JAERI-Conf 2001-002

ICANS-XV
15th Meeting of the International Collaboration on
Advanced Neutron Sources
November 6-9, 2000
Tsukuba, Japan

6.4
JKJ SYNCHROTRON RF SYSTEM

C. Ohmori[1]*, Y. Mori[1], M. Yamamoto[2] and M. Yoshii[1]

[1]High Energy Accelerator Research Organization,
Tsukuba 305-0801, Japan
[2]Japan Atomic Energy Research Institute,
Tokai 319-1195, Japan
*E-mail:chihiro.ohmori@kek.jp

Abstract

The RF acceleration system of JKJ (JAERI-KEK Joint Project) [1,2] synchrotrons will be described. A high field-gradient cavity[3,4] will be used for JKJ synchrotrons.

1. Introduction

The JKJ accelerator complex consists of the linac, 3 GeV synchrotron and 50 GeV one. Both synchrotrons will provide very high intensity beam for experiments. The 3 GeV synchrotron is a rapid-cycling synchrotron and will provide 1 MW proton beam for the neutron source and 15.5 μA for the 50 GeV synchrotron. The main parameters of both synchrotrons are listed in Table 1.

Table 1: Main parameters

	3GeV PS	50GeV PS
Repetition Rate	25 Hz	0.3 Hz(3.42 s)
Rise time	20 ms	1.9 s
Harmonic number	2	10
Circumference	313.5 m	1567.5 m
Injection Energy	400 MeV	3 GeV
Extraction Energy	3 GeV	50 GeV
RF frequency	1.36-1.86 MHz	1.86-1.91MHz
Max. RF Voltage	420 kV	280 kV

2. RF SYSTEM

As listed in Table 1, large RF voltage is required for both synchrotrons. Because the space for the RF system is limited, high field-gradient cavity is necessary. To obtain the very high RF voltage, Magnetic Alloy(MA) will be used for the magnetic cores of the synchrotron RF cavities. As shown in Fig.1, MA core shows very stable characteristics under the high magnetic field and high voltage. Another advantage of MA core is that the tuning circuit to resonate the cavity is not required because of the low Q-value of core. And, the Q-value of the cavity is variable using a cut-core technique.

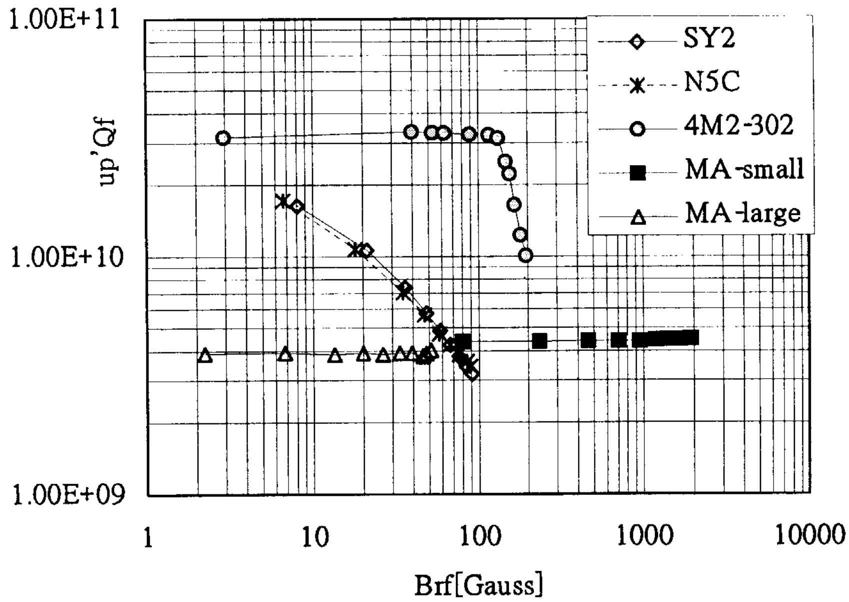

Figure 1. The characteristics of magnetic cores. The horizontal axis is magnetic field in the core and it is proportional to the RF voltage. The vertical axis is the product of permeability, Q-value and frequency and proportional to the shunt impedance. The MA cores show a very stable characteristic under the very high field of 2000 Gauss.

The parameters of the MA cavity are listed in Table 2[5]. The length of the cavity tank is 1.55 m and the field gradient is larger than 30 kV/m for both synchrotrons. The Q-values of both cavities are chosen to optimize the beam loading effects and power consumption. For 3 GeV Synchrotron, the bandwidth is also considered for dual harmonic acceleration. Because the Q-value of the 3 GeV synchrotron is 3, it will generate both fundamental and second harmonic frequencies at the same gap, simultaneously. By the dual harmonic system, the bunching factor of the beam is increased and the space charge tune shift will be reduced. The amplitude of the second harmonic frequency will be reduced according to the increase of the beam energy. Figure 2 shows the RF voltage of the 3 GeV synchrotron and space charge tune shift.

