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HERA Electron Optic with Mini Rotator

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Abstract

With the new HERA mini rotator¹⁾, a smooth optical solution was found which shows that this rotator is well suited to be incorporated in the HERA electron ring. The optic, presented in this note, is given to define the building requirements and to serve as an input for spin matching, which remains to be done. The rotator with its proposed correction for off-energy operation is described.

HERA mini rotator

The new rotator¹⁾ with its proposed parameters and its location within the HERA geometry is shown in Fig. 1. The rotator produces an integral horizontal spin rotation of 72° which, at the rotator design energy of 27,5 GeV, corresponds to the beam deflection of two regular arc magnets. Thus, the rotator replaces two arc magnets and bends the beam by about 20 mrad into the straight interaction line which is translated by 1,2 m with respect to the "Grundstruktur". This translation, which used to be 0,75 m in the HERA proposal, is chosen for allowing a sufficient rotator length. With enough room for quadrupole matching before and aft, the rotator is 45,5 m long, and 4 rotator pairs reduce the maximum degree of polarization to 79,4 %, which seems just bearable. The maximum degree of polarization can, of course, be gradually increased to nearly the full value, up to 90,5 %, by turning off the vertical bends in one rotator pair after another. The added synchrotron radiation loss is 12,4 % and goes down to 5,4 % when all vertical bends are turned off and the ring is run as a flat machine with vertical polarization everywhere.

The rotator magnets provide the correct spin rotation only at their design field, independent of particle energy. Since, in operation, it must be possible to vary the operating energy within a few percent, and since the horizontal ring geometry must be held fixed during this variation, the horizontal bends must be ramped with energy, like all other ring magnets, and will therefore give the wrong spin rotation.

Depolarization due to this effect can be avoided by restoring the vertical orientation of the equilibrium spin vector at the end of the rotator pair. This can be done by modifying the vertical bends, all of them proportionally, such that the spin in the interaction region is in the vertical plane and has no horizontal component. Then, due to the symmetry of horizontal bends and antisymmetry of vertical bends in the rotator pair, the spin will come out vertical again at the end. However, the spin will not remain strictly longitudinal in the interaction region when applying this correction, but will have a vertical component that increases with the energy deviation. Within an energy range of $\pm 4\%$, the required vertical spin rotation and the longitudinal spin component are given in Tab. 1 and Figs. 2,3, together with the maximum excursion and the associated increment in orbit length. Also, the spin precession angle in the rotator is given for each energy; it slightly deviates from the precession angle of the 4 arc magnets that the rotator replaces and causes a spin tune shift $\Delta\nu$ per rotator pair. The numbers show that the corrected rotator indeed permits operation within the energy range of $\pm 3-4\%$.

Optic of the HERA electron ring

Fig. 4 shows the rotator incorporated in the optics design of the HERA ring. By introducing a drift space and a quadrupole triplet before and after the rotator, with opposite polarity in the two triplets, the length of the rotator can be rather comfortably spanned without unduly increasing the beam envelopes. Also, the rotator lends well to being used as a horizontal dispersion suppressor. In vertical direction, the rotator is automatically nondispersive since it restores the original beam direction and contains no quadrupoles.

The optical lattice is given in Tab. 2, and the normalized beam envelopes and dispersions in Tab. 3. Spin matching will be included later.

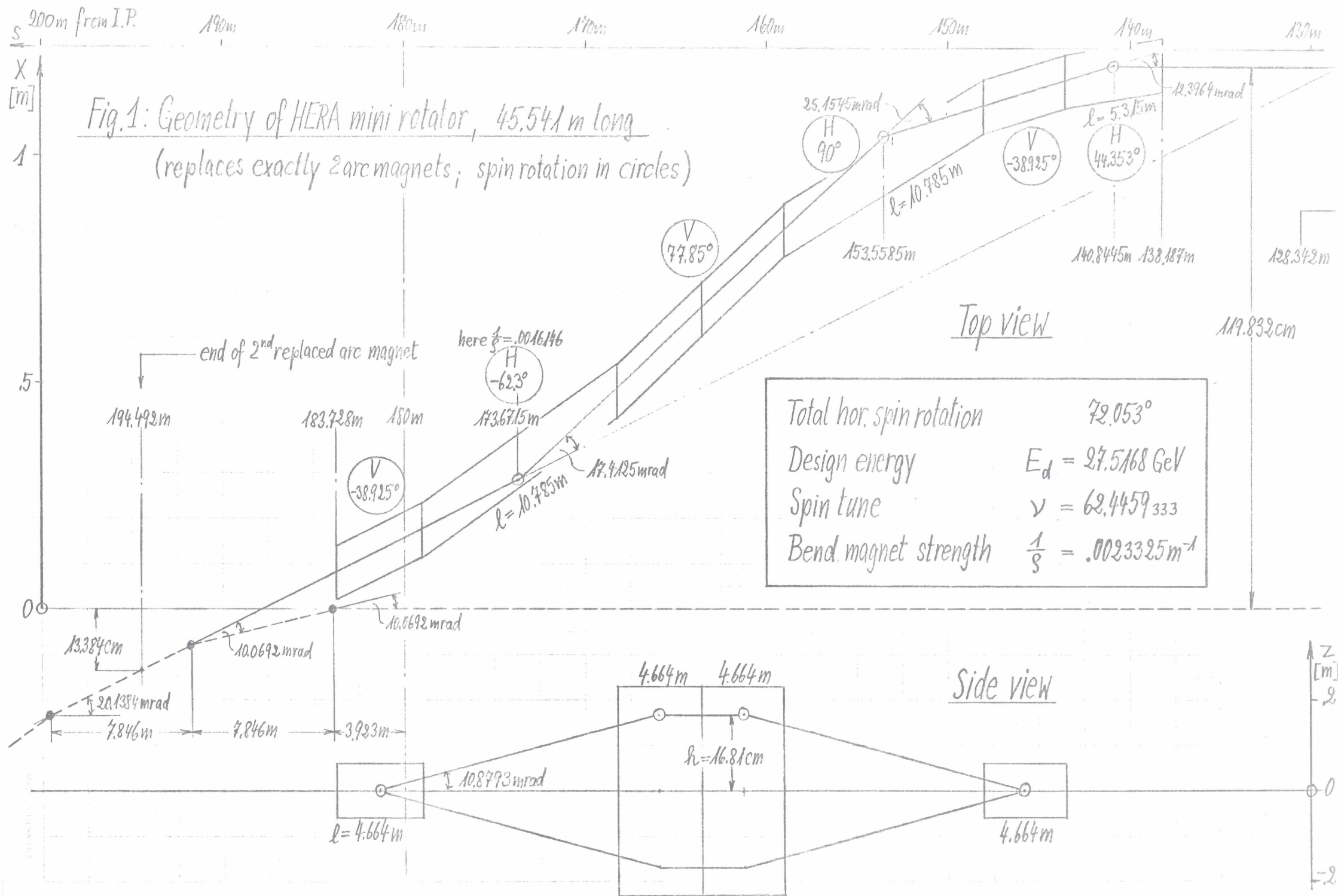
The vertical beam emittance excited by 4 rotator pairs in this optic is 3.5 % of the horizontal emittance and is thus small enough to obtain the proposed ep luminosity without excessive focusing strength.

Acknowledgement

I wish to thank I. Borchardt and U. Naujokat for their continuing effort in keeping up the hybrid computer as a powerful conceptual design tool, and H. Ruge for developing with their guidance the new digital program that was used for final matching and graphical display.

