PS / HI / Note 93 - 11 (Tech.)
22.02.93
rev. 23.09.93

A study on beam dynamics for the case of unpowered IH tanks

M. Bendel

Introduction

To figure out - at commissioning of LINAC 3 - the performance of the three IH tanks separately, it is of interest to know the beam characteristics of subsets of the tank ensemble in operation. This note summarizes the investigations made, using DYNAC [1] for the IH structure and TRACE 3D [2] for the ITF line. The characteristics of the beam of the IH tanks will be measured in the ITF line.
Fig . 20 shows a drawing of the studied part of LINAC 3.

1. Machine modes

ITF - line, stripper out

1. all tanks in operation
2. tanks 1 and 2 in operation
3. tank 1 in operation
4. all 3 tanks off

2. Parameters which are computed here (a) and those to be measured later (b)

a. beam envelops,
Twiss parameters and bunch-lengths
(RF phase-spreads) at different positions,
magnetic dispersion of detector downstream of first spectrometer magnet.

b. mean energy,
energy dispersion,
transversal emittances,
bunch lengths.

3. Results

In all cases the beam can be transported to the last SEMGRID (ITF.MSG05) : 3 MeV/u see fig. 5, 1.9 MeV/u see fig. 10, 0.25 MeV/u see fig. 15. Note, in the last case slightly smaller emittances than in the other runs are assumed.
In all cases transversal emittances should be measurable with the new emittance measuring device in ITFE, at SLFM10.
In some cases the precision of the Δ E/E measurement (spectrometer and MSG10) can be improved by closing the slits (SLH01) almost, if a reduction of beam intensity of 90% is admissible.
The beam dimension due to betatron motion is, in the case of 3 MeV/u , then equivalent to a Δ E/E of 0.3 %.

4. Some remarks with respect to the computer runs

To resolve at the SEMGRID, downstream of the spectrometer magnet, horizontal beam dimensions, resulting from energy dispersion from those from betatron motion, some special TRACE runs were done. Either transversal or longitudinal emittances were set to zero. As long as no slits are involved and the beam is focused at the SEMGRID, the ratio of beam dimensions is then a measure of the obtainable precision of energy dispersion. The run $\varepsilon x=0$ was also used to find the dispersion Dx.
Beam dimensions are deduced from Twiss parameters and emittances.
TRACE 3 D emittances are 5 rms values.
Where DYNAC results were used as TRACE input, the relation
ε-TRACE = 5/4 * ε- DYNAC was applied.

5. Acknowledgement

I would like to give special thanks to A. Lombardi, E. Tanke and P. Têtu for their helpful support.

6. References

[1] P. Lapostolle, E.Tanke and S.Valero
New General Beam Dynamics Formulation for the Program DYNAC
Linac Conference, 1992 Ottawa

[2] K .R Crandall, D. P. Rusthoi
TRACE 3 - D Document, 2nd edition, December 1990, LA-UR-90-4146
Los Alamos National Laboratory, USA

Input parameters

Emean: 0.251 MeV/u

Input parameters at IH tank 1 (MEBT out): Case 1, 2 and 3

x - plane:	α= 1.72	β= 0.9615 mm/mrad	ε= 34.733 mm*mrad
y - plane:	α= 0.507	β= 0.5519 mm/mrad	ε= 35.482 mm*mrad
longitudinal:	α= -1.333	β= 0.0237 deg/keV	ε= 11000.00 keV*deg
	ΔW/W= 2.1%	$\Delta\phi$= 16.14 deg	

4-rms-emittances

Input parameters at MEBT (RFQ out): Case 4

x - plane:	α= -1.370	β= 0.2250 mm/mrad	ε= 20.000 mm*mrad
y - plane:	α= 1.740	β= 0.2565 mm/mrad	ε= 20.000 mm*mrad
longitudinal:	α= 0.000	β= 0.0180 deg/keV	ε= 8500.00 keV*deg
	ΔW/W= 1.3 %	$\Delta\phi$= 12.37 deg	

5-rms-emittances

CASE 1
tank 1, 2 and 3 in operation

1. Parameters in the ITF - line

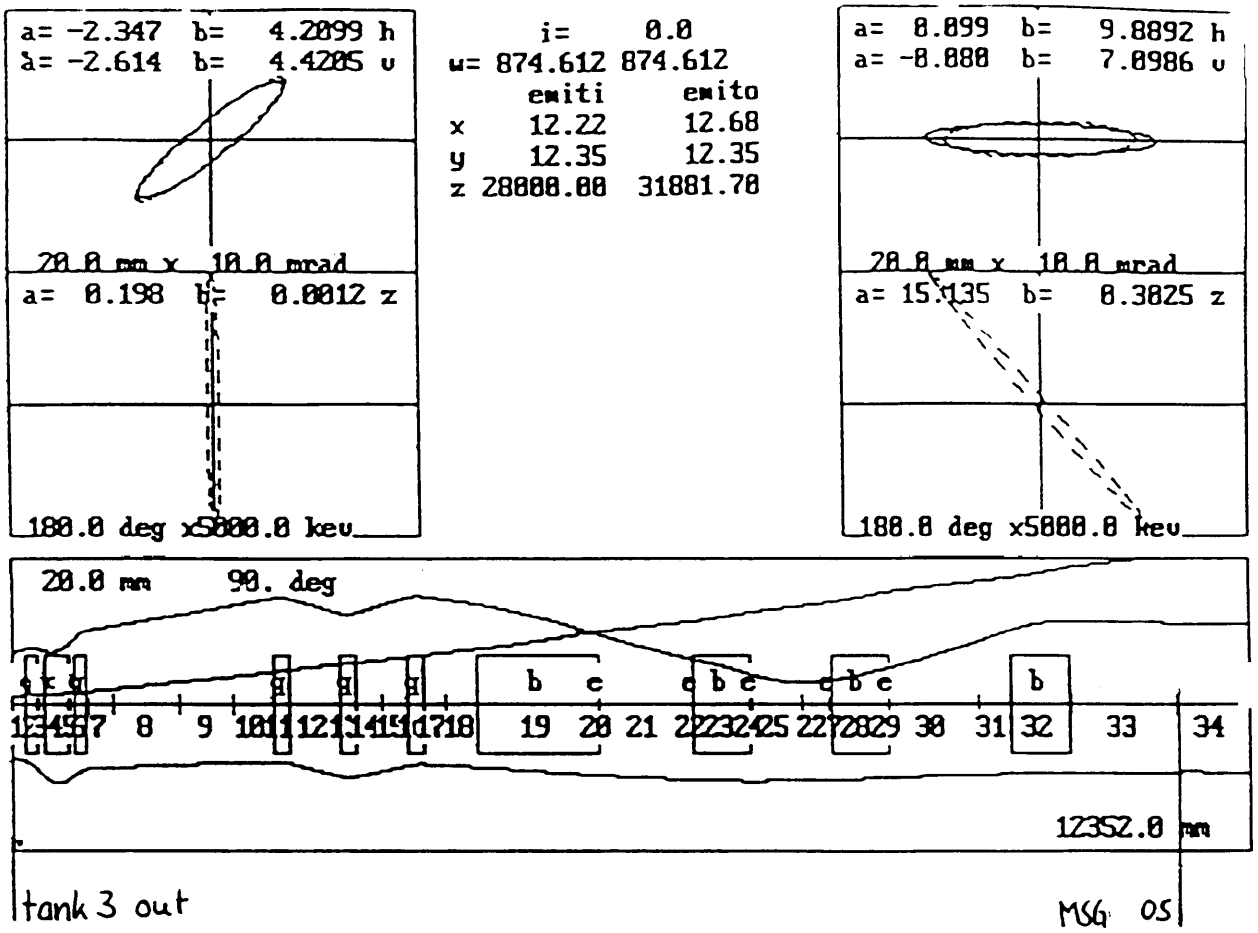
Emean (output tank 3): 4.205 MeV/u
Energy spread: $\Delta W/W = 1.12$ %
Emittances are un-normalized 5-rms surfaces of ellipses of sub phase spaces / π.

*	εx [mm*mrad]	αx	βx [mm/mrad]	εy [mm*mrad]	αy	βy [mm/mrad]	εl [keV*deg]	Δφ [deg]	αl	βl [deg/keV]
output tank 3	12.22	-2.347	4.2099	12.35	-2.614	4.4205	28000.00	5.80	0.198	0.0012
MBLD								10.1784	1.474	0.0037
MSG01 MFP MPHP01		-2.756	15.4615		0.239	5.4131		18.02	3.002	0.0116
MTR15		-4.780	15.4764		2.254	6.9273				
MSG02		2.625	17.1618		-0.530	5.8433				
MSG03		0.070	0.5621		0.157	9.0866				
MSG04 MTR25		-1.916	3.7882		0.300	7.6876				
MSG05 MPHP02		0.171	10.0783		0.019	7.0559	31881.70	93.19	14.359	0.2724
SLFM10		1.361	6.2011		-1.132	10.4129				

2. Quadrupole settings

ITF QFN 01: 19.25 T/m
ITF QDN 02: -22.41 T/m
ITF QFN 03S: 19.25 T/m
ITF QFN 04: 6.86 T/m
ITF QDN 05: -10.21 T/m
ITF QFN 06: 6.29 T/m
IA1. QFN 01: -60.5 T/m
IA1. QDN 02: 55.0 T/m
IA1. QDN 04: 61.5 T/m
IA1. QFN 05: -63.0 T/m
IA1. QFN 07: -66.0 T/m
IA1. QDN 08: 65.0 T/m
IA2. QDN 01: 66.5 T/m
IA2. QFN 02: -66.5 T/m

* In Fig.20 the element names are preceded by " ITF,S,E " to distinguish between different parts of the LINAC, this is not needed here.



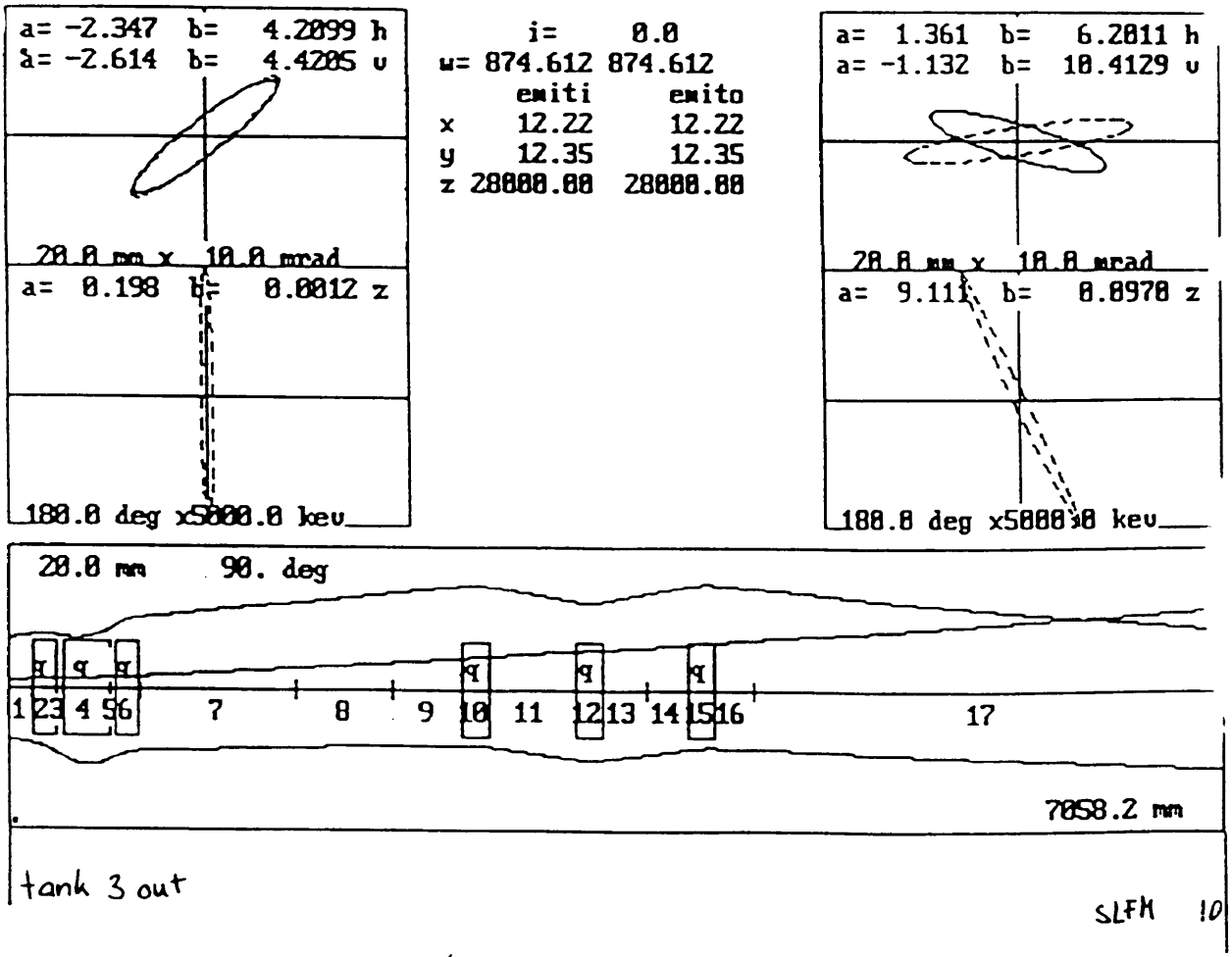


Fig 1. ITF-Linc, all 3 tanks in operation

CASE 1
all three tanks in operation

Energy spectrometer

In this case I did not use the slit, because there is no solution of this case when on one hand the quadrupole fields are limited (ITF QFN 05, 06, 07 = 11.0 T/m) and on the other hand the vertical width of the beam shall be smaller than 32 mm.

