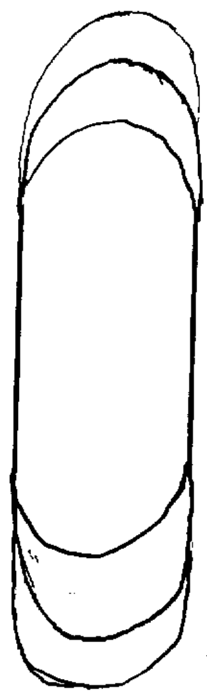
1ST RECIRCULATING LINAC



--Two 200-m Linacs

--Passive beam spreader

--Multiple arcs

CONSTRAINTS:

ε_{rms} (normalized) = 3200 π mm-mrad

Central Momentum (GeV)	dp/p (3σ)	Momentum Spread (GeV)
2	12%	1.760-2.240
4	7.9%	3.685-4.315
6	6.5%	5.610-6.590
8	5.8%	7.535-8.465
10	5.4%	9.460-10.54

GENERAL DESIGN CONSIDERATIONS
(stream of conciousness)

1. Large transverse beam size

@4 GeV, $3\sigma = 9$ cm for $\beta = 10$ m

need continuous quadrupole fields for a round beam, minimal betas ⟹ combined function 90 deg cells--lowest energy arc

2. Large momentum spreads

strong sextupoles, 2^{nd}-order achromat ⟹ 90 deg cells--lowest energy arc

3. Dispersion suppression/matching between linacs and arcs

forget it, far off-momentum orbits do not close

automatic dispersion suppression/ beta-function matching into linac ⟹ integer phase phase advance across arcs*

*implies symmetry point at exit of beam spreader

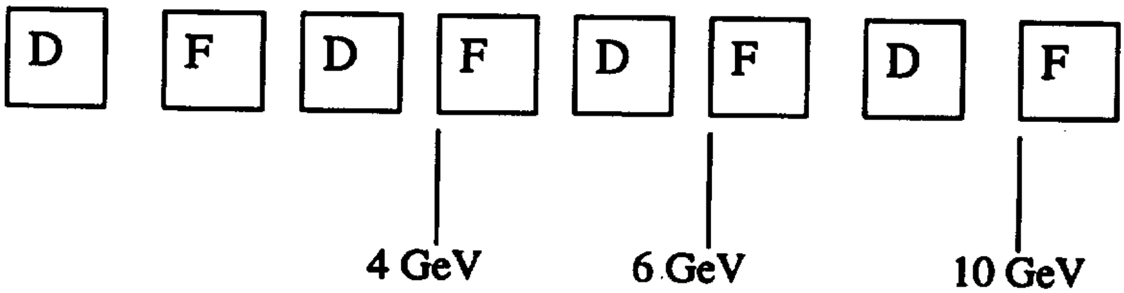
4. Large off-momentum beta matching arc/linac

preserve arc focal length through linac

BEAM SPREADER

The beam spreader is so difficult and constraining it dictates the entire lattice of the RLA.

1. To minimize (ha-ha) apertures in the spreader, a single energy is split off at a time into its separate channel:



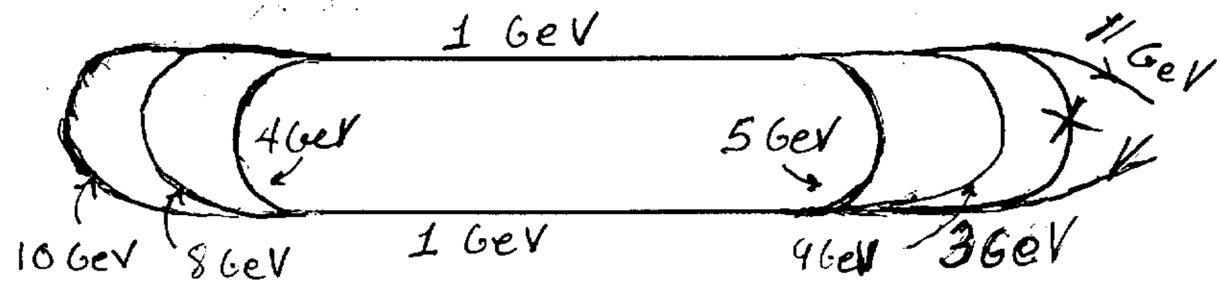
2. The "unseparated" channel must contain the remaining spread in momenta: 6-10 GeV, then 8-10 GeV. The large momentum spreads in each channel result in large apertures in order to contain the remaining combined channels as the distance required to accomplish the split is achieved.

3. The large apertures and required focussing gradients conspire to drive the some of the beam spreader magnets superconducting.

3. The separate channels are defined to be when the highest energy in the channel to be split is .4 m from the lowest energy in the next channel. To achieve this separation, given the table of momentum spreads, results in magnet lengths 1.5-2 m for the above spreader. To keep the beta functions in the arc matched to the spreader, the arc combined function magnets are the same length and gradient as the spreader. (Gradients in separated spreader channels are varied slightly to achieve symmetry points at the start of the arc.)

THE MULTIPLE ARCS

1. To generate an integer spread across the separate channels with no matching, requires the gradient to go as 1/p and the arc energies to follow a sequence: 4, 6, 8 with 2 GeV/turn for 90 degree phase advance @4 GeV and 24 cells. Then the injection energy must be 3 GeV, for 2 GeV would be unstable. The last arc at 10 GeV has to be gently tuned to an integer (over 20 cells)*