Reference

- 1) K. Steffen, "Invertible flat rotators for HERA"
DESY HERA 83/06 (May 1983)



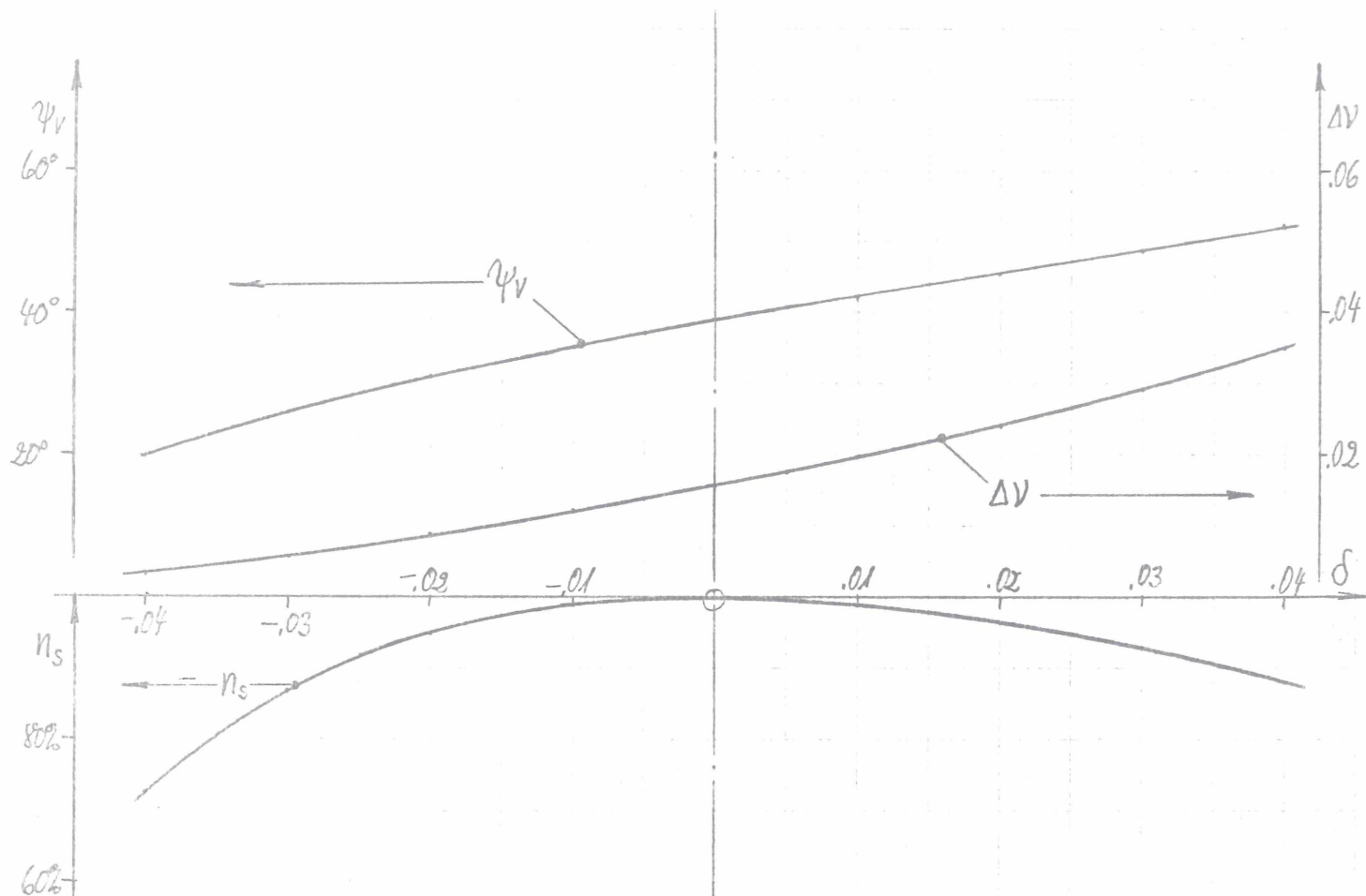


Fig. 2: Vertical spin rotation ψ_v , rotator spin time shift ΔV and longitudinal spin component n_s in the interaction region as a function of $\delta = \frac{\Delta p}{p_0}$ for the HERA mini rotator

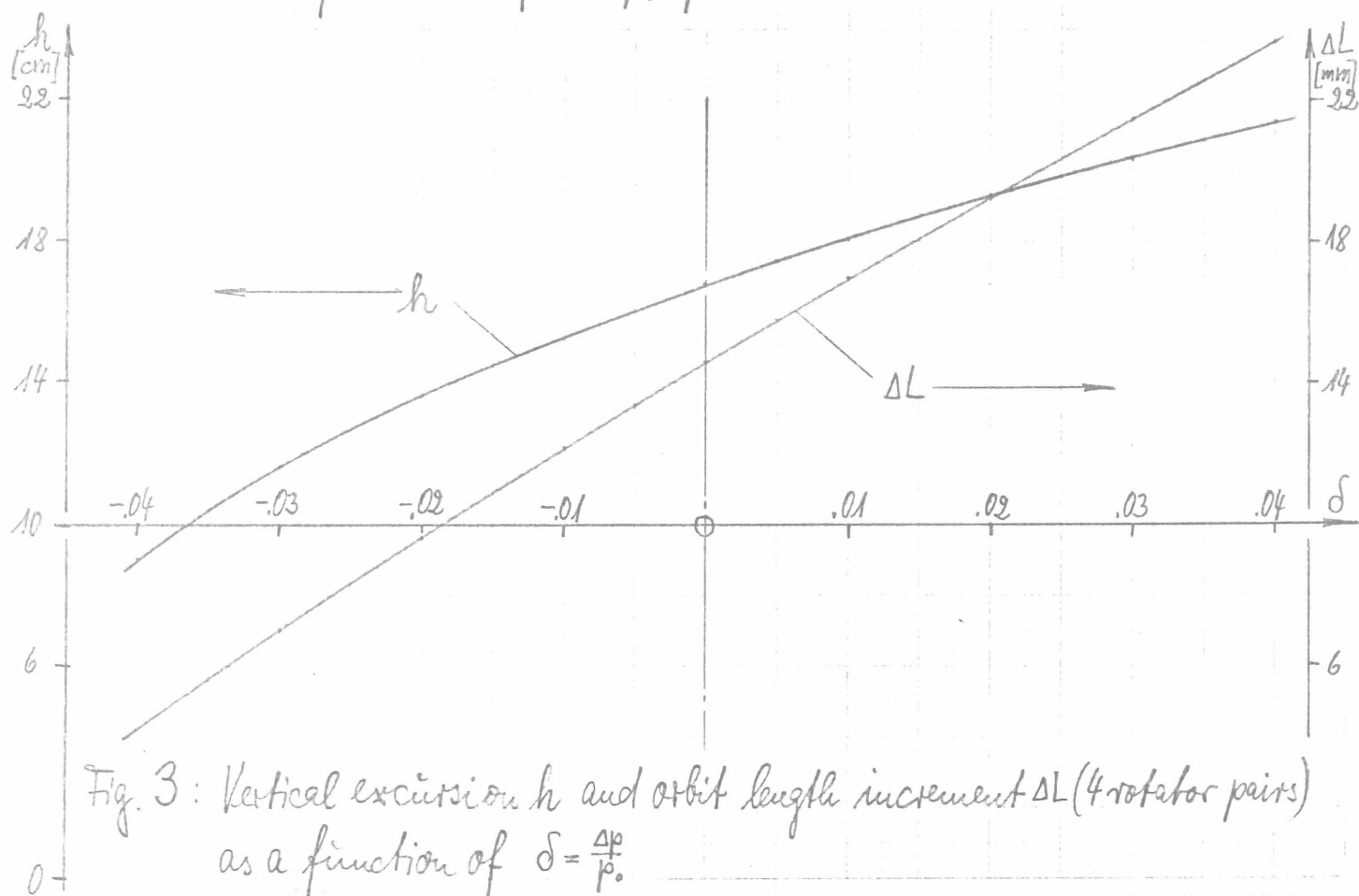
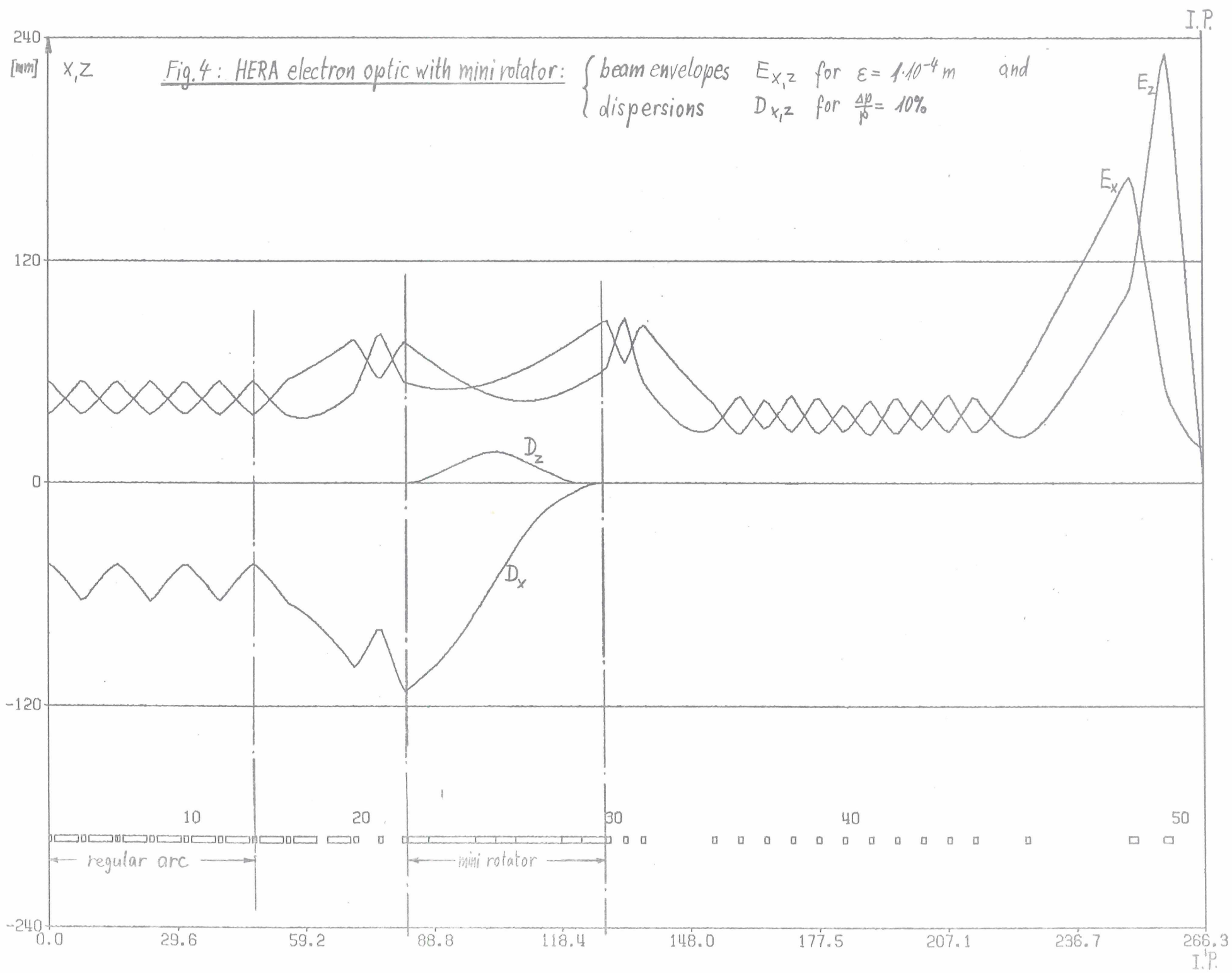