1. Beam characteristics at MSG 10

Dx= 1.760 m

Δx= 1.56 mm
Δy= 112.67 mm

Dx = Dispersion at MSG 10
Δx, Δy = beam half width from betatron oscillation

$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 2.14$$

Energy resolution between two wires (wire distance = 1 mm)

ΔE/E = 0.284 %

4. Quadrupole settings [T/m]

ITF QFN 01 = 6.7790	ITF QFN 04 = 7.3097
ITF QDN 02 = -12.4730	ITF QDN 05 = -9.9692
ITF QFN 03S = 6.7790	ITF QFN 06 = 7.3097

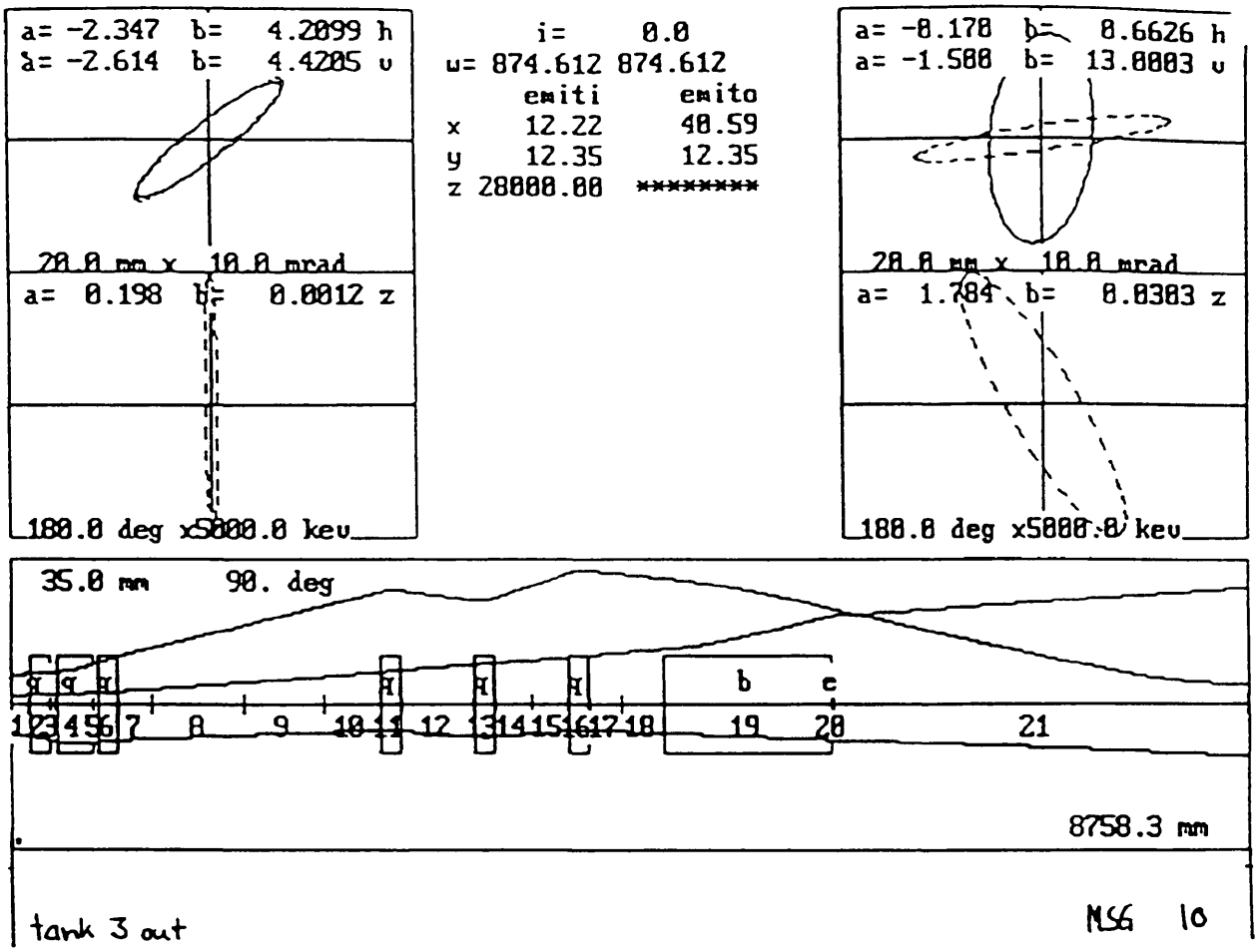
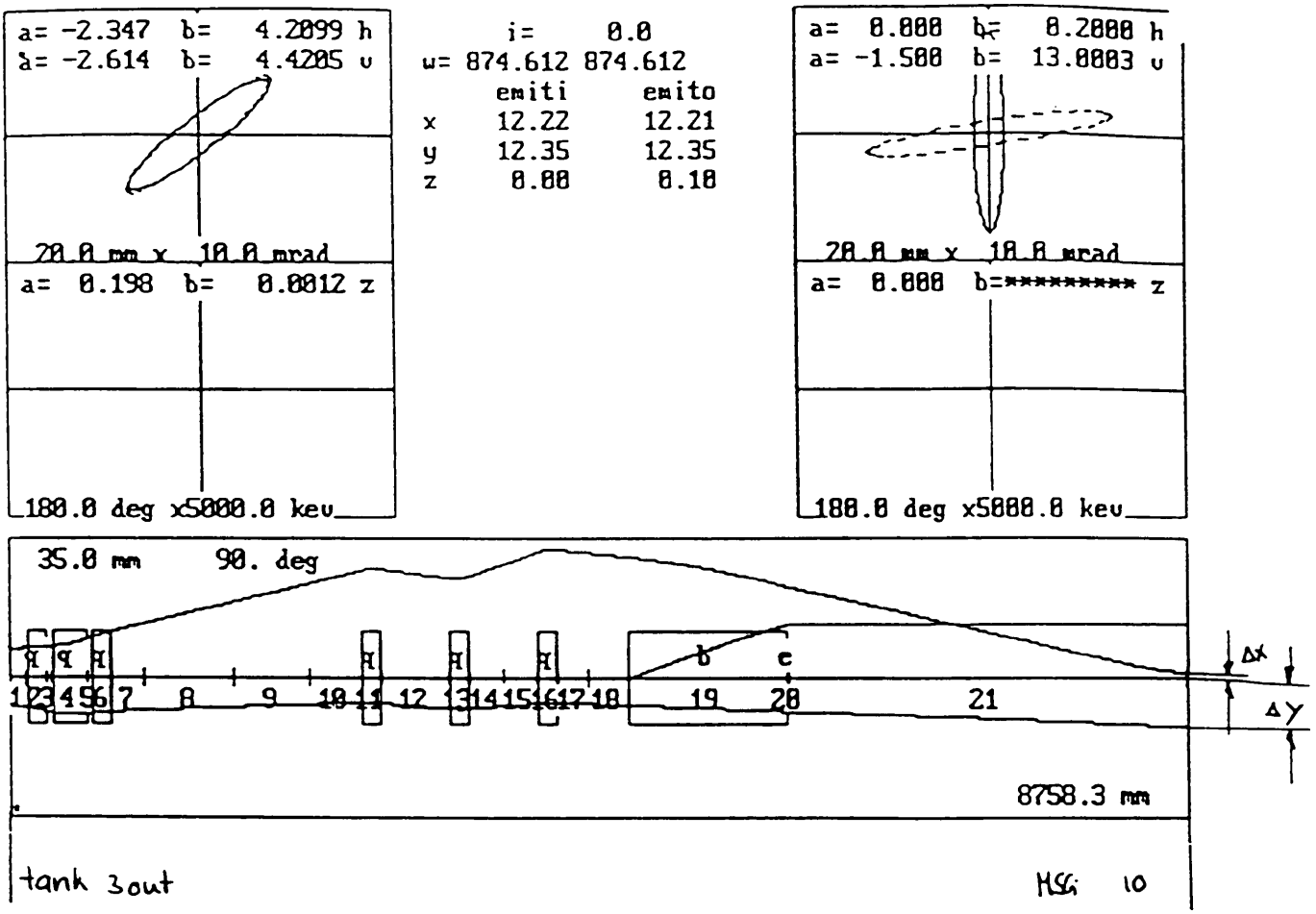
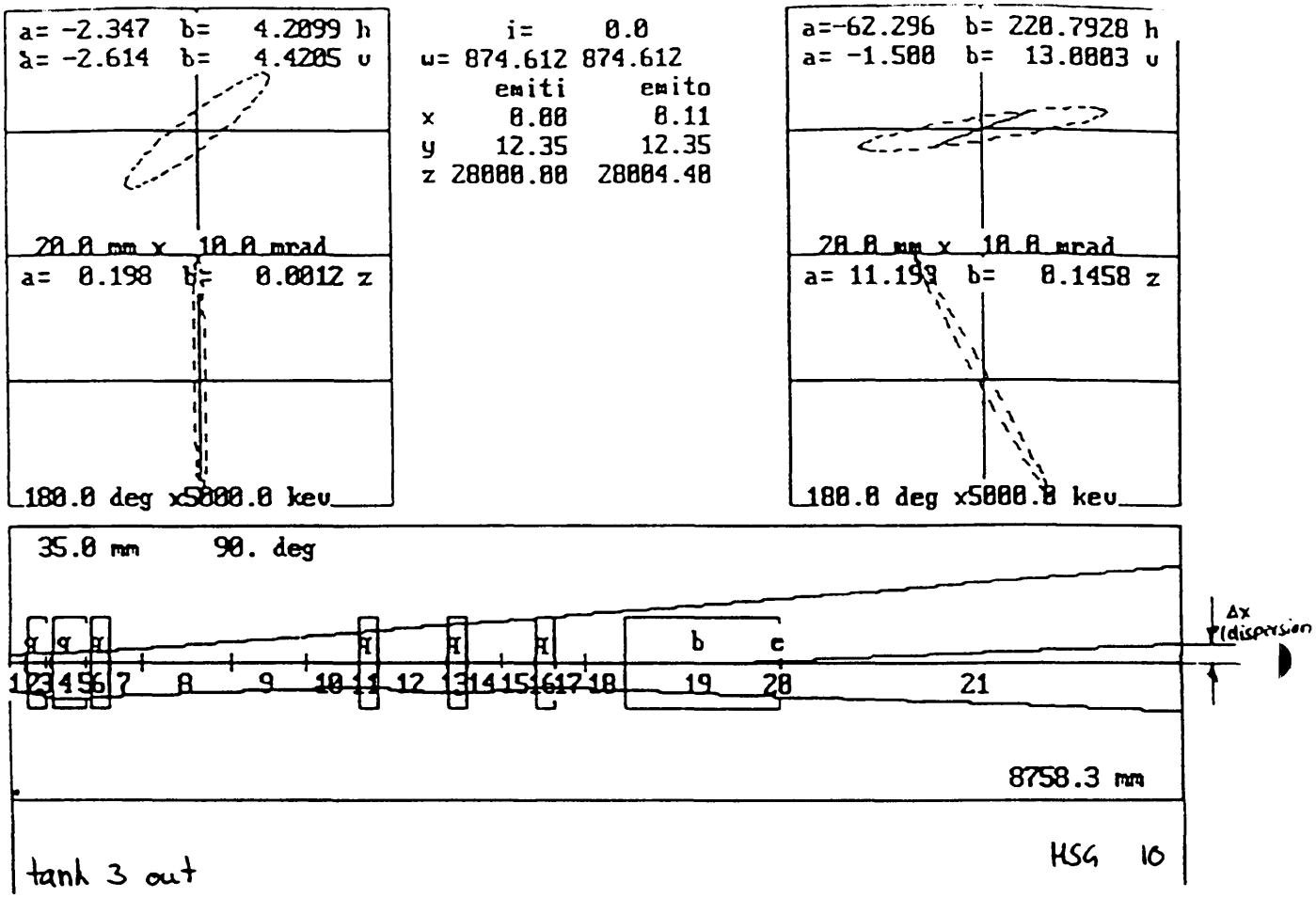


Fig 2 : part of the ITF-Linc = ITFS



$\Delta E \stackrel{!}{\doteq} 0$

Fig 3 part of the ITF-Linc



$\varepsilon_x \overset{!}{\approx} 0$

Fig 4 part of the ITF-Linc

CASE 2
tank 1 and 2 in operation

1. Parameters in the ITF - line

Emean (output tank 2): 3.040 MeV/u
Energy spread: ΔW/W= 0.96 %

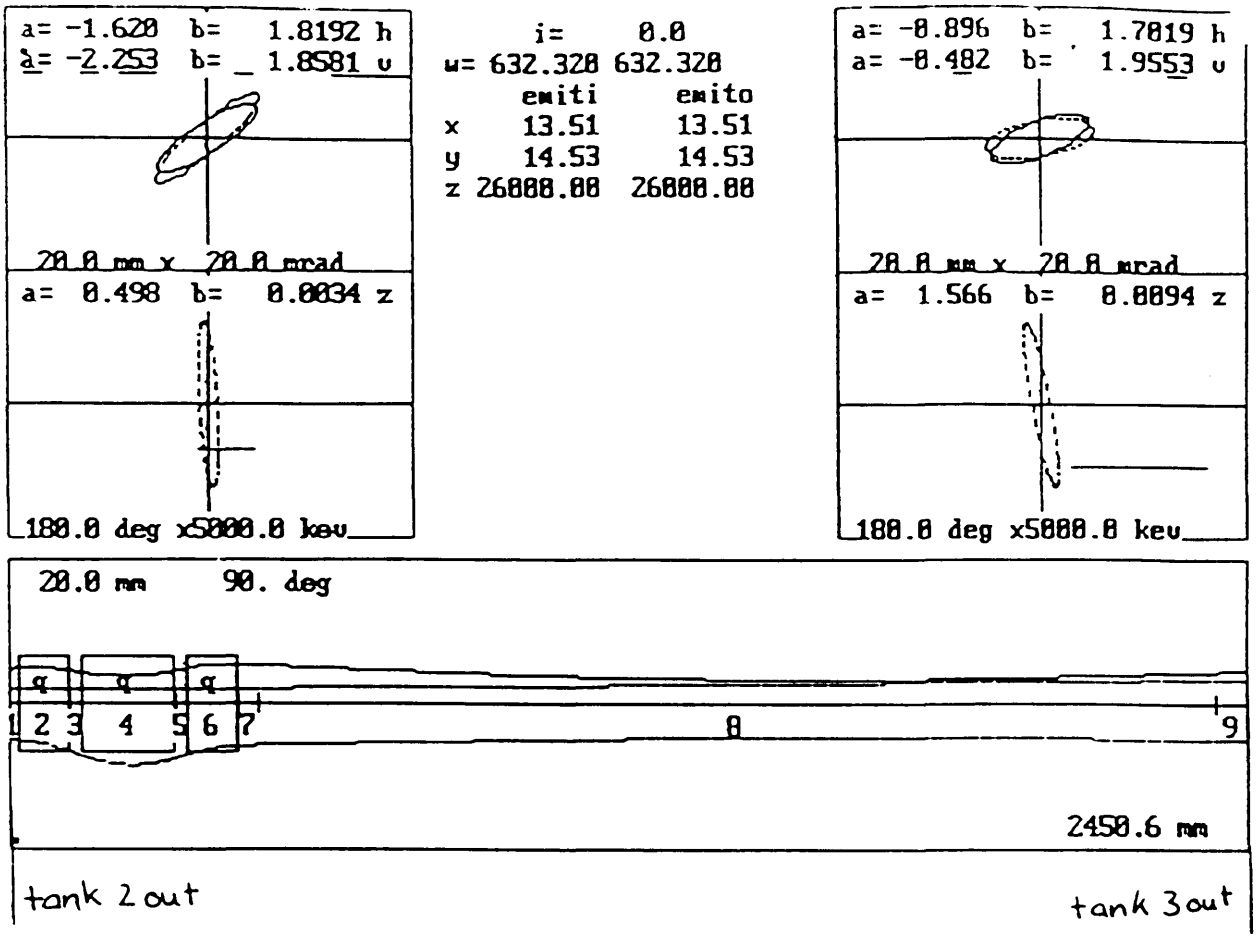
	εx [mm*mrad]	αx	βx [mm/mrad]	εy [mm*mrad]	αy	βy [mm/mrad]	εl [keV*deg]	Δφ [deg]	αl	βl [deg/keV]
output tank 2	13.51	-1.620	1.8192	14.53	-2.253	1.8581	26000.00	9.40	0.498	0.0034
input tank 3		1.168	2.2316		0.746	2.4686		10.32	0.717	0.0041
output tank 3		-0.896	1.7019		-0.482	1.9553		15.63	1.566	0.0094
MBLD								22.23	2.447	0.0190
MSG01 MFP MPHP01		-2.515	1.8170		-1.305	1.3679		30.64	3.502	0.0361
MTR15		-10.822	10.9199		6.145	9.0986				
MSG02		2.691	17.5387		-0.517	5.8278				
MSG03		0.041	0.5120		0.160	8.9942				
MSG04 MTR25		-2.113	4.2758		0.296	7.6020				
MSG05 MPHP02		0.182	10.1721		0.013	6.9896	28511.18	107.39	11.597	0.4045
SLFM10		1.399	6.2921		-1.115	10.3177				

