Report Title WISE Non-Uniformity Correction	**Document Number** SDL/09-161b
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1. NON-UNIFORMITY CORRECTION

The response of WISE to the MIC2 extended source at various temperatures was measured during testing over the period November 4-20, 2008 as part of the MIC2 Test 1 instrument characterization.

The response to the uniform radiance extended source was measured using the "Flat Field and Absolute Response Test Procedure" (SDL/07-581). Table 1 shows the range of extended source temperatures over which useful data were acquired for each of the four WISE bands, the mean response in each band (as reported in as-run log sheets), and the associated filenames.

The Band 4 data were re-acquired (files RSP0041-RSP0045) after excessive noise in one of the Band 4 quadrants was eliminated [SDL NCR #2210].

Note: *this report addresses non-uniformity correction, not absolute responsivity – the temperatures and responses shown below are approximate (hand-written in the as-run log sheets), and should not be used to determine absolute responsivity*.

The MIC2 extended source was placed directly in front of the output port of MIC2 to which WISE is attached. WISE should see only the extended source in this configuration, and any additional input flux is due to light leaks either around the extended source, or in the interface between MIC2 and WISE. Only data for which the WISE response was well above the dark offset level and well below the onset of saturation were used to generate the non-uniformity corrections detailed below (utilized data are highlighted in blue in Table 1).

The as-run procedures are located in the file \\hera\wise_mic2\MIC2_Test_1\ WISE on MIC test 1.pdf.

Table 1 Data Used to Derive Non-Uniformity Correction

Ext. Source Temp. (K)	B1 (DN)	B2 (DN)	B3 (DN)	B4 (DN)	Filename
13.2	123	121	260	285	RSP0001
32.85				596	RSP0002
36.91				2500	RSP0003
39			274	5420	RSP0004
41.07			299	10800	RSP0005
42.38			311	15600	RSP0006
43.52			343	21700	RSP0007
51.82			**2330**		RSP0017
54.84			**5660**		RSP0018
56.58	124	126	**9200**		RSP0019
58.43			**14900**		RSP0020
60.53			24600		RSP0021
118.6		331			RSP0027
130.6		**2070**			RSP0028
137	134	**5500**			RSP0029
141.34	154	**9900**			RSP0030
145.6	170	**16100**			RSP0031
146.7	180	17500			RSP0032
158.8	550				RSP0033
169.5	**2120**				RSP0034
177.6	**5600**				RSP0035
173-183	**10900**				RSP0036
176.2	**4780**				RSP0037
185.9	**14000**				RSP0038
187.1	**15900**				RSP0039
188	17100				RSP0040
14.9				285	RSP0041
35.58				**1600**	RSP0042
39.48				**6560**	RSP0043
41.17				**11250**	RSP0044
42.88				**18280**	RSP0045
43.5				**21400**	RSP0046

Note: The highlighted data are those considered in the analysis. All temperatures and responses listed here are approximate (hand written on the as-run log sheet).

The mean pixel response value, $\eta_k(m)$, for pixel *k* and test *m* was determined using

$$\eta_k(m) = \frac{1}{N}\sum_{n \in N} r_k(m,n) \qquad (1)$$

where *N* is the number of frames (i.e. individual sample-up-the-ramp images) collected during test *m* (particular extended source temperature), and *n* indexes an individual frame. The mean pixel background response, $\eta_{Bkgd,k}$, for pixel *k* was determined as specified in the System Engineering Report on dark offset and repeatability (SDL/09-092).

The darkfields used here can be found in \\hera\wise_mic2\Processed WISE data\MIC2 Test 1\Darkfields\.

The linearity and background corrected pixel response for pixel *k* and test *m*, is then

$$r_{C,k}(m) = F_{Lin,k}(\eta_k(m) - \eta_{Bkgd,k}) \qquad (2)$$

where $F_{Lin,k}$ is the nonlinearity correction function (unitless).