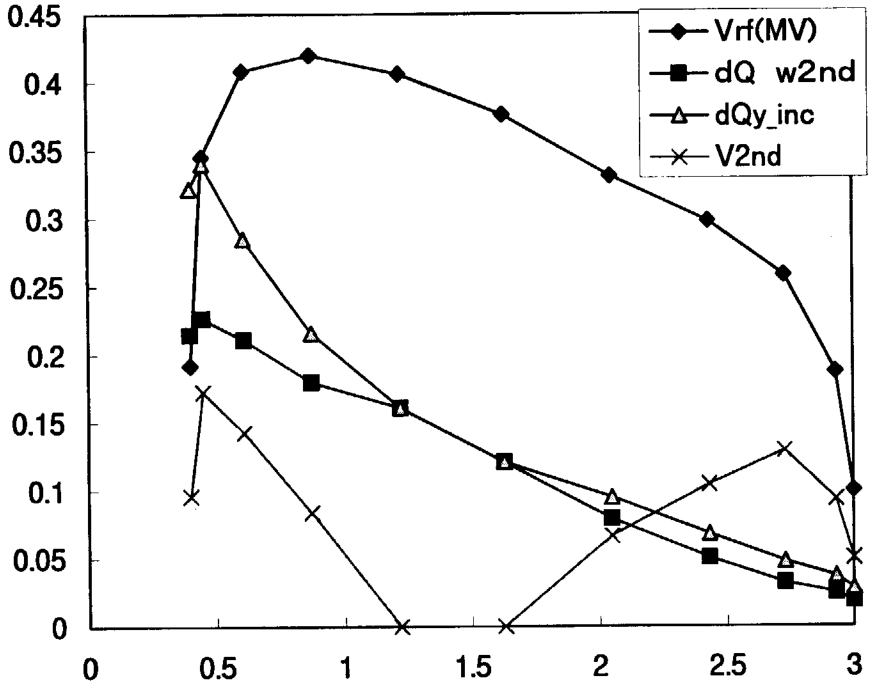

Figure 2. RF voltage and space charge tune shift of dual harmonic system. The reduction of the space charge tune shift by the dual harmonics was calculated from the bunching factor.

Table 2: Parameters of MA cavity

	3GeV Synchrotron	50GeV Synchrotron
Number of cavity	10	6+1
Voltage	42 kV(Max.)	46.7 kV
Number of gaps	3	3
Impedance	2.1 kΩ	3 kΩ
Quality factor	3	10
Duty	50 %	59 %
Number of cores	24	24
Length	1.55 m	1.55 m
Max. Power loss	420 kW	363 kW
Averaged loss	105* kW	214 kW
Loss per core	4.9 kW	8.9 kW
Outer diameter of core	90 cm	90 cm
Inner diameter of core	36 cm	25 cm
Thickness of core	2.6 cm	2.6 cm
Diameter of beam pipe	24.6 cm	14 cm
Power Density in core	0.35 W/cc	0.58 W/cc

3. R&D STATUS

A test cavity using the cut-core technique has been developed and operated using a 1 MW-class push-pull amplifier. The CW operation has been performed up to 10 kW per core that is larger than the required power dissipation for the JKJ project. The waveform was measured from 1.4 to 2 MHz. The significant waveform distortion was not observed although the resonant frequency was fixed at 1.9 MHz and any tuning system was not used.
The cavity is modified and installed in the KEK 12 GeV-PS for the dual harmonic experiment, as shown in Fig. 3. Another 300kW amplifier is used to drive the cavity at 6-8 MHz and 12 MHz.

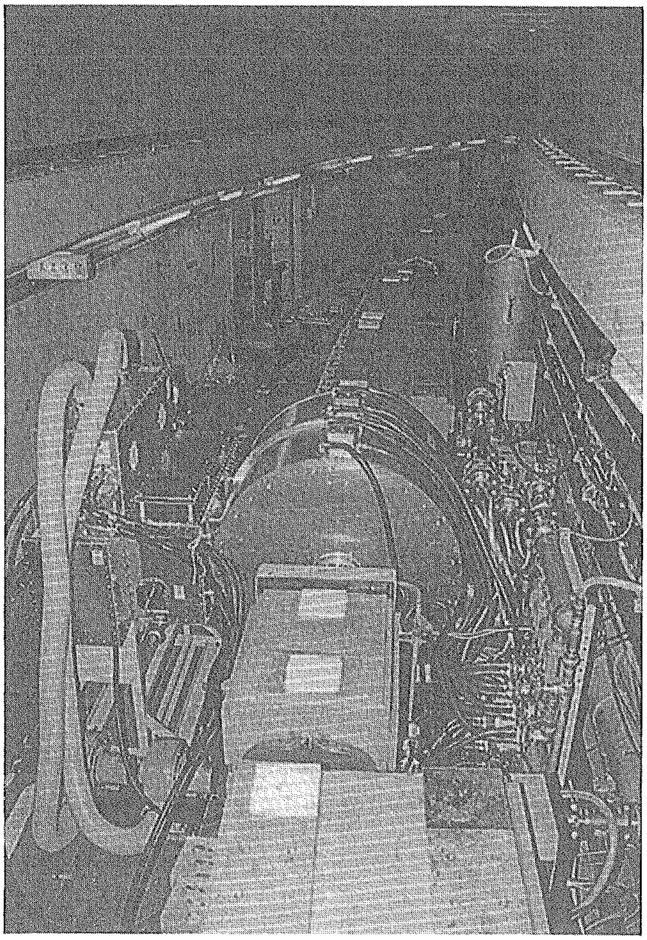

Figure 3. A MA cavity installed in KEK 12 GeV PS.

4. CONCLUSIONS

RF system for the 3 GeV and 50 GeV Proton synchrotrons of Joint Project has been designed. The high field-gradient cavity will be used for both rings. The test cavity has been developed and the high power test has been performed.

REFERENCES

[1] The Joint Project team of JAERI and KEK, KEK-Report 99-4, JAERI-Tech 99-056.
[2] Y. Yamazaki et al., "Accelerator complex for the Joint Project of KEK/JHF and JAERI/NSP", PAC99, New York, April 1999, p513.
[3] C. Ohmori et al., "High Field-Gradient Cavities Loaded with Magnetic Alloys for Synchrotrons", PAC99, New York, April 1999, p413.
[4] Y. Mori et al., "A New Type of RF Cavity for High Intensity Proton Synchrotron using High Permeability Magnetic Alloy", EPAC1998, p299
[5] C. Ohmori et al., "RF Acceleration System for Joint Project", EPAC2000, Vienna.