Fig. 3: Vertical excursion h and orbit length increment ΔL (4 rotator pairs) as a function of $\delta = \frac{\Delta p}{p_0}$.



Tab. 1: Parameters of HERA mini rotator with off-energy correction

relative deviation from rotator design energy	δ	-4%	-3%	-2%	-1%	-0.5%	0	+0.5%	+1%	+2%	+3%	+4%
rot. spin rotation angle	ψ [deg]	20.096°	26.117°	30.981°	35.173°	37.096°	38.925°	40.678°	42.363°	45.567°	48.596°	51.493°
vertical excursion	h [cm]	9.04	11.63	13.65	15.34	16.10	16.81	17.48	18.11	19.29	20.37	21.38
orbit length increment (4 rotator pairs)	ΔL [mm]	4.23	7.00	9.65	12.19	13.42	14.63	15.82	16.99	19.24	21.49	23.67
longitudinal spin component at I.P.	n_s	.7268	.8709	.9499	.9888	.9974	1	.9976	.9907	.9658	.9287	.8820
spin precession angle in one rotator pair	ψ_{rot} [deg]	139.57	141.96	144.45	147.06	148.41	149.79	151.21	152.66	155.70	158.93	162.38
spin precession angle in 4 rotator pairs	$\psi_{4\text{rot}}$ [deg]	138.34	139.78	141.22	142.67	143.39	144.11	144.83	145.55	146.99	148.43	149.87
spin time shift by one rotator pair	ΔV	.0034	.0060	.0090	.0122	.0139	.0158	.0177	.0198	.0242	.0322	.0348

1	2	3	4	5	6	7
TYP	DRIF(M)	L(M)	K(1/M*M)	1/RHO(1/M)	ALFA1(GRAD)	ALFA2
1 QUAD	0.00000	0.50000	-0.10200	0.00000	0.00000	0.00000
2 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
3 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
4 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
5 QUAD	0.69998	0.50000	-0.10200	0.00000	0.00000	0.00000
6 QUAD	0.00000	0.50000	-0.10200	0.00000	0.00000	0.00000
7 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
8 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
9 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
10 QUAD	0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
11 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
12 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
13 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
14 QUAD	0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
15 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
16 QUAD	0.69998	1.00000	0.03115	0.00000	0.00000	0.00000
17 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
18 DRIF	0.69998	1.00000	0.00000	0.00000	0.00000	0.00000
19 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
20 QUAD	0.69998	1.00000	0.07506	0.00000	0.00000	0.00000
21 QUAD	4.66382	1.00000	-0.13798	0.00000	0.00000	0.00000
22 QUAD	4.50000	1.00000	0.07752	0.00000	0.00000	0.00000
23 RE90	0.29999	4.66382	0.00000	-0.00233	-0.31162	-0.31162
24 REMA	0.00000	10.78467	0.00000	-0.00161	0.49884	0.49884
25 RE90	0.00000	4.66382	0.00000	0.00233	0.31161	0.31161
26 RE90	0.00000	4.66382	0.00000	0.00233	0.31161	0.31161
27 REMA	0.00000	10.78467	0.00000	0.00233	-0.72061	-0.72061
28 RE90	0.00000	4.66382	0.00000	-0.00233	-0.31162	-0.31162
29 REMA	0.00000	5.31494	0.00000	0.00233	-0.35513	-0.35513
30 QUAD	0.29399	1.00000	-0.09172	0.00000	0.00000	0.00000
31 QUAD	3.00000	1.00000	0.18569	0.00000	0.00000	0.00000
32 QUAD	3.00000	1.00000	-0.10334	0.00000	0.00000	0.00000
33 DRIF	3.50000	1.00000	0.00000	0.00000	0.00000	0.00000
34 DRIF	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
35 QUAD	5.00000	1.00000	-0.03375	0.00000	0.00000	0.00000
36 QUAD	5.00000	1.00000	0.15403	0.00000	0.00000	0.00000
37 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
38 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
39 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
40 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
41 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
42 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
43 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
44 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
45 QUAD	5.00000	1.00000	-0.15858	0.00000	0.00000	0.00000
46 DRIF	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
47 QUAD	5.00000	1.00000	-0.00669	0.00000	0.00000	0.00000
48 QUAD	22.89258	2.00000	0.06030	0.00000	0.00000	0.00000
49 QUAD	6.00000	2.00000	-0.10042	0.00000	0.00000	0.00000
50 DRIF	0.00000	7.50000	0.00000	0.00000	0.00000	0.00000