The nonlinearity correction for each pixel is applied using \\hera\wise_mic2\Analysis\JGC\NUC\wise_nonlincor.pro.

The nonuniformity correction (NUC) coefficient for each pixel and test *m* was then calculated using Equation (3):

$$F_{FF,k}(m) = \frac{r_{C,k}(m)}{\eta_{arr,median}(m)} \qquad (3)$$

where $\eta_{arr,median}(m)$ is the array response median of $r_{C,k}(m)$ for *nominal* pixels (as specified by the WISE bad pixel maps in \\hera\wise_mic2\Processed WISE data\Masks\).

The mean pixel NUC value for the set of extended source measurements specified in Table 1 for each band was determined using Equation (4):

$$F_{FF,k} = \frac{1}{M}\sum_{m} F_{FF,k}(m) \qquad (4)$$

The nonunifomity correction matrices, $F_{FF,k}$, are located in \\hera\wise_mic2\Processed WISE data\MIC2 Test 1\NUC\. The files are NUC_B1.deb, NUC_B2.deb, NUC_B3_v2.deb and NUC_B4_v2.deb. Note that the median value of this mean pixel NUC for nominal pixels is very slightly different from 1.00000. The matrices are shown as images in Figures 1-4.

For each WISE band, a histogram was generated to display the distribution of NUC coefficients for all nominal pixels (as specified by the WISE bad pixel maps in \\hera\wise_mic2\Processed WISE data\Masks\). These histograms are shown in Figures 5-8. The cumulative fraction of pixels falling below a given bin of the histogram is shown in the dashed curve (and right-hand y axis). The array mean and median (for nominal pixels) is also shown on each histogram.

