Construction and Operation of Superconducting Bending Magnets in Aichi-SR

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Aichi Synchrotron Radiation Center (Aichi-SR) started public use of synchrotron radiation in March 2013 [1]. The facility is operated mainly by Aichi Science & Technology Foundation and is supported by universities, Aichi Prefecture, and industry. At present, 11 beamlines are in operation, including one each from industry and university, and a new beamline for the industry is under construction.

Accelerators of the Aichi-SR consist of a 50 MeV linear accelerator, a 1.2 GeV booster synchrotron, and a 1.2 GeV electron storage ring of a 72 m circumference [2-5]. A notable feature of the Aichi-SR accelerator is that it uses superconducting bending magnets (superbends) to supply synchrotron radiation to multiple beamlines with energies exceeding 10 keV, despite the relatively low electron energy of 1.2 GeV [6]. The magnetic lattice configuration is the four-fold symmetry of triple-bend cell. In the unit cell of the three bending magnets, the two at both ends are normal-conducting magnets with a magnetic field of 1.4 T and a bending angle of 39°, and the one in the center is a superconducting magnet with a peak magnetic field of 5 T and a bending angle of 12°. Figure 1 and Figure 2 show the layout of the accelerators, and the flux of synchrotron radiation from the superbend and the normal-conducting bending magnet at Aichi-SR.

For the cooling of the superbends, a small 4K-GM type refrigerator is placed one by one in each superbend, and the superconducting coils are cooled directly. The direct cooling method, which does not use liquid helium, is advantageous not only in terms of cost but also in terms of ease of maintenance, such as handling in case of quenching. Figure 3 shows a photo of the suberbends.

The refrigerators of the superbends need to be maintained after 10,000 hours of operation. Immediately after the refrigerator was replaced, the temperature rose to about 60 K, but it reached below 3.6 K in about 24 hours. The maintenance of the refrigerators is done once a year, and in all cases since the construction of Aichi-SR, the coil temperature returns to below 3.6 K after the maintenance.

The superbends of the Aichi-SR have had some trouble with the refrigerators, but no problem with the magnets themselves and are now operating smoothly.

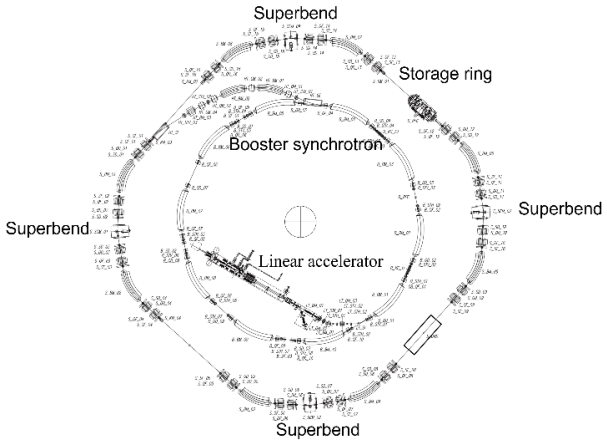

FIGURE 1. Layout of Aichi-SR accelerators.

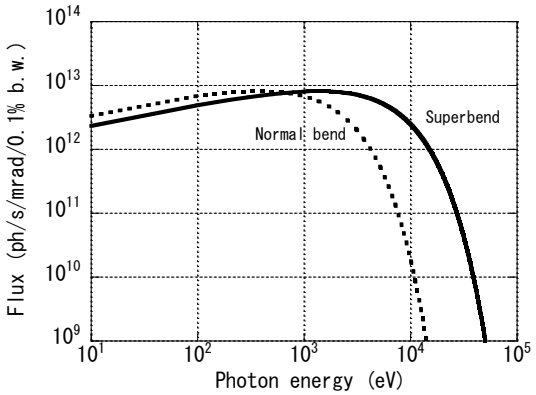

FIGURE 2. Flux of synchrotron radiation from the superconducting bending magnet (Superbend) and the normal-conducting bending magnet (normal bend).

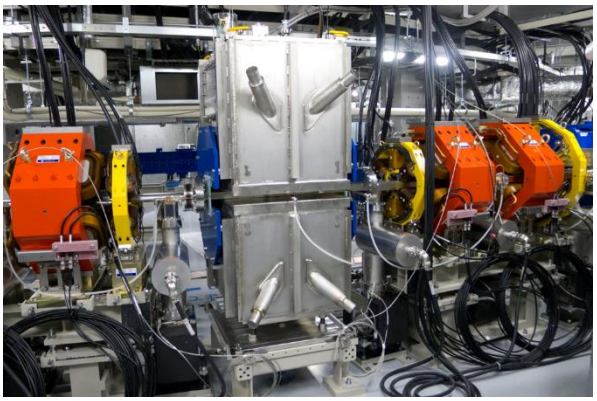

FIGURE 3. Superconducting bending magnet of Aichi-SR.

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