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Stopband Correction of the AGS Booster The Effect of the Skew Sextupole Correction

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Stopband Correction of the AGS Booster
The Effect of the Skew Sextupole Correction

Study Period:	July 14, 1993
Participants:	C. Gardner and Y. Shoji
Reported by:	Y. Shoji
Machine:	User3; parameters were almost the same as that of User1; the power supplies for the chromaticity control were out of order.
Aim:	We had observed a remarkable improvement by the skew sextupole correction (for 2Qx+Qy=14) in May. But now we observe small change of the beam current of User1 by turning ON and OFF the skew sextupole correction (Ahrens and Zeno, Booster/Proton Book X, 1993, p. 39). We want to know the reason for that change.

I Experiment

First we tried to equalize User3 to User1. We loaded the functions of User1 to User3.

1. Tune control
2. RF control; radial steering, frequency, gap voltage
3. Stopband corrections
4. Orbit control
5. (Chromaticity power supplies were turned off.)
6. Slow and fast bump

The beam current of User3 became very close to that of User1 (Fig. 1). But was not identical. We do not know why they are not the same.

We changed the beam current by changing number of injection turns. The beam length from the LINAC was kept constant to 76 degrees. For 50, 75, 100, 125, 150 and 200 turns we observed the improvement of the beam current by the skew sextupole correction. The observed beam current is shown in Fig. 2.

We also observed the improvement for 100, 150 and 200 turns injection before we set the orbit control identical to that of User1. The orbit just after the injection was different as shown in Fig. 3. The results are shown in Fig. 4.

II Discussion

The ratio of improved intensity is plotted against the injection turns at user3 in Fig.5. The white circles in Fig. 5 indicate the results with user1 orbit control. The crosses in Fig.5 indicate the results with User3 orbit control.

With the orbit control of User1, the effect of the skew sextupole correction were maximum at 100-125 turns injection. One of the possible explanations of it is that;
The incoherent tune of a part of the beam has already reached to the 2Qx+Qy=14 at 50 turns injection as schematically shown in Fig. 6(a). The incoherent tune of a most dens part of the beam reaches to 2Qx+Qy=14 at 100-125 turns injection (Fig. 6(b)). And at 200 turns injection, the incoherent tune of the beam goes over 2Qx+Qy=14. And a mean density also decreases because the tune spread is large. This is only a supposition. We would need a long tedious tune space survey to confirm it. And it doesn't explain why the beam loss occurred only at the injection even at the 200 turns. The most dens part would have passed the resonance at some energy.

The orbit change by the correction strings could be the reason of the beam loss especially at the 50 turns. If so we over estimated the tune spread in the above discussion.

With the User3 orbit, things were different. The only change was the orbit control (dipole correction). But it changed the beam current, beam size, aperture and consequently the space charge. It pushed up peak in Fig. 5 to high number of turns injection.

We could not reproduce a big effect which was observed on May 8. At that time (May 8) the beam current just after the injection had been very high and we had been losing the beam throughout the cycle. At this time (July 14) we could not get such a high current at the injection. And we lost the beam mainly at the injection.

We have already observed the change of the effect of resonance. The beam loss by the resonance 3Qy=14 was different with the similar beam current on May 20 and May 28 [Shoji and Gardner, AGS SR-296 and 297] with 5 turns injection (LINAC beam pulse width was not the same). Although the correction of 2Qx+Qy=14 was good on both cases (Of course the skew sextupole correction functions were the same). And the beam loss by the resonance 5Qx=24 was not the same on May 29 and July 25 [Shoji and Gardner, AGS SR-297 and SR-300] with 50 turns injection.

After all the effect of one resonance to the intensity is not simple. The effect depends on many parameters other than the correction strings such as C.O.D., injection bumps, LTB parameters, tunes, etc.

FIGURE CAPTIONS

Fig. 1 Beam current of User1 and User3. 150 turns 76 degrees.
(The beam current of User3 with 'User3 orbit control' is compared with user1 in Fig.4(b)).

Fig. 2 Improvement of the beam current by turning on the skew sextupole correction.

