INJECTION AND EXTRACTION SYSTEM FOR THE 1ST RING CYCLOTRON

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Abstract

The injection and extraction system of the 1st ring cyclotron are redesined. The injection system is composed of two bending magnets, two magnetic inflection channels, two quadrupole magnets and an electrostatic inflection channel. The extraction system is composed of two electrostatic extraction channels, two magnetic extraction channels and a bending magnet. Optimal configurations for some of these element have been determined by using the TRIM code.

1. Introduction

An intermediate energy particle accelerator complex is being designed as a new accelerator facility at RCNP. It consists of an injector cyclotron and two separated sector cyclotrons. Beam injection from the injector into the 1st separated sector cyclotron should be designed to meet necessities of variable energy and variable particles. The injection system has been proposed to meet the optical properties from the point outside the ssc to the 1st equilibrium orbit. Some preliminary studies for the extraction system has been also designed.

2. Injection system

The injection system is designed to fit the high radial focussing frequencies $\nu_r \approx 1.5$. The injection trajectory for accelerated equilibrium orbit and injection elements in the central region of the 1st ring are shown in Fig. 1. The characteristics of the injection elements are given in Table 1.

The radial dispersion matching on the 'point to point' and 'parallel to parallel' transfer mode was studied using the computer code TRANSPORT. The beam envelope and the trajectories for the point and parallel beams are shown in Fig. 2. A beam having an emittance, 12 mm×2.8 mrad in horizontal direction and 12 mm×1.4 mrad in vertical direction, is transfered to the injection point as a beam just match the eigen-elipses, 4.8 mm×7 mrad and 4.2 mm×4 mrad in horizontal and vertical directions respectively. The turn separation of the beams on the injection point is 20 mm. The momentum acceptance of the injection system is more than ±0.5%.

The MIC1 should raise the field inside the channel by about 3.3 KGauss at the maximum excitation of the sector magnet. A combination of the iron shims and 4 turns septum coils is confirmed to be fitted for economical and technical conditions by using the computer code TRIM. A 6 mm thick and 8 cm wide floating iron shims shown in Fig. 3 was chosen. The field inside the MIC1 can be varied about 10% of its maximum by changing the coils currents. The flatness of the field inside the MIC1 at various excitation levels of the sector magnet was also confirmed by the combination of the coils currents. The field distribution in the symmetry plane was shown in Fig. 3.

3. Extraction system

The extraction system is composed of two electrostatic extraction channels (EEC1, EEC2), two magnetic extraction channels (MEC1, MEC2) and a bending magnet (BM3). The characteristics of the extraction elements are given in Table 1. At the extraction point in the valley, the turn separation of the beam is only 5 mm. However, the radial focussing frequencies of the 1st ring is very high ($\nu_r \approx 1.5$) on the extraction radius for protons and light ions. Thus the turn separation of 10 mm can be achieved with proper precessional motion of the beam. The MEC1 is septum coil and the MEC2 has dipole and quadrupole coils. The dipole coils are made of copper hollow conductor. The quadrupole coils are cooled by the dipole coils through He gas filled in the channel. The MEC 1 may be septum magnet composed of 4 turns coils. The field inside the MEC1 was calculated by using TRIM as shown in Fig. 4 . It needs a little more modification by a further study.

Table 1

Characterisitics of the injection and extraction elements

	θ_1	length	θ_2	Max. field	effective width Horiz.	Vert.
BM 1	29°	14cm(10°)	0°	11kG	5cm	3.5cm
BM 2	10°	87cm(110°)	-21°	17.5kG	5cm	3.5cm
MIC1	9°	78cm(94°)	16.8°	(16+3.3)kG	3.5cm	4cm
MIC2	30°	80cm(87°)	22°	(16+0.9)kG	3.5cm	4cm
Q1		15cm		1kG/cm	5cm	5cm
Q2		10cm		0.2kG/cm	4cm	2.5cm
EIC		30cm(3°)		75kV/cm	1.5cm	2cm
EEC1		50cm(0.2°)		60kV/cm	1.3cm	2cm
EEC2		80cm(0.8°)		75kV/cm	1.5cm	2cm
MEC1		75cm		(16-0.5)kG	2cm	4cm
MEC2		60cm(4.5°)		3kG+0.5kG/cm	3cm	2cm
BM 3		107cm(45°)		16kG	6cm	4cm

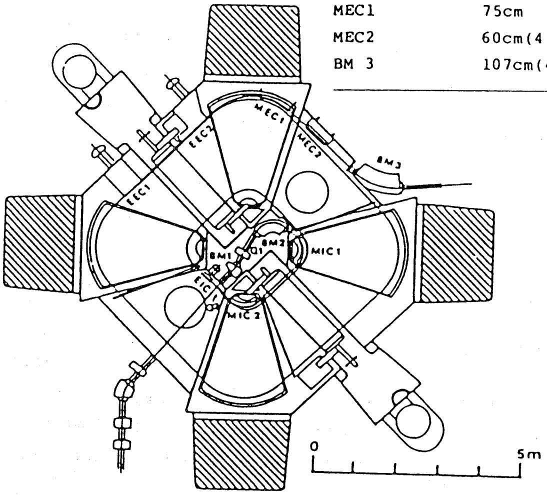

Fig. 1. Layout of the injection and extraction system for the 1st ring.

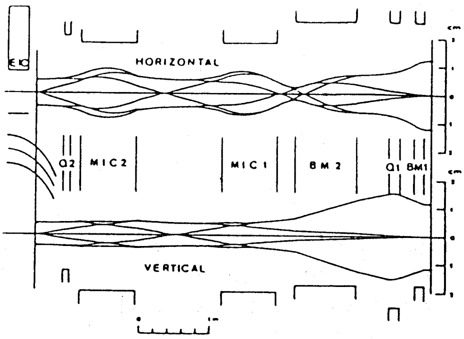

Fig. 2. Beam envelope of injected beam into the 1st ring.

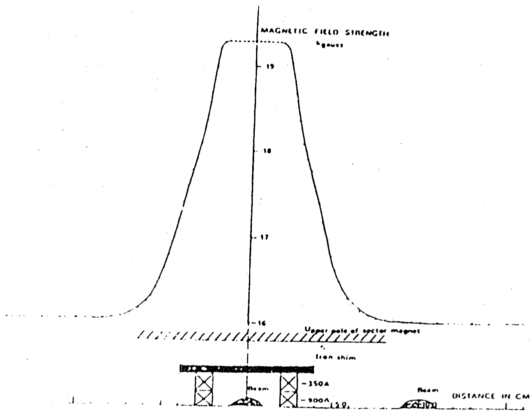

Fig. 3. Calculated field distribution of the magnetic inflection channel 1.

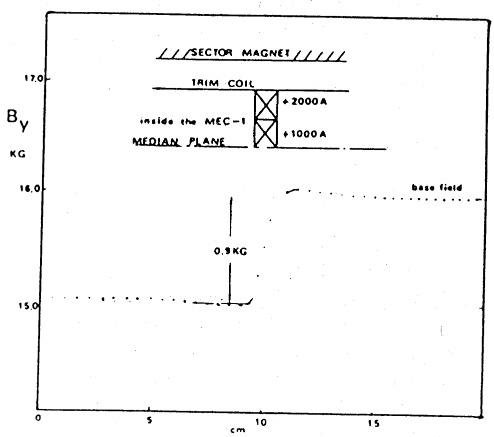

Fig. 4. Calculated field distribution around the MEC-1.