CONSTRUCTION AND CARACTERIZATION OF COMBINED FUNCTION QUADRUPOLES

G. Tosin, LNLS, C.P. 6192, 13081-970, Campinas, SP, Brazil

The magnetic lattice of the Brazilian Synchrotron Light Source uses combined function quadrupole magnets, i.e., special coils are included in the quadrupoles to produce a sextupolar field component. These combined quadrupoles are used in the dispersion free straight sections and the sextupolar component is employed in the minimization of geometrical aberrations produced by the chromatic correction sextupoles. The sextupolar component reaches 26 Tesla/m^2, superimposed on the main quadrupole component of 17 Tesla/m. The magnet core consists of laser cut steel laminations. In this report, we present results on mechanical and magnetic characterization of these magnets, including harmonic analysis and an investigation on the positioning repeatability of the magnetic axis with respect to the reference girder.

I. INTRODUCTION

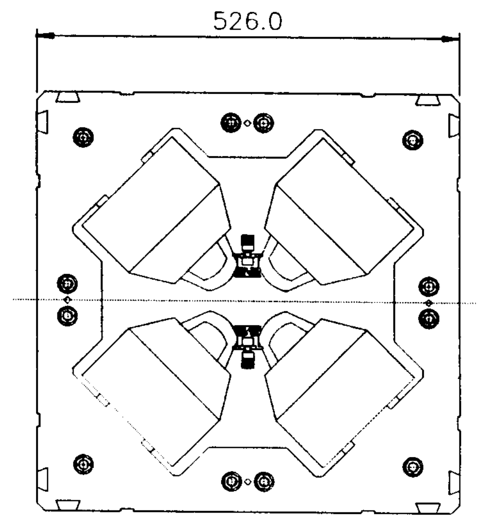
This work describes the construction and magnetic characterization of combined quadrupoles which have additional coils to produce a sextupolar field. These quadrupoles are present in the dispersion-free straight sections of the LNLS UVX electron storage ring and their sextupolar components are used as a means to correct geometric aberrations produced by the chromatic correction sextupoles, thus improving the dynamic aperture.

II. CONSTRUCTION

Two air yoke coils are installed so as to produce a dipolar field with a high sextupolar content (figure 1). The dipolar component is then cancelled out by means of compensating coils.

The air yoke coils were designed to be included into already existing quadrupoles and to reach $d^2B/dx^2 = 26$ Tesla/m^2. Fourteen turns of polyester-coated copper wire are wound on a water-cooled brass yoke. The two coils are serially connected and the current density to produce the necessary field is 12.8 A/mm^2, dissipating 150 Watts. Under these conditions the coils reached a final temperature of 42 ^oC.

The core of the host quadrupole is fabricated with laser-cut steel lamination, of 1.5 mm thickness, with accuracy of ±.03mm. It has a quadrupolar component of 17 Tesla/m with 225 Amps through the main coils. Additional coils are provided for compensating the dipolar field dipolar field originated in the sextupolar coils.



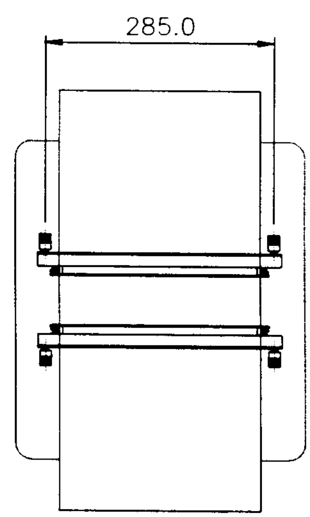


Figure 1: Front and side view of combined quadru-pole prototype

III. MEASUREMENTS

The measurements of the first prototype were performed with the rotating coil technique. Excitation curves of the integrated sextupolar component with quadrupole currents of 10.5 A, 120A and 225 A are shown in Figure 2. These currents correspond to lowest quadrupolar field during injection and to lowest and highest quadrupolar field at full energy, respectively. Negative values come from mixing the sextupole produced by air yoke coils and the sextupole components due to construction errors.

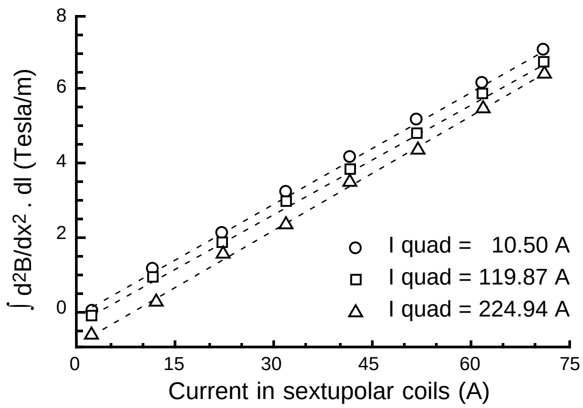


Figure 2: Excitation curve.

Figure 3 shows the harmonic analysis of a pure quadrupole at 10.5 A, a combined quadrupole also with 10.5 A, but with 72 A in sextupolar generating coils and the results of simulation with no quadrupolar current and 71.4 A in sextupolar coils. Note the increase of the undesired 10-pole, 14-pole and 18-pole components.

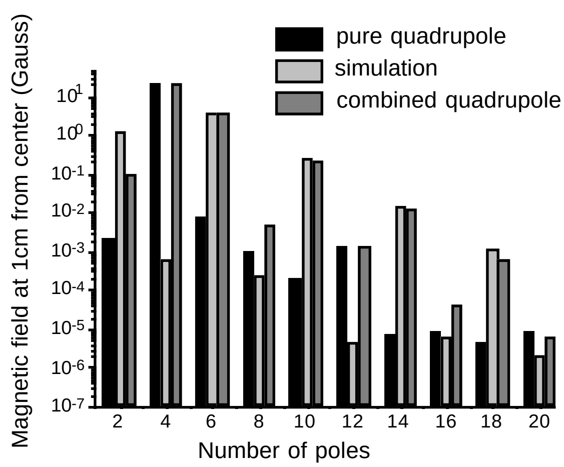


Figure 3: Harmonic analysis. The simulation results were obtained with the 2d code POISSON [1].

In parallel with these measurements, the possibility to align the magnets in straight sections using only one reference girder was tested. To achieve this purpose, high mechanical precision is needed in the construction of the magnet and the reference girder rails.

The procedure used to test this possibility consisted in putting a small girder, which simulates with high accuracy the real girder of a straight section, on top of an upside down quadrupole. This way, mechanical deformations of the small girder are avoided. In this small girder, refrences were fixed to relate the theoretical central orbit position, called geometric center, with the magnetic center of quadrupole localized by rotating coil measurements. The accuracy of these measurements is .01 mm.

The results of placing and taking off the small girder several times on the same quadrupole showed a repeatability of the magnetic center positioning of ±.0.01 mm. The repeatability of the magnet center positioning among several quadrupoles is of ±.0.1mm.

IV. CONCLUSIONS

A combined function quadrupole has been built and characterized and the results showed a significant increase in unwanted high multipole components. The alignment of the magnets in the straight sections will be done with the help of a reference girder, the production of which has been started.

V. REFERENCES

[1] Reference Manual for the POISSON/SUPERFISH Group of Codes, Los Alamos Accelerator Code Group, LA-UR-87-126.