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What If Someone Were to Saw the Two BTA Bends into Halves?

J. Niederer

August 1996

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

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Accelerator Division
Technical Note

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August 26, 1996

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AGS Department
Brookhaven National Laboratory

August 23, 1996

1. Summary

One of many possible schemes for improving the BTA is sketched. Its primary feature is to reduce dispersion in the early bending region by replacing the present pair of dipoles with four shorter ones, separated equally by quads of alternating polarities. These cells are tuned to give a region of vanishing dispersion after the bends, where alternating quads produce the relative X and Y phase advances needed for AGS acceptance. The present lattice from the Booster through quad QH4 is retained, along with the section from DH5 into the AGS. Typical operating Booster delivery parameters and AGS acceptance parameters have been used in these model studies. No Booster perturbations are involved in this particular set of tracking games.

2. The Trial Lattice

The intent here is to explore a relatively simple lattice geometry that makes use of the experience gained from continuing BTA studies. [1, 2]. We show one such plausible lattice and resulting optics in Figure 1, along with the corresponding listing for a tracking run. For simplicity, the existing dipoles DH2 and DH3 have been halved, and V quads placed midway between the halves, in the usual H - B - V - B - H - B - V - B - H pattern. Two additional quads are involved to clamp dispersion through the bend region. The common bend angle was adjusted by about 5% upwards to center beam in bend DH5 near the AGS entrance. The DH5 bend angle was adjusted accordingly, increased by about 15%. This line of bends reaches outwards about .5m closer to the AGS than the present arrangement, using somewhat arbitrary .6m spacings among magnets. The spacing is mainly to keep the bending profile about the same as it is now. All of this pretends that the shield wall is adequately porous. Five quads, QH4, QV4, QH5, QV5, QH6, are spaced equally among these four bends. Similarly eight quads of the present QV5 type are spaced equally in the region of Q6 through Q13, two more than at present as suggested by the previous study, for a total of 19 quads. Again for simplicity, correctors, monitors, and other stuff is omitted. None of these placements or spacings are optimized.

3. The Matching Technique

Matching using the BNL MAD simplex method needed a lot of guidance to deal with the 19 quad current parameters and the given entrance and exit conditions. The incoming dispersion of 2.85m is high and has to be clamped down in the bend region. The existing QV1 - QH4 quad arrangement is not matched to either the BTA or the Booster optics, but is left alone here in favor of easier regions to rebuild. Initially, rather wide AGS acceptance conditions are used to get the parameter search into a reasonable region of parameter space. Amplitudes are clamped strongly at Beta max < 25m. Dispersion limits are then successively reduced to Dmax < 2.5m, which leads to a gently sloping dispersion that crosses zero somewhat after the bends. Then the AGS acceptance windows are reduced in a series of iterations. The final alphas and betas are easily reached, but the dispersion components are not, and the apparent convergence usually has to be watched. The iterations are helped by a feature added to the **FEndMatch** command that optionally writes a file of the set of final fitted parameter values. These values, along with adjustments to constraints and step sizes, are then input to the next iteration.

4. Results

This class of fit has a proper minimum, which is rather flat and has a common center among all of the quad current parameters. The fit is generally insensitive to quad current drifts. The envelopes for the orbit functions are shown in Figure 2, where each of these currents are varied in turn between two amps on either side of the fitted value. Most of the slight width observed is due to the first three quads, QV1, QH2, and QV3. This arrangement is also insensitive to incoming momentum offsets. The envelopes for a -2% to +2% swing in input momentum offset are shown in Figure 3. The eventual fit noted here is a little squeezed by the beta max constraint of < 25m, mostly because of the way that the existing QV1 - QH4 geometry has to deal with the incoming dispersion.

The largest dispersion in this display is at the BTA entrance, set by the unfortunate choice of extraction point in the Booster. This is the limiting constraint for momentum acceptance, and possibly a source for cooking the Booster septum region. While this kind of BTA appears to handle momentum acceptance rather well, it does not eliminate the need for reducing dispersion in the Booster extraction region. Once into the BTA our four bend design permits full control of the dispersion through the bends. It further produces a desirable region of low dispersion with gentle slope downstream, which allows quads there to deal with X and Y phases without unduly prejudicing the dispersion near the AGS. The quads here can undoubtedly be better placed for this phase matching role.

This simple example points towards a more useful set of matching criteria for the actual BTA operation. The bend region should tightly contain dispersion, and slope it to reach zero in the center of the quad group located to deal with phase adjustment. Both dispersion value and slope components should appear as a formal constraint at the given point. The rest of the quads up to the AGS mainly deal with clamping the amplitudes during passage.

5. Comments

This kind of experience suggests including the magnet layout geometry in the matching process. In MAD, lattice geometry is computed in the group of routines that carry out the **Survey** command. Survey now has to be iterated through a number of separate runs to adjust quantities such as bend angle to lay out the beam path along an actual floor or whatever. While there is a private survey match feature attached to Cern MAD V8 [3], unfortunately it doesn't mix very easily with our simplex, for which tracking is based on our vastly improved data base. Beam line matches with their numerous free parameters have needed the far more capable simplex variant developed here. Survey matching has thus been grafted into our versions of MAD, which is easy enough because of our structure tools and much better developed matching features, inspired far too much by this BTA mess. This kind of code maintenance is in fact so straightforward that well over a thousand lines of new code for survey matching commands and constraints have been added throughout the approximately 6700 lines of the MatchF source file within a day, without affecting the present BTA match calculations. Survey matching should make it rather simple to optimize magnet placements, bend angles, and spacing for more careful beam line designs.

