Fermilab Booster Magnets Sextupole Components

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time	Ekinet	SEXTS	SEXTL	measured chromaticity chrX	chrY	ssf	ssd	MAD calculated chromaticity chrX	chrY
msec	GeV					m^{-3}	m^{-3}		
Vertical chromaticity is measured at $dP/P < 0$									
1.3	0.4241	0.0	0.0	-10.6	-7.0	-0.0013	0.0005	-10.653856	-7.014106
3.5	0.5638	0.0	0.0	-11.8	-5.75	-0.0017	-0.0023	-11.550247	-5.744129
6.4	0.9674	0.0	0.0	-7.0	-5.0	0.0047	-0.0080	-6.717868	-4.976895
8.2	1.3469	0.0	0.0	-5.4	-11.6	0.0015	0.0106	-5.163965	-11.553786
11.6	2.3012	0.0	0.0	-2.3	-5.9	0.0098	-0.0088	-2.062360	-5.861498
20.6	5.4880	0.0	0.0	-1.45	3.8	0.0185	-0.0390	-1.387028	3.775474
25.5	6.9703	0.0	0.0	-2.7	4.0	0.0169	-0.0381	-2.464583	4.028357
29.5	7.7413	0.0	0.0	-3.9	4.4	0.0158	-0.0385	-3.647657	4.419051
Vertical chromaticity is measured at $dP/P > 0$									
1.3	0.4241	0.0	0.0	-10.6	8.5	0.0110	-0.0459	-10.644737	8.476492
3.5	0.5638	0.0	0.0	-11.8	8.75	0.0097	-0.0457	-11.590868	8.769252
6.4	0.9674	0.0	0.0	-7.0	7.25	0.0143	-0.0448	-6.737509	7.308808
8.2	1.3469	0.0	0.0	-5.4	6.0	0.0153	-0.0423	-5.134933	6.034780
11.6	2.3012	0.0	0.0	-2.3	4.0	0.0175	-0.0386	-2.092543	4.043066
20.6	5.4880	0.0	0.0	-1.45	3.8	0.0185	-0.0390	-1.387028	3.775474
25.5	6.9703	0.0	0.0	-2.7	4.0	0.0169	-0.0381	-2.464583	4.028357
29.5	7.7413	0.0	0.0	-3.9	4.4	0.0158	-0.0385	-3.647657	4.419051

Table 1: MAD calculated sextupole components of focusing and defocusing Booster magnets (ssf, ssd). Calculations are done based on measured chromaticities chrX and chrY (Ray Tomlin, August-September 2003). Data located in the last two columns are chromaticities calculated by MAD with found ssf and ssd.

time	Ekinet	B_{foc}	$B\rho$	$b2_{foc} \cdot 10^4$	$b2_{defoc} \cdot 10^4$	ssf	ssd
msec	GeV	T	$T \cdot m$			m^{-3}	m^{-3}
0.0	0.3644	0.0738	3.0145	-0.3	-6.6	-0.0023	-0.0426
7.0	1.0938	0.1472	6.0126	1.3	-6.1	0.0099	-0.0394
10.3	1.9237	0.2208	9.0189	2.05	-5.8	0.0156	-0.0374
13.0	2.7857	0.2943	12.0211	2.2	-5.75	0.0167	-0.0371
15.5	3.6635	0.3679	15.0274	2.4	-5.75	0.0182	-0.0371
18.0	4.5488	0.4415	18.0337	2.4	-5.5	0.0182	-0.0355
20.3	5.4363	0.5149	21.0318	2.4	-5.6	0.0182	-0.0361
23.0	6.3241	0.5881	24.0218	2.4	-5.75	0.0182	-0.0371
26.5	7.1663	0.6574	26.8524	2.3	-5.8	0.0175	-0.0374
33.3	8.0000	0.7259	29.6504	2.2	-6.0	0.0167	-0.0387

Table 2: Measured sextupole components of the Booster focusing and defocusing magnets (Joe DiMarco, August 2003).

