UPDATED OVERVIEW OF COS ON-ORBIT PERFORMANCE

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ABSTRACT

The Cosmic Origins Spectrograph (COS) was installed onboard the Hubble Space Telescope (*HST*) in May, 2009 as part of the Servicing Mission 4 (SM4). COS is optimized for observing faint point sources at moderate spectral resolutions and is the most sensitive UV spectrograph, with peak effective area of 3000 cm^2, ever flown on *HST*. Since the installation, several ambitious science programs have been initiated and completed. In nine months COS has increased the number of known low-redshift intergalactic Ly-alpha absorbers by a factor of 40 and proven the ability to measure trace species in extrasolar planetary atmospheres at three to four times the signal-to-noise ratio with which STIS can detect hydrogen. Since Servicing Mission Observatory Verification, Cycle 17 calibration activities have deepened our understanding of the instrument's characteristics. The routine science-related calibrations include flux and spectroscopic performance monitoring, flat field characterization, and wavelength calibration. A review of interesting characteristics such as the sensitivity changes over time, target acquisitions, and dark current rate as a function of time in the NUV detector are discussed.

SENSITIVITY

Monitoring of COS on-orbit sensitivity shows that the throughput of several modes is declining faster than anticipated. On the NUV side, the medium-resolution G225M and G285M gratings exhibit the largest drop in sensitivity. These gratings have a bare Aluminum coating, while the G230L and G185M, whose throughputs are unchanged, have a coating of Al + MgF$_2$. The FUV channel exhibits an ongoing sensitivity decline, which is independent of grating, detector segment, and target, but is wavelength dependent, being greatest at long wavelengths.