J. Glenn has suggested that there may be ways to play with the potential focusing capabilities of the present two main BTA dipoles, which might lead to some of the dispersion reducing effects discussed here. This idea might be explored further in these models.

References

1. J. Niederer, *BNL MAD Program Notes: BTA Lattice Matching.* AGS/AD Tech Note 431. Internal Report. March, 1996.
2. J. Niederer, *More BTA Lattice Matching.* AGS/AD Tech Note 440. Internal Report. August, 1996.
3. H. Grote, CERN.

Documents

Unix Typesetter Format - troff / psroff Files.

Host	**rapt.ags.bnl.gov**
This Report	/usr/disc2/jn/Docum+/BTA.notes2
Reference 2	/usr/disc2/jn/Docum+/BTA.notes1
Reference 1	/usr/disc2/jn/Docum+/Match.notes
FMatch	/usr/disc2/jn/Docum+/Fmatch.man
Runtwiss	/usr/disc2/jn/Docum+/Runtwiss.man

To Print from rapt: (To Room 218 AGS 2nd Floor)

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alias it.   'cat * | psroff -t -ms > ppp; lp ppp'
    it.     Manual Name
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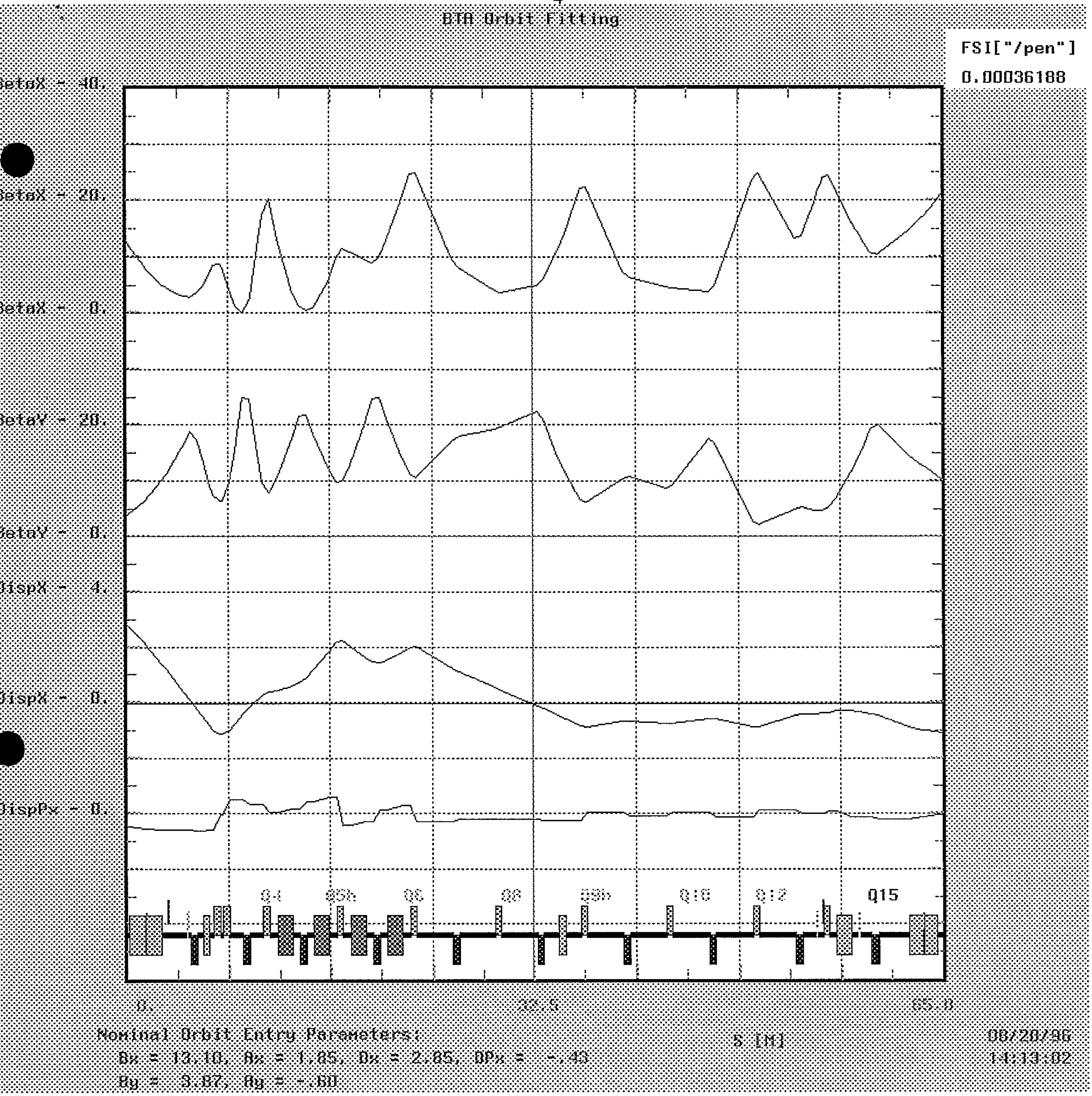

Figure 1. Tracking functions for BTA with four bends.

