-124-

Beam Parameters

$E = 180 - 350$ MeV

$\varepsilon_x = \varepsilon_y = 10^{-6}$ [m rad]

$\Delta p/p = 1\%$

l_b bunch length from the Linac

$l_b = 1.5$ mm

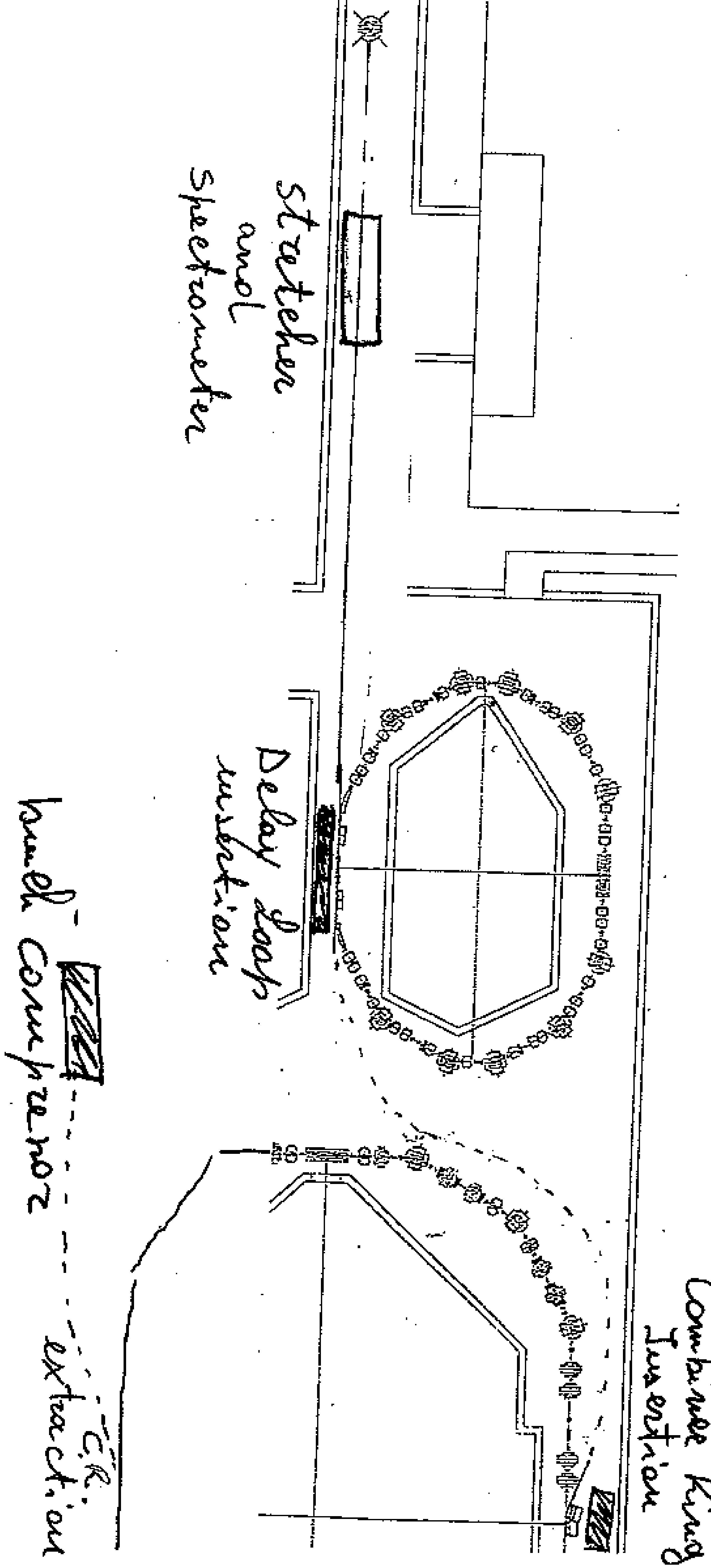
Δl_b bunch length tunability

$\Delta l_b = \pm 1.6$ mm

CTF3 Transfer Line

Catia Milardi

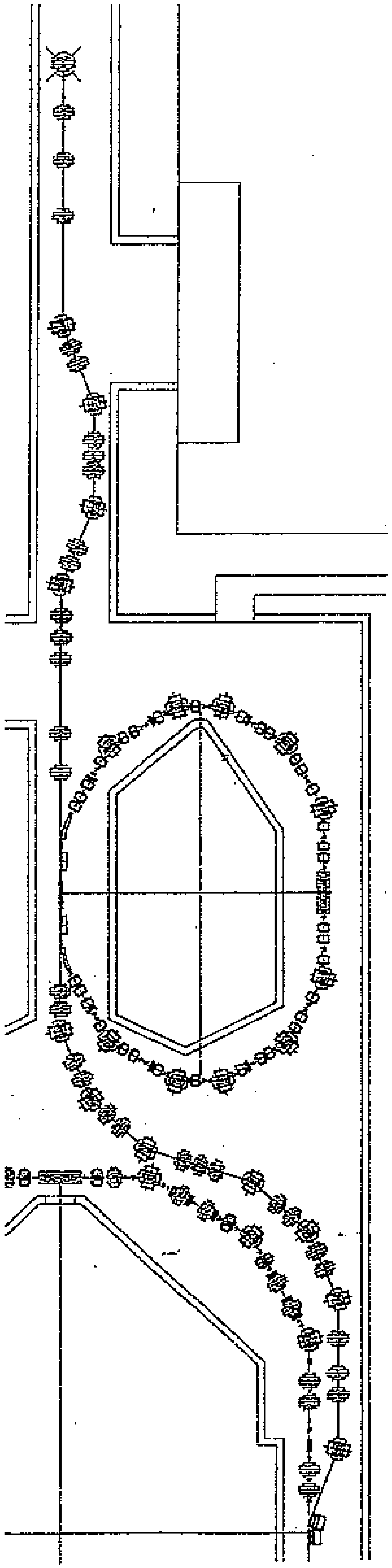
October 2-3 2001



General Requirements

The CTF3 Transfer Line main issues:

- * **isochronicity**
- * **bunch length/match tuning**
- * **low $\beta_{x,y}$ to minimize chromatic effects**
- * **low η_x to have small contribution to second order isochronicity as well as to transverse emittance.**
- * **match the Delay Loop and Combiner Ring insertions**
- * **reuse as much as possible EPA magnets and power supplies**



Isochronicity

The path length variation with energy is:

$$c\Delta t = R_{51}x + R_{52}x' + R_{56}\Delta p/p + T_{566}(\Delta p/p)^2 + \ldots$$