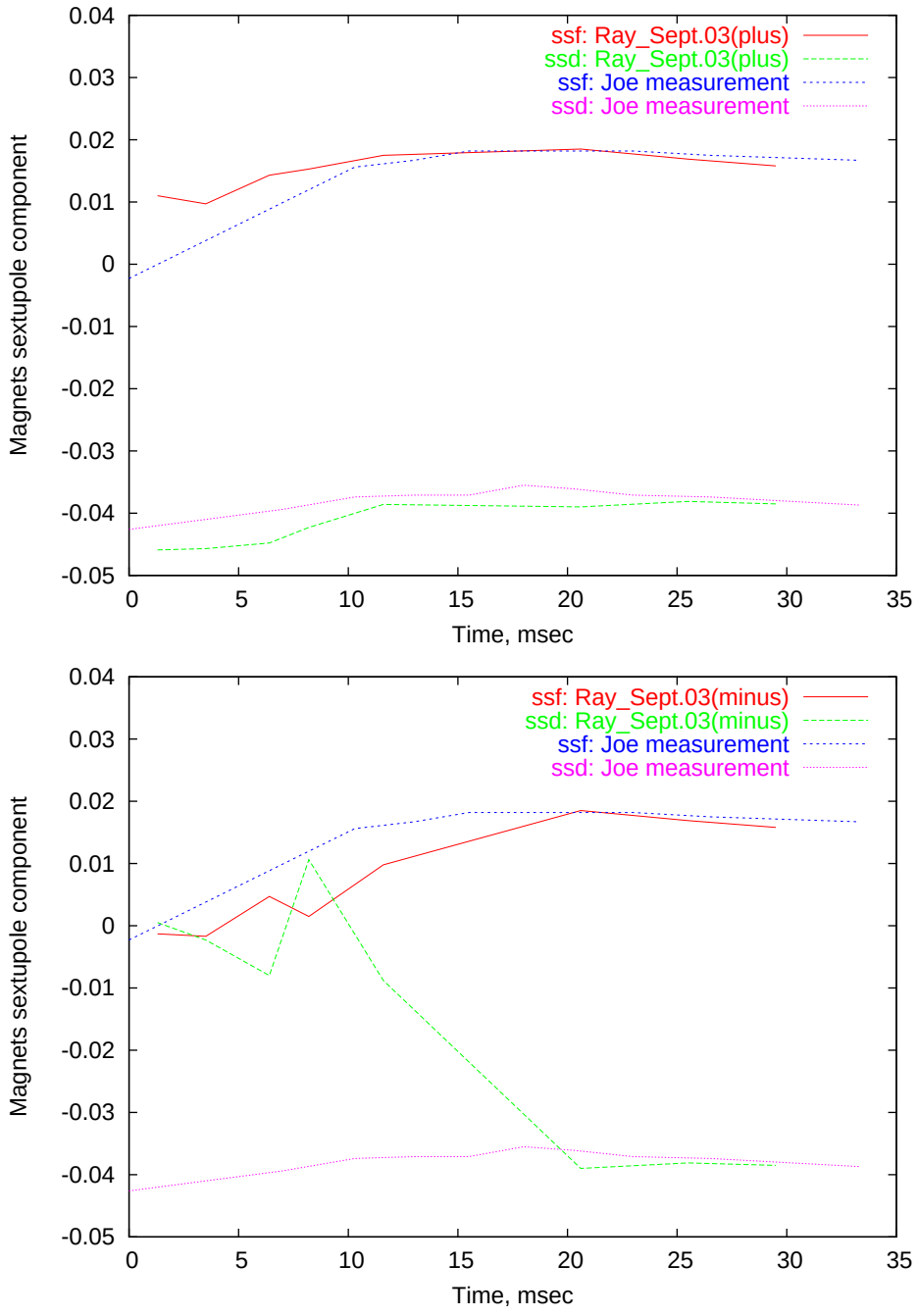

Figure 1: Main magnets sextupole components calculated with MAD from measured chromaticity (Ray Tomlin, August-September 2003), and measured sextupole components (Joe DiMarco, August 2003). Top - vertical chromaticity is measured at $dP/P > 0$, bottom - vertical chromaticity is measured at $dP/P < 0$