2. Quadrupole settings

IA2 QDN 01: 61.37 T/m
IA2 QFN 02: -61.01 T/m
IA2 QDN 03S: 61.37 T/m

ITF QFN 01: 38.96 T/m
ITF QDN 02: -25.81 T/m
ITF QFN 03S: 38.96 T/m

ITF QFN 04: 5.83 T/m
ITF QDN 05: -8.96 T/m
ITF QFN 06: 5.83 T/m



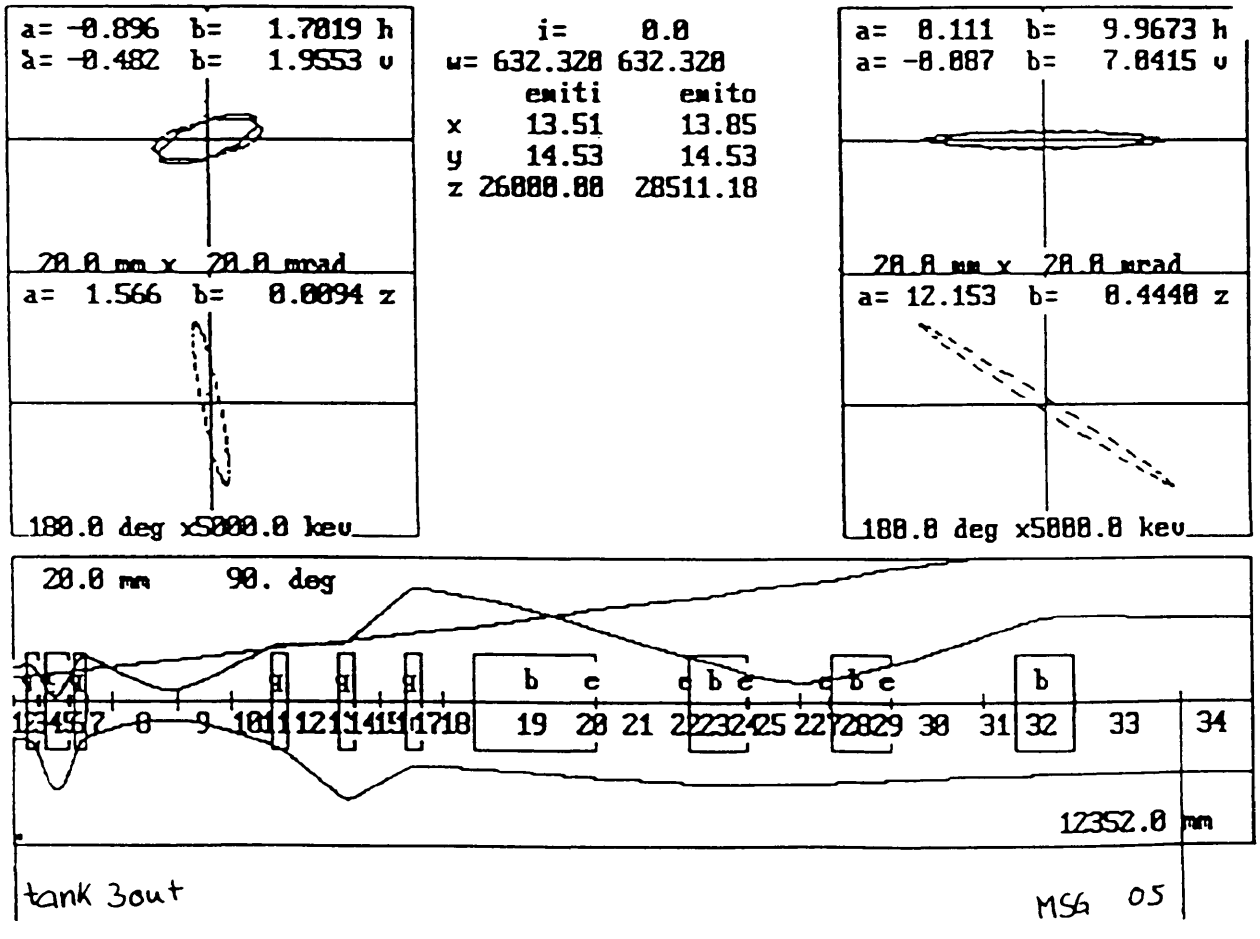


fig 5 : Linac tank 3 and ITF-Linc, tank 1 and 2 in operation

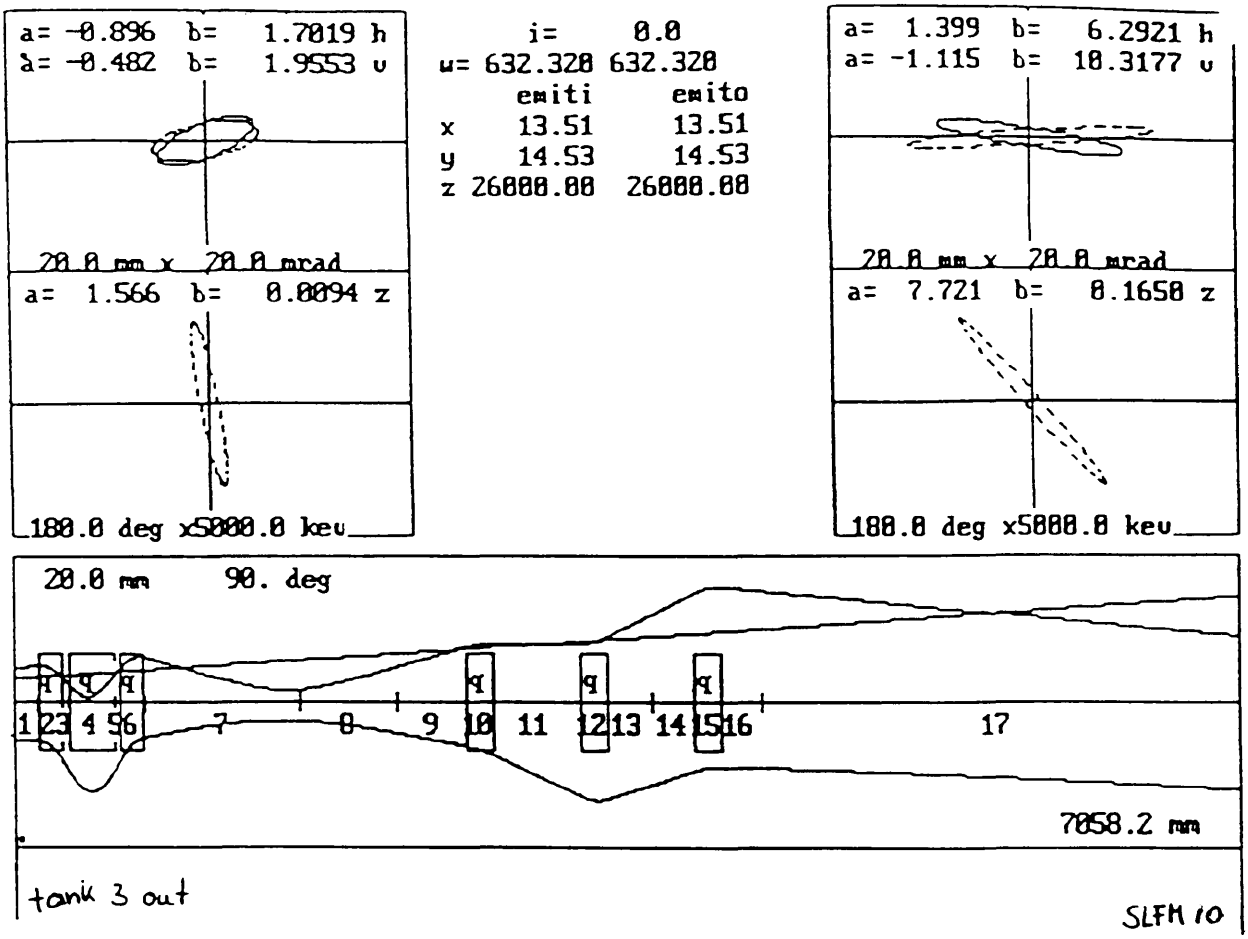


Fig 6: iTF-Linc, tank 1 and 2 in operation

CASE 2
tanks 2 and 3 in operation

Energy spectrometer

1. Beam characteristics before slit

x - plane:	α= 0.00	β= 8.000 mm/mrad	ε= 13.51 mm*mrad	Δx= 10.40mm
y - plane:	α= 1.00	β= 3.000 mm/mrad	ε= 14.53 mm*mrad	

Δx= beam half-width

2. Slit

Slit-width = 1.00 mm
Intensity after slit = 0.082 * I_0 (parabolic distribution)

I_0 = Intensity before slit

3. Beam characteristics at MSG 10

Dx= 1.802 m

Δx= 1.67 mm
Δy= 15.89 mm

Dx = Dispersion at MSG 10
Δx, Δy = beam half width from betatron oscillation

Slit almost closed (1mm)

$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 2.62$$

Slit open

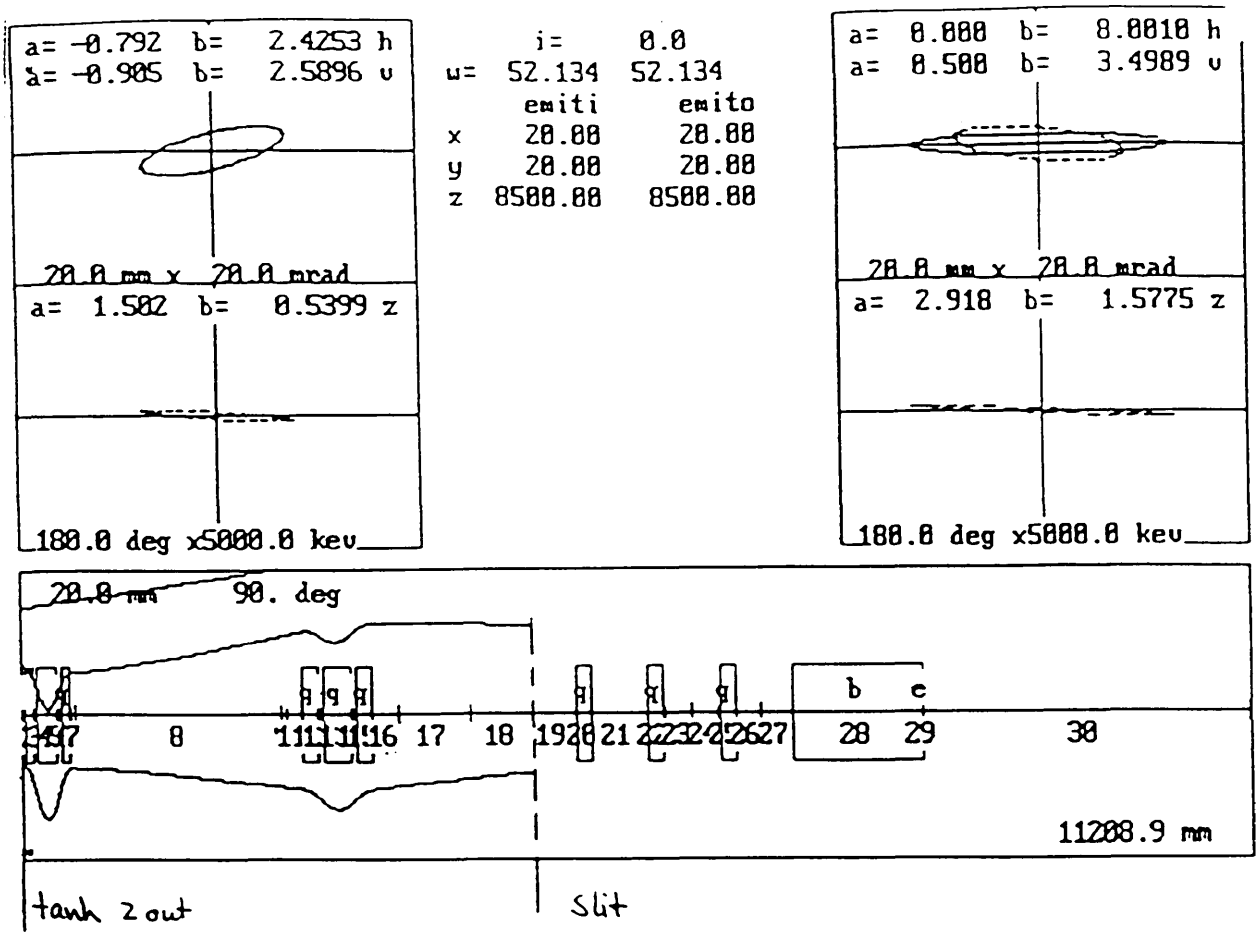
$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 2.14$$

Energy resolution between two wires (wire distance = 1 mm)

$\Delta E/E$ = 0.277 %

4. Quadrupole settings [T/m]

IA2 QDN 01= 42.0640	ITF QFN 01 = 15.3559	ITF QFN 04 = 10.4736
IA2 QFN 02 = -44.7659	ITF QDN 02 = -17.5430	ITF QDN 05 = -12.3283
IA2 QDN 03S = 42.0640	ITF QFN 03S = 15.3559	ITF QFN 06 = 10.4736