Fig. 3 Default C.O.D. just after the injection.

Fig. 4 Improvement of the beam current by turning on the skew sextupole correction. The orbit control was not the same as that of User1.

Fig. 5 Improvement of the beam current against the total beam current. The white circles show the results with User1 orbit control. The crosses show the results with User3 orbit control.

Fig. 6 Scheme which explains the change of the stopband effect against the beam current.

Fig. 7 The effect of the skew sextupole correction observed by T. Roser on May 8.

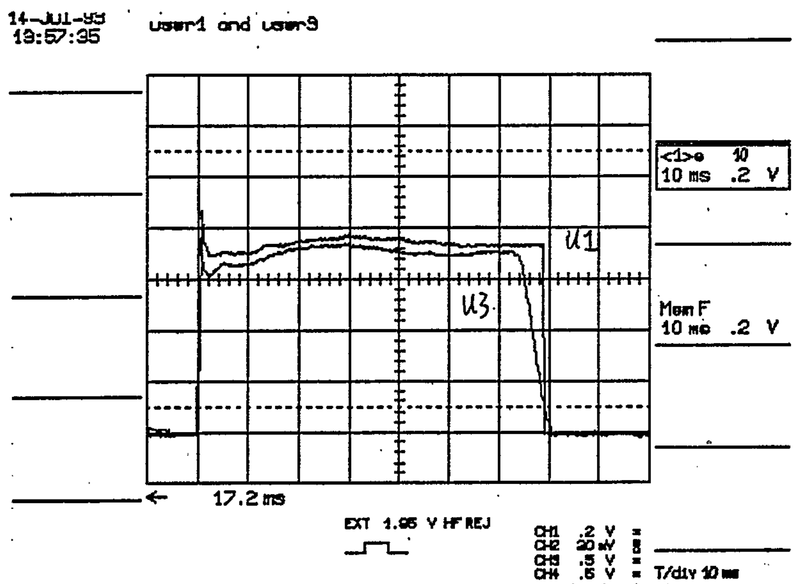

14-Jul-93
19:57:35
user1 and user9
<1>e 10
10 ms .2 V
U1
U3
Mem F
10 ms .2 V
17.2 ms
EXT 1.95 V HF REJ
CH1 .2 V
CH2 20 mV
CH3 .5 V
CH4 .5 V
T/div 10 ms

