SINGLE PASS COLLIDER MEMO CN- 257

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REPLACES CN#

TITLE: <u>ONE WAY TO SAVE THE NUMBER OF BPM BUTTONS IN THE ARCS THAT IS NOT RECOMMENDED</u>

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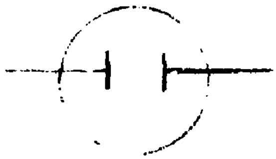
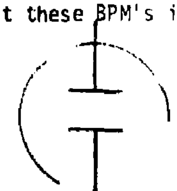
It has been suggested as a possibility by the beam dynamics task force that the SLC arcs be provided a beam position monitor at every gap between magnets. In this scenario of orbit correction scheme, the BPM's are used alternately for the horizontal and the vertical orbit measurements. One way to construct these BPM's is therefore

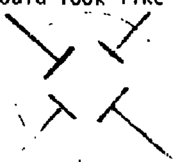


x-BPM



y-BPM

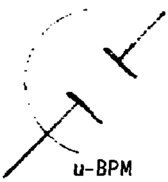
One problem of this construction as pointed out by Pellegrin and Rees, however, is that synchrotron radiation will hit the buttons of the x-BPM's. It was suggested then that the x-BPM's should look like



x-BPM

This construction requires 4 buttons instead of 2, meaning an increase of cost.

As an attempt to reduce the number of buttons needed for arc orbit correction, we have studied a variation of the orbit correction scheme. In this scheme, orbits are not corrected in the x and y corrdinates but in the coordinates that are tilted by 45^{o} relative to x and y. Let these coordinates be called u and v, then the BPM's would look like



u-BPM

v-BPM

The first question to ask is whether such a scheme does correct orbit down to a reasonable rms. In this note, we present 2 sets of simulations of arc orbit correction using the u- and v-BPM's. We conclude that the orbit corrected using the u- and v-BPM's is not as good as that obtained using the x- and y-BPM's. Recognizing the critical importance of orbit control in the arcs, the idea of saving BPM buttons by using the u- and v-BPM's is not recommended.

Simulation Set 1

In the first set of simulations, we begin with one achromat with al its 20 magnets randomly misaligned at their ends by an rms of 100 μm. The TRANSP T program is then used to calculate the orbits for 7 cases as described in Table 1.

Table 1

Case	BPM type	BPM misalignment	direc on of magnet moveme
1	(no orbit correction)		
2	x, y	0	x, y
3	x, y	100 μm	x, y
4	u, v	0	x, y
5	u, v	100 μm	x, y
6	u, v	0	67.4^0 w.r.t. x, y
7	u, v	100 μm	67.4^0 w.r.t. x, y

The corrector magnets in cases 6 and 7 are moved not in the x and y directions but in directions 67.4^0 relative to them. The angle 67.4^0 is determined by the following. As a F-magnet is moved at an angle of 67.4^0 with respect to the x-direction, the orbit displacement produced at a BPM immediately upstream of the next F-magnet is purely in the u-direction. Similarly, as a D-magnet is moved in a direction 67.4^0 from the y-direction, the orbit displacement produced immediately in front of the next D-magnet

Table 2 The x Orbit (μm)

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
	-26.5	68.7	74.7	79.2	83.0	25.0	33.5
	-486.3	0	30.4	53.3	72.8	-131.2	-146.6
	-502.3	-15.7	6.4	36.2	21.8	-121.7	-164.4
	-97.2	0	-36.5	3.1	-165.6	109.0	-19.4
	78.4	-60.3	-94.5	-60.7	-223.8	133.2	24.5
	717.7	0	34.3	34.3	48.6	-103.1	-153.1
	772.8	49.6	96.8	82.3	98.3	-148.8	-225.5
	167.1	0	31.7	-8.6	-162.7	141.5	78.8
	-127.5	1.8	4.0	-5.4	-128.7	144.5	120.6
	-789.1	0	-103.1	39.7	213.0	-86.5	-19.0
	-656.2	22.2	-86.2	40.4	221.4	-61.7	-24.7
	435.5	0	-25.2	-116.8	-200.9	49.7	114.8
	539.7	-45.3	-33.4	-138.0	-184.3	28.4	158.9
	84.2	0	90.0	141.3	514.7	-14.4	185.5
	-203.6	0.6	88.1	127.9	476.3	-18.2	131.3
	[illegible]	0	45.2	-164.2	-337.9	-75.6	-46.4
	-715.9	-42.2	-18.1	-185.8	-360.6	-64.2	-3.6
	881.2	0	-20.3	232.2	575.1	148.8	251.3
	[illegible]	45.2	28.1	244.5	545.4	128.4	200.1
	334.7	0	39.9	-311.7	-701.2	-191.9	-274.5
rms =	578	29.5	58.8	135	329	109	144