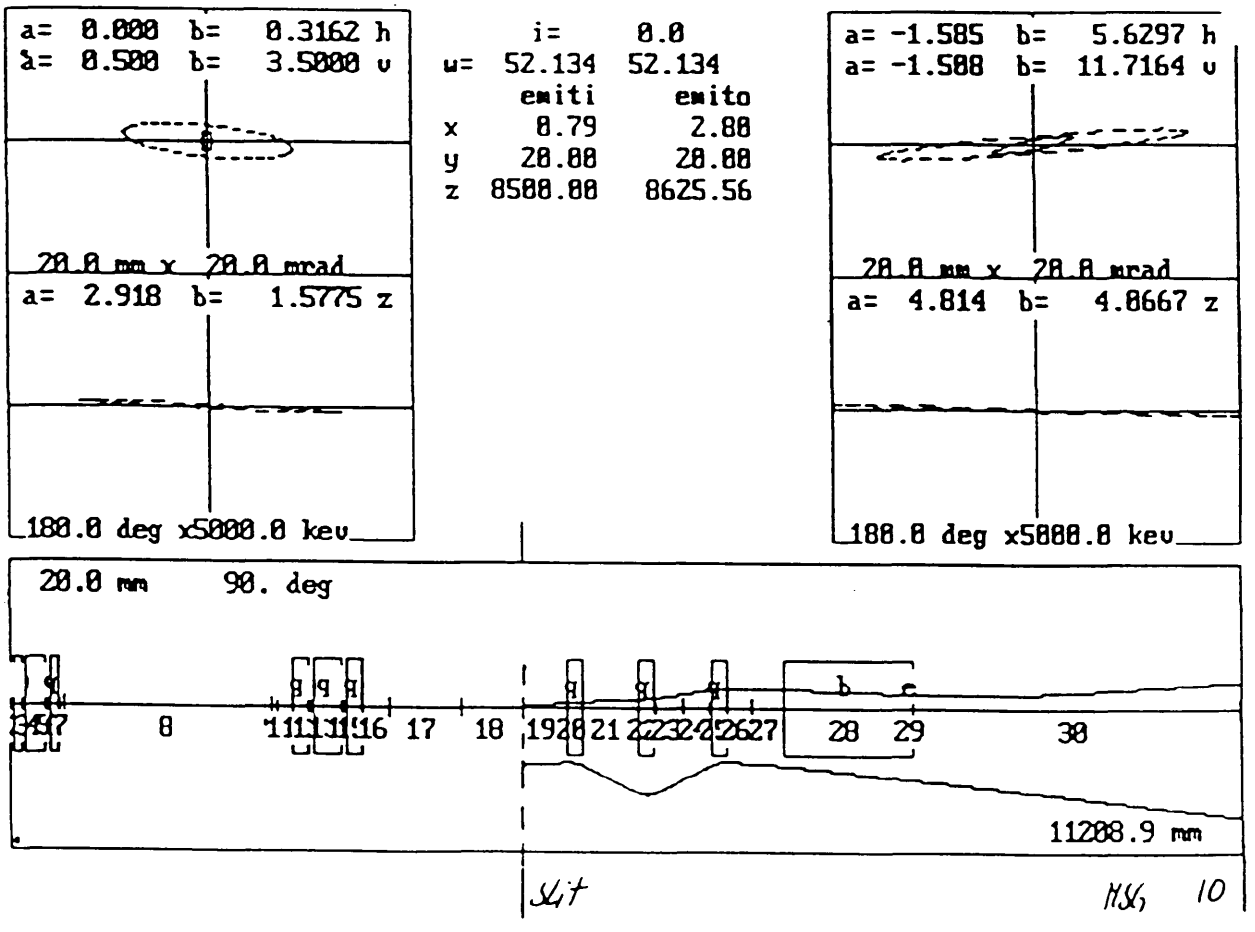
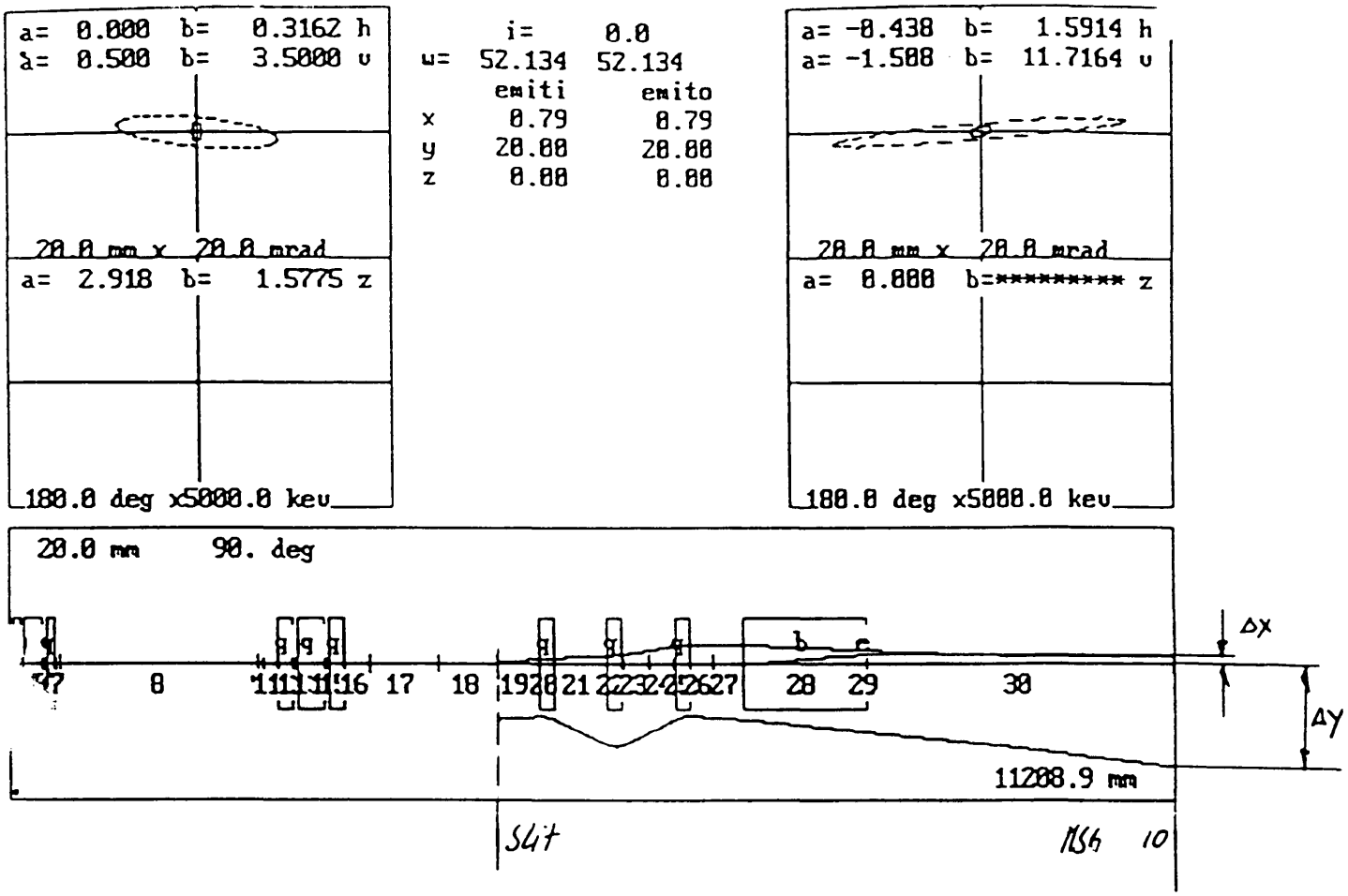
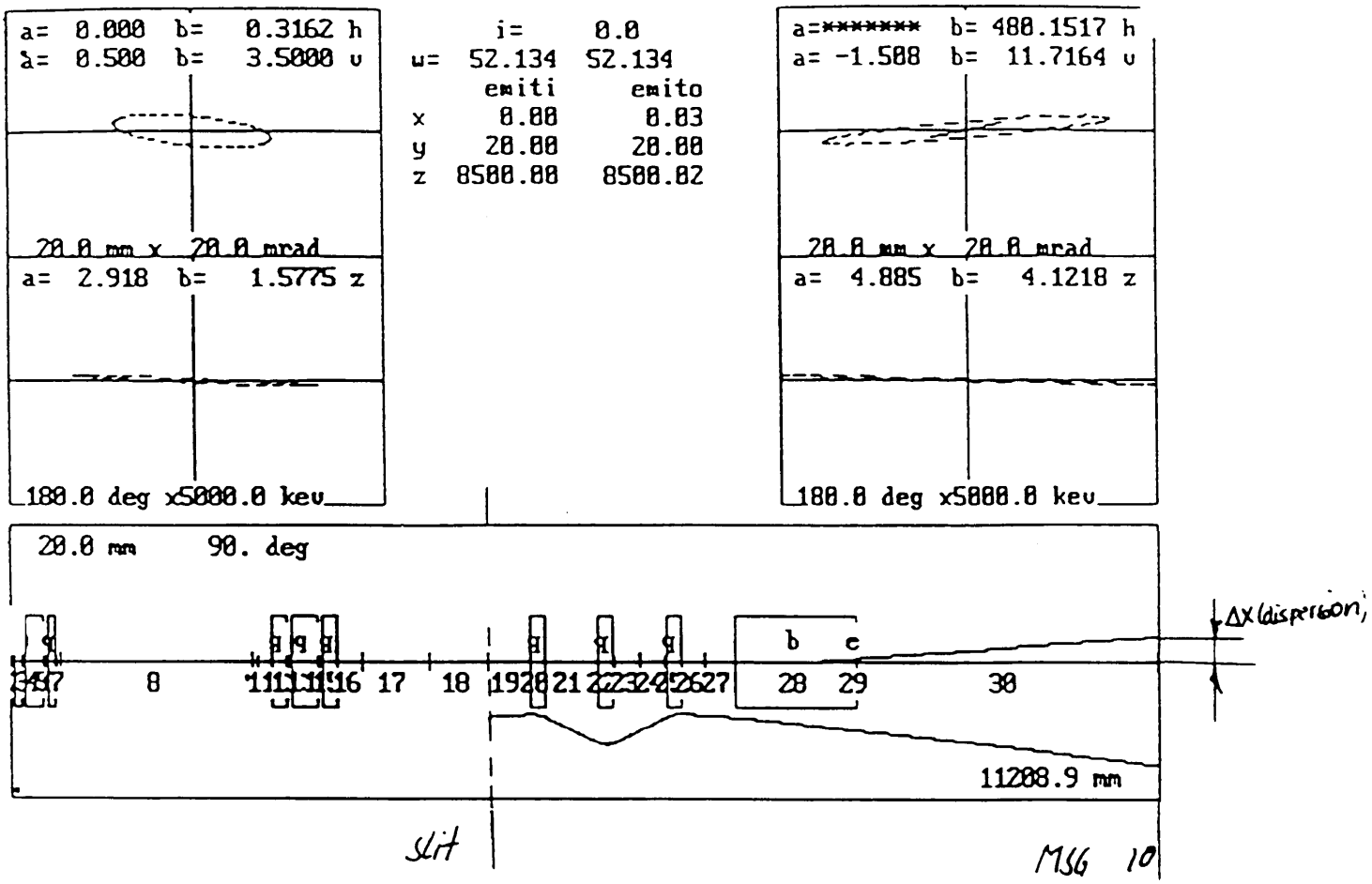


Fig 7 : Linac tank 3 and part of the ITF-Line



$\Delta E \approx 0$

Fig 8. Linac tank 3 and part of the ITF-Linac



$\varepsilon_x \approx 0$

Fig. 9: Linac tank 3 and part of the ITF-Linac

CASE 3
tank 1 in operation

1. Parameters in the ITF - line

Emean (output tank 1): 1.859 MeV/u
Energy spread: ΔW/W= 0.86 %

	εx [mm*mrad]	αx	βx [mm/mrad]	εy [mm*mrad]	αy	βy [mm/mrad]	εl [keV*deg]	Δφ [deg]	αl	βl [deg/keV]
output tank 1	16.93	-1.554	1.4892	16.79	-3.922	3.3413	13500.00	8.13	0.013	0.0049
input tank 2		1.395	1.6199		3.367	3.4264		8.46	0.277	0.0053
output tank 2		-1.554	1.4892		-2.109	1.5135		11.79	1.049	0.0103
input tank 3		1.148	1.7771		1.107	1.9033		13.35	1.304	0.0132
output tank 3		-1.392	2.2544		-1.171	2.0280		20.32	2.293	0.0306
MBLD								24.21	2.807	0.0434
MSG01 MFP MPHP01		-2.159	10.1961		-0.689	4.5759		28.95	3.422	0.0621
MTR15		-3.654	8.9959		4.413	8.9890				
MSG02		2.500	9.9998		-0.285	6.5017				
MSG03		-0.886	1.3255		0.372	7.7007				
MSG04 MTR25		-1.218	4.5632		0.362	5.8853				
MSG05 MPHP02		0.965	5.3567		-0.019	5.2061	15901.30	72.06	7.463	0.3266
SLFM10		0.506	1.7327		-0.742	9.3263				

