CURRENT HEART-LIKE WIGGLER

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Abstract

A new wiggler structure for free electron lasers was presented. Current Heart-like wiggler produced magnetic fields which are spatially periodic. The current wiggler structure is a stacks of modified circle wires. The current has alternating directions. The magnetic field components for each wire present a 120 C_3 symmetry (for a model with 3 branches). The wiggler transverse cross-section (Fig.1) in arbitrary units was given by expressions:

x:=a(δ+sin(3φ))cos(φ) , y:= a(δ+sin(3φ))sin(φ) , z:= constant, where δ and a are parameters. In cylindrical coordinates the Biot - Savart law was evaluated numerically. The magnetic field aspect was mainly longitudinal. Also it's easily adjusted with the current. The versatility of this structure permits new geometrical forms and developments in the wiggler and undulator design.

INTRODUCTION

One of the main trends in free-electron laser (FEL) is the studies concerning the FEL principal component (wiggler or undulator) where the phenomenon of coherent radiation take place. For longitudinal wiggler the magnetic field component was mainly longitudinal and this kind of beam need a transversal momentum [1].

MODEL

The current wiggler structure is a stacks of modified heart like circle wires with current in alternating directions (Fig. 1 in arbitrary units). The transversal wiggler cross section expressions are: x:= a(δ+sin(3φ))cos(φ) , y:= a(δ+sin(3φ))sin(φ) , z:= constant (1), where a and δ are parameters. The x vector potential component A_x was given by the relation:

$$A_x = \frac{1}{a}\int_0^{2\pi} \frac{16\sin^4\varphi + 18\sin^2\varphi + \delta\sin\varphi - 3}{\sqrt{\left(\frac{Z - z_c}{a}\right)^2 + \left(\delta + 3\sin\varphi - 4\sin^3\varphi\right)^2}} d\varphi$$

(2), Z the abscissa, z_c the wire position. Similar A_y component. The A_z compound was zero. The potential vector components expressions implies the direct numerical evaluation of magnetic components.

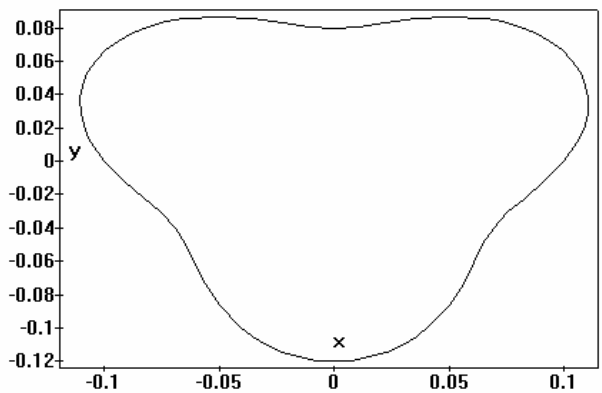

Figure 1: The Current Heart-like Wiggler (a=0.02, δ=5).

In Fig. 2 the normalized expression of the z magnetic field $B_{z_1} = B_z \Big/ \left(\mu_r \mu_0 / I\right)$ on the z axis vs. z computed by Biot-Savart law in arbitrary SI units was represented.

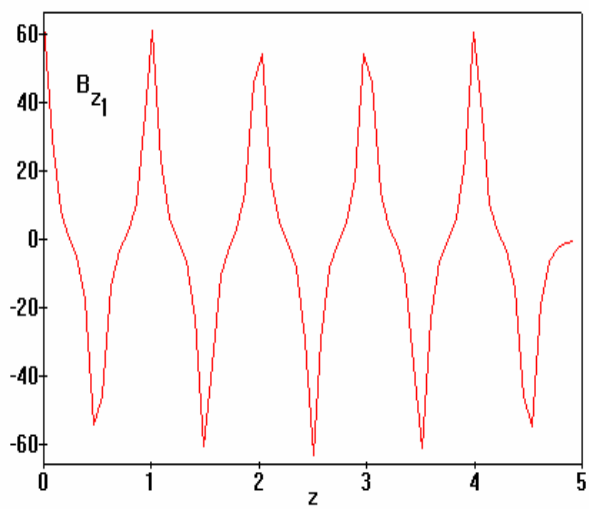

Figure 2: Bz_1 component of the Heart like Wiggler (a=0.02; δ=5).

