Construction of the IRC for RIKEN RI-Beam Factory

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Abstract

The IRC is a four-sector ring cyclotron for RIKEN RI-Beam Factory. Manufacturing of the IRC started in 1998. Machining of yoke plates and poles have been finished for two sector magnets. Manufacturing of two main resonators has been started this summer. All the components of the IRC will be completed by the end of March, 2001.

1 Introduction

The IRC (Intermediate Ring Cyclotron) is a room-temperature ring cyclotron with four sectors that is utilized for RIKEN RI-Beam Factory. It will be installed in the intermediate stage between the existing RIKEN Ring cyclotron (RRC) and the superconducting ring cyclotron (SRC) [1]. The IRC, having a K-value of 980 MeV, accelerates the extracted beams from the RRC; the maximum energy and the maximum magnetic rigidity of the IRC are 126.7 MeV/nucleon and 4.57 Tm, respectively [2].

Figure 1 shows a plan view of the IRC. The IRC consists mainly of four sector magnets, two main RF resonators, one flattop resonator, and injection and extraction devices. Main components of the IRC are installed in the area of 14 meters square.

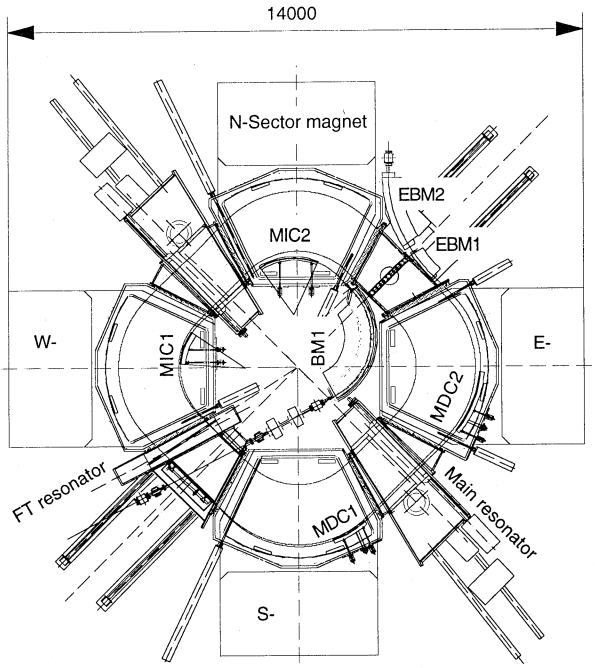

Fig. 1 Plan view of the IRC

The IRC will be operated with a harmonic of 7, while that of the RRC is 9. Thus the injection radius of the IRC is determined to be 7/9 of the extraction radius of the RRC. Main parameters of the IRC are listed in Table 1.

Table 1
Main Parameters of the IRC

K-value		930 MeV
Number of sectors		4
Harmonic		7
Mean radius:	Injection	2.77 m
	Extraction	4.15 m
Velocity gain factor		1.5
Number of resonators	Main	2
	Flattop	1
Cyclotron frequency		2.57-5.45 MHz

2 Sector magnet

The fundamental structure of the sector magnet of the IRC is similar to that of the RRC. Parameters of the sector magnets are listed in Table 2.A Purcell gap of 1 mm is set between the pole and the yoke. Main coils of the sector magnets are designed to be low power consumption. The maximum power of the main coils is suppressed to 70 % of that of the RRC, although the maximum magnetic field is higher than that of the RRC. Temperature increase of cooling water by main coils is calculated to be less than 10 degrees. Material of the poles and yokes is low carbon steel. Table 3 shows typical measured characteristics of the low carbon steel.

Table 2
Characteristics of the sector magnet.

