SPring-8 Beam Performance

Recent update of accelerators

Renewal of the low-level radio-frequency (LLRF) system of the storage ring has been in progress. The LLRF system is distributed at four RF stations along the storage ring and has been dedicated to user operations since the SPring-8 accelerator complex was constructed in the 90 s. However, the analogue NIM modules have gradually become unreliable owing to their degradation over time. Also, one of our future concerns is that some of the electric parts inside the system will no longer be available on the market. Thus, we have developed a new LLRF system based on the modern standard MicroTCA.4 [1] and commenced user operations in fiscal year 2018 with one of the four RF stations, called the A-station, operated by the new LLRF system. So far, the new system has been working properly without any fatal errors, although several minor errors have been recognized and fixed. We plan to renew the LLRF system in the B- and C-stations in the summer of fiscal year 2019 and in the D-station at the end of the fiscal year.

At SPring-8, we have studied the possibility of applying permanent-magnet-based dipole magnets to next-generation light sources, especially SPring-8-II [2]. We have recently replaced one of the dipole magnets in the beam transport from the booster synchrotron to the storage ring with a newly developed permanent-magnet-based dipole magnet. Permanent magnets are advantageous over conventional electromagnets in that they consume less power and 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 permanent magnets 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]. At the end of fiscal year 2017, we replaced one of the beam transport magnets between the booster synchrotron and the storage ring, SSBT-BM5, with a permanent dipole magnet that we had newly fabricated (Fig. 1). We designed the magnet so that the dipole magnetic field would be insensitive to temperature drift and the demagnetization due to radiation damage could be monitored using precise magnetic field measurement probes based on NMR. Although we do not expect significant demagnetization, we installed correction magnets just in case it occurs. The beam transport through the new dipole magnet has been stably carried out for a year, and no demagnetization due to radiation damage has been observed as we expected. We will continue to observe the performance to verify the reliability of the permanent dipole magnet we developed.

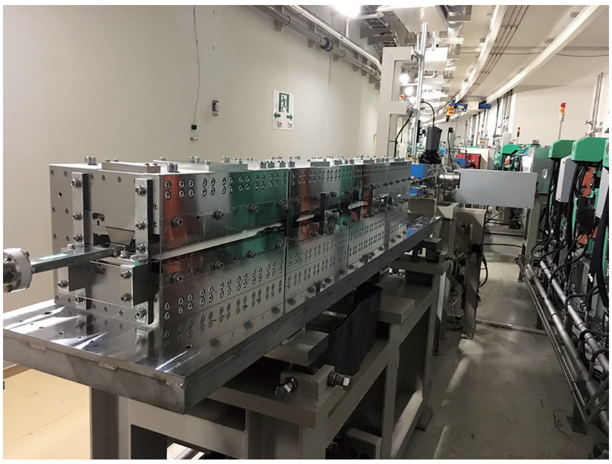

Fig. 1. C-shaped permanent dipole magnet newly installed in the beam transport between the booster synchrotron and the storage ring. The magnet consists of four segments; the first and third segments are made of a samarium-cobalt magnet, and the second and fourth segments are made of a neodymium-iron-boron (NdFeB) magnet.

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References

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