Fig. 1

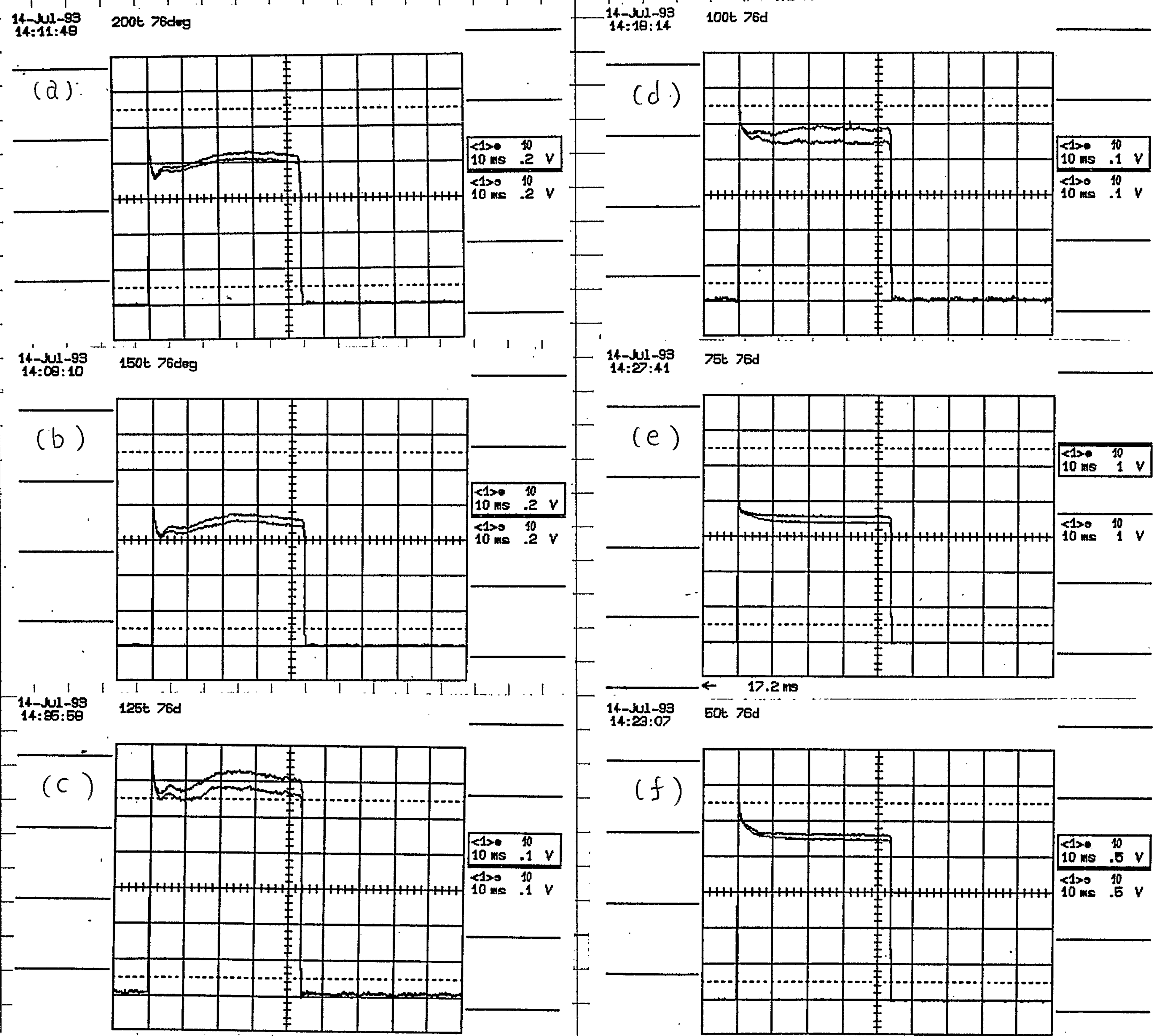

14-Jul-93 14:11:49
200t 76deg
(a)
<1>e 10 10 ms .2 V
<1>s 10 10 ms .2 V
14-Jul-93 14:09:10
150t 76deg
(b)
<1>e 10 10 ms .2 V
<1>s 10 10 ms .2 V
14-Jul-93 14:35:58
125t 76d
(c)
<1>e 10 10 ms .1 V
<1>s 10 10 ms .1 V
14-Jul-93 14:18:14
100t 76d
(d)
<1>e 10 10 ms .1 V
<1>s 10 10 ms .1 V
14-Jul-93 14:27:41
75t 76d
(e)
<1>e 10 10 ms 1 V
<1>s 10 10 ms 1 V
17.2 ms
14-Jul-93 14:23:07
50t 76d
(f)
<1>e 10 10 ms .5 V
<1>s 10 10 ms .5 V