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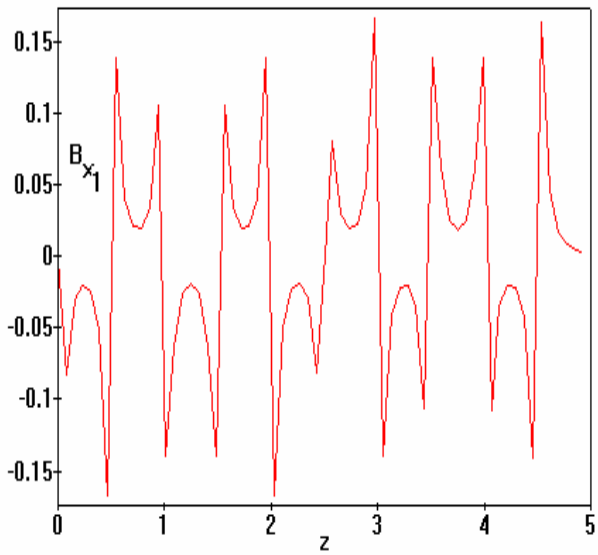

Figure 3: The B_{x1} component of the Heart like Wiggler (a=0.02, δ=5).

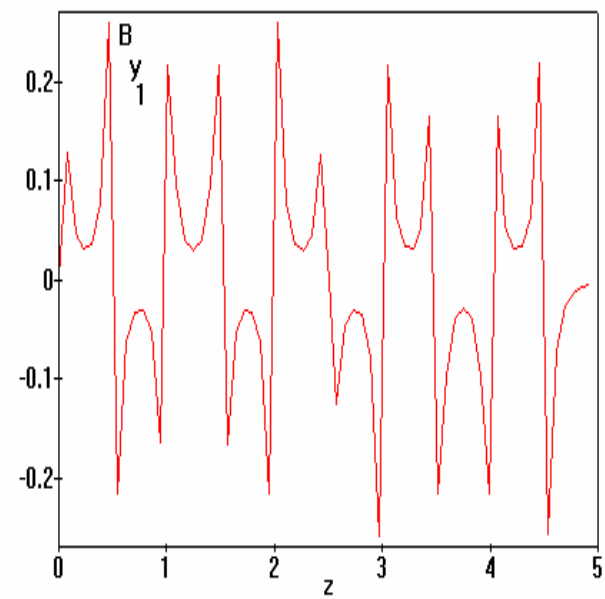

Figure 4: The normalized B_y component of the Heart like Wiggler (a=0.02, δ=5).

The z magnetic field components is about one thousand time greater than x and y ones, which are comparable. We notice that the Bx is the image of the By. The z component have shoulders. Figure 5 presents the FFT Modulus for z magnetic field component.

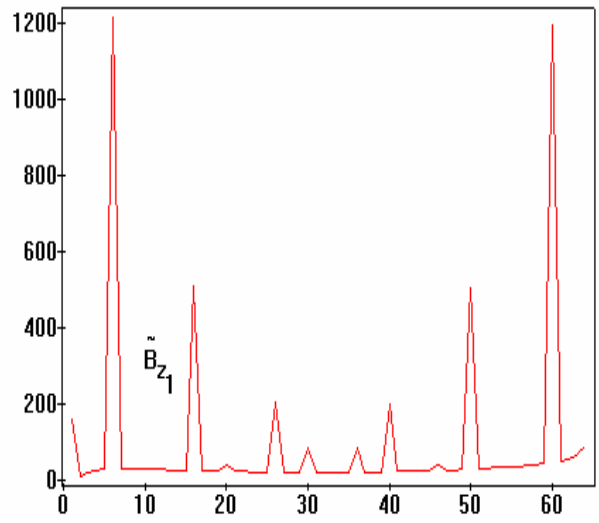

Figure 5: FFT Modulus for z magnetic field component.

The FFT maxim peak values are placed symmetrically on a parabolic in accordance with C_3.

CONCLUSION

The C_3 symmetry in the amplitudes of the magnetic x and y components and FFT were noticed. The z magnetic field component is about one thousand time greater than x and y ones, which are comparable and have similar forms. Because of the Bz magnitude this structure type is useful for beams with transversal momentum.

REFERENCES

[1] S.Chouhan, G.Mishra, Il Nuovo Cimento, Vol. 115 B, N.12, 2000, p.1411