2	2 (100K)	OFF	-5.
123947	ANTI-BLOOMING_503	FULL	56000	CL1	CL2	2 (100K)	OFF	-5.