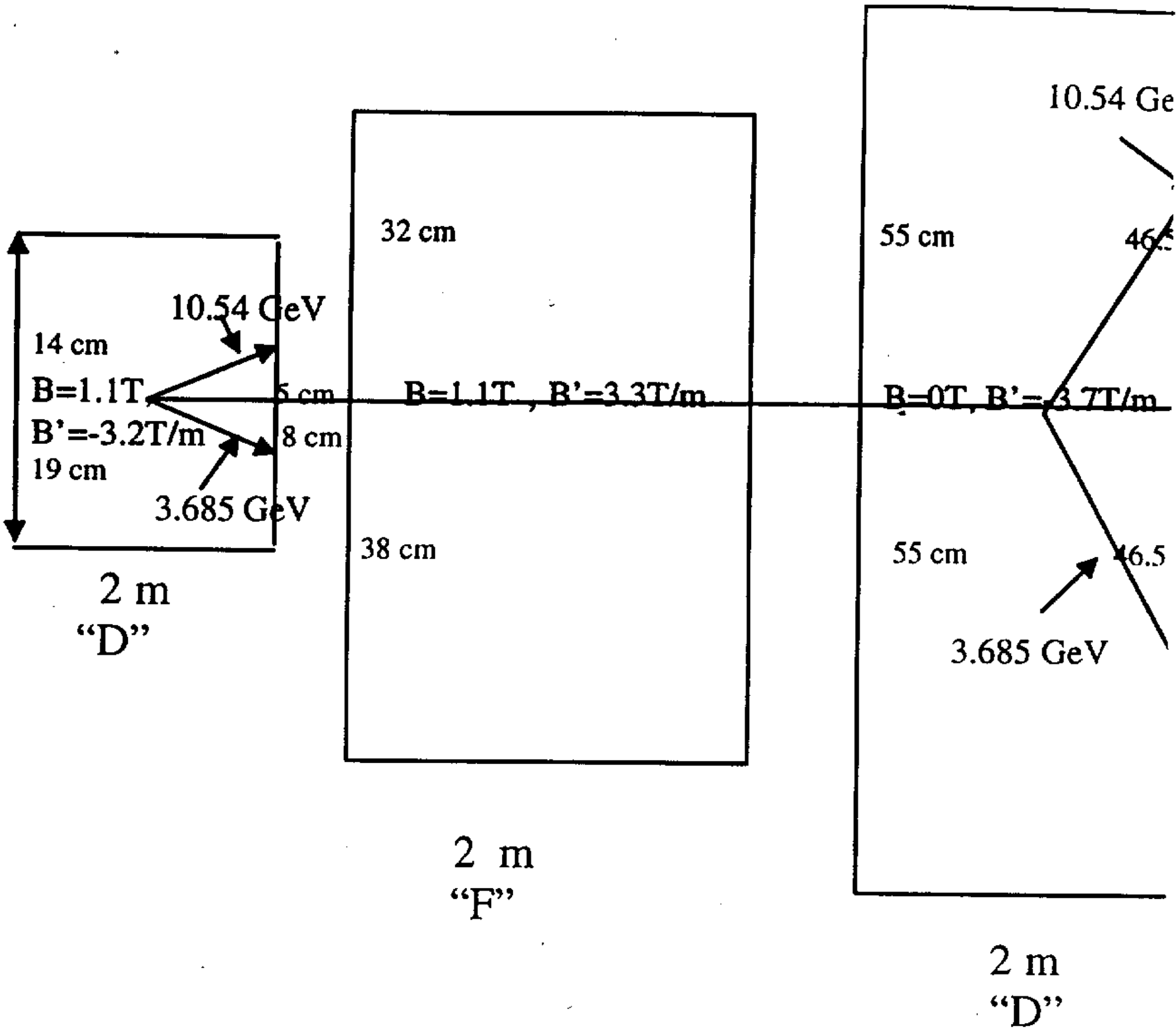


*The 5,7,9 arc also has to be slightly adjusted in overall gradient.

2. In order to keep the arcs from ending up in the buffalo pasture, they are nested with equal arc lengths. This is particularly important for superconducting arcs where interleaving would require incredible spacings per arc.

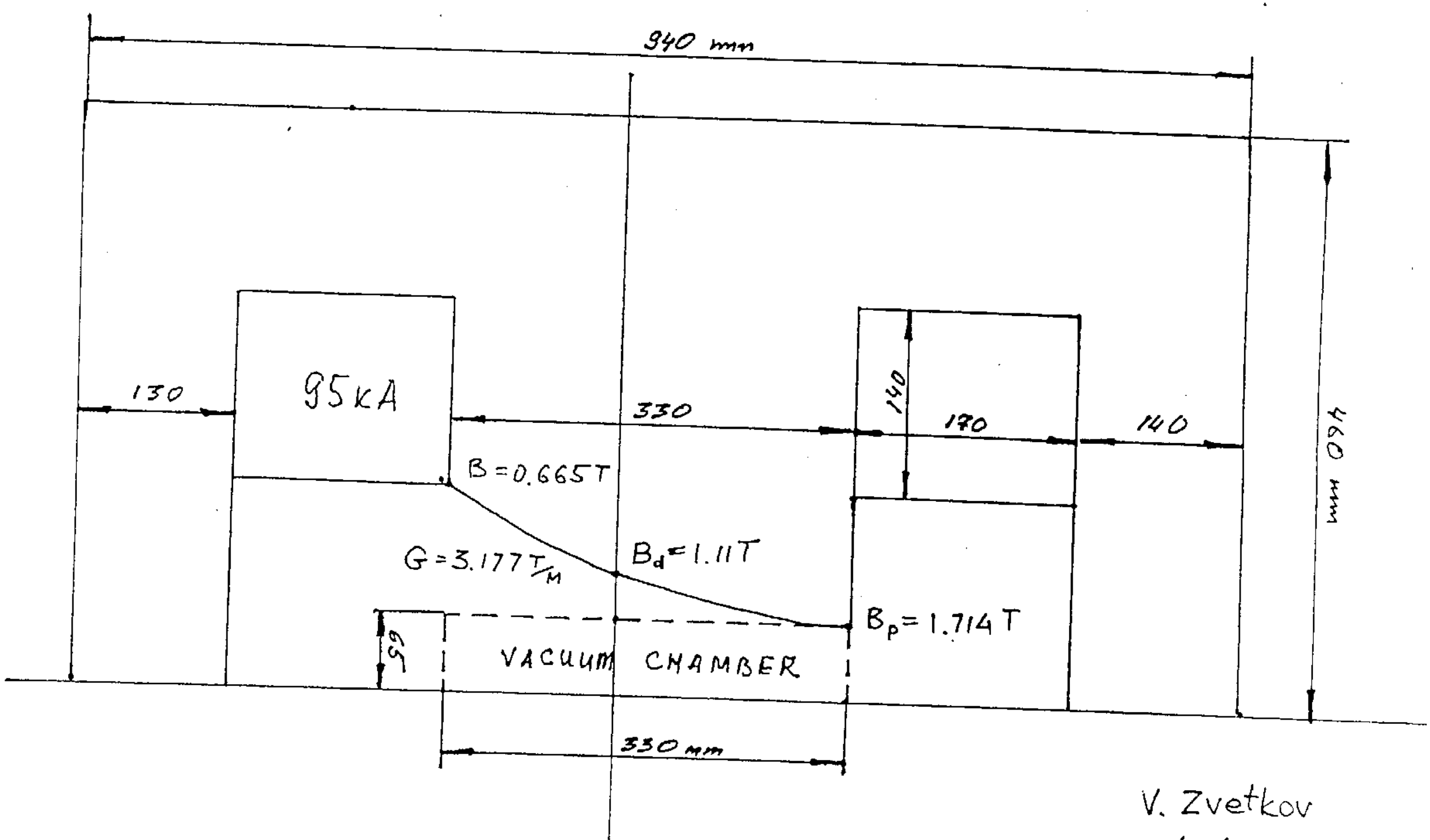
2. The beam spreader sets up an unavoidable, but periodic dispersion wave throughout the arc. Sextupoles are introduced once the channels are separate to flatten the momentum compaction over the momentum spread.

