COR-1B Vacuum Recalibration, May 2005

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The SECCHI-B SCIP bench, with the COR-1B instrument, was installed in the NRL A13 vacuum tunnel, for a final recheck and calibration before thermal vacuum testing, and subsequent delivery to APL for integration into the STEREO-B spacecraft. The primary objective of this test was to confirm that the instrument performance—particularly the stray light properties—still met requirements. Thus, instead of the week-long testing that had been initially performed in November 2004, these tests were performed in a single day. In addition, these tests allowed the performance of the flight Camera Electronics Box (CEB) to be established.

1 Stray light

Stray light is measured by illuminating an aperture at the far end of the vacuum chamber with a bright Xenon arc source. Two different photometers were used to measure the brightness of the light reaching the instrument, a white-light photometer, and a Gamma Scientific photometer with a spare flight bandpass filter. The white light telephotometer reading, off of a 45° Macbeth Plaque, was 200 foot-lamberts, which corresponds to 0.016 $B/B_\odot$. The Gamma Scientific photometer reading was 0.6 W/m^2, which works out to a slightly higher 0.018 $B/B_\odot$. The previous COR-1B calibration used the Gamma Scientific reading, and the same will be done here.

The results are shown in Figure 1. To within the limits we can measure, there is no significant difference in the scattered light performance between November 2004 and May 2005. There is a slight difference in overall brightness, as shown in Figure 2, but that is attributable to the uncertainty in the relative calibrations between the two data sets.

Because one of the motors in the vacuum tank was not working properly during the May 2005 tests, the alignment may not be quite as good as in November 2004. This is not expected to have a large effect on the overall scattered light, but may affect the small circular or arc-shaped features which had been previously determined to be from the front surface of the field lens. Indeed, these small features show considerable difference in brightness, though not in position, between the two measurements. The brightest spot in the November 2004 measurements was 1.4×10^{-6} $B/B_\odot$; in the May 2005 measurements, the maximum (from the same spot) was 2.6×10^{-6} $B/B_\odot$, which is still below the requirement of 3×10^{-6} $B/B_\odot$. Since the brightness of these small features is sensitive to alignment, one cannot conclude that the instrument performance has changed.

2 Resolution

Focus was tested by projecting an Air Force Target (AFT) onto the instrument (Figure 3. Details can be seen down to the full-resolution Nyquist frequency. As before, we measured the contrast

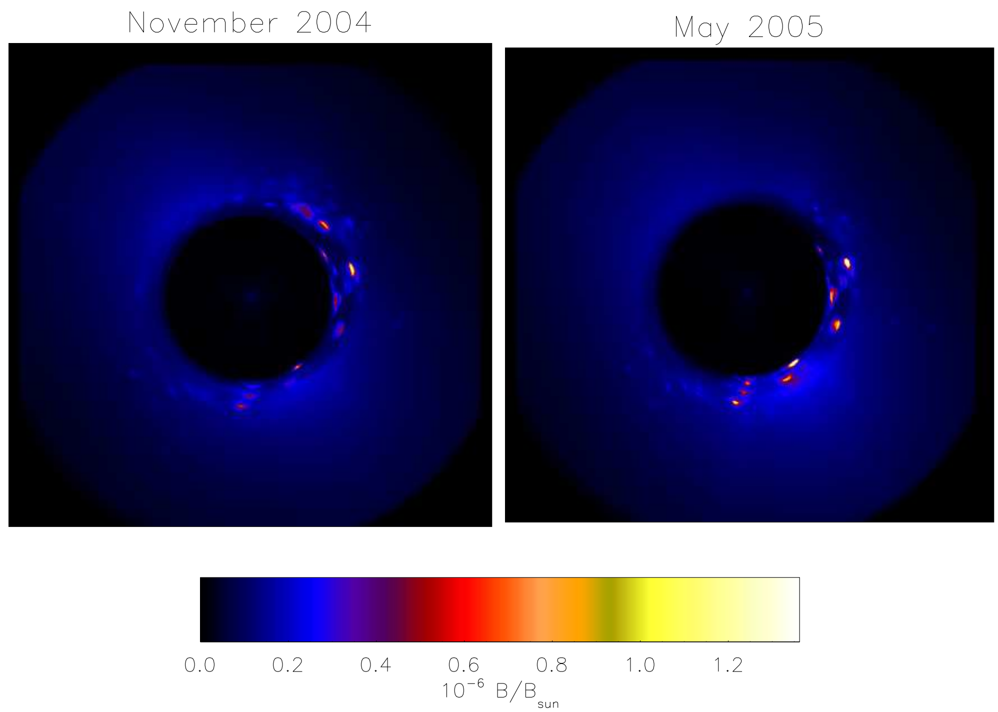

Figure 1: Comparison of the scattered light patterns from the November 2004 and May 2005 measurements.

