Orbit Matching with AGS Helical Snake

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The field in the dual-pitch helical snake described by Huang[1], like any helical field, contains nonlinear components and longitudinal fields off the axis of the helix. Since, in the helix, the orbit deviates from the axis these fields cause horizontal-vertical coupling. Tune shifts, and mismatches in the orbit functions. With a 30% snake at injection energy (kinetic energy 1.5 GeV) the tune shifts are of the order of 0.2 units, and the beta functions fluctuate throughout the ring up to values around 100 m instead of the matched maximum of about 22 m.

For computational purposes we assume helical fields with nonlinear components demanded by Maxwell's equations as detailed by Blewett and Chasman[2], ignoring end effects. The resulting fields are similar to those obtained by Okamura and presented in ref. 1. Integrating the equations for these fields we obtain transfer matrices and compute the orbit functions. We show that with a suitable solenoid superimposed on the helical field, and with trim quadrupoles in the superperiod containing the snake, the coupling and the beta function mismatch can be eliminated, but the tune shifts are still considerable. With a 3 Tesla helix the solenoid at injection should be about 0.3 T, and six trim quadrupoles, 50 cm long, with gradients less than 2.5 T/m are required; the tune shifts have to be handled with the regular tuning quadrupoles. At higher energies the optimal solenoid strength is reduced, while the trim quadrupoles may be kept at fixed absolute strength.

[1]H. Huang, this Symposium

[2]J. P. Blewett and R. Chasman, J. App. Phys. **48**, 2692(1977)