DESIGN OF A COMPACT FFAG ACCELERATOR WITH SPIRAL SECTOR MAGNET

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Abstract

It is hoped that a Fixed Field Alternating Gradient (FFAG) accelerator, which is a compact and can accelerate high intensity beam, will be developed as versatile accelerator and available for many applications. Up to now, although some radial sector type FFAG accelerators have constructed and are under construction, a spiral sector type FFAG accelerator has not constructed. A spiral sector type FFAG accelerator is better for compactness than a radial sector type. We are developing a compact FFAG accelerator with spiral sector magnet and report the status of the design.

INTRODUCTION

Since the acceleration for 500keV proton beam using pop-FFAG accelerator was achieved at KEK in 2000[1], FFAG accelerator is prospective as a compact and versatile accelerator.

For zero chromaticity of FFAG accelerator two types sector magnet is possible. One is radial sector type magnet and other is spiral sector magnet. A spiral sector type magnet is better for compactness than a radial sector magnet because the deflection angle of beam is not inversed. For many industrial applications the compactness of accelerator is good feature and developments of spiral sector FFAG accelerator are not so much recently. So we are going to work on the study of spiral sector FFAG accelerator.

DESIGN OF SPIRAL SECTOR MAGNET

Configuration of Magnet Field

Spiral sector type magnet is proposed by K. R. Symon et al.[2] and the needed configuration of magnet field is shown below.

$$B(r,\theta) = B_0\left(\frac{r}{r_0}\right)^k \left[1+\sin\left\{N\theta - N\tan\xi\ln\left(r/r_0\right)\right\}\right]$$

N is period of circumferential magnetic field, i.e. number of magnets and ξ is spiral angle of magnet. The outline of magnetic field is shown in figure 1.

Using spiral shape in this way all magnets have same deflection angle of beam, big injection angle and big extraction angle, and alternating gradient focusing power has achieved.

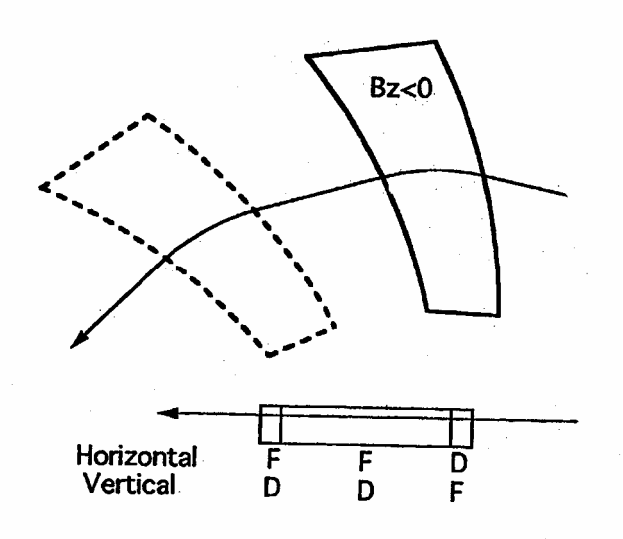

Figure 1: Outline of magnetic field

Design of Spiral Sector Magnet

Some model of spiral sector type magnet was proposed and we take on the model that D. W. Kerst was proposed[3]. The outline of Kerst model is shown in figure 2 and the feature is that gap height is increased in proportion to radius of magnet.

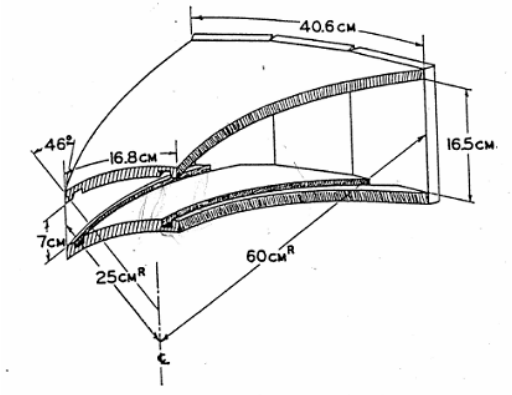

Figure 2: Outline of Kerst model[3]

We have simulated the magnetic field of Kerst model magnet by using the solvers for analysing 3D electromagnetic phenomena. The specifications of the magnet model are shown in table 1

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Table 1: Specifications of magnet model

k-value	0.5
B_0	74Gauss
R	20 - 40 cm
Spiral Angle	40 deg
Angle of Magnet body	30 deg

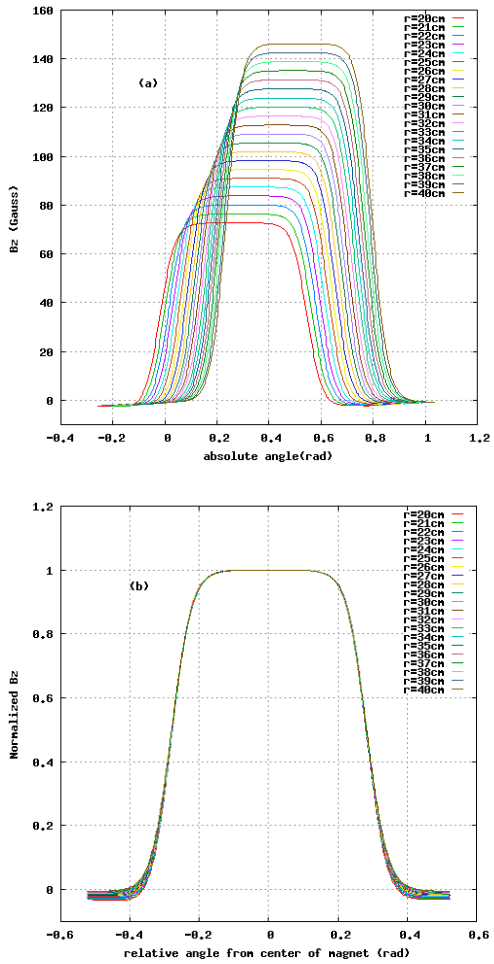

Figure 3: A typical result of simulation

A typical result of simulation is shown in figure 3. In figure 3(a) the magnetic field Bz in absolute value according to circumference is shown and in (b) the normalized magnetic field is shown. The shape of magnetic field at each radius is enough similar each other and the needed configuration magnetic field is available.

SUMMARY

We calculated the magnetic field of Kerst model and got the needed configuration magnetic field for spiral sector type magnet. So we are now working on the calculation the optics of FFAG accelerator with the spiral sector type magnet and the design of details of accelerator.

REFERENCES

[1] M. Aiba et al., Proc of EPAC 2000, Vienna, Austria, August (2000) 581

[2] K. R. Symon et al., Phys. Rev. 103 (1956) 1837.

[3] D. W. Kerst et al., Review of Science Instruments 31(1960) 1076.