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DECAPOLE MAGNET DESIGN STUDY

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On several occasions when considering improvements to main ring, the possibility of installing correction decapoles has arisen. This leads to the question of how one makes a decapole and what decapole fields are reasonable (i.e. how long does the corrector have to be.) Figure 1 shows a decapole design with the following design properties: 1) exact ten fold symmetry. 2) 2.4" pole tip radius. 3) constant coil cross section with increasing radius. This design has a field of 25 gauss/in⁴/1000 amp-turns. It is starting to saturate the iron at 10000 amp-turns in the conductor block at which current the field is 233 gauss/in⁴. The field quality is excellent with the first allowed higher order term (thirty-pole) of 0.5×10^{-4} of the decapole field at one inch. If it were actually desired to run at this very high decapole field, the magnet would have to be expanded beyond the size of Figure 1 to a diameter of about 22 inches to reduce the current density to something reasonable e.g. 2000 amps/in². This first design has more iron and less copper than would be needed for a distributed main ring decapole corrector. Several design variations were considered with the following results: 1) With a 2.4 inch pole tip radius, the field continues to scale as 25 gauss/in⁴/1000 amp-turns. 2) It is possible to modify the cross section to increase the coil area and reduce the current density below 500 amps/in² and not saturate the steel up to 34 gauss/in⁴. This current density has been used operationally in the present main ring chromaticity correcting sextupoles with solid copper wire. Since our best estimate of required decapole field is 60 gauss in/in⁴ to correct the decapole in four B1's, a six inch long corrector would need 10 gauss/in⁴. This can be done with a magnet about 13 inches in diameter. Based on the present cost of new main ring sextupoles, such a decapole might cost about \$5,000. The main ring would need about 100 to correct the decapole in B1's. An equal number (running at a lower current) would be needed to correct the decapole in B2's. Tracking studies would have to be done to determine whether this would be worthwhile.

861 amps/cm^2

DECAPOLE VERSION 6 10000 AMPS ; Poisson cycle number 1330