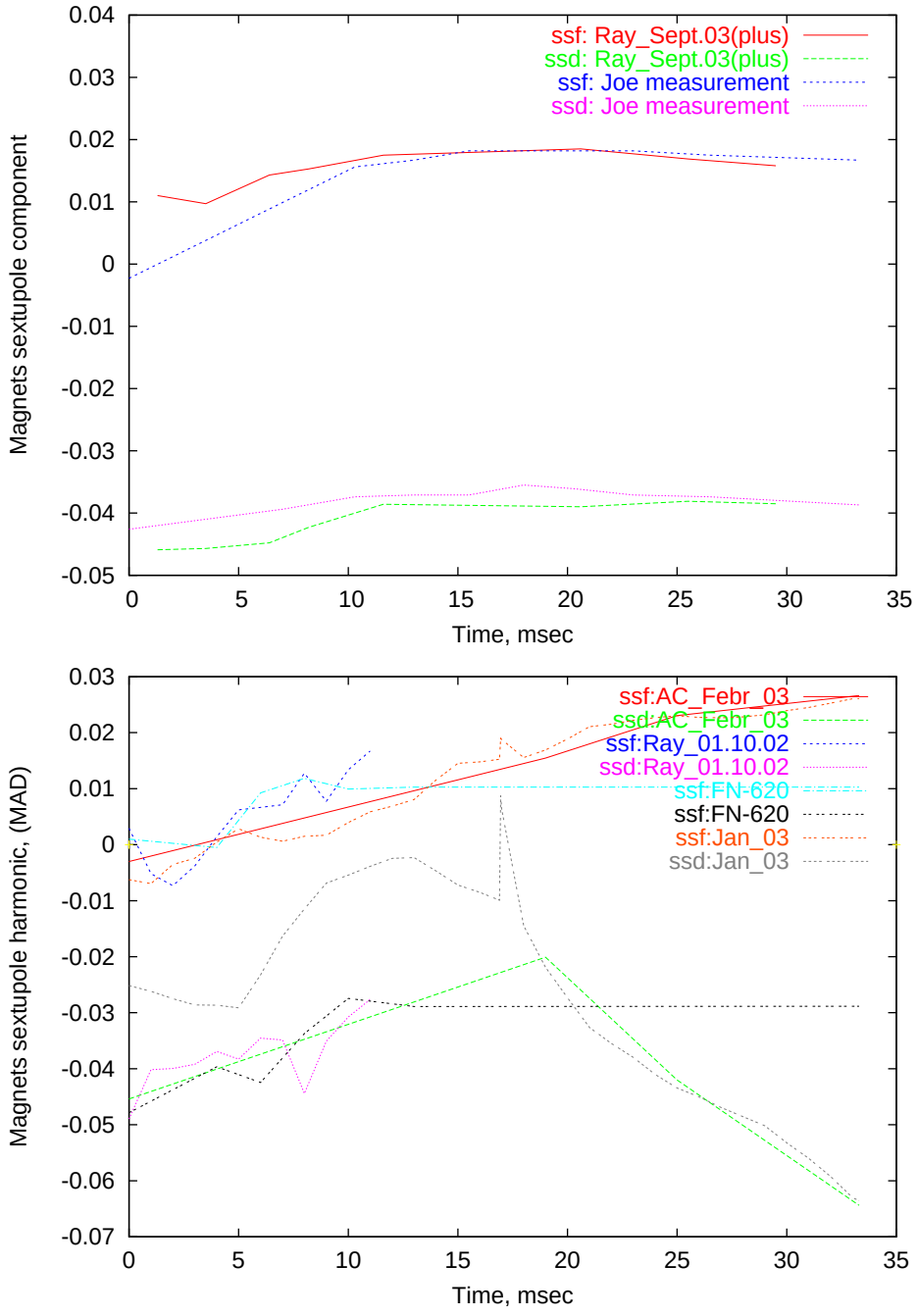

Figure 2: Main magnets sextupole components calculated with MAD from measured chromaticity, and measured sextupole components. Top - measurements of August-September 2003, chromaticity is measured at $dP/P > 0$, bottom - early measurements.

