LATTICE STRUCTURE AND MAGNET DESIGN FOR THE TEST RING

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Abstract

The TEST RING for developement of knowledge and technology conserning beam storage and beam dynamics of heavy ions is being constructed. Heavy ions from SF cyclotron at INS are to be injected and accumulated.

1. Introduction

A storage ring which accumulates heavy ions more than a thousand turns is considered to be one of very powerful methods to obtain high intensity heavy ion beam of high energy. The TEST RING is designed to enable a multiturn injection into betatron phase space and an RF stacking into synchrotron phase space. Special care is needed to give enough aperture for larger amplitudes of betatron and synchrotron oscillations due to relatively large beam emittance and momentum spread,respectively.

2. Lattice Structure

The TEST RING is a separated-function strong-focusing type and has 8 cells of FODO. Similar structure with the ring in the NUMATRON project would be useful for further developement of the project.

The lengths of the dipole and quadrupole magnets are 1.047 m (at the center line) and 0.2 m, respectively. In order to give enough spaces for installation of various equipments, a pair of straight sections with lengths of 0.527 m and 1.8 m are made in every unit cell. A unit cell is shown in fig.1. The circumference of the ring is made to be 31.8 m at the central orbit for the purpose of synchronization of the RF system between the ring and SF cyclotron at the injection time. The harmonic number of the ring is chosen to be 7. The mean radius becomes 5.1 m.

The number of betatron oscillations per revolution,ν, is determined to be 2.25 both in horizontal and vertical directions, because the beam size is expected to be optimized for the value. The beta-functions and dispersion function are shown in fig.2.

Correction of the chromaticity is to be made by sextupole magnets installed in every drift spaces of 0.527 m length and pole face winding in the dipole magnets.

3. Magnet Design

In the calculation of useful aperture requirement, we assumed the beam emittance after a multiturn injection and the momentum spread after an RF stacking to be 54π mm·mrad and ±2.5%, respectively. Typical use of aperture is shown in fig.3 for the dipole and radially focusing quadrupole magnets. Considering the additional spaces for vacuum chamber wall, heat insuration and distributed ion pump, the aperture of the window-frame type dipole magnet is determined to be 258 x 70 mm^2 and the bore radius of the quadrupole magnet with the pole shape of a hyperbola tangentially connected to straight lines at both ends is made to be 65 mm. The field gradient calculated by the computer program TRIM is shown in fig.4. Specifications of the magnets are listed in the table.

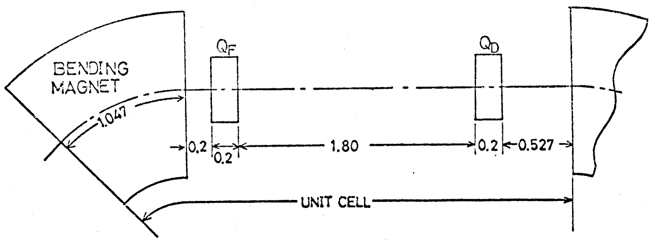

Fig.1. Dimensions in a Unit Cell.

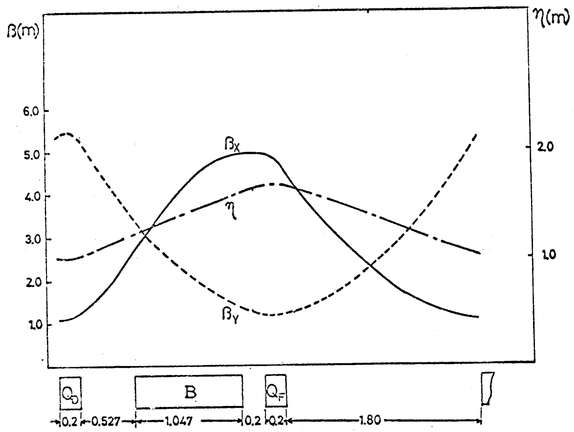

Fig.2. Beta and Dispersion Functions.

Table Specificasions of the Magnets

Dipole Magnet(window-Frame type)	
Pole Width	258 mm
Gap Height	70 mm
Pole Length (at the center line)	1047 mm
Radius of Curvature	1333 mm
Field Strength	9.3 kG
Ampere Turns	55200 AT
Current Density	5.38 A/mm^2
Space Factor	0.475
Quadrupole Magnet	
Field Gradient	0.7 kG/cm
Pole Length	200 mm
Bore Radius	65 mm
Ampere Turns per Pole	12000 AT
Current Density	8.33 A/mm^2
Space Factor	0.661

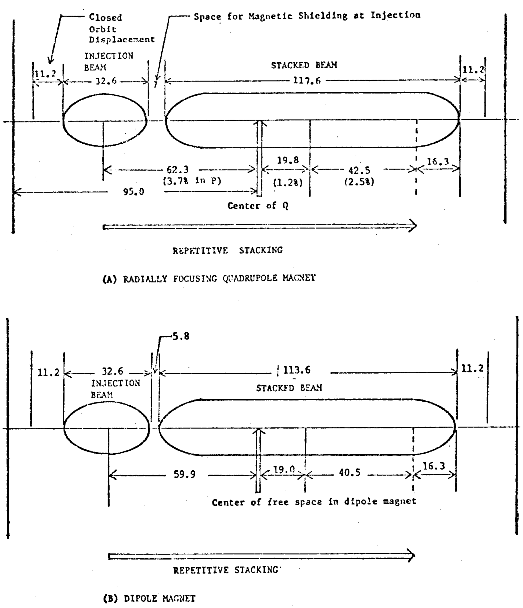

Fig.3. Typical Use of Aperture.

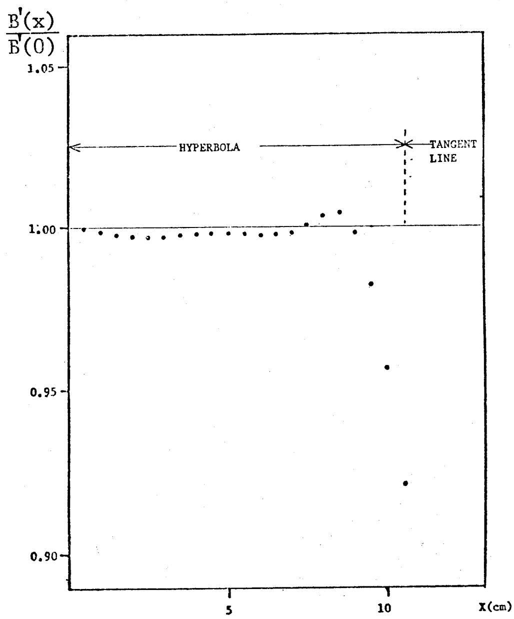

Fig.4. Field gradient in the Quadrupole Magnet