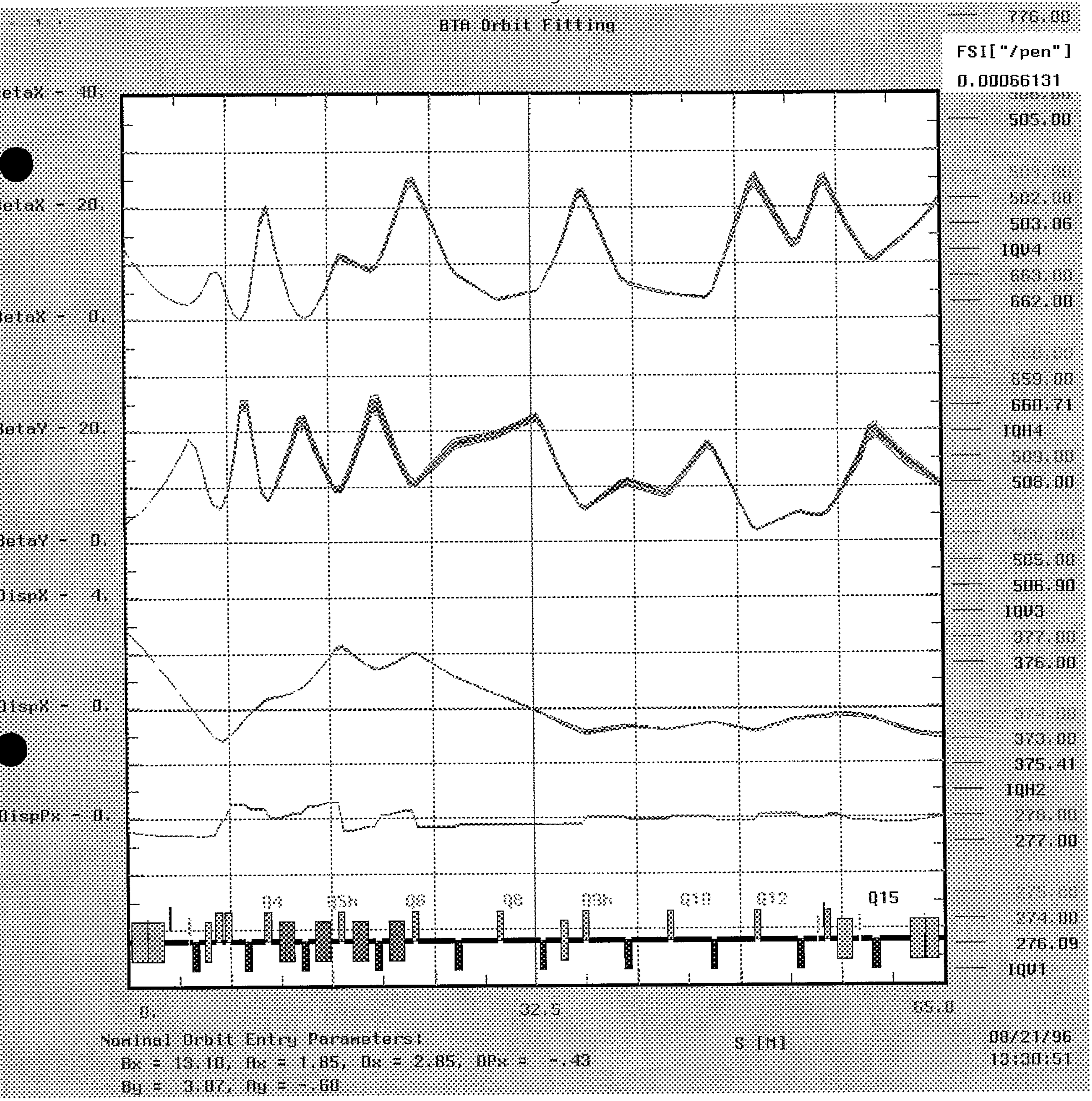

Figure 2. Sensitivity to -2 Amp through +2 Amp quad current drifts.