the first order approximation neglects contribution from T matrix

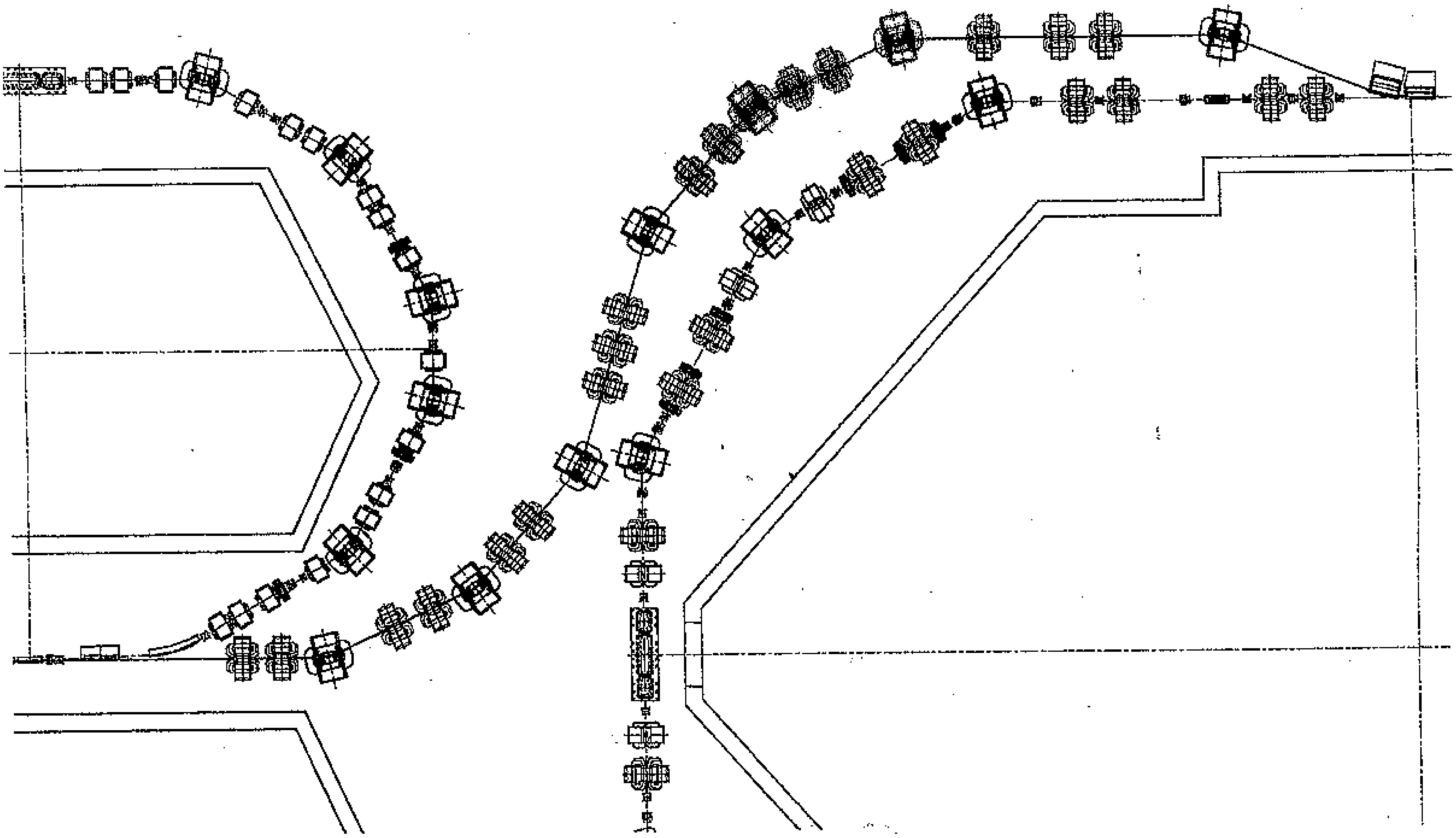
the achromatic condition implies

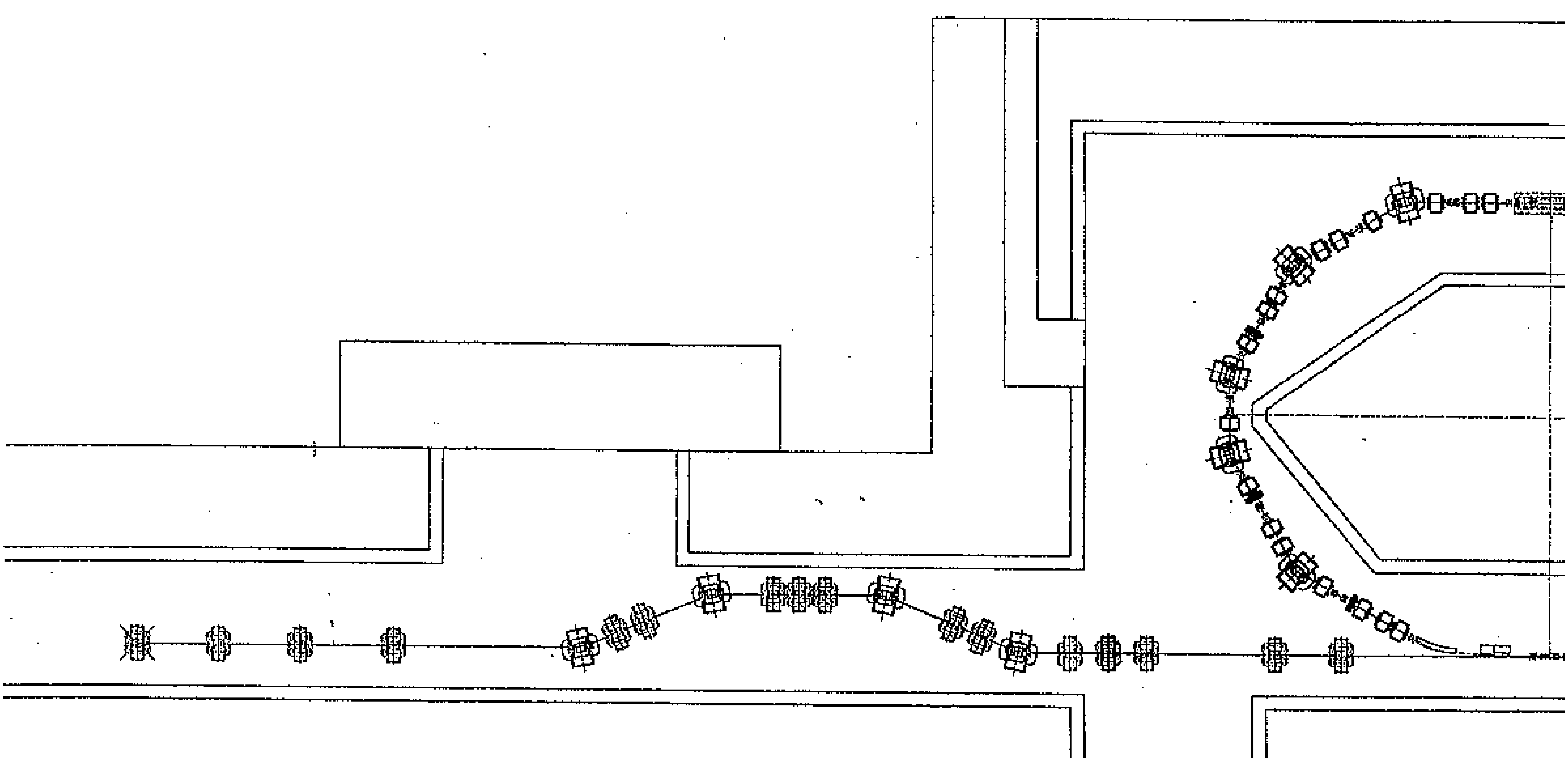
$$R_{51} = R_{52} = 0$$

$$c\Delta t = R_{56}\Delta p/p$$

the isochronicity condition becomes

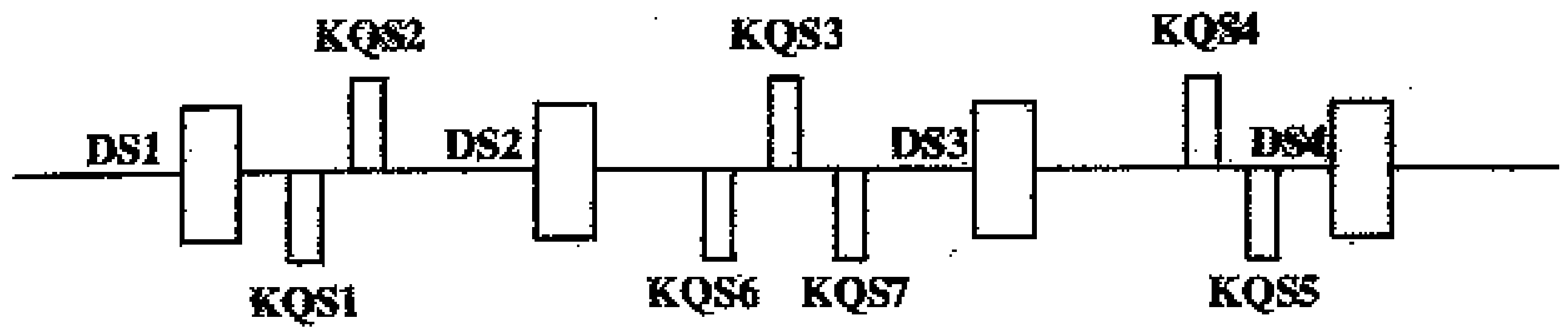
$$R_{56} = 0$$





