

NICMOS Parallel Thermal Background: Results from SMOV and Cycle 7.

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ABSTRACT

This ISR presents the results of the analysis of NICMOS parallel thermal background data obtained as part of both SMOV and the cycle 7 calibration plan. Parallel observations in NICMOS Camera 2 and Camera 3 are taken at different pointings and analysis of the data shows the HST thermal emission to be fairly stable, with an orbital variation of ~5% and a secular variation of ~8%. The secular variations are oscillations around the average over time scales of about one month. As expected, these oscillations are correlated with the temperature of the telescope's optics. Background measurements are recommended when observing in the thermal filters, specially for images separated by large periods of time.

1. Introduction

The NICMOS parallel thermal background program is a test performed as part of the Servicing Mission Orbital Verification (SMOV) and the cycle 7 calibration plan. The test consists in obtaining NICMOS images in the thermal filters when other instruments are primary. It is known that during observations with NICMOS, thermal emission from the HST OTA reaches the instrument's focal plane. The NICMOS parallel observations are used here to measure the stability of the thermal emission from the telescope over long timescales, both orbital (hours) and secular (months). In addition, the observations are used to test the stability of the background when other instruments are primary.

2. Analysis and Discussion

Pure parallel observations, were obtained with NICMOS Camera 2 and Camera 3. For the observations with Camera 2 the filter used was F237M and with Camera 3 F222M. During SMOV the data was taken in 13 random pointings for Camera 2 and 71 pointings for Camera 3, whereas, during the cycle 7 calibration plan, observations were made at 20 different pointings in random directions for each camera.

At each pointing, observations were performed with 8 exposures during SMOV and 5 exposures during the Cycle 7 calibrations. For each exposure the data were taken using the MULTIACCUM readout mode with the STEP 64 sequence and NSAMP=11. The total exposure time per exposure was 127.962 seconds.

In this study, the thermal background measurements are presented as the average count-rate calculated over the entire chip. As mentioned in the Cycle 7-NICMOS Handbook, Camera 3 has a vignetting problem which affects the count-rate in rows 1 - 100 from all columns. The average count-rate in this camera is therefore computed in the unvignetted area between row 100 and row 256. For Camera 2 the average count-rate is calculated over the entire area of the chip.

Figure 1 presents the mean count-rate for each exposure in Camera 2 and Camera 3 as a function of the day of observation. The deviation around the mean value is about 5% at each pointing. As mentioned before, each pointing consists of 5 or 8 independent exposures. The first exposure of each set is generally more than 5% away from the average. This deviation is due to the DC pedestal. In order to determine the stability of the thermal background, the average count-rate is calculated for each of the pointings after removing the first exposure of each set, and the results are shown in Figure 2.

Figure 1: This figure shows the results of all exposures for each of the pointings in average count-rate as a function of day of observation (day 1997.100 to day 1997.200). SMOV data is represented by DIAMONDS and Cycle 7 by PLUS sign. The higher count-rate for first exposure at each pointing is a manifestation of the pedestal effect. Each exposure has an exposure time of 127.962 seconds.

