BNL-104171-2014-TECH

AGS.SN298;BNL-104171-2014-IR

Stopband Correction of the AGS Booster Quadrupole and Sextupole Correction Parameters for 2Qy=9

C. Gardner

May 1993

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

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AGS Complex Machine Studies (AGS Studies Report No. 298) Stopband Correction of the AGS Booster Quadrupole and Sextupole Correction Parameters for 2Qy=9
Study Period: May 26, 1993
Participants: C. Gardner and Y. Shoji
Reported by: Y. Shoji
Machine: User3; MMPS: high intensity 30 G/ms injection, all correction strings were turned on; chromaticities were -0.5 (horz.) and -0.75 (vert.); ninth sextupole strings SH3=-6.7, SV3=9.986
Beam: Low intensity (middle 5 turns, 60 degrees)
Aim: Search correction parameters for 2Qy=9

According to the result of the tune space survey of the AGS Booster [Shoji and Gardner AGS SR-297], the stop band 2Qy=9 limits the working area. To correct this stop band through the cycle, we need correction parameters of quadrupoles; N(cos9QY) and N(sin9QY) and sextupoles; SH3 and SV3. The correction of this resonance is necessary to investigate the effect of 4th structure resonances at a high intensity. Now the effect of this resonance to the intensity is not so serious. But we cannot avoid this point to get bright beam (high intensity with low emittance).

The quadrupole correction; N(cos9QY) and N(sin9QY) were measured for two kinds of momentum displacement (dRset) and at 5 different timings through the Booster cycle. The five measured points are shown in Fig.1; (a) through the cycle and (b) in the B-dB/dt space. The results were listed in Table I.

We made difference and sum of data at dRset=1.6 and dRset=-0.6 for each timing. The differences, indicated by δ, are proportional to the slope and the sum, indicated by Σ, are roughly the twice of quadrupole correction current. They were fitted with function;

$$\delta, \Sigma = No + Nb\, B + Nbt\, (dB/dt) \,. \qquad (1)$$

The results are listed in Table II. The reduced X^2 ; X^2/f were large. Then the errors might have been under estimated.

The slopes are connected with ninth sextupole strings; SH3 and SV3 by the equations;

$$\begin{pmatrix} \delta N(\cos 9QY)/\delta dRset \\ \delta N(\sin 9QY)/\delta dRset \end{pmatrix} = \begin{pmatrix} 3.38 \pm 0.29 & 0.68 \pm 0.31 \\ 0.08 \pm 0.29 & 2.28 \pm 0.29 \end{pmatrix} \begin{pmatrix} SH3 \\ SV3 \end{pmatrix} \tag{2}$$

This equation was obtained at the 1.7kG flat porch [Shoji and Gardner, SR-293], but it should be the same through the cycle. From this equation (2) and the fitted result to δ listed in Table II we obtain

$$\begin{aligned} SH3 &= (-20.2 \pm 3.9) &&+(-6.1 \pm 1.3)\,B &&+(-0.318 \pm 0.045)(dB/dt) \\ SV3 &= (\ 6.5 \pm 5.3) &&+(-0.4 \pm 1.8)\,B &&+(\ 0.203 \pm 0.054)(dB/dt). \end{aligned} \tag{3}$$

To get correct functions, we have to invert signs and add off-set.

$$\begin{aligned} SH3 &= (\ 13.5 \pm 3.9) &&+(\ 6.1 \pm 1.3)\,B &&+(\ 0.318 \pm 0.045)(dB/dt) \\ SV3 &= (\ 3.5 \pm 5.3) &&+(\ 0.4 \pm 1.8)\,B &&+(-0.203 \pm 0.054)(dB/dt). \end{aligned} \tag{4}$$

From equation (4) we can calculate the excitation functions of SH3 and SV3. For the high intensity cycle; 30G/ms injection, the calculated functions are shown in Fig.2. The calculated function of SH3 goes over the current limit of the present power supply; 50A. But the present power supply is acceptable because the correction of 2Qy=9 is necessary at only near the injection. Although we should measure these slopes again with the corrections based on (4). The errors of equations (4) are not sufficiently small.

We can also calculate correction parameters of the quadrupole components from the Σ data.

$$\begin{aligned} N(\cos 9QY) &= (138 \pm 11)\ +(90.6+3.5)\,B &&+(\ 3.36 \pm 0.07)(dB/dt) \\ N(\sin 9QY) &= (-43 \pm 12)\ +(38.8+3.7)\,B &&+(-6.30 \pm 0.09)(dB/dt) \end{aligned} \tag{5}$$

They may be close to the N(cos9QY) and N(sin9QY) when 9th sextupole corrections are applied. These coefficients were already shown in a different report [Shoji and Gardner, AGS SR-288].

