COMISSIONING OF THE WORLD SMALLEST ELECTRON STORAGE RING

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Abstract

The photon storage ring(PhSR) which is composed of the world smallest electron storage ring is under constraction. The PhSR is a light source which produces ultra-high intensity far-infrared-ray as well as hard x-ray beams At present the PhSR is set at IMS, Okazaki for beam injection useing the 15 MeV linac. We have started the commissioning of the ring in December and observed the circulating beam on the Christmas Eve.

1 CONFIGURATION OF THE RING

The world smallest electron storage ring is under construction, which has the 0.156 m orbit radius.[1] The parameters of the ring is shown in Table 1. The configuration of the ring is rather simple as shown in Fig. 1, which is composed of one cylindrical normal conducting magnet, pear of perturbator coils, and dual acceleration cavities. Magnetic channels are not introduced, which is usually used for guiding electron beam passing through the magnetic fringing field. A field clamp is introduced in the present ring instead. Special difficulties encountered are the limited space for the cavities and the perturbators. Those are placed in the 80 mm pole gape. The power to the both cavities are fed through one 80 mmϕ hole in the center of the magnet with 22 mmϕ coaxial pipe. Four cooling water lines and pickup signal lines are also installed in the same hole.

The magnet has been completed as shown in Fig. 2, which is similar to AURORA[2] but is made of normal conducting coils. The measured magnetic field was found so as to be designed at the central field but not at the fringing field.

Two accelerator cavities of 2.45 GHz is installed between the pole gapes of 80 mm wide as shown in Fig. 3.[4] These have a quite extraordinary shape. A large slit is open to let the synchrotron radiation out. But we have obtained the TM01 fundamental mode so to be designed, and we could apply nearly 0.5 kW power equally to each cavity. The measured field distribution is shown in Fig. 4. The field was flat over 60 mm wide span in the transverse direction within a 5% variation.

The microwave power is fed by one source

Table 1

Magnet	Weak focusing, normal conducting, Cylindrical		
Pole gap	100 mm		
Orbit radius	0.156 m		
n-value	0.52		
RF Cavity	Twe set, re-entrant type		
frequency	2.44 GHz		
Harmonics	8		
RF-voltage	50 kV		
RF Source	Magnetron		
Perturbator	Pair of one turn coil		
pulse source	0.4 μs width, 6500 A peak current		
repitition	Max 100		
Injector(Okazaki)	15 MeV linac, 3 Hz repitition		
(Ritsumeikan)	22 MeV microtron		
Electron energy	15 MeV	22MeV	50 MeV
Damping time	3.2 s	1.0 s	0.085 s
Critical wavelength	25.8 μm	8.1 μm	0.69 μm

through the T-shape coaxial pipe. As a result two cavities are coupling each other. We have established the method for feeding power equally to the both cavities by one source. Due to the limited budget, a 1 kW magnetron was used for the microwave source while a klystron is normally used. The magnetron frequency was depend on the power, so that we could chose the cavity igen frequency by changing the power. The magnetron frequency varied within 2 MHz/s, which is 0.1% variation. So far we have succeeded in feeding 0.5 kW power continuously for more than one hour. We do not know yet how the frequency change affects to the electron beam quality. We will change the source to klystron in

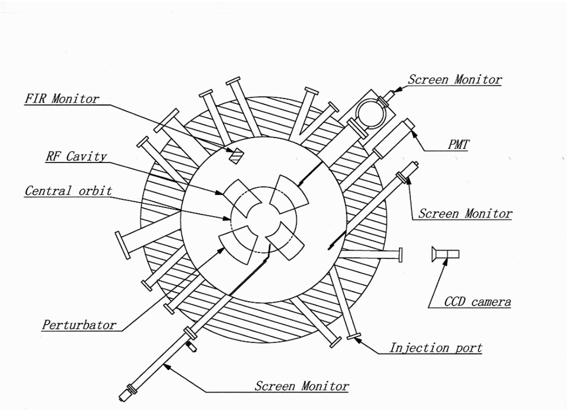

Fig. 1 The configulation of the world smallest electron storage ring.