THE 4-GEV SPLITTER



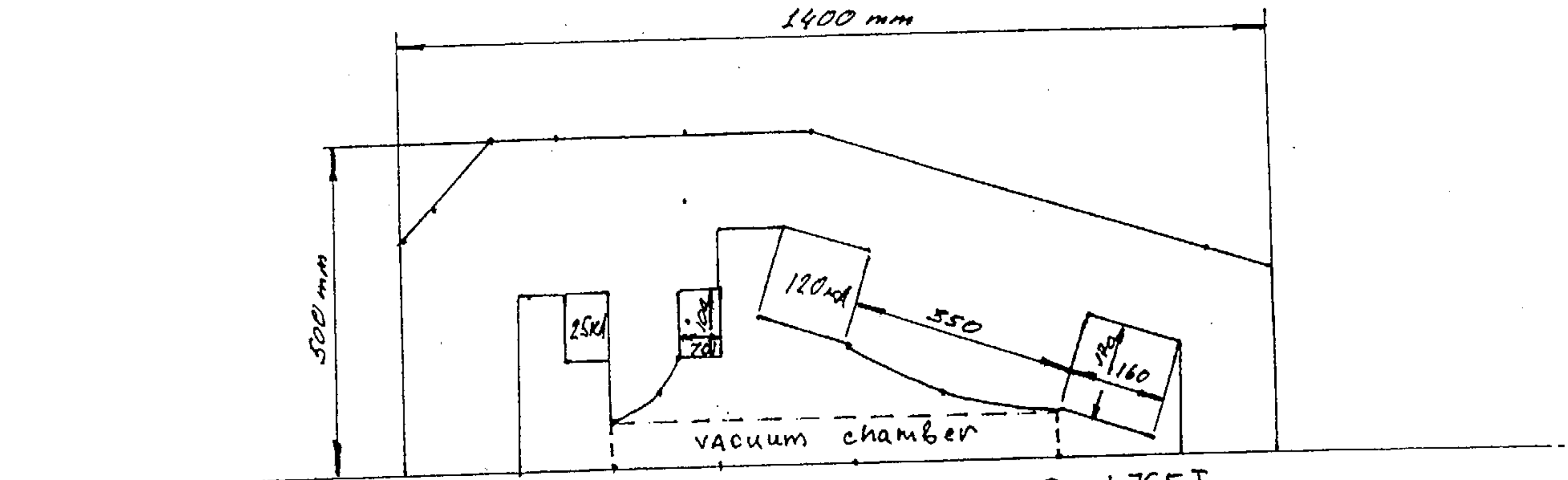
Vertical Aperture: 13 cm

½ Magnet N1.



V. Zvetkov
2/14/00

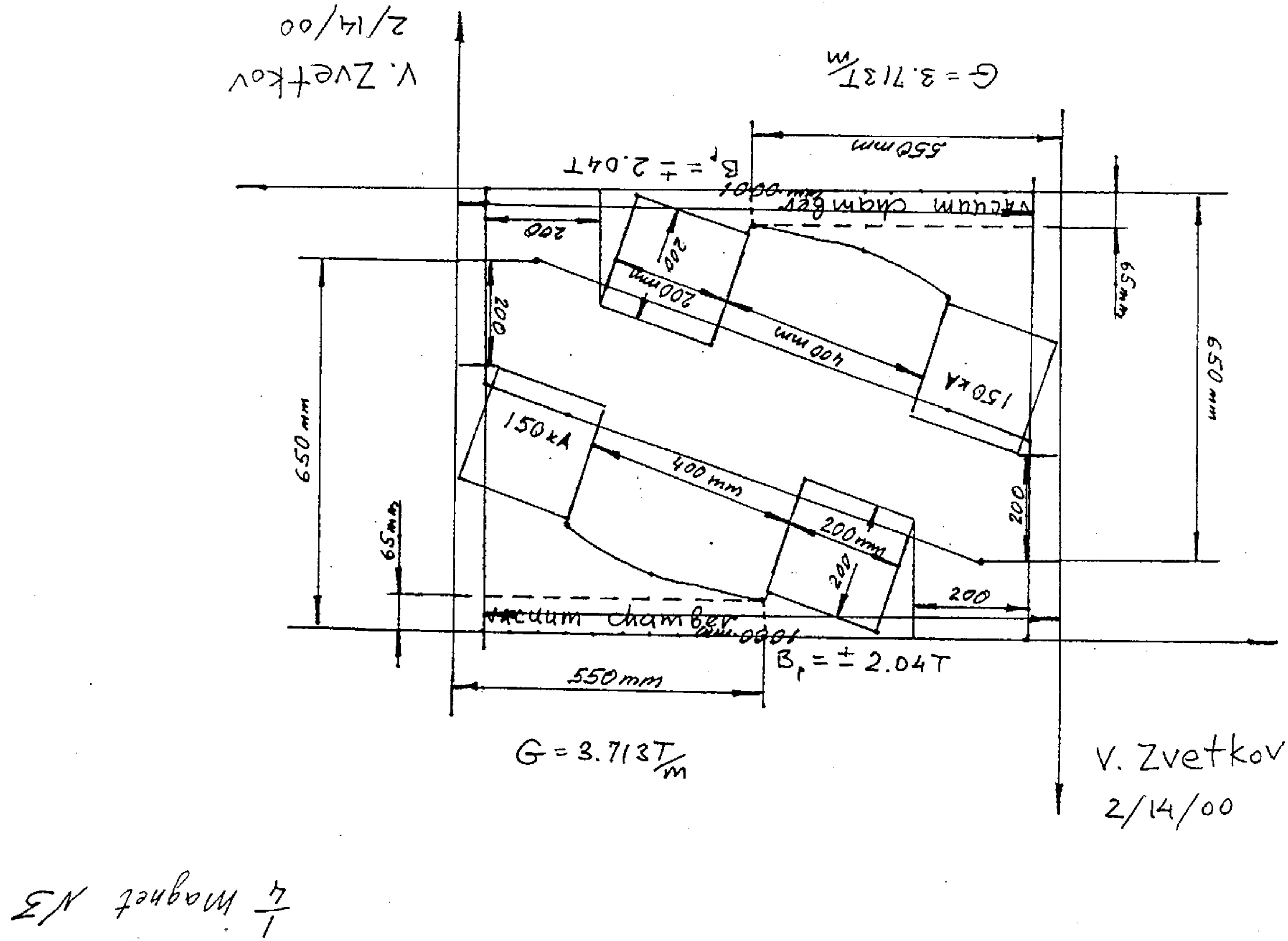
½ Magnet N2.