Sector angle	53°
Gap width	8 cm
Height of magnet	5.2 m
Total weight	640 × 4 ton
Main coil	
Maximum magnetic field	1.9 T
Maximum magnetomotive force	1.78×10^5 AT
Maximum current	450 A
Maximum power	330 kW
Trim coil	
Number of trim coils	20 pairs
Maximum current	400, 500, 600 A
Maximum power	180 kW

Table 3
Typical measured characteristics of the low carbon steel. (weight percent)

C	Si	Mn	P	S	Cu	Al
0.002	0.007	0.13	0.006	0.002	0.02	0.020

Manufacturing of the sector magnets is in progress at Niihama works of Sumitomo Heavy Industries, Ltd. Machining of yoke plates and poles for 2 sector magnets have already been finished. Figure 2 shows a photograph of lower yoke of the first sector magnet (E-sector) under assembling. Figure 3 shows the main coil of the sector magnet. The first sector magnet will be completed this autumn. Magnetic field measurement of the sector magnet will start from this winter. Firstly, measurement for one sector magnet will be performed. After that, two sector magnets will be aligned with a configuration same as the real one. Then field mapping of 180 degrees region will be performed in order to measure the coupling effect of the sector magnets. The field mapper of the IRC is designed to be able to measure 360 degree mapping after installation of the whole sector magnets into RIKEN site.

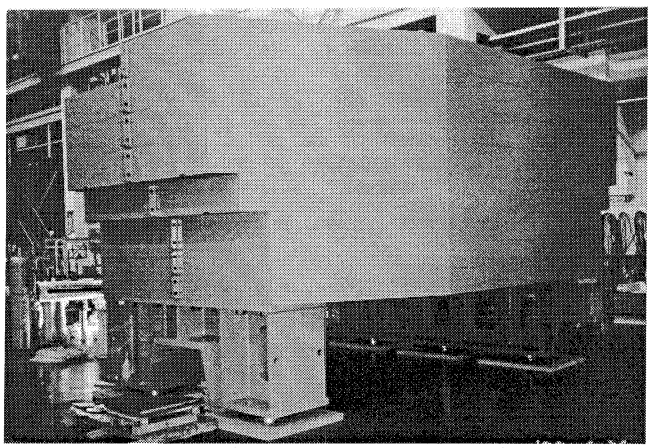

Fig. 2 Lower yoke of E-sector magnet under assembling at Niihama works, Sumitomo Heavy Industries, Ltd.

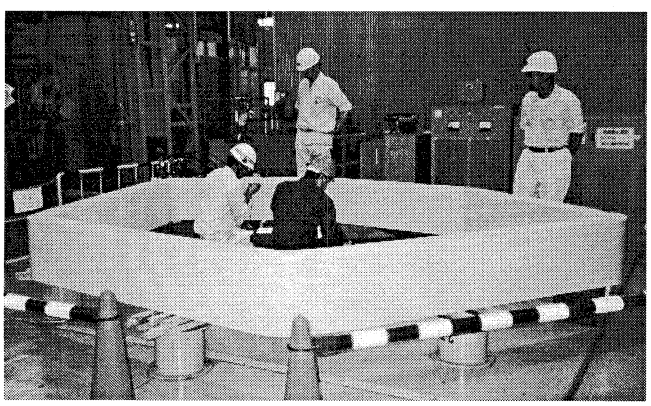

Fig. 3 Main coil for the sector magnet

3 Resonators

Two kinds of resonators are adopted for the IRC: two main resonators and one flattop resonator. The main resonators are of a single-gap type with flapping panels for changing resonant frequency [3]. The flattop resonator is of a single-gap type with shorting plates. In order to realize ultra-high vacuum, duplicated-wall structure is adopted [4]. Manufacturing of the main resonators has been started and will be completed in the summer of 2000.

4 Conclusion

Manufacturing of the IRC for RIKEN RI-Beam Factory has been started and is in progress on schedule. Machining of yoke plates and poles for two sector magnets was finished. Assembling of the first sector magnet (E-sector) will be complete this autumn. Magnetic field measurement of the sector magnets will be started this winter. Manufacturing of the main resonators has been started. All the components of the IRC will be completed by the end of March 2001.

References

[1] Y. Yano et al., "RIKEN RI Beam Factory Project", Proc. of 1997 Partl. Accel. Conf.,(1997) 930
[2] T. Mitsumoto et al., "Design Study of the IRC for RIKEN RI-Beam Factory", RIKEN Accel. Prog. Rep. 32, (1999) 195
[3] N. Sakamoto et al., "Model Test of the RIKEN-IRC Main Resonator", in this proceedings
[4] T. Hiasa et al., "Vacuum Design RF-resonator for the RIKEN Intermediate-stage Ring Cyclotron", in this proceedings