Technical Instrument Report WFPC2-00-01

SMOV3A Flat Field Stability Check

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February 28, 2000

ABSTRACT

We compare WFPC2 Earthflats taken before and after the 1999 service mission 3A. Most of the field-of-view shows no change (<0.3%) in flat field calibration. The largest changes occur only near the CCD corners, particularly near the apex, and reach ~1.5%; these are likely attributable to long-term changes in the camera geometry, rather than SM3A.

1. Introduction

As part of our post-servicing check-out of WFPC2 after SM3A, we have examined a series of F502N Earthflats to test the flat field stability. The goal of these observations is to test for any unexpected OTA obscuration or contamination in WFPC2 that may have occurred as a result of the servicing mission. The flats are also capable of revealing changes in the OTA / WFPC2 geometry, as well as any QE changes localized to one CCD camera or to a small region of the field-of-view. While internal flats can provide some of this information, the Earthflats are unique in providing an end-to-end test of the OTA+WFPC2 system. Detailed discussion of Earthflats and WFPC2 flat fields can be found elsewhere (Biretta 1995).

2. Observations and Analyses

Earthflats were observed as part of the routine calibration proposals 8053 and 8445 for late Cycle 7 and Cycle 8, as well as proposal 8495 during SMOV3A. All the F502N flats are 1.2 second exposures of the bright Earth made with gain 15. Since we are interested primarily in changes to the flat field, we select subsets of these to construct a pre-SMOV and an SMOV flat.

For the pre-SMOV observations we started with a total of 174 Earthflats in F502N taken between March 1999 and July 1999 as part of proposals 8053 and 8445. We discarded images with mean counts in the PC1 below 600 DN and mean counts in the three WFC chips above 3200 (to avoid saturation), leaving a total of 48 images. These images were then examined for streaks (produced by features on the Earth moving across the

detector), after multiplying with the current F502N flat field reference file. The streaks increase the overall RMS of the image; displaying the images and examining them with IMSTAT allowed the rejection of images with prominent streaks (more than around 0.8% overall normalized RMS, and exceeding about 1% peak-to-peak amplitude). Images with prominent “worms” in WF2 were also rejected. The remaining eight images, u59m1l03r, u59m2n04r, u59m2x04r, u59m3i03r, u59m3q04r, u59m4q04r, u59m4s03r, and u59m7104r, were combined with the task STREAKFLAT to produce an averaged, de-streaked pre-SMOV flat.

The same rejection criteria were applied to the 44 Earthflats taken after the service mission as part of programs 8445 and 8495. Again the images were displayed and examined with IMSTAT, rejecting those with too high an RMS and large peak-to-peak streak vartiations. All the flats from program 8495 had to be discarded, either because of low flux or saturation, or unacceptable streak variations. The remaining five acceptable images were all from program 8445, taken during Feb 16 - 21, 2000. These images, u5jf3i04r, u5jf3k03r, u5jf3m03m, u5jf3o04r, and u5jf3p04r, were combined with STREAKFLAT to produce the SMOV flat.

We then divided the SMOV flat by the pre-SMOV image, and normalized so that the central 400x400 pixels of WF3 had a mean of unity. The resulting SMOV / pre-SMOV ratio image is shown in Figure 1.

3. Results

Figure 1 shows that the mean ratio between the pre- and post-servicing flats is essentially unity. The most significant changes are seen in the corners of PC1 and WF4 near the pyramid apex, where departures from unity reach about 1.5% within about 10 pixels of the apex. These effects in the CCD corners are most likely due to small changes in the camera vignetting, which in turn result from small changes in the geometry of WFPC2. Other evidence of such small on-going geometric changes is also seen in K-spot images and is described by Mutchler and Stiavelli (1997).

There is also slight evidence of the “worm” features on WF2 at low levels (0.2% peak-to-peak), related to contamination on the CCD windows. This is to be expected, since our only acceptable post-SMOV Earthflats were several weeks after decontamination.

The pixel-to-pixel fluctuations (over the central 400 x 400 pixels) in the ratio image are typically 0.4% RMS for the WFC CCDs, and 0.8% RMS for PC1, which is entirely consistent with photon statistical noise. After smoothing with a 10-pixel FWHM Gaussian function, the fluctuations decrease to <0.1% RMS, as would be expected for photon noise.

No change in chip-to-chip sensitivity is seen in on any levels above ~0.3% in the average ratio of post-SMOV / pre-SMOV counts over the central 400x400 pixels of each CCD. There is also no significant evidence of obscuration or other changes in the OTA.

