Note on Position Sensitivity of the Sum Signal from a Main Injector BPM

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This note describes the relationship between the beam position and the sum signal from the standard Main Injector BPM (photo above). Data used in this analysis are from September 1996 BPM test stand measurements of MI BPM serial number #1006, randomly selected from the ~250 BPMs that were measured.

The test stand measurement scanned a stretched wire stimulated at 53MHz across the aperture of the BPM between ±25 mm horizontally and ±15 mm vertically in 5 mm steps while recording the electrode signals.

The sum of the signals from the four electrodes was computed and normalized to the value at the BPM center. The result is plotted in Figure 1. The magnitude of the sum signal is seen to vary by over 50% in the range scanned.

A 6^{th} order polynomial makes a reasonable fit, i.e. errors at ~ 4% level, to this surface. The coefficients are shown in Table 1. The first column of I gives the power of the x term of each monomial corresponding to the power of the y term given in the second column. The rows of I and coeffs correspond. The model function is then:

$$\mathrm{sum}(x,y) := \sum_{i=0}^{\mathrm{last}(\mathrm{coeffs})} \left(\mathrm{coeffs}_i \cdot x^{I_{i,0}} \cdot y^{I_{i,1}} \right)$$

The difference between the normalized measured sum and the polynomial is plotted in Figure 2.

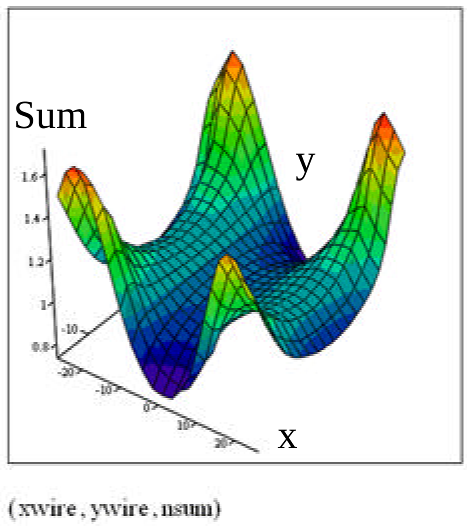

Figure 1. MI BPM normalized sum signal vs. position

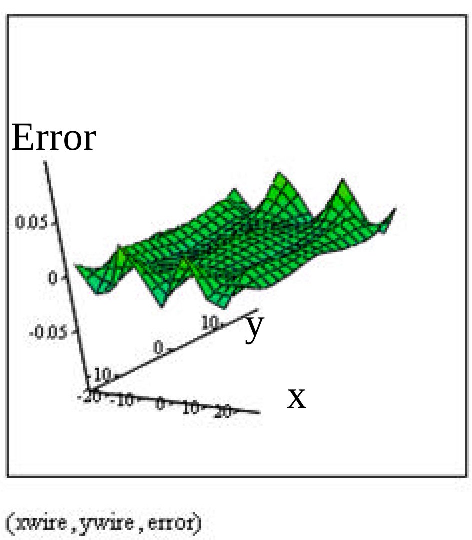

Figure 2. Difference between normalized sum and polynomial fit

I =

	0	1
0	1	5
1	0	6
2	0	5
3	0	4
4	1	4
5	2	4
6	0	3
7	1	3
8	2	3
9	3	3
10	0	2
11	1	2
12	2	2
13	3	2
14	4	2
15	0	1
16	1	1
17	2	1
18	3	1
19	4	1
20	5	1
21	0	0
22	1	0
23	2	0
24	3	0
25	4	0
26	5	0
27	6	0

coeffs =

	0
0	$8.631\cdot10^{-11}$
1	$4.679\cdot10^{-10}$
2	$3.372\cdot10^{-9}$
3	$-1.872\cdot10^{-6}$
4	$-1.632\cdot10^{-10}$
5	$1.143\cdot10^{-8}$
6	$-1.989\cdot10^{-6}$
7	$-1.667\cdot10^{-7}$
8	$7.74\cdot10^{-9}$
9	$4.942\cdot10^{-10}$
10	$-7.854\cdot10^{-4}$
11	$-5.524\cdot10^{-6}$
12	$1.321\cdot10^{-5}$
13	$1.048\cdot10^{-8}$
14	$-1.601\cdot10^{-8}$
15	$2.865\cdot10^{-4}$
16	$2.506\cdot10^{-5}$
17	$2.434\cdot10^{-6}$
18	$3.012\cdot10^{-7}$
19	$-3.381\cdot10^{-9}$
20	$-3.89\cdot10^{-10}$
21	1.007
22	$-3.986\cdot10^{-4}$
23	$4.993\cdot10^{-4}$
24	$7.242\cdot10^{-7}$
25	$-9.14\cdot10^{-7}$
26	$-3.157\cdot10^{-10}$
27	$-9.099\cdot10^{-11}$

Table 1. Polynomial coefficients (see text)