Fig. 2

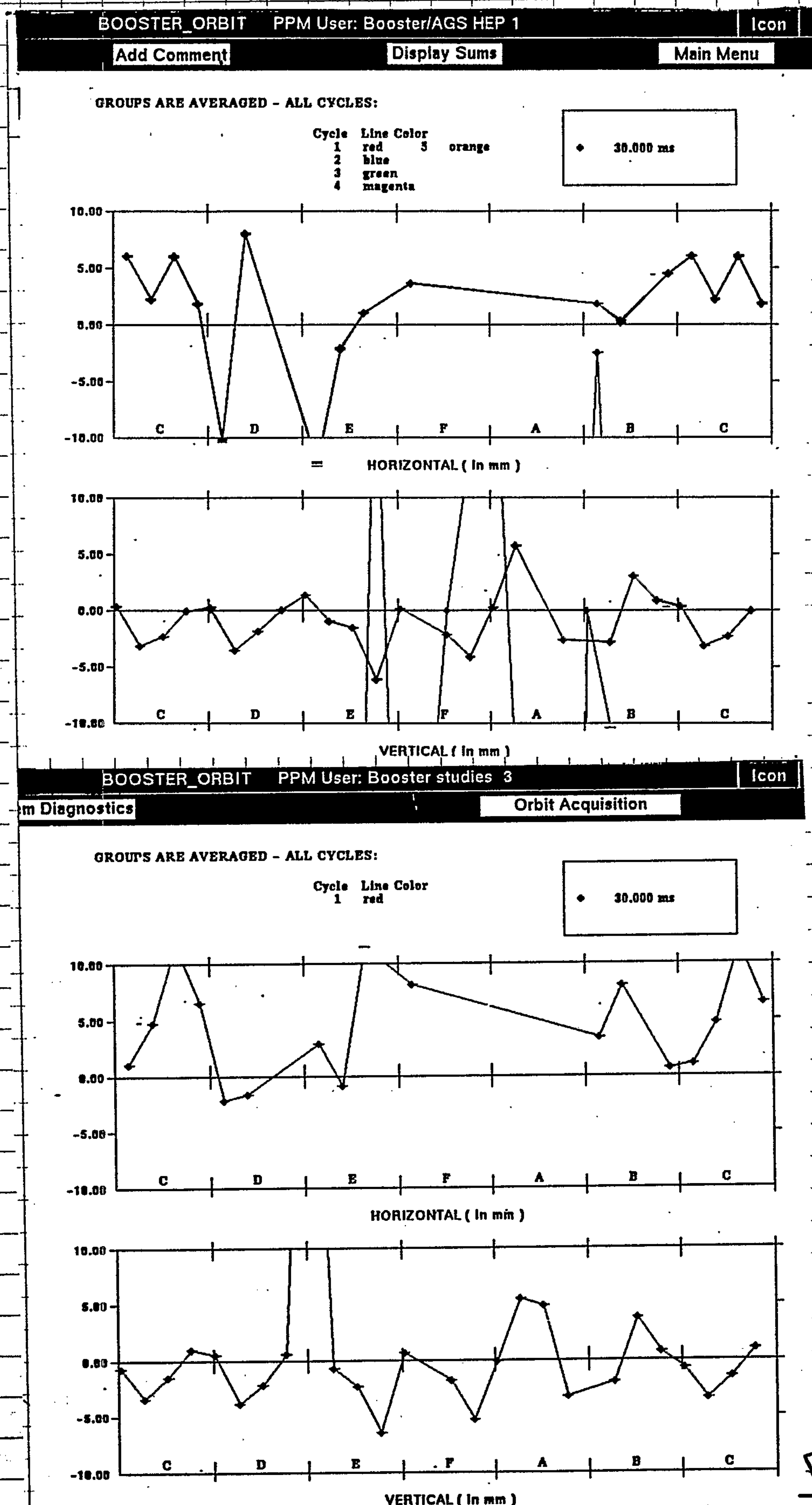

BOOSTER_ORBIT PPM User: Booster/AGS HEP 1
Icon
Add Comment
Display Sums
Main Menu
GROUPS ARE AVERAGED - ALL CYCLES:
Cycle Line Color
1 red 5 orange
2 blue
3 green
4 magenta
30.000 ms
10.00
5.00
0.00
-5.00
-10.00
C D E F A B C
HORIZONTAL (In mm)
VERTICAL (In mm)
BOOSTER_ORBIT PPM User: Booster studies 3
Icon
m Diagnostics
Orbit Acquisition
GROUPS ARE AVERAGED - ALL CYCLES:
Cycle Line Color
1 red
30.000 ms
HORIZONTAL (In mm)
VERTICAL (In mm)

