ISTITUTO NAZIONALE DI FISICA NUCLEARE
Laboratori Nazionali di Frascati

LNF-78/54(R)
28 Novembre 1978

A. Turrin: PRELIMINARY ANALYSIS OF STEFFEN'S MAGNET ARRANGEMENT FOR A SIBERIAN SNAKE WITH SMALL ORBIT DISPLACEMENT.

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A Siberian Snake configuration with small orbit displacement has been proposed recently by Steffen(1). This configuration is represented in Fig. 1. In the present note we give the expression for the corresponding effective precession wave number, ν, of the polarization vector as a function of the beam energy, E. (To do this, we have used 2-component spinor algebra(2)). The same notation as that used by Montague(2) is adopted throughout. The conclusion is that this configuration, when rotated by $\pi/2$ around the y (velocity) axis, can be used as a very efficient fixed-geometry snake.

We first consider the snake configuration as originally proposed by Steffen. We find that the extrema for the half trace $\cos(\pi\nu)$ of the transfer matrix around one revolution are given as a function of E by the equation

$$\left|\cos(\pi\nu)\right|_{extr} = \sqrt{A^2 + B^2} ,$$

where

$$A = c^2(8)\,c^2(4) + c^2(8)\,s^2(4)\,c(2) - s^3(4)\,s(2) + $$
$$+ s^2(8)\,c^2(4)\,c(2) + s^2(8)\,s^2(4)\,c(1) ,$$

and

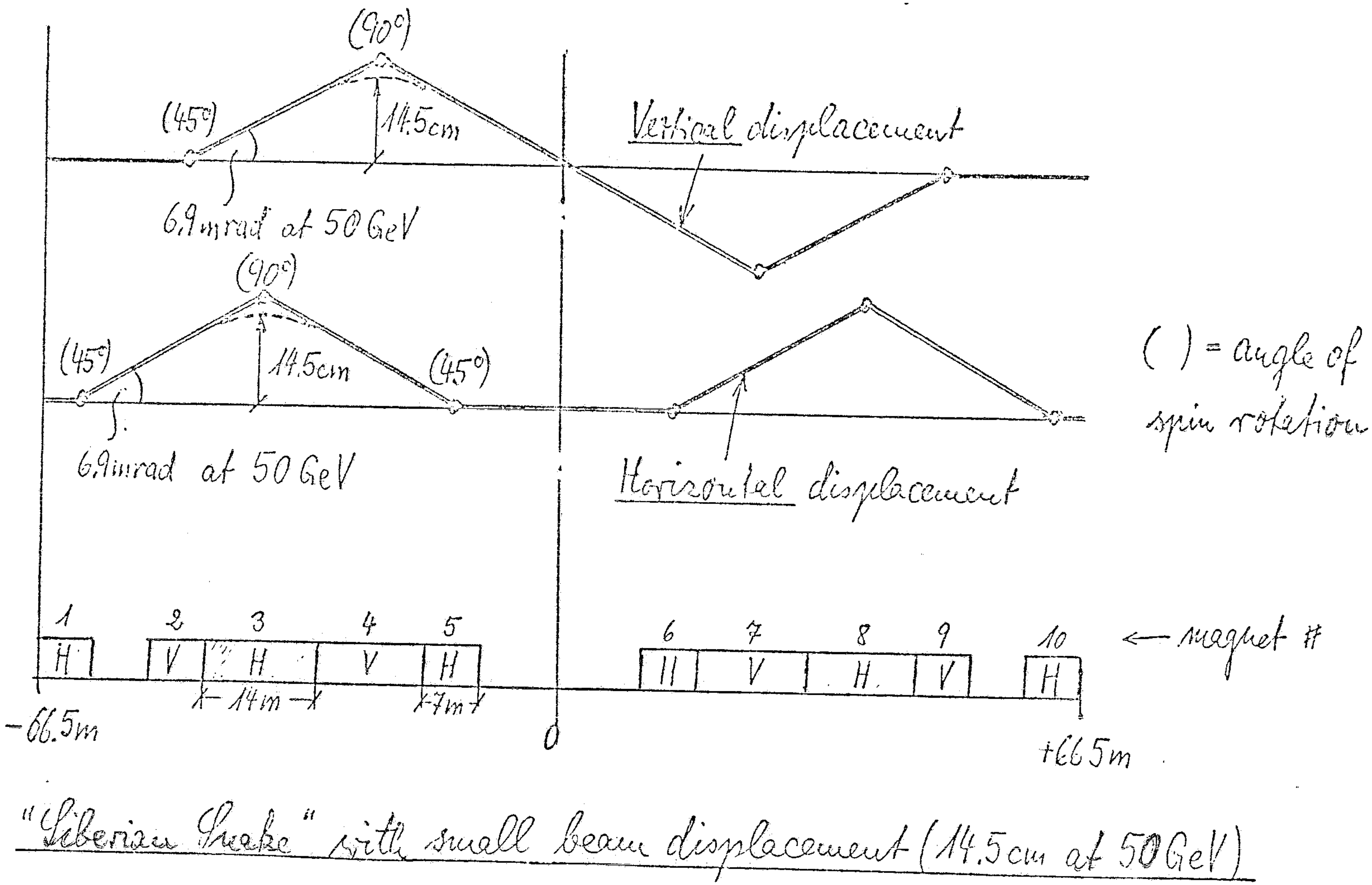

FIG. 1 - Siberian Snake configuration with small beam displacement, as originally proposed by Steffen (Ref. (1)).

