Steering in the Linac4 Transfer Line

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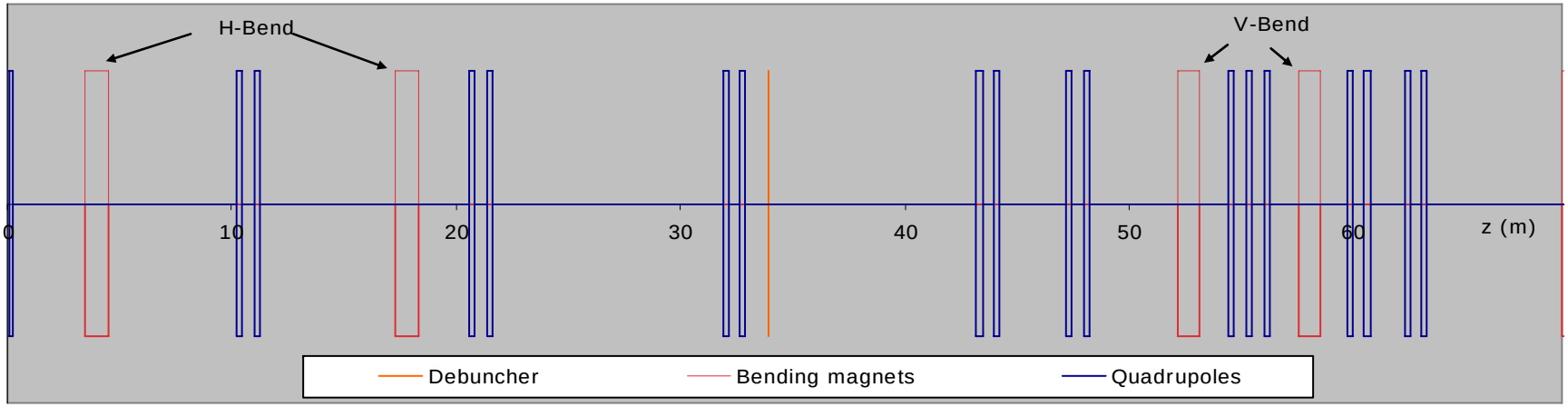
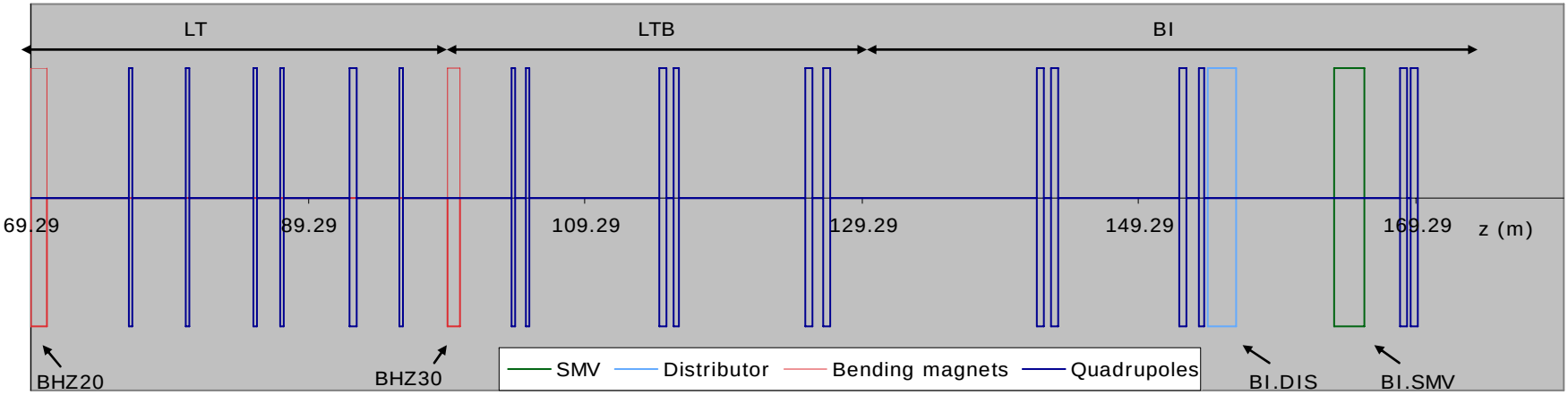
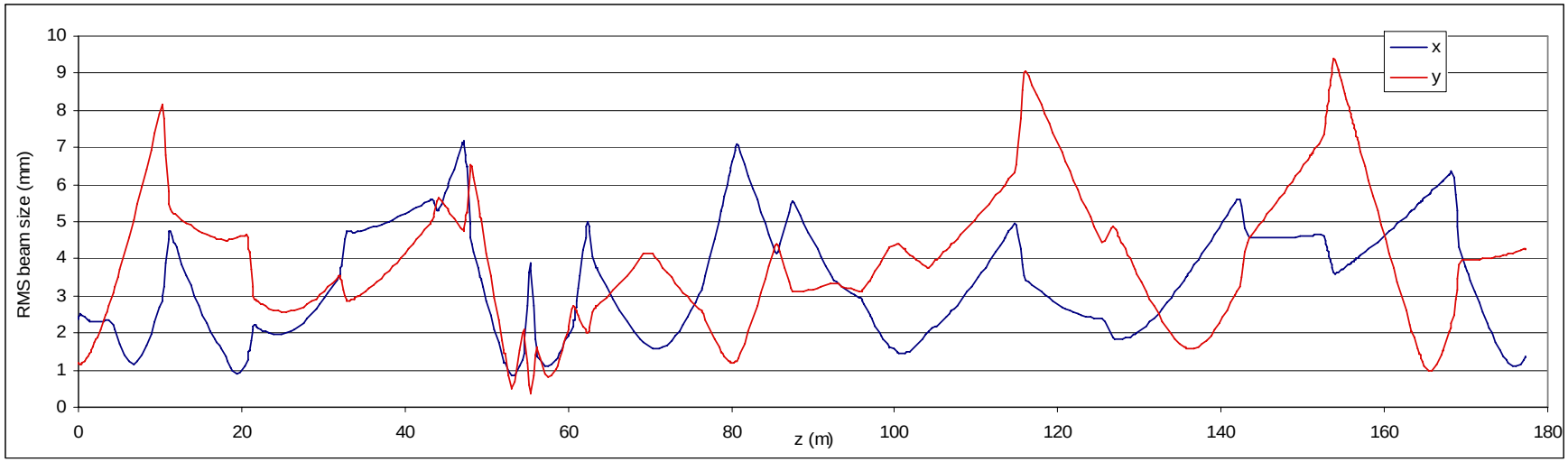
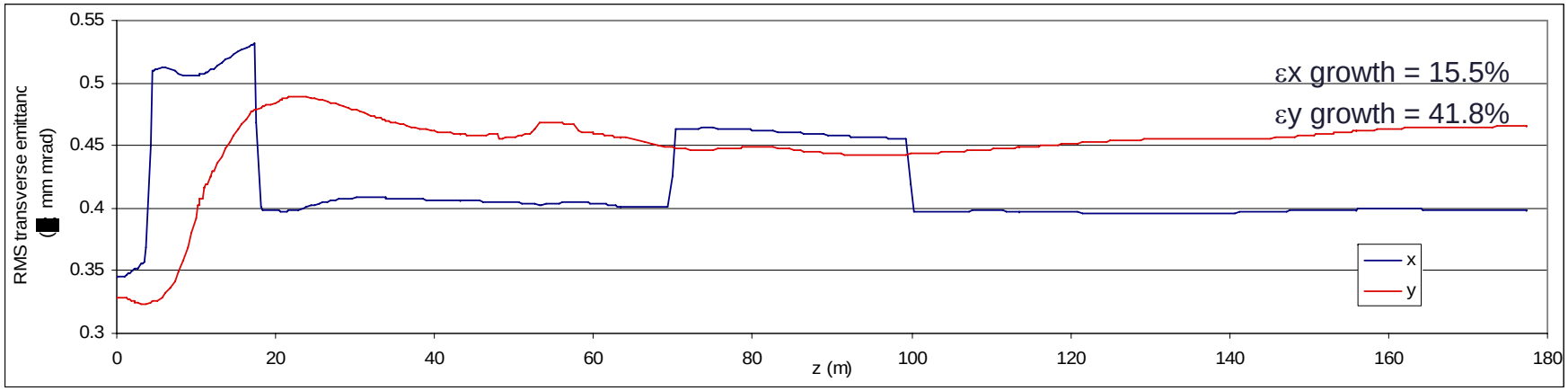
Layout of the line