1	2	3	4	5	6	7
TYP	DRIF(M)	L(M)	K(1/M*M)	1/RHO(1/M)	ALFA1(GRAD)	ALFA2
1 QUAD	0.00000	0.50000	-0.10200	0.00000	0.00000	0.00000
2 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
3 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
4 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
5 QUAD	0.69998	0.50000	-0.10200	0.00000	0.00000	0.00000
6 QUAD	0.00000	0.50000	-0.10200	0.00000	0.00000	0.00000
7 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
8 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
9 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
10 QUAD	0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
11 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
12 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
13 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
14 QUAD	0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
15 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
16 QUAD	0.69998	1.00000	0.03115	0.00000	0.00000	0.00000
17 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
18 DRIF	0.69998	1.00000	0.00000	0.00000	0.00000	0.00000
19 REMA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
20 QUAD	0.69998	1.00000	0.07506	0.00000	0.00000	0.00000
21 QUAD	4.66382	1.00000	-0.13798	0.00000	0.00000	0.00000
22 QUAD	4.50000	1.00000	0.07752	0.00000	0.00000	0.00000
23 RE90	0.29999	4.66382	0.00000	-0.00233	-0.31162	-0.31162
24 REMA	0.00000	10.78467	0.00000	-0.00161	0.49884	0.49884
25 RE90	0.00000	4.66382	0.00000	0.00233	0.31161	0.31161
26 RE90	0.00000	4.66382	0.00000	0.00233	0.31161	0.31161
27 REMA	0.00000	10.78467	0.00000	0.00233	-0.72061	-0.72061
28 RE90	0.00000	4.66382	0.00000	-0.00233	-0.31162	-0.31162
29 REMA	0.00000	5.31494	0.00000	0.00233	-0.35513	-0.35513
30 QUAD	0.29399	1.00000	-0.09172	0.00000	0.00000	0.00000
31 QUAD	3.00000	1.00000	0.18569	0.00000	0.00000	0.00000
32 QUAD	3.00000	1.00000	-0.10334	0.00000	0.00000	0.00000
33 DRIF	3.50000	1.00000	0.00000	0.00000	0.00000	0.00000
34 DRIF	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
35 QUAD	5.00000	1.00000	-0.03375	0.00000	0.00000	0.00000
36 QUAD	5.00000	1.00000	0.15403	0.00000	0.00000	0.00000
37 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
38 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
39 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
40 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
41 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
42 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
43 QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
44 QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
45 QUAD	5.00000	1.00000	-0.15858	0.00000	0.00000	0.00000
46 DRIF	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
47 QUAD	5.00000	1.00000	-0.00669	0.00000	0.00000	0.00000
48 QUAD	22.89258	2.00000	0.06030	0.00000	0.00000	0.00000
49 QUAD	6.00000	2.00000	-0.10042	0.00000	0.00000	0.00000
50 DRIF	0.00000	7.50000	0.00000	0.00000	0.00000	0.00000

Tab.3: Hor. and vert. beam envelopes and hor. dispersi

PROBLEM

HERA, E, MINIROTATOR

19.05

MESSWERTE

DP/P(1/1000) = 0.0000 0.0000
 EPS (MM*MRAD) = 100.0000 100.0000
 CHR.ABERR. = 0 0

NR.	TYP	EX(MM)	EX'(MRAD)	EZ(MM)	EZ'(MRAD)
0		37.15821	0.00000	55.15040	0.00000
1	QUAD	37.65722	1.99967	54.45622	-2.77060
2	DRIF	39.10116	2.12365	52.53258	-2.72484
2	REMA	52.54523	2.72555	39.09064	-2.12329
3	DRIF	54.46936	2.77128	37.64698	-1.99921
3	QUAD	54.46934	-2.77131	37.64700	1.99924
4	DRIF	52.54519	-2.72559	39.09067	2.12332
4	REMA	39.10093	-2.12368	52.53278	2.72486
5	DRIF	37.65697	-1.99969	54.45644	2.77062
5	QUAD	37.15794	-0.00004	55.15062	0.00001
6	QUAD	37.65693	1.99961	54.45646	-2.77060
7	DRIF	39.10084	2.12360	52.53282	-2.72483
7	REMA	52.54470	2.72552	39.09086	-2.12330
8	DRIF	54.46880	2.77125	37.64720	-1.99922
8	QUAD	54.46879	-2.77129	37.64722	1.99925
9	DRIF	52.54465	-2.72555	39.09090	2.12333
9	REMA	39.10060	-2.12363	52.53302	2.72486
10	DRIF	37.65668	-1.99964	54.45667	2.77062
10	QUAD	37.65668	1.99964	54.45667	-2.77062
11	DRIF	39.10060	2.12363	52.53301	-2.72486
11	REMA	52.54466	2.72555	39.09090	-2.12333
12	DRIF	54.46879	2.77129	37.64721	-1.99925
12	QUAD	54.46881	-2.77125	37.64720	1.99922
13	DRIF	52.54470	-2.72552	39.09086	2.12330
13	REMA	39.10084	-2.12360	52.53281	2.72483
14	DRIF	37.65693	-1.99961	54.45645	2.77060
14	QUAD	37.65697	1.99969	54.45643	-2.77062
15	DRIF	39.10093	2.12368	52.53278	-2.72486
15	REMA	52.54519	2.72559	39.09067	-2.12332
16	DRIF	54.46935	2.77131	37.64699	-1.99924
16	QUAD	56.40982	1.09853	36.32343	-0.65120

on. (Values at the end of the element).

.83

100.0000

100.0000

0

DX (MM)	DX' (MRAD)	Q1	Q2
43.86133	0.00000	0.0	0.0
44.42174	2.24639	0.00571	0.00264
45.99417	2.24639	0.01328	0.00653
60.96908	3.25332	0.05598	0.04925
63.24634	3.25332	0.05987	0.05682
63.24648	-3.25305	0.06514	0.06826
60.96940	-3.25305	0.06904	0.07583
45.99596	-2.24612	0.11173	0.11855
44.42372	-2.24612	0.11930	0.12244
43.86348	0.00037	0.12501	0.12508
44.42410	2.24688	0.13073	0.12772
45.99687	2.24688	0.13829	0.13161
60.97444	3.25381	0.18099	0.17433
63.25205	3.25381	0.18488	0.18190
63.25237	-3.25316	0.19016	0.19333
60.97522	-3.25316	0.19405	0.20091
46.00120	-2.24623	0.23675	0.24362
44.42888	-2.24623	0.24431	0.24752
44.42941	2.24730	0.25574	0.25279
46.00248	2.24730	0.26331	0.25669
60.98235	3.25423	0.30601	0.29941
63.26025	3.25423	0.30990	0.30698
63.26058	-3.25358	0.31517	0.31841
60.98314	-3.25358	0.31907	0.32598
46.00681	-2.24665	0.36176	0.36870
44.43420	-2.24665	0.36933	0.37260
44.43458	2.24741	0.38076	0.37787
46.00772	2.24741	0.38832	0.38177
60.98818	3.25434	0.43102	0.42448
63.26616	3.25434	0.43491	0.43206
65.52093	1.24351	0.44007	0.44377

Tab. 3

Tab. 3: Hor. and Vert. beam envelopes and

PROBLEM

HERA, E, MINIROTATOR

MESSWERTE

DP/P (1/1000) = 0.0000
EPS (MM*MRAD) = 100.0000
CHR. ABERR. = 0

NR.	TYP	EX (MM)	EX' (MRAD)	EZ (MM)
0		37.15821	0.00000	55.15040
1	QUAD	37.65722	1.99967	54.45622
2	DRIF	39.10116	2.12365	52.53258
2	REMA	52.54523	2.72555	39.09064
3	DRIF	54.46936	2.77128	37.64698
3	QUAD	54.46934	-2.77131	37.64700
4	DRIF	52.54519	-2.72559	39.09067
4	REMA	39.10093	-2.12368	52.53278
5	DRIF	37.65697	-1.99969	54.45644
5	QUAD	37.15794	-0.00004	55.15062
6	QUAD	37.65693	1.99961	54.45646
7	DRIF	39.10084	2.12360	52.53282
7	REMA	52.54470	2.72552	39.09086
8	DRIF	54.46880	2.77125	37.64720
8	QUAD	54.46879	-2.77129	37.64722
9	DRIF	52.54465	-2.72555	39.09090
9	REMA	39.10060	-2.12363	52.53302
10	DRIF	37.65668	-1.99964	54.45667
10	QUAD	37.65668	1.99964	54.45667
11	DRIF	39.10060	2.12363	52.53301
11	REMA	52.54466	2.72555	39.09090
12	DRIF	54.46879	2.77129	37.64721
12	QUAD	54.46881	-2.77125	37.64720
13	DRIF	52.54470	-2.72552	39.09086
13	REMA	39.10084	-2.12360	52.53281
14	DRIF	37.65693	-1.99961	54.45645
14	QUAD	37.65697	1.99969	54.45643
15	DRIF	39.10093	2.12368	52.53278
15	REMA	52.54519	2.72559	39.09067
16	DRIF	54.46935	2.77131	37.64699
16	QUAD	56.40982	1.09853	36.32343

hor. dispersion. (Values at the end of the element).