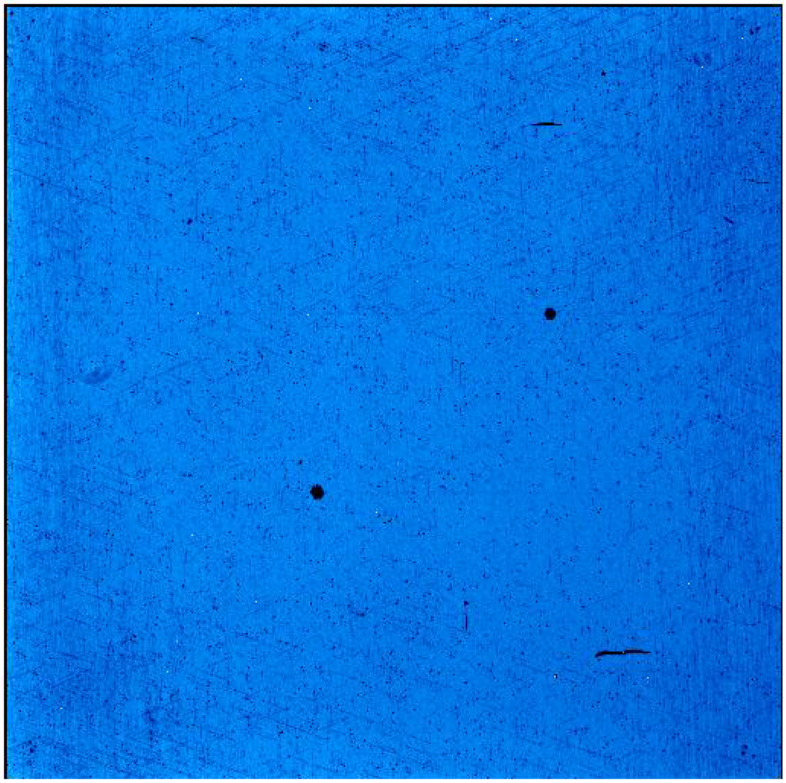

Figure 1 Band 1 Flat Field

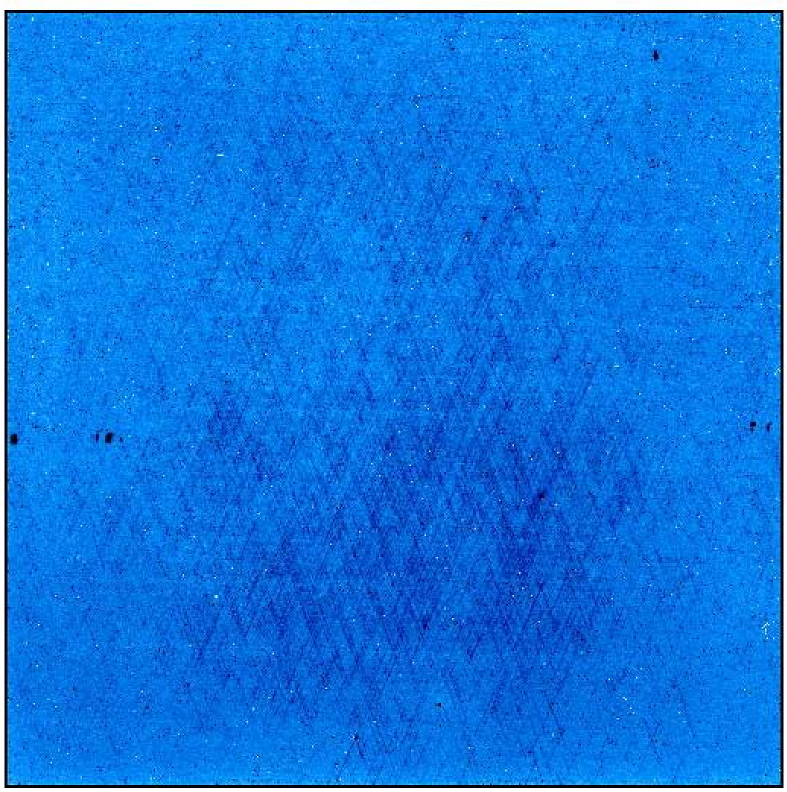

Figure 2 Band 2 Flat Field

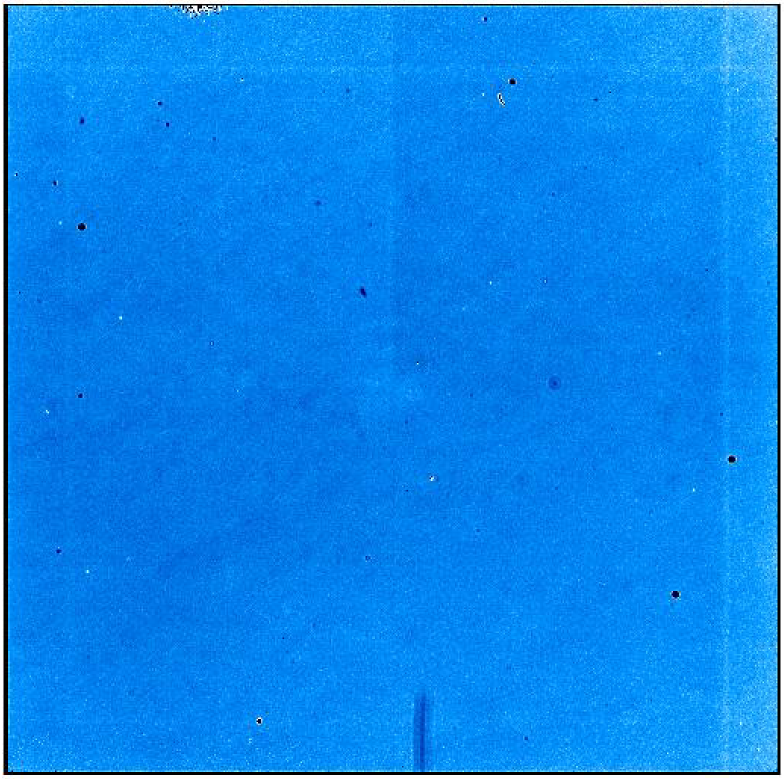

Figure 3 Band 3 Flat Field

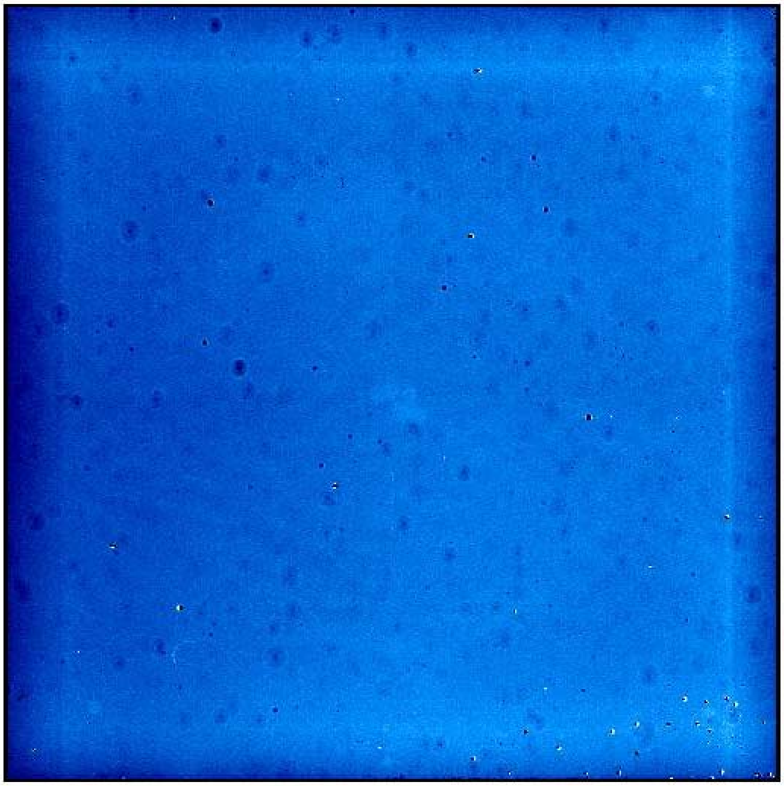

Figure 4 Band 4 Flat Field

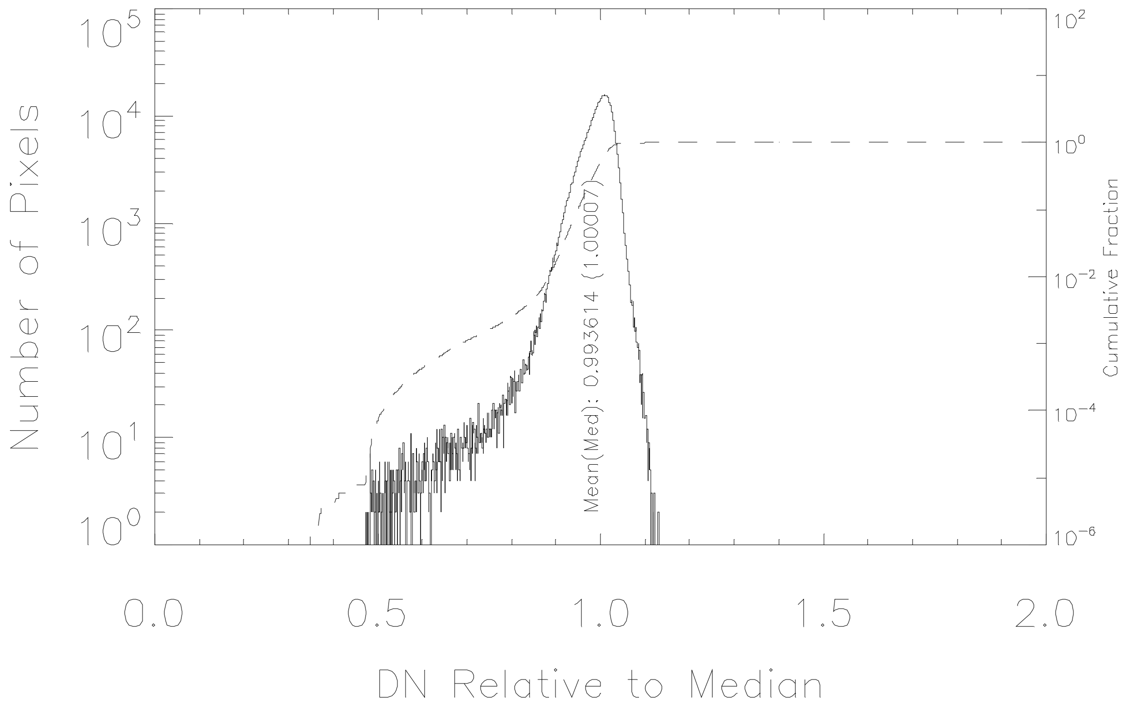

Figure 5 Band 1 Non-Uniformity Correction Coefficient Histogram

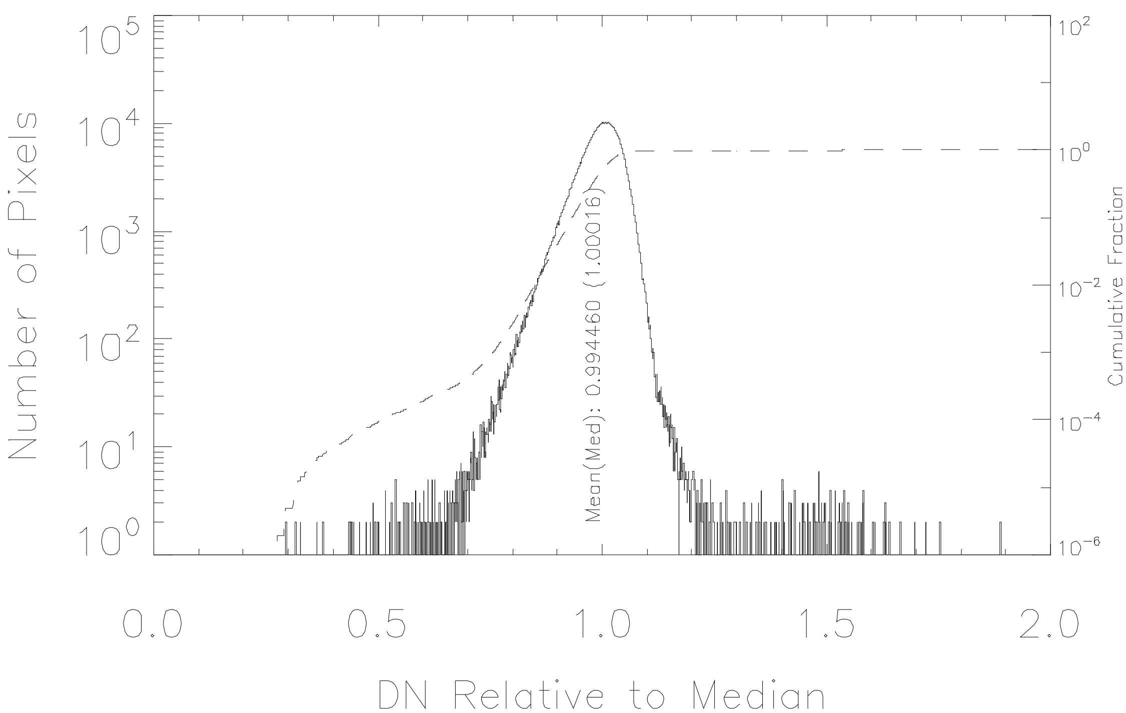

Figure 6 Band 2 Non-Uniformity Correction Coefficient Histogram

