

Accumulator Lattice Modifications to increase γ_t

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7/23/89

Lattice modifications to the Accumulator will be required in order to reduce the value of η by about a factor of two, in connection with a planned increase in the bandwidth of the stack-tail system by that same factor of two to from 1-2 GHz to 2-4 GHz. After the change in η , the width of the stack-tail Schottky bands at 4 GHz will be the same as it is now at 2 GHz. Without this modification to the Accumulator lattice, the Schottky bands would overlap in frequency and the periodic notch filter required to keep the core free of stack-tail power would be ineffective.

The quantity η is given by:

$$\eta = 1/\gamma^2 - 1/\gamma_t^2 ;$$

here the quantity $1/\gamma_t^2$ is a property of the lattice, and is given by

$$1/\gamma_t^2 = \langle D\theta/L \rangle.$$

In this equation, D is the local value of the dispersion function, θ is the local orbit bend angle, and L is the length of the magnet providing the bend angle.

The indicated average is over the entire ring. Nominally, the Accumulator has $\gamma_t = 5.42$; to achieve the required reduction in η , we must increase the value of γ_t to about 7.1. From the above equation, it can be seen that if we fix θ and L (i.e., no major changes in the ring geometry), then our only choice in increasing γ_t is to reduce the value of the local dispersion D at the dipoles. In the case of the Accumulator, this turns out to be practical only at B7, B9 and B10; there is too little dispersion at B3 and B8 to be useful.

The general procedure is to use SYNCH to adjust the strengths of all the quadrupoles in a sector of the ring, subject to the requirements of a reduced dispersion at B7, B9, and B10, zero dispersion in the low-dispersion straight section, and roughly the same values for the lattice functions at their maximum points in the sector. None of the quadrupole positions or lengths were changed; i.e., the ring geometry is unchanged. The results for the new quadrupole strengths and some global lattice parameters are given in the table.

ACCUMULATOR LATTICE MODIFICATION		
PARAMETER	NOMINAL LATTICE	NEW LATTICE
Q1 (kG/m)	103.8	81.2
Q2(kG/m)	-103.8	-100.6
Q3(kG/m)	103.8	114.1
Q4(kG/m)	96.63	53.5
Q5(kG/m)	-97.41	-90.7
Q6(kG/m)	96.63	104.4
Q7(kG/m)	-97.41	-95.4
Q8(kG/m)	96.63	110.3
Q9(kG/m)	-97.41	-69.1
Q10(kG/m)	40.87	63.4
Q11(kG/m)	89.39	39.1
Q12/13(kG/m)	-89.39	-68.3
Q14(kG/m)	89.39	104.7
γ_t	5.42	7.07
Q_x	6.61	6.67
Q_y	8.61	7.51
S10(kG/m ²)	134	260
S12(kG/m ²)	-170	-167

The lattice functions and the dispersion functions for the new and old lattices are shown in figs. 1,2,3, and 4.

Several comments are in order regarding this solution. First, of course, it must be considered preliminary: really, it is no more than an existence proof at present. There are a number of points which must be addressed:

1. The fact that all the quadrupoles run at different field gradients is obviously a problem. A solution should be found which minimizes the number of quadrupoles running at different currents. Moreover, although at worst the field gradients are no more than about 10% higher than at present, the behavior of the magnets at that gradient should be checked to be sure that the field quality is still OK.

2. The values given above for the two sextupole families require that S10 be moved to a new location (just after Q10). Moreover, preliminary work indicates that adding another sextupole after Q5 can allow S10 to be substantially reduced in strength (to about 180 kG/m²), which is highly desirable. This should be investigated further. The role of the other sextupoles (S7, S9) and the octupoles must be examined.

3. The implications of operation at the new working point must be examined. This will include tracking calculations, examination of sensitivity to resonances, etc.

4. The implications of the new phase advances on the placement of the stochastic cooling systems must be evaluated.

5. Detailed examination of the machine aperture limits with the new lattice functions must be carried out.

6. The implications of the change in η on the RF systems must be evaluated. The bucket area for a given voltage varies like $1/\sqrt{\eta}$, so in principle the RF voltage can be reduced by $\sqrt{2}$. This may be useful in connection with the change in stability requirements (see 8., below).