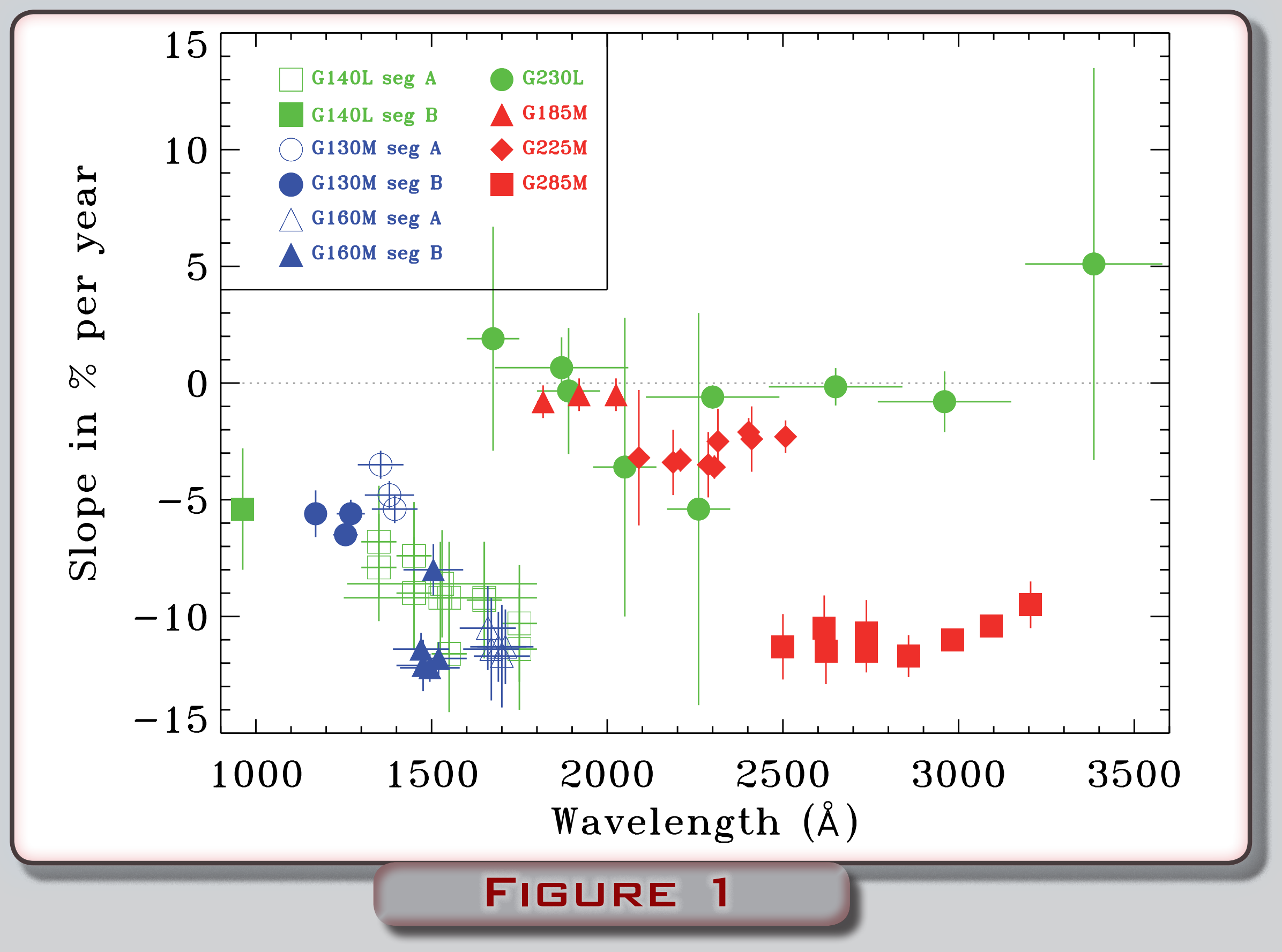

FIGURE 1

Figure 1 shows measured on-orbit rate of change for the COS gratings. The rates have been derived from monitoring observations of spectrophotometric flux standards at selected grating and central wavelength and are plotted as a function of wavelength.

The bare Aluminum NUV gratings exhibited sensitivity decline on the ground, due to the buildup of a thin oxide layer; the rates of decline were about 1.6% per year for the G225M and 4.5% per year for the G285M grating. Both the internal and external on-orbit NUV sensitivity monitoring indicates that the throughput of the Al gratings continues to decline.

The FUV channel exhibits a time-dependent sensitivity decline; the rates of decline range from 3 to 13% per year depending on the wavelength. The cause of the decline is unknown, but may be related to changes in the Cesium-Iodide photocathode.

TARGET ACQUISITION

We can estimate the blind pointing accuracy of *HST* and COS by reverse engineering the spacecraft motions necessary to center a target in the aperture. Fig. 2 shows the observed blind-pointing results for all COS target acquisitions (TAs) prior to February 28, 2010. Overall, we observed an initial pointing bias of −0.23±0.51 and −0.18±0.68 arcsec in dispersion (AD) and cross-dispersion (XD) direction, respectively. The FGS-to-COS offset was corrected by an adjustment to the Science Instrument Aperture File (SIAF) on March 1, 2010.