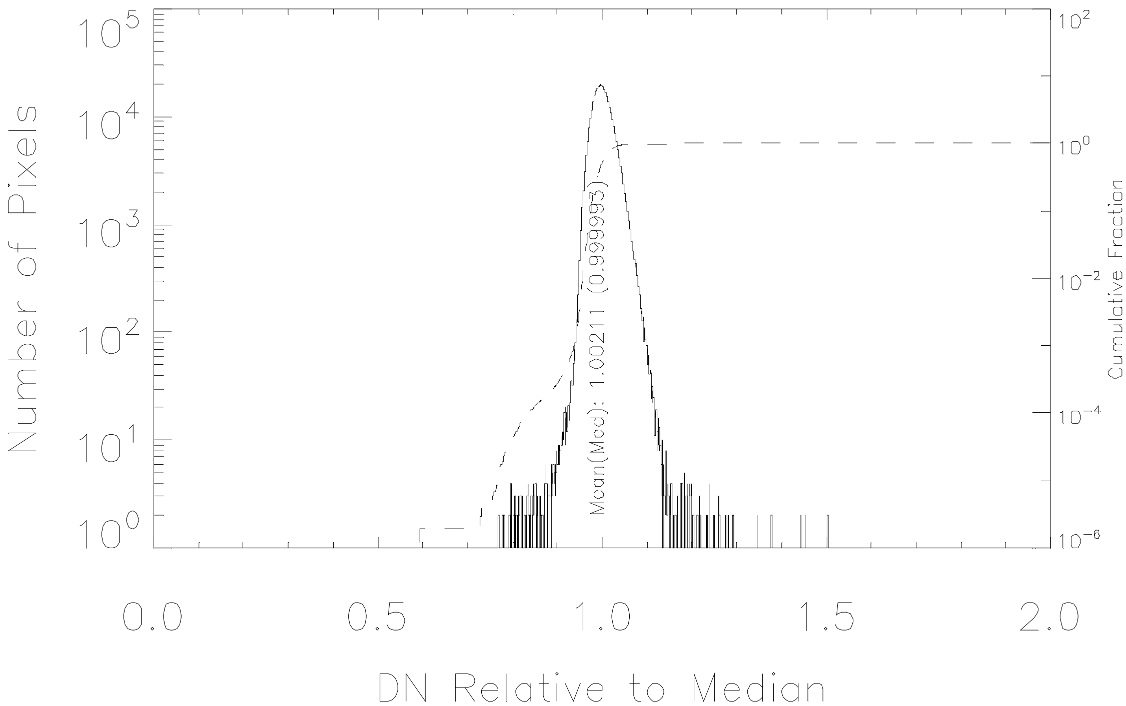

Figure 7 Band 3 Non-Uniformity Correction Coefficient Histogram

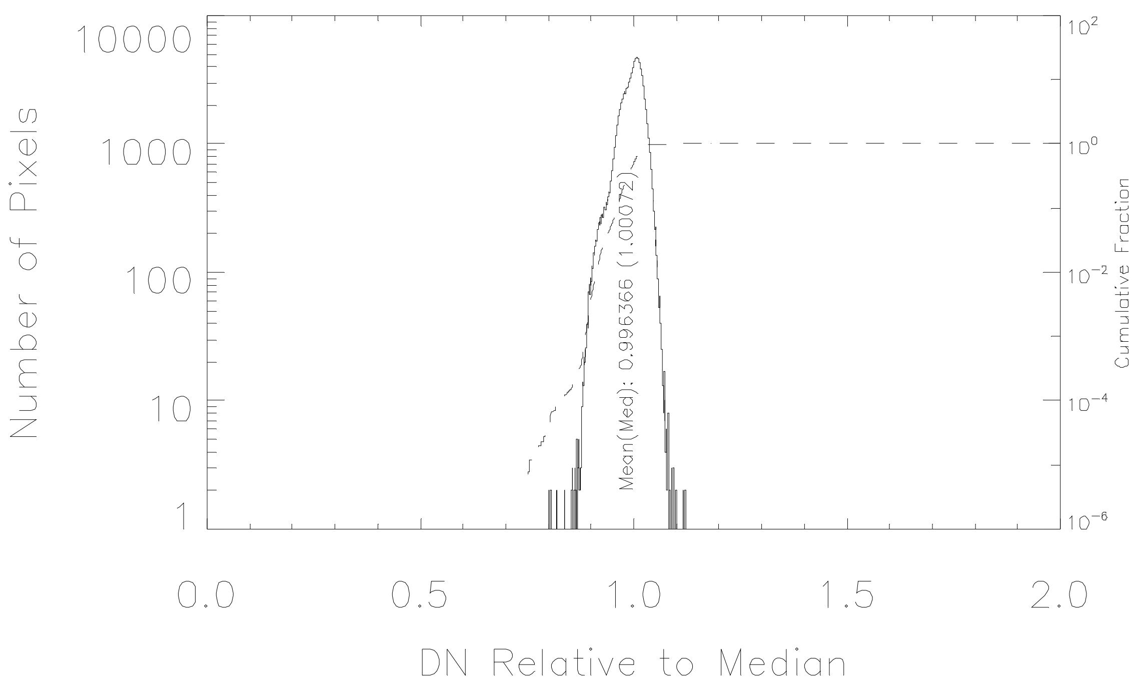

Figure 8 Band 4 Non-Uniformity Correction Coefficient Histogram

2. POST-ENVIRONMETAL FLATFIELDS

A new set of flatfields was acquired post-environmental using EM electronics (the pre-environmental flatfields were acquired using flight electronics). The primary reason for acquiring a new set was to avoid the semi-permanent latents that were present in the band 3 and band 4 flats pre-environmental.