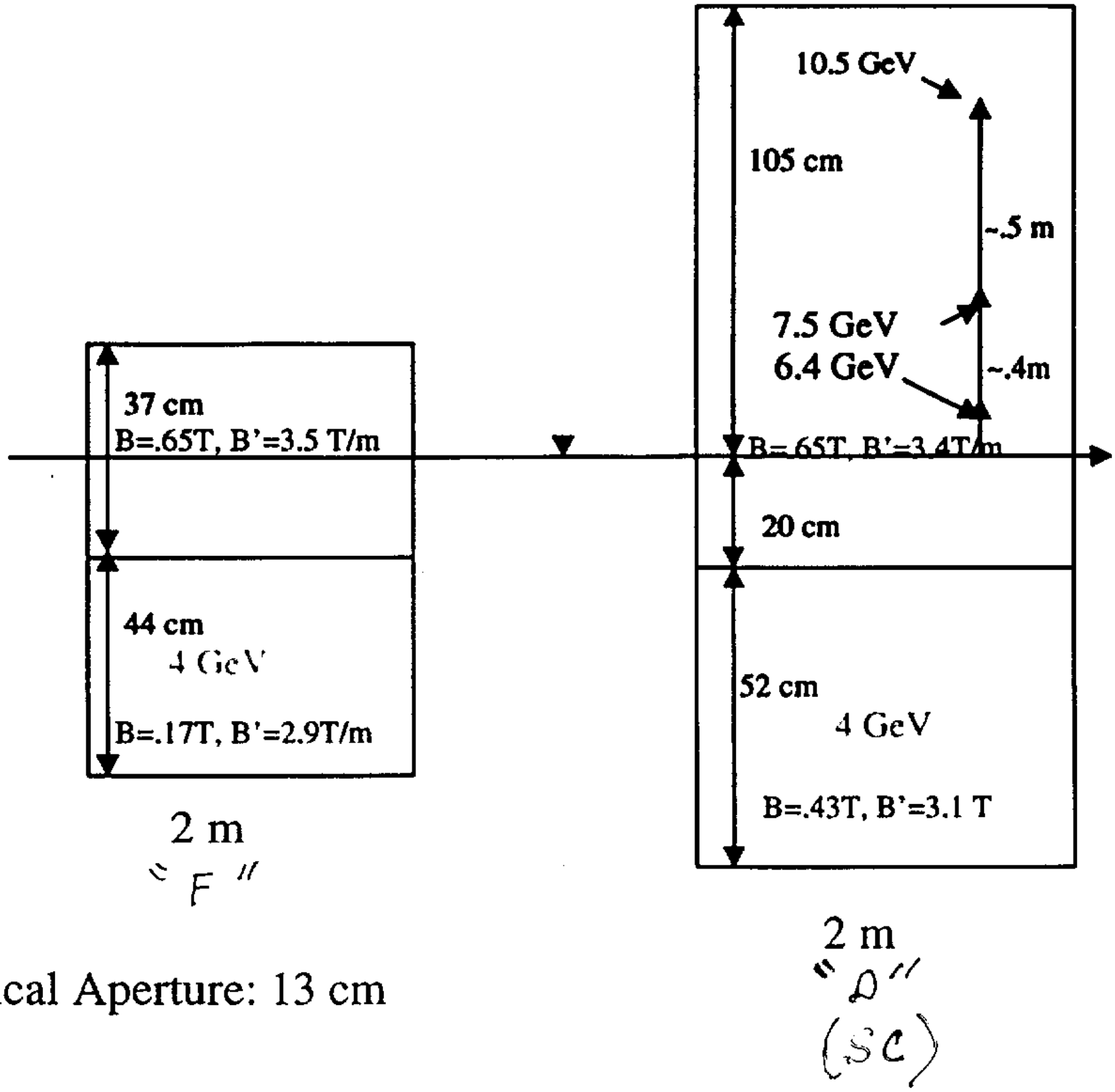


G = 3.329 T/m

Y. Zvetkov
2/14/00

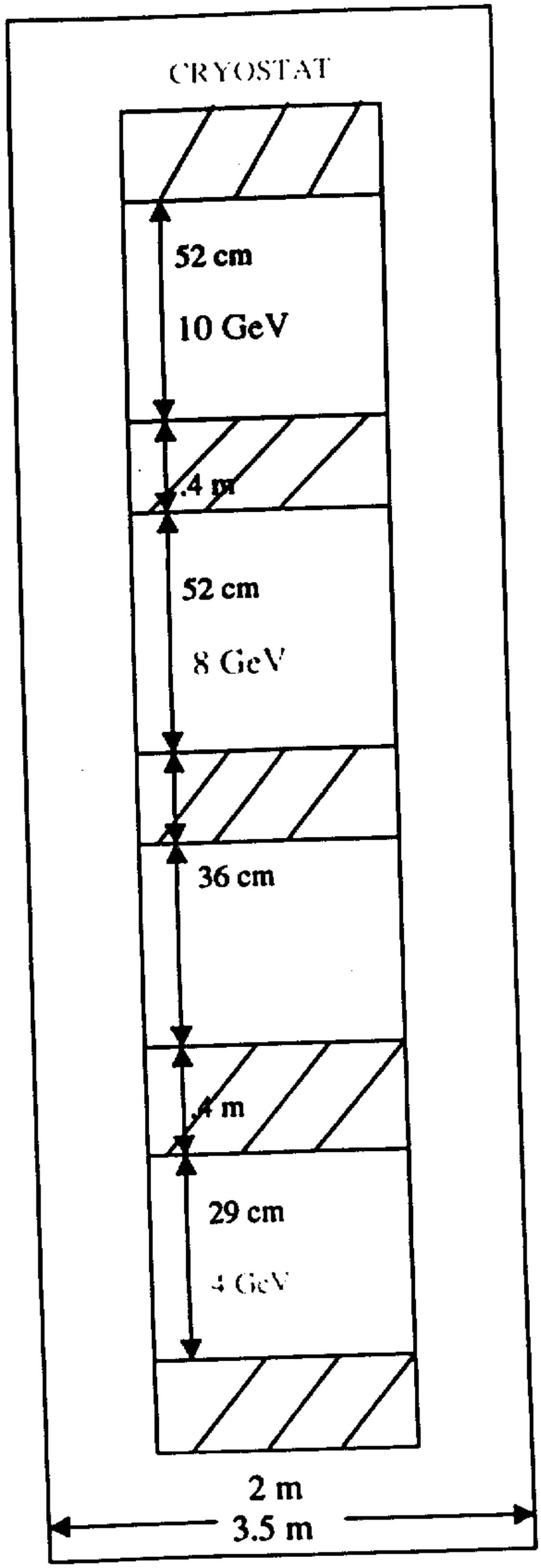
$\frac{1}{4}$ Magnet N3





Vertical Aperture: 13 cm

ARC MAGNETS



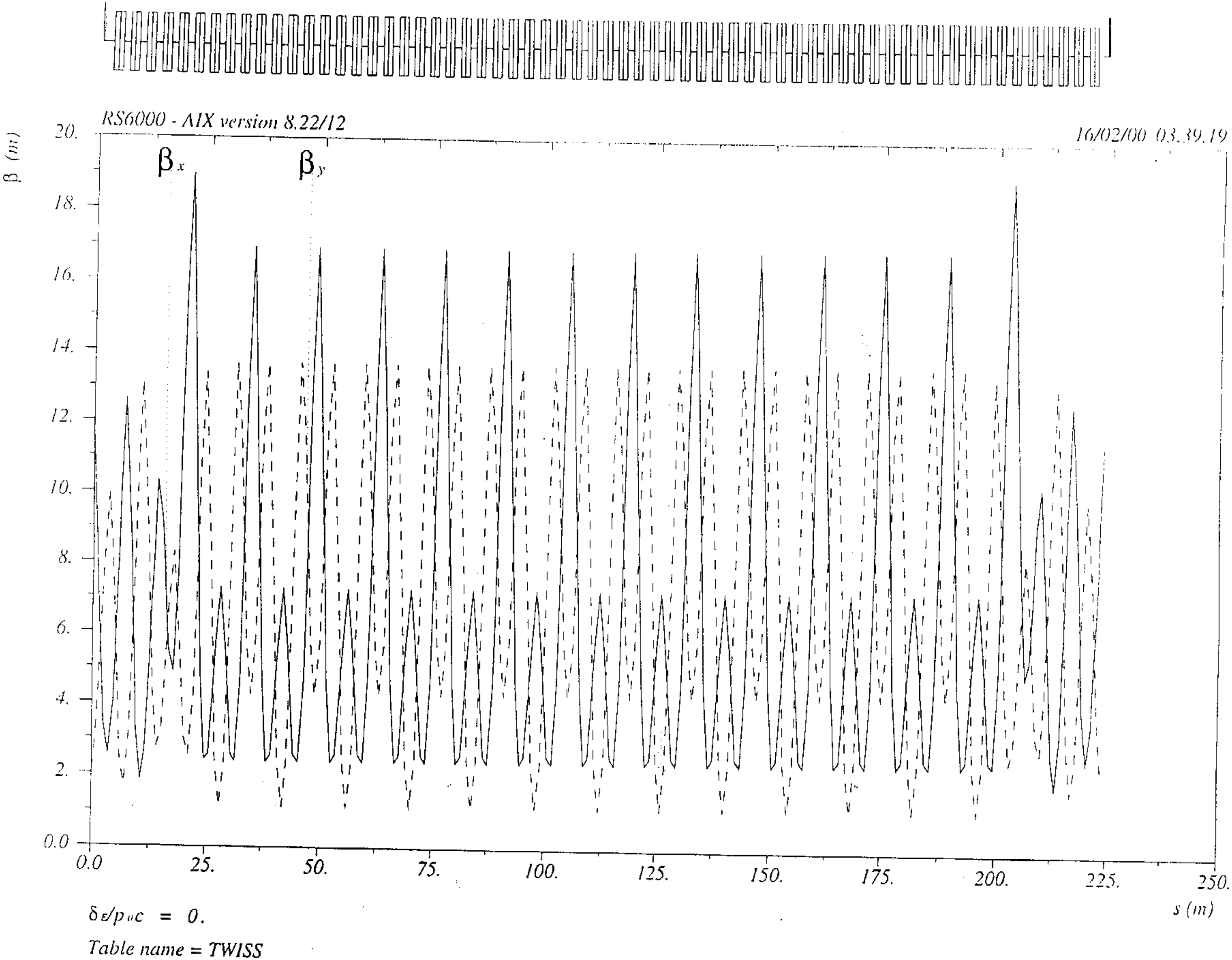
Vertical Aperture: 13 cm

B = .3T *p/4*