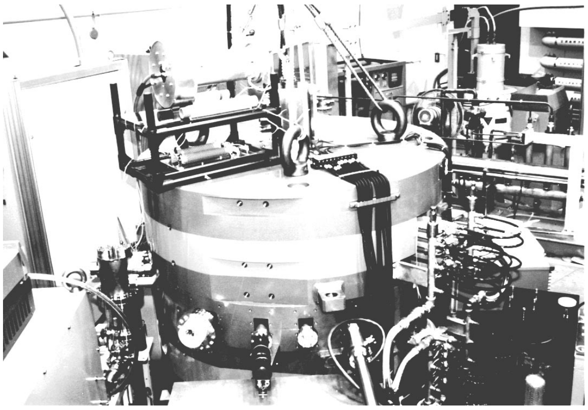

Fig. 2 View of the smallest electron storage ring at the injector site of UVSOR, Okazaki. The out diameter is 1.2 m, the hight is 1.5 m. The magnetic pulse compression system is seen on the top of the magnet.

near future.

For the machine control we have adopted GPIB-ENET(National Instruments Co. Ltd.) which runs on an existing TCP/IP network system. The man-machine interface is “Laboview” on Windows’95 runs on several personal computers. Initially we made the remote control of the main magnet coil, 5 trim coils, and the magnetron power.

2 2/3 RESONANCE INJECTION SCHEME

A 2/3 resonance injection method is introduced, which is similar to the 1/2 integer resonance method[3] which was successful with AURORA. Pair of perturbator magnets are made of one turn coils, as also shown in Fig.3, which kick electrons orbiting outer and inner edges, respectively. The perturbators have also slits in the median plane. To produce enough kick by one turn air core coil for the 2/3 resonance injection, the maximum of 300 G is the necessary field strength for the 15 MeV injection. We use the half cycle sin shape pulse which has a 4 μs width with

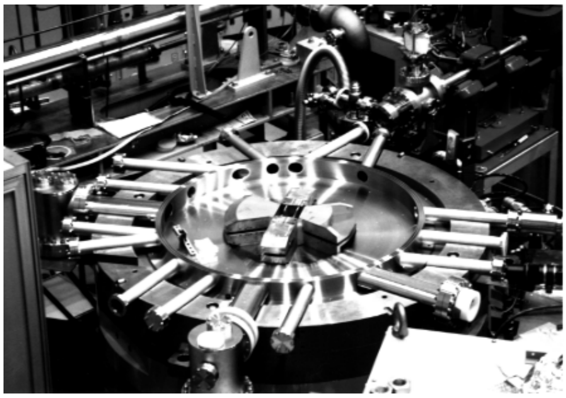

Fig. 3 Inside of the vaccum chamber is shown. Pair of the perturbator and dual accelerator cavitys are seen. Every component has a slit of 12 mm wide in the median plane.

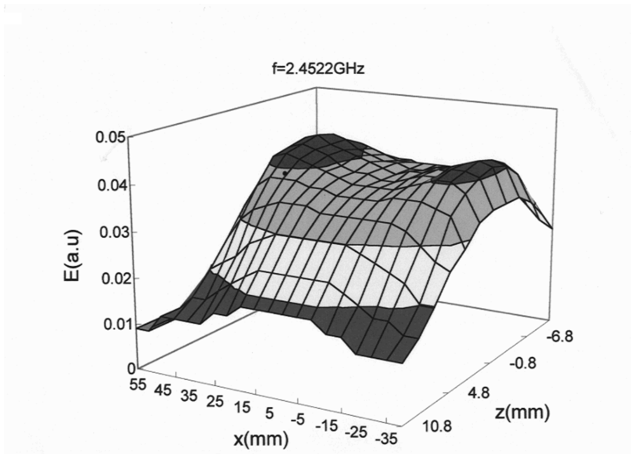

Fig. 4 The demonstrated flat field distribution of the accelerator cavity in the radial direction.

maximum of 30 kV and 4.5 kA peak current. For the further compression we have developed a magnetic pulse compression technique(as seen on the top of the magnet in Fig. 2) by using amolphas core and successfully achieved the maximum of 6.5 kA peak current with less than 0.4μs pulse width.

