1. Accelerator

Our accelerator complex offers a unique advantage, with a third-generation SR source (SPring-8) collocated with an X-ray Free-Electron Laser (XFEL) source (SACLA) at the same site. Building upon this advantage is central to our accelerator upgrade strategy.

SPring-8 and SACLA started user operations in October 1997 and March 2012, respectively. Since SPring-8 has operated for more than twenty years and is close to its expected lifespan, it is the first priority for the upgrade. In 2007, an upgrade plan for the SPring-8 source included a transition towards the diffraction limited performance in the X-ray wavelength region. In 2013, as our investigation moved into the execution phase, we shifted the approach by changing the target from X-ray diffraction limited performance to a high coherence X-ray source with an emittance value of 100 pm rad, which offers a coherent fraction of several percent at a photon energy of 10 keV.

In addition to high source performance, the following conditions are critically important for quickly restarting user operations and for reducing the running costs for energy:

(1) reusing the existing accelerator tunnel and experimental hall,
(2) keeping the same source point for all undulator beamlines (BLs) and minimizing any changes of source conditions for the bending magnet BLs,
(3) adopting a permanent-magnet dipole system,
(4) lowering the stored beam energy from 8 to 6 GeV to reduce energy consumption,
(5) adopting shorter period in-vacuum undulators with the same spectral range as the current ones, with a stored beam energy of 6 GeV,
(6) increasing the stored current from 100 to 200 mA to maintain photon flux,
(7) enabling time-shared use of the SACLA linac as a ring beam injector.

R&D on all the required accelerator components began in 2015 and nearly completed in 2017. Figure 1 illustrates the feature integration and separation of the accelerator complex, including NewSUBARU.

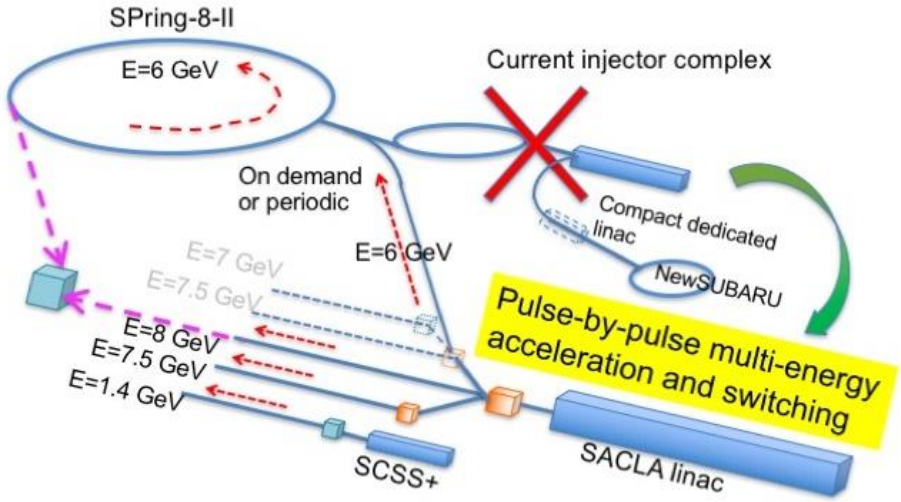

Fig. 1. Future integration and separation of the accelerator complex.

At that time, construction of a next generation 3 GeV SX (Soft X-ray) SR source, which was the top priority among existing light source related projects in Japan, had been discussed and in 2018 the Aobayama campus of Tohoku University was selected as the site. Construction officially started in March 2019, with close involvement from the accelerator group at the SPring-8 campus. Before proceeding to our SPring-8-II upgrade project, we had to first complete development of the 3 GeV SR source. Under these circumstances, we considered the 3 GeV SR construction as a prototype for SPring-8-II and hence, applied all our R&D effort to the accelerator system design. The results and learnings obtained through the 3 GeV construction project and commissioning will be applied to the upgrade project. In parallel to the above collaborative activities, we have progressed the accelerator system development for timesharing the SACLA linac as a current ring injector. We are now in the final stages of system tuning and plan for a beam injection test from the SACLA linac to be in regular user operation in February 2020.

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