Fig. 3

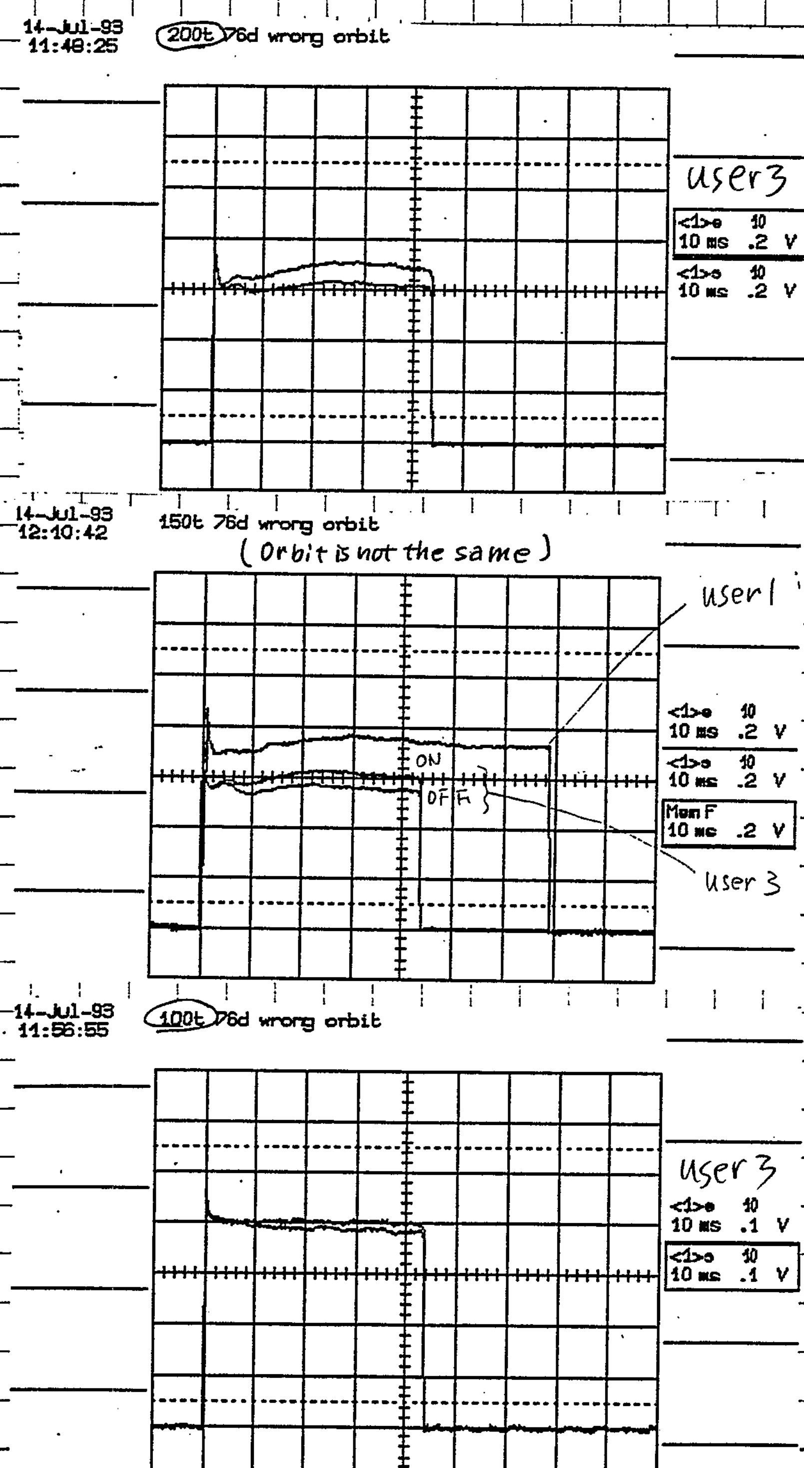
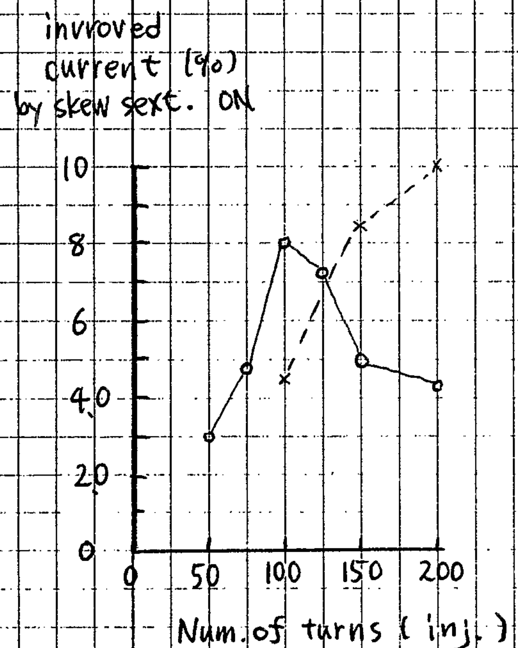