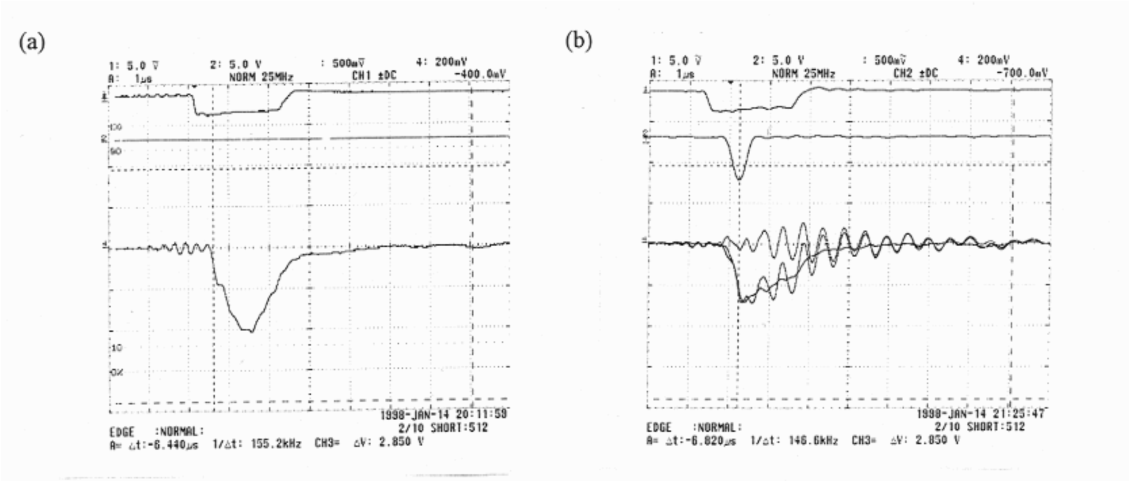

Fig. 5 Degital osciloscope pictures; from the top, the linac beam shape detected by CT, puterbator pulse shape, and the PM singnal. (a) shows the case without puterbator. The PM signal is cut in the top part in (b), which indicates that the beam is captured, thus the electrons did not generate γ-rays.

3 BEAM INJECTION

The beam diagnostics for the beam injection is a difficult task, because the critical wavelength of the synchrotron radiation is 25 μm for 15 MeV, and the available detector response is rather poor. We have used TGS detector without chopper, thus we were only able to detect the infra-red rays generated by the linac pulse beam but not by the stored beam. Measurement of γ-rays with a photo-multiplier is an alternative method. The γ-rays are generated by electrons when they hit the mass of chamber wall or the inside components. The kind of detectors and each position are shown in Fig. 1. The 0.3 mm thick thin screen monitor made of CaF(Eu) was useful to see the beam profile of the circulating beam.

At present the smallest ring is placed at UVSOR injector room. The 15 MeV linac was used for the beam injection test. We have started the beam injection in the last December, and established the circulating beam in the Christmas Eve. We do not have a direct observation of the beam, but the γ-ray detector clearly shows the evidence as shown in Fig 5. Fig. 5(b) shows the linac beam shape detected by CT, puterbator pulse, and the PM singnal, while 5(a) shows the case without puterbator. The PM signal is cut in the top part in Fig. 5(b), which indicates that the beam is captured, thus the electrons did not generate γ-rays. The distortion of the PM signal started coincidentally at the top of the purterbator signal as predicted by the resonance injection scheme. From the ratio of both PM signals we see the injection efficiency which is about 30%. We like to remind that the energy distribution of the linac is extremely poor compared with the microtrn which was used for the AURORA injection. We believe that the 30% is rather high efficiency.

We have now scheduled moving the ring from Okazaki to Ritsumeikan University. The new building is ready for the instalation. A 22 MeV microtron will be installed in the collaboration with P.L.Kapitza Institute.

4 REFERENCES

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