Four-Bends Achromat

$-.16\ [\mathrm{m}] \leq R_{56} \leq .16\ [\mathrm{m}]$

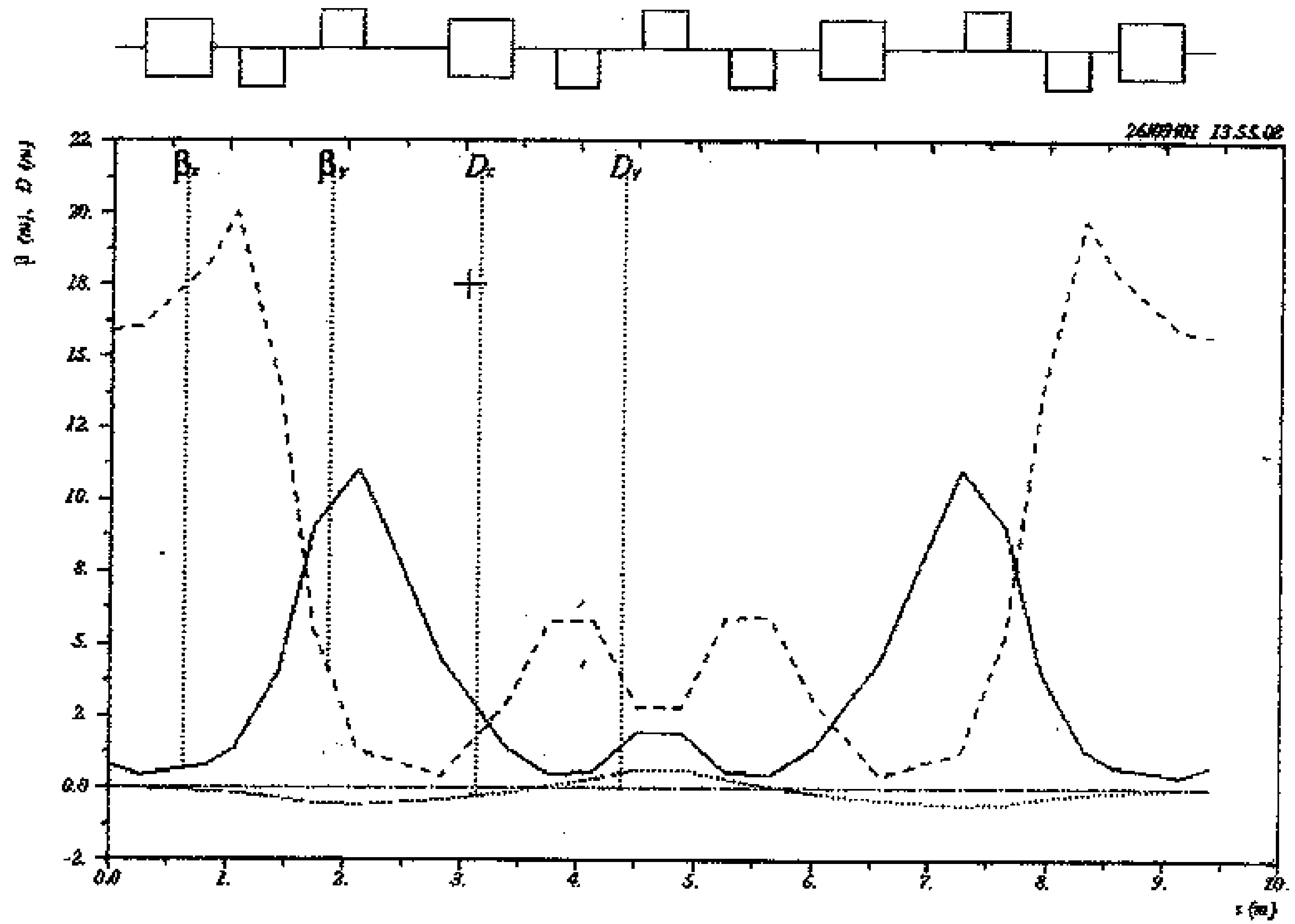


	R_{56} = -.16 [m]	R_{56} = 0 [m]	R_{56} = .16 [m]
KQS1 K (m^{-1})	-1.04	- .99	-1.28
KQS2	2.18	1.89	1.53
KQS3	1.73	1.84	2.4
KQS4	1.82	1.89	1.53
KQS5	1.50	- .99	-1.28
KQS6	- .86	- .79	-1.55
KQS7	- .91	- .79	-1.55