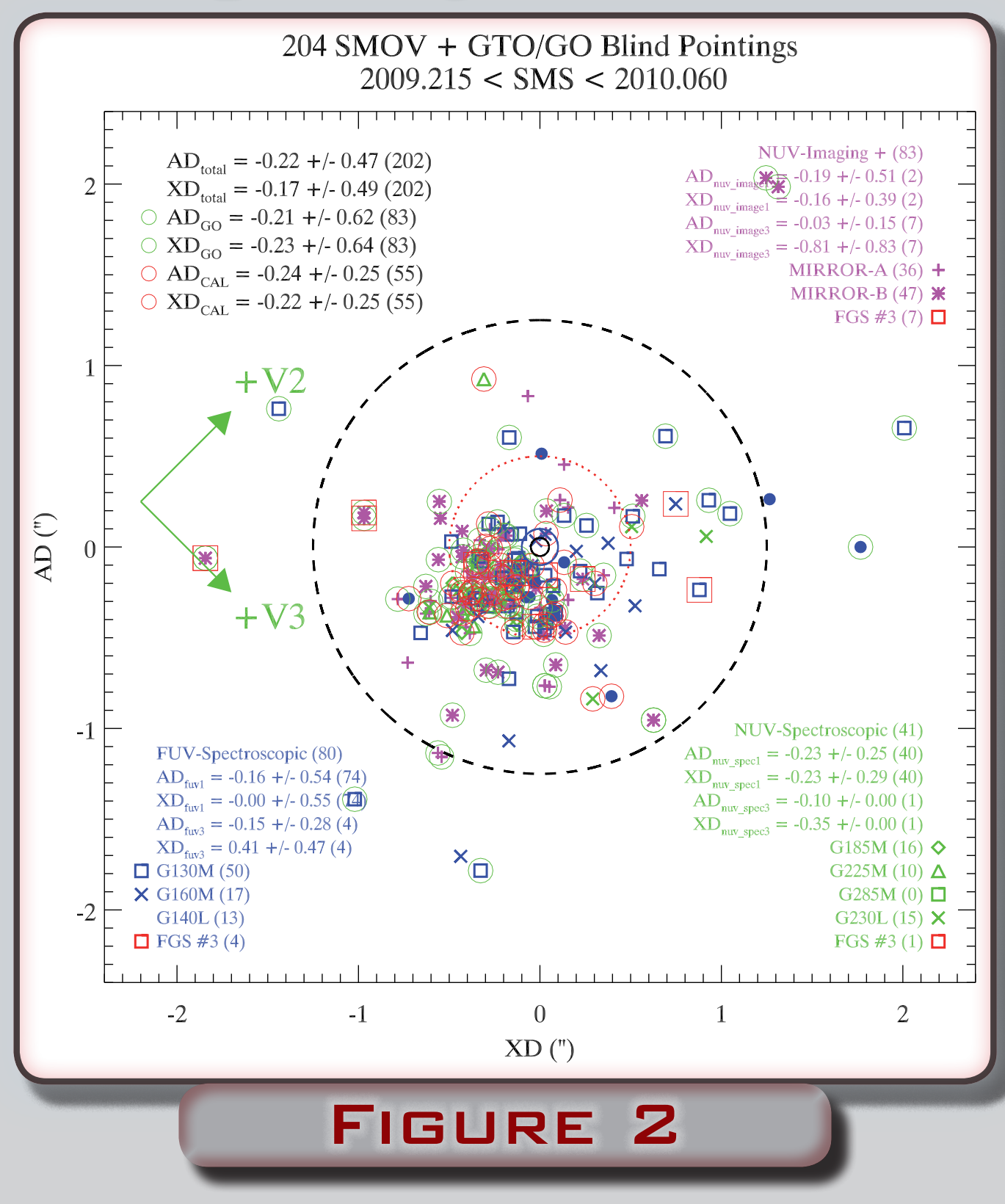

FIGURE 2

Fig. 3 shows blind-pointing results for TAs after the SIAF update. The pointings are distributed around the center of the aperture, suggesting that the FGS and COS are now wellaligned. *If this trend continues, STScI may relay the strong recommendation that all COS visits begin with an ACQ/SEARCH.*

