PS/AA/BA/afm

25 October 1982

AA LONG TERM NOTE 20

Summary of the meeting of October 19, 1982

Present : B. Autin, V. Chohan, T. Dorenbos, S.X. Fang, W. Hardt, H. Haseroth, C. Johnson, E. Jones, H. Koziol, M. Martini, C. Metzger, S. Milner, G. Nassibian, K.H. Reich, G. Schneider, J.C. Schnuriger, R. Sherwood, C. Taylor, S. van der Meer, E.J.N. Wilson

Topic : A Lattice Principle for the Antiproton Collector, by W. Hardt

The attached note explains how a lattice composed of sets of nine 60 degree phase advance cells can have a variable γ-transition without altering the tune values nor the zero dispersion in special straight sections. An application is made to the AC lattice having a race track or a triangular shape.

B. Autin

A LATTICE PRINCIPLE FOR THE ANTIPROTON COLLECTORS

W. Hardt

Ten years ago a device changing the momentum compaction α without Q-change was implemented in the PS[1)]. The basic elements are quadrupole-doublets placed at F-sections π apart in phase advance and of opposite polarity, but with the same modulus of the dimensionless strength $|q| = \beta \int |K| ds$. They leave the beta function unperturbed. The change of beta inside this doublet can easily be described by $x = \tilde{\beta}/\beta$ which follows :

$$\frac{1}{2} x\ddot{x} - \frac{1}{4} \dot{x}^2 + x^2(1 + q.\delta(\psi_K)) = 1 \quad . \qquad (1)$$

$\delta(\psi_K)$ described the short lens approximation $\dot{x} = dx/d\psi$; $\tilde{\beta}$ = the new β ; ψ = phase advance. The solution of eq (1) in the $(x,\dot{x}/2)$ plane is a circle centered at $x = 1 + q^2/2$ and intersecting the $\dot{x}/2$ axis at $\pm q$ for $x = 1$. See Fig. 1.