time	E_{kinet}	ssf	ssd	$Axssf$	$Axssd$	$Ayssf$	$Ayssd$
msec	GeV						
0.00	0.40000	-0.00230	-0.04260	981.99395	256.89699	-236.16499	-403.99598
0.12	0.40000	-0.00230	-0.04260	981.73695	256.70699	-232.92099	-396.98998
1.00	0.41261	-0.00060	-0.04210	983.38195	257.94999	-234.29599	-398.84698
2.00	0.45098	0.00120	-0.04170	982.50695	258.10399	-234.98599	-399.59098
3.00	0.51652	0.00290	-0.04120	977.19495	256.56799	-234.83499	-398.75598
4.00	0.61102	0.00470	-0.04080	972.26595	254.86499	-234.32399	-397.60798
5.00	0.73601	0.00640	-0.04030	969.63195	253.72099	-233.75799	-396.73898
6.00	0.89233	0.00820	-0.03990	968.46195	252.95399	-233.16099	-396.03298
7.00	1.07988	0.00990	-0.03940	965.98295	251.84699	-232.55199	-395.02698
8.00	1.29765	0.01160	-0.03880	962.72495	250.42499	-231.71499	-393.63298
9.00	1.54384	0.01340	-0.03820	961.83695	249.95199	-231.41699	-393.19198
10.00	1.81611	0.01510	-0.03760	960.97795	249.52099	-231.15599	-392.78598
11.00	2.11169	0.01590	-0.03730	960.41595	249.20599	-230.93699	-392.47298
12.00	2.42753	0.01630	-0.03720	959.99295	248.92399	-230.69599	-392.16098
13.00	2.76041	0.01670	-0.03710	960.17095	248.78899	-230.41499	-391.91898
14.00	3.10699	0.01730	-0.03710	959.72395	248.38299	-229.93499	-391.37498
15.00	3.46383	0.01790	-0.03710	958.01995	247.45699	-229.10699	-390.27098
16.00	3.82747	0.01820	-0.03680	956.40795	246.68499	-228.50899	-389.40298
16.90	4.15771	0.01820	-0.03610	955.10295	246.11499	-228.11999	-388.79098
16.94	4.17418	0.01820	-0.03610	1413.95093	414.06298	-311.82899	-523.79198
17.00	4.19441	0.01820	-0.03610	1358.93494	396.10998	-303.99599	-511.29598
18.00	4.56117	0.01820	-0.03550	951.88795	244.82299	-227.33699	-387.44998
19.00	4.92432	0.01820	-0.03580	949.87895	243.99899	-226.81899	-386.58298
20.00	5.28046	0.01820	-0.03600	948.49795	243.45599	-226.50699	-386.02998
21.00	5.62631	0.01820	-0.03640	949.48795	243.87399	-226.79699	-386.49398
22.00	5.95869	0.01820	-0.03670	950.49895	244.31099	-227.11199	-386.98298
23.00	6.27455	0.01820	-0.03710	952.43295	245.11399	-227.64599	-387.85098
24.00	6.57101	0.01800	-0.03720	963.49995	249.57199	-230.43699	-392.51698
25.00	6.84538	0.01780	-0.03730	966.62095	250.84299	-231.25299	-393.85098
26.00	7.09515	0.01760	-0.03740	966.44795	250.79699	-231.25599	-393.82198
27.00	7.31808	0.01740	-0.03750	966.18095	250.71499	-231.23799	-393.75498
28.00	7.51214	0.01730	-0.03770	965.72195	250.54599	-231.15199	-393.59198
29.00	7.67558	0.01720	-0.03790	965.06195	250.29399	-231.01399	-393.34198
30.00	7.80692	0.01710	-0.03810	963.96895	249.86799	-230.76499	-392.90998
31.00	7.90499	0.01700	-0.03830	963.10495	249.53299	-230.57199	-392.57098
32.00	7.96889	0.01690	-0.03850	962.20095	249.18299	-230.37099	-392.21798
33.00	7.99805	0.01670	-0.03860	961.17995	248.78199	-230.13299	-391.80698
33.30	8.00000	0.01680	-0.03870	960.84895	248.65899	-230.06799	-391.68598