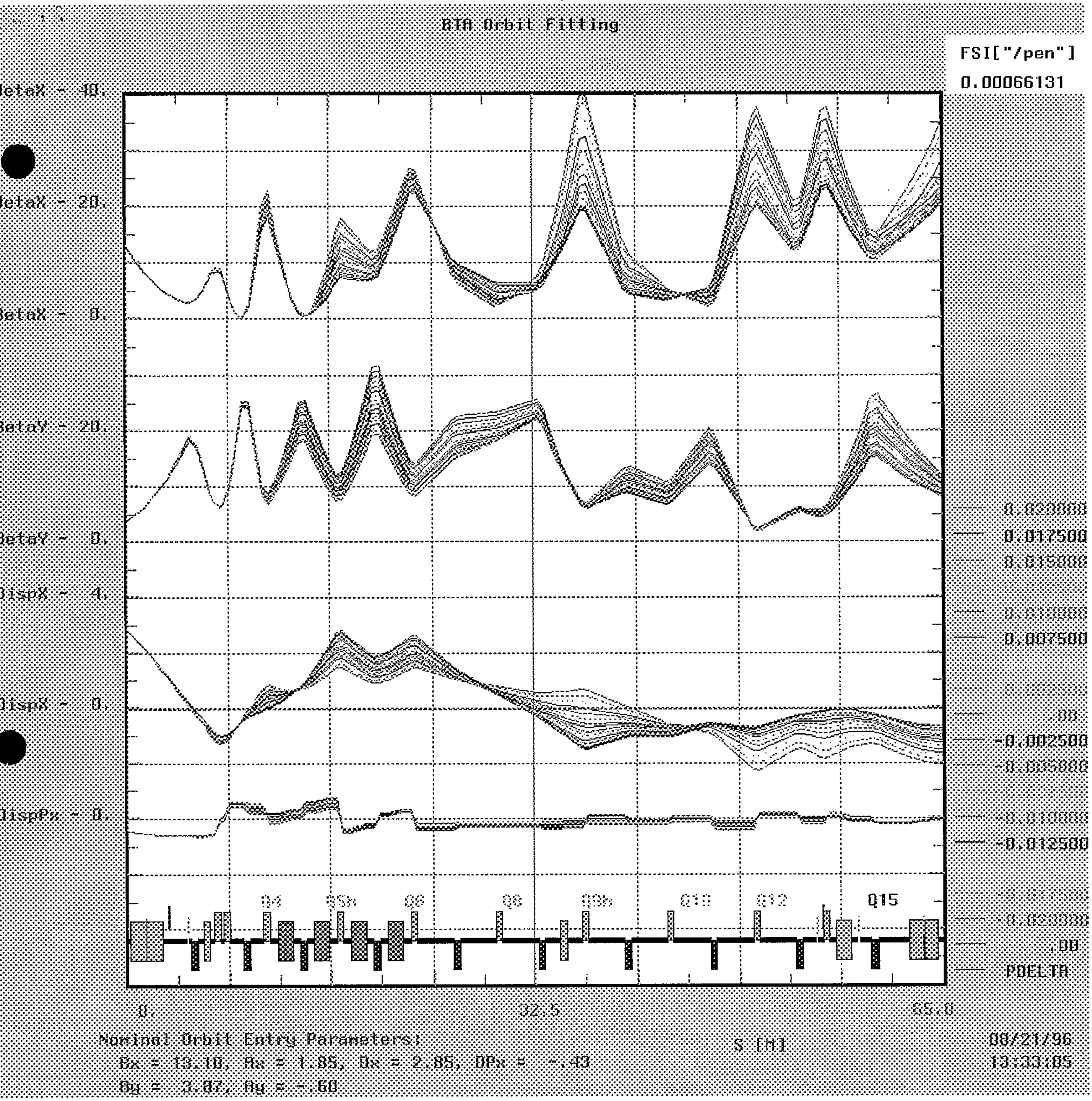

Figure 3. Sensitivity to -2% through +2% momentum offset.