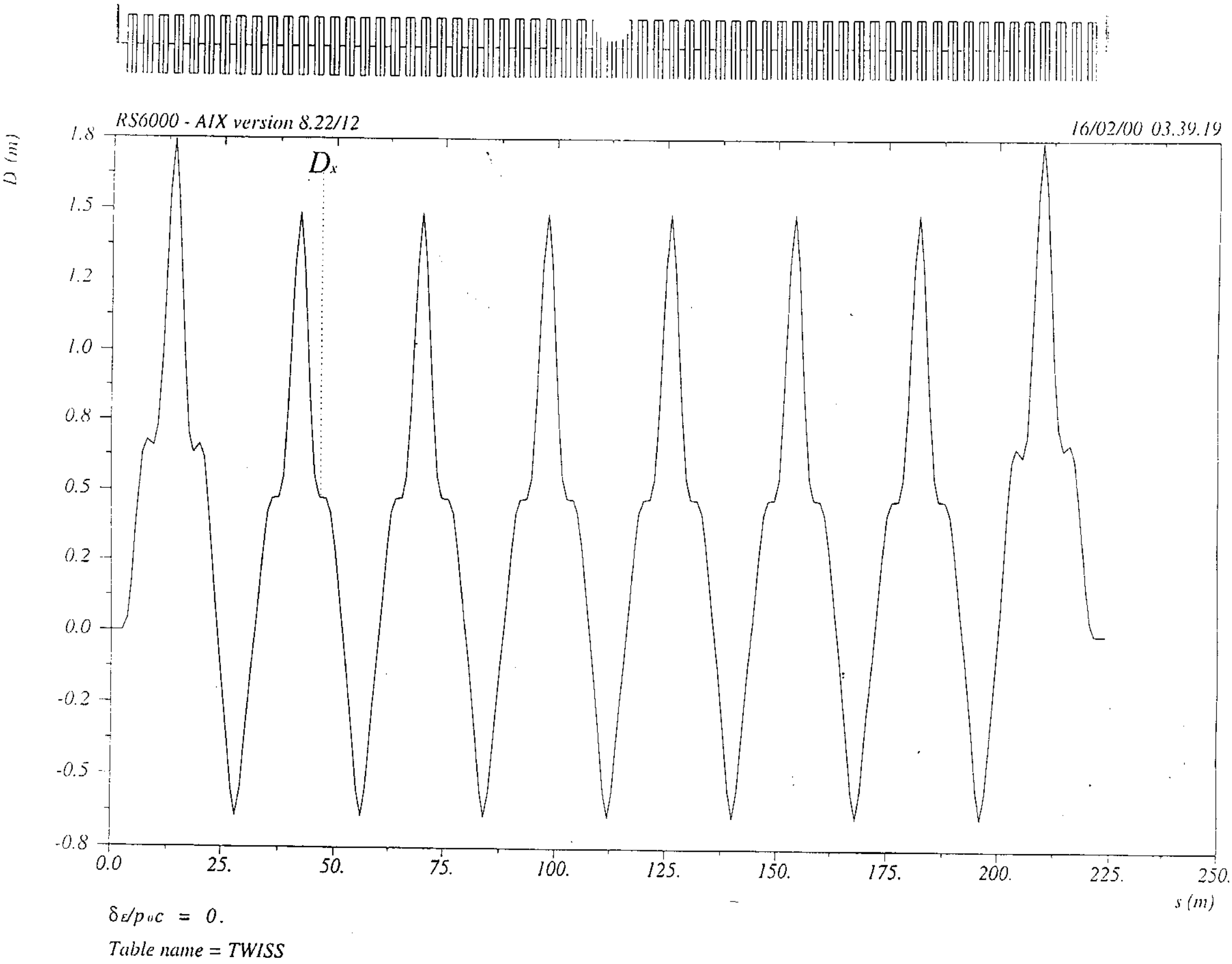
B'~ 3.6 T/m

* chosen to achieve $\alpha = .002$ for 1/2 arclength of 225m

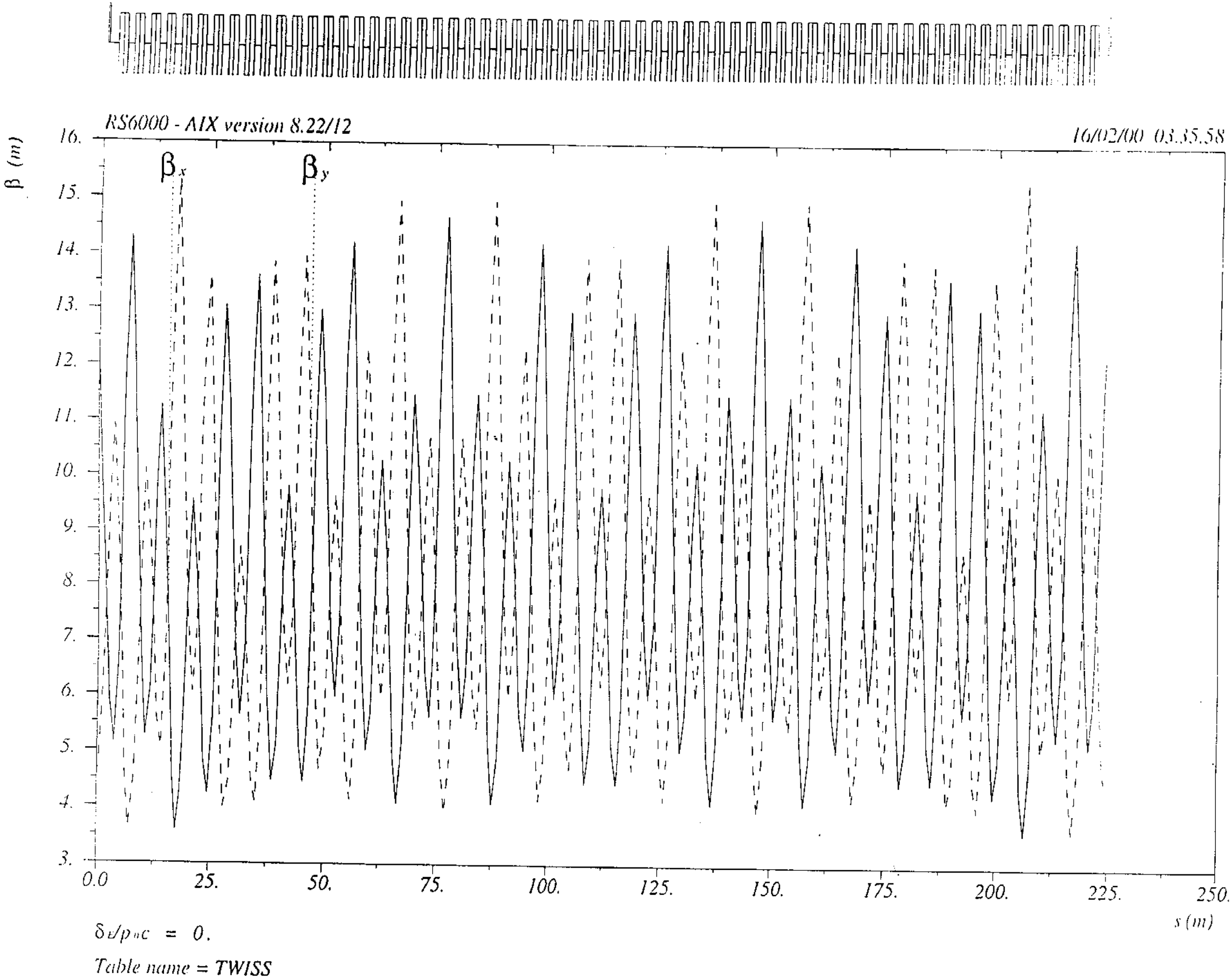
TOTAL ARC LENGTH: 450 m



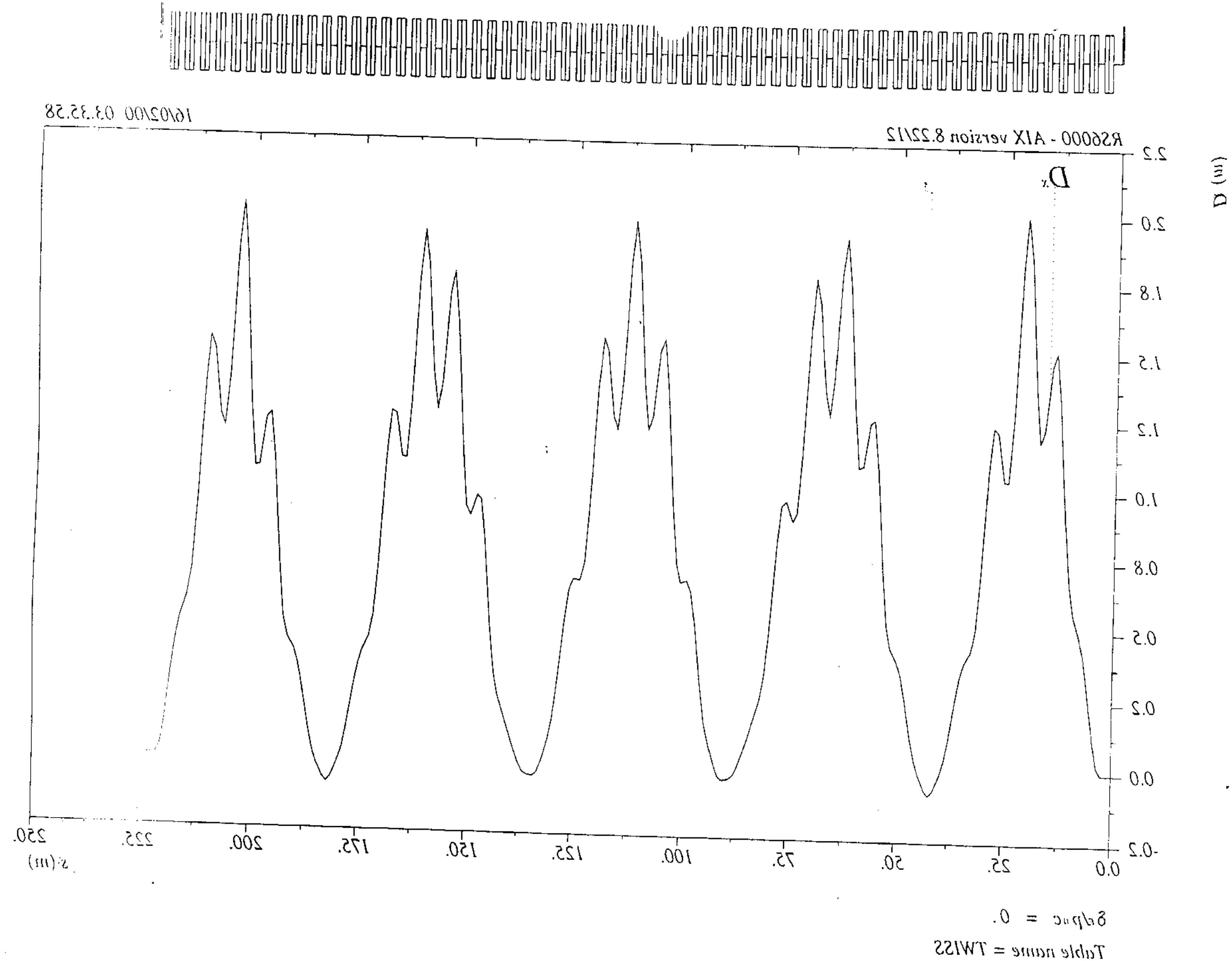
4 GeV ARC : β FUNCTIONS