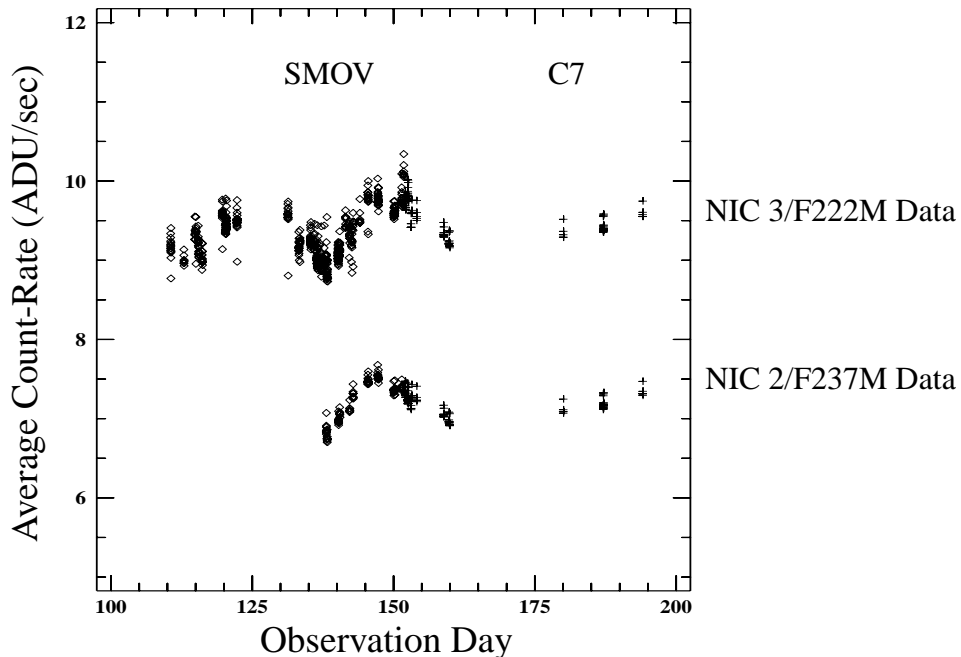
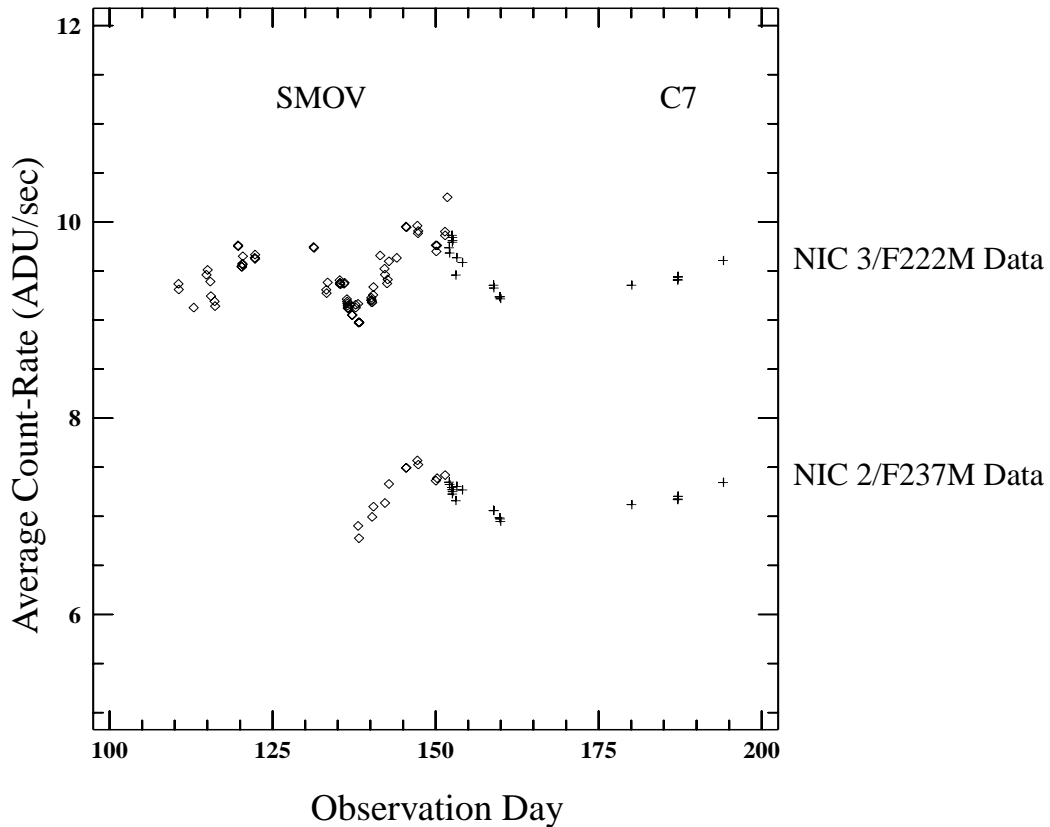