At the time the flats discussed in Section 1 above were acquired, a grid of latents was observed that persisted after the preceding focus and scanner pointing measurements – these semi-permanent latents could not be annealed away, unlike the normal latents induced when a bright source is incident on the arrays for a relatively short time. After environmental testing, flatfields were acquired prior to any point source testing, leading to latent-free flats. The data set is summarized in Table 2.

Table 2. Post-environmental flatfield data set

Ext. Source Temp. (K)	B1 (DN)	B2 (DN)	B3 (DN)	B4 (DN)	Filename
13.8				0	RSP0047
39.5				6400	RSP0048
41.92				13800	RSP0049
41.92				13600	RSP0050
42.97				18500	RSP0051
43.41			330	20400	RSP0052
54.67			5500		RSP0058
56.97			10600		RSP0059
58.73			16600		RSP0060
60.27			23800		RSP0061
135.88		4720			RSP0067
141.11		9620			RSP0068
143.06		12150			RSP0069
144.62		14290			RSP0071
177.8	5820				RSP0073
181.64	9000				RSP0074
184.22	11930				RSP0075
186.52	15080				RSP0076
186.52	15030				RSP0077

Reading directly from Tables 1 and 2 (temperatures and responses copied directly from the as-run logsheets), a quick comparison of pre- and post-environmental response is shown in Figure 9. Note that these quicklook response values have not been linearity corrected, background subtracted, or limited to good pixels. Nonetheless, clearly **the response did not change appreciably due to environmental testing.**