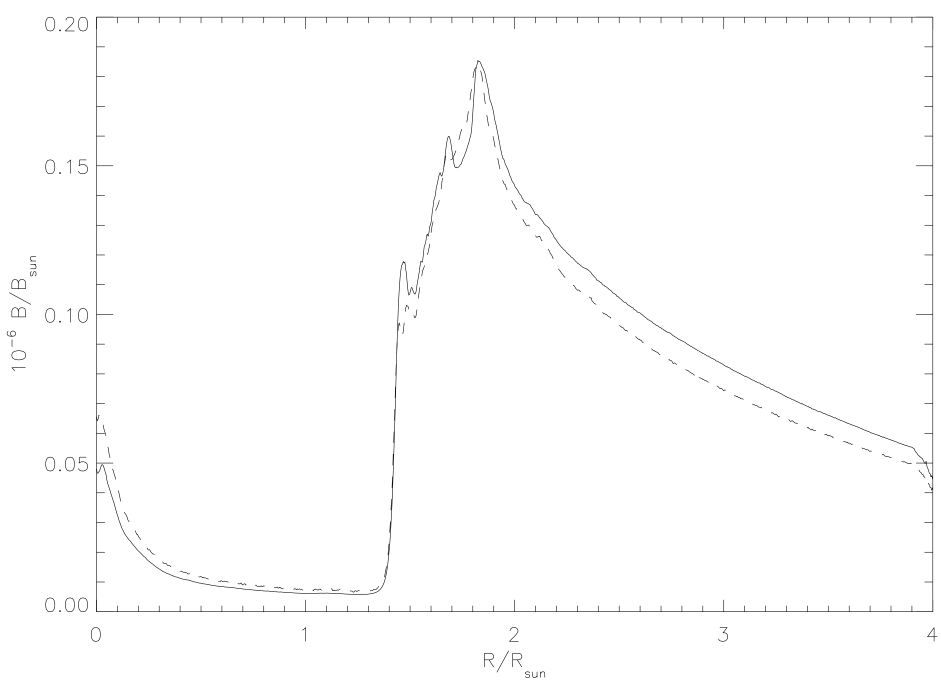

Figure 2: Average radial profiles of the data from Figure 1. Solid: May 2005, dashed: November 2004.

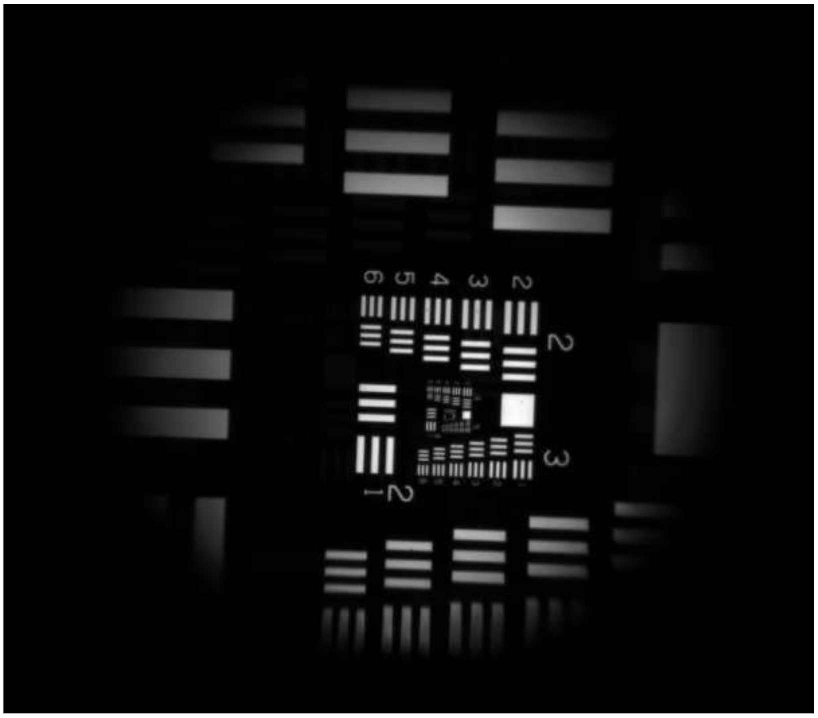

Figure 3: Air Force 1951 resolution test target image.

for group 3-6, whose bars are 1.5 pixels wide. The contrast was ≥0.50 for the horizontal bars, and ≥0.45 for the vertical bars, which compares well with previous measurements.