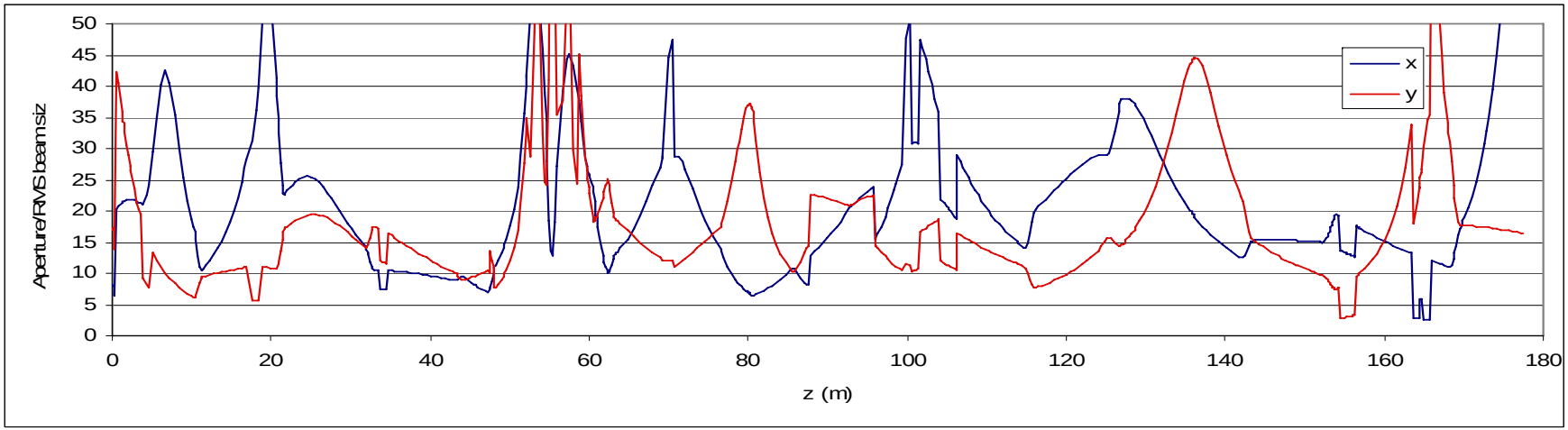


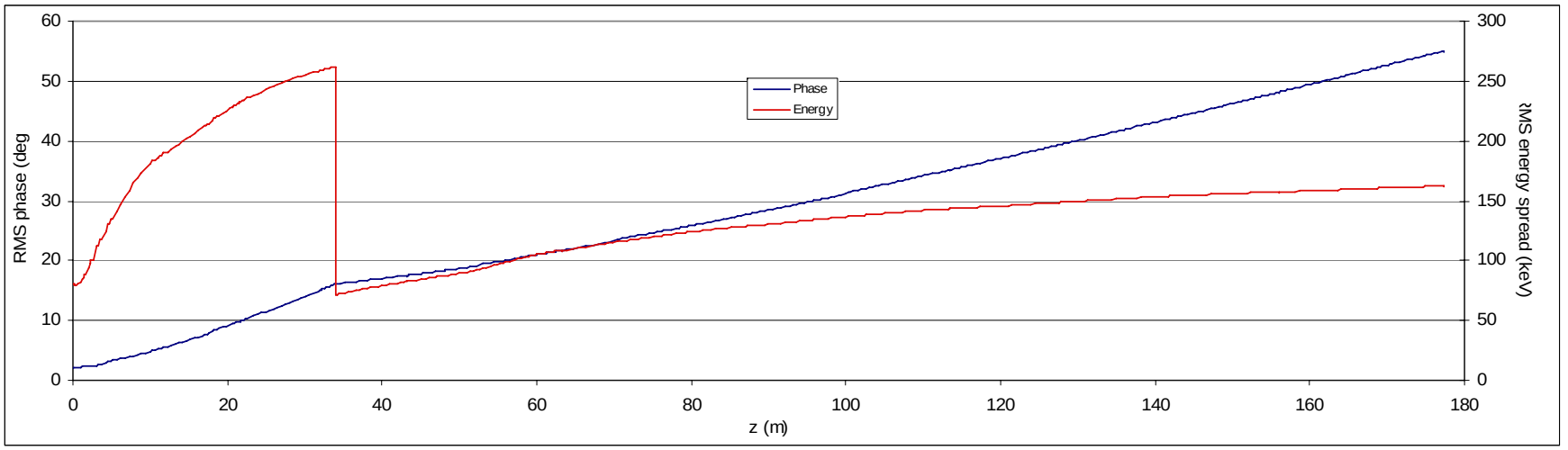
Nominal optics





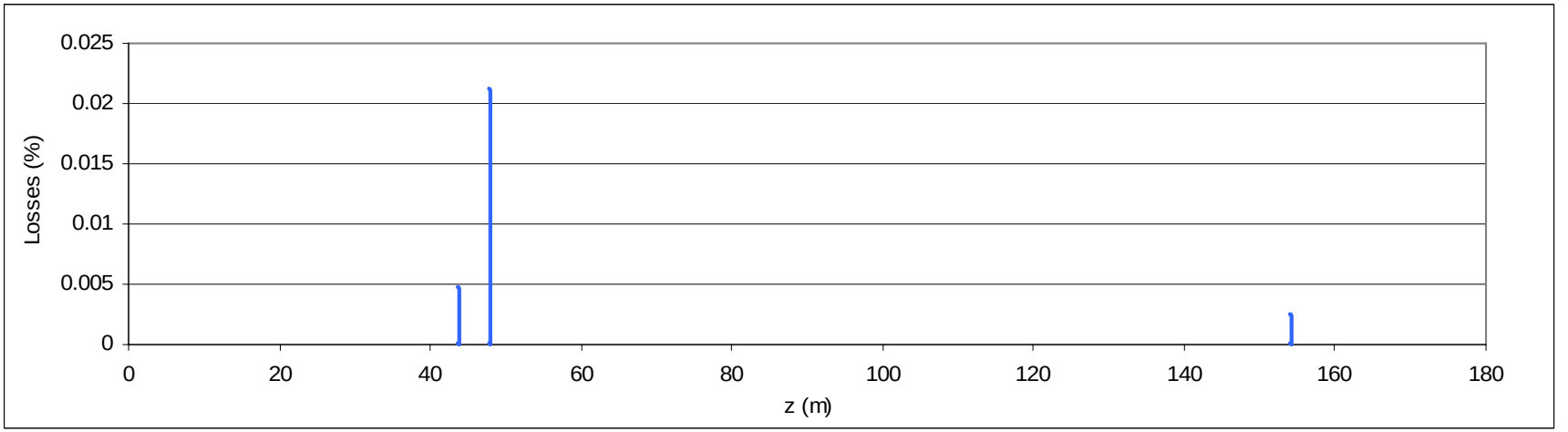
Nominal optics