7. The requirements for retuning the injection and extraction lines to accomodate matching for the new lattice must be worked out.

8. The implications of the change in η on the machine stability must be investigated. To first order, the stability limit varies like η , so it will be reduced by a factor of two.

This is only a partial list. It is hoped that this provides a starting point from which a serious study of this topic can proceed.

FIGURE 1

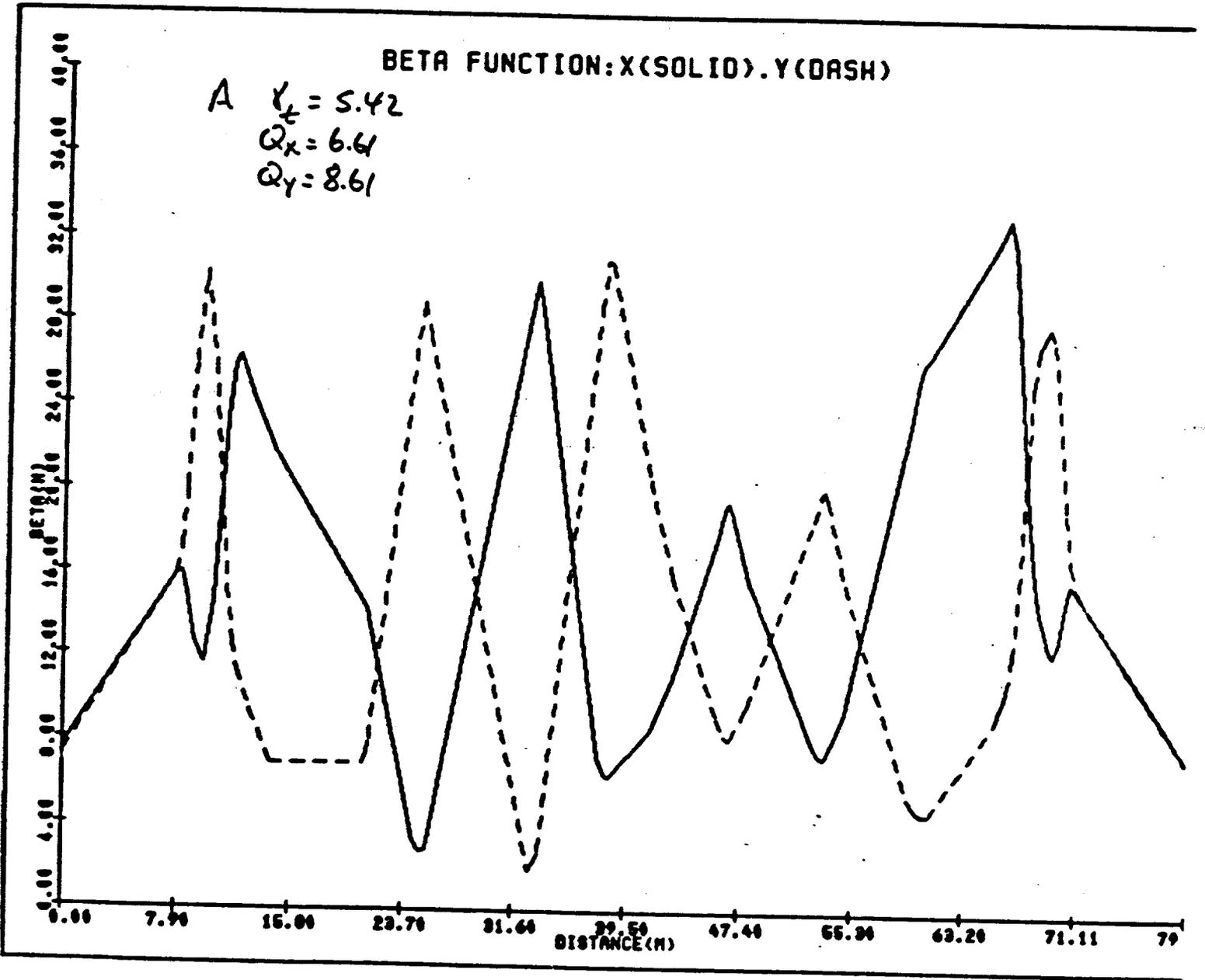


FIGURE 2

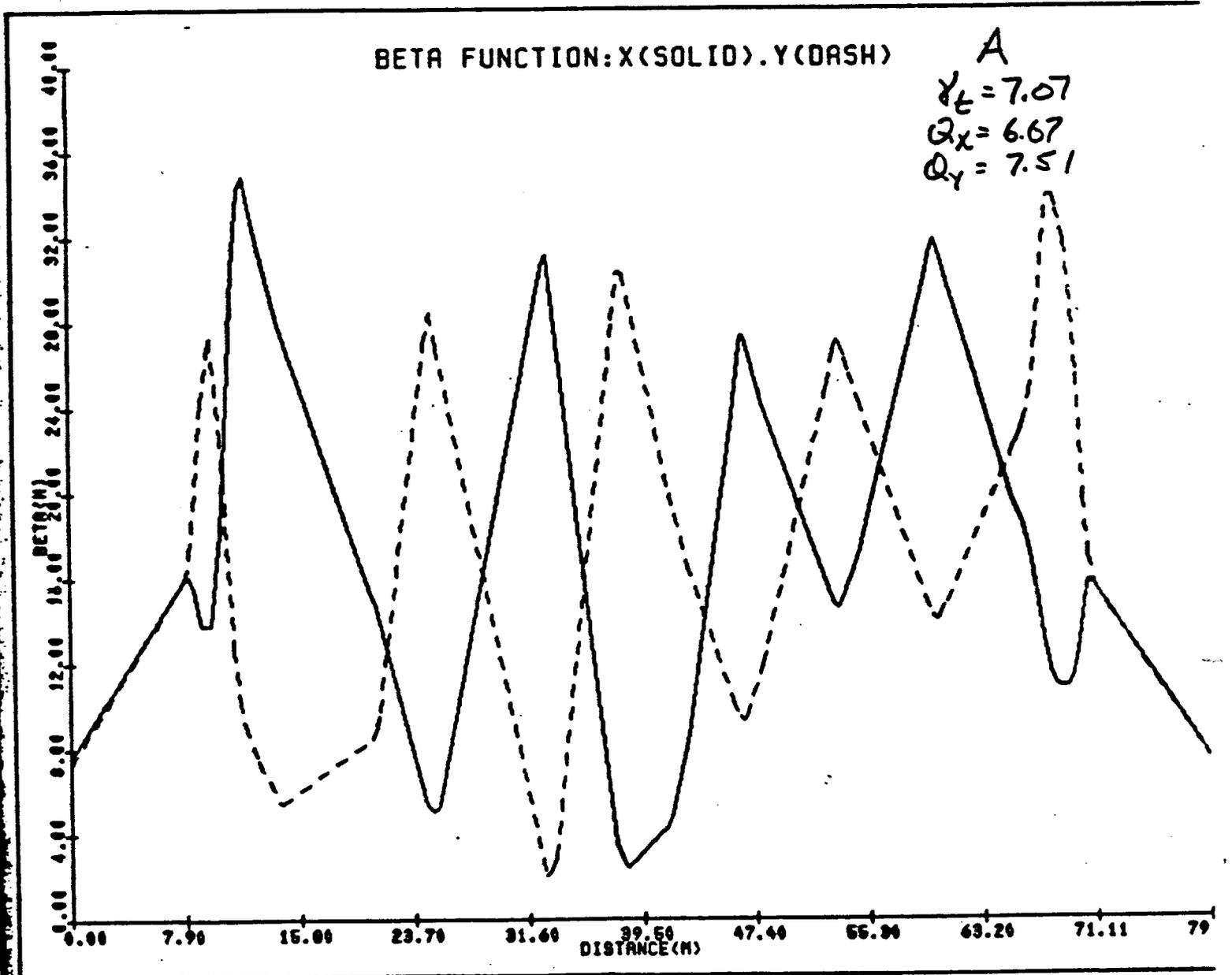


FIGURE 3

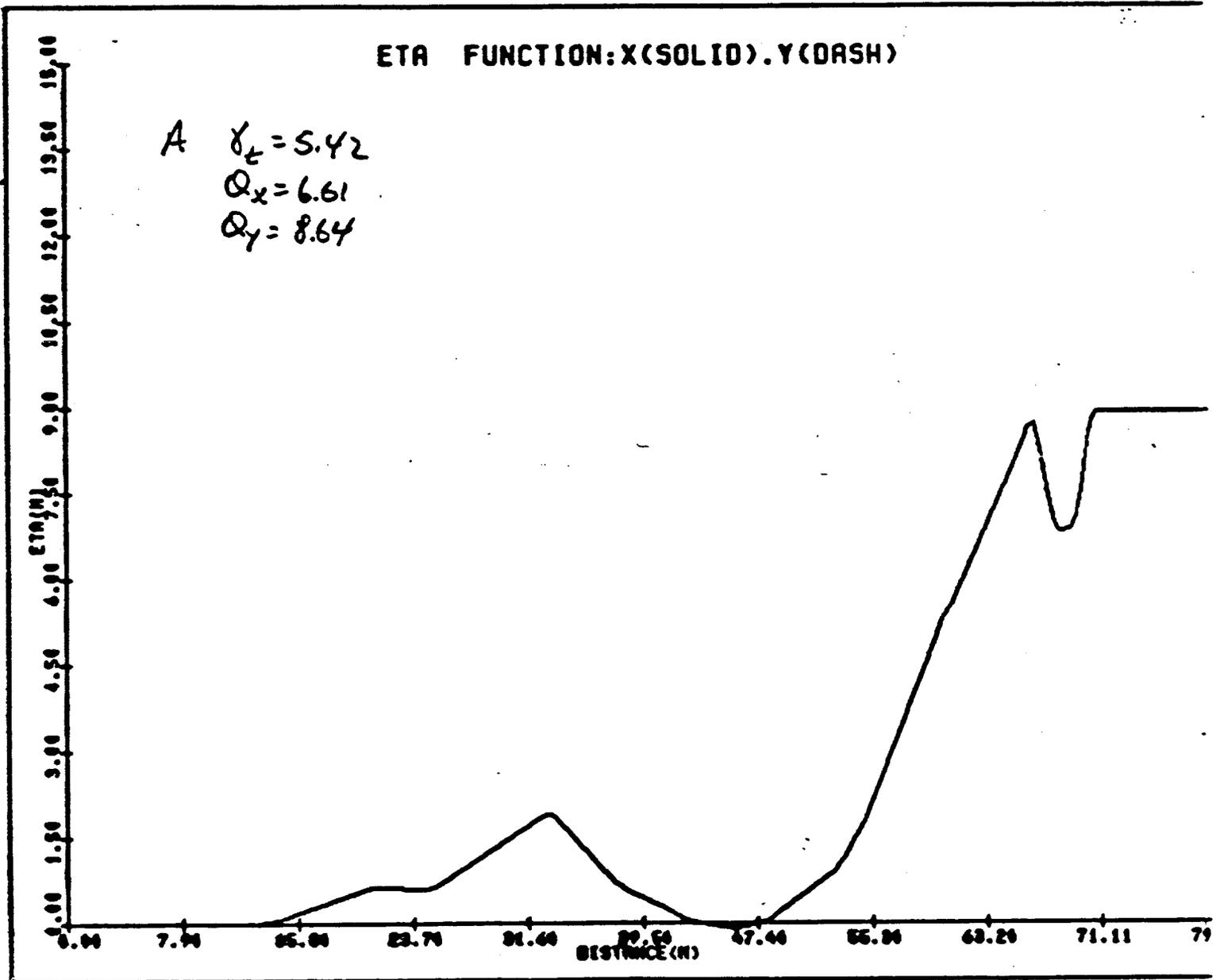


FIGURE 4