DS1
DS2 $\alpha = 18^0$
DS3 $\rho = 1.79$ m
DS4

DS1, ..,DS4 are the EPA TL magnets

Four-bends achromat twiss functions



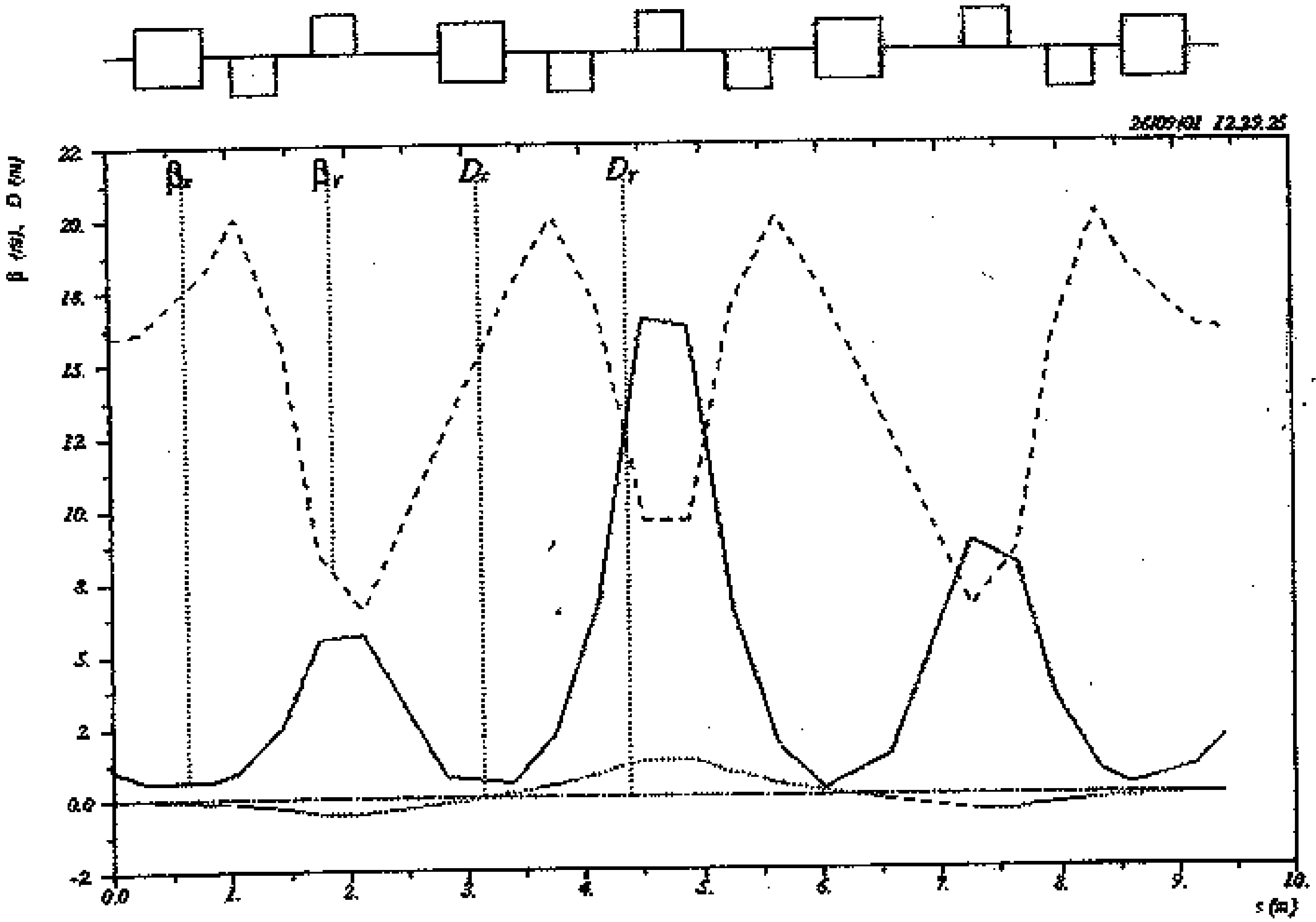
$R_{56} \sim .16$

assuming no E, z correlation the rsm bunch lenght σ_l is

$$\sigma^2_l = \sigma^2_{l0} + R_{56}\sigma^2_e$$