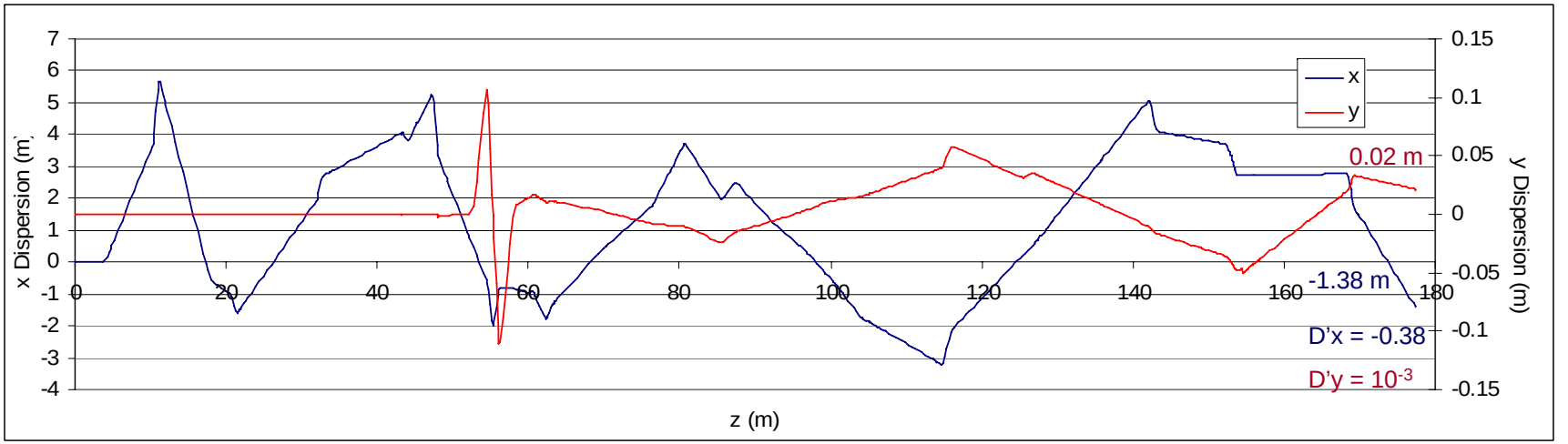




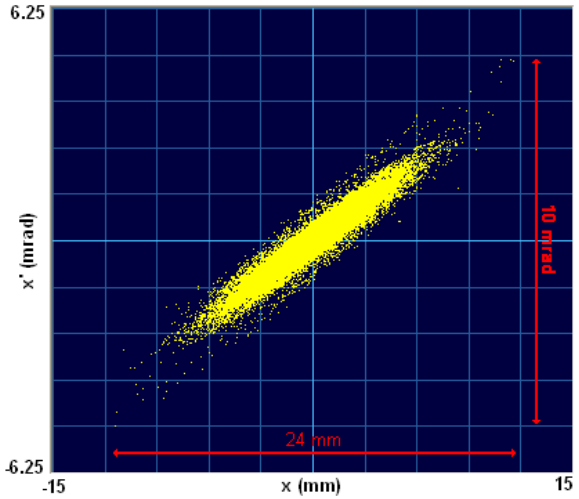
Nominal optics

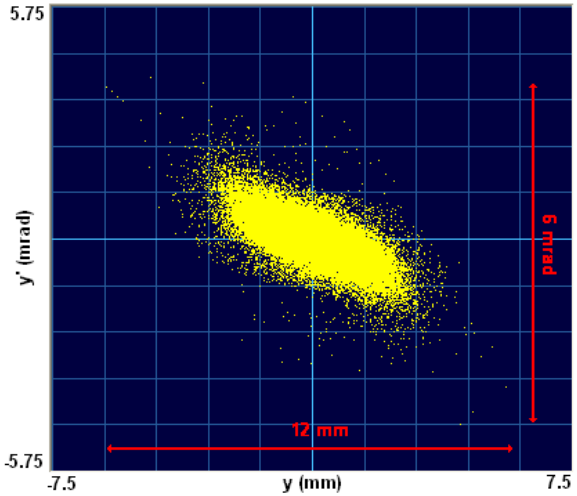
T = 99.97%, power lost/particle = 0.194 W

