

Proposal for LENA Image Distortion Recovery

Based on the plots that Michael Johnson and Dennis Chorney showed at the LENA telecon yesterday, I propose the following procedure for recovering the images after they became distorted on 29 August 2000. The plots shown may be interpreted as indicating that the A111 preamplifier outputs have been modified such that if x_1 and x_2 are the original output

$$x'_1 = ax_1 \quad \text{and} \quad x'_2 = bx_2, \quad (1)$$

where x'_1 and x'_2 are the output following 29 August 2000.

Thus, the undistorted ratio, R , is

$$R = \frac{x_1}{x_1 + x_2} = \frac{1}{1 + x_2/x_1}. \quad (2)$$

Since $\frac{x'_1}{x'_2} = \frac{ax_1}{bx_2} \Rightarrow \frac{x_2}{x_1} = \frac{a}{b} \frac{x'_2}{x'_1}, \quad (3)$

$$R = \frac{1}{1 + \frac{a}{b} \frac{x'_2}{x'_1}}. \quad (4)$$

Following 29 August 2000, the distorted ratio R' is

$$R' = \frac{x'_1}{x'_1 + x'_2} = \frac{1}{1 + x'_2/x'_1}. \quad (5)$$

Thus, $1 + \frac{x'_2}{x'_1} = \frac{1}{R'} \Rightarrow \frac{x'_2}{x'_1} = \frac{1}{R'} - 1. \quad (6)$

or, using (4) above $R = \frac{1}{1 + \frac{a}{b} (\frac{1}{R'} - 1)} = \frac{b}{(b-a) + a/R'}, \quad (7)$

or $\boxed{R = \frac{bR'}{a + (b-a)R'}}. \quad (8)$

Using the plot from yesterday, the coefficients a and b may be estimated as

$$a = 0.33 \quad b = 2.0 \quad (9)$$

So that $R = \frac{2.0R'}{0.33 + 1.67R'}. \quad (10)$

Equivalently, $R' = \frac{0.33R}{2.0 - 1.67R}. \quad (11)$

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Dividing the interval $[0, 1]$ up into 12 equally spaced polar bins, we can specify the mapping using (10) and (11) of the distorted bins (\mathcal{R}') to the undistorted bins (\mathcal{R}). In many cases, this will involve mapping a single count from a distorted bin into a fractional count in many undistorted bins:

Polar Bin 0: $\mathcal{R}' = 0.000 - 0.083$

New Polar Bin:	0	1	2	3	4
	0.000-0.014	0.015-0.031	0.032-0.051	0.052-0.076	0.077-0.083
	0.175	0.205	0.241	0.301	0.078

In other words, the distorted ratio 0.000-0.014 maps into the undistorted polar bin 0 (0.000-0.083), the distorted ratio 0.015-0.031 maps into the undistorted polar bin 1 (0.084-0.166), etc. Consequently, every count in distorted bin 0 becomes 0.175 counts in undistorted polar bin 0, 0.205 counts in undistorted polar bin 1, etc.

Polar Bin 1: $\mathcal{R}' = 0.084 - 0.166$

New Polar Bin:	4	5	6
	0.084-0.105	0.106-0.141	0.142-0.166
	0.262	0.439	0.299

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Polar Bin 2: $Q' = 0.167 - 0.249$