One can also use the AFT images to test the movement of the image on the detector as the polarizer is rotated. By cross-correlating images taken at polarization angles 120° apart, one can determine that each image is 0.187 ± 0.020 pixels off from the average image. This agrees well with the ∼0.29 pixels measured during final assembly.

3 Polarization response

Figure 4 shows the instrument response to polarized light as a function of hollow core motor (HCM) position. The results are consistent with 100% polarization. This shows that the HCM is stepping correctly. In this plot, the zero angle position is defined as HCM step #0, which was determined from the previous tests. The orientation of the incoming polarized light was uncontrolled.

4 Photon curve

Figure 5 shows the response of the instrument to light as a function of exposure time. These measurements were made with the calibration lamp illuminating a series of diffusers. The 16 second image was used to calculate a relative exposure time for each pixel, compared to the brightest pixels. This exposure correction factor was then applied to measurements taken at exposure times running from 1 to 24 seconds. The response is linear up to ∼14000 DN, after which the detector starts to

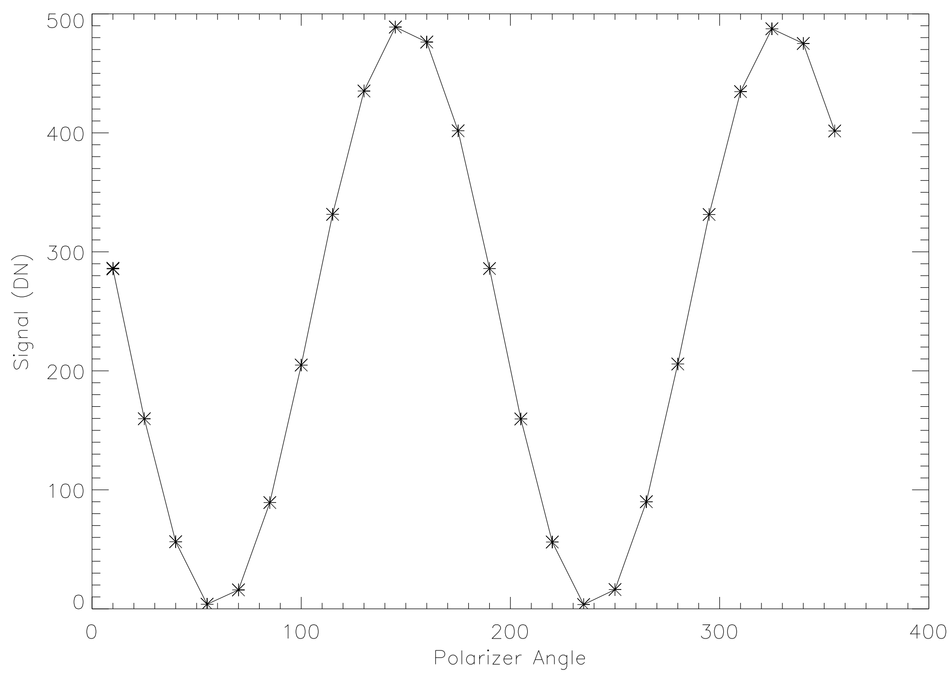

Figure 4: Instrumental response to polarized light.

saturate.

5 Photometric calibration

The photometric calibration of the instrument was measured by illuminating the aperture at the end of the tank with a diffuse unpolarized light source of known intensity. The resulting illumination pattern on the detector is shown in Figure 6. Because the aperture is not in focus, the brightness decreases linearly around the edge of the image. There's also a slight $\sim$5% asymmetry, mostly left-to-right, which is probably due to the lamp.

The response was measured by taking the average in the center of the pattern, where the image is unvignetted. The average response was 56.74 ± 0.57 DN/sec. Since the lightbox had a brightness of $6.75 \times 10^{-9} B/B_\odot$, this means that the photometric calibration of the instrument is $1.19 \times 10^{-10} B_\odot$/DN, which agrees well with the value of 1.09×10^{-10} measured during the original calibration.