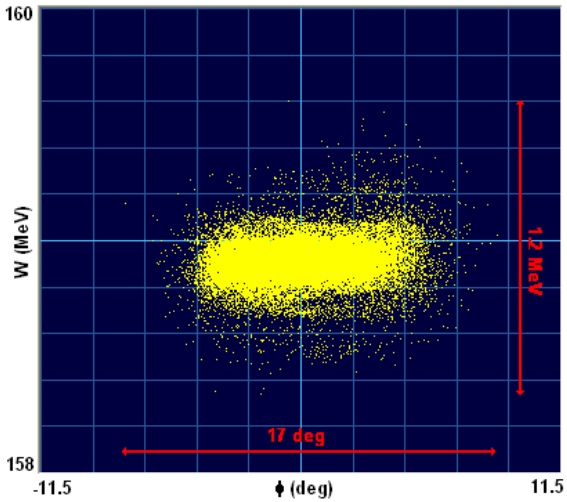




Input beam



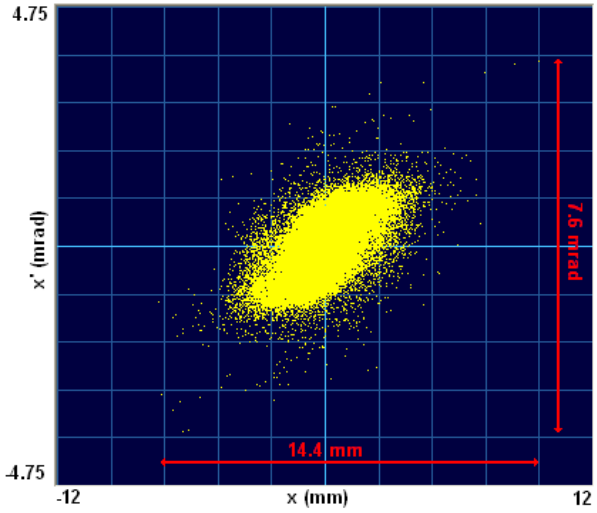


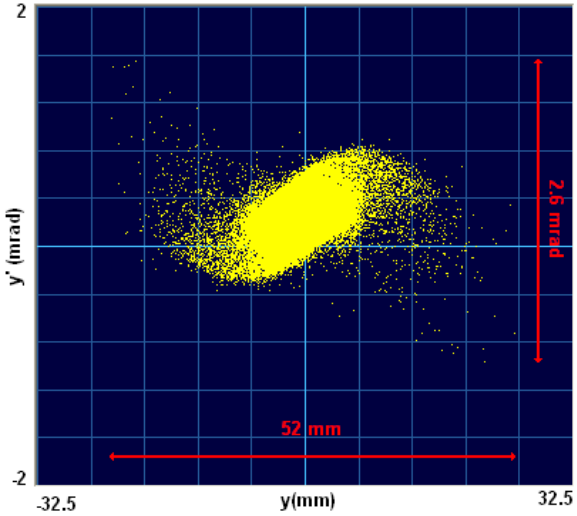


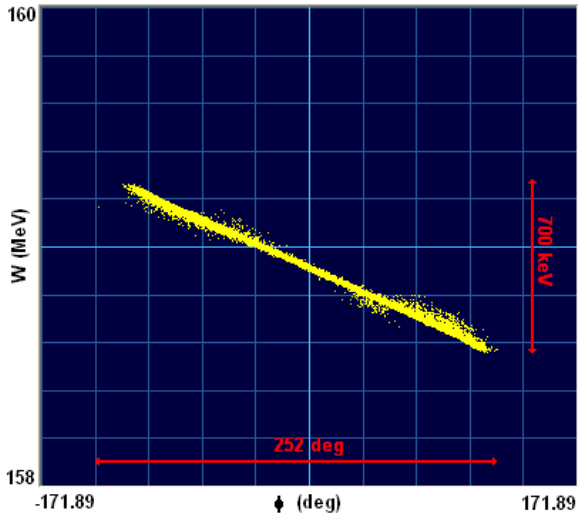
	x-x'	y-y'	ϕ-ΔW
α	-3.397	0.971	-0.131
β	10.024	2.714	28.055
RMS ε	0.345 (Norm.)	0.328 (Norm.)	0.178

Beam at the end of the Transfer Line

(~ 8 m from BI.QN60)







	x-x'	y-y'	ϕ-ΔW
α	-0.751	-0.431	20.652
β	2.889	23.862	7006.344
RMS ε	0.399 (Norm.)	0.466 (Norm.)	0.433

Error implemented

Quadrupole errors:

Type of error	Error maximum value/1 σ	Distribution
Rotation along the z axis	± 0.2 deg	Uniform
Misalignment (in both x and y)	± 0.2 mm (1 σ)	Gaussian (cut at 3 σ)
Gradient	± 0.50%	Uniform

Only static errors have been considered, the values given by the survey people.

