DAΦNE TECHNICAL NOTE

INFN - LNF, Accelerator Division

Frascati, September 11, 1997

Note: **I-15**

ABOUT e$^-$ TRANSFER LINES

C. Biscari

During the first accumulator commissioning runs (1996), the main goal being to accumulate and measure the beam in the accumulator, the transfer line was not optimized.

The beam from the Linac had high current, large energy spread and large emittance, with values far from the nominal ones for which the transfer lines were designed. The quadrupole configuration was chosen in order to minimize the dispersion function, and therefore optimize the energy acceptance of the transport. That quadrupole configuration does not fit the requirements for the extraction of the beam from the accumulator and its injection in the e$^-$ ring.

In view of the next commissioning (which includes the latter items), a new configuration must be used. Quadrupole currents and polarities, optical functions, beam envelopes, expected beam sizes at targets are shown in the following tables and drawings for both the lines Linac $\rightarrow$ Accumulator and Accumulator $\rightarrow$ e$^-$ ring lines.

The optical functions at the transfer line initial point are determined by the last linac quadrupoles. Figure 1 shows the dependence of the autobeta functions at the center of the last linac quadrupole on the strength of the same quadrupole, under the assumption that the last quadrupoles in the linac focusing structure are set at constant phase advance.

The gradient and the current of the quadrupole are also plotted for the nominal energy of 510 MeV.

Obviously given a certain current of the quadrupole, the gradient is fixed and corresponds in Fig. 1 at a certain value K^2_{nom}. The value of K^2 is inversely proportional to the energy:

$$K^2 = \frac{1}{B\rho} G$$

therefore if the linac output energy is $E_{out}(MeV)$, the FODO autobetas are those corresponding to the value

$$K^2 = \frac{510}{E_{out}} K^2_{nom}$$

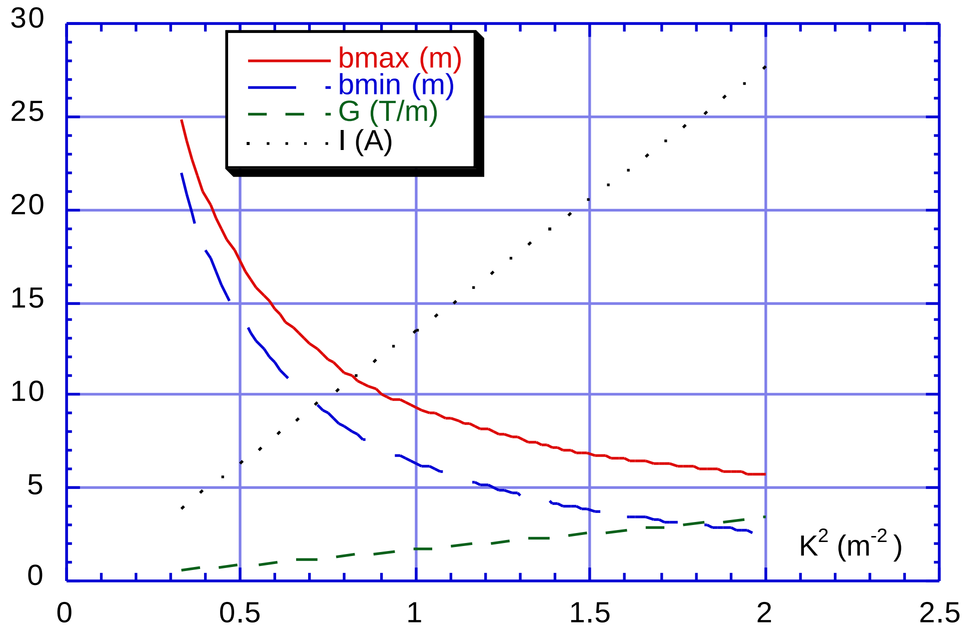


Figure 1 - Last linac FODO cell: autobeta, gradient, current.

An usual value of the linac last quadrupole current in the last runs corresponded to $K^2 = 1.m^{-2}$, horizontally focusing. The corresponding autobeta are 9.3 and 6.3 m. The quadrupole configuration of the line between the linac and the accumulator has been optimized with these initial values.

Figure 2 shows the optical functions and the beam envelopes along the line for the nominal emittance and energy spread for electrons:

$$\varepsilon_x = \varepsilon_y = 1\ mm\ mrad$$
$$\Delta E / E = \pm\ 0.5\%$$

The dashed lines in the envelope plot correspond to a factor two on these values $(\varepsilon_x = \varepsilon_y = 2\ mm\ mrad \qquad \Delta E / E = \pm 1\%)$. It is evident that the betatron acceptance of the line is larger than the nominal values, while the energy acceptance is not so large.

Table I lists the values of the strengths, currents and polarities of all the quadrupoles. The polarity is the one to be set by the control system, taking into account the present cabling configuration. The focusing or defocusing configuration is defined in the strength list. In the matching section (TM) four of the nine quadrupoles can be switched off.

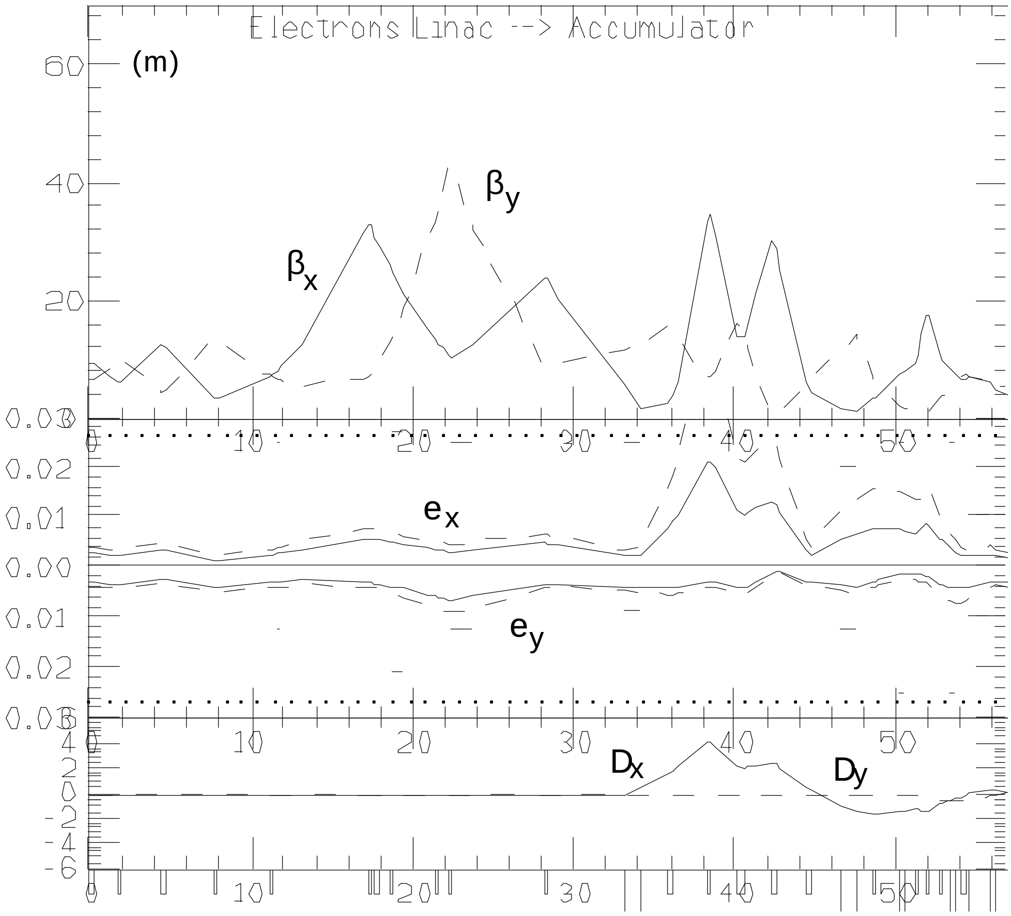
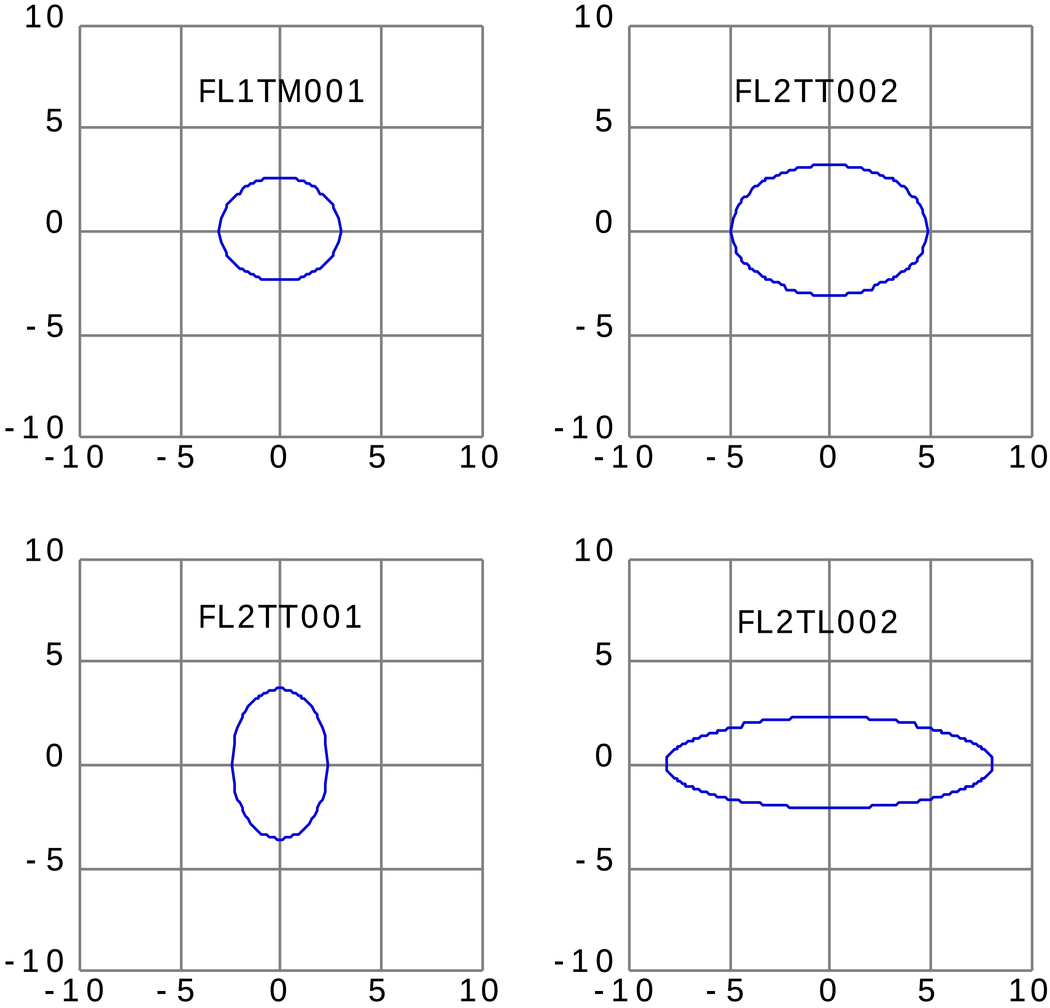