19.05.83

0.0000		100.0000		
100.0000		100.0000		
0		0		
EZ' (MRAD)	DX (MM)	DX' (MRAD)	Q1	Q2
0.00000	43.86133	0.00000	0.0	0.0
-2.77060	44.42174	2.24639	0.00571	0.00264
-2.72484	45.99417	2.24639	0.01328	0.00653
-2.12329	60.96908	3.25332	0.05598	0.04925
-1.99921	63.24634	3.25332	0.05987	0.05682
1.99924	63.24648	-3.25305	0.06514	0.06826
2.12332	60.96940	-3.25305	0.06904	0.07583
2.72486	45.99596	-2.24612	0.11173	0.11855
2.77062	44.42372	-2.24612	0.11930	0.12244
0.00001	43.86348	0.00037	0.12501	0.12508
-2.77060	44.42410	2.24688	0.13073	0.12772
-2.72483	45.99687	2.24688	0.13829	0.13161
-2.12330	60.97444	3.25381	0.18099	0.17433
-1.99922	63.25205	3.25381	0.18488	0.18190
1.99925	63.25237	-3.25316	0.19016	0.19333
2.12333	60.97522	-3.25316	0.19405	0.20091
2.72486	46.00120	-2.24623	0.23675	0.24362
2.77062	44.42888	-2.24623	0.24431	0.24752
-2.77062	44.42941	2.24730	0.25574	0.25279
-2.72486	46.00248	2.24730	0.26331	0.25669
-2.12333	60.98235	3.25423	0.30601	0.29941
-1.99925	63.26025	3.25423	0.30990	0.30698
1.99922	63.26058	-3.25358	0.31517	0.31841
2.12330	60.98314	-3.25358	0.31907	0.32598
2.72483	46.00681	-2.24665	0.36176	0.36870
2.77060	44.43420	-2.24665	0.36933	0.37260
-2.77062	44.43458	2.24741	0.38076	0.37787
-2.72486	46.00772	2.24741	0.38832	0.38177
-2.12332	60.98818	3.25434	0.43102	0.42448
-1.99924	63.26616	3.25434	0.43491	0.43206
-0.65120	65.52093	1.24351	0.44007	0.44377

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17	DRIF	57.19223	.13673	35.91933	-0.50256
17	REMA	64.09375	1.38387	36.48042	0.69929
18	DRIF	65.07160	1.40986	37.01967	0.84043
18	DRIF	66.49922	1.44500	37.95635	1.03055
19	DRIF	67.51889	1.46826	38.72165	1.15485
19	REMA	75.94411	1.61725	47.15493	1.87176
20	DRIF	77.08167	1.63288	48.48785	1.93580
20	QUAD	75.83012	-4.12011	52.32086	5.77509
21	DRIF	56.94775	-3.95359	79.75452	5.95252
21	QUAD	56.90512	3.86738	80.14127	-5.18799
22	DRIF	74.72791	4.03162	57.07223	-5.04005
22	QUAD	75.84128	-1.81947	54.22237	-0.69492
23	DRIF	75.29650	-1.81252	54.01674	-0.67599
23	RE90	67.12514	-1.68405	51.59167	-0.35664
24	REMA	51.53249	-1.13567	52.11378	0.44940
25	RE90	47.11035	-0.74297	54.94337	0.75595
26	RE90	44.75120	-0.25615	59.08183	1.00960
27	REMA	48.41208	0.89008	72.29369	1.40044
28	RE90	53.43594	1.24660	79.08852	1.50861
29	REMA	60.87938	1.53560	87.35947	1.59899
30	DRIF	61.33273	1.54848	87.83020	1.60337
30	QUAD	65.76014	7.37253	85.41930	-6.38804
31	DRIF	87.99606	7.44145	66.34820	-6.31711
31	QUAD	87.17186	-9.06418	66.10811	5.82959
32	DRIF	60.07796	-8.98359	83.71996	5.90301
32	QUAD	54.09630	-3.07969	85.24137	-2.88657
33	DRIF	43.79789	-2.77283	75.25049	-2.81826
33	DRIF	41.08854	-2.64167	72.44442	-2.79341
34	DRIF	30.42014	-1.44753	58.88328	-2.61235
34	DRIF	29.15850	-1.06770	56.29654	-2.55993
35	DRIF	29.35021	1.13716	44.39436	-2.15281
35	QUAD	31.17935	2.52040	41.56689	-3.48209
36	DRIF	46.62582	3.46972	26.98565	-2.04466
36	QUAD	46.50911	-3.70002	27.25959	2.59693
37	DRIF	30.00135	-2.68384	44.22709	3.88447
37	QUAD	30.02363	2.72888	44.35060	-3.64111
38	DRIF	46.73585	3.73660	28.47212	-2.45072
38	QUAD	46.49746	-4.20637	28.63475	2.77931
39	DRIF	27.64292	-3.03843	45.97616	3.89739
39	QUAD	27.15689	2.05709	45.95982	-3.92959

66.39137	1.24351	0.44352	0.45231
75.90488	2.25044	0.46725	0.52052
77.48015	2.25044	0.46992	0.52878
79.73059	2.25044	0.47360	0.54011
81.30585	2.25044	0.47608	0.54770
96.30280	3.25736	0.49302	0.59590
98.58289	3.25736	0.49492	0.60077
98.12284	-4.17171	0.49761	0.60712
78.66673	-4.17171	0.51483	0.62495
79.88824	-6.64275	0.51986	0.62738
109.78059	6.64275	0.53673	0.64307
112.11004	-2.01399	0.53950	0.64828
111.50587	-2.01399	0.54034	0.64991
102.10636	-2.01671	0.55505	0.67667
70.96837	-3.75807	0.60550	0.74236
53.43718	-3.75966	0.63627	0.76840
35.89964	-3.76080	0.67177	0.79134
8.90853	-1.24519	0.75469	0.83197
3.10065	-1.24535	0.78354	0.84496
-0.22374	-0.00565	0.80966	0.85722
-0.22540	-0.00565	0.81091	0.85783
-0.24154	-0.02690	0.81492	0.85992
-0.32224	-0.02690	0.82318	0.86835
-0.31885	0.03356	0.82519	0.87209
-0.21816	0.03356	0.83431	0.88072
-0.19539	0.01238	0.83929	0.88291
-0.15206	0.01238	0.86289	0.89160
-0.13968	0.01238	0.87174	0.89452
-0.07779	0.01238	0.93724	0.91322
-0.06541	0.01238	0.95522	0.91802
-0.00352	0.01238	1.05452	0.95008
0.00887	0.01247	1.07205	0.95866
0.07121	0.01247	1.12793	1.03219
0.07795	0.00083	1.13508	1.05446
0.08210	0.00083	1.19341	1.12252
0.09004	0.01526	1.21162	1.13041
0.16633	0.01526	1.26961	1.19520
0.16722	-0.01350	1.27673	1.21533
0.09972	-0.01350	1.34032	1.27734
0.09443	0.00277	1.36220	1.28466

