Development of the Pulse Magnets for the Booster Synchrotron of SPring-8

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1. Introduction

The SPring-8 synchrotron is required that the synchrotron accepts the electron beam of 1 GeV from the SPring-8 linac, accelerates the beam upto 8 GeV and ejects the electron beam to make stacking into the SPring-8 storage ring with the repetition period of 1s. In multi-bunch mode-operation of the ring, the long-pulse electron-beam which has macro-bunch length of 1 μs from the linac is accepted in half-number, continuos buckets of the synchrotron. In a single-bunch mode-operation, the synchrotron accepts the short-pulse beam which has macro-bunch length less than 1ns. Eight buckets of the synchrotron are occupied in equal spacings by the short-pulse beam from the linac. The electrons which occupy the 8 buckets are injected in a single bucket of the ring with contolling the timing trigger signals for the electron gun of the linac and the pulse magnets of the injection and extraction systems of the synchrotron.

2. Injection and Extraction Magnets

Beam injection of the synchrotron was designed to be on-axis injection method. Injection system of the synchrotron is composed of two septum magnets and two kicker magnets. Extraction system of the synchrotron consists of three kicker magnets, four septum magnets and four bump magnets, which are used to extract the electron beam with 8 GeV from the synchrotron.

3. Pulse Magnets

3-1 Second Septum Magnet of Extraction System

Magnetic-field strength of the 2nd septum magnet was measured. The field distribution on the extraction orbit at the magnet end is shown in Fig. 1. The effective length of the field is 9 mm longer than the core length, and the magnetic rigidity of 3.4×10^{-5} Tm due to the leakage flux is smaller than the leakage allowance of 1.2×10^{-3} Tm.

3-2 Third Septum Magnet of Extraction System

Magnetic-field strength of the 3rd septum magnet was measured. The field distribution on the extraction orbit at the magnet end is shown in Fig. 2. The effective length of the field is 20 mm longer than the core length, and the magnetic rigidity of 1.1×10^{-3} Tm due to the leakage flux is smaller than the leakage allowance of 2.1×10^{-3} Tm.

3-3 Kicker Magnet of Extraction System

In order to achieve the single-bunch mode-operation of the storage ring, rise time and fall time of the magnetic field have to be shorter than 50 ns and 150 ns, respectively. The flat-top time is required to be longer than 60 ns. Trial manufacture of the kicker magnet was completed successfuly[1]. The field distribution of $K_e 1$ along the design orbit is shown in Fig. 3. The effective length is 18 mm longer than the pole length, and the waveform of the magnetic field distribution is gratified.

3-4 Bump Magnet of Extraction System

The waveform of the kicker magnet at the beam extraction must be very fast. It is difficult to get strong magnetic-flux density over a long pole length of the kicker. The bump orbit is formed with four bump magnets and the extraction orbit is achieved on the bump orbit because of the low magnetic-rigidity of the fast kicker. The field distribution of $B_p 2$ along the design orbit is shown in Fig. 4 and the effective length is 36 mm longer than the core length of the magnet.

4. Conclusion

In the synchrotron, fifteen pulse magnets are installed to inject and eject electron beam. Some magnets which might be considered to have some difficulties in manufacturing have been constructed in an early stage of the synchrotron-construction plan. These magnets and the power supplies were completed successfully. We have started to manufacture the remainders of the pulse magnets on schedule.

Reference

[1] Y.Sasaki, H.Yonehara, H.Suzuki and T. Aoki; Proceedings of the 9th Symposium on Accelerator Science and Technology, Tsukuba, Japan p.255, 1993.

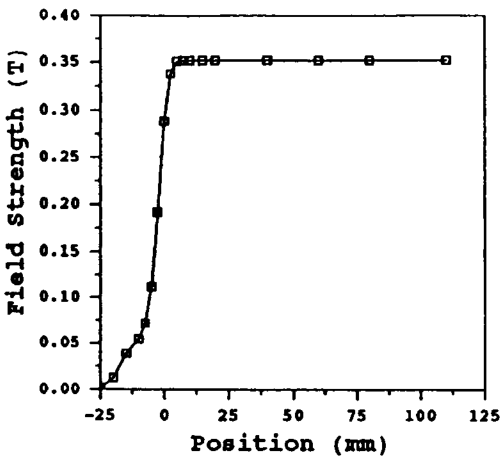

Fig.1. Magnetic-Field Distribution of S_e2 at the Upstream End ---The position of s=0mm shows the core end of S_e2.

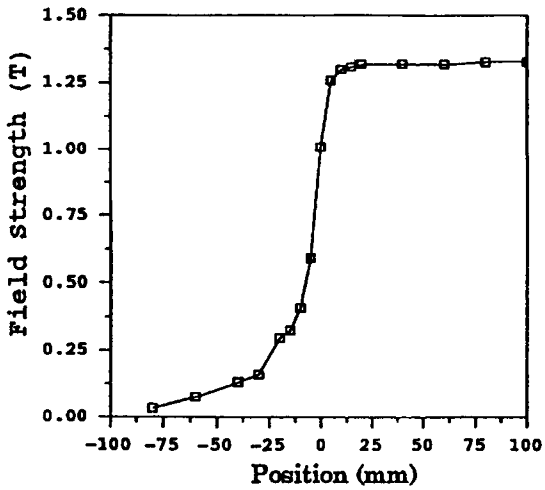

Fig.2. Magnetic-Field Distribution of S_e3 at the Upstream End ---The position of s=0mm shows the core end of S_e3.

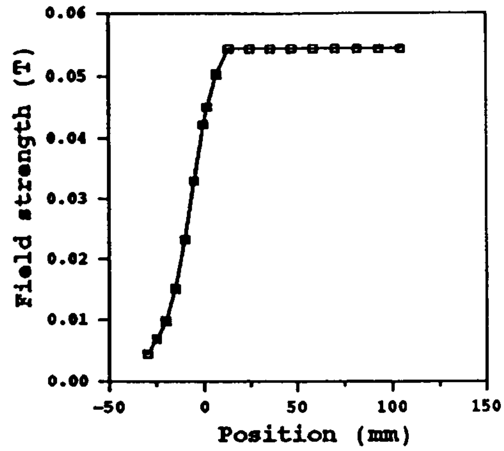

Fig.3. Magnetic-Field Distribution of K_e1 ---The position of s=0mm shows the pole end of K_e1.

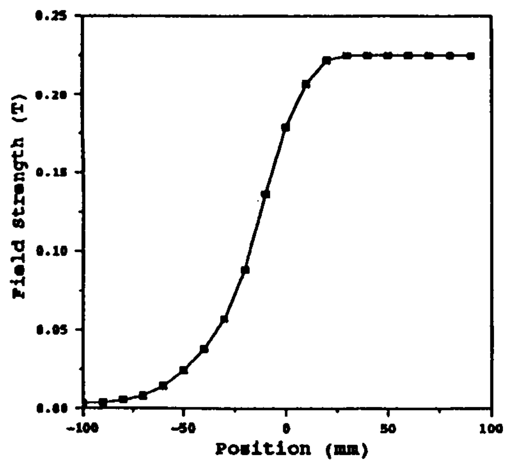

Fig.4. Magnetic-Field Distribution of B_p2 at the Downstream End ---The position of s=0mm shows the core end of B_p2.