Table I Optimized N(cos9QY) and N(sin9Qy)

T (ms)	dRset (cm)	N(cos9QY)	N(sin9QY)	crossing speed(dQ/ms)	residual loss(%)
28.5	1.6	240+10	-120+15	0.016	22
	-0.8	495+10	-200+10	0.034	38
41.5	1.6	350+10	-345+10	0.005	1.5
	-0.8	810+10	-475+10	0.005	2
75.0	1.6	520+20	-230+20	0.014	0
	-0.8	1050+10	-335+10	0.014	0.5
93.0	1.6	420+10	100+10	0.0085	2
	-0.8	825+20	50+20	0.0046	0
134.5	1.6	80+10	460+15	0.02	0
	-0.8	230+10	550+10	0.02	2.3

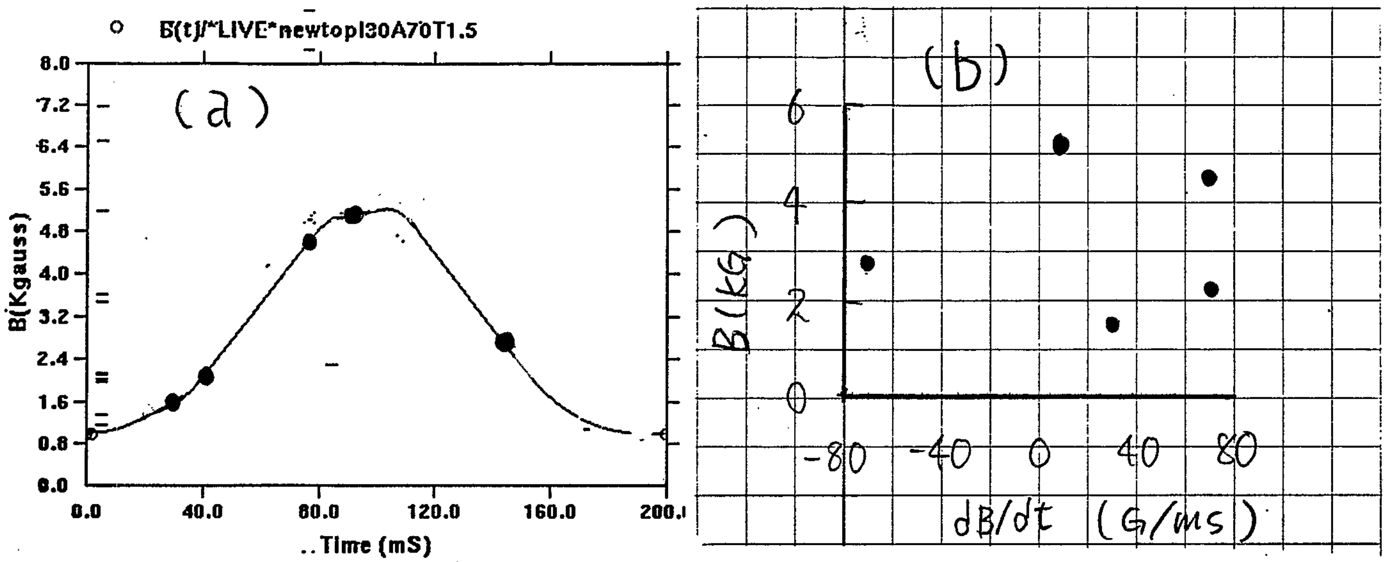
Table II Difference and Sum of dRset=1.6cm and -0.8cm.

T	B	dB/dt	N(cos9QY)			N(sin9QY)		
(ms)	(kG)	(G/ms)	δ	Σ	err	δ	Σ	err
28.5	1.54	30	-255	735	±15	80	-320	±20
41.5	2.17	70	-460	1160	±15	130	-820	±15
75.	4.51	70	-530	1570	±25	105	-565	±25
93.	5.10	10	-405	1245	±25	50	150	±25
134.5	2.72	-70	-150	310	±15	-90	1010	±20
off-set	No		-153	277	±20	32	-85	±23
B term	Nb		-50.5	181.1	±6.8	-3.2	77.6	±7.3
dB/dt term	Nbt		-2.25	6.72	±.14	1.05	-12.60	±.17
X^2/f			9.04	2.68		0.72	4.84	