4. References

Biretta, J., “WFPC2 Flat Field Calibration,” in Calibrating HST: Post Servicing Mission, eds. A. Koratkar and C. Leitherer, STScI, p. 257, 1995.

Mutchler, M. and Stiavelli, M. “WFPC2 Internal Monitoring for SM97,” Technical Instrument Report WFPC2-97-07.

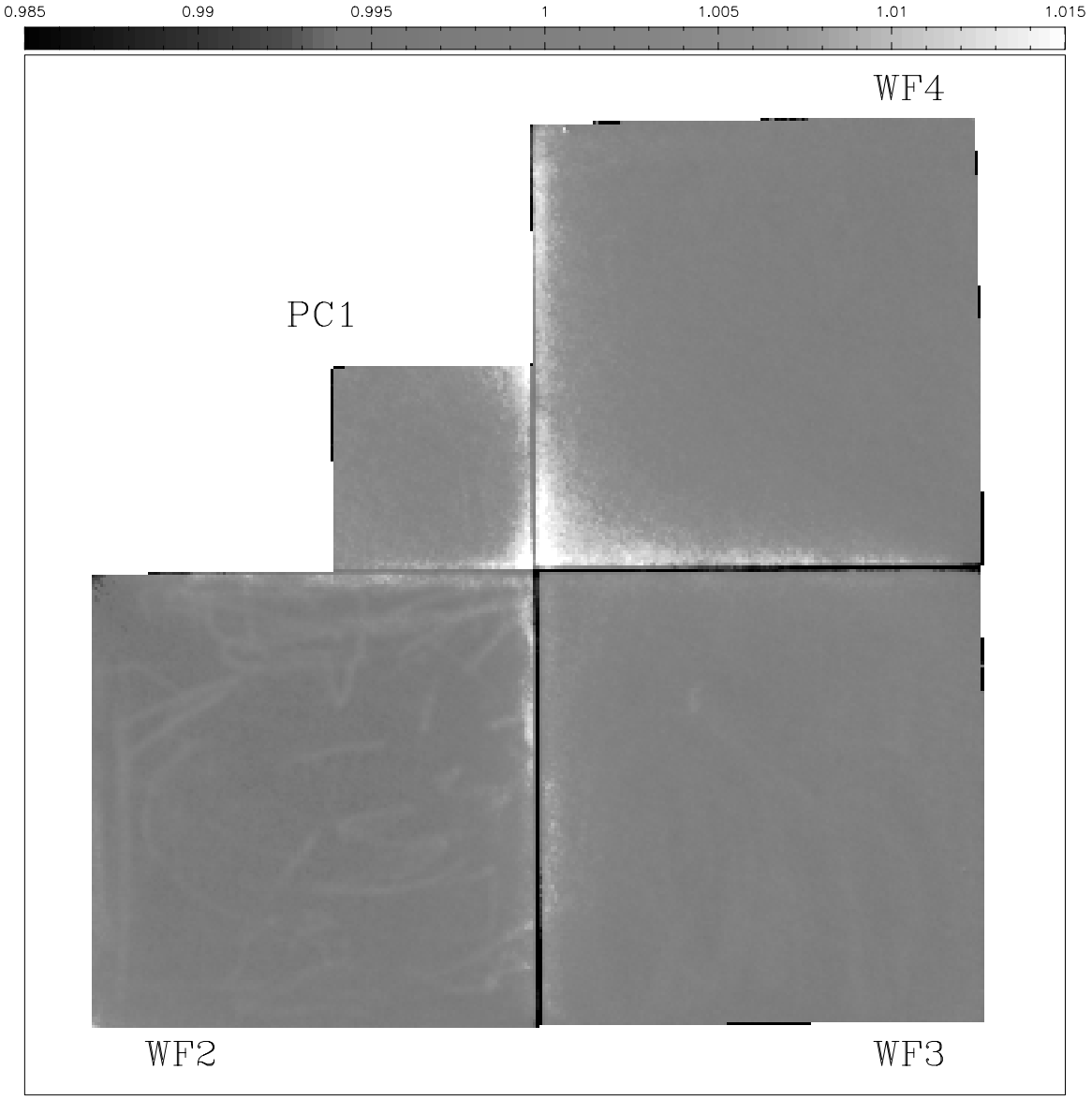

Figure 1: Ratio of SMOV / pre-SMOV flats taken in F502N. The display greyscale ranges from 0.985 (black) to 1.015 (white). The label of each WFPC2 chip is indicated in the figure. For display purposes the original 1600 x 1600 pixel image has been median-smoothed and averaged using a 5x5 pixel box.