New Polar Bin: 6 7

0.167-0.186 0.187-0.249

0.238 0.762

Polar Bin 3: $Q' = 0.250 - 0.332$

New Polar Bin: 8

0.250-0.332

1.000

Polar Bin 4: $Q' = 0.333 - 0.416$

New Polar Bin: 9

0.333-0.416

1.000

Polar Bin 5: $Q' = 0.417 - 0.499$

New Polar Bin: 9 10

0.417-0.450 0.451-0.499

0.409 0.591

Polar Bin 6: $Q' = 0.500 - 0.582$

New Polar Bin: 10

0.500-0.582

1.000

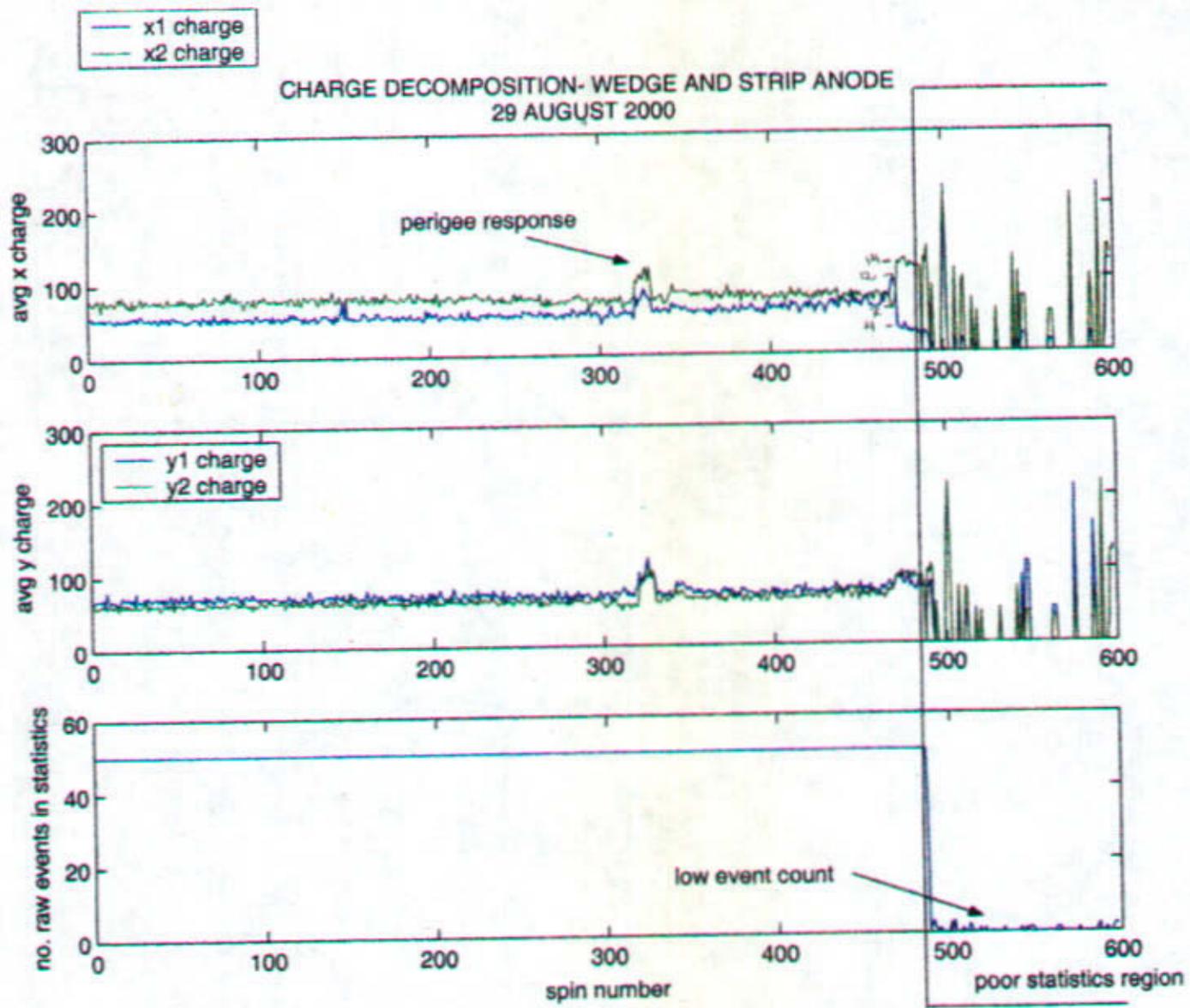
Polar Bin 7: $R' = 0.583 - 0.666$

New Polar Bin:	10	11
	0.583 - 0.645	0.646 - 0.666
	0.753	0.247

Polar Bins 8, 9, 10, 11: $R' = 0.667 - 1.000$

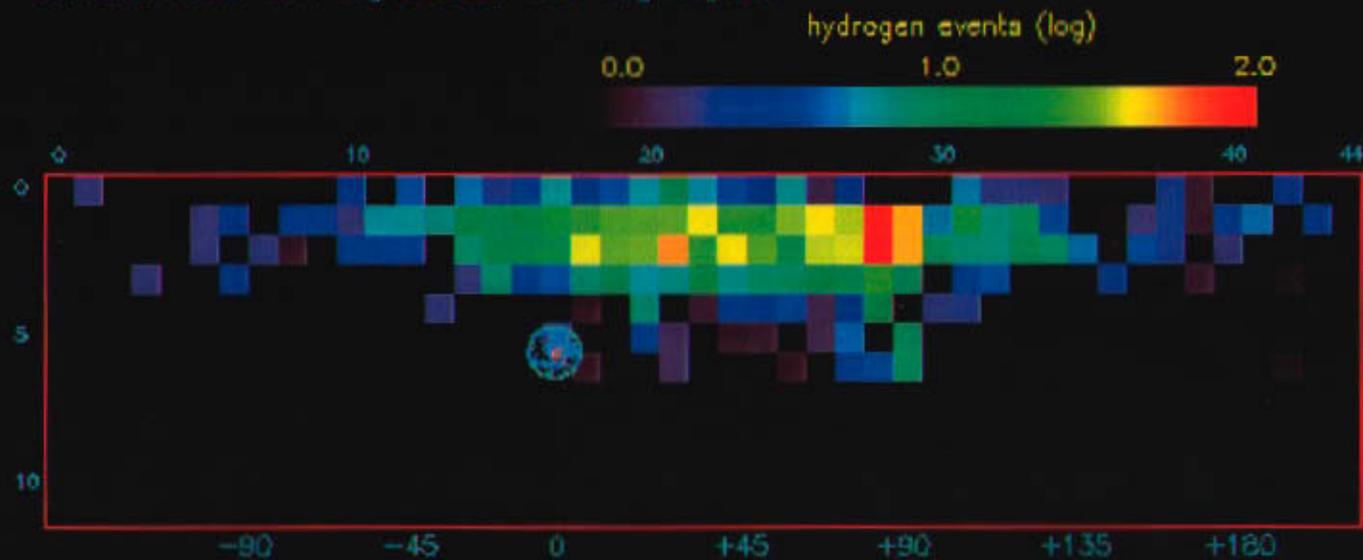