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17	DRIF	57.19223	1.13673	35.91933	-0.50256
17	REMA	64.09375	1.38387	36.48042	0.69929
18	DRIF	65.07160	1.40986	37.01967	0.84043
18	DRIF	66.49922	1.44500	37.95635	1.03055
19	DRIF	67.51889	1.46826	38.72165	1.15485
19	REMA	75.94411	1.61725	47.15493	1.87176
20	DRIF	77.08167	1.63288	48.48785	1.93580
20	QUAD	75.83012	-4.12011	52.32086	5.77509
21	DRIF	56.94775	-3.95359	79.75452	5.95252
21	QUAD	56.90512	3.86738	80.14127	-5.18799
22	DRIF	74.72791	4.03162	57.07223	-5.04005
22	QUAD	75.84128	-1.81947	54.22237	-0.69492
23	DRIF	75.29650	-1.81252	54.01674	-0.67599
23	RE90	67.12514	-1.68405	51.59167	-0.35664
24	REMA	51.53249	-1.13567	52.11378	0.44940
25	RE90	47.11035	-0.74297	54.94337	0.75595
26	RE90	44.75120	-0.25615	59.08183	1.00960
27	REMA	48.41208	0.89008	72.29369	1.40044
28	RE90	53.43594	1.24660	79.08852	1.50861
29	REMA	60.87938	1.53560	87.35947	1.59899
30	DRIF	61.33273	1.54848	87.83020	1.60337
30	QUAD	65.76014	7.37253	85.41930	-6.38804
31	DRIF	87.99606	7.44145	66.34820	-6.31711
31	QUAD	87.17186	-9.06418	66.10811	5.82959
32	DRIF	60.07796	-8.98359	83.71996	5.90301
32	QUAD	54.09630	-3.07969	85.24137	-2.88657
33	DRIF	43.79789	-2.77283	75.25049	-2.81826
33	DRIF	41.08854	-2.64167	72.44442	-2.79341
34	DRIF	30.42014	-1.44753	58.88328	-2.61235
34	DRIF	29.15850	-1.06770	56.29654	-2.55993
35	DRIF	29.35021	1.13716	44.39436	-2.15281
35	QUAD	31.17935	2.52040	41.56689	-3.48209
36	DRIF	46.62582	3.46972	26.98565	-2.04466
36	QUAD	46.50911	-3.70002	27.25959	2.59693
37	DRIF	30.00135	-2.68384	44.22709	3.88447
37	QUAD	30.02363	2.72888	44.35060	-3.64111
38	DRIF	46.73585	3.73660	28.47212	-2.45072
38	QUAD	46.49746	-4.20637	28.63475	2.77931
39	DRIF	27.64292	-3.03843	45.97616	3.89739
39	QUAD	27.15689	2.05709	45.95982	-3.92959

66.39137	1.24351	0.44352	0.45231
75.90488	2.25044	0.46725	0.52052
77.48015	2.25044	0.46992	0.52878
79.73059	2.25044	0.47360	0.54011
81.30585	2.25044	0.47608	0.54770
96.30280	3.25736	0.49302	0.59590
98.58289	3.25736	0.49492	0.60077
98.12284	-4.17171	0.49761	0.60712
78.66673	-4.17171	0.51483	0.62495
79.88824	6.64275	0.51986	0.62738
109.78059	6.64275	0.53673	0.64307
112.11004	-2.01399	0.53950	0.64828
111.50587	-2.01399	0.54034	0.64991
102.10636	-2.01671	0.55505	0.67667
70.96837	-3.75807	0.60550	0.74236
53.43718	-3.75966	0.63627	0.76840
35.89964	-3.76080	0.67177	0.79134
8.90853	-1.24519	0.75469	0.83197
3.10065	-1.24535	0.78354	0.84496
-0.22374	-0.00565	0.80966	0.85722
-0.22540	-0.00565	0.81091	0.85783
-0.24154	-0.02690	0.81492	0.85992
-0.32224	-0.02690	0.82318	0.86835
-0.31885	0.03356	0.82519	0.87209
-0.21816	0.03356	0.83431	0.88072
-0.19539	0.01238	0.83929	0.88291
-0.15206	0.01238	0.86289	0.89160
-0.13968	0.01238	0.87174	0.89452
-0.07779	0.01238	0.93724	0.91322
-0.06541	0.01238	0.95522	0.91802
-0.00352	0.01238	1.05452	0.95008
0.00887	0.01247	1.07205	0.95866
0.07121	0.01247	1.12793	1.03219
0.07795	0.00083	1.13508	1.05446
0.08210	0.00083	1.19341	1.12252
0.09004	0.01526	1.21162	1.13041
0.16633	0.01526	1.26961	1.19520
0.16722	-0.01350	1.27673	1.21533
0.09972	-0.01350	1.34032	1.27734
0.09443	0.00277	1.36220	1.28466

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40	DRIF	41.72425	3.47086	28.47223	-2.80006
40	QUAD	41.66620	-3.58522	28.27845	2.40857
41	DRIF	26.60068	-2.11697	44.02768	3.62596
41	QUAD	26.99484	2.91246	43.91769	-3.84267
42	DRIF	45.49796	4.16825	27.20149	-2.53689
42	QUAD	45.78616	-3.60036	27.20126	2.53642
43	DRIF	29.85339	-2.55190	43.91541	3.84232
43	QUAD	30.00073	2.84980	44.02526	-3.62588
44	DRIF	47.28427	3.84178	28.27682	-2.40828
44	QUAD	47.10049	-4.20394	28.47080	2.80017
45	DRIF	28.15843	-3.09335	45.95934	3.92982
45	QUAD	27.48785	1.74027	46.23854	-3.37912
46	DRIF	40.50344	3.18870	31.27202	-2.42284
46	DRIF	43.76184	3.32291	29.02587	-2.05580
47	DRIF	61.44793	3.68985	25.45941	0.81727
47	QUAD	65.36786	4.15316	26.48290	1.21726
48	DRIF	164.22209	4.38386	102.10874	3.84460
48	QUAD	153.23609	-15.14798	122.69133	17.14867
49	DRIF	62.47102	-15.07730	225.63637	17.16231
49	QUAD	43.36394	-4.63725	213.89115	-28.51167
50	DRIF	19.30876	0.00392	3.50687	0.03186

0.10828	0.00277	1.43493	1.34706
0.10190	-0.01535	1.44383	1.36745
0.02514	-0.01535	1.51832	1.43322
0.01152	-0.01228	1.54120	1.44122
-0.04988	-0.01228	1.60793	1.50995
-0.05763	-0.00301	1.61536	1.53215
-0.07268	-0.00301	1.67496	1.60088
-0.08204	-0.01598	1.69328	1.60888
-0.16192	-0.01598	1.75061	1.67466
-0.16388	0.01212	1.75755	1.69505
-0.10331	0.01212	1.81907	1.75746
-0.09917	-0.00373	1.84025	1.76475
-0.11781	-0.00373	1.91437	1.82095
-0.12154	-0.00373	1.92336	1.83852
-0.14019	-0.00373	1.95312	1.95679
-0.14439	-0.00468	1.95709	1.98046
-0.25155	-0.00468	1.99129	2.14113
-0.23081	0.02500	1.99251	2.14377
-0.08078	0.02500	2.00249	2.14722
-0.04414	0.01286	2.01506	2.14784
0.05234	0.01286	2.19173	2.39540

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40	QUAD	41.66620	-3.58522	28.27845	2.40857
41	DRIF	26.60068	-2.11697	44.02768	3.62596
41	QUAD	26.99484	2.91246	43.91769	-3.84267
42	DRIF	45.49796	4.16825	27.20149	-2.53689
42	QUAD	45.78616	-3.60036	27.20126	2.53642
43	DRIF	29.85339	-2.55190	43.91541	3.84232
43	QUAD	30.00073	2.84980	44.02526	-3.62588
44	DRIF	47.28427	3.84178	28.27682	-2.40828
44	QUAD	47.10049	-4.20394	28.47080	2.80017
45	DRIF	28.15843	-3.09335	45.95934	3.92982
45	QUAD	27.48785	1.74027	46.23854	-3.37912
46	DRIF	40.50344	3.18870	31.27202	-2.42284
46	DRIF	43.76184	3.32291	29.02587	-2.05580
47	DRIF	61.44793	3.68985	25.45941	0.81727
47	QUAD	65.36786	4.15316	26.48290	1.21726
48	DRIF	164.22209	4.38386	102.10874	3.84460
48	QUAD	153.23609	-15.14798	122.69133	17.14867
49	DRIF	62.47102	-15.07730	225.63637	17.16231
49	QUAD	43.36394	-4.63725	213.89115	-28.51167
50	DRIF	19.30876	0.00392	3.50687	0.03186