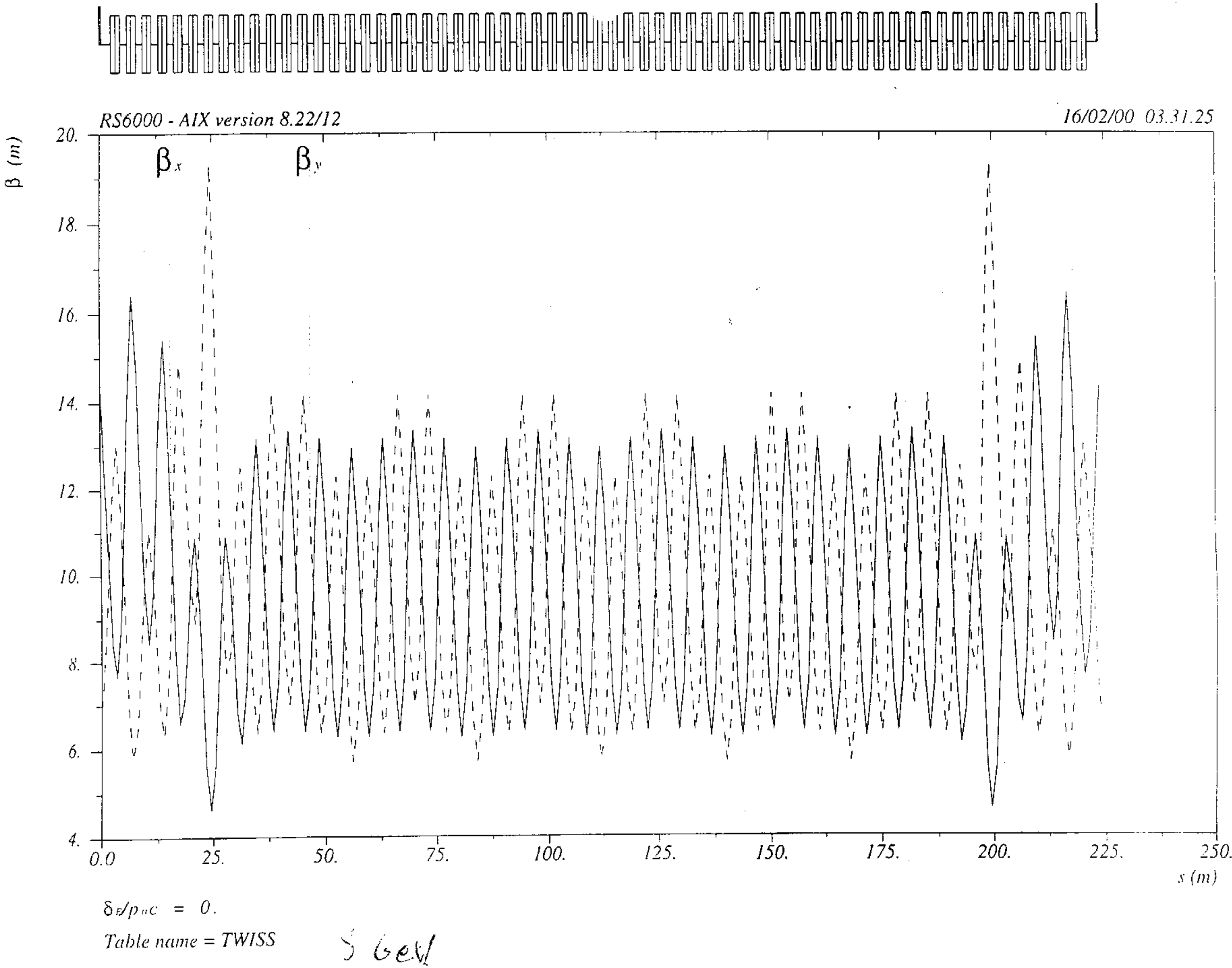


4 GeV ARC: DISPERSION WAVE



RS6000 - AIX version 8.22/12
16/02/00 03.35.58
β (m)
β_x
β_y
16.
15.
14.
13.
12.
11.
10.
9.
8.
7.
6.
5.
4.
3.
0.0
25.
50.
75.
100.
125.
150.
175.
200.
225.
250.
s (m)
δ_E/p_0c = 0.
Table name = TWISS


16/02/00 03.35.58
RS6000 - AIX version 8.22/12
D (m)
D_x
s (m)
δp/p0 = 0.
Table name = TWISS



RS6000 - AIX version 8.22/12
16/02/00 03.31.25
β (m)
βx
βy
20.
18.
16.
14.
12.
10.
8.
6.
4.
0.0
25.
50.
75.
100.
125.
150.
175.
200.
225.
250.
s (m)
δE/p0c = 0.
Table name = TWISS
5 GeV

