SPring-8 Beam Performance

Recent update of accelerators

One of the recent works on the SPring-8 accelerator complex has been to renew the low-level radio-frequency (LLRF) system of the storage ring. The LLRF system is distributed at four RF stations along the storage ring, and the existing system based on analogue NIM modules has been dedicated to user operations since the SPring-8 accelerator complex was constructed in the 90s. Now we are aiming to replace the existing system with a new one based on the modern standard MicroTCA.4 before the existing system becomes unreliable due to its degradation over time. Also, one of our concerns is that some of the electric parts inside the system will no longer be available on the market.

This fiscal year we first tested our new LLRF system at the test RF stand, and its operation was successfully demonstrated. Therefore, we installed the new LLRF system in one of the four RF stations, called the A-station, after finishing this fiscal year's user operation in February 2018. From the beginning of user operation in fiscal year 2018, we plan to commence user operations with the new LLRF system at one of the four RF stations. Later, we intend to complete the installation of the new system in all four RF stations unless some unexpected problems occur. The new system is expected to provide more reliable and stable user operations by taking advantage of MicroTCA.4 [1].

Fig. 1. Permanent dipole magnet under magnetic field measurement. The magnet consists of four segments; the first and third segments are made of samarium-cobalt, and the second and fourth segments are made of neodymium-iron-boron (NdFeB).

Another recent work has been to replace one of the dipole electromagnets used in the beam transport from the booster synchrotron to the storage ring with a newly developed permanent magnet-based dipole magnet. At SPring-8, we have studied a possibility of applying permanent magnet-based dipole magnets for next generation light sources, especially SPring-8-II [2]. Permanent magnets are advantageous over conventional electromagnets in that they consume less power, are physically more compact, and there is less risk of a magnet-related accelerator failure due to, for example, a power failure or water leakage. It follows that a permanent magnet could be beneficial to both the facility and its users. However, there are also practical challenges in using permanent magnets as the main magnets for light sources. For example, the behavior of a permanent magnet is known to be temperature-dependent, which may result in a shift in the electron energy caused by ambient temperature drift in the accelerator tunnel. Radiation damage of the permanent magnet is also a concern when one considers the fact that the demagnetization of undulator permanent magnets has been observed at several accelerator facilities [3]. In recent years, we have designed, fabricated, and tested several kinds of permanent dipole magnets to overcome these challenges [2]. In this fiscal year, we fabricated a 2-m-long C-shaped permanent dipole magnet, in which the magnetic circuit was designed so that the dipole magnetic field was insensitive to temperature drift. After implementing several measurements in the magnet measurement room (see Fig.1), we replaced one of the beam transport magnets between the booster synchrotron and the storage ring, SSBT-BM5, with the permanent dipole magnet after the end of this fiscal year's user operation. We will start operations with the new permanent dipole magnet in fiscal year 2018.

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References

[1] T. Ohshima *et al.*: Proc. IPAC2017(2017), THPAB117.
[2] T. Watanabe *et al.*: Phys. Rev. Acc. Beams **20** (2017) 072401.
[3] T. Bizen *et al.*: Sci. Rep. **6** (2016) 37937.