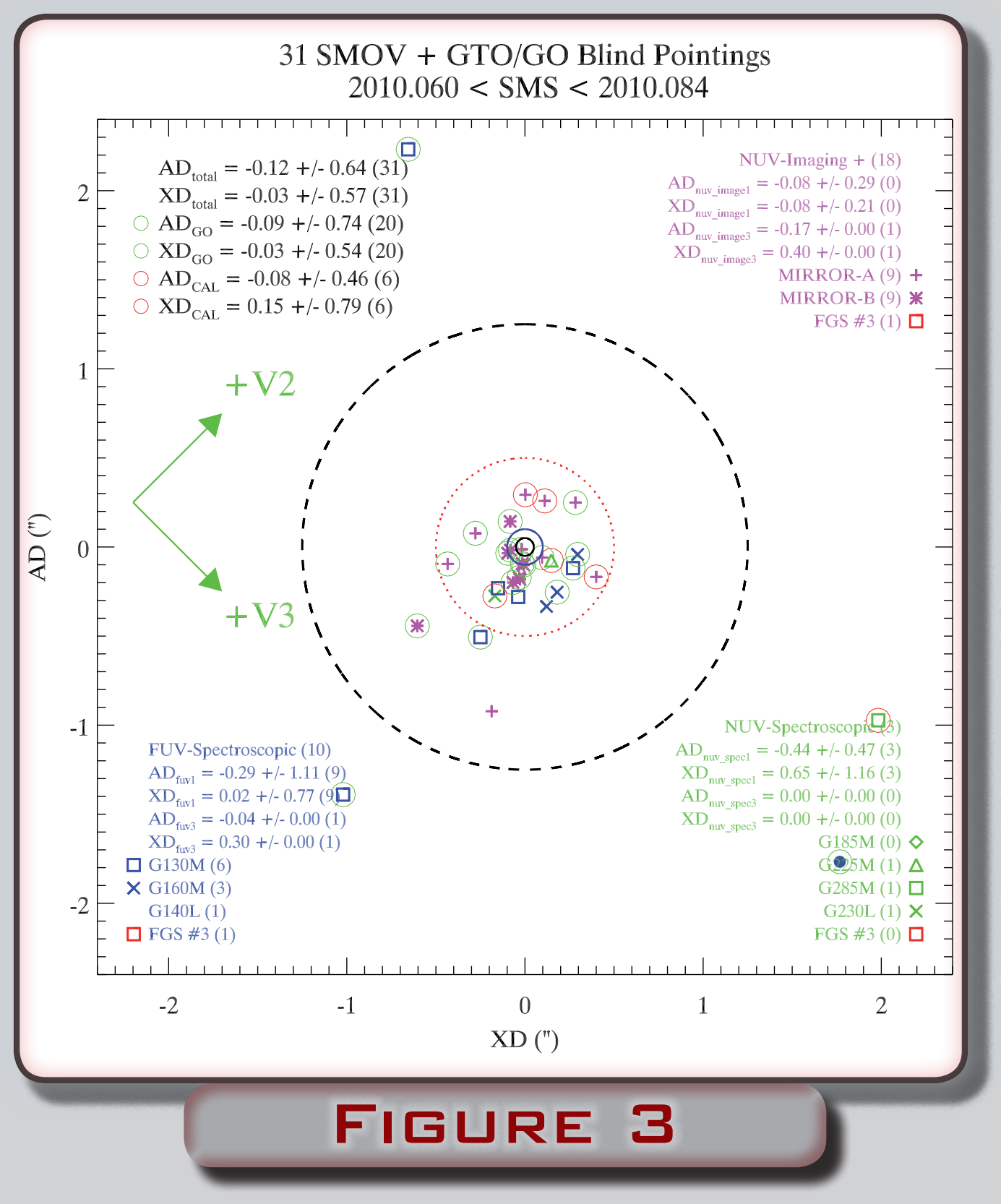

FIGURE 3

Fig. 4 shows the final slew due to the target acquisition procedure. Lines show the commanded centerings. The right panel shows the final centerings, compared to the TA requirements.