Trial BTA Lattice with Split Bends

Date and time of this run: 08/22/96 17:27:41

LINEAR LATTICE PARAMETERS FOR BEAM LINE: "JBTA ", RANGE = "#S / #E"
DELTA(P)/P = 0.000000 symm = F

POS. NO.	ELEMENT NAME	OCC. NO.	DIST [M]	BETAX [M]	ALFAX [1]	MUX [2PI]	X(CO) [MM]	PX(CO) [.001]	DX [M]	DPX [1]	BETAY [M]	ALFAY [1]	MUY [2PI]	Y(CO) [MM]	PY(CO) [.001]	DY [M]	DPY [1]	ELEMENT	LENGTH	STRENGTH
	ELEMENT SEQUENCE			HORIZONTAL							VERTICAL									
BEGIN	JBTA	1	0.000	13.101	1.851	0.000	0.000	0.000	2.850	-0.427	3.870	-0.596	0.000	0.000	0.000	0.000	0.000			
BEGIN	L0	1	0.000	13.101	1.851	0.000	0.000	0.000	2.850	-0.427	3.870	-0.596	0.000	0.000	0.000	0.000	0.000			
1	MQHF6	1	0.000	13.101	1.851	0.000	0.000	0.000	2.850	-0.427	3.870	-0.596	0.000	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
2	DRQF6	1	0.236	12.246	1.771	0.003	0.000	0.000	2.749	-0.427	4.171	-0.679	0.009	0.000	0.000	0.000	0.000	DRIFT	0.23610	0.0000
3	DHF6A	1	1.486	8.297	1.348	0.023	0.000	0.000	2.160	-0.507	6.415	-1.090	0.048	0.000	0.000	0.000	0.000	SBEND	1.25000	-0.0715
4	DRF6A1	1	1.506	8.244	1.341	0.023	0.000	0.000	2.150	-0.507	6.458	-1.097	0.049	0.000	0.000	0.000	0.000	DRIFT	0.01975	0.0000
5	DHF6T	1	1.506	8.244	1.341	0.023	0.000	0.000	2.150	-0.507	6.458	-1.097	0.049	0.000	0.000	0.000	0.000	HKICK	0.00000	0.0000
6	DRF6A2	1	1.526	8.191	1.335	0.023	0.000	0.000	2.140	-0.507	6.501	-1.104	0.049	0.000	0.000	0.000	0.000	DRIFT	0.01975	0.0000
7	DHF6B	1	2.853	5.251	0.885	0.056	0.000	0.000	1.425	-0.572	9.999	-1.531	0.075	0.000	0.000	0.000	0.000	SBEND	1.32690	-0.0594
8	DRF6B	1	3.259	4.588	0.747	0.069	0.000	0.000	1.193	-0.572	11.299	-1.666	0.082	0.000	0.000	0.000	0.000	DRIFT	0.40640	0.0000
END	L0	1	3.259	4.588	0.747	0.069	0.000	0.000	1.193	-0.572	11.299	-1.666	0.082	0.000	0.000	0.000	0.000			
BEGIN	L1	1	3.259	4.588	0.747	0.069	0.000	0.000	1.193	-0.572	11.299	-1.666	0.082	0.000	0.000	0.000	0.000			
9	PUEH001	1	3.259	4.588	0.747	0.069	0.000	0.000	1.193	-0.572	11.299	-1.666	0.082	0.000	0.000	0.000	0.000	MONITOR	0.00000	0.0000
10	DR001	1	4.344	3.368	0.378	0.114	0.000	0.000	0.573	-0.572	15.308	-2.029	0.095	0.000	0.000	0.000	0.000	DRIFT	1.08490	0.0000
11	MW006	1	4.344	3.368	0.378	0.114	0.000	0.000	0.573	-0.572	15.308	-2.029	0.095	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
12	DR006	1	4.776	3.104	0.231	0.135	0.000	0.000	0.326	-0.572	17.126	-2.174	0.099	0.000	0.000	0.000	0.000	DRIFT	0.43260	0.0000
13	DV007	1	5.005	3.016	0.154	0.147	0.000	0.000	0.195	-0.572	18.138	-2.250	0.101	0.000	0.000	0.000	0.000	VKICK	0.22860	0.0000
14	DR007	1	5.166	2.975	0.099	0.155	0.000	0.000	0.103	-0.572	18.869	-2.304	0.102	0.000	0.000	0.000	0.000	DRIFT	0.16060	0.0000
15	QV1	1	5.724	3.634	-1.361	0.184	0.000	0.000	-0.216	-0.593	17.486	4.602	0.107	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	-0.6755
16	DRQ1	1	6.128	4.859	-1.677	0.199	0.000	0.000	-0.455	-0.593	13.981	4.091	0.111	0.000	0.000	0.000	0.000	DRIFT	0.40315	0.0000
17	DH1	1	6.661	6.871	-2.096	0.214	0.000	0.000	-0.760	-0.553	9.963	3.439	0.118	0.000	0.000	0.000	0.000	RBEND	0.53330	0.0364
END	L1	1	6.661	6.871	-2.096	0.214	0.000	0.000	-0.760	-0.553	9.963	3.439	0.118	0.000	0.000	0.000	0.000			
BEGIN	JJ2	1	6.661	6.871	-2.096	0.214	0.000	0.000	-0.760	-0.553	9.963	3.439	0.118	0.000	0.000	0.000	0.000			