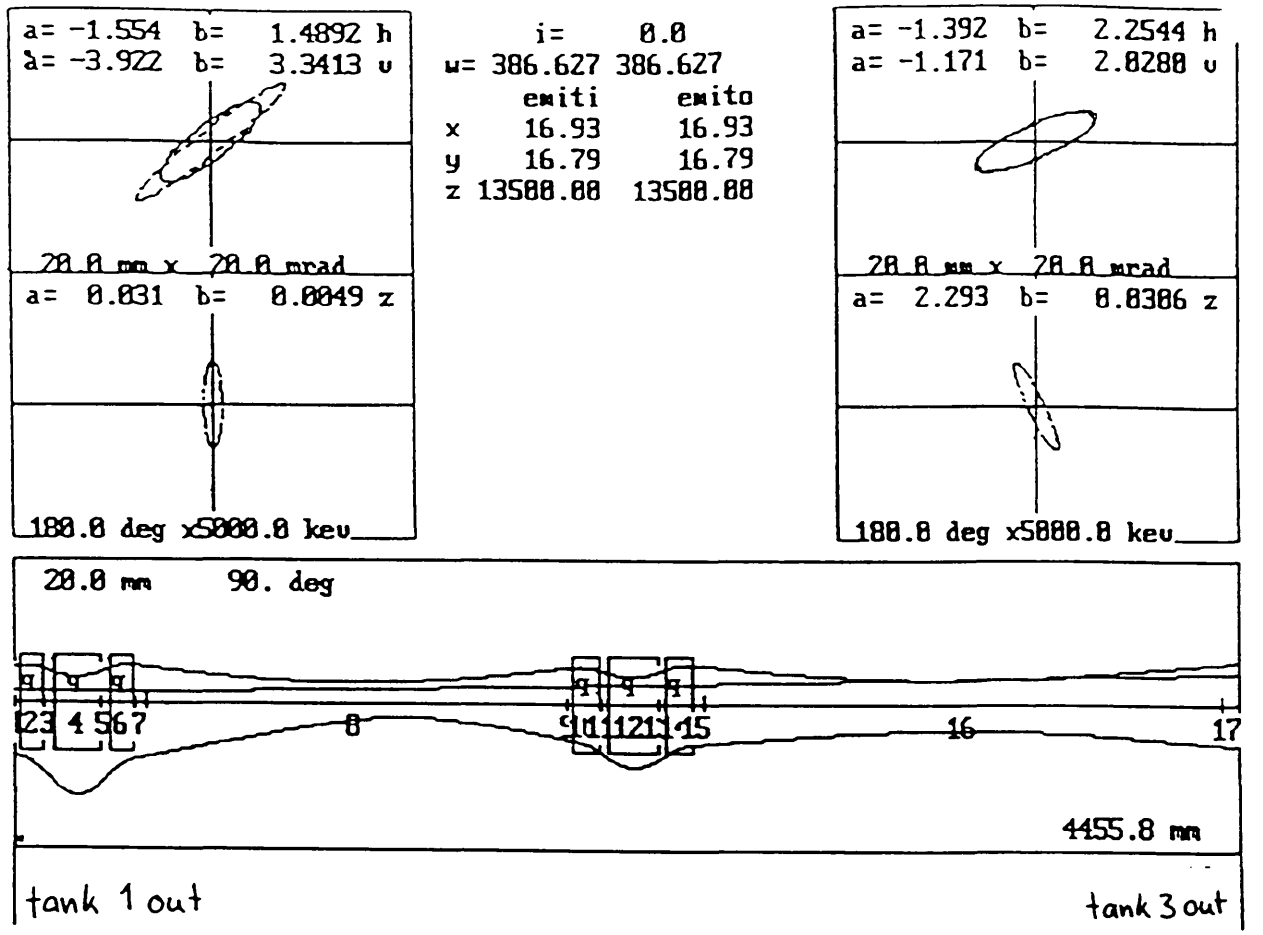
2. Quadrupole settings

IA1 QFN 07: 60.01 T/m
IA1 QDN 08: -61.09 T/m
IA1 QFN 09S: 60.01 T/m

IA2 QDN 01: -51.90 T/m
IA2 QFN 02: 51.88 T/m
IA2 QDN 03S: -51.90 T/m

ITF QFN 01: 12.56 T/m
ITF QDN 02: -14.28 T/m
ITF QFN 03S: 12.56 T/m

ITF QFN 04: 6.37 T/m
ITF QDN 05: -10.20 T/m
ITF QFN 06: 6.37 T/m



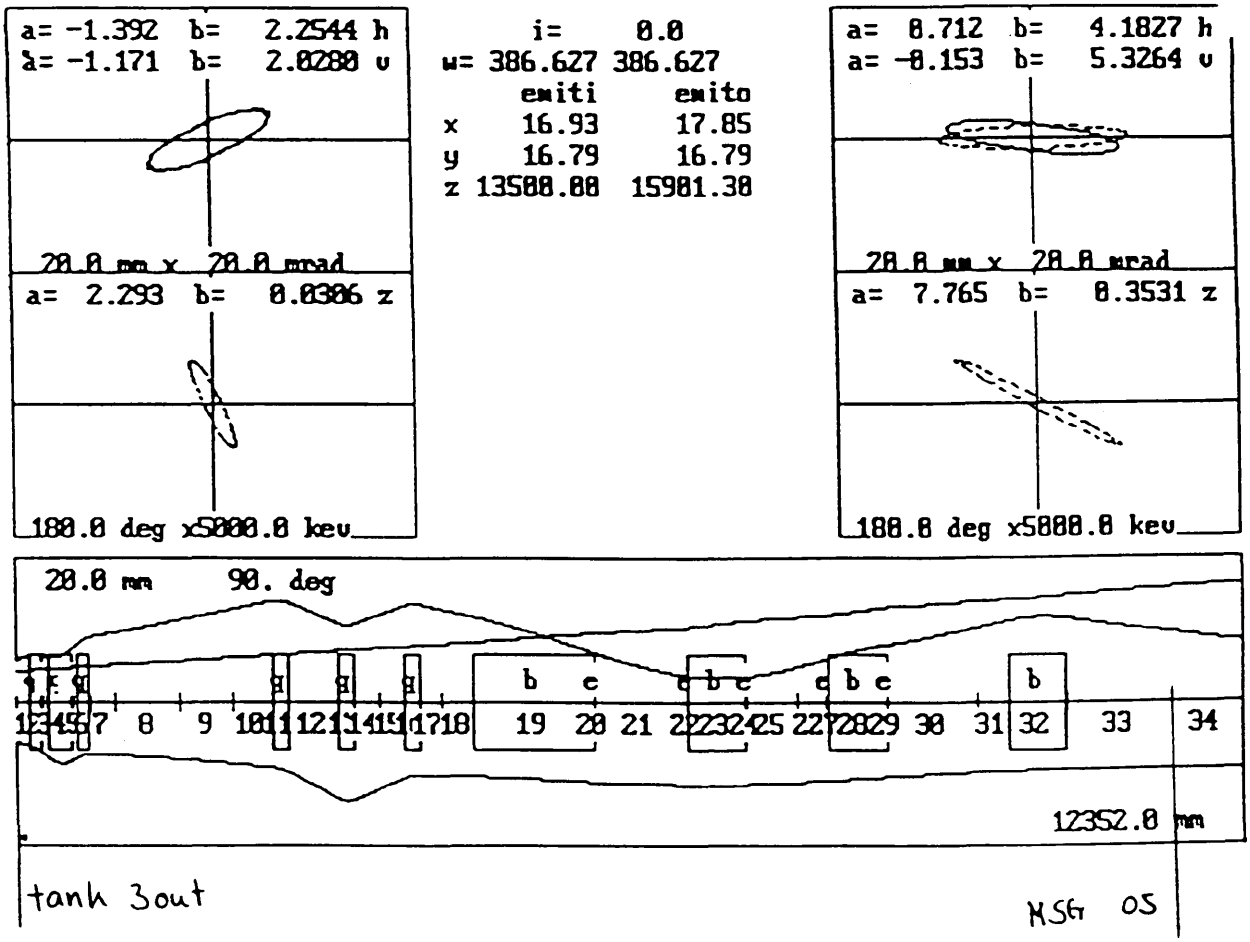
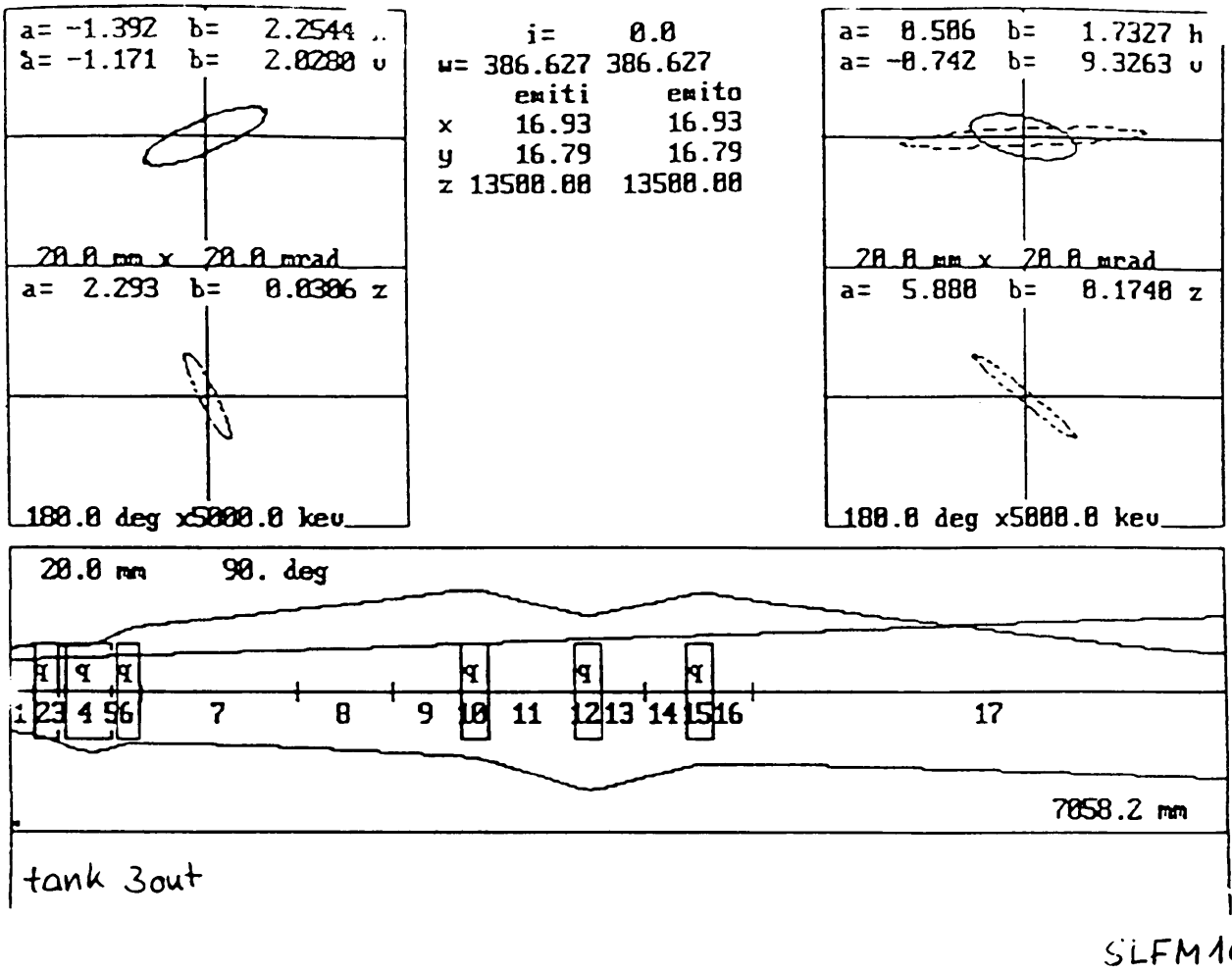


Fig 10: Linac tanks and ITF-Linc, tank 1 in operation



SLFM10

Fig 11 : ITF-Linc, tank 1 in operation

CASE 3
tank 1 in operation

Energy spectrometer

1. Beam characteristics before slit

x - plane:	α= 0.00	β= 8.000 mm/mrad	ε= 16.93 mm*mrad	Δx= 11.63 mm
y - plane:	α= 0.80	β= 4.000 mm/mrad	ε= 16.79 mm*mrad	

Δx= beam half-width

2. Slit

Slit-width = 1.00 mm
Intensity after slit = 0.073 * I_0 (parabolic distribution)

I_0 = Intensity before slit

3. Beam characteristics at MSG 10

Dx= 1.745 m

Δx= 1.96 mm
Δy= 15.17 mm

Dx = Dispersion at MSG 10
Δx, Δy = beam half width from betatron oscillation

Slit almost closed (1mm)

$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 1.91$$

Slit open

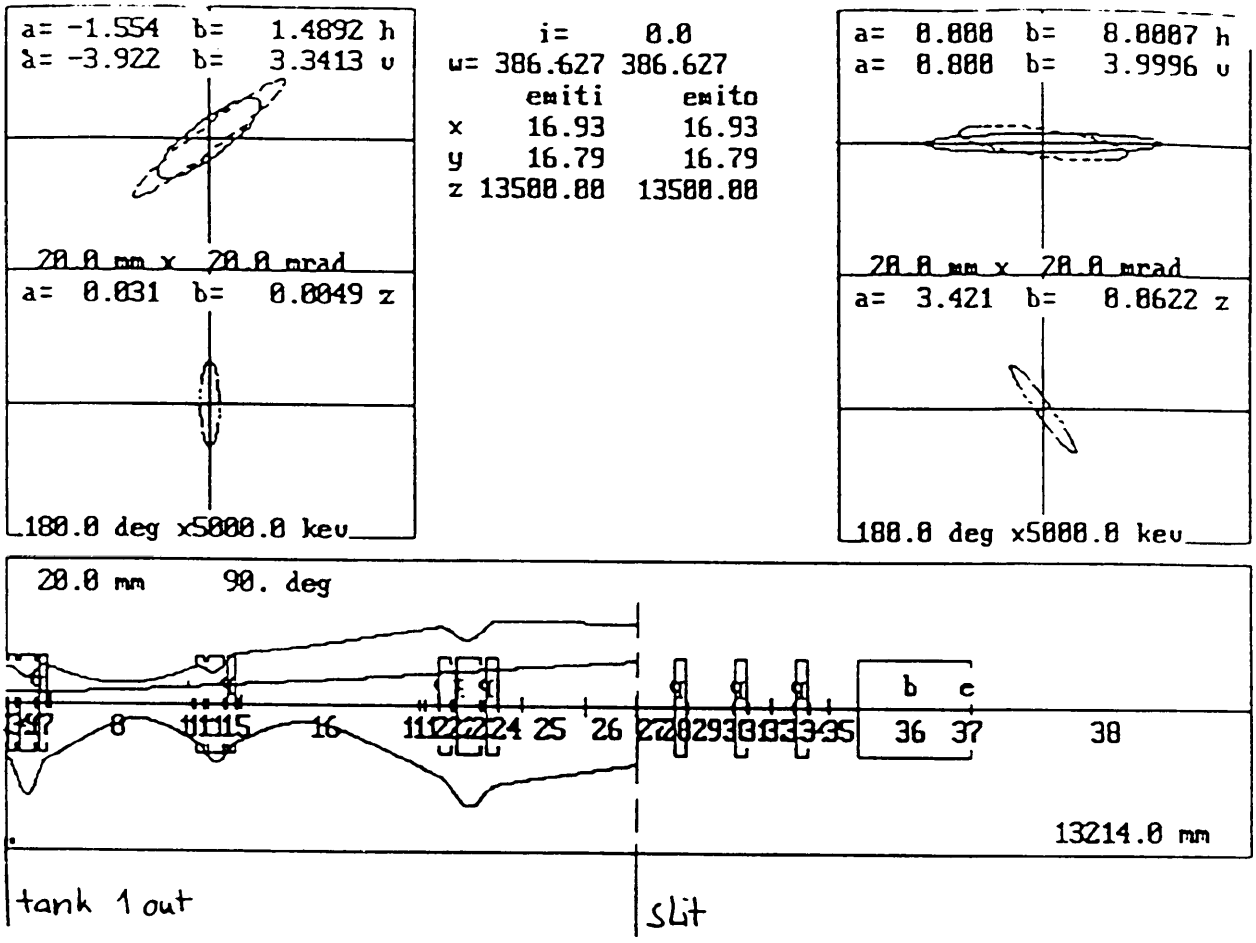
$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 1.83$$

Energy resolution between two wires (wire distance = 2.5 mm)

$\Delta E/E$ = 0.285 %

4. Quadrupole settings [T/m]

IA2 QDN 01= 40.7128	ITF QFN 01 = 14.0839	ITF QFN 04 = 8.1056
IA2 QFN 02 = -47.5070	ITF QDN 02 = -16.6877	ITF QDN 05 = -10.0043
IA2 QDN 03S = 40.7128	ITF QFN 03S = 14.0839	ITF QFN 06 = 8.1056