14-Jul-93
11:48:25
200t 76d wrong orbit
user3
<1>e 10
10 ms .2 V
<1>s 10
10 ms .2 V
14-Jul-93
12:10:42
150t 76d wrong orbit
(Orbit is not the same)
user1
ON
OFF
<1>e 10
10 ms .2 V
<1>s 10
10 ms .2 V
Mem F
10 ms .2 V
user 3
14-Jul-93
11:56:55
100t 76d wrong orbit
user3
<1>e 10
10 ms .1 V
<1>s 10
10 ms .1 V

Fig.4



# of turns	difference ↓	current w/ skew ↓	
50	×5·10^8	14 / 461	= .030
75	10^9	17 / 358	= .048
100	10^9	38 / 482	= .080
125	10^9	42 / 597	= .072
150	2·10^9	18 / 361	= .050
200	2·10^9	18 / 422	= .043
	ppp		

bad orbit (U3)

100	1.8 / 400	×10^9
150	2.80 / 302	×2×10^9
200	3.4 / 342	×2×10^9

Fig. 5

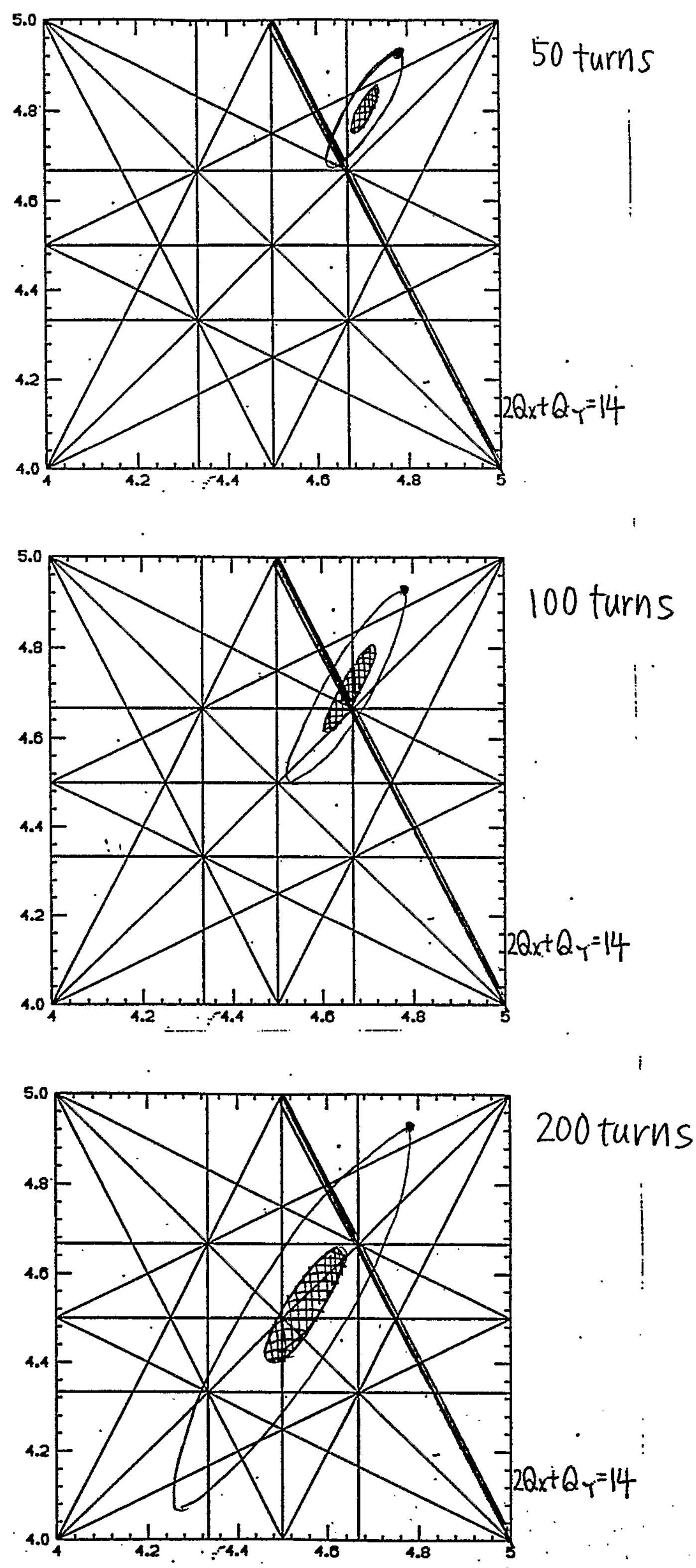
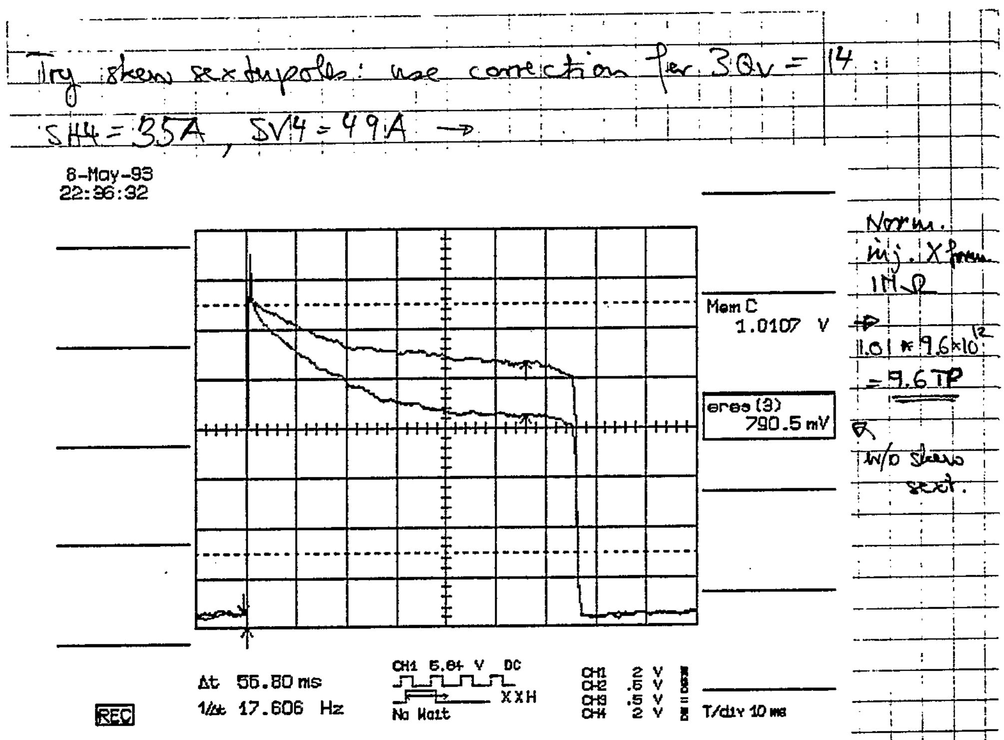

50 turns
2Qx+QY=14
100 turns
2Qx+QY=14
200 turns
2Qx+QY=14
5.0
4.8
4.6
4.4
4.2
4.0
4
4.2
4.4
4.6
4.8
5

Fig. 6



with vs without skew sextupoles

Fig. 7