0.10190	-0.01535	1.44383	1.36745
0.02514	-0.01535	1.51832	1.43322
0.01152	-0.01228	1.54120	1.44122
-0.04988	-0.01228	1.60793	1.50995
-0.05763	-0.00301	1.61536	1.53215
-0.07268	-0.00301	1.67496	1.60088
-0.08204	-0.01598	1.69328	1.60888
-0.16192	-0.01598	1.75061	1.67466
-0.16388	0.01212	1.75755	1.69505
-0.10331	0.01212	1.81907	1.75746
-0.09917	-0.00373	1.84025	1.76475
-0.11781	-0.00373	1.91437	1.82095
-0.12154	-0.00373	1.92336	1.83852
-0.14019	-0.00373	1.95312	1.95679
-0.14439	-0.00468	1.95709	1.98046
-0.25155	-0.00468	1.99129	2.14113
-0.23081	0.02500	1.99251	2.14377
-0.08078	0.02500	2.00249	2.14722
-0.04414	0.01286	2.01506	2.14784
0.05234	0.01286	2.19173	2.39540

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Tab. 2: Lattice definition

SYSTEMDATEN

19.05.83

1	2	3	4	5	6	7
TYPE	DRIF (H)	L (M)	K (1/M*MM)	1/RHO (1/M)	ALFA1 (GRAD)	ALFA2
1 QUAD	0.69998	0.50000	-0.10200	0.00000	0.00000	0.00000
2 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
3 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
4 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
5 QUAD	0.69998	0.50000	-0.10200	0.00000	0.00000	0.00000
6 QUAD	0.00000	0.50000	-0.10200	0.00000	0.00000	0.00000
7 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
8 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
9 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
10 QUAD	0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
11 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
12 QUAD	0.69998	1.00000	0.10200	0.00000	0.00000	0.00000
13 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
14 QUAD	-0.69998	1.00000	-0.10200	0.00000	0.00000	0.00000
15 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
16 QUAD	0.69998	1.00000	0.03115	0.00000	0.00000	0.00000
17 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
18 DRIF	0.69998	1.00000	0.00000	0.00000	0.00000	0.00000
19 REQA	0.69998	5.44580	0.00000	0.00185	-0.28845	-0.28845
20 QUAD	0.69998	1.00000	0.07506	0.00000	0.00000	0.00000
21 QUAD	4.66382	1.00000	-0.13798	0.00000	0.00000	0.00000
22 QUAD	4.50000	1.00000	0.07752	0.00000	0.00000	0.00000
23 REQA	0.69998	4.66382	0.00000	-0.00233	-0.31162	-0.31162
24 REQA	0.00000	10.78457	0.00000	-0.00161	0.49884	0.49884
25 REQA	0.00000	4.66382	0.00000	0.00233	0.31161	0.31161

26	RE90	0.00000	4.66332	0.00000	0.00233	0.31161	0.31161
27	RENA	0.00000	10.78657	0.00000	0.00233	-0.72061	-0.72061
28	RE90	0.00000	4.66332	0.00000	-0.00233	-0.31162	-0.31162
29	RENA	0.00000	5.31494	0.00000	0.00233	-0.35513	-0.35513
30	QUAD	0.29399	1.00000	-0.09172	0.00000	0.00000	0.00000
31	QUAD	3.00000	1.00000	0.18569	0.00000	0.00000	0.00000
32	QUAD	3.00000	1.00000	-0.10334	0.00000	0.00000	0.00000
33	DRIE	3.50000	1.00000	0.00000	0.00000	0.00000	0.00000
34	DRIE	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
35	QUAD	5.00000	1.00000	-0.03375	0.00000	0.00000	0.00000
36	QUAD	5.00000	1.00000	0.15403	0.00000	0.00000	0.00000
37	QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
38	QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
39	QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
40	QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
41	QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
42	QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
43	QUAD	5.00000	1.00000	-0.17000	0.00000	0.00000	0.00000
44	QUAD	5.00000	1.00000	0.17000	0.00000	0.00000	0.00000
45	QUAD	5.00000	1.00000	-0.15858	0.00000	0.00000	0.00000
46	DRIE	5.00000	1.00000	0.00000	0.00000	0.00000	0.00000
47	QUAD	5.00000	1.00000	-0.00669	0.00000	0.00000	0.00000
48	QUAD	22.29258	2.00000	0.06030	0.00000	0.00000	0.00000
49	QUAD	6.00000	2.00000	-0.10042	0.00000	0.00000	0.00000
50	DRIE	0.00000	7.50000	0.00000	0.00000	0.00000	0.00000

Tab.3: Hor. and vert. beam envelopes and hor. dispersion (Values at the end of the element)

PROBLEM

HELP & DEMONSTRATION

19.05.83

DESSWERT

DP/P (1/1000) = 0.0000 0.0000 100.0000
EPS (MM/MRAD) = 100.0000 100.0000 100.0000
CHR. ABERR. = 0 0 0

NR.	TYP	EX(MM)	EX'(MRAD)	EZ(MM)	EZ'(MRAD)	TX(MM)	TX'(MRAD)	Q1	Q2
0		37.15821	0.00000	55.15040	0.00000	43.86133	0.00000	0.0	0.0
1	QUAD	37.65722	1.99967	54.45622	-2.77060	44.42174	2.24639	0.00571	0.00264
2	DRIF	39.10116	2.12365	52.53258	-2.72484	45.99417	2.24639	0.01328	0.00653
2	REMA	52.54523	2.72555	39.09064	-2.12329	60.96908	3.25332	0.05598	0.04925
3	DRIF	54.46936	2.77128	37.64698	-1.99921	63.24634	3.25332	0.05987	0.05682
3	QUAD	54.46934	-2.77131	37.64700	1.99924	63.24648	-3.25305	0.06514	0.06826
4	DRIF	52.54519	-2.72559	39.09067	2.12332	60.96940	-3.25305	0.06904	0.07583
4	REMA	39.10093	-2.12368	52.53278	2.72486	45.99596	-2.24612	0.11173	0.11855
5	DRIF	37.65697	-1.99969	54.45644	2.77062	44.42372	-2.24612	0.11930	0.12244
5	QUAD	37.15794	-0.00004	55.15062	0.00001	43.86348	0.00037	0.12501	0.12508
6	QUAD	37.65693	1.99961	54.45646	-2.77060	44.42410	2.24688	0.13073	0.12772
7	DRIF	39.10084	2.12360	52.53282	-2.72482	45.99687	2.24688	0.13829	0.13161
7	REMA	52.54470	2.72552	39.09086	-2.12330	60.97444	3.25381	0.18099	0.17433
8	DRIF	54.46880	2.77125	37.64720	-1.99922	63.25205	3.25381	0.18488	0.18190
8	QUAD	54.46879	-2.77129	37.64722	1.99925	63.25237	-3.25316	0.19016	0.19333
9	DRIF	52.54465	-2.72555	39.09090	2.12333	60.97522	-3.25316	0.19405	0.20091
9	REMA	39.10060	-2.12363	52.53302	2.72486	46.00120	-2.24623	0.23675	0.24062
10	DRIF	37.65668	-1.99964	54.45667	2.77062	44.42888	-2.24623	0.24431	0.24731
10	QUAD	37.65668	1.99964	54.45667	-2.77062	44.42941	2.24730	0.25574	0.25270
11	DRIF	39.10060	2.12363	52.53301	-2.72486	46.00248	2.24730	0.26331	0.25669
11	REMA	52.54465	2.72555	39.09090	-2.12333	60.98235	3.25423	0.30601	0.29941
12	DRIF	54.46879	2.77129	37.64721	-1.99925	63.26025	3.25423	0.30990	0.30698
12	QUAD	54.46881	-2.77125	37.64720	1.99922	63.26058	-3.25358	0.31517	0.31841
13	DRIF	52.54470	-2.72552	39.09086	2.12330	60.98314	-3.25358	0.31907	0.32598
13	REMA	39.10084	-2.12360	52.53281	2.72483	46.00681	-2.24665	0.36176	0.36870
14	DRIF	37.65692	-1.99961	54.45645	2.77060	44.43420	-2.24665	0.36933	0.37260
14	QUAD	37.65697	1.99969	54.45643	-2.77062	44.43458	2.24741	0.38075	0.37787
15	DRIF	39.10093	2.12368	52.53278	-2.72486	46.00772	2.24741	0.38832	0.38177
15	REMA	52.54519	2.72559	39.09067	-2.12332	60.98818	3.25434	0.43102	0.42448
16	DRIF	54.46935	2.77131	37.64699	-1.99924	63.26616	3.25434	0.43491	0.43206
16	QUAD	56.40982	1.09853	36.32343	-0.65120	65.52093	1.24351	0.44007	0.44377