18	DRD1	1	7.040	8.574	-2.393	0.221	0.000	0.000	-0.970	-0.553	7.539	2.950	0.125	0.000	0.000	0.000	0.000	DRIFT	0.37935	0.0000
19	QH2A	1	7.599	8.732	2.138	0.231	0.000	0.000	-1.127	0.004	6.411	-0.741	0.139	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	0.9271
20	DRQ2A	1	7.715	8.246	2.064	0.233	0.000	0.000	-1.127	0.004	6.586	-0.769	0.142	0.000	0.000	0.000	0.000	DRIFT	0.11580	0.0000
21	QH2B	1	8.274	4.374	4.182	0.248	0.000	0.000	-0.965	0.559	9.802	-5.531	0.153	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	0.9271
22	DRQ2B	1	8.734	1.421	2.238	0.277	0.000	0.000	-0.708	0.559	15.571	-7.014	0.159	0.000	0.000	0.000	0.000	DRIFT	0.45990	0.0000
23	XF019	1	8.734	1.421	2.238	0.277	0.000	0.000	-0.708	0.559	15.571	-7.014	0.159	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
24	DR019A	1	9.324	0.252	-0.257	0.500	0.000	0.000	-0.378	0.559	24.973	-8.916	0.164	0.000	0.000	0.000	0.000	DRIFT	0.59020	0.0000
25	QV3	1	9.883	2.232	-3.736	0.646	0.000	0.000	-0.120	0.391	24.889	9.047	0.167	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	-1.2487
26	DRQ3A	1	9.989	3.101	-4.447	0.653	0.000	0.000	-0.079	0.391	23.007	8.693	0.168	0.000	0.000	0.000	0.000	DRIFT	0.10610	0.0000
27	FOIL024	1	9.989	3.101	-4.447	0.653	0.000	0.000	-0.079	0.391	23.007	8.693	0.168	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
28	DR024	1	10.933	17.467	-10.772	0.673	0.000	0.000	0.290	0.391	9.559	5.551	0.178	0.000	0.000	0.000	0.000	DRIFT	0.94400	0.0000
END	JJ2	1	10.933	17.467	-10.772	0.673	0.000	0.000	0.290	0.391	9.559	5.551	0.178	0.000	0.000	0.000	0.000			
BEGIN	JJ3	1	10.933	17.467	-10.772	0.673	0.000	0.000	0.290	0.391	9.559	5.551	0.178	0.000	0.000	0.000	0.000			
29	QH4	1	11.491	20.336	6.517	0.677	0.000	0.000	0.422	0.061	7.897	-2.100	0.189	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	1.5902
30	JDQH4	1	12.091	13.286	5.234	0.683	0.000	0.000	0.459	0.061	10.663	-2.511	0.200	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
31	NBH2A	1	13.301	3.737	2.665	0.711	0.000	0.000	0.626	0.217	17.540	-3.131	0.214	0.000	0.000	0.000	0.000	SBEND	1.21000	0.1443
32	JDH2A	1	13.901	1.320	1.364	0.754	0.000	0.000	0.757	0.217	21.519	-3.501	0.219	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
33	NQV4	1	14.400	0.592	0.167	0.852	0.000	0.000	0.924	0.462	21.807	2.951	0.222	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.5923
34	JDQV4	1	15.000	1.017	-0.875	0.993	0.000	0.000	1.201	0.462	18.426	2.684	0.227	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
35	NBH2B	1	16.210	5.643	-2.953	1.077	0.000	0.000	1.852	0.615	12.361	2.292	0.240	0.000	0.000	0.000	0.000	SBEND	1.21000	0.1443
36	JDH2B	1	16.810	9.806	-3.986	1.090	0.000	0.000	2.221	0.615	9.792	1.989	0.249	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
37	NQH5	1	17.308	11.600	0.657	1.097	0.000	0.000	2.274	-0.402	9.972	-2.376	0.257	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.8912
38	JDQH5	1	17.908	10.856	0.583	1.105	0.000	0.000	2.033	-0.402	13.063	-2.776	0.265	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
39	NBH3A	1	19.118	9.582	0.471	1.124	0.000	0.000	1.638	-0.251	20.514	-3.337	0.277	0.000	0.000	0.000	0.000	SBEND	1.21000	0.1443
40	JDH3A	1	19.718	9.062	0.395	1.135	0.000	0.000	1.488	-0.251	24.732	-3.692	0.281	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000