$$B = c^2(8)\, s^2(4)\, s(2) - s^2(4)\, c(4)\, s(2) +$$
$$- s^2(8)\, c^2(4)\, s(2) - s^2(8)\, s^2(4)\, s(1)\,.$$

Here,

$$c(i) \equiv \cos(\phi/i) \qquad (i = 1, 2, 4, 8)$$
$$s(i) \equiv \sin(\phi/i)$$

and

$$\phi = \pi E/E_o.$$

E_o is the reference energy, and ϕ is the precession angle around the y-direction suffered by the particle after the snake is passed through. The graph of $|\cos(\pi\nu)|_{extr}$ is shown by the dashed line in Fig. 2. From this graph, the available energy range (i.e. the energy range over which depolarization is avoided) appears to be rather short when this configuration is used under fixed-geometry conditions.

Now let us turn to an arrangement of magnets in which the V(H) magnets of the Steffen's configuration are replaced by H(V) magnets. For such a configuration, we have

$$\left|\cos(\pi\nu)\right|_{extr}^{\substack{V\to H\\ H\to V}} = s^2(4)\left[c^3(4) + s^2(4)\cos(3\phi/4)\right] +$$
$$+ c^2(4)\left[c^3(4) + s^2(4)\, c(4)\, c(2) - s^3(4)\, s(2)\right]\,.$$

The plot of $\left|\cos(\pi\nu)\right|_{extr}^{\substack{V\to H\\ H\to V}}$ is given in Fig. 2 (solid line). This graph indicates that this snake configuration makes available a wide energy range in which depolarization can be prevented. It should be noted, however, that there is need to cross few imperfection resonaces at $E/E_o \approx 2$.

The expression for the corresponding longitudinal polarization in the straight section diametrically opposite to the snake insertion will be given in a forthcoming report.

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(2) - B.W. Montague, LEP-70/76 (May, 1978).

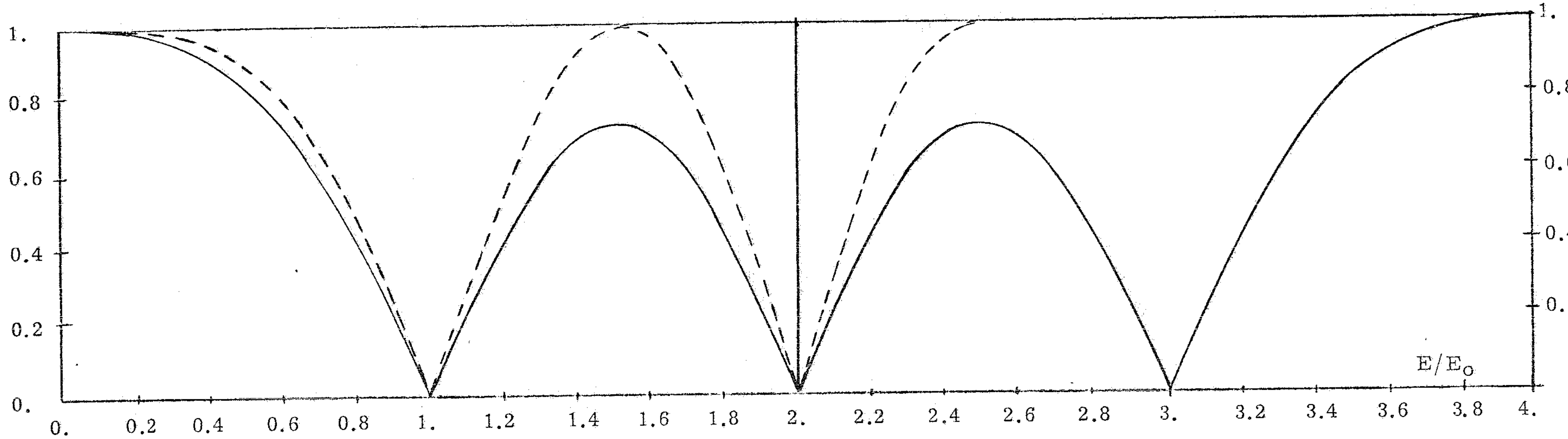

FIG. 2 - $|\cos(\pi\nu)|_{extr}$ for the magnet arrangement of Fig. 1 (dashed line) and for the same arrangement rotated by $\pi/2$ around the y (velocity) axis (solid line). In the latter case, however, few imperfection resonances occur at $E/E_o \approx 2$.

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