Tab.3

17	DRIF	57.19223	1.13673	35.91933	-0.50256
17	REMA	64.09375	1.38387	36.48042	0.69929
18	DRIF	65.07160	1.40986	37.01967	0.84043
18	DRIF	66.49922	1.44500	37.95635	1.03055
19	DRIF	67.51889	1.46826	38.72165	1.15485
19	REMA	75.94411	1.61725	47.15493	1.87176
20	DRIF	77.08167	1.63288	48.48785	1.93580
20	QUAD	75.83012	-4.12011	52.32086	5.77509
21	DRIF	56.94775	-3.95359	79.75452	5.95252
21	QUAD	56.90512	3.86738	80.14127	-5.18799
22	DRIF	74.72791	4.03162	57.07223	-5.04005
22	QUAD	75.84128	-1.81947	54.22237	-0.69492
23	DRIF	75.29650	-1.81252	54.01674	-0.67599
23	RE90	67.12514	-1.68405	51.59167	-0.35664
24	REMA	51.53249	-1.12567	52.11378	0.44940
25	RE90	47.11035	-0.74297	54.94337	0.75595
26	RE90	44.75120	-0.25615	59.08183	1.00960
27	REMA	48.41208	0.89008	72.29369	1.40044
28	RE90	53.43594	1.24660	79.08852	1.50861
29	REMA	60.87938	1.53560	87.35947	1.59899
30	DRIF	61.33273	1.54848	87.83020	1.60337
30	QUAD	65.76014	7.37253	85.41930	-6.38804
31	DRIF	87.99606	7.44145	66.34820	-6.31711
31	QUAD	87.17186	-9.06418	66.10811	5.82959
32	DRIF	60.67796	-8.98359	83.71996	5.90301
32	QUAD	54.09630	-3.07969	65.24137	-2.88657
33	DRIF	43.79789	-2.77283	75.25049	-2.81826
33	DRIF	41.92854	-2.64167	72.44442	-2.79341
34	DRIF	30.42014	-1.44753	58.88328	-2.61235
34	DRIF	29.15850	-1.06770	56.29654	-2.55993
35	DRIF	29.35021	1.13716	44.39436	-2.15281
35	QUAD	31.12935	2.52040	61.56687	-3.48209
36	DRIF	46.55582	3.40972	26.98565	-2.04466
36	QUAD	46.84911	-3.73002	27.28959	2.59693
37	DRIF	30.89135	-1.67384	44.22709	3.88447
37	QUAD	30.52363	2.71322	66.38060	-3.64111
38	DRIF	46.55585	3.73666	28.47212	-2.45072
38	QUAD	47.49744	-4.10637	25.62475	2.77931
39	DRIF	27.64292	-3.07843	31.27616	3.89739
39	QUAD	27.15689	2.05709	65.95982	-3.92959

66.39137	1.24351	0.44352	0.45231
75.90488	2.25044	0.46725	0.52052
77.48015	2.25044	0.46992	0.52878
79.73059	2.25044	0.47360	0.54011
81.30585	2.25044	0.47608	0.54770
96.30280	3.25736	0.49302	0.59590
98.58289	3.25736	0.49492	0.60077
98.12284	-4.17171	0.49761	0.60712
78.66673	-4.17171	0.51483	0.62495
79.88824	6.64275	0.51986	0.62738
109.78059	6.64275	0.53673	0.64307
112.11004	-2.01399	0.53950	0.64828
111.50587	-2.01399	0.54034	0.64991
102.10636	-2.01671	0.55505	0.67667
70.96837	-3.75807	0.60550	0.74236
53.43718	-3.75966	0.63627	0.76840
35.89964	-3.76080	0.67177	0.79134
8.90853	-1.24519	0.75469	0.83197
3.10065	-1.24535	0.78354	0.84496
-0.22374	-0.00565	0.80966	0.85722
-0.22540	-0.00565	0.81091	0.85783
-0.24154	-0.02690	0.81492	0.85992
-0.32224	-0.02690	0.82318	0.86835
-0.31885	0.03356	0.82519	0.87209
-0.21816	0.03356	0.83431	0.88072
-0.19539	0.01238	0.83929	0.88291
-0.15206	0.01238	0.86289	0.89160
-0.13968	0.01238	0.87174	0.89452
-0.07779	0.01238	0.93724	0.91322
-0.06541	0.01238	0.95522	0.91802
-0.00352	0.01238	1.05452	0.95008
0.00887	0.01247	1.07209	0.95866
0.07121	0.01247	1.12793	1.03219
0.07795	0.00083	1.13508	1.05446
0.03210	0.00083	1.19341	1.12252
0.09004	0.01526	1.21162	1.13041
0.16633	0.01526	1.25961	1.19520
0.16722	-0.01356	1.27673	1.21533
0.09972	-0.01356	1.34032	1.27734
0.09443	0.00277	1.36220	1.28466

Table 3, 11

40	DRIF	41.72425	3.47086	28.47223	-2.80006
40	QUAD	41.66620	-3.58522	28.27845	2.40857
41	DRIF	26.60068	-2.11697	44.02768	3.62596
41	QUAD	26.92484	2.91246	42.91769	-3.84267
42	DRIF	45.49796	4.16825	27.20149	-2.53689
42	QUAD	45.78616	-2.60036	27.20126	2.53642
43	DRIF	29.85339	-2.55190	43.91541	3.84232
43	QUAD	30.00073	2.84980	44.02526	-3.62588
44	DRIF	47.28427	3.64178	28.27682	-2.40828
44	QUAD	47.10049	-4.20394	28.47080	2.80017
45	DRIF	28.15843	-2.09335	45.95934	3.92982
45	QUAD	27.48785	1.74027	46.23854	-3.37912
46	DRIF	40.50344	3.16870	51.27202	-2.42284
46	DRIF	43.76184	3.32291	29.02587	-2.05580
47	DRIF	61.44793	3.68985	25.45941	0.81727
47	QUAD	65.36786	4.15316	26.48290	1.21726
48	DRIF	164.22209	4.38386	102.10874	3.84460
48	QUAD	153.23609	-15.14798	122.69133	17.14867
49	DRIF	62.47102	-15.07730	225.63637	17.16231
49	QUAD	43.26394	-4.63725	213.89115	-28.51167
50	DRIF	19.30876	0.00392	2.50687	0.03186

0.10828	0.00277	1.43493	1.34706
0.10190	-0.01535	1.44383	1.36745
0.02514	-0.01535	1.51832	1.43322
0.01152	-0.01228	1.54120	1.44122
-0.04988	-0.01228	1.60793	1.50995
-0.05763	-0.00301	1.61536	1.53215
-0.07268	-0.00301	1.67496	1.60088
-0.08204	-0.01598	1.69328	1.60888
-0.16192	-0.01598	1.75061	1.67466
-0.16388	0.01212	1.75755	1.69505
-0.10331	0.01212	1.81907	1.75746
-0.09917	-0.00373	1.84025	1.76475
-0.11781	-0.00373	1.91437	1.82095
-0.12154	-0.00373	1.92336	1.83852
-0.14019	-0.00373	1.95312	1.95679
-0.14439	-0.00468	1.95709	1.98046
-0.25155	-0.00468	1.99129	2.14113
-0.23081	0.02500	1.99251	2.14377
-0.08078	0.02500	2.00249	2.14722
-0.04414	0.01286	2.01506	2.14784
0.05234	0.01286	2.19173	2.39540

Tab. 3, 11