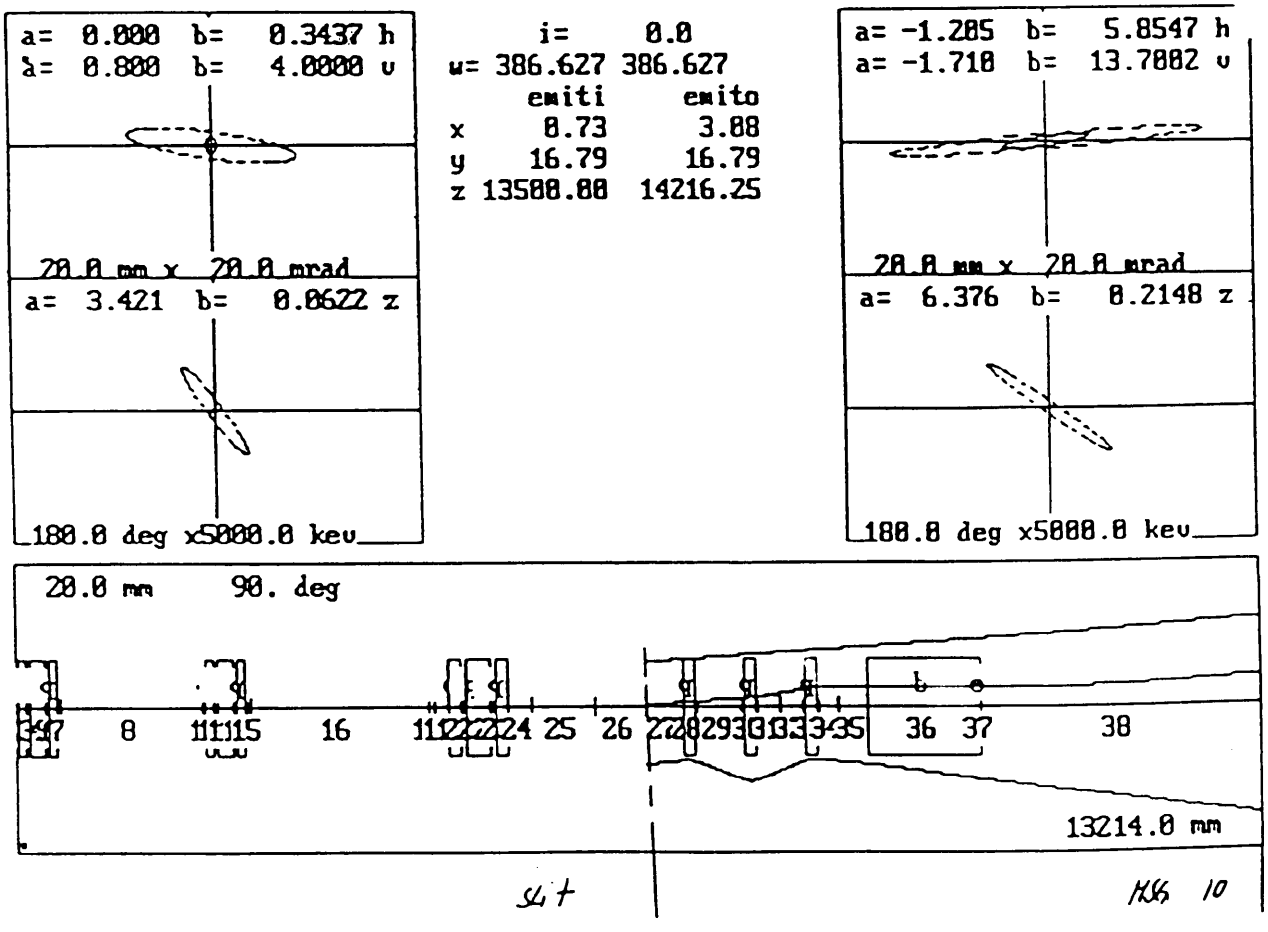
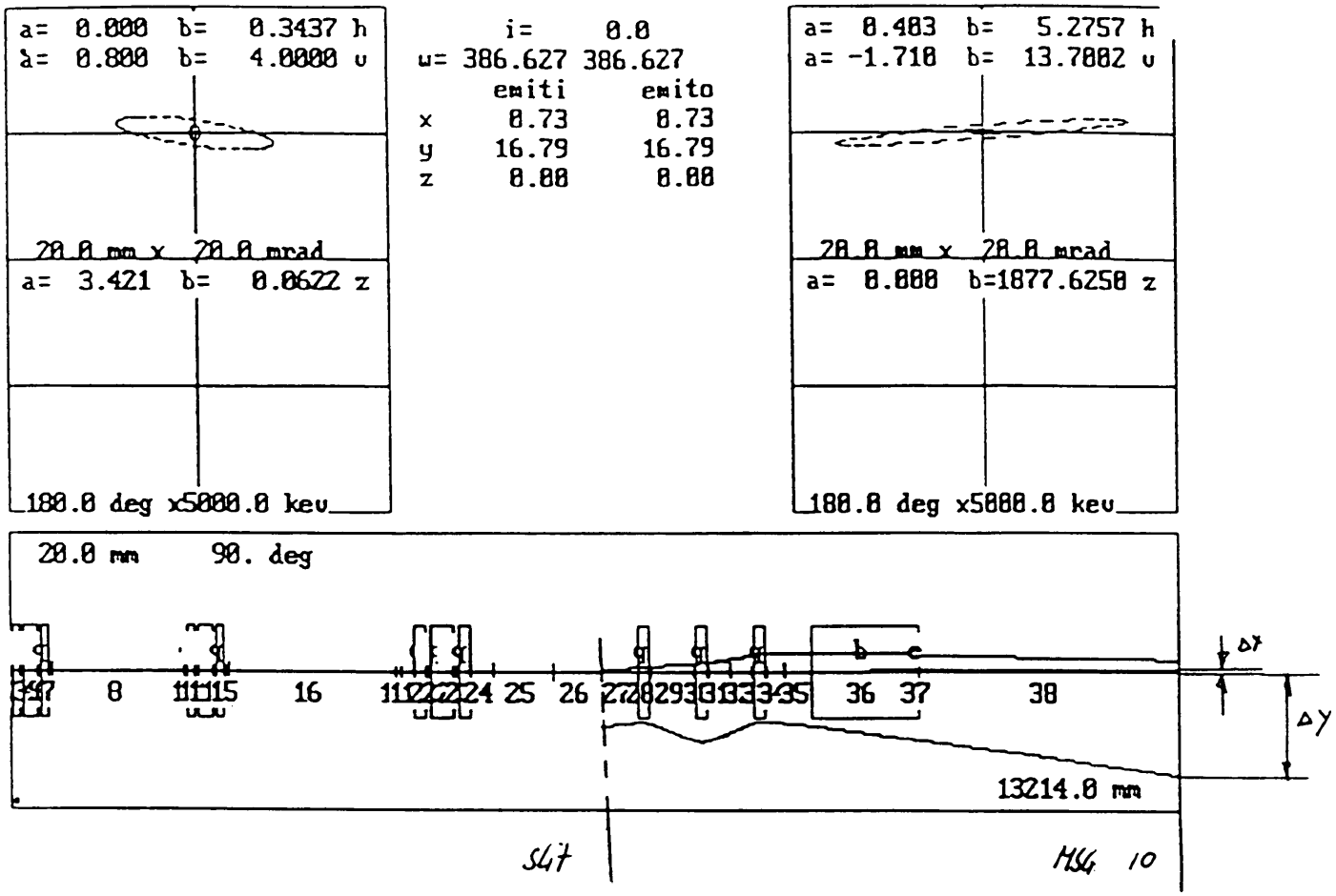
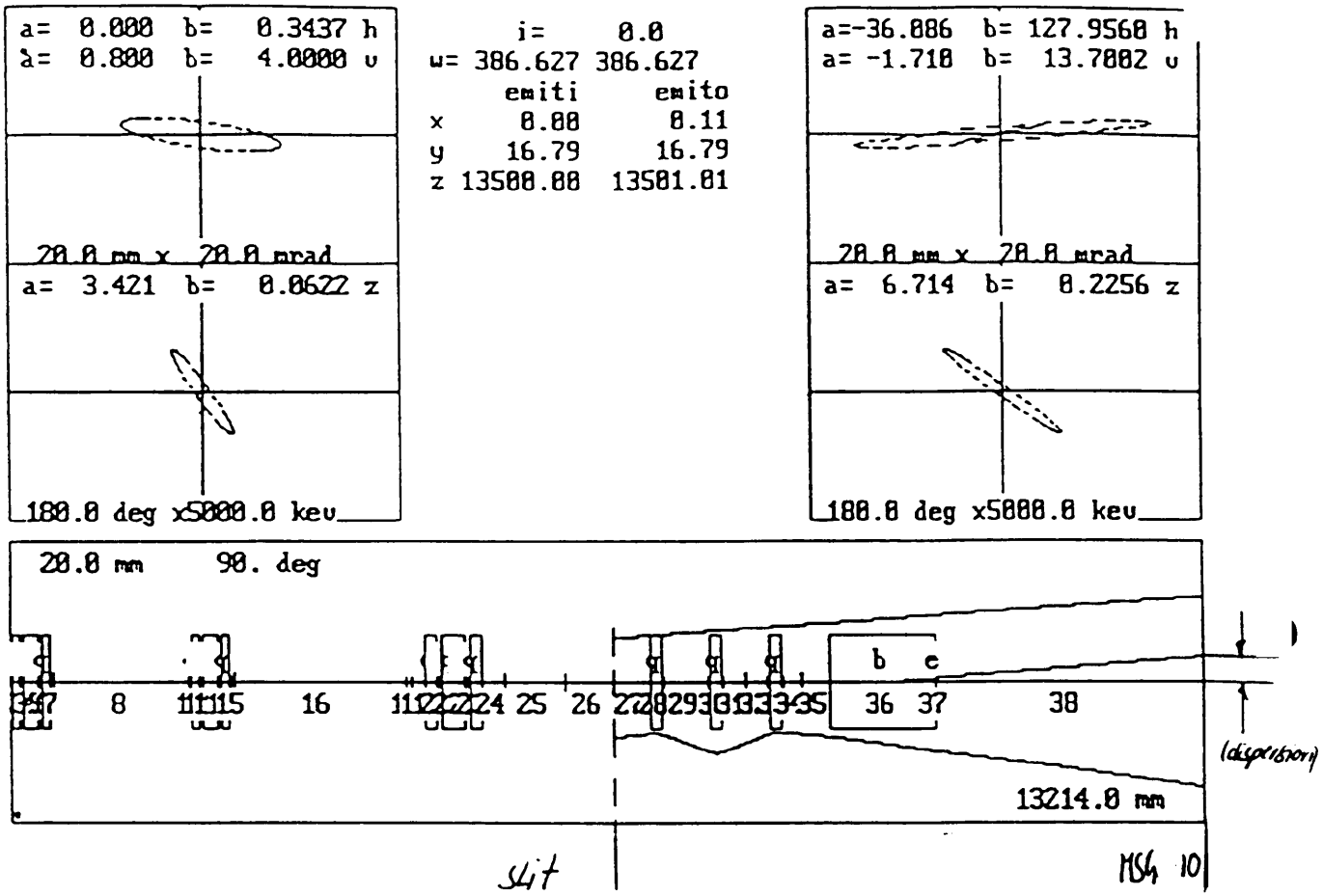


Fig 12: linac tank 2 and 3 and part of the ITF-Line



$\Delta E \overset{!}{\cong} 0$

Fig 13. Linac tank 2 and 3, and part of the ITF-Linac



$\varepsilon_x \overset{!}{\simeq} 0$

Fig 14 Linac tank 2 and 3, and part of the ITF-Line

CASE 4
all tanks off

1. Parameters in the ITF -line

Emean: 0.251 MeV/u
Energy spread: ΔW/W= 0.86 %

	εx [mm*mrad]	αx	βx [mm/mrad]	εy [mm*mrad]	αy	βy [mm/mrad]	εl [keV*deg]	Δφ [deg]	αl	βl [deg/keV]
input tank 1	20.00	1.544	0.6532	20.00	-0.271	0.4636	8500.00	38.09	-0.127	0.1707
output tank 1		-0.453	1.6788		-0.476	1.4063		50.52	0.901	0.3003
input tank 2		0.228	1.5687		0.163	1.4616		54.19	1.041	0.3455
output tank 2		-0.792	2.4253		-0.905	205896		67.74	1.502	0.5399
input tank 3		0.641	2.3429		0.444	2.7050		72.57	1.654	0.6196
output tank 3		-0.532	2.1312		-0.418	2.6543		92.26	2.245	1.0014
MBLD								102.85	2.551	1.2445
MSG01 MFP MPHP01		-1.475	6.2770		-0.707	4.6958		115.76	2.917	1.5764
MTR15		-2.759	6.0363		4.740	9.1989				
MSG02		1.511	7.0520		-0.153	6.4489				
MSG03		-0.442	1.2250		0.396	6.8833				
MSG04 MTR25		-0.925	3.3119		0.313	5.1648				
MSG05 MPHP02		0.440	3.6909		-0.108	4.7601	9057.46	232.90	5.736	6.9886
SLFM10		0.231	2.2631		-0.589	8.4882				

2. Quadrupole settings

IA1 QFN 01: -52.47 T/m
IA1 QDN 02: 37.79 T/m
IA1 QFN 03S: -52.47 T/m

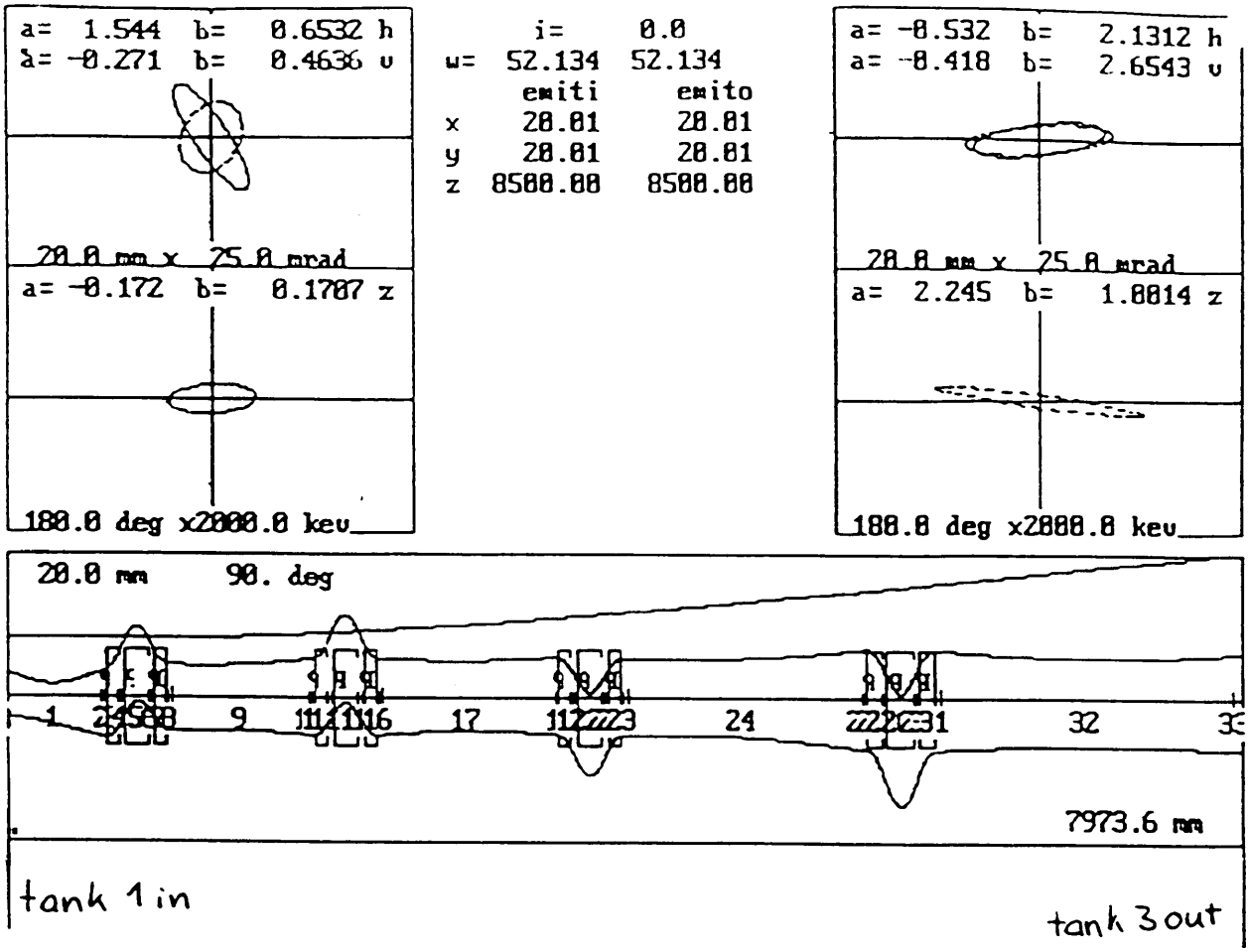
IA1 QDN 04: -46.61 T/m
IA1 QFN 05: 32.41 T/m
IA1 QDN 06S: -46.61 T/m