Figure 2 - Optical functions and beam envelope in the Linac → Accumulator line.

TABLE I - Quadrupoles from Linac to Accumulator

Name	K^2 (m^{-2})	Current A	Polarity
QUATM001	-1.400	21.753	POS
QUATM002	1.600	23.759	NEG
QUATM003	-1.250	19.478	POS
QUATM004	0.000	0.000	NEG
QUATM005	0.950	13.898	POS
QUATM006	0.000	0.000	POS
QUATM007	0.000	0.000	POS
QUATM008	0.000	0.000	POS
QUATM009	-1.100	17.202	NEG
QUATT006	0.930	13.595	NEG
QUATT005	-0.740	15.316	POS
QUATT004	1.770	35.684	NEG
QUATT003	-2.080	42.543	POS
QUATT002	1.565	31.519	NEG
QUATT001	-1.230	25.272	POS
QUATL005	1.000	14.657	POS
QUATL004	-2.200	33.890	NEG
QUATL003	4.000	60.170	POS
QUATL002	-2.000	30.856	POS
QUATL001	-1.600	24.787	NEG

Figure 3 shows the expected aspect ratio and size in the transverse plane of the beam at the SEM flags along the line for the nominal beam parameters.



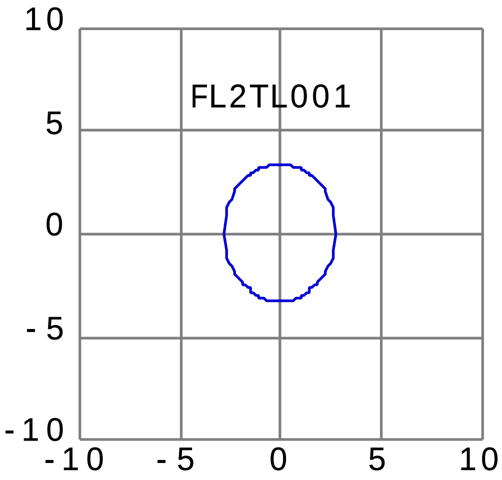


Figure 3 - Expected beam size (mm) and aspect ratio in targets along the Linac → Accumulator line.

(La figura serve solo a pubblicizzare il prodotto...)

A variation of even 50% of the current in the last linac quadrupole can be easily matched with the first quadrupoles of the line. The absolute values of the strengths of the five matching quadrupoles of the line TM are plotted as a function of the last linac quadrupole variation in Fig. 4.

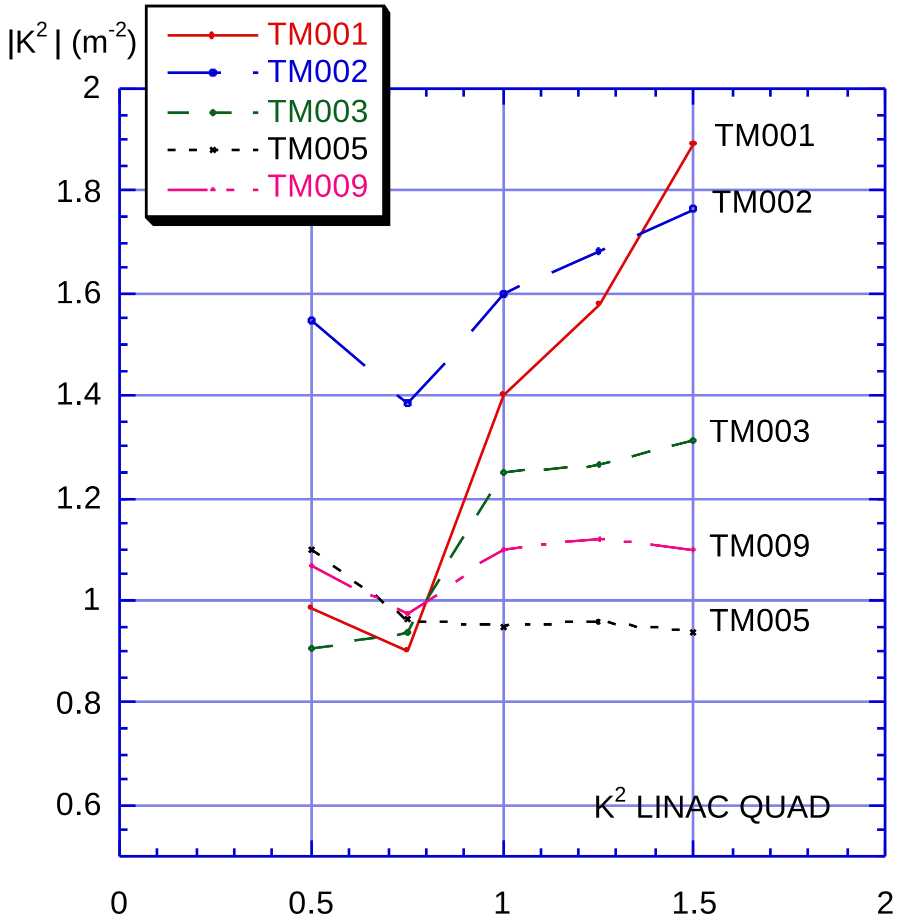


Figure 4 - Variation of the five matching quadrupoles as a function of the strength of the last linac quadrupole.

The line for extraction from the accumulator and injection in the e^- ring is described in Figs. 5 and 6 and table II. The beam parameters used for the envelope computation are:

$$\varepsilon_x = 0.3 \quad mm\ mrad$$

$$\varepsilon_y = 0.15\ mm\ mrad$$

$$\Delta E / E = \pm 0.1\%$$

The initial values of the betatron functions are those at the septum entrance for the accumulator working point (3.146, 1.162).

The list of the betatron functions along the lines is given in the Appendix.