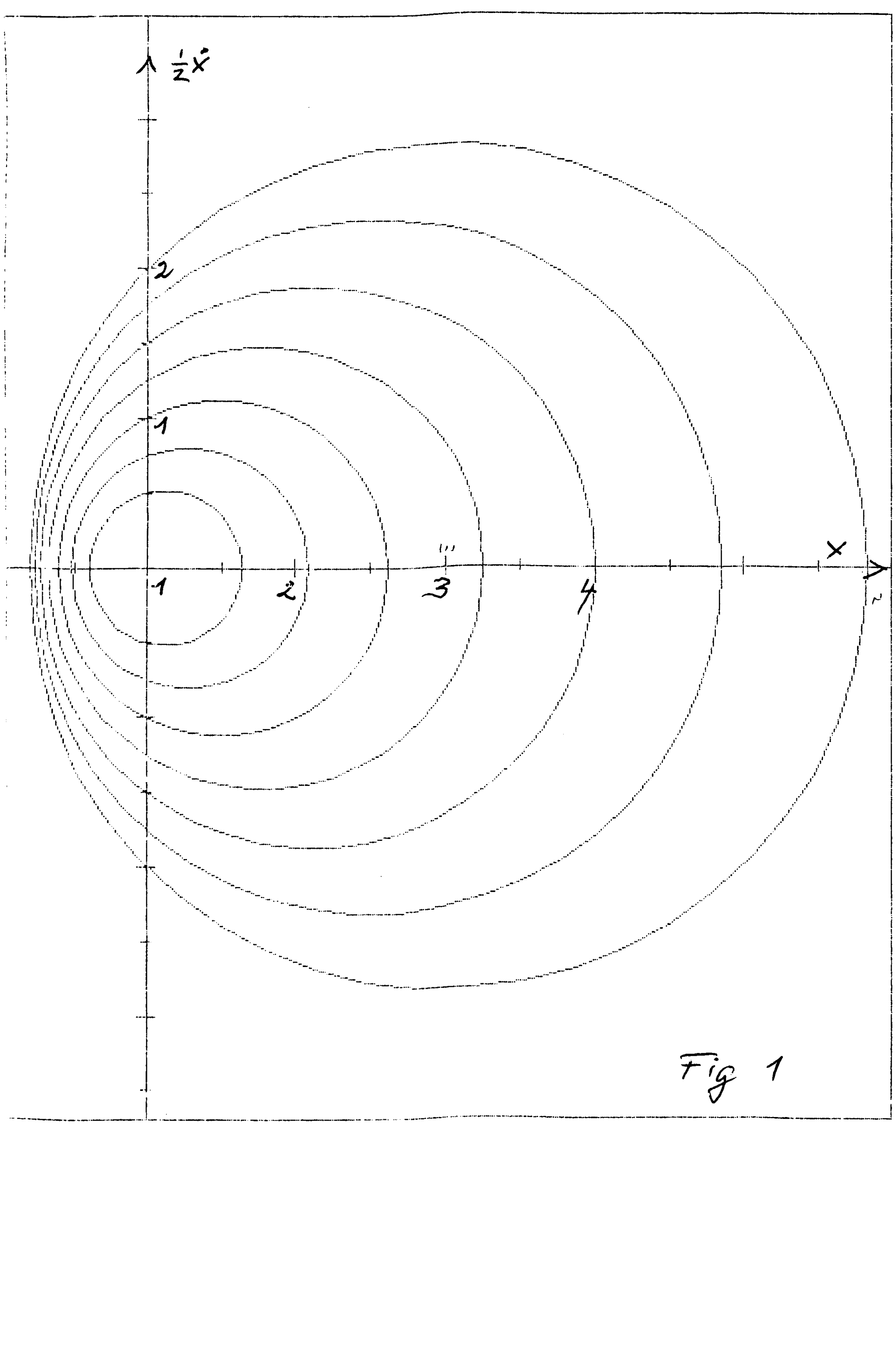

Fig 1

We suppose that the conditions for π phase distance and strength q can simultaneously be met for the vertical and the horizontal motion, but the horizontal motion is more important since anyway only F-lenses will be powered where β_H is large and β_V is small.

The effect of the doublet on the dispersion function D is conveniently described by the Floquet-transform ξ of ΔD :

$$\xi = \frac{\sqrt{\beta\pm}}{D\pm} \frac{\Delta D}{\sqrt{\beta}}$$

for which holds

$$\ddot{\xi} + \xi = -q_K(1 + \xi)\delta(\psi_K) \quad . \tag{2}$$

Ignoring for a moment what happens inside the doublet, the $\Delta\dot{\xi}$ experienced by the two lenses add up and the $\xi(\psi_K)$ is perturbed everywhere. But we can exploit the fact that the $\bar{p}$-collector has dispersion-free sections. When arranging two consecutive doublets such that their neighbouring lenses are spaced by π in phase advance and their extreme lenses are in dispersion-free regions we have established an element with the following properties. (See fig. 2 for the second part of this element).

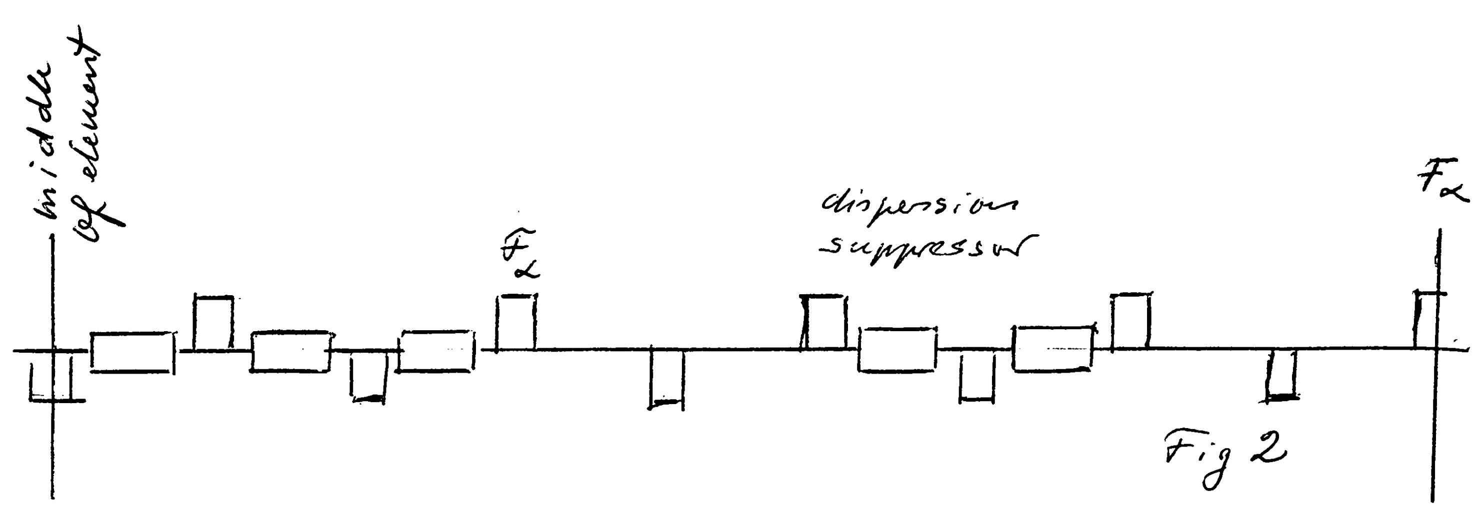

Fig 2

(i) length in phase 3π.

(ii) beta changes only in the first and the last doublet.

(iii) dispersion change only in the middle, where, of course, are the bends.

(iv) α-change linear with q so that we can adjust for bunch rotation by say a modest $\Delta\alpha > 0$ (if $\gamma_{t_0} > \gamma_{AA}$) and change to a fairly large $\Delta\alpha < 0$.