the achromat can be used to stretch the bunch

Four-bends achromat twiss functions

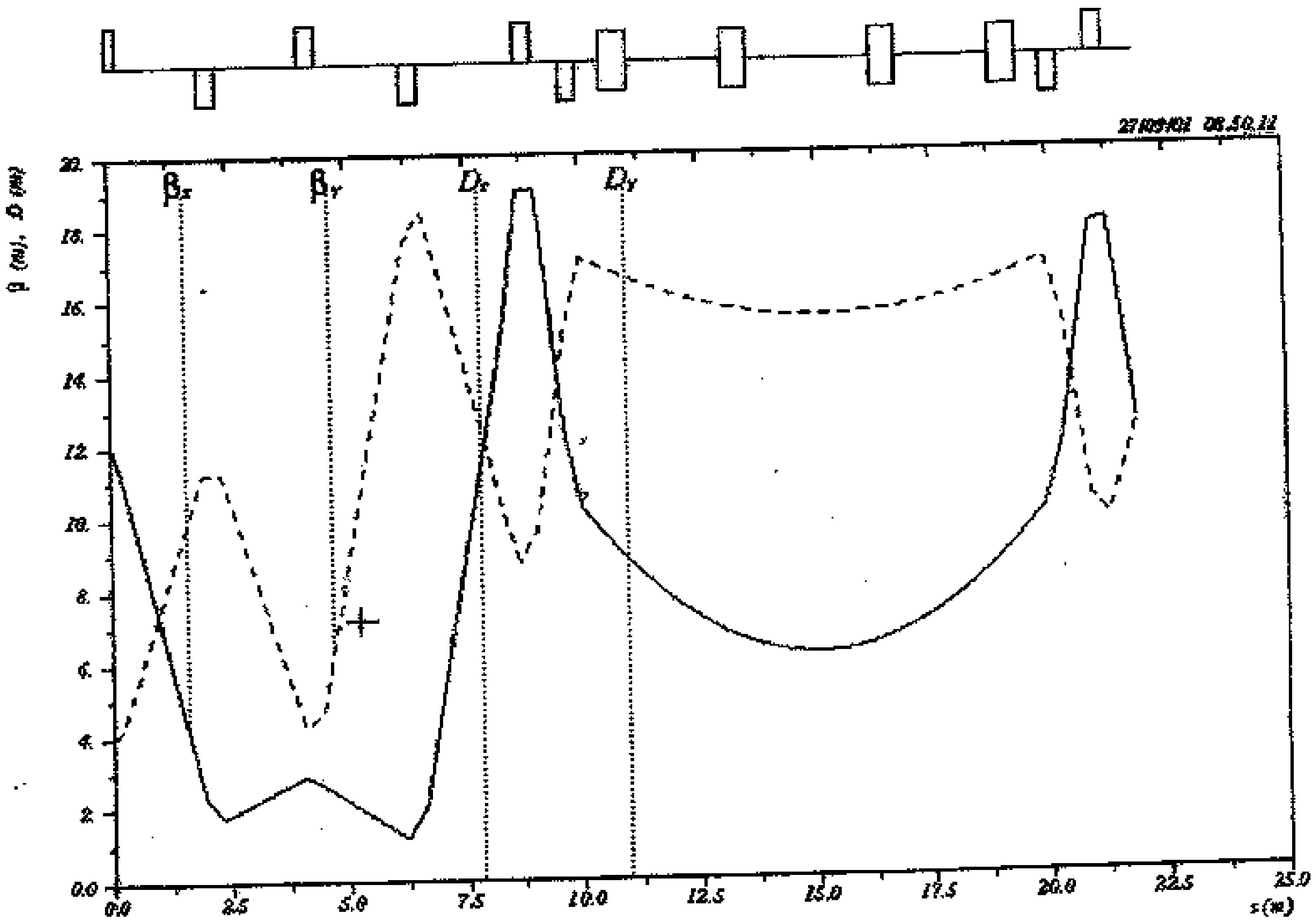


$R_{56} \sim 0$

the achromat is isochronous

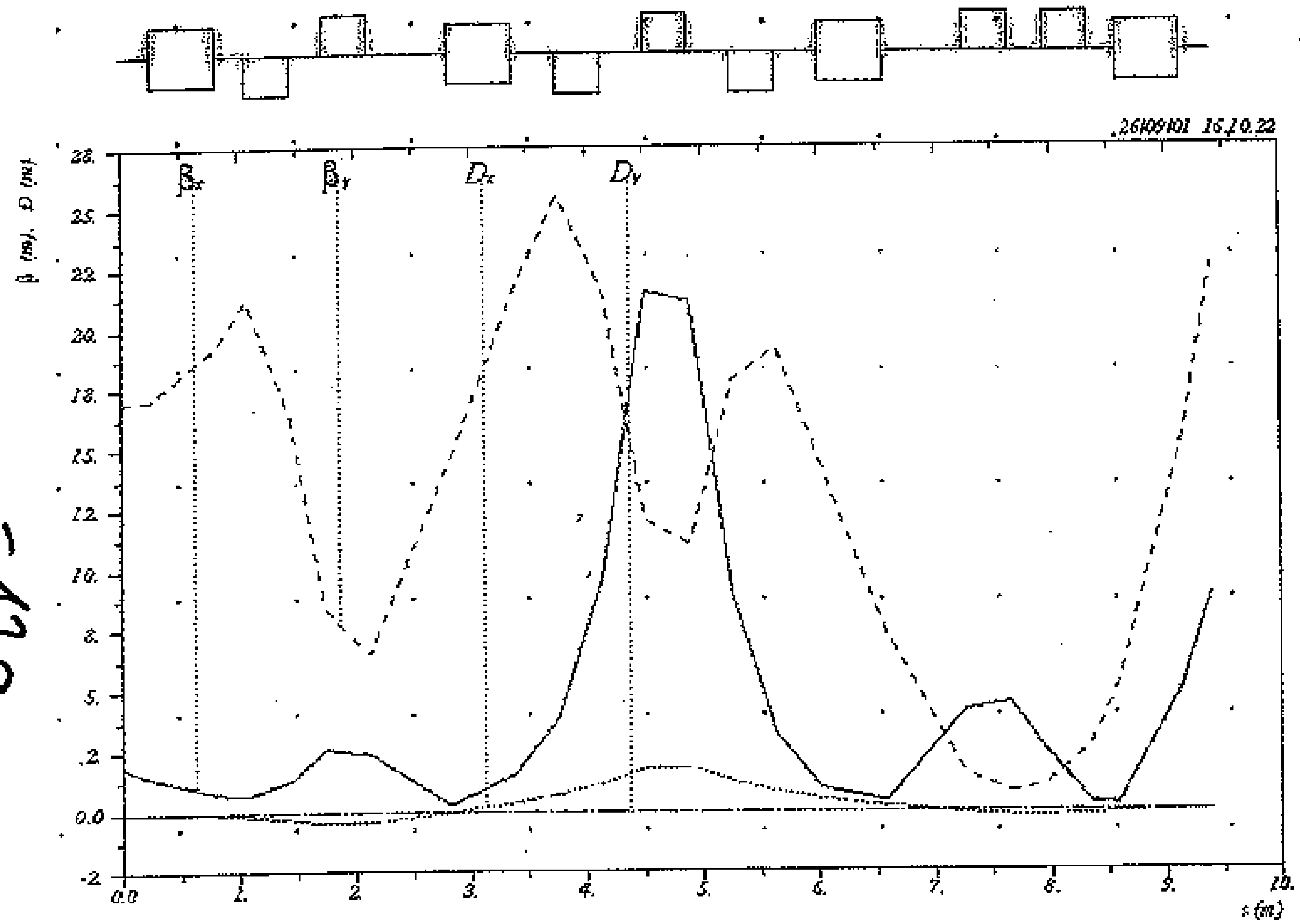
- 639 -

Four-bends achromat off twiss functions



$R_{56} = 0.$!!