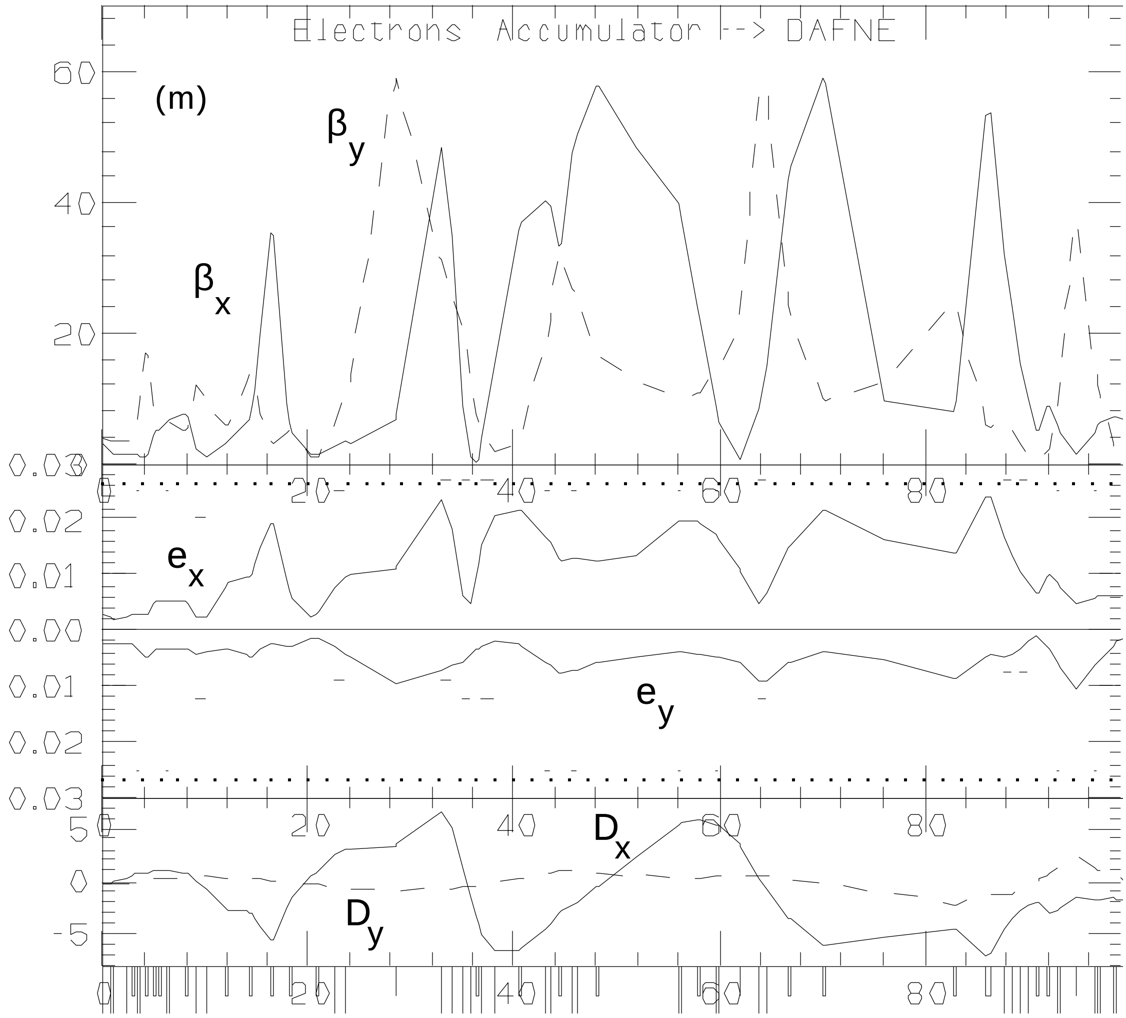


Figure 5 - Optical functions and beam envelope of the Accumulator $\rightarrow e^-$ ring line.

In Fig. 6 the beam sizes are computed for the nominal horizontal emittance and vertical emittance ten times smaller, corresponding to 10% coupling in the accumulator.

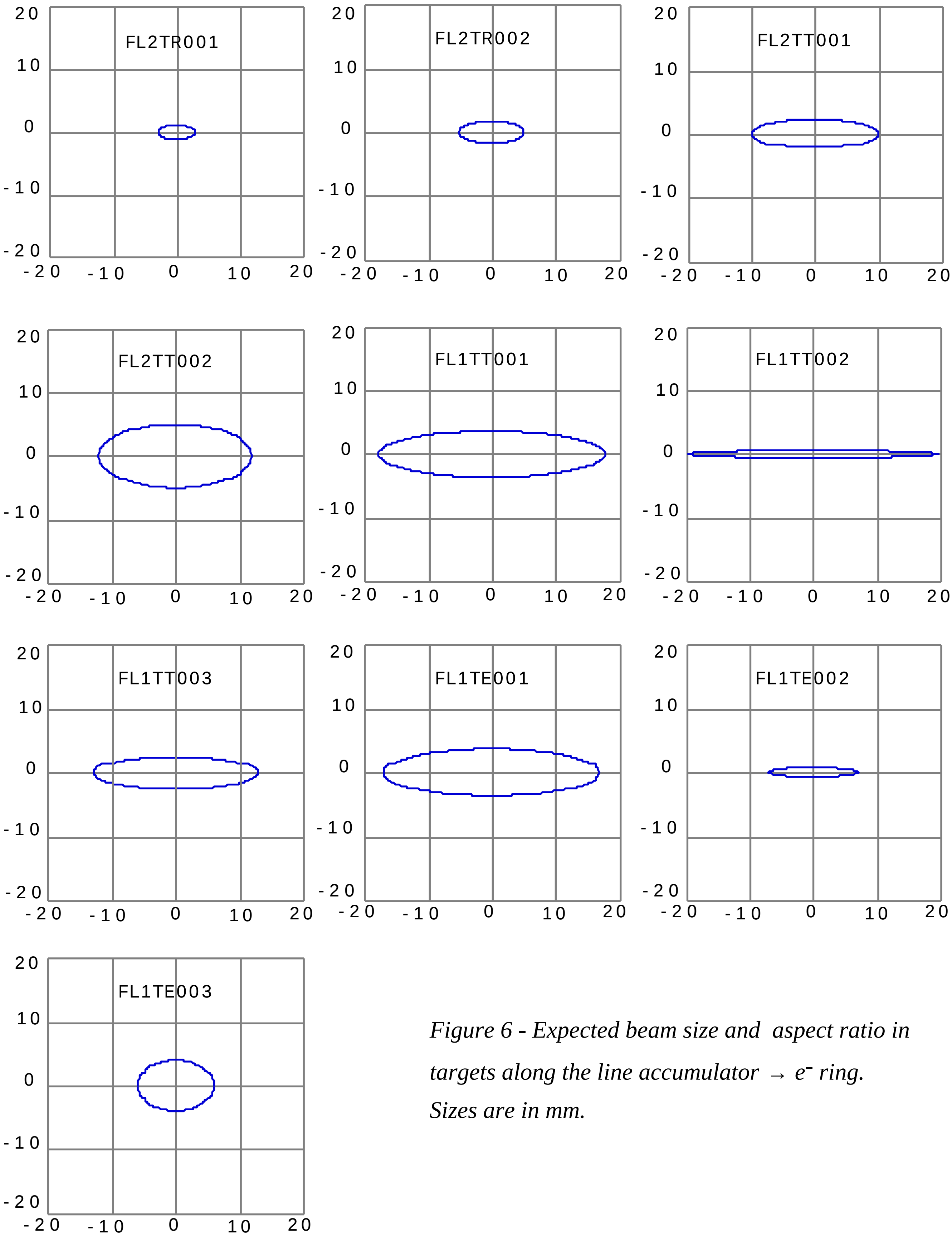


Figure 6 - Expected beam size and aspect ratio in targets along the line accumulator → e^- ring. Sizes are in mm.

TABLE II - Quadrupoles in the Accumulator → e^- ring line

Name	K^2 (m^{-2})	Current (A)	Polarity
QUATR001	3.6586679	54.991	
QUATR002	-4.4987010	68.763	
QUATR003	3.1783390	47.704	
QUATR004	-0.1568800	2.894	
QUATR005	2.5674580	38.437	
QUATT001	1.2300000	24.712	
QUATT002	-1.5650000	32.079	
QUATT003	2.0800000	41.983	
QUATT004	-1.7700000	36.244	
QUATT005	0.7400000	14.756	
QUATT006	-0.9300000	14.623	
QUATT007	2.2100000	33.014	
QUATT008	0.6000000	8.589	
QUATT009	-1.3200000	20.540	
QUATT010	0.2800000	3.734	
QUATE001	0.3450000	4.720	
QUATE002	1.3300000	19.663	
QUATE003	0.7700000	11.168	
QUATE004	0.7100000	10.257	
QUATE005	-1.1100000	17.354	
QUATE006	1.7400000	25.883	
QUATE007	-3.9300000	60.136	
QUATE008	2.4300000	36.351	
QUATE009	-2.4800000	38.138	

