R&D PLAN OF THE 8 GEV BOOSTER SYNCHROTRON FOR 1989-90

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Abstract

We describe R&D plans of the booster synchrotron for coming one or two years. The present R&D subjects can be divided into four groups; magnets and the power supply, RF system, vacuum system and beam monitors.

Introduction

The role of the booster synchrotron is to accelerate electron/positron beams of the energy of about 1 GeV from the linac up to 8 GeV for the storage ring.[1] Low emittance (1.95×10^{-7} mrad), high current (10 mA in average) and short(1 ns) or long(1.3 μs) pulse beam is requested. The design policy is that the system should be reliable, capable of various types of the operational mode, at a minimum of manpower with automation and maintenance free. Under these conditions we are now designing the synchrotron. A concepual desigh has been reported elsewhere.[2] The apparatus for the R&D are under construction and the design of the system must reflect results from the investigation.

Magnets and power supplies

In the design of the magnet systems there still remain some difficulties at the injection/extraction part because of its rapid rise time of the magnetic fields. The problem on the septum magnet is to minimize the leakage field out of the septum plate. As to the kicker magnet, both rise and fall times of around 100 ns should be achieved. So we have to test and develop a septum magnet and a kicker magnet with their power supplies. At the same time we will establish a methods of measurement of such fast varying magnetic fields.

In the R&D we also make each prototype of the dipole, quadrupole and sextupole magnet with power supplies . The purpose of the research is to clear following points prior to the commissioning to the facility; 1) whether the quality of the magnetic fields agree with our requirement, 2) whether the computer calculation of the magnetic fields, using LINDA, agrees with measured ones, and 3) to verify the performance of the bellow type and/or the reinforced thin duct against eddy currents by measuring magnetic fields in the duct, 4) to develop an easy method of the test of the magnets before installation. The basic parameters of the magnets are shown in Table 1.

Table 1
Parameters of Magnets

Bending Magnet	
No. of Magnet	68
Strength at 8 GeV	0.85 T
Length	2.9 m
Bending Radius	31.4 m
Type	C-Shape
Quadrupole Magnet	
No. of Magnet(QF/QD)	40/40
Strength at 8 GeV(QF/QD)	14.6/12.4 T/m
Length	0.6 m
Sextupole Magnet	
No. of Magnet(SF/SD)	16/32
Strength at 8 GeV(SF/SD)	204/163 T/m^2
Length	0.15 m
Extraction Septum Magnet	
Type : sin wave-Horizontal deflection	
Bending Angle	8.3 mrad
Bending Radius	48.2 m
Max Field	0.554 T
Pulse Shape	2.5 kHz
Thickness	< 2 mm
Channel Aperture	8Hx14W mm^2
Laminated Length	40 cm
Extraction Kicker Magnet	
Type : delay line-Horizontal deflection	
Deflection Angle	0.6 mrad
Max Field	0.04 T
Pulse Duration	180 ns
Rise Time	~100 ns
Mechanical Length	0.4 m

RF system

In the R&D plan for the RF system we first make a full scale model and test basic characteristics of the cavity at low power level. The subjects are ; 1) the resonant frequency, 2) Q values of each mode, which are compared with calculated ones and the condition of the cavity surface will be estimated from the results, 3) measurements of the distribution of electromagnetic fields in the cavity, 4) shunt impedance from the measurement 3) and an estimation of necessary power , 5) characteristics of the antenna, 6) performance of the tuner which enables to get best of the field distribution and an automatic frequency control also, 7) development of a computer control and a data taking system.

The results from the cold experiments should be reflected to the design of a cavity which is to be used in high power tests. Using a klystron test stand we will proceed high power experiments. The main subjects on the high power test stand as well as those of mentioned above are 1) a ceramic window which is capable of CW 250 kW,

2) thermal distortion of the cavity especially of the nose cone, 3) method of cooling and its efficiency.
The present design of the RF cavity is shown in Fig. 1 and the parameters are summarized in Table 2.

Table 2
RF System Parameters

Type of Cavity	5 cells Slot coupled
Cavity Length	177 cm
Cell Length	29.5 cm($\lambda/2$)
Radius	21.5 cm
Effective Shunt Impedance	21 MΩ/m
Cavity Power (Peak)	250 kW
No. of Cavity	8
Frequency	508.58 MHz
Harmonic No.	672
Klystron Power (peak)	1.2 MW
No. of Klystrons	2
Accel Voltage at 8 GeV	17.1 MV
Accel Voltage at 1 GeV	1.8 MV
Over Voltage Factor	1.48
Synchrotron Freq at 8 GeV	32.4 kHz
Radiation Loss per One Turn at 8 Gev	11.6 MeV

Vacuum

The design of the vacuum system is determined from the duct size, allowable pressure of the residual gas and allowance of the field distortion, which are related to beam dynamics, beam life time and eddy currents due to dB/dt, respectively. Because our synchrotron will be operated at 1 Hz, we have to prepare against eddy currents applying a particular duct: a bellow type or a thin tube reinforced by ribs.

For the R&D we made two test stands. One is a prototype beam duct with a pumping system, which is equivalent to that of a unit cell of the synchrotron. The study plans on the model duct are; 1) to know the reality of the pressure distribution, by varying pump power and distribution, and to compare measured one and calculated one, 2) to test performance of an alternative pumping system and 3) to test spatial problems of the duct circumstances with a combination of model magnets.

Another one is a test chamber which is to be used to evaluate outgassing rate of vacuum materials. To lower outgassing rate, pre-treatment for the ducts will be investigated.

Beam monitors

Various types of beam monitors have been proposed for the synchrotron. Although methods of those monitors have been well established, it seems that there arise further difficulties in our synchrotron due to short pulse, single bunch and 1 Hz operations. We consider that every method should be tested/improved as R&D before application.

Among those monitors we first test an emittance monitor. Both of multi-grid and multi-plate type detector with a slit are prepared and to be tested at the JAERI linac.[3,4] By mounting a fluorescent screen near those detectors emittance will be cross checked. As one of the position monitors we provide photodiode arrays and this will be tested applying to our compact ring (JSR).[4,5]

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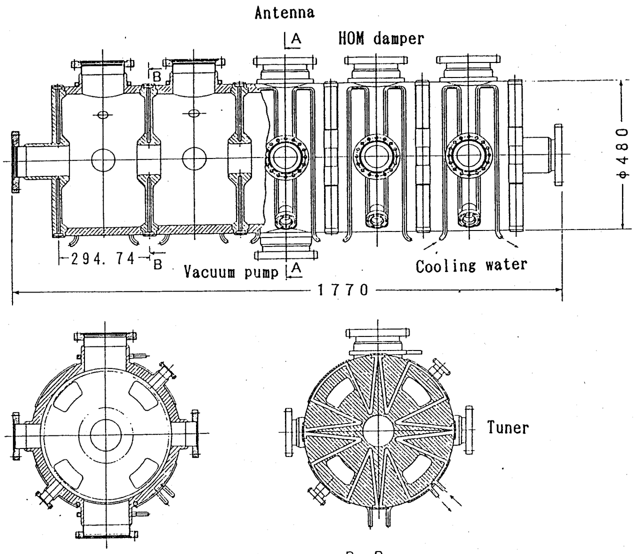

Fig.1 Design of the RF cavity