Table 3 The y-Orbit (μm)

Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
108.0	108.0	108.0	108.0	108.0	-86.8	[illegible]
107.8	60.4	41.7	53.3	29.7	-131.2	-189.7
241.9	0	-95.4	-36.2	-156.8	121.7	29.5
140.7	26.0	-39.1	3.1	-113.9	109.0	32.3
-601.7	0	-119.5	60.7	54.8	-133.2	-193.5
-539.3	-14.7	-145.7	34.3	0.1	-103.1	-201.6
508.1	0	-174.1	-82.3	-344.5	148.8	-20.7
622.6	82.3	-43.2	-8.6	-207.4	141.5	34.0
-359.8	0	117.1	5.4	294.3	-144.5	45.0
-685.9	24.4	184.9	39.7	358.7	-86.5	126.8
-1248.3	0	96.3	-40.4	-85.2	61.7	[illegible]
-1087.8	-100.4	-0.3	-116.8	-165.2	49.7	150.4
621.2	0	180.0	133.0	438.9	-28.4	95.6
1078.4	25.2	197.5	141.3	400.2	-14.4	[illegible]
1217.6	0	60.4	-127.9	-390.8	18.2	[illegible]
749.8	-49.9	6.2	-164.2	-401.9	-75.6	-112.4
-1078.7	0	150.3	185.8	573.2	64.2	216.1
-1255.4	71.9	208.8	232.2	603.8	148.8	280.0
-468.8	0	-12.3	-244.5	-562.8	-128.4	-217.5
43.9	-17.1	81.2	-311.7	-757.6	-191.9	-330.9
rms = 752	50.0	123	136	368	110	160

is purely in the v-direction. Moving magnets in those oblique directions thus makes the correctors more orthogonal in producing their responses at the u- and v-BPM's.

The sampling of the x and y orbit for these cases are tabulated in Tables 2 and 3, respectively. We have given the orbits only at the BPM's. This tends to give a smaller rms for all cases (especially case 2), but the relative quality of orbit correction can still be obtained by comparing the rms values.

From Tables 2 and 3, it can be seen that the orbits for cases 4 and 5 are substantially worse than those for cases 2 and 3. The u- and v-BPM's do not provide a good orbit correction of the arc if the corrector magnets are moved in the x and y directions. The reason is that betatron oscillations which occur in x and y planes between BPM's are pushing the orbits from the origin. Cases 6 and 7 show that if the corrector magnets are moved at 67.4^0 angle, the orbit correction is much better than cases 4 and 5 but still not as good as cases 2 and 3 when the x- and y-BPM's are used.

Simulation Set 2

In the second set of simulations, we use the simulation program BEAMCORR to correct orbits as it is described in CN-252 to study a string of 7 achromats. The 7 cases are repeated and the results are given in Table 4.

Table 4

Orbits and Magnet Movements in μm

Case	x-orbit rms	x-orbit max.	y-orbit rms	y-orbit max.	max. x-magnet movement	max. y-magnet movement
1	1013	2808	1145	2596	--	-
2	26	91	97	506	95	93
3	88	211	122	471	104	91
4	261	592	261	562	134	135
5	248	721	245	581	124	103
6	125	448	136	572	156	164
7	129	329	152	587	183	172

We see again from Table 4 that in the cases 6 and 7 misalignments produce larger rms values of orbits then for the cases 2 and 3 correspondingly although the orbit correction in these cases is much better than in the cases 4 and 5 respectively.

Repeating the conclusion once more we think that it is not worthwhile to use the system of u^- and v^- types of BPM.

One additional slight disadvantage of the u^- or v^- or any other two-buttons type-BPM's is that they do not provide an easy way to evaluate the beam intensity or to normalize its readings.

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