APPENDIX 1

Optical functions in Linac → Accumulator line

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Linear lattice functions.     TWISS              line: LINEL                range: #S/#E
Delta(p)/p:     0.000000      symm: F            super:    1                                                page    1
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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]
begin	LINEL	1	0.000	9.300	0.000	0.000	0.000	0.000	0.000	0.000	6.300	0.000	0.000	0.000	0.000	0.000	0.000
1	D0	1	0.000	9.300	0.000	0.000	0.000	0.000	0.000	0.000	6.300	0.000	0.000	0.000	0.000	0.000	0.000
begin	LIE	1	0.000	9.300	0.000	0.000	0.000	0.000	0.000	0.000	6.300	0.000	0.000	0.000	0.000	0.000	0.000
begin	LIE1	1	0.000	9.300	0.000	0.000	0.000	0.000	0.000	0.000	6.300	0.000	0.000	0.000	0.000	0.000	0.000
2	QLE0	1	0.140	9.121	1.270	0.002	0.000	0.000	0.000	0.000	6.427	-0.916	0.004	0.000	0.000	0.000	0.000
3	DL0	1	1.140	6.867	0.984	0.023	0.000	0.000	0.000	0.000	8.546	-1.202	0.025	0.000	0.000	0.000	0.000
4	DL1	1	1.670	5.905	0.832	0.036	0.000	0.000	0.000	0.000	9.900	-1.354	0.034	0.000	0.000	0.000	0.000
5	QLE1	1	1.870	5.908	-0.849	0.041	0.000	0.000	0.000	0.000	9.889	1.410	0.037	0.000	0.000	0.000	0.000
6	DL2	1	4.490	12.353	-1.611	0.091	0.000	0.000	0.000	0.000	4.576	0.618	0.101	0.000	0.000	0.000	0.000
7	QLE2	1	4.690	12.208	2.321	0.093	0.000	0.000	0.000	0.000	4.630	-0.892	0.108	0.000	0.000	0.000	0.000
8	BPSTM001	1	4.690	12.208	2.321	0.093	0.000	0.000	0.000	0.000	4.630	-0.892	0.108	0.000	0.000	0.000	0.000
9	DL3	1	7.610	3.113	0.793	0.172	0.000	0.000	0.000	0.000	13.142	-2.024	0.169	0.000	0.000	0.000	0.000
10	QLE3	1	7.810	2.965	-0.039	0.183	0.000	0.000	0.000	0.000	13.294	1.277	0.172	0.000	0.000	0.000	0.000
11	DL4	1	8.066	3.007	-0.125	0.196	0.000	0.000	0.000	0.000	12.653	1.227	0.175	0.000	0.000	0.000	0.000
12	CHVTM001	1	8.066	3.007	-0.125	0.196	0.000	0.000	0.000	0.000	12.653	1.227	0.175	0.000	0.000	0.000	0.000
13	DL4A1	1	10.995	6.639	-1.115	0.310	0.000	0.000	0.000	0.000	7.165	0.647	0.224	0.000	0.000	0.000	0.000
14	DL4A2	1	11.010	6.672	-1.120	0.310	0.000	0.000	0.000	0.000	7.145	0.644	0.225	0.000	0.000	0.000	0.000
15	QLE4	1	11.210	7.134	-1.187	0.315	0.000	0.000	0.000	0.000	6.896	0.604	0.229	0.000	0.000	0.000	0.000
16	DL5	1	11.638	8.212	-1.332	0.324	0.000	0.000	0.000	0.000	6.415	0.520	0.240	0.000	0.000	0.000	0.000
17	CHVTM002	1	11.638	8.212	-1.332	0.324	0.000	0.000	0.000	0.000	6.415	0.520	0.240	0.000	0.000	0.000	0.000
18	DL5A	1	11.827	8.728	-1.396	0.327	0.000	0.000	0.000	0.000	6.225	0.482	0.244	0.000	0.000	0.000	0.000
19	MF	1	11.827	8.728	-1.396	0.327	0.000	0.000	0.000	0.000	6.225	0.482	0.244	0.000	0.000	0.000	0.000
end	LIE1	1	11.827	8.728	-1.396	0.327	0.000	0.000	0.000	0.000	6.225	0.482	0.244	0.000	0.000	0.000	0.000
begin	LIE2	1	11.827	8.728	-1.396	0.327	0.000	0.000	0.000	0.000	6.225	0.482	0.244	0.000	0.000	0.000	0.000
20	DL5A1	1	13.012	12.510	-1.796	0.346	0.000	0.000	0.000	0.000	5.361	0.248	0.277	0.000	0.000	0.000	0.000
21	DL5A2	1	16.864	31.357	-3.097	0.377	0.000	0.000	0.000	0.000	6.391	-0.515	0.392	0.000	0.000	0.000	0.000
22	CHVTM003	1	16.864	31.357	-3.097	0.377	0.000	0.000	0.000	0.000	6.391	-0.515	0.392	0.000	0.000	0.000	0.000
23	DL5A22	1	17.120	32.965	-3.183	0.378	0.000	0.000	0.000	0.000	6.667	-0.566	0.398	0.000	0.000	0.000	0.000
24	QLE5	1	17.320	32.983	3.095	0.379	0.000	0.000	0.000	0.000	7.164	-1.949	0.402	0.000	0.000	0.000	0.000
25	DL5B	1	17.720	30.558	2.967	0.381	0.000	0.000	0.000	0.000	8.831	-2.217	0.410	0.000	0.000	0.000	0.000
26	QLE6	1	17.920	29.384	2.903	0.382	0.000	0.000	0.000	0.000	9.744	-2.351	0.414	0.000	0.000	0.000	0.000
27	BPSTM002	1	17.920	29.384	2.903	0.382	0.000	0.000	0.000	0.000	9.744	-2.351	0.414	0.000	0.000	0.000	0.000
28	DL6	1	18.520	26.016	2.710	0.385	0.000	0.000	0.000	0.000	12.806	-2.753	0.422	0.000	0.000	0.000	0.000
29	QLE7	1	18.720	24.944	2.646	0.387	0.000	0.000	0.000	0.000	13.934	-2.887	0.425	0.000	0.000	0.000	0.000
30	DL7A	1	19.477	21.122	2.403	0.392	0.000	0.000	0.000	0.000	18.689	-3.394	0.432	0.000	0.000	0.000	0.000
31	MFF	1	19.477	21.122	2.403	0.392	0.000	0.000	0.000	0.000	18.689	-3.394	0.432	0.000	0.000	0.000	0.000
32	DL7B1	1	20.877	15.021	1.954	0.404	0.000	0.000	0.000	0.000	29.504	-4.332	0.442	0.000	0.000	0.000	0.000
33	DL7B2	1	21.320	13.353	1.812	0.409	0.000	0.000	0.000	0.000	33.474	-4.628	0.444	0.000	0.000	0.000	0.000
34	QLE8	1	21.520	12.641	1.748	0.412	0.000	0.000	0.000	0.000	35.352	-4.762	0.445	0.000	0.000	0.000	0.000
35	DL8A	1	21.710	11.988	1.687	0.414	0.000	0.000	0.000	0.000	37.186	-4.890	0.446	0.000	0.000	0.000	0.000
36	CHVTMC04	1	21.710	11.988	1.687	0.414	0.000	0.000	0.000	0.000	37.186	-4.890	0.446	0.000	0.000	0.000	0.000
37	DL8	1	22.220	10.351	1.523	0.422	0.000	0.000	0.000	0.000	42.347	-5.231	0.448	0.000	0.000	0.000	0.000
38	QLE9	1	22.420	10.198	-0.751	0.425	0.000	0.000	0.000	0.000	42.569	4.138	0.449	0.000	0.000	0.000	0.000
39	BPSTM003	1	22.420	10.198	-0.751	0.425	0.000	0.000	0.000	0.000	42.569	4.138	0.449	0.000	0.000	0.000	0.000
40	DL9	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
41	MPUL	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
end	LIE2	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000

TRANSPORT LINES (updated 5/95) "MAD" Version: 8.9/0 Run: 10/09/97 10.03.14
Linear lattice functions. TWISS line: LINEL range: #S/#E
Delta(p)/p: 0.000000 symm: F super: 1 page 2

