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ACCELERATOR DEPARTMENT
Informal Report

SUPERCONDUCTING WIGGLER MAGNET FOR THE PROPOSED
BNL ELECTRON STORAGE RING

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ABSTRACT

A conceptual design is presented of a superconducting magnet system devised to enhance the synchrotron radiation spectrum from the proposed 1.5 GeV BNL electron storage ring.

MASTER

NOTICE

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Introduction

An important element in electron storage rings proposed for synchrotron radiation sources is an array of special high field magnets inserted in one or more of the machine straight sections for the purpose of shortening the photon spectrum wavelength, in accordance with the relation $\lambda_{\max} = (BE^2)^{-1}$ between the wavelength of the peak in the spectrum and the local magnetic field and the electron energy. Such a device is known as a "wavelength shifter" or "wiggler". It consists of a dipole triplet, generally superconducting for maximum field, arranged to first bend the electron beam away from and then back to and restore the normal equilibrium orbit. The radiation emitted by the beam while passing through the wiggler magnets may be adjusted for any spectral range simply by adjusting the field strength, independent of the normal lattice bending magnets. Moreover, since $dI/d\lambda$ corresponding to the peak of the spectrum varies inversely as the square of the orbit radius of curvature, the intensity of the radiation is also enhanced compared to that available from a normal lattice magnet. We present here a conceptual design for a wiggler magnet intended for the projected BNL 1.5 GeV synchrotron radiation facility.¹

Magnet Design

The magnet arrangement is shown schematically in Fig. 1a. It consists of two separate flat racetrack or rectangular-shaped coils producing a sequence of three adjacent + - + deflecting fields for particles travelling in a direction normal to the long axis of the coils (z-axis). The coils are assumed sufficiently long so that end effects do not appreciably perturb the field patterns. They are designed to be wound from the wide braided conductor utilized generally in the BNL superconducting accelerator magnet program. The calculations below are for an air core design, although the final device will most likely incorporate an iron yoke, which can further enhance the field strength, tailor the field shape somewhat, and help support the coils against the considerable magnetic forces.

1. R. Chasman, G.K. Green and E.M. Rowe, Proc. 1975 Particle Accelerator Conference, Washington, D.C. 1975, in press.

Field Distribution

The present storage ring design calls for a wiggler capable of deflecting particles of momentum 1.5 GeV/c by approximately $+5^\circ$, -10° , $+5^\circ$ which is achieved with the calculated field distribution shown in Fig. 1b. The required coil excitation is approximately 8×10^5 ampere-turns in the main or central coil (or 270 superconducting turns each carrying 3000 amperes) and 2.7×10^5 ampere-turns in the smaller outer coil (or 90 turns, each again carrying 3000 amperes). The corresponding overall current density in the windings is 17.9 kG/cm^2 , a fairly modest requirement. At 35 kG deflecting field on the magnet axis the peak field is 49.6 kG, and occurs on the inner surface of the main winding.

Magnet Forces

The magnet forces acting on each block in the first quadrant of the wiggler are tabulated below, including the torque around the center of each block. A positive F_x is horizontally outward, F_y is positive upward, and the torque at the block center is positive counterclockwise.

	Coil 1	Coil 2
F_x , lb/ft	1.42×10^4	2.22×10^4
F_y , lb/ft	-6.42×10^4	-6.50×10^4
TQ, lb	1.43×10^2	-5.00×10^1

Distr.: AADD External

$$J = 18 \text{ kA/cm}^2$$

Fig. 1a

Fig. 1b