national accelerator laboratory

FN-192-A
0300

VARIATION OF BOOSTER TUNES WITH MOMENTUM (ADDENDUM)

S. C. Snowdon

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Purpose

Although the results of a previous note with the same title as above (FN-192) are correct when the magnet lengths are chosen to be identical with the design or comparison case (SYNCH), a small correction must be made for the reshaping of the closed orbits, if the magnet lengths are changed. This correction is included below.

Closed Orbit Correction

If L_s designates the magnet length used in the design (SYNCH) of the booster lattice, then for increments ΔS to this length at each end of the magnet the net bending relation becomes

$$2NB_{yF}(0)(L_s + 2\Delta S_F) + 2NB_{yD}(0)(L_s + 2\Delta S_D) = 2\pi\langle BR\rangle \quad , \qquad (1)$$

where N is the sector number. From the turns ratio and the gap ratio of F to D magnets, one has

$$\frac{B_{yF}(0)}{B_{yD}(0)} = \frac{N_F}{N_D} \cdot \frac{G_D}{G_F} = \frac{48}{56} \times \frac{2.25}{1.64} = 1.175958. \qquad (2)$$

The radii of curvature in the F and D magnets are

$$\rho_F = \frac{\langle BR \rangle}{B_{yF}(0)} \quad ; \quad \rho_D = \frac{\langle BR \rangle}{B_{yD}(0)} \quad . \tag{3}$$

Thus, for booster parameters, since $L_{sF} = L_{sD} = L_s$

$$\rho_F = 18.77192\left\{1+\frac{2\Delta S_D}{L_s}+1.175958\left(1+\frac{2\Delta S_F}{L_s}\right)\right\} \quad , \tag{4}$$

and

$$\rho_D = 22.07492\left\{1+\frac{2\Delta S_D}{L_s}+1.175958\left(1+\frac{2\Delta S_F}{L_s}\right)\right\} \quad , \tag{5}$$

where the radii of curvature are measured in meters.

Since ΔS_F and ΔS_D were not considered adjustable in the least squares fitting procedure of FN-192, the formulation there is correct except that the radii of curvature associated with all measured quantities (M), for example κ_{xM}, should be changed to those given by Eqs. (4-5). All radii of curvature associated with the design or comparison quantities such as κ_{xS} remain unchanged. These modifications have been incorporated into the TUNA code.

Results

Two changes are occasioned by the above corrections

1. Figure 5 (FN-192) -- $\Delta\nu_x$ and $\Delta\nu_y$ are both lowered at all points by approximately 0.05.

2. Table 1 (FN-192) -- The adjusted coefficients representing the best end shape become

	F-Magnet	D-Magnet
ΔS(m)	0.007689	0.011621
A	-0.006135	-0.048929
B(m^{-1})	-1.0087	0.220639
C(m^{-2})	-12.2669	12.5400
D(m^{-3})	1.4638E+3	-9.4746E+2
E(m^{-4})	7.1491E+3	-6.3731E+3
F(m^{-5})	-7.2394E+5	4.3327E+5
G(m^{-6})	-9.6114E+5	2.0319E+5
H(m^{-7})	1.1316E+8	-6.1980E+7

3. Further corrections having no effect on results

   a. Equation (29) in FN-192 should have a capital S subscript.

   b. Equation (31) in FN-192 should read

   $$L_{xS} = \frac{1}{\rho} \quad .$$