pos. no.	ELEMENT SEQUENCE element name	occ. no.	dist [m]	HORIZONTAL betax [m]	alfax [1]	mux [2pi]	x(co) [mm]	px(co) [.001]	Dx [m]	Dpx [1]	VERTICAL betay [m]	alfay [1]	muy [2pi]	y(co) [mm]	py(co) [.001]	Dy [m]	Dpy [1]
end	LIE	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
begin	EINC	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
begin	LLE4	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
42	XV	1	23.771	12.508	-0.958	0.444	0.000	0.000	0.000	0.000	32.166	3.563	0.454	0.000	0.000	0.000	0.000
43	D17	1	28.120	23.745	-1.625	0.484	0.000	0.000	0.000	0.000	9.229	1.711	0.495	0.000	0.000	0.000	0.000
44	QQE11	1	28.320	23.513	2.772	0.486	0.000	0.000	0.000	0.000	8.892	-0.006	0.498	0.000	0.000	0.000	0.000
45	BPSTT004	1	28.320	23.513	2.772	0.486	0.000	0.000	0.000	0.000	8.892	-0.006	0.498	0.000	0.000	0.000	0.000
46	D16	1	28.881	20.519	2.565	0.490	0.000	0.000	0.000	0.000	8.934	-0.070	0.509	0.000	0.000	0.000	0.000
47	CHVTT005	1	28.881	20.519	2.565	0.490	0.000	0.000	0.000	0.000	8.934	-0.070	0.509	0.000	0.000	0.000	0.000
48	D16A	1	33.070	5.512	1.018	0.554	0.000	0.000	0.000	0.000	11.490	-0.541	0.576	0.000	0.000	0.000	0.000
49	M6	1	33.070	5.512	1.018	0.554	0.000	0.000	0.000	0.000	11.490	-0.541	0.576	0.000	0.000	0.000	0.000
50	HPE1	1	34.183	1.685	1.683	0.608	0.000	0.000	0.415	0.707	12.833	-0.666	0.591	0.000	0.000	0.000	0.000
51	BPSTT003	1	34.183	1.685	1.683	0.608	0.000	0.000	0.415	0.707	12.833	-0.666	0.591	0.000	0.000	0.000	0.000
end	LLE4	1	34.183	1.685	1.683	0.608	0.000	0.000	0.415	0.707	12.833	-0.666	0.591	0.000	0.000	0.000	0.000
begin	LLE3C	1	34.183	1.685	1.683	0.608	0.000	0.000	0.415	0.707	12.833	-0.666	0.591	0.000	0.000	0.000	0.000
begin	ALLE3	1	34.183	1.685	1.683	0.608	0.000	0.000	0.415	0.707	12.833	-0.666	0.591	0.000	0.000	0.000	0.000
52	D15	1	35.833	2.325	-2.071	0.951	0.000	0.000	1.582	0.707	15.336	-0.851	0.610	0.000	0.000	0.000	0.000
53	QQE10	1	36.133	3.991	-3.606	0.967	0.000	0.000	1.849	1.086	14.836	2.483	0.613	0.000	0.000	0.000	0.000
54	D14	1	36.389	6.067	-4.504	0.975	0.000	0.000	2.127	1.086	13.596	2.359	0.616	0.000	0.000	0.000	0.000
55	CHVTT004	1	36.389	6.067	-4.504	0.975	0.000	0.000	2.127	1.086	13.596	2.359	0.616	0.000	0.000	0.000	0.000
56	D14A	1	38.178	33.412	-10.781	0.995	0.000	0.000	4.070	1.086	6.701	1.495	0.646	0.000	0.000	0.000	0.000
57	QQE9	1	38.478	34.468	7.448	0.996	0.000	0.000	4.067	-1.104	6.876	-2.111	0.653	0.000	0.000	0.000	0.000
58	D13	1	38.734	30.762	7.028	0.998	0.000	0.000	3.785	-1.104	8.010	-2.315	0.658	0.000	0.000	0.000	0.000
59	CHVTT003	1	38.734	30.762	7.028	0.998	0.000	0.000	3.785	-1.104	8.010	-2.315	0.659	0.000	0.000	0.000	0.000
60	D13A	1	40.178	13.881	4.663	1.009	0.000	0.000	2.191	-1.104	16.349	-3.461	0.679	0.000	0.000	0.000	0.000
61	QQE8	1	40.478	13.642	-3.819	1.012	0.000	0.000	2.058	0.202	15.369	6.522	0.682	0.000	0.000	0.000	0.000
62	D12	1	40.734	15.672	-4.111	1.015	0.000	0.000	2.109	0.202	12.215	5.797	0.684	0.000	0.000	0.000	0.000
63	CHVTT002	1	40.734	15.672	-4.111	1.015	0.000	0.000	2.109	0.202	12.215	5.797	0.684	0.000	0.000	0.000	0.000
64	D12A	1	41.328	20.959	-4.790	1.020	0.000	0.000	2.229	0.202	6.328	4.114	0.695	0.000	0.000	0.000	0.000
65	BPSTT002	1	41.328	20.959	-4.790	1.020	0.000	0.000	2.229	0.202	6.328	4.114	0.695	0.000	0.000	0.000	0.000
66	D12B	1	42.178	29.927	-5.761	1.026	0.000	0.000	2.400	0.202	1.381	1.706	0.742	0.000	0.000	0.000	0.000
67	QQE7	1	42.478	29.145	8.244	1.027	0.000	0.000	2.292	-0.913	0.729	0.567	0.791	0.000	0.000	0.000	0.000
68	D11	1	42.734	25.079	7.638	1.029	0.000	0.000	2.059	-0.913	0.557	0.103	0.857	0.000	0.000	0.000	0.000
69	CHVTT001	1	42.734	25.079	7.638	1.029	0.000	0.000	2.059	-0.913	0.557	0.103	0.857	0.000	0.000	0.000	0.000
70	D11A	1	44.448	5.847	3.583	1.051	0.000	0.000	0.494	-0.913	5.530	-3.004	1.072	0.000	0.000	0.000	0.000
71	QQE6	1	44.748	4.427	1.322	1.061	0.000	0.000	0.242	-0.779	6.770	-0.975	1.080	0.000	0.000	0.000	0.000
72	MQ	1	44.748	4.427	1.322	1.061	0.000	0.000	0.242	-0.779	6.770	-0.975	1.080	0.000	0.000	0.000	0.000
73	D10	1	46.520	1.691	0.222	1.173	0.000	0.000	-1.138	-0.779	11.128	-1.485	1.113	0.000	0.000	0.000	0.000
end	ALLE3	1	46.520	1.691	0.222	1.173	0.000	0.000	-1.138	-0.779	11.128	-1.485	1.113	0.000	0.000	0.000	0.000
74	TTE1C	1	47.520	1.314	-0.495	1.281	0.000	0.000	-1.345	-0.236	14.387	4.793	1.125	0.000	0.000	0.000	0.000
end	LLE3C	1	47.520	1.314	-0.495	1.281	0.000	0.000	-1.345	-0.236	14.387	4.793	1.125	0.000	0.000	0.000	0.000
begin	LLE2	1	47.520	1.314	-0.495	1.281	0.000	0.000	-1.345	-0.236	14.387	4.793	1.125	0.000	0.000	0.000	0.000
75	D9	1	48.483	3.147	-1.408	1.360	0.000	0.000	-1.572	-0.236	6.701	3.188	1.141	0.000	0.000	0.000	0.000
76	QQE5	1	48.683	3.609	-0.869	1.369	0.000	0.000	-1.588	0.081	5.731	1.728	1.146	0.000	0.000	0.000	0.000
77	D8A	1	48.939	4.086	-0.994	1.380	0.000	0.000	-1.567	0.081	4.892	1.550	1.154	0.000	0.000	0.000	0.000
78	CHVTL003	1	48.939	4.086	-0.994	1.380	0.000	0.000	-1.567	0.081	4.892	1.550	1.154	0.000	0.000	0.000	0.000
79	D8	1	50.206	7.384	-1.610	1.417	0.000	0.000	-1.464	0.081	2.080	0.669	1.219	0.000	0.000	0.000	0.000

TRANSPORT LINES (updated 5/95) "MAD" Version: 8.9/0 Run: 10/09/97 10.03.14
Linear lattice functions. TWISS line: LINEL range: #S/#E
Delta(p)/p: 0.000000 symm: F super: 1 page 3

ELEMENT SEQUENCE			I	HORIZONTAL							I	VERTICAL						
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]
80	M5	1	50.206	7.384	-1.610	1.417	0.000	0.000	-1.464	0.081		2.080	0.669	1.219	0.000	0.000	0.000	0.000
81	VBM	1	50.556	8.279	-0.900	1.424	0.000	0.000	-1.409	0.233		1.699	0.427	1.248	0.000	0.000	-0.033	-0.193
82	D7	1	51.106	9.336	-1.021	1.434	0.000	0.000	-1.281	0.233		1.440	0.044	1.305	0.000	0.000	-0.139	-0.193
83	QQE4	1	51.306	10.623	-5.605	1.437	0.000	0.000	-1.290	-0.329		1.327	0.503	1.328	0.000	0.000	-0.171	-0.124
84	D6A	1	51.600	14.183	-6.502	1.441	0.000	0.000	-1.387	-0.329		1.114	0.225	1.367	0.000	0.000	-0.208	-0.124
85	CHVTL002	1	51.600	14.183	-6.502	1.441	0.000	0.000	-1.387	-0.329		1.114	0.225	1.367	0.000	0.000	-0.208	-0.124
86	D6	1	51.856	17.712	-7.283	1.443	0.000	0.000	-1.471	-0.329		1.060	-0.016	1.405	0.000	0.000	-0.239	-0.124
87	QQE3	1	52.056	17.754	7.084	1.445	0.000	0.000	-1.419	0.843		1.286	-1.173	1.433	0.000	0.000	-0.284	-0.330
88	D5	1	52.599	10.911	5.519	1.451	0.000	0.000	-0.961	0.843		3.104	-2.176	1.477	0.000	0.000	-0.464	-0.330
89	QQE2	1	52.799	9.598	1.217	1.454	0.000	0.000	-0.829	0.487		3.759	-1.010	1.486	0.000	0.000	-0.510	-0.134
90	D4A	1	53.117	8.850	1.135	1.460	0.000	0.000	-0.674	0.487		4.456	-1.181	1.498	0.000	0.000	-0.553	-0.134
91	BPSTL001	1	53.117	8.850	1.135	1.460	0.000	0.000	-0.674	0.487		4.456	-1.181	1.498	0.000	0.000	-0.553	-0.134
92	CHVTL001	1	53.117	8.850	1.135	1.460	0.000	0.000	-0.674	0.487		4.456	-1.181	1.498	0.000	0.000	-0.553	-0.134
93	D4	1	53.348	8.340	1.075	1.464	0.000	0.000	-0.561	0.487		5.031	-1.306	1.506	0.000	0.000	-0.584	-0.134
94	VBP	1	53.698	7.328	1.764	1.471	0.000	0.000	-0.380	0.537		6.004	-1.493	1.516	0.000	0.000	-0.597	0.058
end	LLE2	1	53.698	7.328	1.764	1.471	0.000	0.000	-0.380	0.537		6.004	-1.493	1.516	0.000	0.000	-0.597	0.058
begin	LLE1	1	53.698	7.328	1.764	1.471	0.000	0.000	-0.380	0.537		6.004	-1.493	1.516	0.000	0.000	-0.597	0.058
95	D3	1	53.975	6.393	1.609	1.478	0.000	0.000	-0.232	0.537		6.872	-1.642	1.523	0.000	0.000	-0.581	0.058
96	QQE1	1	54.175	6.163	-0.432	1.483	0.000	0.000	-0.131	0.479		7.092	0.568	1.528	0.000	0.000	-0.551	0.240
97	D2	1	54.651	6.618	-0.524	1.495	0.000	0.000	0.097	0.479		6.594	0.479	1.539	0.000	0.000	-0.437	0.240
98	SSE2	1	55.884	5.818	1.095	1.525	0.000	0.000	0.282	-0.188		5.696	0.249	1.571	0.000	0.000	-0.140	0.240
99	D1	1	56.274	5.021	0.947	1.536	0.000	0.000	0.209	-0.188		5.530	0.176	1.582	0.000	0.000	-0.047	0.240
100	SSE1	1	56.895	3.985	0.720	1.558	0.000	0.000	0.081	-0.223		5.383	0.061	1.600	0.000	0.000	0.103	0.240
end	LLE1	1	56.895	3.985	0.720	1.558	0.000	0.000	0.081	-0.223		5.383	0.061	1.600	0.000	0.000	0.103	0.240
end	EINC	1	56.895	3.985	0.720	1.558	0.000	0.000	0.081	-0.223		5.383	0.061	1.600	0.000	0.000	0.103	0.240
end	LINEL	1	56.895	3.985	0.720	1.558	0.000	0.000	0.081	-0.223		5.383	0.061	1.600	0.000	0.000	0.103	0.240

