

## Modification to observed pointing wobble during staring observations

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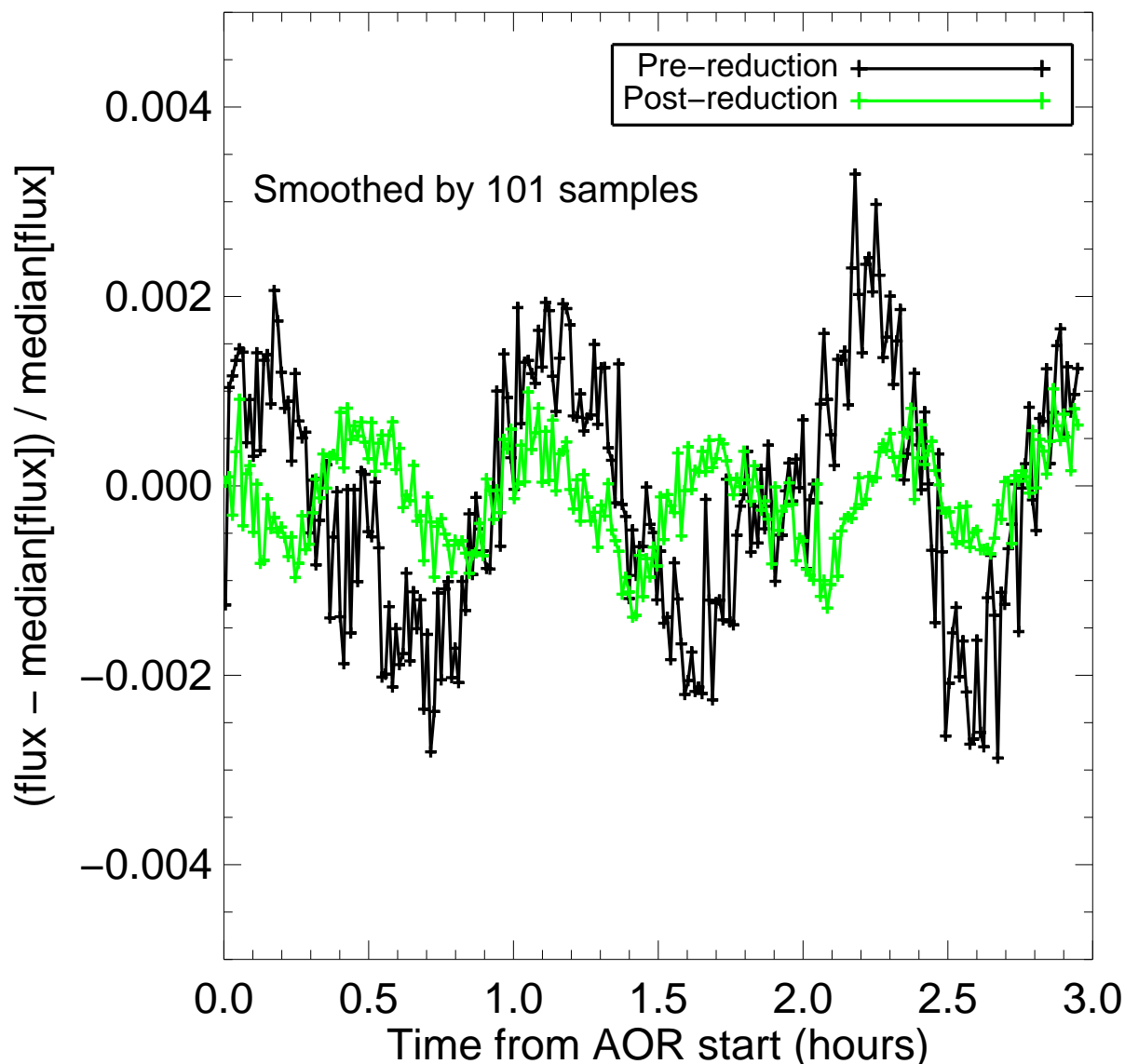
Updated: 28 October 2010

As of 17 Oct 2010 07:25:00 UTC, the pointing wobble observed in long staring observations with IRAC was significantly reduced in amplitude and the period decreased from 60 minutes to 40 minutes. The cyclic pointing wobble and the response variations across a given detector pixel (the pixel-phase effect) for the IRAC arrays combine to produce a variation in photometry for long staring observations. Observers will still need to correct the photometric variation for science (e.g. exoplanet transits) requiring high precision. The expectation is that by reducing the amplitude and increasing the frequency of the wobble the resulting photometry will have better precision and residual photometric fluctuations will have a period which is much shorter than the periods of astronomically interesting (transits and secondary eclipses) events.

From a comprehensive analysis, the Spitzer engineering team was able to correlate the pointing wobble with the cycling of a heater used to keep a battery within its operating temperature range. The heater cycling results in a 1 degree Celsius temperature change to the battery with a period of one hour. After extensive testing and review, it was determined that the heater cycling could be safely reduced to 0.5 degrees Celsius. It was hypothesized that the thermal cycling led to a small flexing between the telescope boresight and star trackers used to keep the spacecraft attitude constant, and that reducing the cycling would reduce the associated flexing and pointing wobble. Please note that the pointing wobble is much smaller than the Spitzer pointing stability requirement and that the pointing performance of the observatory far exceeds its design specification and requirement.

The efficacy of this change was tested by performing identical staring observations of the standard calibration star, HD 158460, which has exhibited no measured variability in the infrared. The observations are identical three-hour stares of the star using 0.4 second sub-array frames at 4.5 microns. The observations were executed back-to-back with the heater cycling changed in between. The pre-change AOR is 40837888 and the post-change AOR is 40838144. The data are publicly available via Leopard and the Spitzer Heritage Archive. We encourage interested observers to download the data and compare the resulting light-curves.

The SSC has performed a preliminary analysis of the data and finds that the photometric variations associated with the pointing wobble are reduced. The period of the pointing wobble after the heater cycling change is estimated to be 36 minutes from a periodogram analysis of the measured stellar centroids. It is possible that this period will change (decrease) as a new equilibrium is reached with the implementation of the heater cycling change.



Comparison of relative flux variation with time for two staring observations of HD 158460. The black curve is the data from the pre-change AOR (40837888). The green curve is the data from the post-change AOR (40838144). Each data set has been boxcar smoothed using a window of 101 samples.

No additional structure is noted in the light curve. After fitting for the pixel-phase effect using a 2nd order polynomial in  $\Delta X$ ,  $\Delta Y$  (relative centroid position), the signal-to-noise of the pre-change data is 444.3 per exposure, the signal-to-noise for the post-change data is 463.2, while the theoretical signal-to-noise for the observations should be 533.6. That is, the pre-change SNR is 80% of the ideal, and the post-change is 84% of ideal. This initial analysis suggests that the precision of the binned data after the change is even better. A more in-depth analysis will be presented in an upcoming memo.