Note that these numbers are based on the average signal at the detector. Because the internal polarizer only allows one state of polarization through, and thus cuts unpolarized light in half, the calibration parameter to be applied to B or pB values derived by rotating the polarizer is $5.95 \times 10^{-11} B_\odot$/DN. (The data in Figure 1 are based on the original calibration—if the most recent calibration is used, then both the November 2004 and May 2005 data would be raised by $\sim$9%, and the relative comparison between them would remain unchanged.)

The lightbox was found to have a slight polarization of 1.35 ± 0.18 percent.

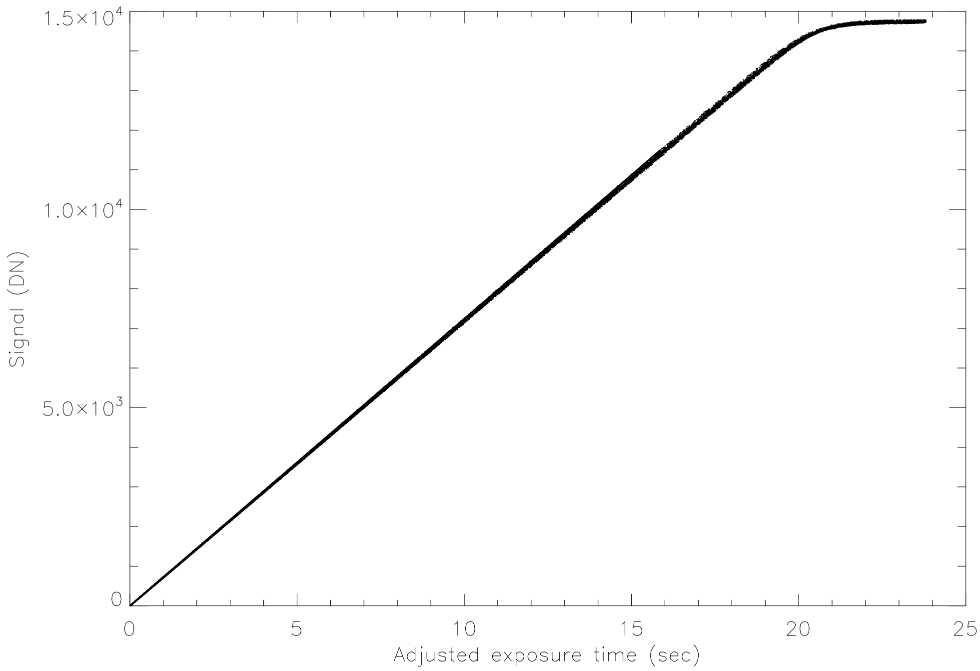

Figure 5: Instrumental response as a function of adjusted exposure time.

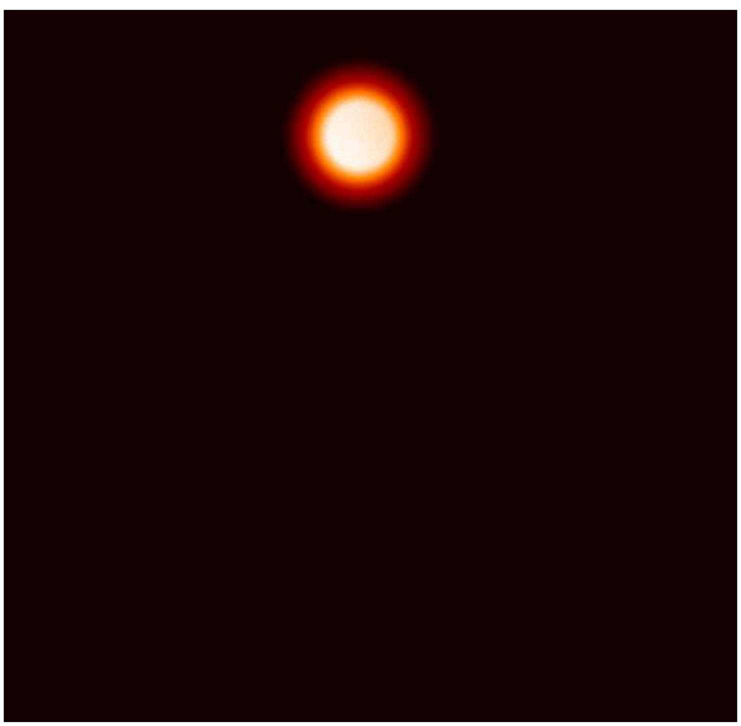

Figure 6: Image of the test aperture at the end of the vacuum tank.

6 Conclusions

The performance of the COR-1B instrument has not changed since it was delivered in November 2004.