total length =	56.894762	mux =	1.558379	muy =	1.600205
delta(s) =	0.000000 mm	dmux =	-1.954306	dmuy =	-1.382733
		betax(max) =	34.468273	betay(max) =	42.569024
		Dx(max) =	4.069769	Dy(max) =	0.597232
		Dx(r.m.s.) =	1.261102	Dy(r.m.s.) =	0.179696

APPENDIX 2

Optical functions in Accumulator → e⁻ ring line

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Linear lattice functions.   TWISS       line: EOUTT        range: #S/#E
Delta(p)/p:   0.000000      symm: F     super:   1                                  page   1
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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]
begin	EOUTT	1	0.000	3.070	1.017	0.000	0.000	0.000	0.000	0.000	4.041	0.458	0.000	0.000	0.000	0.000	0.000
1	DC	1	0.000	3.070	1.017	0.000	0.000	0.000	0.000	0.000	4.041	0.458	0.000	0.000	0.000	0.000	0.000
begin	EOUT	1	0.000	3.070	1.017	0.000	0.000	0.000	0.000	0.000	4.041	0.458	0.000	0.000	0.000	0.000	0.000
begin	LE1	1	0.000	3.070	1.017	0.000	0.000	0.000	0.000	0.000	4.041	0.458	0.000	0.000	0.000	0.000	0.000
2	SE1	1	0.621	2.060	0.609	0.040	0.000	0.000	0.011	0.035	3.588	0.272	0.026	0.000	0.000	0.000	0.000
3	D1	1	1.011	1.686	0.350	0.073	0.000	0.000	0.024	0.035	3.421	0.155	0.044	0.000	0.000	0.000	0.000
4	SE2	1	2.244	1.384	-0.134	0.211	0.000	0.000	0.416	0.582	3.493	-0.214	0.102	0.000	0.000	0.000	0.000
5	D2	1	2.720	1.678	-0.484	0.261	0.000	0.000	0.693	0.582	3.764	-0.356	0.123	0.000	0.000	0.000	0.000
6	QE1	1	2.920	1.647	0.629	0.280	0.000	0.000	0.756	0.045	4.512	-3.562	0.131	0.000	0.000	0.000	0.000
7	D3	1	3.197	1.364	0.394	0.310	0.000	0.000	0.768	0.045	6.718	-4.403	0.139	0.000	0.000	0.000	0.000
end	LE1	1	3.197	1.364	0.394	0.310	0.000	0.000	0.768	0.045	6.718	-4.403	0.139	0.000	0.000	0.000	0.000
begin	LE2	1	3.197	1.364	0.394	0.310	0.000	0.000	0.768	0.045	6.718	-4.403	0.139	0.000	0.000	0.000	0.000
8	VBP	1	3.547	1.147	0.215	0.355	0.000	0.000	0.770	-0.036	10.148	-5.459	0.145	0.000	0.000	0.000	0.000
9	D4	1	3.778	1.096	0.004	0.388	0.000	0.000	0.762	-0.036	12.832	-6.160	0.149	0.000	0.000	0.033	0.193
10	D4A	1	4.096	1.186	-0.286	0.433	0.000	0.000	0.750	-0.036	17.057	-7.125	0.152	0.000	0.000	0.078	0.193
11	QE2	1	4.296	1.580	-1.801	0.457	0.000	0.000	0.811	0.656	16.802	8.323	0.154	0.000	0.000	0.139	0.193
12	D5	1	4.839	4.327	-3.258	0.490	0.000	0.000	1.167	0.656	8.996	6.052	0.161	0.000	0.000	0.164	0.054
13	QE3	1	5.039	5.099	-0.434	0.497	0.000	0.000	1.222	-0.112	7.732	0.533	0.165	0.000	0.000	0.194	0.054
14	D6	1	5.295	5.336	-0.493	0.505	0.000	0.000	1.194	-0.112	7.470	0.490	0.170	0.000	0.000	0.217	0.183
15	QE4	1	5.495	5.577	-0.714	0.510	0.000	0.000	1.175	-0.075	7.235	0.684	0.175	0.000	0.000	0.264	0.183
16	D7	1	6.045	6.445	-0.863	0.525	0.000	0.000	1.134	-0.075	6.544	0.573	0.187	0.000	0.000	0.300	0.174
17	VBM	1	6.395	6.835	-0.231	0.533	0.000	0.000	1.087	-0.192	6.170	0.502	0.196	0.000	0.000	0.395	0.174
18	D8	1	7.662	7.668	-0.426	0.561	0.000	0.000	0.844	-0.192	5.223	0.245	0.232	0.000	0.000	0.423	-0.018
19	D8A	1	7.918	7.896	-0.466	0.567	0.000	0.000	0.794	-0.192	5.111	0.193	0.240	0.000	0.000	0.399	-0.018
20	QE5	1	8.118	7.292	3.380	0.571	0.000	0.000	0.716	-0.583	5.580	-2.617	0.246	0.000	0.000	0.395	-0.018
21	D9	1	9.081	2.362	1.739	0.608	0.000	0.000	0.155	-0.583	11.926	-3.972	0.265	0.000	0.000	0.411	0.187
22	M5	1	9.081	2.362	1.739	0.608	0.000	0.000	0.155	-0.583	11.926	-3.972	0.265	0.000	0.000	0.591	0.187
end	LE2	1	9.081	2.362	1.739	0.608	0.000	0.000	0.155	-0.583	11.926	-3.972	0.265	0.000	0.000	0.591	0.187
begin	LE3	1	9.081	2.362	1.739	0.608	0.000	0.000	0.155	-0.583	11.926	-3.972	0.265	0.000	0.000	0.591	0.187
23	FE1	1	10.081	1.077	0.449	0.708	0.000	0.000	-0.659	-1.060	9.250	1.205	0.280	0.000	0.000	0.508	-0.083
24	D10	1	11.853	2.988	-1.527	0.933	0.000	0.000	-2.536	-1.060	5.811	0.735	0.319	0.000	0.000	0.361	-0.083
25	MQ	1	11.853	2.988	-1.527	0.933	0.000	0.000	-2.536	-1.060	5.811	0.735	0.319	0.000	0.000	0.361	-0.083
26	QE6	1	12.153	3.616	-0.489	0.947	0.000	0.000	-2.709	-0.083	6.029	-1.487	0.327	0.000	0.000	0.356	0.048
27	D11A	1	13.867	6.299	-1.076	1.006	0.000	0.000	-2.851	-0.083	12.693	-2.401	0.358	0.000	0.000	0.439	0.048
28	D11	1	14.123	6.873	-1.164	1.012	0.000	0.000	-2.872	-0.083	13.957	-2.537	0.361	0.000	0.000	0.451	0.048
29	QE7	1	14.423	8.685	-5.159	1.018	0.000	0.000	-3.102	-1.469	13.511	3.954	0.365	0.000	0.000	0.434	-0.162
30	D12	1	14.679	11.535	-5.973	1.022	0.000	0.000	-3.478	-1.469	11.567	3.639	0.368	0.000	0.000	0.392	-0.162
31	D12A	1	15.273	19.752	-7.861	1.028	0.000	0.000	-4.351	-1.469	7.678	2.907	0.378	0.000	0.000	0.296	-0.162
32	D12B	1	16.123	35.413	-10.563	1.034	0.000	0.000	-5.600	-1.469	3.625	1.861	0.404	0.000	0.000	0.158	-0.162
33	QE8	1	16.423	35.032	11.753	1.035	0.000	0.000	-5.511	2.053	3.204	-0.370	0.418	0.000	0.000	0.123	-0.076
34	D13A	1	17.867	9.371	6.018	1.048	0.000	0.000	-2.547	2.053	5.013	-0.882	0.477	0.000	0.000	0.014	-0.076
35	D13	1	18.123	6.550	5.001	1.053	0.000	0.000	-2.022	2.053	5.488	-0.973	0.485	0.000	0.000	-0.005	-0.076
36	QE9	1	18.423	4.697	1.500	1.062	0.000	0.000	-1.552	1.116	5.213	1.839	0.493	0.000	0.000	-0.027	-0.067
37	D14A	1	20.212	1.545	0.262	1.177	0.000	0.000	0.444	1.116	1.323	0.335	0.613	0.000	0.000	-0.147	-0.067
38	D14	1	20.468	1.456	0.085	1.204	0.000	0.000	0.730	1.116	1.206	0.120	0.645	0.000	0.000	-0.164	-0.067
39	QE10	1	20.768	1.373	0.184	1.238	0.000	0.000	1.037	0.919	1.291	-0.407	0.684	0.000	0.000	-0.189	-0.106
40	D15	1	22.418	2.815	-1.058	1.397	0.000	0.000	2.553	0.919	5.094	-1.897	0.795	0.000	0.000	-0.364	-0.106

