# THE EFFECT OF THE SUPERCONDUCTING WIGGLER ON THE DYNAMIC APERTURE ISI-800

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*Abstract.* The superconducting wiggler for the synchrotron light source ISI-800 of the Ukrainian National Synchrotron Radiation Center is under development at KIPT. The physical model considering the effect of higher multipoles of the wiggler field on the ring focusing is suggested. The dynamic aperture of the storage ring is defined by computer simulations.

To produce reasonable SR photon fluxes with energies between 10 and 30 keV by using SRS with a stored electron energy of about 1 GeV, it is necessary to insert superconducting wiggler magnets with a field of ~ 10 T [1]. This insert exerts a strong effect on the focusing of the storage ring. In this connection there is a need to solve several problems of matching the wiggler to the magnet lattice.

The device under development will be a three-pole wiggler with a peak field of ~ 7 T in the principal pole and a field of ~ 4.5 T in the half-poles. A schematic sketch of the wiggler is given in Fig.1. The distribution of the quadrupole component $\partial B_z / \partial x$ and one of the highest multipole components $\partial^2 B_z / \partial z^2$ in the coordinate system following a reference trajectory is presented in Fig.2.

Tentatively, the wiggler effect on particle dynamics in the storage ring can be estimated by assuming the latter in the form of bending magnets with the edge focusing (Fig.1) which must be equal

$$\frac{1}{f} = \frac{tg\beta}{R} = \frac{1}{B\rho}\int_s \frac{\partial B_z}{\partial x} ds$$

where $\beta$ - the angles of the magnetic wedges,

R - bending radius,

$\frac{1}{B\rho}\int_s \frac{\partial B_z}{\partial x}$ - path integrals in magnets.

This condition is realized by the corresponding choise of the lengths $L_i$, $l_i$. Besides, it is need to shift the principal pole relative to half-pole positions by the value of the maximum particle deviation $\Delta x$ (Fig.1).

This assumption permits to calculate the system compensating the wiggler effect through the use of the magnet lattice elements. However, the calculation of the wiggler effect only in the linear approximation is insufficient, because the high multipole components of the wiggler-generated field can also have significant influence on the particle motion in the storage ring.

So, to calculate correctly the effect of the wiggler on particle dynamics in the storage ring, we have developed the codes to compute the fields components, to determine the particle trajectories and obtain the field expansion up to third-order terms in the coordinate system following a reference trajectory.

The values of the high order terms of the field expantion are input data for thin multipoles (Fig.1). The displacement of these multipoles is determined by the behavior of each curve $\partial^n B_z / \partial x^i \partial z^{n-i}$ *(y)*.

For the synchrotron light source of the Ukrainian Synchrotron Radiation Center ISI-800 [2] we have calculated the dynamic aperture of the storage ring with the operating wiggler. The betatron tune shift $\Delta Q_z$ is equal 0.04. The high multipole components of the wiggler field were calculated in the thin lens approximation. The results of calculations for the stored beam energy $E_0$ = 0.8 GeV and the wiggler field $B_z$ = 7 T are presented in Fig.3. It is seen, that the high multipole components of the wiggler field reduce the dynamic aperture.

References

1. S. Sugiyama et al. Design of 10-T superconducting wiggler for angiography. Rew. of Scientific Instrum., vol.63 ¹1, 1992.

2. V. Androsov et al. Synchrotron radiation complex ISI-800. Journal of Electron Spectroscopy and Related Phenomena, 68 (1994) 747-755.

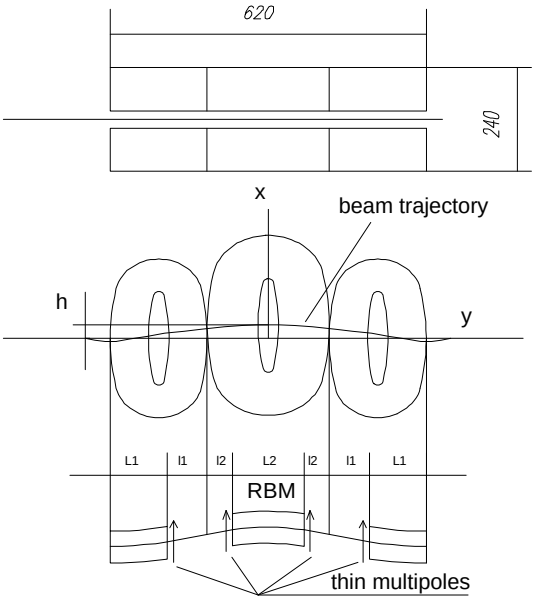


Fig.1. The wiggler diagram. RBM - rectangular bending magnets, h - the shift of the principal pole.