FIGURE CAPTIONS

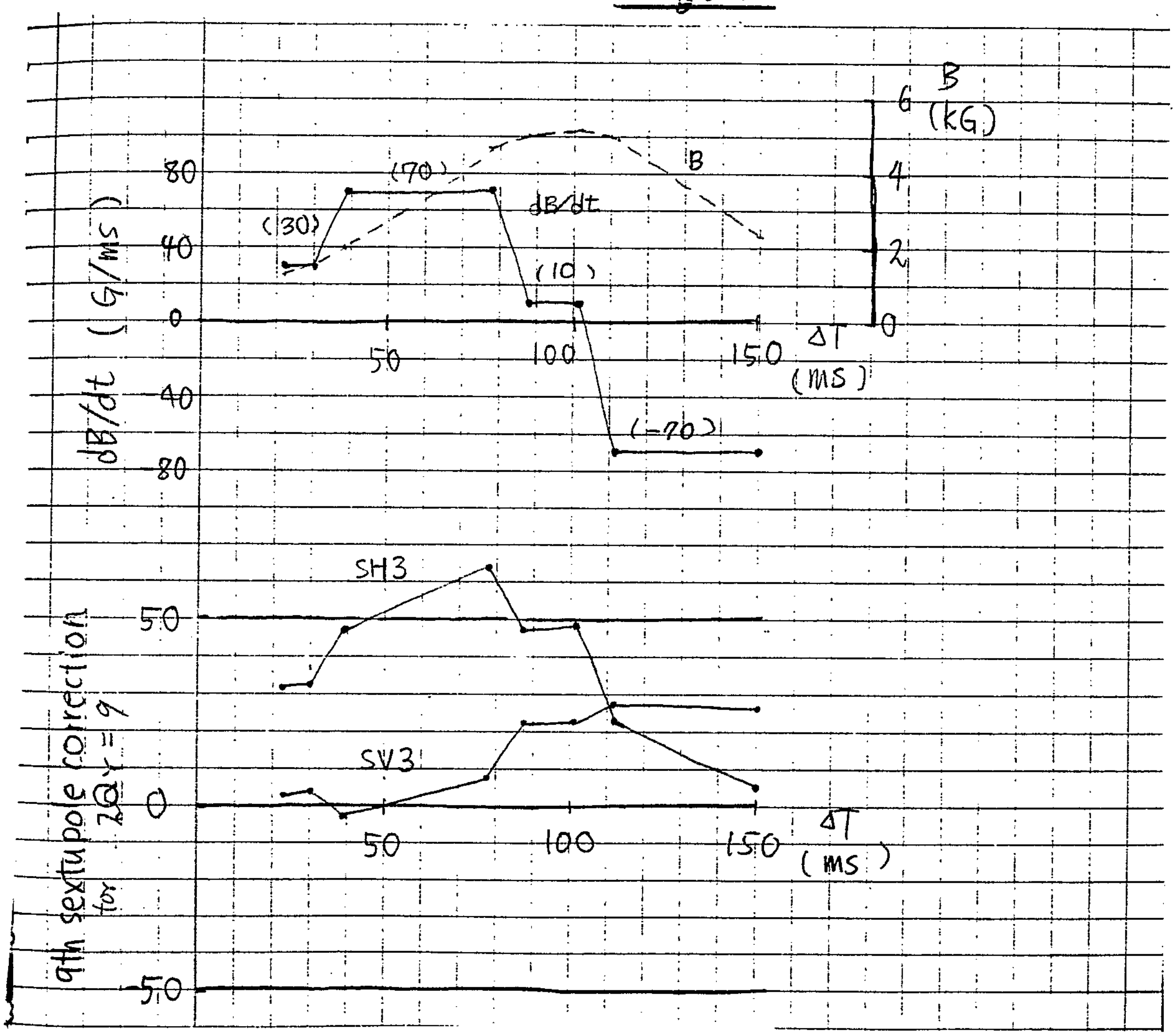
Fig. 1 (a) Measured points through the Booster cycle.
(b) Measured points in the B - dB/dt plane.

Fig. 2 Calculated excitation function of 9th sextupole corrections; SH3 and SV3.



B(t)/*LIVE*newtopl30A70T1.5
(a)
B(Kgauss)
8.0
7.2
6.4
5.6
4.8
4.0
3.2
2.4
1.6
0.8
0.0
0.0
40.0
80.0
120.0
160.0
200.0
..Time (mS)
(b)
B(kG)
6
4
2
0
-80
-40
0
40
80
dB/dt (G/ms)

Fig. 1



dB/dt (G/ms)
80
40
0
-40
-80
(30)
(70)
(10)
(-70)
dB/dt
B
B (kG)
6
4
2
0
50
100
150
ΔT (ms)
9th sextupole correction for $2Q_y = 9$
SH3
SV3
50
0
-50
50
100
150
ΔT (ms)

Fig. 2