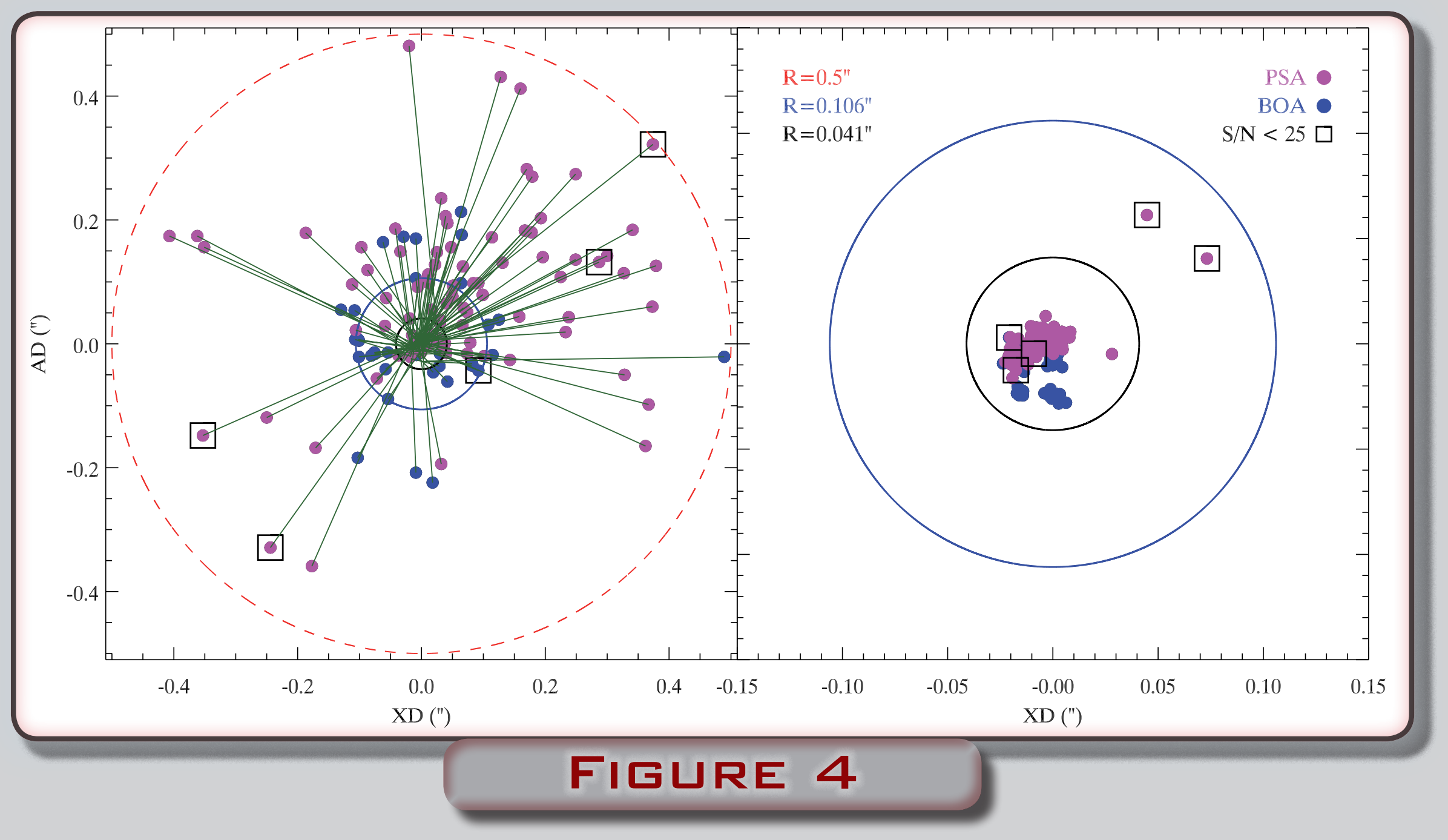

FIGURE 4

NUV DARK RATE

The COS NUV dark rate has been rising since SM4, doubling every ~200 days. The cause of the increase is not yet well understood, but it is possible that the increased dark rate is due to a window phosphorescence similar to that seen in the STIS NUV MAMA detector. The dark rate has been found to correlate with the detector temperature as shown in Figure 5.