Table 3: Chromaticity coefficients $Axssf, Axssd, Ayssf, Ayssd$ calculated by MAD from measured sextupole components ssf and ssd. Extraction bump at Long-03 after shutdown Oct.2003.

$$\Delta\xi_x = Axssf * ssf + Axssd * ssd$$
$$\Delta\xi_y = Ayssf * ssf + Ayssd * ssd$$

time	E_{kinet}	I_{sexts}	I_{sextl}	Kxs	Kxl	Kys	Kyl
msec	GeV						
0.00	0.40000	11.40000	0.00000	0.48574	-0.09776	-0.07534	0.32012
0.12	0.40000	11.40000	0.00000	0.48549	-0.10318	-0.07520	0.28857
1.00	0.41261	14.40000	0.85000	0.47690	-0.10227	-0.07431	0.28631
2.00	0.45098	9.00000	2.55000	0.45177	-0.09802	-0.07071	0.27653
3.00	0.51652	8.40000	5.10000	0.41434	-0.09082	-0.06511	0.26028
4.00	0.61102	4.80000	8.50000	0.37202	-0.08215	-0.05857	0.23940
5.00	0.73601	1.80000	11.05000	0.32997	-0.07315	-0.05192	0.21619
6.00	0.89233	-1.20000	14.45000	0.29078	-0.06451	-0.04566	0.19281
7.00	1.07988	-7.80000	22.95000	0.25521	-0.05657	-0.04005	0.17098
8.00	1.29765	-11.40000	28.90000	0.22401	-0.04953	-0.03513	0.15130
9.00	1.54384	-12.60000	36.55000	0.19765	-0.04357	-0.03098	0.13392
10.00	1.81611	-13.20000	45.90000	0.17523	-0.03850	-0.02746	0.11890
11.00	2.11169	-12.60000	55.25000	0.15627	-0.03422	-0.02448	0.10604
12.00	2.42753	-10.80000	63.75000	0.14024	-0.03059	-0.02195	0.09507
13.00	2.76041	-9.60000	69.70000	0.12672	-0.02753	-0.01980	0.08572
14.00	3.10699	-8.80000	74.80000	0.11517	-0.02492	-0.01796	0.07776
15.00	3.46383	-4.20000	78.20000	0.10522	-0.02265	-0.01637	0.07098
16.00	3.82747	11.40000	79.90000	0.09672	-0.02073	-0.01502	0.06520
16.90	4.15771	27.00000	81.60000	0.09012	-0.01926	-0.01399	0.06071
16.94	4.17418	29.40000	81.60000	0.21366	-0.03093	-0.02713	0.07380
17.00	4.19441	30.60000	81.60000	0.19875	-0.02919	-0.02580	0.07129
18.00	4.56117	46.20000	64.60000	0.08306	-0.01769	-0.01288	0.05602
19.00	4.92432	57.60000	32.30000	0.07763	-0.01649	-0.01204	0.05238
20.00	5.28046	65.40000	11.05000	0.07299	-0.01547	-0.01131	0.04923
21.00	5.62631	72.60000	-5.95000	0.06912	-0.01463	-0.01072	0.04650
22.00	5.95869	75.00000	-18.70000	0.06578	-0.01391	-0.01021	0.04415
23.00	6.27455	72.30000	-31.45000	0.06295	-0.01331	-0.00978	0.04213
24.00	6.57101	73.20000	-43.35000	0.06102	-0.01302	-0.00951	0.04057
25.00	6.84538	73.20000	-55.25000	0.05899	-0.01262	-0.00920	0.03917
26.00	7.09515	73.20000	-60.35000	0.05713	-0.01222	-0.00891	0.03791
27.00	7.31808	73.20000	-67.15000	0.05555	-0.01187	-0.00867	0.03685
28.00	7.51214	73.20000	-72.25000	0.05423	-0.01158	-0.00846	0.03598
29.00	7.67558	73.20000	-75.65000	0.05316	-0.01134	-0.00829	0.03526
30.00	7.80692	73.20000	-78.20000	0.05230	-0.01114	-0.00816	0.03470
31.00	7.90499	73.20000	-78.20000	0.05167	-0.01100	-0.00806	0.03429
32.00	7.96889	73.20000	-79.05000	0.05126	-0.01090	-0.00799	0.03402
33.00	7.99805	73.20000	-79.90000	0.05104	-0.01084	-0.00796	0.03388
33.30	8.00000	73.20000	-80.00000	0.05102	-0.01084	-0.00796	0.03387