POS. NO.	ELEMENT NAME	OCC. NO.	DIST [M]	BETAX [M]	ALFAX [1]	MUX [2PI]	X(CO) [MM]	PX(CO) [.001]	DX [M]	DPX [1]	BETAY [M]	ALFAY [1]	MUY [2PI]	Y(CO) [MM]	PY(CO) [.001]	DY [M]	DPY [1]	ELEMENT	LENGTH	STRENGTH
41	NQV5	1	20.217	9.984	-2.328	1.143	0.000	0.000	1.464	0.156	24.940	3.294	0.284	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.5594
42	JDQV5	1	20.817	13.009	-2.714	1.152	0.000	0.000	1.558	0.156	21.158	3.009	0.289	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
43	NBH3B	1	22.027	20.414	-3.412	1.163	0.000	0.000	1.837	0.308	14.316	2.605	0.300	0.000	0.000	0.000	0.000	SBEND	1.21000	0.1443
44	JDH3B	1	22.627	24.731	-3.784	1.168	0.000	0.000	2.022	0.308	11.386	2.279	0.307	0.000	0.000	0.000	0.000	DRIFT	0.60000	0.0000
45	NQH6	1	23.125	24.966	3.336	1.171	0.000	0.000	2.030	-0.275	10.724	-0.890	0.314	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.5696
END	JJ3	1	23.125	24.966	3.336	1.171	0.000	0.000	2.030	-0.275	10.724	-0.890	0.314	0.000	0.000	0.000	0.000			
BEGIN	JJ4	1	23.125	24.966	3.336	1.171	0.000	0.000	2.030	-0.275	10.724	-0.890	0.314	0.000	0.000	0.000	0.000			
46	JDQH6	1	26.036	9.662	1.922	1.201	0.000	0.000	1.231	-0.275	17.319	-1.376	0.349	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
47	NQV7	1	26.534	8.173	1.099	1.210	0.000	0.000	1.115	-0.190	18.083	-0.137	0.353	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.1450
48	JDQV7	1	29.445	4.065	0.313	1.294	0.000	0.000	0.562	-0.190	19.359	-0.301	0.378	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
49	NQH8	1	29.943	3.812	0.194	1.314	0.000	0.000	0.467	-0.192	19.714	-0.411	0.382	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.0083
50	JDQH8	1	32.854	4.989	-0.598	1.430	0.000	0.000	-0.093	-0.192	22.610	-0.584	0.404	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
51	NQV8	1	33.352	6.147	-1.794	1.445	0.000	0.000	-0.194	-0.218	21.224	3.282	0.408	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.3573
52	JDQH8A	1	34.541	11.380	-2.609	1.468	0.000	0.000	-0.453	-0.218	14.207	2.623	0.419	0.000	0.000	0.000	0.000	DRIFT	1.18858	0.0000
53	DH4	1	35.074	14.358	-2.975	1.474	0.000	0.000	-0.564	-0.199	11.563	2.333	0.425	0.000	0.000	0.000	0.000	RBEND	0.53330	0.0171
54	JDQH8B	1	36.263	22.398	-3.790	1.485	0.000	0.000	-0.801	-0.199	6.804	1.671	0.447	0.000	0.000	0.000	0.000	DRIFT	1.18858	0.0000
END	JJ4	1	36.263	22.398	-3.790	1.485	0.000	0.000	-0.801	-0.199	6.804	1.671	0.447	0.000	0.000	0.000	0.000			
BEGIN	JJ5A	1	36.263	22.398	-3.790	1.485	0.000	0.000	-0.801	-0.199	6.804	1.671	0.447	0.000	0.000	0.000	0.000			
55	NQH9	1	36.761	22.616	3.376	1.488	0.000	0.000	-0.835	0.062	6.231	-0.460	0.459	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.6323
56	JDQH9	1	39.672	7.609	1.781	1.524	0.000	0.000	-0.654	0.062	10.559	-1.027	0.517	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
57	NQV9	1	40.170	6.461	0.578	1.535	0.000	0.000	-0.647	-0.034	10.818	0.519	0.525	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.2976
58	JDQV9	1	43.081	4.844	-0.023	1.622	0.000	0.000	-0.744	-0.034	8.789	0.178	0.573	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
59	NQH10	1	43.579	4.594	0.513	1.639	0.000	0.000	-0.736	0.068	9.244	-1.112	0.582	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.2735
60	JDQH10	1	46.490	3.938	-0.287	1.759	0.000	0.000	-0.538	0.068	17.764	-1.816	0.618	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
61	NQV11	1	46.988	4.971	-1.890	1.778	0.000	0.000	-0.546	-0.099	16.833	3.587	0.623	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.6246
62	JDQV11	1	49.899	23.765	-4.567	1.821	0.000	0.000	-0.833	-0.099	2.931	1.189	0.691	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
63	NQH12	1	50.397	24.922	2.355	1.824	0.000	0.000	-0.823	0.138	2.278	0.181	0.723	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.5677
64	JDQH12	1	53.307	13.437	1.591	1.849	0.000	0.000	-0.420	0.138	5.065	-1.139	0.886	0.000	0.000	0.000	0.000	DRIFT	2.91045	0.0000
END	JJ5A	1	53.307	13.437	1.591	1.849	0.000	0.000	-0.420	0.138	5.065	-1.139	0.886	0.000	0.000	0.000	0.000			
BEGIN	JJ5B	1	53.307	13.437	1.591	1.849	0.000	0.000	-0.420	0.138	5.065	-1.139	0.886	0.000	0.000	0.000	0.000			
65	QV13	1	53.806	13.908	-2.583	1.855	0.000	0.000	-0.382	0.017	5.462	0.384	0.901	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	-0.6135
66	DRQ13	1	54.403	17.189	-2.913	1.861	0.000	0.000	-0.372	0.017	5.078	0.258	0.919	0.000	0.000	0.000	0.000	DRIFT	0.59695	0.0000
67	MW166	1	54.403	17.189	-2.913	1.861	0.000	0.000	-0.372	0.017	5.078	0.258	0.919	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
68	DR166	1	54.833	19.799	-3.150	1.865	0.000	0.000	-0.364	0.017	4.895	0.168	0.933	0.000	0.000	0.000	0.000	DRIFT	0.43050	0.0000
69	DV168	1	55.077	21.368	-3.285	1.867	0.000	0.000	-0.360	0.017	4.825	0.117	0.941	0.000	0.000	0.000	0.000	VKICK	0.24380	0.0000
70	DR168	1	55.374	23.364	-3.448	1.869	0.000	0.000	-0.355	0.017	4.775	0.054	0.951	0.000	0.000	0.000	0.000	DRIFT	0.29640	0.0000
71	PUEH170	1	55.374	23.364	-3.448	1.869	0.000	0.000	-0.355	0.017	4.775	0.054	0.951	0.000	0.000	0.000	0.000	MONITOR	0.00000	0.0000
72	DR170	1	55.492	24.188	-3.514	1.870	0.000	0.000	-0.353	0.017	4.765	0.030	0.955	0.000	0.000	0.000	0.000	DRIFT	0.11835	0.0000
73	QH14	1	55.990	24.679	2.568	1.873	0.000	0.000	-0.323	0.102	5.399	-1.354	0.971	0.000	0.000	0.000	0.000	QUADRUPO	0.49850	0.4962
74	DRQ14	1	56.497	22.155	2.412	1.876	0.000	0.000	-0.271	0.102	6.906	-1.620	0.984	0.000	0.000	0.000	0.000	DRIFT	0.50675	0.0000
75	DH5	1	57.743	16.645	2.031	1.887	0.000	0.000	-0.255	-0.076	11.524	-2.038	1.006	0.000	0.000	0.000	0.000	RBEND	1.24560	-0.1619
END	JJ5B	1	57.743	16.645	2.031	1.887	0.000	0.000	-0.255	-0.076	11.524	-2.038	1.006	0.000	0.000	0.000	0.000			
BEGIN	L6	1	57.743	16.645	2.031	1.887	0.000	0.000	-0.255	-0.076	11.524	-2.038	1.006	0.000	0.000	0.000	0.000			
76	DRD5	1	58.194	14.874	1.892	1.891	0.000	0.000	-0.290	-0.076	13.456	-2.240	1.012	0.000	0.000	0.000	0.000	DRIFT	0.45160	0.0000
77	DV181	1	58.438	13.970	1.817	1.894	0.000	0.000	-0.308	-0.076	14.575	-2.349	1.015	0.000	0.000	0.000	0.000	VKICK	0.24380	0.0000
78	DR181	1	58.818	12.634	1.700	1.899	0.000	0.000	-0.337	-0.076	16.424	-2.519	1.019	0.000	0.000	0.000	0.000	DRIFT	0.37980	0.0000
79	XF183	1	58.818	12.634	1.700	1.899	0.000	0.000	-0.337	-0.076	16.424	-2.519	1.019	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
80	DR183	1	59.344	10.933	1.538	1.906	0.000	0.000	-0.377	-0.076	19.195	-2.754	1.023	0.000	0.000	0.000	0.000	DRIFT	0.52550	0.0000