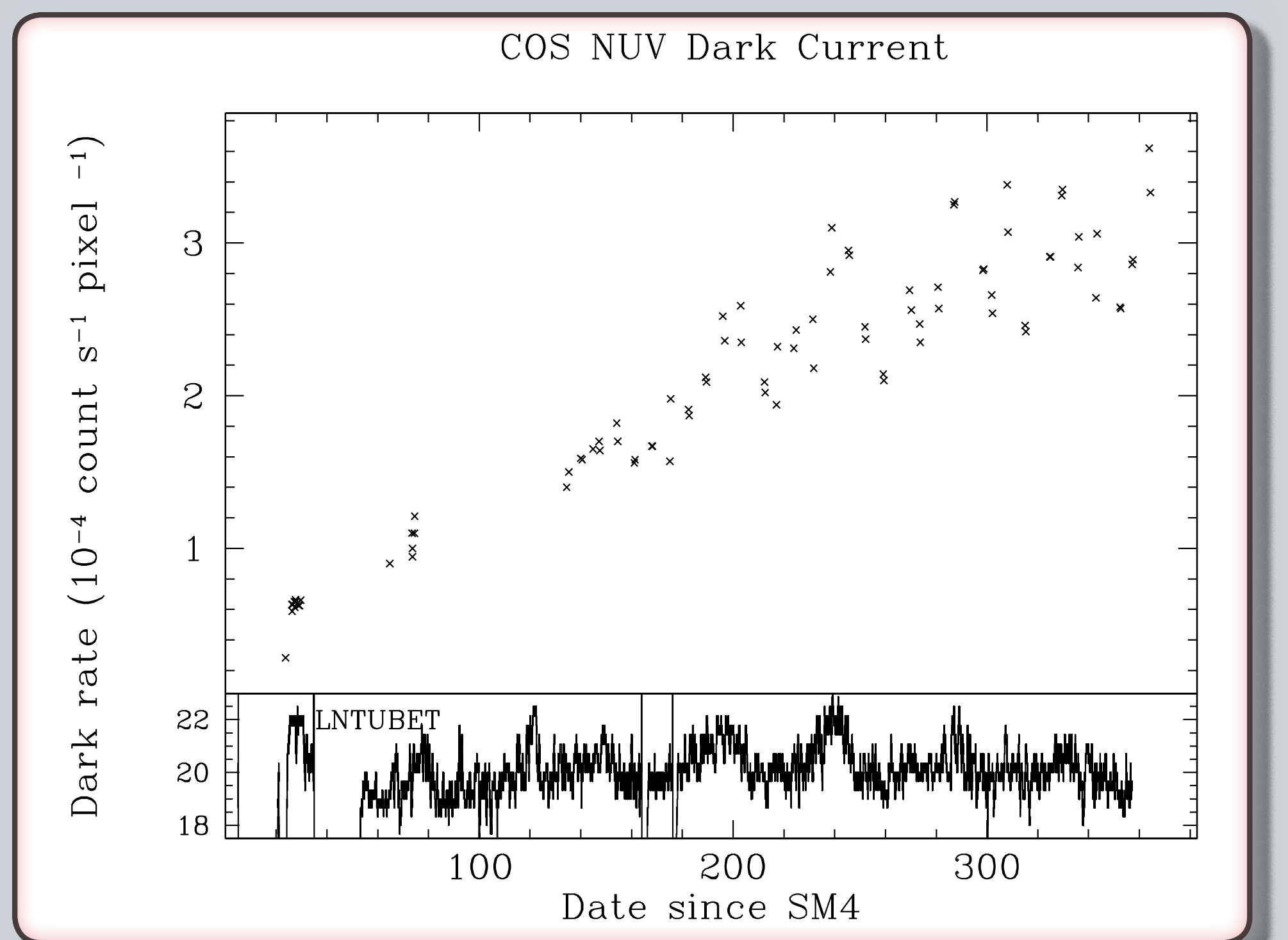

FIGURE 5

CYCLE 17 ACTIVITIES

Several calibration enhancements aimed at optimizing COS science have been implemented in the Cycle 17 calibration program that is currently underway. One of the major ongoing COS calibration activity is the monitoring of the instrument performance in the areas of dark current, flux and wavelength calibration, while supplemental activities have put special emphasis on observations that will improve our understanding of the FUV channel throughput below 1150Å, observations in two new G130M settings extending FUV coverage down to 900Å at higher resolution, observations to characterize the Geocoronal Lyman-alpha emission, observations to improve the flat field correction for the FUV detector, checks on the zero point of the wavelength scale for a number of settings, and re-determination of the best focus position for the G140L grating. Most of these calibration programs will be executed during the Summer 2010. It is anticipated that one-dimensional flat field corrections for FUV observations will be fully implemented into CalCOS once the on-orbit data from the Cycle 17 calibration has been fully analyzed (late 2010).