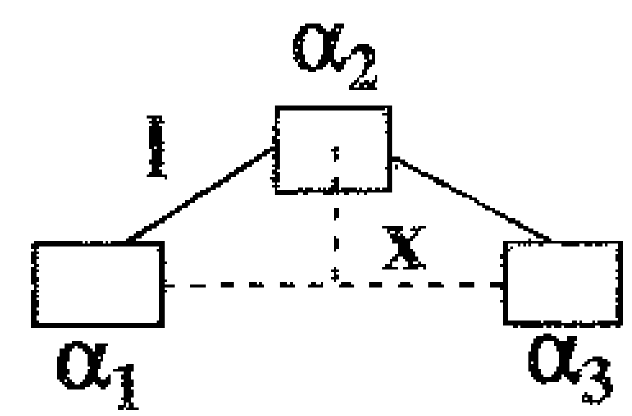
Four-bends achromat
twiss functions



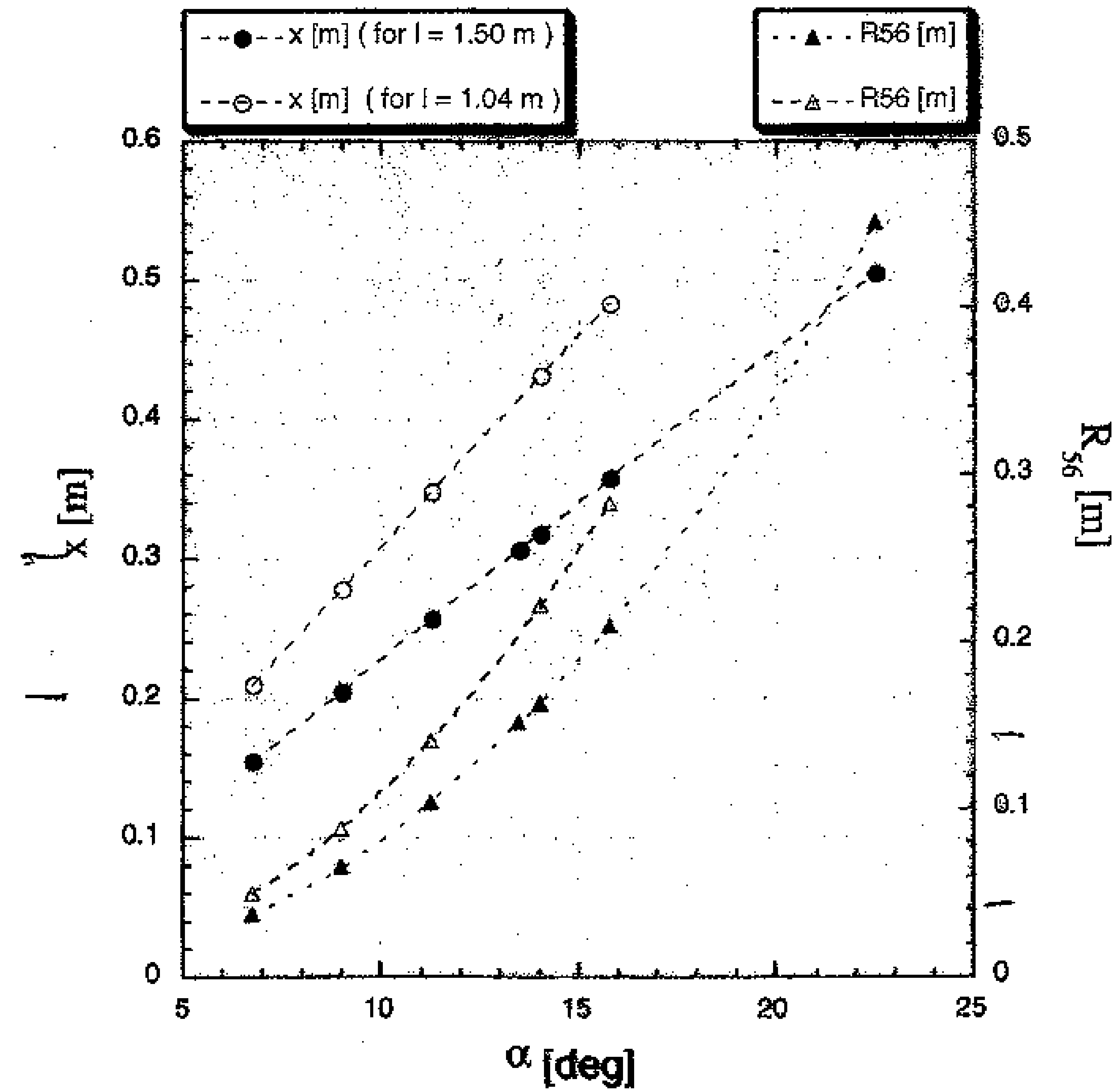
$R_{56} \sim -.16$

Three-bends achromat

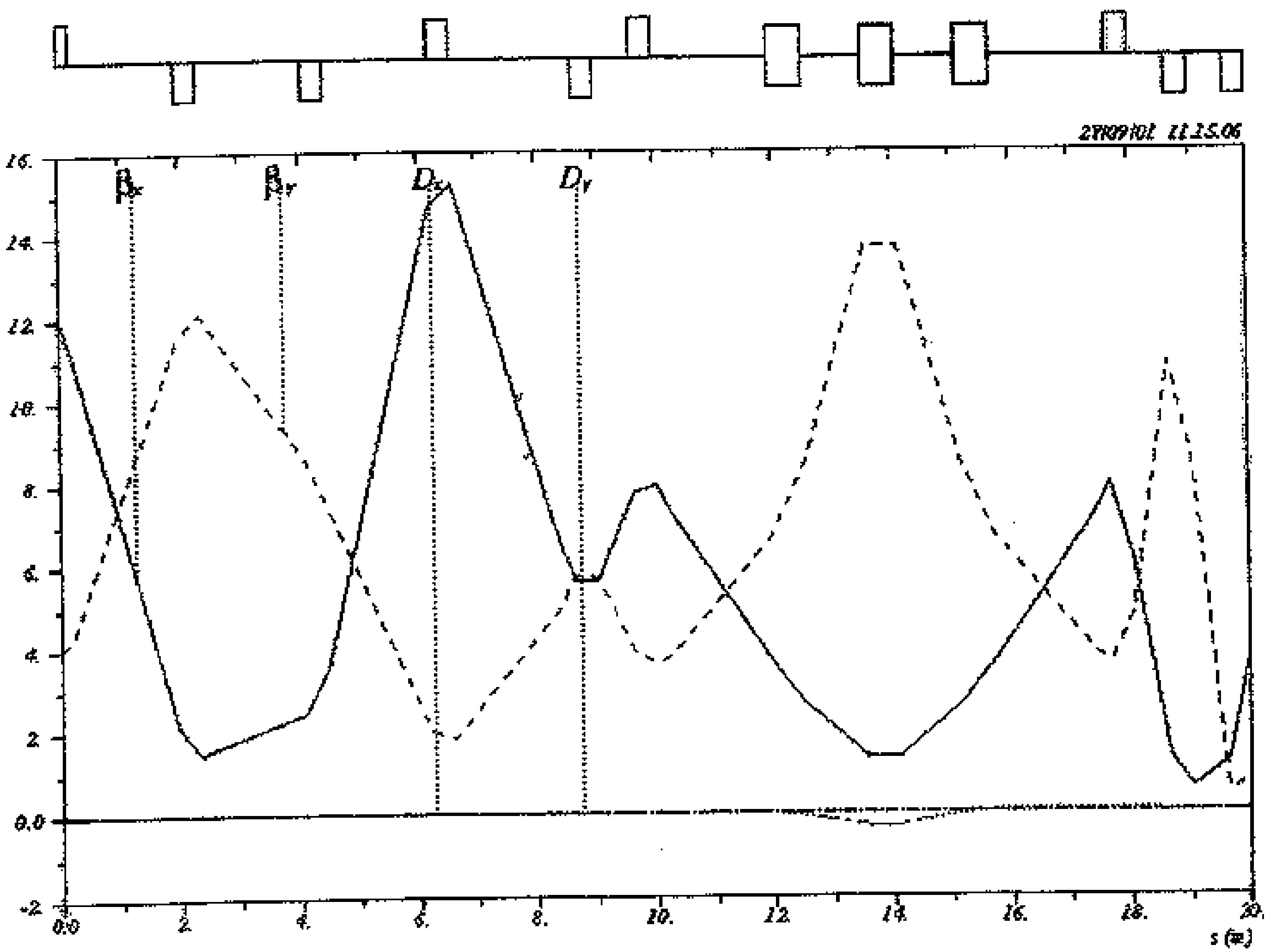
$\alpha_1 = \alpha_3$
$\alpha_2 = 2\,\alpha_1$
$.06\ [m] \le R_{56} \le .16\ [m]$