IA1 QFN 07: 45.42 T/m
IA1 QDN 08: -31.76 T/m
IA1 QFN 09S: 45.42 T/m

IA2 QDN 01: 43.06 T/m
IA2 QFN 02: -28.85 T/m
IA2 QDN 03S: 43.06 T/m

ITF QFN 01: -2.85 T/m
ITF QDN 02: 3.03 T/m
ITF QFN 03S: -2.85 T/m

ITF QFN 04: 2.39 T/m
ITF QDN 05: -3.84 T/m
ITF QFN 06: 2.39 T/m



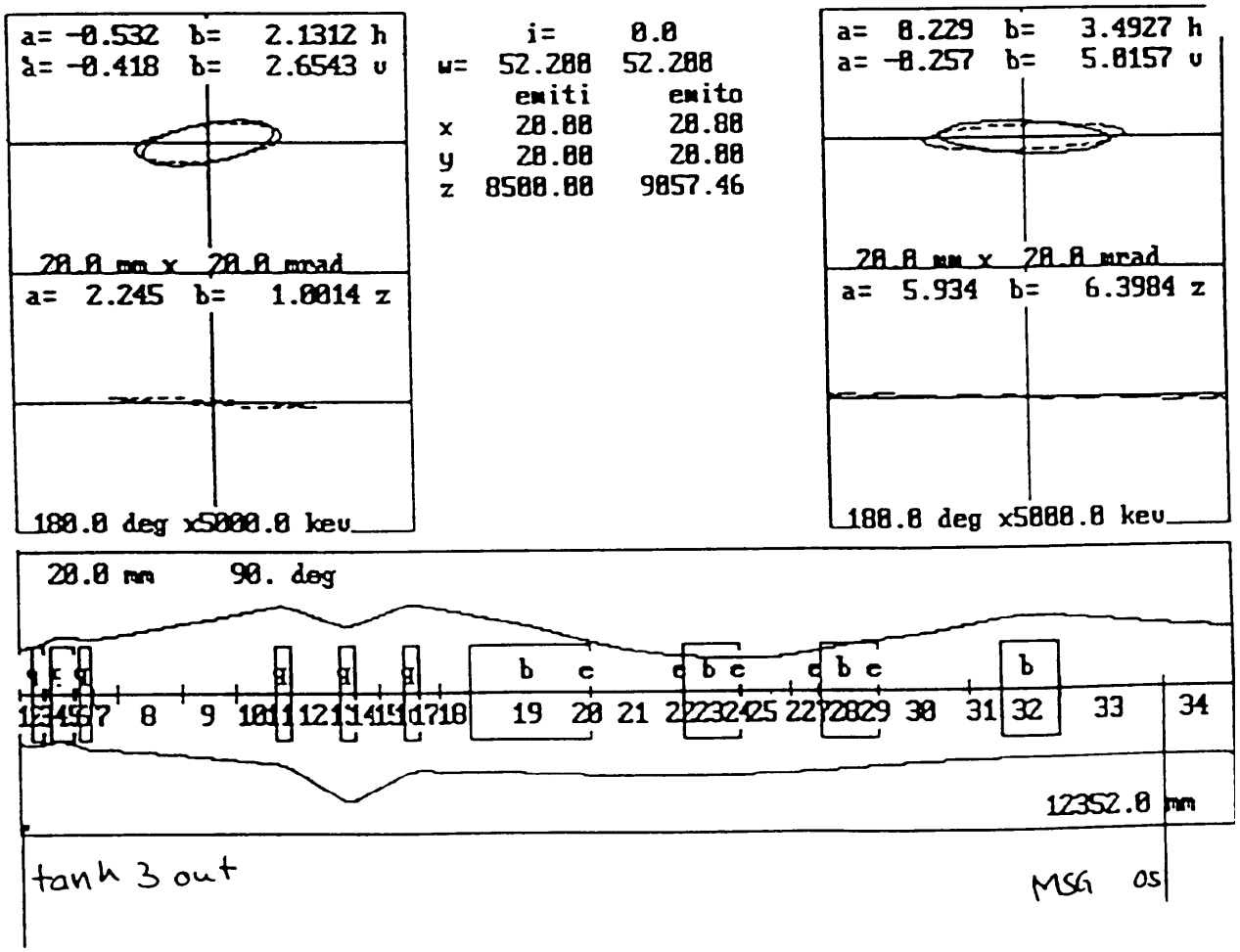
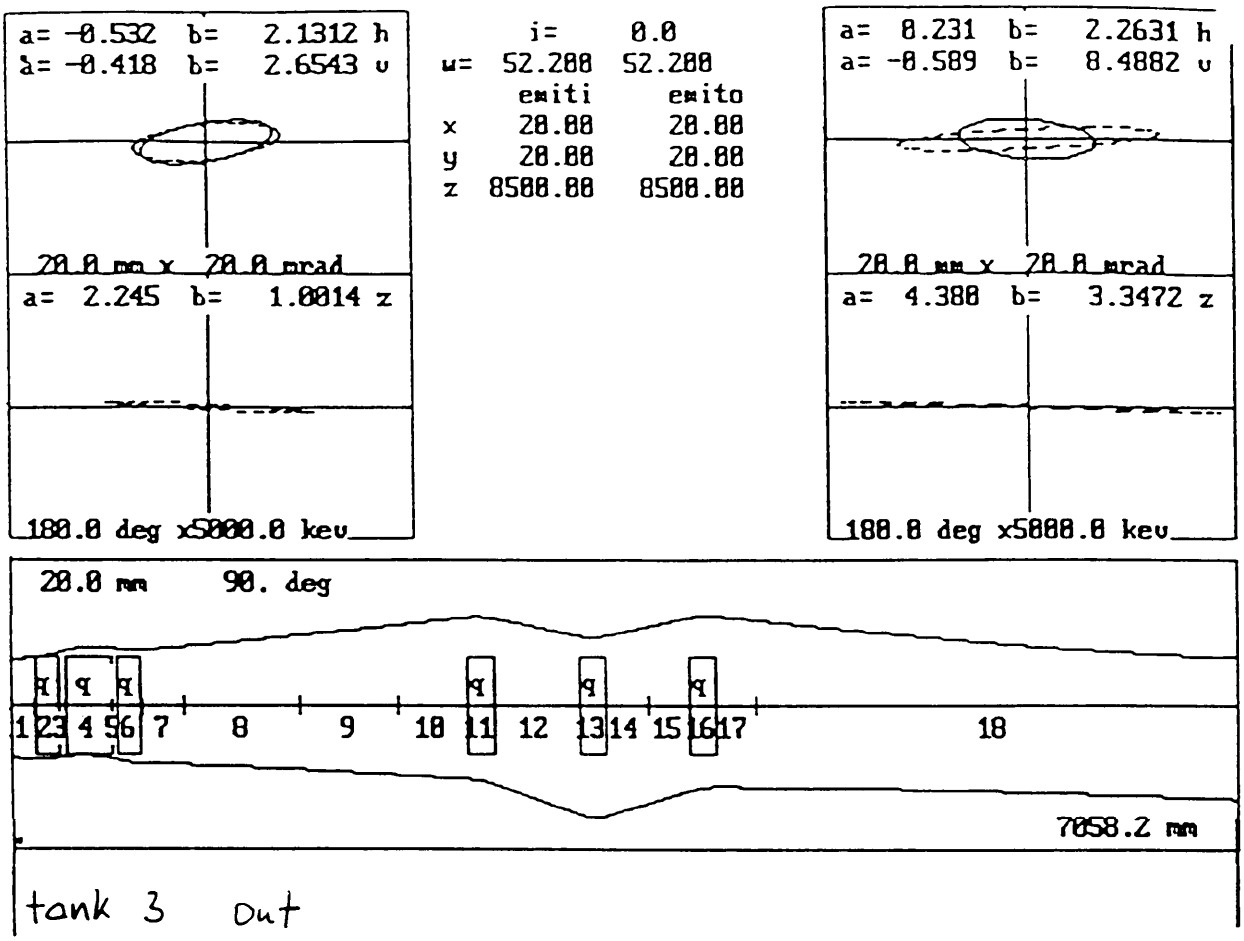


fig 15 Linac tanks and ITF Linc, all 3 tanks off



SLFM10

Fig 16: ITF - Linc, all 3 tanks off

CASE 4
all three tanks off

Energy spectrometer

1. Beam characteristics before slit

x - plane:	α= 0.00	β= 8.000 mm/mrad	ε= 20.00 mm*mrad	Δx= 12.65 mm
y - plane:	α= 0.50	β= 3.500 mm/mrad	ε= 20.00 mm*mrad	

Δx= beam half-width

2. Slit

Slit-width = 1.00 mm
Intensity after slit = 0.067 * I_0 (parabolic distribution)

I_0 = Intensity before slit

3. Beam characteristics at MSG 10

Dx= 1.765 m

Δx= 1.12 mm
Δy= 15.31 mm

Dx = Dispersion at MSG 10
Δx, Δy = beam half width from betatron oscillation

Slit almost closed (1mm)

$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 3.39$$

Slit open

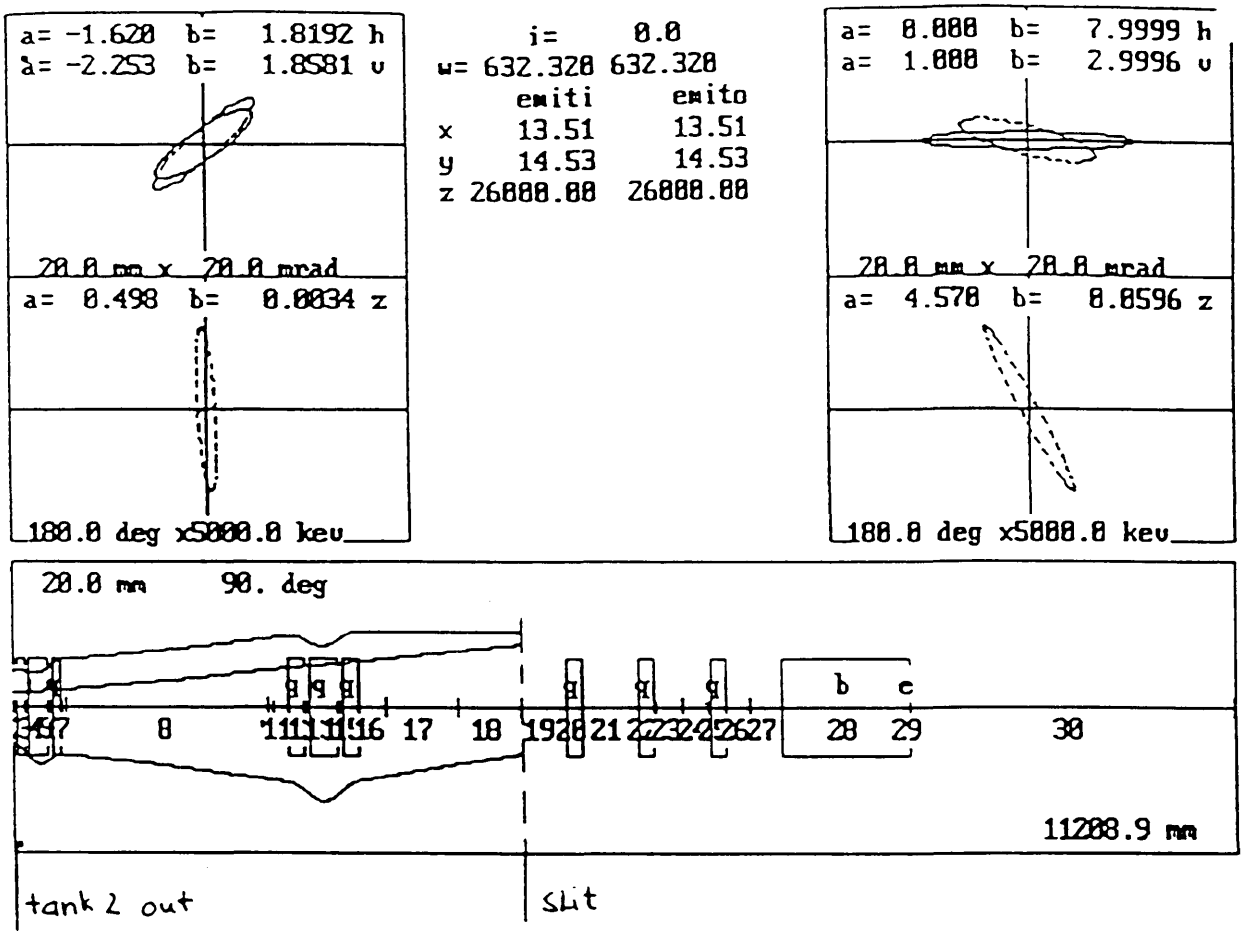
$$\left(\frac{\Delta x(dispersion)}{\Delta x(betatron)}\right) = 2.69$$

Energy resolution between two wires (wire distance = 2.5 mm)

$\Delta E/E$ = 0.283 %

4. Quadrupole settings [T/m]

IA2 QDN 01= 41.0654	ITF QFN 01 = 4.5761	ITF QFN 04 = 3.7891
IA2 QFN 02 = -27.8098	ITF QDN 02 = -5.0201	ITF QDN 05 = -4.6645
IA2 QDN 03S = 41.0654	ITF QFN 03S = 4.5761	ITF QFN 06 = 3.7891