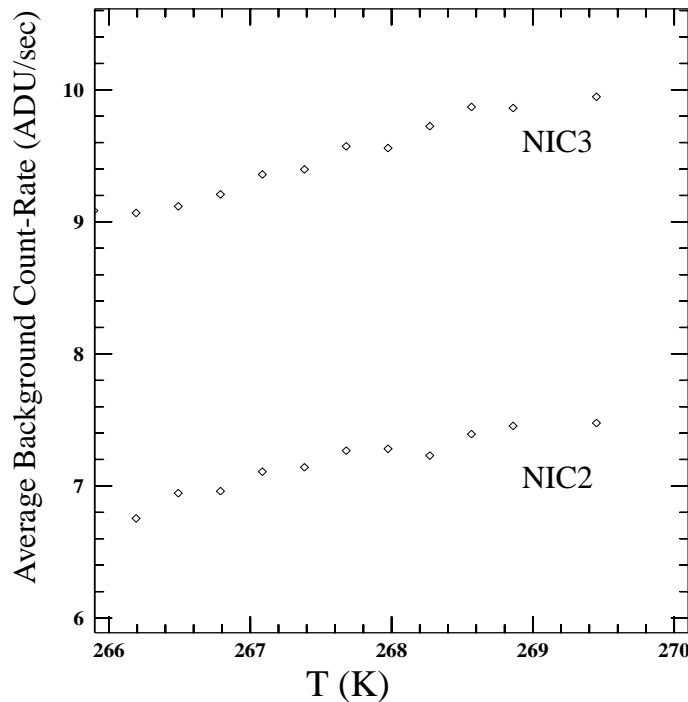
Figure 2 shows the median-combined exposures of each pointing as a function of observation day. The thermal background is fairly stable, with oscillations of ~8% amplitude over approximately one month timescale. These oscillations are independent of the instrument used in the prime observations, confirming that the use of other instruments with NICMOS in parallel has only a small effect on the NICMOS thermal background. The global average thermal emission is 7.18 ADU/sec in NIC2/F237M and 9.51 ADU/sec in NIC3/F222M, regardless of the instrument used in the prime observations. These results showing a stable thermal background are in agreement with the results of NICMOS-ISR-97-025.

Figure 2: This figure shows the combined average count-rate for each pointing. The mean value is of 7.18 ADU/sec for Camera 2 and 9.51 ADU/sec for Camera 3. Each observation set has an exposure time of 1023.70 seconds for SMOV data (127.962seconds*8) and 639.81 seconds for cycle 7 data (127.962 seconds*5). SMOV data is represented by DIAMONDS and Cycle 7 data by PLSU sign.



We have correlated the secular (monthly baseline) variations of the thermal background with the temperature of the HST optics (Figure 3) to investigate the nature of the oscillations in the two above figures. We find a positive correlation between the two quantities, as expected. Thus the secular variation around the mean, of the order of $\sim 8\%$, is entirely due to changes in the temperature of the telescope, with a rate $\frac{\Delta C^2}{C^2} = 0.031\Delta T$

Figure 3: The average count-rate of each pointing as a functions of the temperature of the HST optics.



3. Conclusions

In this ISR we have demonstrated that the HST thermal background is stable (within 5%) over orbital timescales, and within 8% over secular timescales. The background flux is about 9.51 ADU/sec (60.91 (e/pic/sec)) in the F222M filter in Camera 3 and 7.18 ADU/sec (45.99 (e/pix/sec)) in the F237M filter in Camera 2. The analysis also shows stability in the NICMOS data regardless of the prime instrument used during parallel observations. We recommend observers to obtain a background measurement when observing in the thermal filters once per orbit or every few orbits, and to definitely obtain thermal background measurements for images separated by large periods of time (\sim weeks).