Initial beam errors:

Type of error	1 σ	Distribution
Position jitter (in both x and y)	± 0.3 mm (1 σ)	Gaussian (cut at 3 σ)
Divergence jitter (in both x' and y')	± 1 mrad (1 σ)	Gaussian (cut at 3 σ)

These values are based on error studies on the upstream Linac4 structures (error propagation)

Statistical effects (1750 runs)

	Nominal	Mean ± Std Deviation
Transmission (%)	99.972	92.261 ± 18.573
<x> (mm)	-0.006	-0.157 ± 5.801
<y> (mm)	-0.465	-0.784 ± 8.843
RMS ε_x (π mm mrad)	0.399	0.395 ± 0.050
RMS ε_y (π mm mrad)	0.466	0.464 ± 0.042
ε_x growth (%)	15.518	14.406 ± 14.292
ε_y growth (%)	41.829	41.436 ± 12.338

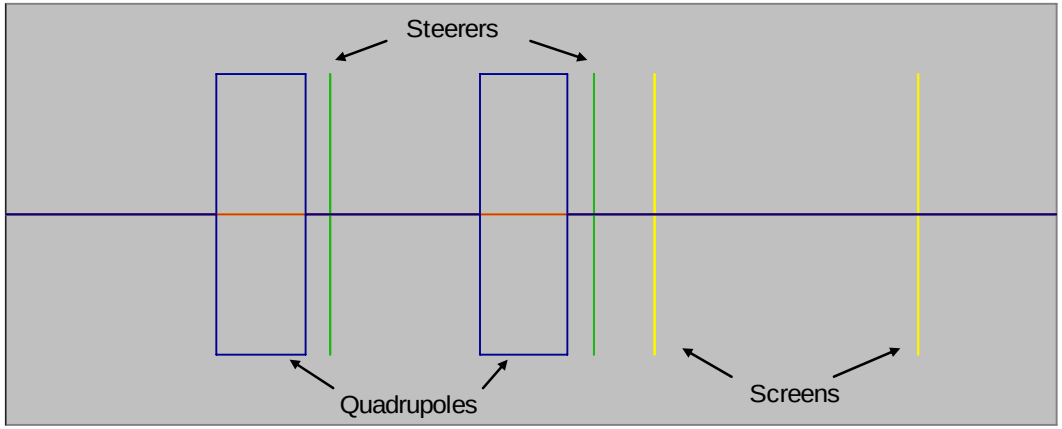
Worst case: T = 0%

Correction scheme

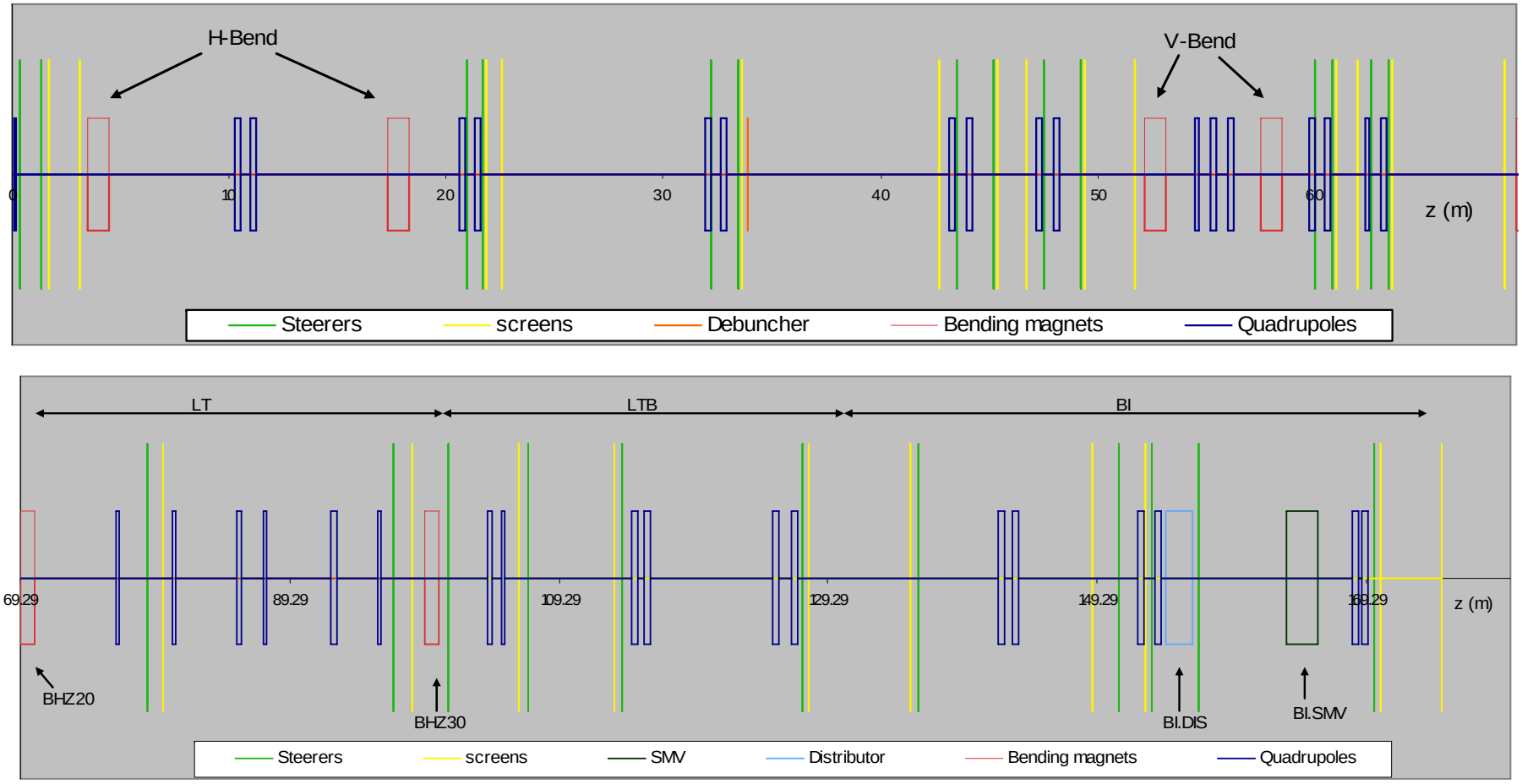
Steerers and screens

There are 22 *2 (horizontal and vertical) steerers and as many screens along the line:

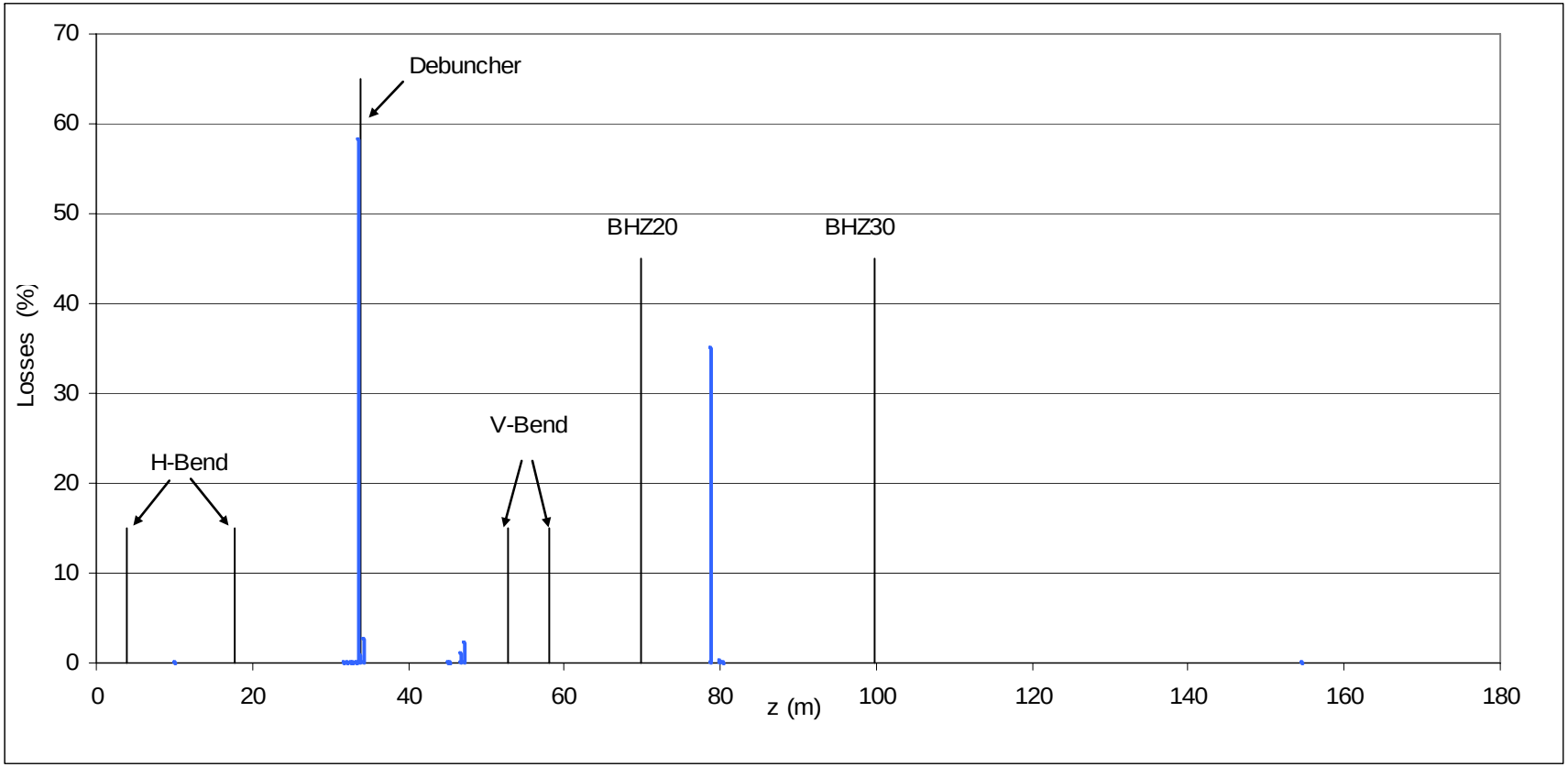
- two steerers and two screens for each doublet in the new section of the line, for a total of 14*2
- downstream of BHZ20, same number and position of steerers and screens which are presently in the LINAC2 transfer line, for a total of 8*2
- maximum strength of the steerers: 4 mT m