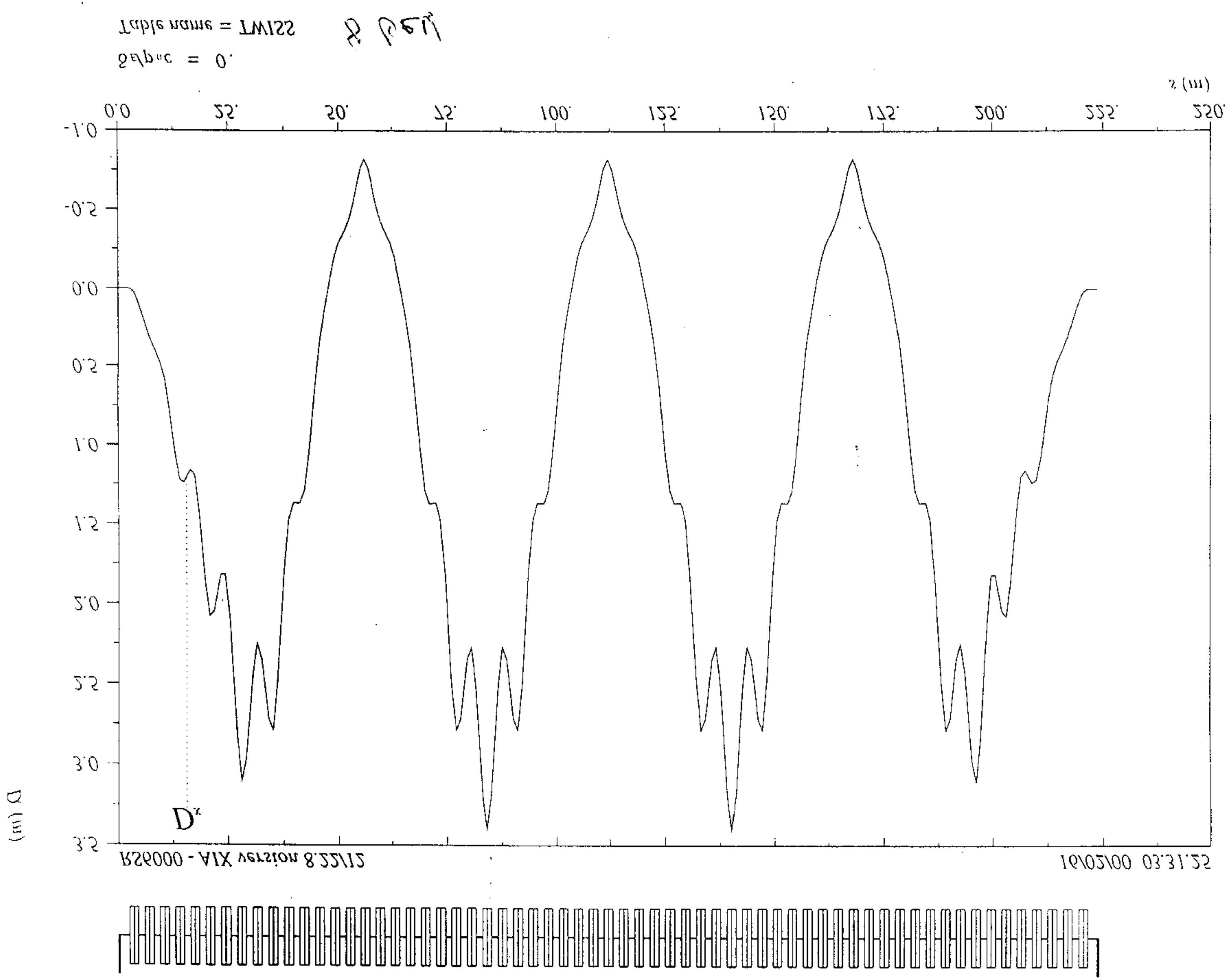
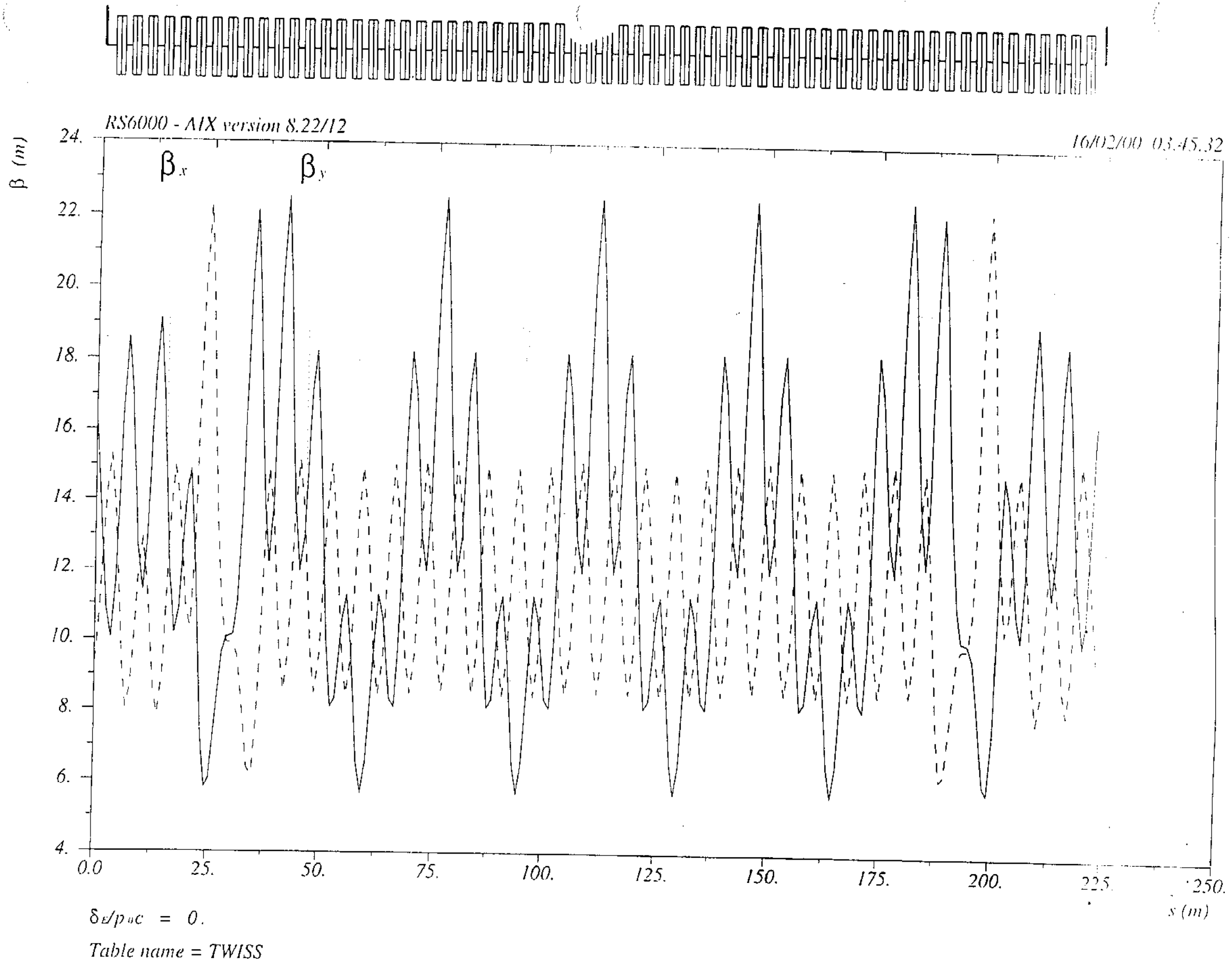
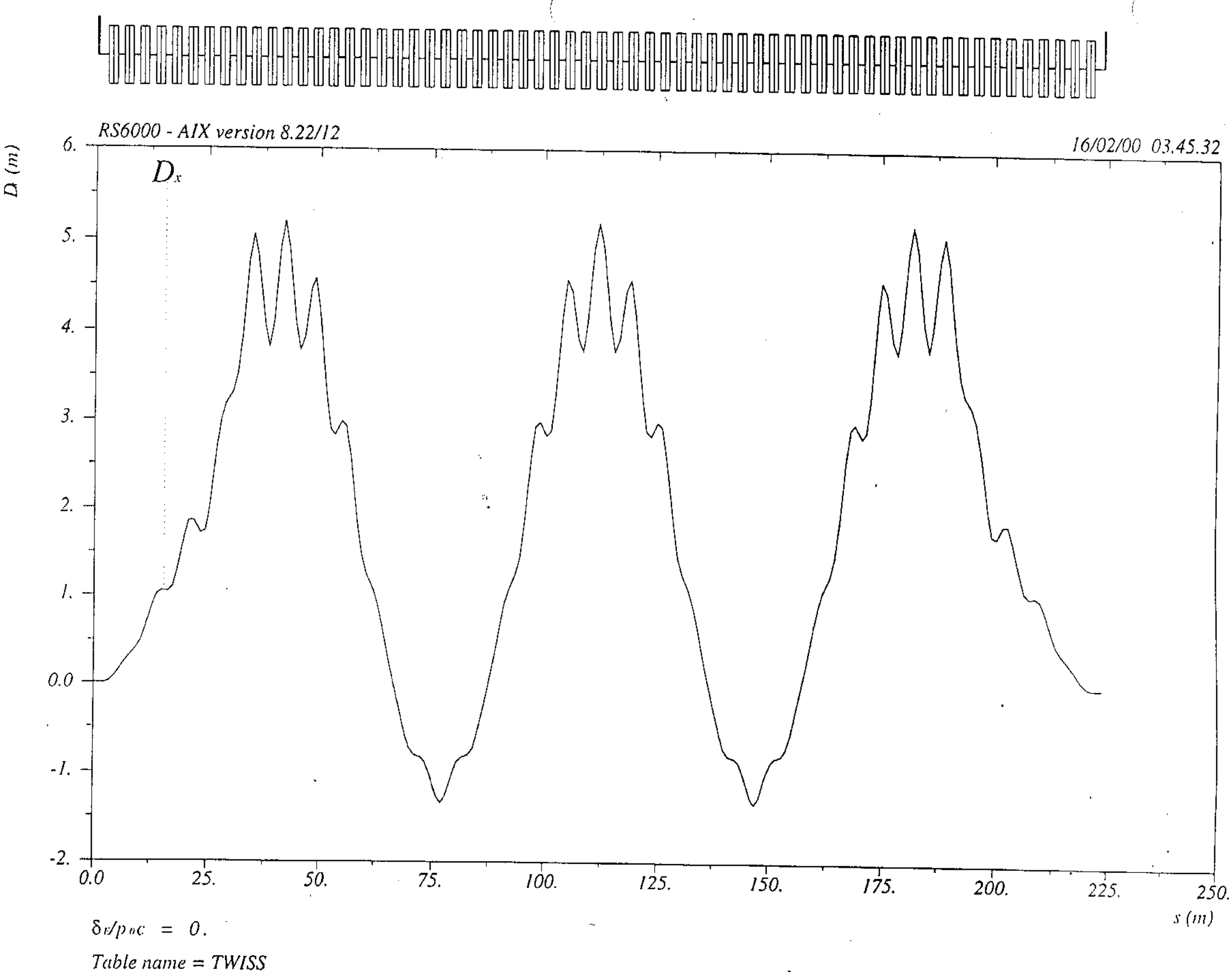


Table name = TWISS
δp/c = 0.
s (m)
D (m)
Dx
RS6000 - AIX version 8.22/12
16/02/00 03.31.25



10 GeV ARC: β FUNCTIONS



10 GeV Arc : Dispersion Wave

R&D

Everything:

Magnet design: conventional appears ok, but superconducting spectrometers with meter horizontal apertures?

Extensive tuning—particularly sextupoles for off-momentum matching

Tracking with kinematical effects and fringe fields (COSY)

Polarization survival?

Dynamic aperture and error analysis