New Polar Bin:	11
	0.667 - 1.000
	1.000

The two attached images show examples of the original distorted image and the corrected product using the above algorithm.



IMAGE/LENA

90 04:50:08 --- 90 04:50:08 03/31/2001
8.1 Earth radii; 85.0 deg latitude, 103.1 deg longitude

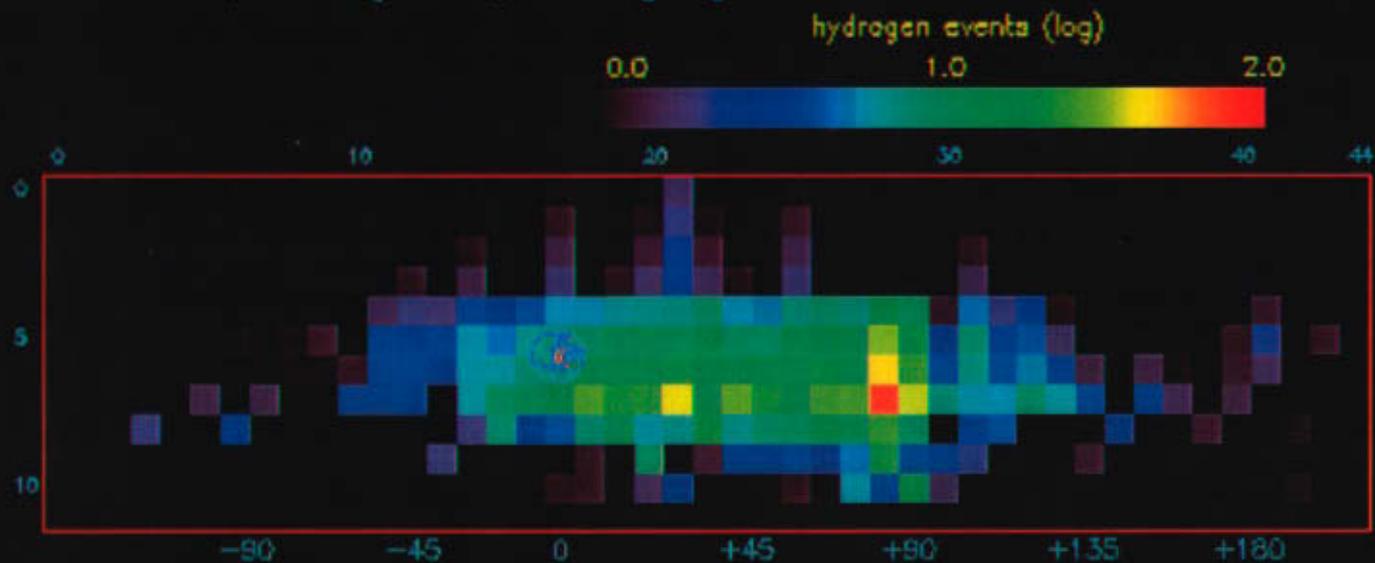


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plot created: Tue Dec 4 18:25:45 2001

IMAGE/LENA

90 04:50:08 — 90 04:50:08 03/31/2001
8.1 Earth radii; 85.0 deg latitude, 103.1 deg longitude



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plot created: Tue Dec 4 18:11:06 2001