Fig. 3 shows a ring with three of those elements and the required polarities of the 9 active F-lenses.

In order not to sit at Q = 4.5 we would have to depart a little from $\mu = \pi/3$. The P.U. kicker distance can be made an odd multiple of $\pi/2$ by shifting the respective elements 3-half-periods up or down stream. There are 3 of those half-straight section pairs.

Of course, the possibility is open to make a race track with 2 of those elements. Since the number of magnets would be only 20 instead of 30, the magnet length and thus the cell length would have to be longer so that the race track would consist of 20 periods.

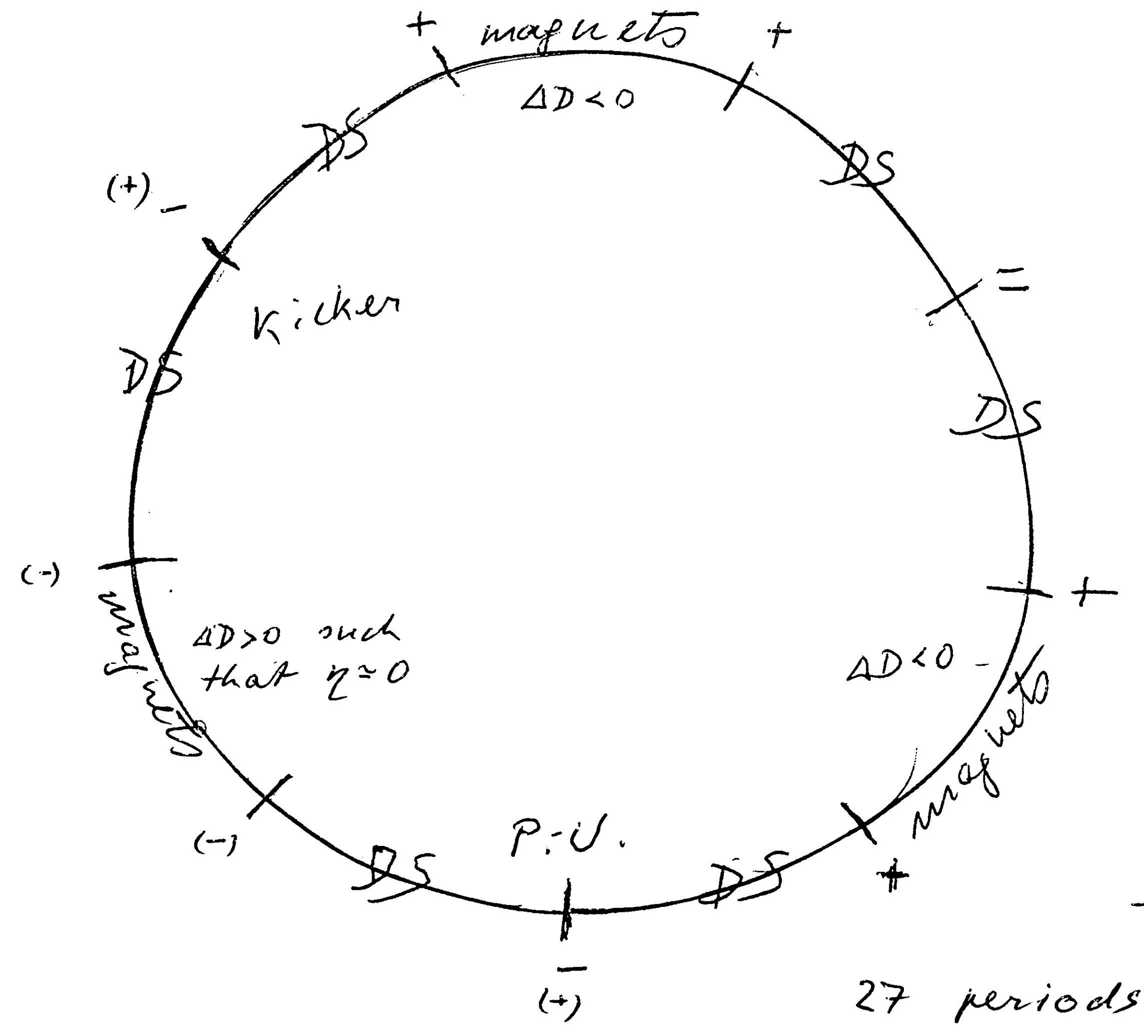

Fig 3

27 periods

Some parameters are given for a triangle ring and a race track :

	Race track	Triangle-ring
Number of α change elements	2	3
Number of periods	20 = 2(9 + 1)	27 = 3×9
Length of magnet fôr B = 1.6 T	2.3 m	1.53 m
Length of cell	7.85 m	5.82 m
Strength of normal cell quadrupole	3 T	4 T
β_{max} expected	13.6 m	10 m
D_{max} expected	5.8 m	4 m