LINEAR LATTICE PARAMETERS FOR BEAM LINE: "JBTA ", RANGE = "#S / #E"
DELTA(P)/P = 0.000000 symm = F

POS. NO.	ELEMENT NAME	OCC. NO.	DIST [M]	BETAX [M]	ALFAX [1]	MUX [2PI]	X(CO) [MM]	PX(CO) [.001]	DX [M]	DPX [1]	BETAY [M]	ALFAY [1]	MUY [2PI]	Y(CO) [MM]	PY(CO) [.001]	DY [M]	DPY [1]	ELEMENT	LENGTH	STRENGTH
	ELEMENT SEQUENCE			HORIZONTAL							VERTICAL									
81	QV15	1	59.902	10.471	-0.681	1.914	0.000	0.000	-0.442	-0.159	20.079	1.233	1.028	0.000	0.000	0.000	0.000	QUADRUPO	0.55880	-0.3641
82	DRQ15	1	60.139	10.800	-0.714	1.918	0.000	0.000	-0.480	-0.159	19.503	1.203	1.030	0.000	0.000	0.000	0.000	DRIFT	0.23630	0.0000
83	SHOLE	1	60.139	10.800	-0.714	1.918	0.000	0.000	-0.480	-0.159	19.503	1.203	1.030	0.000	0.000	0.000	0.000	MARKER	0.00000	0.0000
END	L6	1	60.139	10.800	-0.714	1.918	0.000	0.000	-0.480	-0.159	19.503	1.203	1.030	0.000	0.000	0.000	0.000			
BEGIN	L7	1	60.139	10.800	-0.714	1.918	0.000	0.000	-0.480	-0.159	19.503	1.203	1.030	0.000	0.000	0.000	0.000			
84	DRQ15B	1	62.401	14.745	-1.030	1.946	0.000	0.000	-0.839	-0.159	14.702	0.919	1.051	0.000	0.000	0.000	0.000	DRIFT	2.26190	0.0000
85	L20SPTM1	1	63.466	17.095	-1.179	1.957	0.000	0.000	-0.969	-0.087	12.827	0.837	1.063	0.000	0.000	0.000	0.000	RBEND	1.06514	0.0655
86	DRL20A1	1	63.496	17.166	-1.183	1.957	0.000	0.000	-0.972	-0.087	12.777	0.833	1.064	0.000	0.000	0.000	0.000	DRIFT	0.02987	0.0000
87	L20SPTMT	1	63.496	17.166	-1.183	1.957	0.000	0.000	-0.972	-0.087	12.777	0.833	1.064	0.000	0.000	0.000	0.000	HKICK	0.00000	0.0000
88	DRL20A2	1	63.525	17.237	-1.187	1.958	0.000	0.000	-0.975	-0.087	12.727	0.829	1.064	0.000	0.000	0.000	0.000	DRIFT	0.02987	0.0000
89	L20SPTM2	1	64.560	19.840	-1.331	1.967	0.000	0.000	-1.028	-0.017	11.105	0.735	1.078	0.000	0.000	0.000	0.000	RBEND	1.03454	0.0637
90	DRL20B	1	65.033	21.130	-1.398	1.970	0.000	0.000	-1.036	-0.017	10.441	0.670	1.085	0.000	0.000	0.000	0.000	DRIFT	0.47272	0.0000
END	L7	1	65.033	21.130	-1.398	1.970	0.000	0.000	-1.036	-0.017	10.441	0.670	1.085	0.000	0.000	0.000	0.000			
END	JBTA	1	65.033	21.130	-1.398	1.970	0.000	0.000	-1.036	-0.017	10.441	0.670	1.085	0.000	0.000	0.000	0.000			

TOTAL LENGTH =	65.032629	MUX =	1.970210	MUY =	1.084962
DELTA(S) =	0.000000 mm	DMUX =	-6.083708	DMUY =	-1.191087
		BETAX(MAX) =	24.965708	BETAY(MAX) =	24.973000
		DX(MAX) =	2.850000	DY(MAX) =	0.000000