$\alpha_1 = \alpha_2 = \alpha_3 = 0 \qquad R_{56} = 0.$

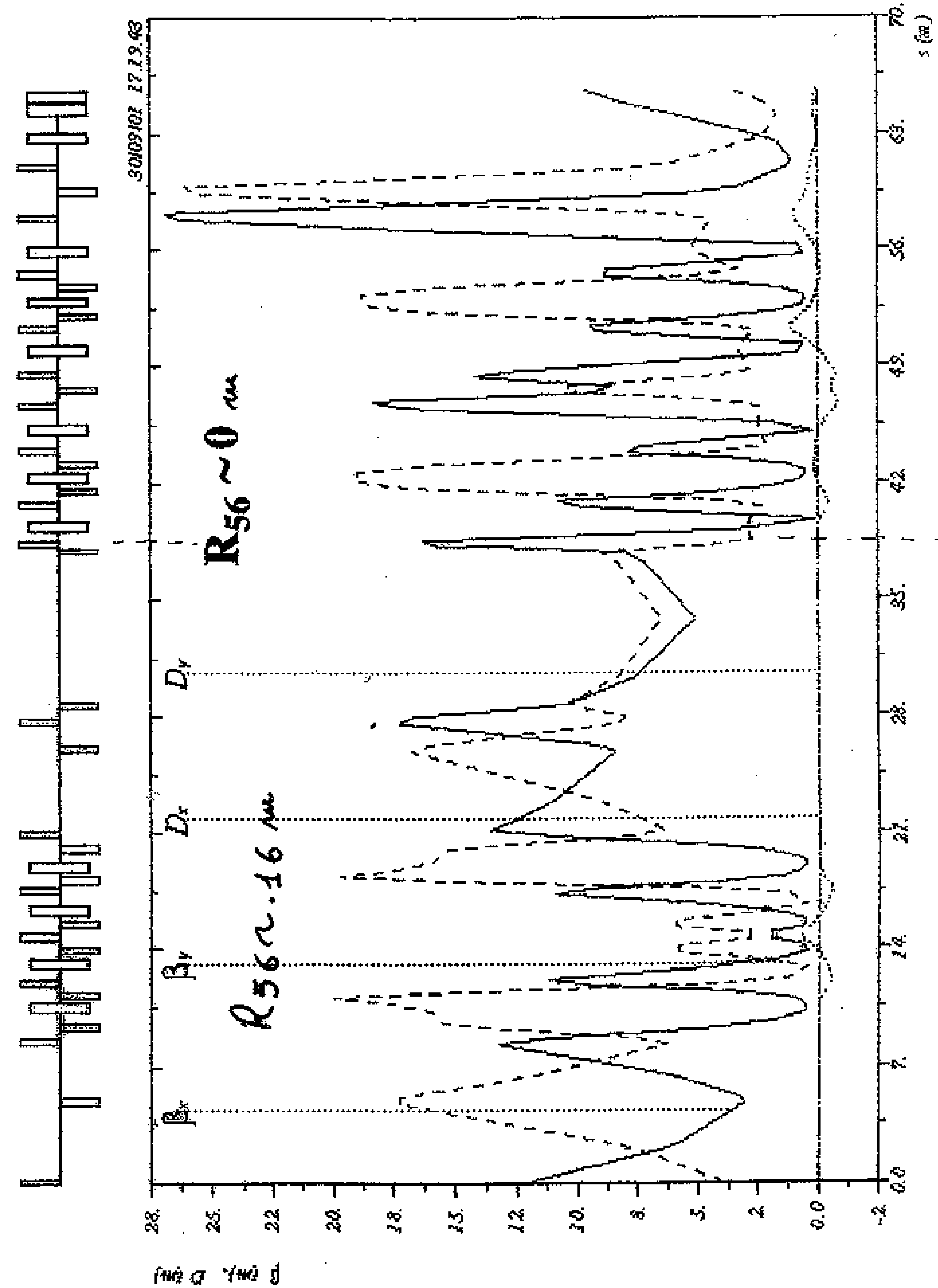


Three-bends achromat twiss functions



$R_{56} \sim .16$

CTF3 Transfer Line twiss functions



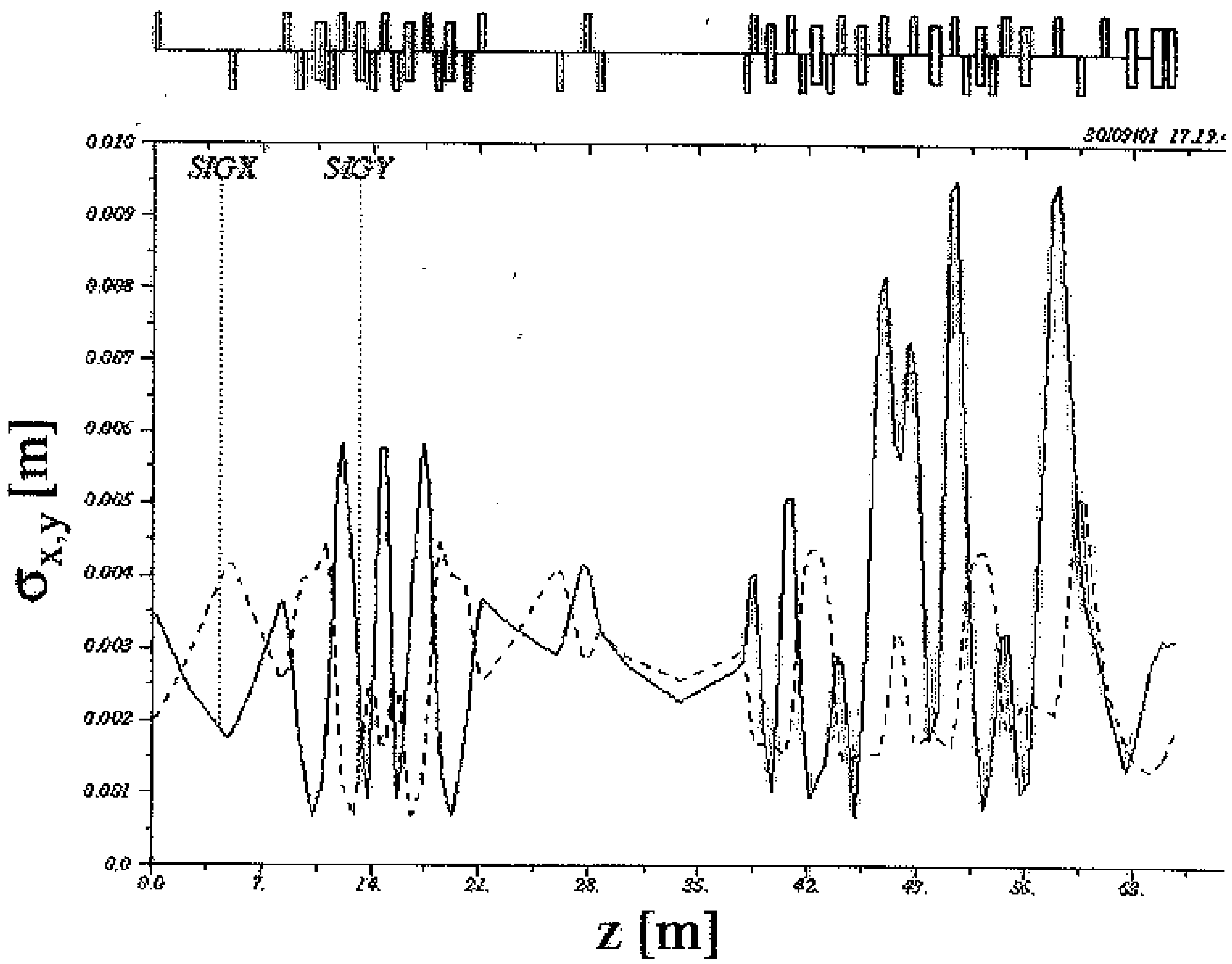
Beam Envelope

$\varepsilon_x = \varepsilon_y = 10^{-6}$ [m rad]