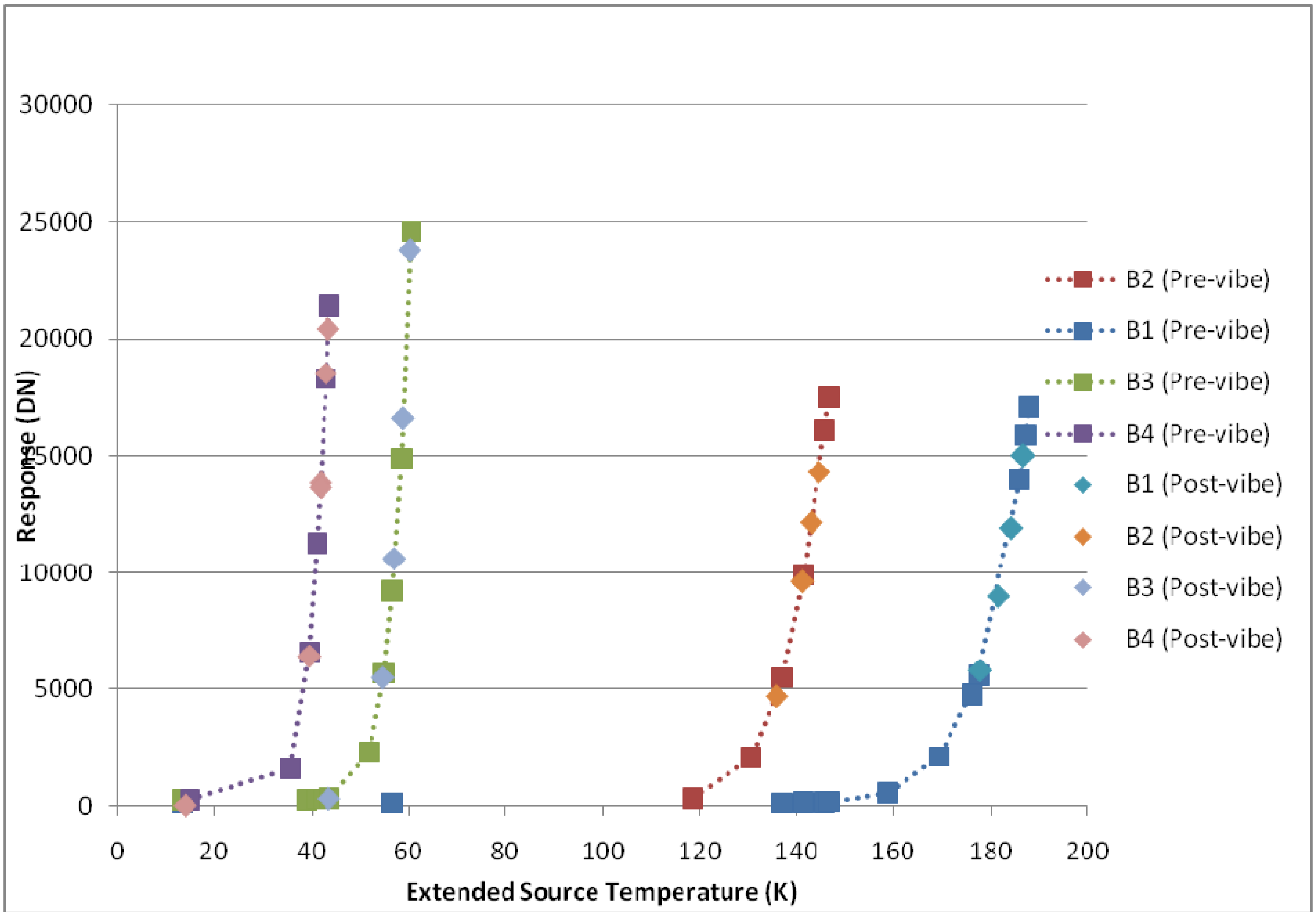

Figure 9: Quicklook comparison of pre- and post-environmental extended source response

3. CHANGE RECORD

Rev	Date	Description	Changed By
–	3/19/2009	Original Release	–
A	3/23/2009	Added Proprietary Markings	JDrake
B	5/11/2009	Added section 2: Post Environmental Flatfields.	JCardon