Table 4: Chromaticity coefficients Kxs, Kxl, Kys, Kyl calculated by MAD using sextupole correctors currents I_{sexts} and I_{sextl}. Extraction bump at Long-03 after shutdown Oct.2003.

$$\Delta\xi_x = Kxs * I_{sexts} + Kxl * I_{sextl}$$
$$\Delta\xi_y = Kys * I_{sexts} + Kyl * I_{sextl}$$

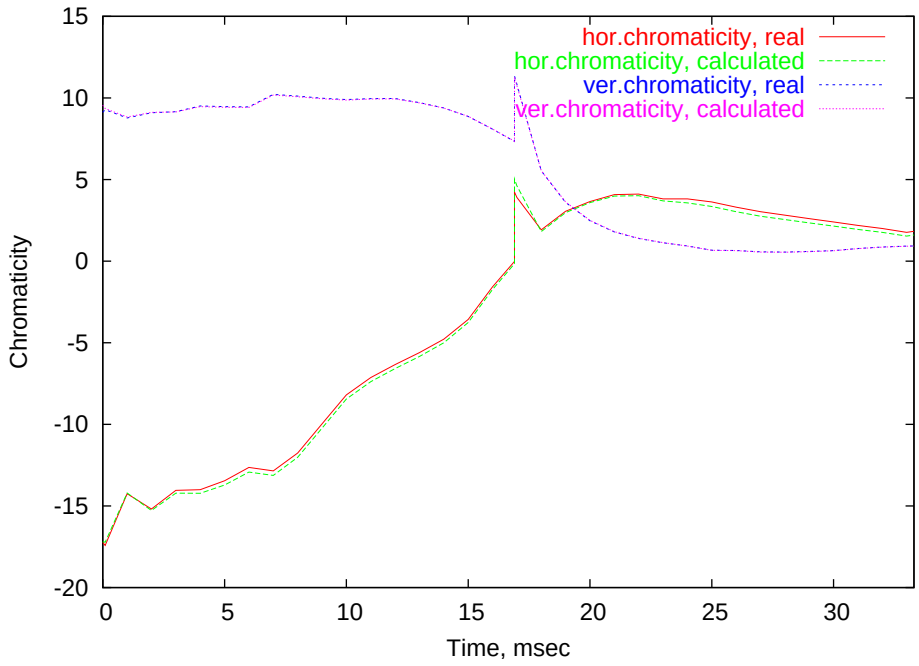

Figure 3: Booster real chromaticity and chromaticity calculated using chromaticity coefficients.
$\xi_x = -9.5185 + Axssf * ssf + Axssd * ssd + Kxs * I_{sexts} + Kxl * I_{sextl}$
$\xi_y = -7.0781 + Ayssf * ssf + Ayssd * ssd + Kys * I_{sexts} + Kyl * I_{sextl}$
Booster bare chromaticity is $\xi_x = -9.5185, \xi_y = -7.0781$