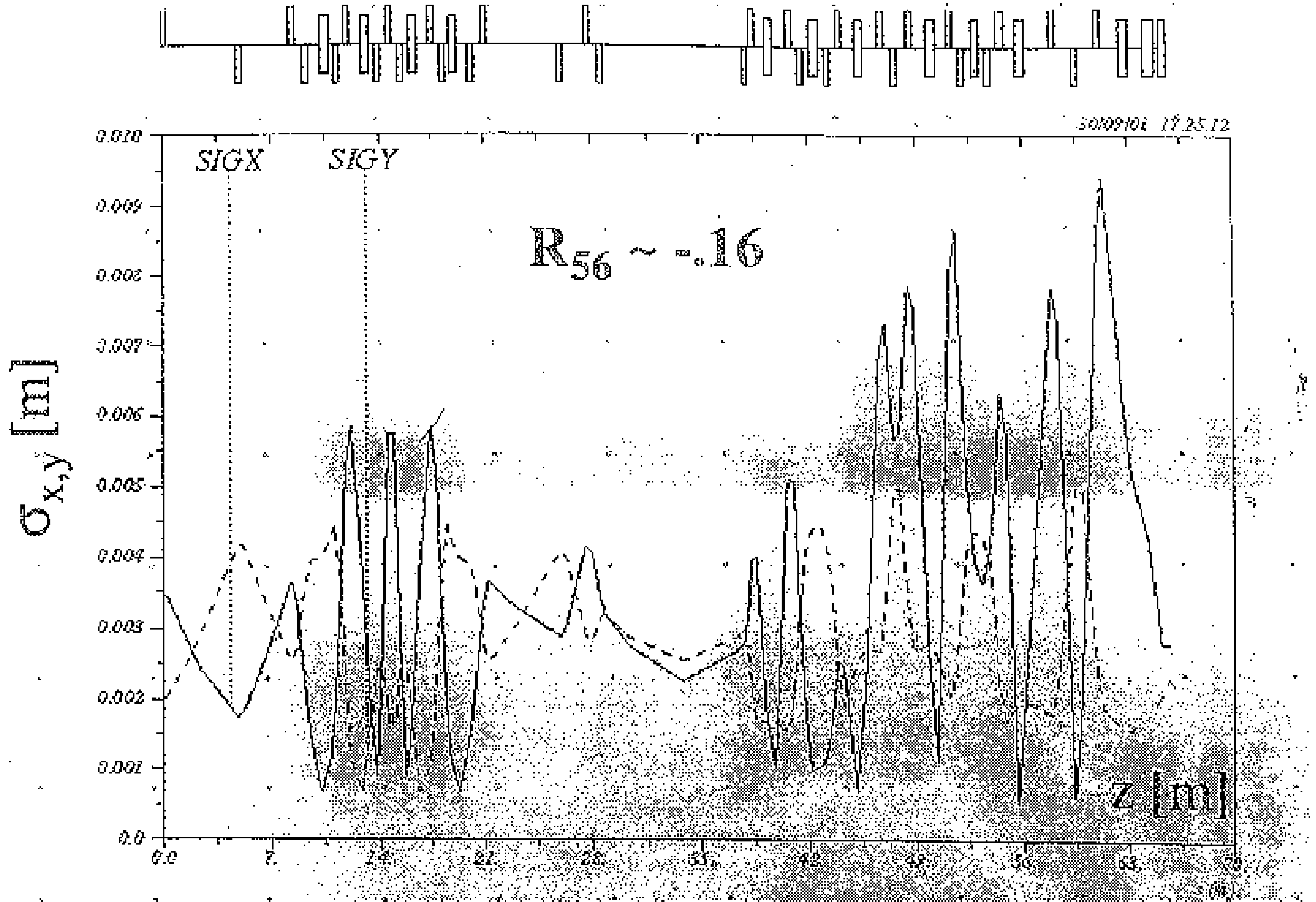
$\sigma_e = .8\%$

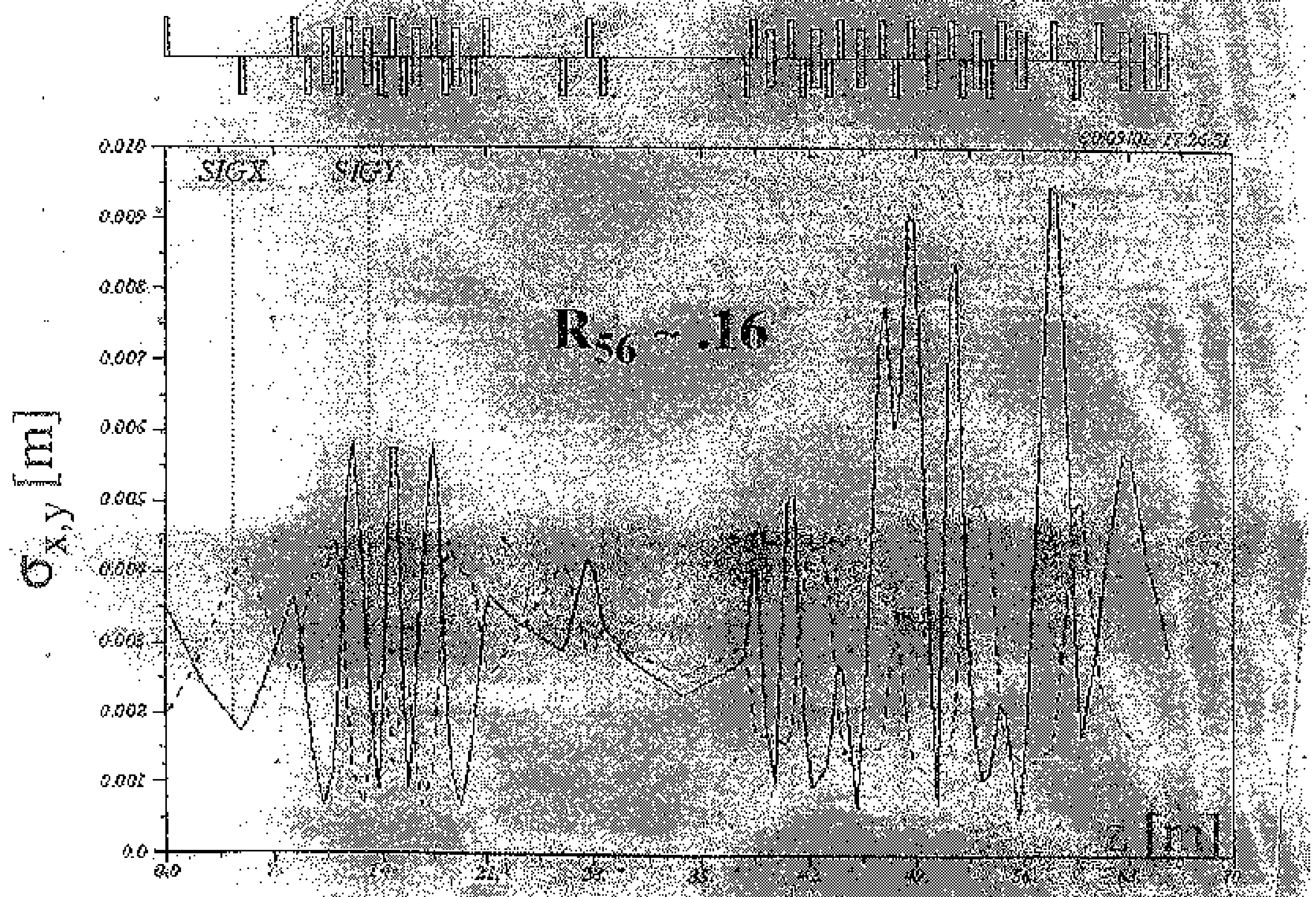
$\sigma_x = [\varepsilon_x\beta_x+\sigma_e\eta^2{}_x]^{1/2}$

$\sigma_y = [\varepsilon_y\beta_y]^{1/2}$



$R_{56} \sim 0$





Magnets Used

32 Quadrupoles
11 Bending magnets
2 Septa

Quadrupoles:

l_m = .38 m (overall .592 m)

K_{MAX} = 9.21 m^{-2} @.18 GeV
K_{MAX} = 4 73 m^{-2} @.35 GeV

Bendings:

l_m = .561 m (overall .87 m)

α = .392 rd

Bend & Septum List

	L_m [m]	Angle [rad]	Zone
DS1	.561	-.3927	4 Bends Achromat
DS2	.561	.3927	
DS3	.561	.3927	
DS4	.561	-.3927	
ID1	.561	-.4248	I Isochronous Arc
ID2	.561	-.4248	
ID3	.561	-.4248	
ID4	.561	.4248	II Isochronous Arc
ID5	.561	.4248	
ID6	.561	.4248	
SPT1	.6197	-.0349	Combiner Ring Injection
SPT2	.7122	-.3428	
DSP	.561	.3777	

Quadrupole List

	l_m [m]	$K l_m$ [m^{-1}]	Zone
Q1	.38	.29	From Linac
Q2	.38	.26	
Q3	.38	.82	
Q4	.38	.43	
KQS1	.38	- .99	4 Bends Achromat
KQS2	.38	1.89	
KQS3	.38	1.84	
KQS4	.38	1.89	
KQS5	.38	- .99	
KQS6	.38	- .79	
KQS7	.38	- .79	
KQDL	.38	-.36	
KQDL1	.38	.70	
KQDL2	.38	-.31	Delay Loop Insertion
KQDL3	.38	1.49	
KQDL4	.38	-.33	
KQDL5	.38	-1.55	
KQDL6	.38	2.28	
KQF(1)	.38	1.85	I isochronous arc
KQD(1)	.38	-.67	
KDDQ1	.38	1.18	
KDDQ2	.38	-1.31	
KDDQ3	.38	1.15	
KQF(2)	.38	1.668	II isochronous arc
KQD(2)	.38	-.60	
KSPQ1	.38	.95	Combiner Ring Injection
KSPQ2	.38	-.79	
KSPQ3	.38	.48	

Conclusions

* The CTF3 Transfer Line has been completely designed up to the Combiner Ring, and some of its parts can be used for the line joining the RF power source.

* satisfies the CTF3 spatial general layout

* reuse the EPA magnets

* match the ring insertions

* satisfies the first order isochronicity

* keeps low the value of the Twiss functions

* Two schemes have been studied for an achromat insertion able to tune R_{56} in the $\pm$ .16 [m] range.

* The S-shape section is also tunable in terms of R_{56} always in the $\pm$ .16 [m] range.

Next

* further optics optimization

* complete the Combiner Ring extraction line

* fix the bunch diagnostic tools and their position

* vacuum chamber definition and project

* study the impact of the higher order terms on the beam dynamics