Correction scheme

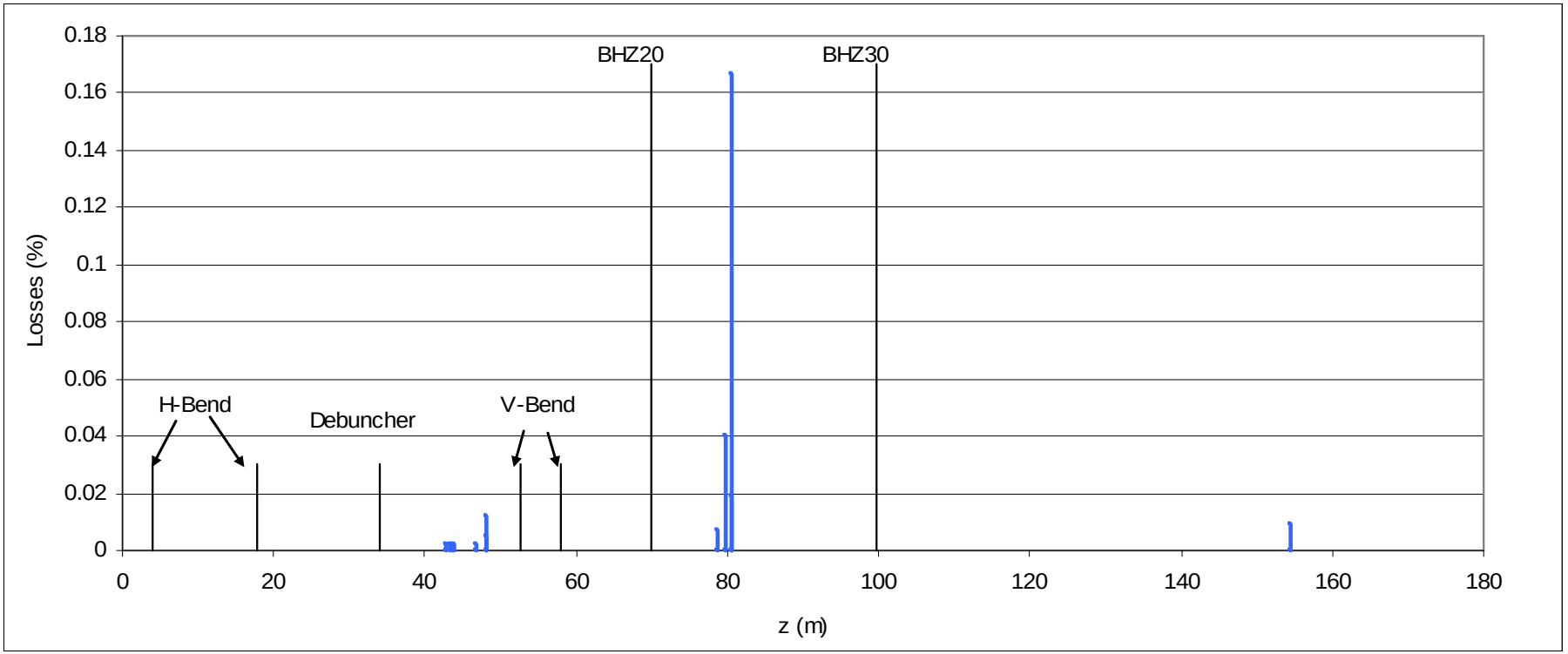


Worst case: T = 0%

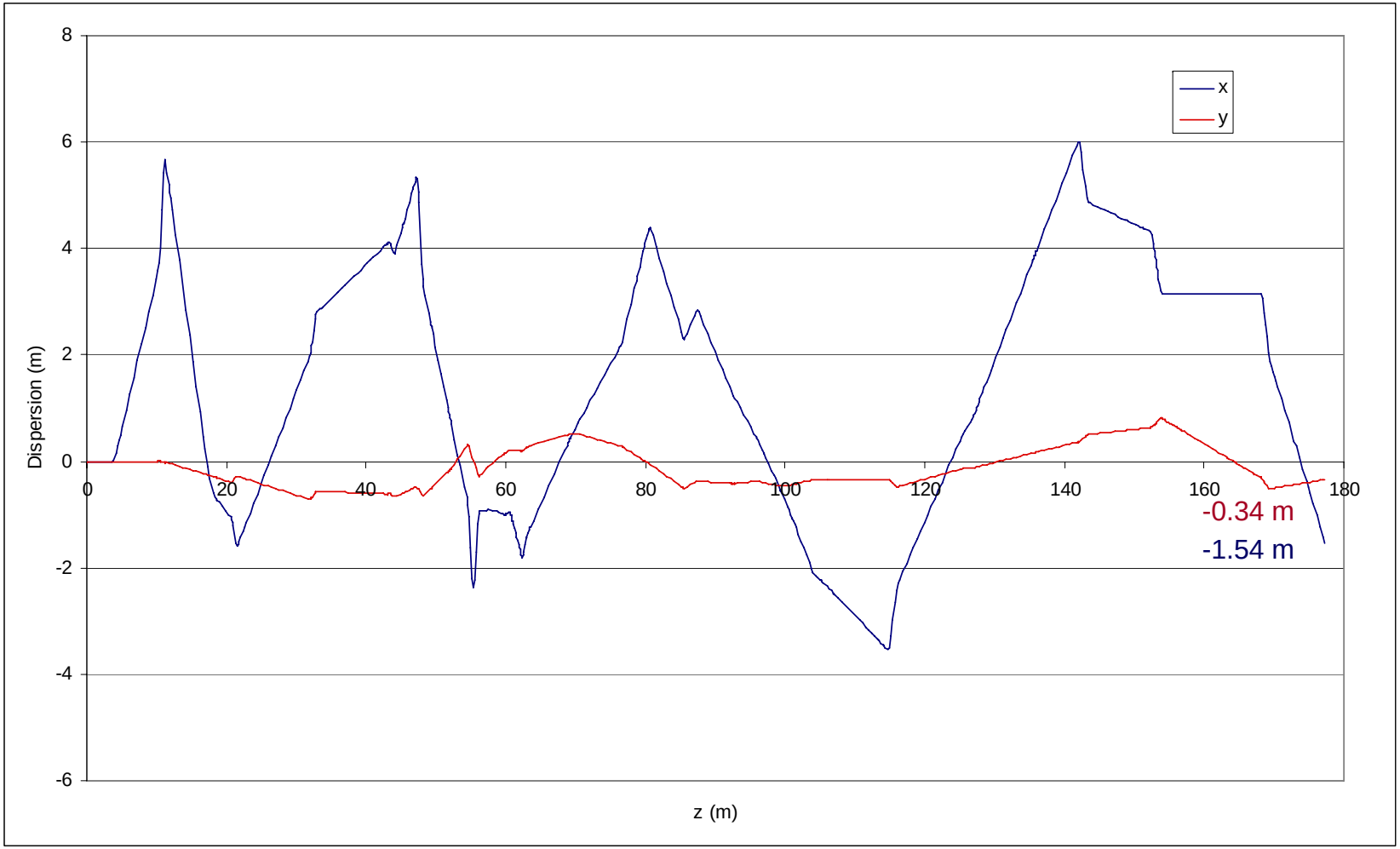


Worst case after steering

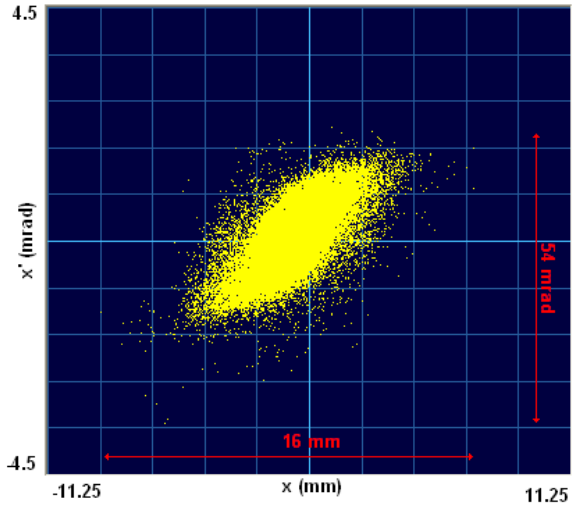
T = 99.72%

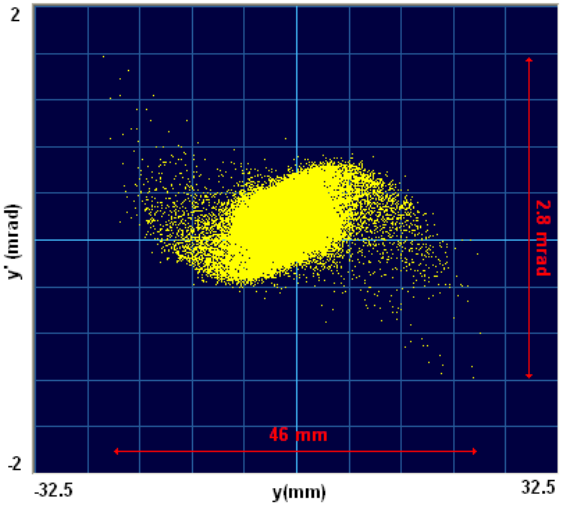


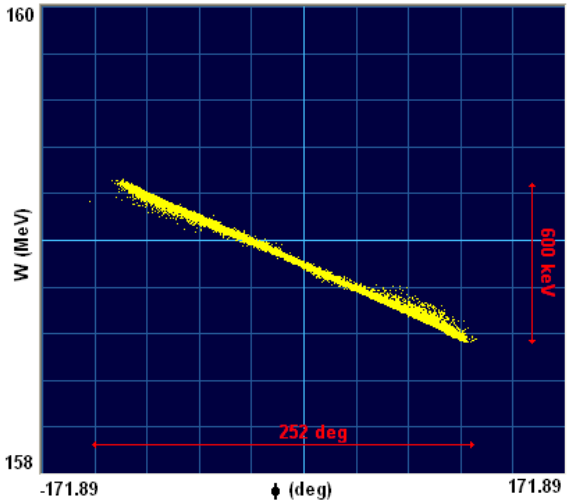
Worst case after steering



Beam at the end of the Transfer Line







	x-x'	y-y'	ϕ-ΔW
α	-0.956	-0.276	21.861
β	3.191	23.120	7455.196
RMS ε	0.437 (Norm.)	0.515 (Norm.)	0.401

Summary and conclusions

Worst case: all the beam is lost

Steering: 4 couples of steerers used

(maximum 4 mT/m -> maximum kick 2.11 mrad)

After steering:

- Trasmission 99.7%
- Emittance growth: 26.65% in x, 56.72% in y
- Dispersion:

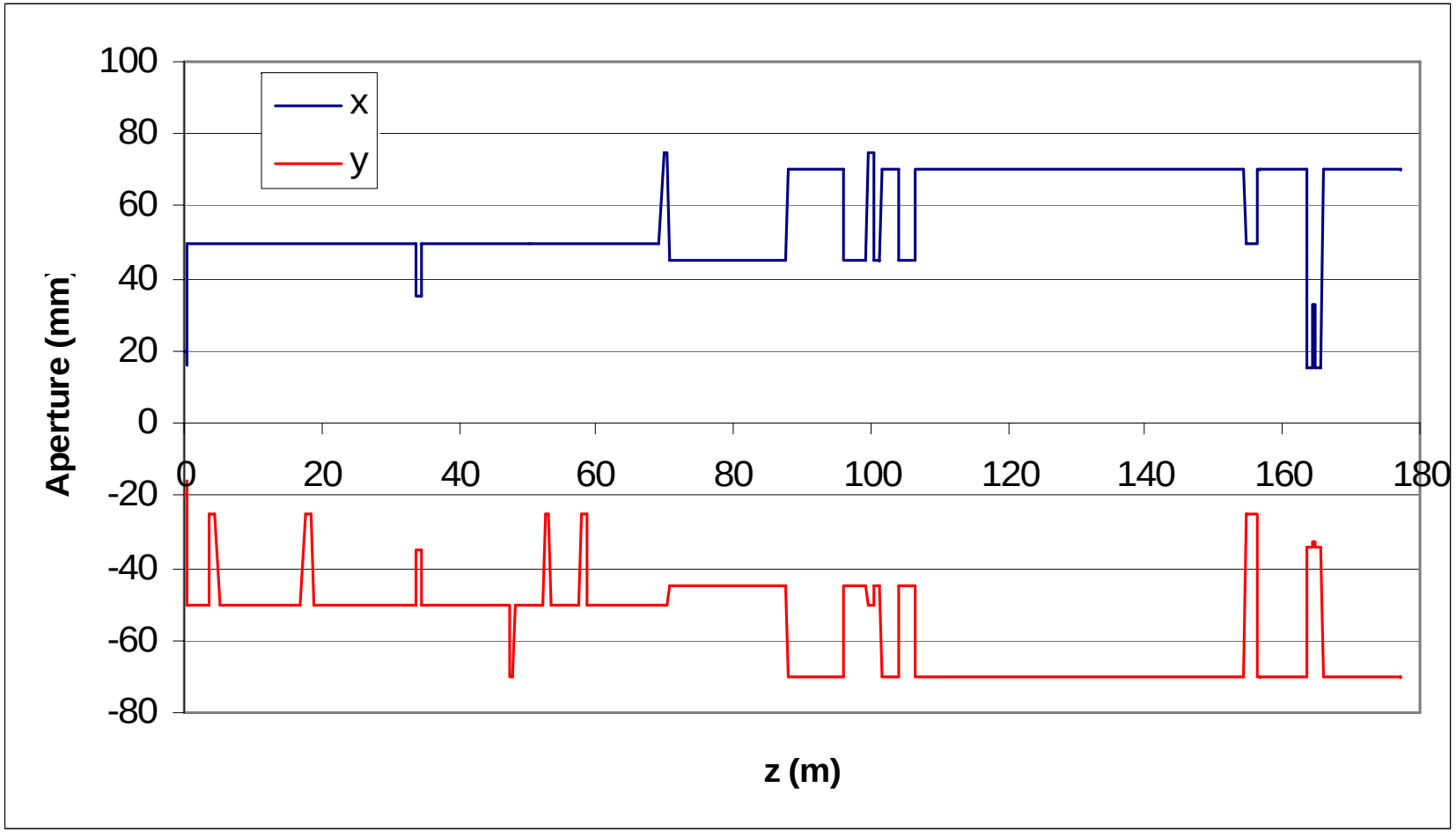
Dx	Dy
-1.54 m	-0.34 m

Steerer	X' (mrad)	Y' (mrad)
1	2.11	1.36
2	1.44	-0.58
D40	2.11	-0.36
D50	-2.11	2.11
DL10	-0.98	-2.11
DL20	2.11	0.22
DL30	0.30	0.28
DL40	-0.78	0.03

Conclusions

In case of huge losses due to static errors on the quadrupoles in the transfer line, the transmission can be efficiently recovered with the chosen steering scheme

Aperture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60
40
20
0
-20
-40
-60
-80
0
20
40
60
80
100
120
140
160
180
x
y
Aperture (mm)
z (m)