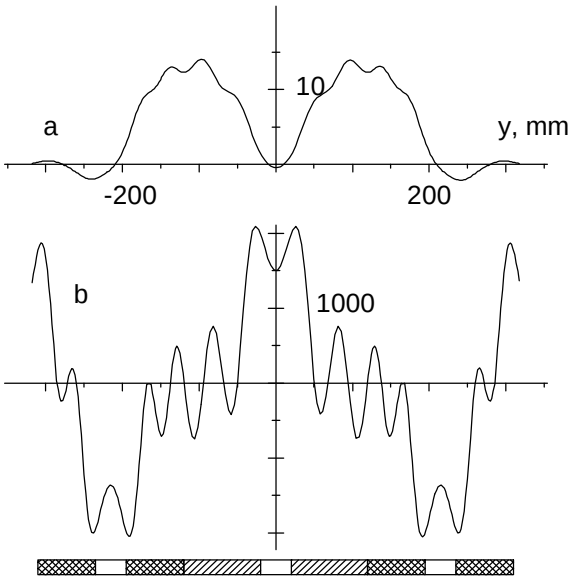


Fig.2 The distribution of the quadrupole and multipole components of the wiggler field:
a - $-\partial B_z / \partial x$,
b - $\partial^2 B_z / \partial z^2$

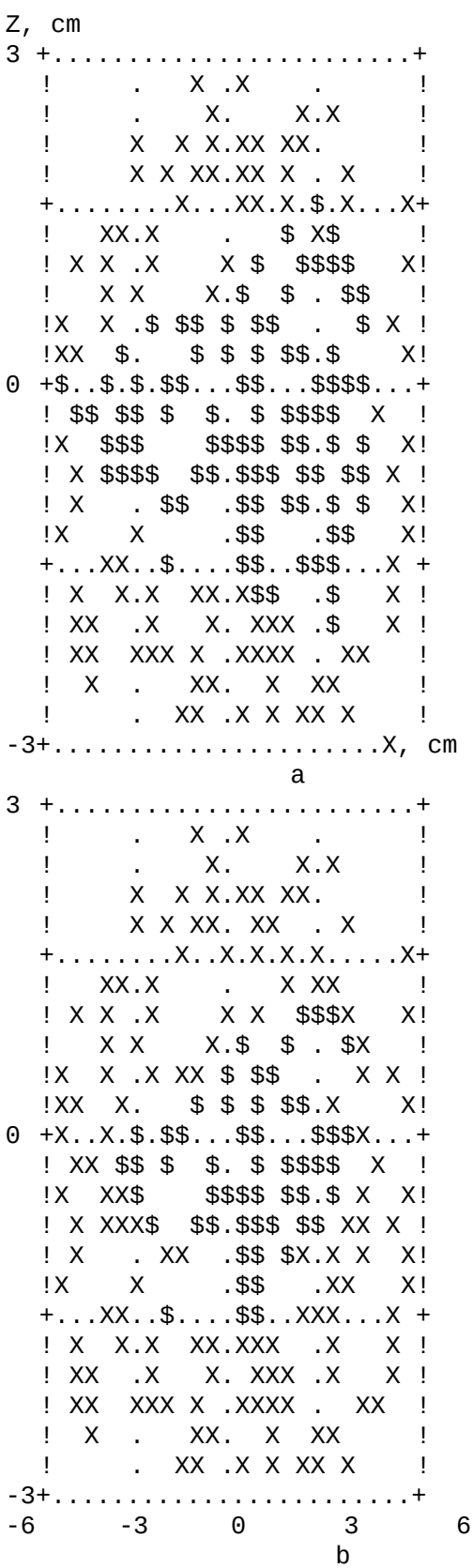


Fig.3 Dynamic aperture of the storage ring ISI-800
a - only linear fields of the wiggler are taken into account, b - multipole fields are considered, X - lost particles, $ - circulating particles.