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TRANSPORT LINES ( updated 5/95 )                                        "MAD" Version: 8.9/0      Run: 10/09/97  10.07.53
Linear lattice functions.   TWISS            line: EOUT                  range: #S/#E
Delta(p)/p:     0.000000    symm: F          super:   1                                                     page      2
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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]
end	LE3	1	22.418	2.815	-1.058	1.397	0.000	0.000	2.553	0.919	5.094	-1.897	0.795	0.000	0.000	-0.364	-0.106
begin	LE4	1	22.418	2.815	-1.058	1.397	0.000	0.000	2.553	0.919	5.094	-1.897	0.795	0.000	0.000	-0.364	-0.106
41	HPE1	1	23.531	3.663	0.460	1.447	0.000	0.000	3.141	0.083	10.436	-2.903	0.820	0.000	0.000	-0.482	-0.106
42	M6	1	23.531	3.663	0.460	1.447	0.000	0.000	3.141	0.083	10.436	-2.903	0.820	0.000	0.000	-0.482	-0.106
43	D16	1	24.092	3.251	0.274	1.473	0.000	0.000	3.187	0.083	13.977	-3.409	0.827	0.000	0.000	-0.541	-0.106
44	D16A	1	28.281	6.758	-1.111	1.649	0.000	0.000	3.535	0.083	58.389	-7.193	0.851	0.000	0.000	-0.985	-0.106
45	QE11	1	28.481	7.481	-2.551	1.654	0.000	0.000	3.617	0.746	59.086	3.753	0.851	0.000	0.000	-0.988	0.078
46	D17	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
47	MV	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
end	LE4	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
end	EOUT	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
begin	ED	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
begin	EDA	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
begin	ED1	1	32.830	48.653	-6.916	1.690	0.000	0.000	6.861	0.746	31.273	2.642	0.867	0.000	0.000	-0.648	0.078
48	HPE2	1	33.943	35.134	16.457	1.694	0.000	0.000	5.184	-3.604	25.708	2.358	0.874	0.000	0.000	-0.561	0.078
49	D18	1	35.024	8.595	8.093	1.704	0.000	0.000	1.289	-3.604	20.907	2.082	0.881	0.000	0.000	-0.476	0.078
50	M4	1	35.024	8.595	8.093	1.704	0.000	0.000	1.289	-3.604	20.907	2.082	0.881	0.000	0.000	-0.476	0.078
51	HPE3	1	35.780	0.939	2.503	1.745	0.000	0.000	-1.509	-4.139	12.889	7.028	0.888	0.000	0.000	-0.360	0.231
52	D19	1	36.204	0.207	-0.777	2.040	0.000	0.000	-3.264	-4.139	7.632	5.370	0.895	0.000	0.000	-0.252	0.231
53	QE12	1	36.404	0.783	-2.015	2.121	0.000	0.000	-3.936	-2.536	6.211	1.943	0.900	0.000	0.000	-0.217	0.129
54	D20	1	36.861	3.975	-4.969	2.163	0.000	0.000	-5.095	-2.536	4.596	1.592	0.913	0.000	0.000	-0.158	0.129
55	HPE4	1	37.974	15.520	-3.178	2.183	0.000	0.000	-6.559	0.042	2.005	0.736	0.973	0.000	0.000	-0.015	0.129
end	ED1	1	37.974	15.520	-3.178	2.183	0.000	0.000	-6.559	0.042	2.005	0.736	0.973	0.000	0.000	-0.015	0.129
begin	ED2	1	37.974	15.520	-3.178	2.183	0.000	0.000	-6.559	0.042	2.005	0.736	0.973	0.000	0.000	-0.015	0.129
56	D21	1	40.474	35.879	-4.966	2.200	0.000	0.000	-6.454	0.042	3.131	-1.187	1.213	0.000	0.000	0.307	0.129
57	QE13	1	40.674	37.008	-0.633	2.201	0.000	0.000	-6.369	0.813	3.720	-1.782	1.222	0.000	0.000	0.336	0.167
58	D22	1	43.061	40.247	-0.724	2.211	0.000	0.000	-4.428	0.813	18.623	-4.461	1.268	0.000	0.000	0.735	0.167
end	ED2	1	43.061	40.247	-0.724	2.211	0.000	0.000	-4.428	0.813	18.623	-4.461	1.268	0.000	0.000	0.735	0.167
begin	ED3	1	43.061	40.247	-0.724	2.211	0.000	0.000	-4.428	0.813	18.623	-4.461	1.268	0.000	0.000	0.735	0.167
59	VBP	2	43.411	39.275	3.451	2.212	0.000	0.000	-4.062	1.261	21.862	-4.852	1.271	0.000	0.000	0.827	0.360
60	D23	1	44.318	33.285	3.153	2.216	0.000	0.000	-2.918	1.261	31.587	-5.870	1.277	0.000	0.000	1.153	0.360
61	QE14	1	44.518	33.781	-5.676	2.217	0.000	0.000	-2.741	0.518	32.258	2.571	1.278	0.000	0.000	1.194	0.048
62	D24	1	45.627	47.581	-6.767	2.221	0.000	0.000	-2.166	0.518	26.846	2.309	1.284	0.000	0.000	1.248	0.048
63	V3M	2	45.977	50.608	-1.721	2.222	0.000	0.000	-1.945	0.735	25.268	2.227	1.286	0.000	0.000	1.231	-0.144
end	ED3	1	45.977	50.608	-1.721	2.222	0.000	0.000	-1.945	0.735	25.268	2.227	1.286	0.000	0.000	1.231	-0.144
begin	ED4	1	45.977	50.608	-1.721	2.222	0.000	0.000	-1.945	0.735	25.268	2.227	1.286	0.000	0.000	1.231	-0.144
64	D25	1	47.984	57.832	-1.878	2.228	0.000	0.000	-0.470	0.735	17.278	1.754	1.301	0.000	0.000	0.942	-0.144
65	QE15	1	48.184	57.936	1.362	2.229	0.000	0.000	-0.321	0.757	16.775	0.771	1.303	0.000	0.000	0.918	-0.092
66	D26	1	51.880	48.538	1.180	2.240	0.000	0.000	2.477	0.757	12.374	0.420	1.344	0.000	0.000	0.578	-0.092
end	ED4	1	51.880	48.538	1.180	2.240	0.000	0.000	2.477	0.757	12.374	0.420	1.344	0.000	0.000	0.578	-0.092
begin	ED5	1	51.880	48.538	1.180	2.240	0.000	0.000	2.477	0.757	12.374	0.420	1.344	0.000	0.000	0.578	-0.092
67	D51	1	55.949	39.750	0.980	2.255	0.000	0.000	5.558	0.757	10.533	0.033	1.402	0.000	0.000	0.204	-0.092
68	VBP	3	56.299	37.627	4.974	2.256	0.000	0.000	5.720	0.161	10.521	0.000	1.407	0.000	0.000	0.205	0.101
69	D52	1	57.857	23.787	3.908	2.265	0.000	0.000	5.972	0.161	10.752	-0.148	1.431	0.000	0.000	0.362	0.101
70	QE16	1	58.057	21.939	5.292	2.266	0.000	0.000	5.963	-0.251	10.965	-0.920	1.434	0.000	0.000	0.385	0.126
71	D53	1	59.617	8.646	3.229	2.284	0.000	0.000	5.571	-0.251	14.246	-1.183	1.454	0.000	0.000	0.582	0.126
72	V3M	3	59.967	6.273	3.427	2.292	0.000	0.000	5.381	-0.829	15.090	-1.242	1.458	0.000	0.000	0.592	-0.066

TRANSPORT LINES (updated 5/95)
Linear lattice functions. TWISS line: EOUTT "MAD" Version: 8.9/0 Run: 10/09/97 10.07.53
Delta(p)/p: 0.000000 symm: F super: 1 range: #S/#E

