SPring-8 Beam Performance

Recent update of accelerators

We have fully replaced the 1 GeV linear accelerator (linac) and the 8 GeV booster synchrotron with the 8 GeV linac of SACLA for injection to the SPring-8 storage ring [1]. Since SACLA is constantly operated for the X-ray Free Electron Laser (XFEL), we now operate only one injector, i.e., the 8 GeV linac, for both the storage ring and XFEL. As a result, we can significantly suppress power consumption in the accelerator complex by not operating the 1 GeV linac and the 8 GeV booster.

SPring-8 and SACLA issued a green facility statement in August 2021. The facilities are used for research activities related to the Sustainable Development Goals (SDGs) and carbon neutrality. At the same time, we promote energy saving in the facility including the accelerator complex. Thus, the full-energy direct injection setup from the SACLA linac to the storage ring has been built for a more energy efficient facility.

We needed to build the new injection setup in such a way that SACLA experiments would not be affected after adding the new function of full-energy direct beam injection to the storage ring. Yet, the injection system must deliver electron beams to the storage ring whenever it is demanded from the storage ring. For that, we developed a new timing system in which on-demand beam injections could be executed without interfering with XFEL experiments.

In addition, some experiments at SPring-8 require a bunch purity of 10^{-8} or better. The bunch purity is the ratio of the number of electrons in the satellite bunches to that expected to fill specific RF buckets in the filling patterns for each operation mode. Before the new injection setup from SACLA was introduced, undesired electrons in the satellite buckets were removed using the RF knock-out in the 8 GeV booster synchrotron. With the new injection setup, it was no longer possible to remove such undesired electrons in the booster, so we developed a new bunch cleaner in the storage ring. The new bunch cleaner is composed of a signal-generating digital processor, amplifiers, and a stripline kicker. The stripline kicker is installed in cell 30 of the storage ring, and the beam scraper is placed in cell 48. As a result, sufficiently high bunch purities of the order of 10^{-9} or better are constantly delivered in current user operations. We note that our high-definition bunch purity monitor developed in SPring-8 also plays a key role in securing such a high bunch purity.

Almost two years have passed since the new injection setup was started. Now, highly reliable beam injection at the same level as that using the 1 GeV linac and the 8 GeV booster and sufficiently high bunch purities are consistently achieved while saving energy.

Not only the accelerator reliability but also stability are achieved. Until recent years, orbit fluctuations excited by pulsed kicker magnets at ID 23 and 25 had long been observed, which distorted some user experiments. Therefore, we have developed and optimized an adaptive feedforward orbit correction system [2]. Presently, almost no orbit fluctuation due to ID 23 or 25 kickers is observed in the user time.

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References

[1] T. Hara *et al.*: Phys. Rev. Accel. Beams **24** (2021) 110702.
[2] M. Masaki *et al.*: J. Synchrotron Rad. **28** (2021) 1758.