§3. Development of the Design Code for a Curved Dipole Superconducting Coil

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A particle beam is transported from a particle accelerator to a target through a beam line composed of magnets for the purpose of researching in several fields of physics, biology, etc.. As the magnets for the beam line, resistive magnets are usually used. It is therefore difficult to reduce the size, weight and power consumption of the beam line because of the characteristics of resistive magnets. In the case of the beam line which consists of superconducting magnets, the beam line can be small, light, and energy-saving compared with the beam line including the resistive magnets. Consequently, the design of the superconducting coil for the beam line was carried out in this study. As the coil configuration, a curved dipole coil based on a saddle shape which can bend a beam effectively was selected as illustrated in Fig.1. The curved dipole coil cannot uniformly generate vertical magnetic fields in the area of beam transport due to the curved coil configuration. In the curved coil design, an integrated magnetic field strength *BL* as described in Eq.1 was used.

$$BL = \int B_{(\theta)} ds \qquad (1)$$

where $B_{(\theta)}$ is a vertical magnetic field on the beam orbit、 s is a length of the beam orbit. To fulfill the design requirement with *BL*, an optimized design code for the curved dipole coil was developed. Fig.2 shows the results of normalized *BL* for optimized and unoptimized curved dipole coils. In the optimized design code, conductor positions of the coil cross-section are iteratively adjusted until the design requirement is fulfilled.

By using the optimized design code, the curved dipole coil was designed based on the coil parameters as follows: The number of coil layers is 8, the coil inner diameter is 100 mm, the good field region is 30 mm, the coil bending radius is 0.5 m, the coil bending angle is 30 degrees, and the diameter of the conductor is 1.3 mm. Fig. 3 shows the coil cross-section after optimized design, the coil cross-section is asymmetric. This is because the coil was designed to meet the requirement of *BL* in consideration of the influence of the curved saddle configuration on a magnetic field distribution.

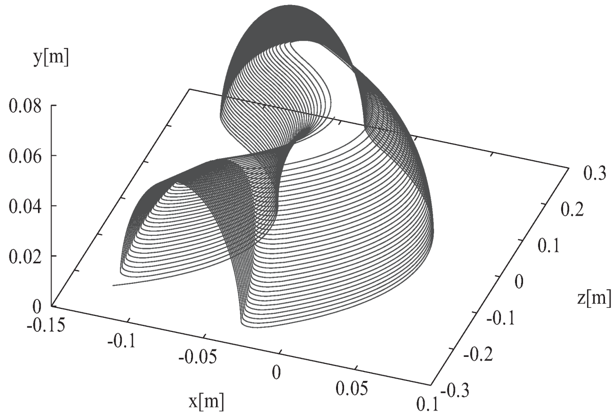

Fig. 1. Schematic view of the curved dipole superconducting coil.

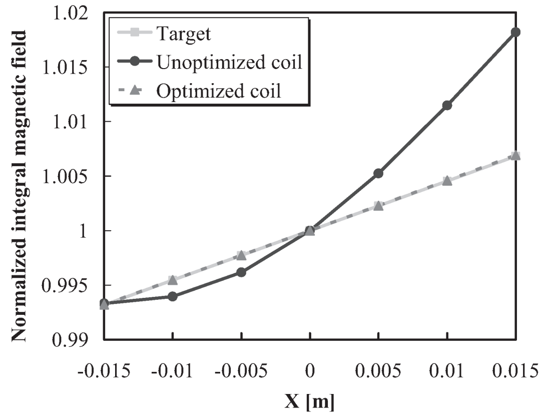

Fig. 2. Normalized integral magnetic field generated by the optimized and unoptimized curved dipole superconducting coil.

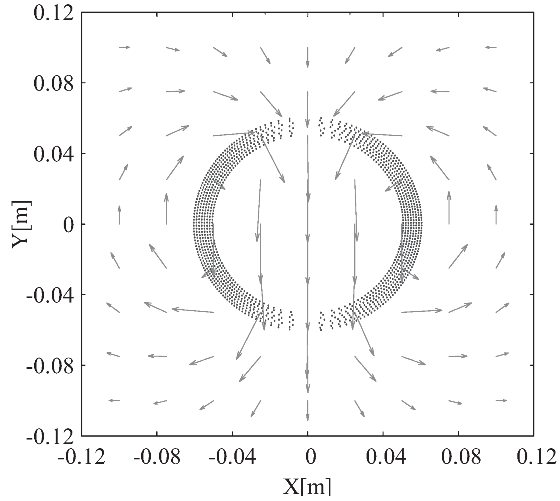

Fig. 3. Cross-section of the superconducting coil and magnetic flux generated by the coil.

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