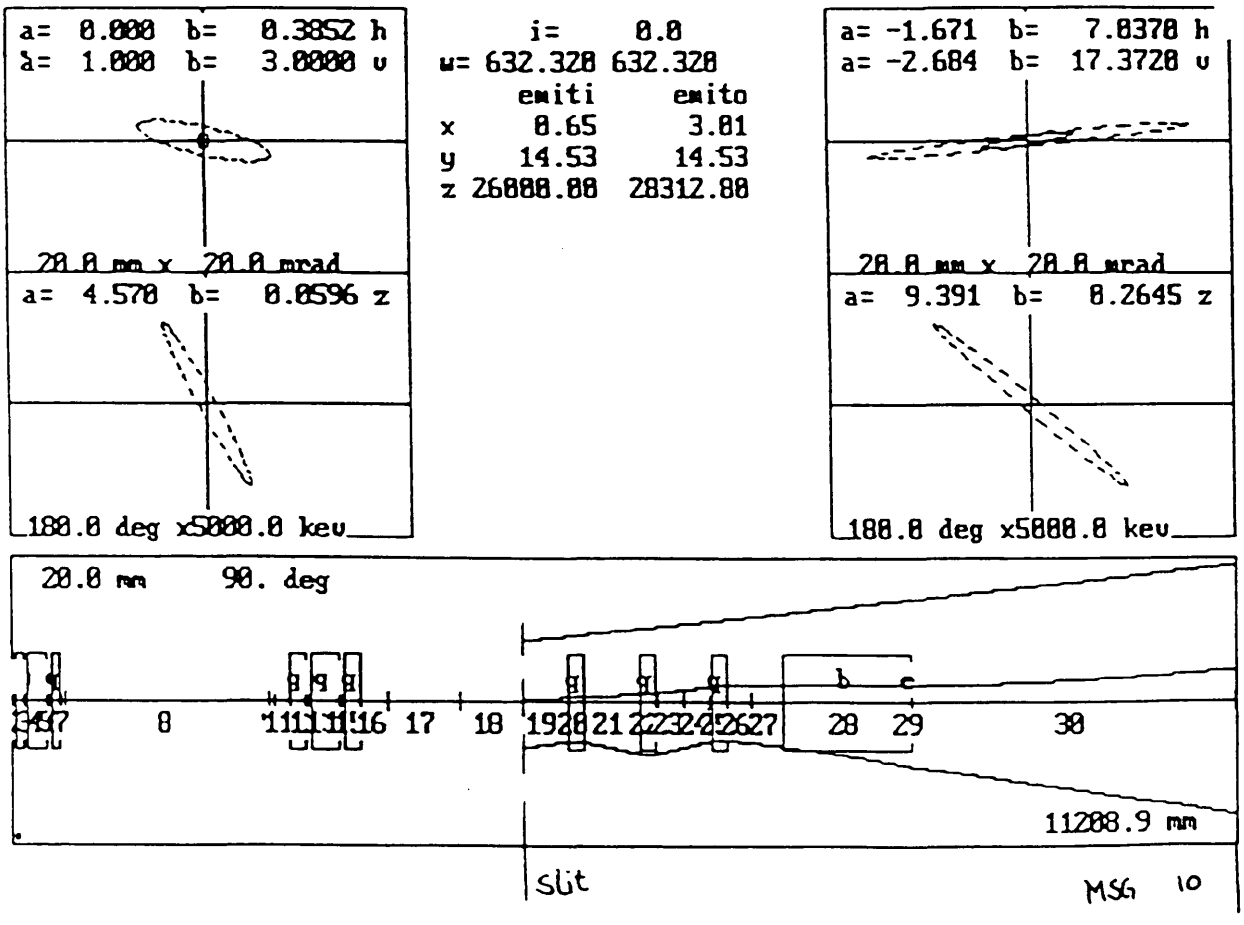
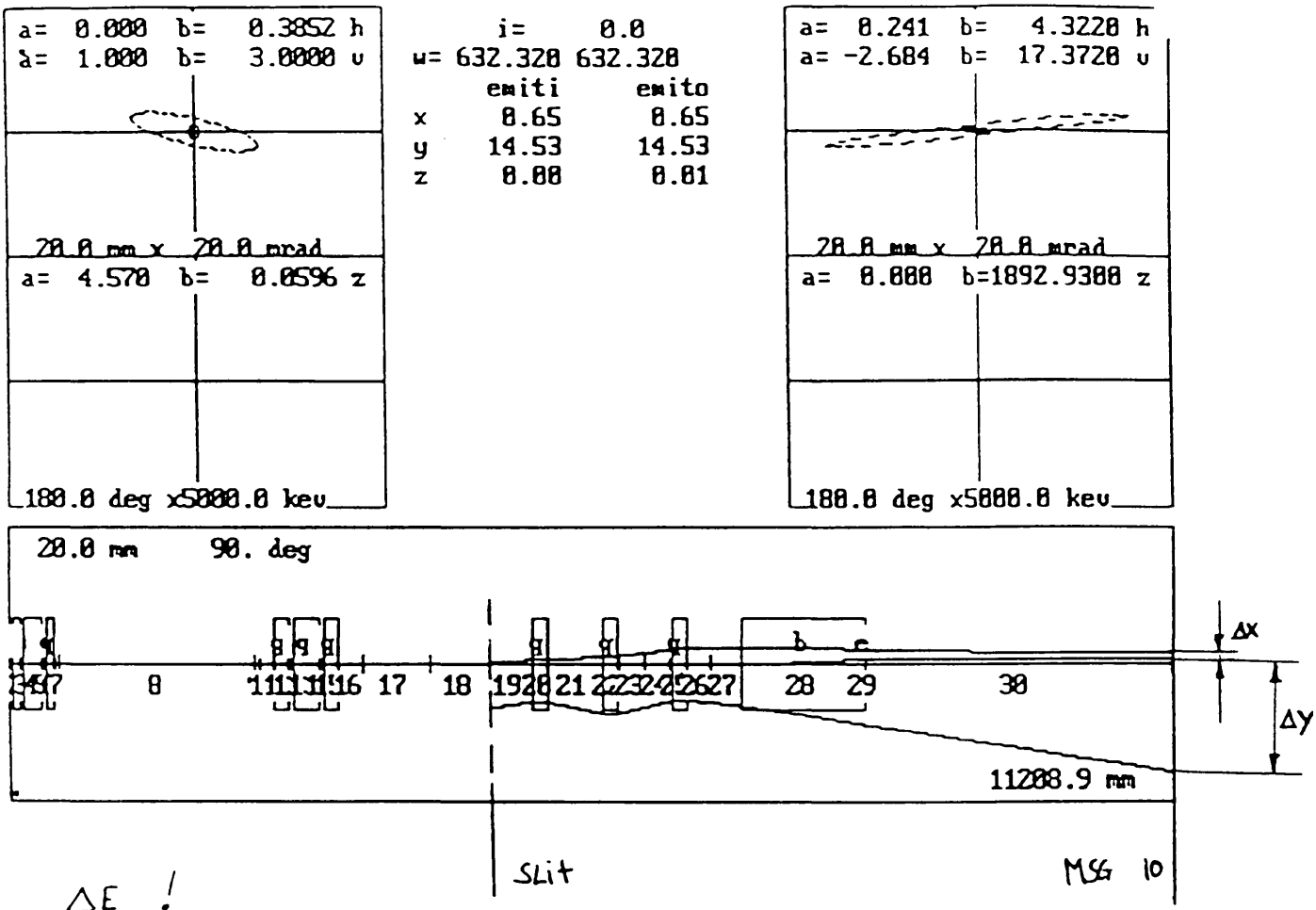
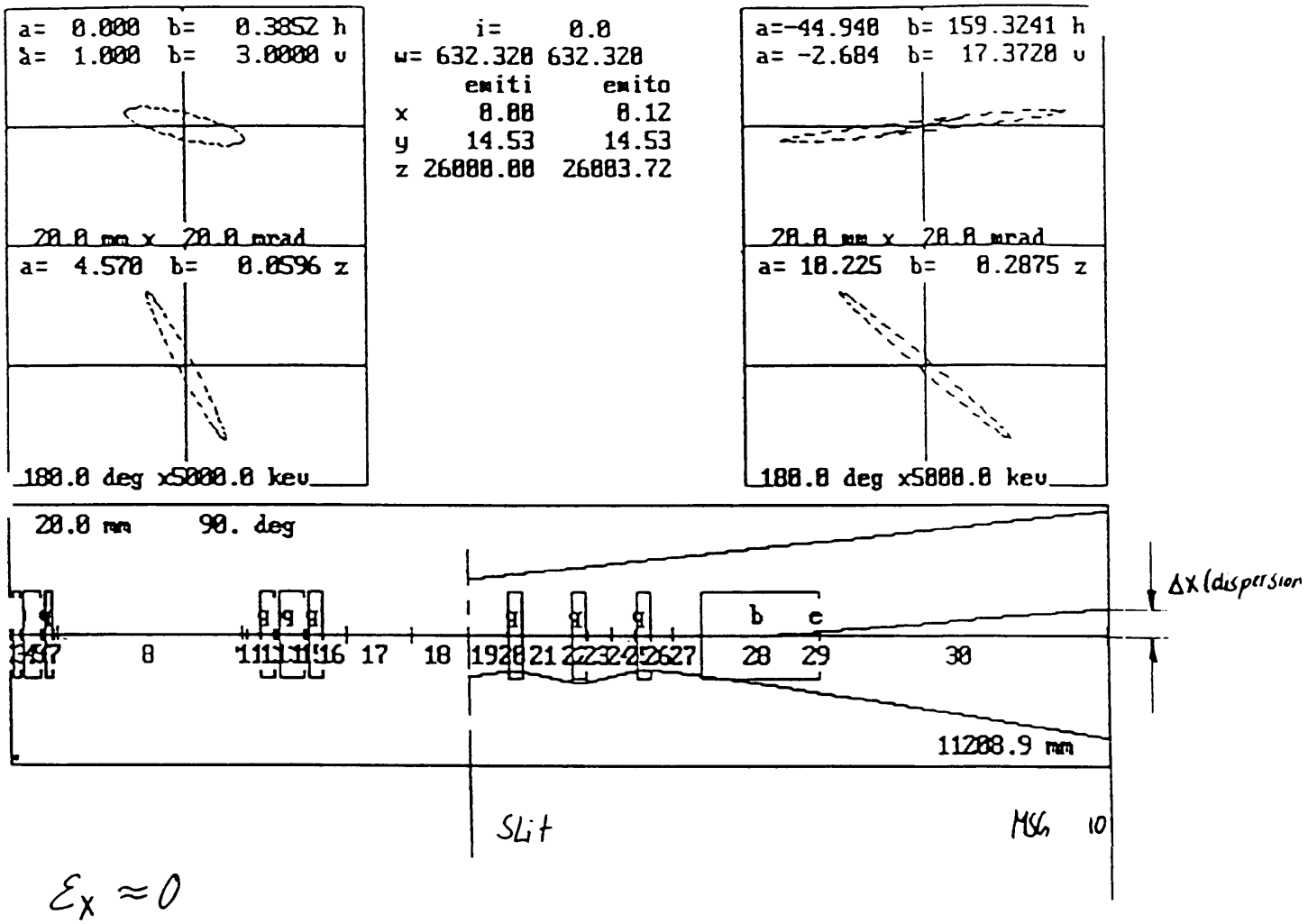


Fig 17: Linac tank 3 and part of the ITF-Line



$\frac{\Delta E}{E} \stackrel{!}{=} 0$

Fig 18: Linac tank 3 and part of the ITF-Linc



$\mathcal{E}_x \approx 0$

Fig 19: Linac tank 3 and part of the ITF-Linc

Appendix: Some TRACE3D files

1) all tanks in operation, beamtransfer of 208Pb from outlet of tank3 to ITF.MSG05

```
&data
er= 193648.000, q= 25., w= 874.612, xi= 0.000,
emiti(1)= 12.215, 12.348, 28000.00,
beami(1)= -2.347, 4.2099, -2.614, 4.4205, 0.198, 0.0012,
beamf(1)= -0.115, 0.2781, 0.807, 8.2357,
mt= 8, nc= 4, mp(1,1)= 1, mp(1,2)= 1, mp(1,3)= 1, mp(1,4)= 1,
mp(2,1)= 2, mp(2,2)= 4, mp(2,3)= 11, mp(2,4)= 13,
mvc(1,1)= 1, mvc(2,1)= 6, mvc(3,1)= 1,
mvc(1,3)= 1, mvc(2,3)= 16, mvc(3,3)= 1,
freq= 202.56, pqext= 2.5, ichrom= 0.,
xm= 20.00, xpm= 10.0, ym=20.0, dpm= 180.0, dwm= 5000.0, dpp= 90.0,
n1= 1, n2= 34, smax= 5.0, pqsmax= 2.5,
nt( 1)= 1, a(1, 1)= 136.70,
nt( 2)= 3, a(1, 2)= 19.2503 ,150.00 ,0.0000 ,0.0000 ,0.0000,
nt( 3)= 1, a(1, 3)= 32.00,
nt( 4)= 3, a(1, 4)= -22.4097 ,270.00 ,0.0000 ,0.0000 ,0.0000,
nt( 5)= 1, a(1, 5)= 32.00,
nt( 6)= 3, a(1, 6)= 19.2503 ,150.00 ,0.0000 ,0.0000 0.0000,
nt( 7)= 1, a(1, 7)= 240.00,
nt( 8)= 1, a(1, 8)= 660.00,
nt( 9)= 1, a(1, 9)= 550.00
nt(10)= 1, a(1,10)= 400.00,
nt(11)= 3, a(1,11)= 6.8638 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(12)= 1, a(1,12)= 499.75,
nt(13)= 3, a(1,13)= -10.2106 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(14)= 1, a(1,14)= 250.00
nt(15)= 1, a(1,15)= 250.00,
nt(16)= 3, a(1,16)= 6.8638 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(17)= 1, a(1,17)= 222.00,
nt(18)= 1, a(1,18)= 300.00,
nt(19)= 8, a(1,19)= -28.65 ,-2400.00 ,0.00
nt(20)= 9, a(1,20)= -7.00 ,-2400.00 ,70.00 ,0.45 ,2.80,
nt(21)= 1, a(1,21)= 943.57,
nt(22)= 9, a(1,22)= 5.00 ,1200.00 ,70.00 ,0.45 ,2.80,
nt(23)= 8, a(1,23)= 28.65 ,1200.00 ,0.00
nt(24)= 9, a(1,24)= 5.00 ,1200.00 ,70.00 ,0.45 ,2.80,
nt(25)= 1, a(1,25)= 500.00,
nt(26)= 1, a(1,26)= 300.00,
nt(27)= 9, a(1,27)= 5.00 ,1200.00 ,70.00 ,0.45 ,2.80,
nt(28)= 8, a(1,28)= 28.65 ,1200.00 ,0.00
nt(29)= 9, a(1,29)= 1.00 ,1200.00 ,70.00 ,0.45 ,2.80,
nt(30)= 1, a(1,30)= 920.00,
nt(31)= 1, a(1,31)= 330.00,
nt(32)= 8, a(1,32)= -28.65 ,-1200.00 ,0.00
nt(33)= 1, a(1,33)= 1050.00,
nt(34)= 1, a(1,34)= 700.00,
&end
```

2) all tanks in operation, beamtransfer of 208Pb25+ from outlet of tank3 to ITFE.SLFM10
(measurement of transversal emittances)

```
&data
er= 193648.000, q= 25., w= 874.612, xi= 0.000,
emiti(1)= 12.215, 12.348, 28000.00,
beami(1)= -2.347, 4.2099, -2.614, 4.4205, 0.198, 0.0012,
beamf(1)= -0.115, 0.2781, 0.807, 8.2357,
mt= 8, nc= 4, mp(1,1)= 1, mp(1,2)= 1, mp(1,3)= 1, mp(1,4)= 1,
mp(2,1)= 2, mp(2,2)= 4, mp(2,3)= 10, mp(2,4)= 12,
mvc(1,1)= 1, mvc(2,1)= 6, mvc(3,1)= 1,
mvc(1,3)= 1, mvc(2,3)= 15, mvc(3,3)= 1,
freq= 202.56, pqext= 2.5, ichrom= 0.,
xm= 20.00, xpm= 10.0, ym=20.0, dpm= 180.0, dwm= 5000.0, dpp= 90.0,
n1= 1, n2= 17, smax= 5.0, pqsmax= 2.5,
nt( 1)= 1, a(1, 1)= 136.70,
nt( 2)= 3, a(1, 2)= 19.2503 ,150.00 ,0.0000 ,0.0000 ,0.0000,
nt( 3)= 1, a(1, 3)= 32.00,
nt( 4)= 3, a(1, 4)= -22.4097 ,270.00 ,0.0000 ,0.0000 ,0.0000,
nt( 5)= 1, a(1, 5)= 32.00,
nt( 6)= 3, a(1, 6)= 19.2503 ,150.00 ,0.0000 ,0.0000 0.0000,
nt( 7)= 1, a(1, 7)= 900.00,
nt( 8)= 1, a(1, 8)= 550.00
nt( 9)= 1, a(1, 9)= 400.00,
nt(10)= 3, a(1,10)= 6.8638 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(11)= 1, a(1,11)= 499.75,
nt(12)= 3, a(1,12)= -10.2106 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(13)= 1, a(1,13)= 250.00
nt(14)= 1, a(1,14)= 250.00,
nt(15)= 3, a(1,15)= 6.8638 ,155.25 ,0.0000 ,0.0000 ,0.0000,
nt(16)= 1, a(1,16)= 222.00,
nt(17)= 1, a(1,17)= 2750.00,
&end
```

3) all tanks in operation, beamtransfer of 208Pb25+ from outlet of tank3 to ITFS.MSG10
(measurement of energy dispersion)

```
&data
er= 193648.000, q= 25., w= 874.612, xi= 0.000,
emiti(1)= 12.215, 12.348, 28000.00,
beami(1)= -2.347, 4.2099, -2.614, 4.4205, 0.198, 0.0012,
beamf(1)= 0.000, 0.2000, -1.500, 13.0000
mt= 8, nc= 4, mp(1,1)= 1, mp(1,2)= 1, mp(1,3)= 1, mp(1,4)= 1,
mp(2,1)= 2, mp(2,2)= 4, mp(2,3)= 11, mp(2,4)= 13,
mvc(1,1)= 1, mvc(2,1)= 6, mvc(3,1)= 1,
mvc(1,3)= 1, mvc(2,3)= 16, mvc(3,3)= 1,
freq= 202.56, pqext= 2.5, ichrom= 0.,
xm= 20.00, xpm= 10.0, ym=35.0, dpm= 180.0, dwm= 5000.0, dpp= 90.0,
n1= 1, n2= 34, smax= 5.0, pqsmax= 2.5,
nt( 1)= 1, a(1, 1)= 136.70,
nt( 2)= 3, a(1, 2)=  6.7790  ,150.00   ,0.0000 ,0.0000 ,0.0000,
nt( 3)= 1, a(1, 3)=  32.00,
nt( 4)= 3, a(1, 4)= -12.4730  ,270.00   ,0.0000 ,0.0000 ,0.0000,
nt( 5)= 1, a(1, 5)=  32.00,
nt( 6)= 3, a(1, 6)=  6.7790  ,150.00   ,0.0000 ,0.0000 0.0000,
nt( 7)= 1, a(1, 7)= 240.00,
nt( 8)= 1, a(1, 8)= 660.00,
nt( 9)= 1, a(1, 9)= 550.00
nt(10)= 1, a(1,10)= 400.00,
nt(11)= 3, a(1,11)=  7.3097  ,155.25   ,0.0000 ,0.0000 ,0.0000,
nt(12)= 1, a(1,12)= 499.75,
nt(13)= 3, a(1,13)= -9.9692  ,155.25   ,0.0000 ,0.0000 ,0.0000,
nt(14)= 1, a(1,14)= 250.00
nt(15)= 1, a(1,15)= 250.00,
nt(16)= 3, a(1,16)=  7.3097  ,155.25   ,0.0000 ,0.0000 ,0.0000,
nt(17)= 1, a(1,17)= 222.00,
nt(18)= 1, a(1,18)= 300.00,
nt(19)= 8, a(1,19)= -28.65 ,-2400.00   ,0.00
nt(20)= 9, a(1,20)=  -7.00 ,-2400.00  ,70.00   ,0.45   ,2.80,
nt(21)= 1, a(1,21)= 2950.00,
&end
```