HORIZONTAL

pos. no.	element name	occ. no.	dist [m]	betax [m]	alfax [1]	mux [2pi]	x(co) [mm]	px(co) [.001]	Dx [m]	Dpx [1]
73	D54	1	61.856	0.575	-0.411	2.558	0.000	0.000	3.814	-0.829
74	QE17	1	62.056	0.783	-0.612	2.606	0.000	0.000	3.549	-1.813
75	D55	1	63.831	8.485	-3.727	2.727	0.000	0.000	0.331	-1.813
end	ED5	1	63.831	8.485	-3.727	2.727	0.000	0.000	0.331	-1.813
begin	ED6	1	63.831	8.485	-3.727	2.727	0.000	0.000	0.331	-1.813
76	M7	1	63.831	8.485	-3.727	2.727	0.000	0.000	0.331	-1.813
77	HE5	1	64.588	14.784	-4.994	2.737	0.000	0.000	-0.783	-1.272
78	D56	1	66.693	43.585	-8.688	2.750	0.000	0.000	-3.460	-1.272
79	QE18	1	66.893	45.730	-1.927	2.751	0.000	0.000	-3.660	-0.722
80	D57	1	70.093	59.117	-2.257	2.761	0.000	0.000	-5.970	-0.722
81	QE19	1	70.293	58.344	6.087	2.761	0.000	0.000	-6.029	0.132
82	D58	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
83	M8	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
end	ED6	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
end	EDA	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
begin	EDB	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
begin	ED7	1	76.093	9.676	2.304	2.801	0.000	0.000	-5.264	0.132
84	D59	1	82.821	8.187	-2.083	3.164	0.000	0.000	-4.376	0.132
85	QE20	1	83.021	9.441	-4.277	3.168	0.000	0.000	-4.447	-0.844
86	D60	1	86.021	53.494	-10.408	3.189	0.000	0.000	-6.978	-0.844
87	QE21	1	86.221	53.909	8.382	3.190	0.000	0.000	-6.903	1.586
88	D61	1	87.672	32.367	6.464	3.195	0.000	0.000	-4.602	1.586
89	HE6	1	88.429	23.742	5.512	3.200	0.000	0.000	-3.660	1.030
90	D62	1	89.251	15.567	4.425	3.206	0.000	0.000	-2.813	1.030
91	HE7	1	90.008	9.879	3.473	3.216	0.000	0.000	-2.271	0.474
end	ED7	1	90.008	9.879	3.473	3.216	0.000	0.000	-2.271	0.474
begin	ED8	1	90.008	9.879	3.473	3.216	0.000	0.000	-2.271	0.474
92	D63	1	90.781	5.301	2.451	3.233	0.000	0.000	-1.905	0.474
93	QE22	1	90.981	5.148	-1.647	3.239	0.000	0.000	-1.959	-1.025
94	D64	1	91.851	8.560	-2.275	3.260	0.000	0.000	-2.851	-1.025
95	QE23	1	92.051	8.634	1.914	3.263	0.000	0.000	-2.915	0.388
96	D65	1	92.837	5.959	1.489	3.281	0.000	0.000	-2.611	0.388
97	VBM	4	93.187	4.784	1.807	3.291	0.000	0.000	-2.427	0.654
98	D66	1	94.545	1.520	0.596	3.375	0.000	0.000	-1.539	0.654
99	QE24	1	94.745	1.459	-0.277	3.397	0.000	0.000	-1.483	-0.089
100	D67	1	96.505	4.719	-1.576	3.514	0.000	0.000	-1.640	-0.089
101	VBP	4	96.855	5.720	-1.229	3.525	0.000	0.000	-1.641	0.084
102	D68	1	97.068	6.263	-1.323	3.531	0.000	0.000	-1.623	0.084
end	ED8	1	97.068	6.263	-1.323	3.531	0.000	0.000	-1.623	0.084
begin	ED9	1	97.068	6.263	-1.323	3.531	0.000	0.000	-1.623	0.084
103	SED2	1	98.301	7.446	0.479	3.558	0.000	0.000	-1.604	-0.053
104	D69	1	98.691	7.097	0.415	3.566	0.000	0.000	-1.624	-0.053
105	SED1	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084
106	D70	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084
end	ED9	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084
end	EDB	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084

VERTICAL

pos. no.	element name	betay [m]	alfay [1]	muy [2pi]	y(co) [mm]	py(co) [.001]	Dy [m]	Dpy [1]
73	D54	20.381	-1.560	1.475	0.000	0.000	0.467	-0.066
74	QE17	22.138	-7.379	1.476	0.000	0.000	0.466	0.057
75	D55	56.227	-11.826	1.484	0.000	0.000	0.567	0.057
end	ED5	56.227	-11.826	1.484	0.000	0.000	0.567	0.057
begin	ED6	56.227	-11.826	1.484	0.000	0.000	0.567	0.057
76	M7	56.227	-11.826	1.484	0.000	0.000	0.567	0.057
77	HE5	58.065	9.745	1.486	0.000	0.000	0.529	-0.150
78	D56	24.362	6.266	1.495	0.000	0.000	0.213	-0.150
79	QE18	22.629	2.489	1.497	0.000	0.000	0.186	-0.119
80	D57	9.954	1.472	1.531	0.000	0.000	-0.196	-0.119
81	QE19	9.653	0.051	1.534	0.000	0.000	-0.222	-0.149
82	D58	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
83	M8	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
end	ED6	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
end	EDA	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
begin	EDB	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
begin	ED7	12.558	-0.552	1.622	0.000	0.000	-1.087	-0.149
84	D59	24.682	-1.250	1.685	0.000	0.000	-2.089	-0.149
85	QE20	24.092	4.157	1.686	0.000	0.000	-2.073	0.315
86	D60	5.978	1.881	1.726	0.000	0.000	-1.129	0.315
87	QE21	5.647	-0.189	1.732	0.000	0.000	-1.104	-0.072
88	D61	6.580	-0.455	1.770	0.000	0.000	-1.208	-0.072
89	HE6	5.436	1.738	1.790	0.000	0.000	-1.081	0.384
90	D62	3.077	1.130	1.822	0.000	0.000	-0.765	0.384
91	HE7	1.191	0.987	1.887	0.000	0.000	-0.359	0.608
end	ED7	1.191	0.987	1.887	0.000	0.000	-0.359	0.608
begin	ED8	1.191	0.987	1.887	0.000	0.000	-0.359	0.608
92	D63	0.656	-0.294	2.057	0.000	0.000	0.111	0.608
93	QE22	0.726	-0.041	2.102	0.000	0.000	0.221	0.476
94	D64	1.842	-1.241	2.238	0.000	0.000	0.634	0.476
95	QE23	2.613	-2.738	2.252	0.000	0.000	0.762	0.812
96	D65	8.926	-5.294	2.278	0.000	0.000	1.401	0.812
97	VBM	13.003	-6.426	2.284	0.000	0.000	1.650	0.620
98	D66	36.454	-10.843	2.294	0.000	0.000	2.492	0.620
99	QE24	37.137	7.539	2.294	0.000	0.000	2.491	-0.626
100	D67	15.424	4.798	2.306	0.000	0.000	1.389	-0.626
101	VBP	12.275	4.256	2.310	0.000	0.000	1.205	-0.434
102	D68	10.532	3.925	2.313	0.000	0.000	1.112	-0.434
end	ED8	10.532	3.925	2.313	0.000	0.000	1.112	-0.434
begin	ED9	10.532	3.925	2.313	0.000	0.000	1.112	-0.434
103	SED2	3.222	2.004	2.347	0.000	0.000	0.578	-0.434
104	D69	1.894	1.396	2.372	0.000	0.000	0.408	-0.434
105	SED1	0.762	0.431	2.459	0.000	0.000	0.140	-0.434
106	D70	0.762	0.431	2.459	0.000	0.000	0.140	-0.434
end	ED9	0.762	0.431	2.459	0.000	0.000	0.140	-0.434
end	EDB	0.762	0.431	2.459	0.000	0.000	0.140	-0.434

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]
end	ED	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084	0.762	0.431	2.459	0.000	0.000	0.140	-0.434

TRANSPORT LINES (updated 5/95)
Linear lattice functions. TWISS line: EOUTT
Delta(p)/p: 0.000000 symm: F super: 1

"MAD" Version: 8.9/0 Run: 10/09/97 10.07.53
range: #S/#E page 4

	ELEMENT SEQUENCE		I	HORIZONTAL							I	VERTICAL					
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]
end	EOUTT	1	99.311	6.638	0.325	3.581	0.000	0.000	-1.667	-0.084	0.762	0.431	2.459	0.000	0.000	0.140	-0.434

total length =	99.311121	mux =	3.580729	muy =	2.458605
delta(s) =	0.000000 mm	dmux =	-11.161022	dmuy =	-8.479248
		betax(max) =	59.116996	betay(max) =	59.085522
		Dx(max) =	6.977679	Dy(max) =	2.491529
		Dx(r.m.s.) =	3.392686	Dy(r.m.s.) =	0.753441