R&D Status of the ERL Light Source Project in Japan

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Over the last 30 years synchrotron radiation has contributed to significant progress of basic science and continual growth of forefront industry in the world. The synchrotron radiation source has greatly improved its performance in the same years, and attained to a state of the art facility: 3rd-generation light source. The science and industry in the 21st century, however, urge the light source to acquire novel features such as coherence and femtosecond pulses, which are common properties of lasers. Responding to the demand of the further evolution in synchrotron radiation facilities, next-generation light sources have been proposed. In order to realize X-rays with coherence and femtosecond pulses, there exist two approaches: X-ray free-electron laser (XFEL) and energy-recovery linac (ERL).

In the ERL, a high-brightness electron beam from a photocathode electron gun is accelerated by superconducting linac, and transported to many insertion devices for X-ray generation. The electron beam is then decelerated by the same linac and goes to a beam dump. In the deceleration, the electron energy is converted back to the RF energy and reused to accelerate succeeding electrons. The energy-recovery technique enables one to operate a high-energy and high average-current accelerator with a practical electric power. Moreover, the ERL can produce femtosecond electron bunches and an electron beam whose emittance is small enough to generate spatially coherent X-rays in 10-keV energy region. Therefore, the ERL is a promising accelerator for the next-generation light source.

Two Japanese institutes, the High Energy Accelerator Research Organization (KEK) and the Japan Atomic Energy Agency (JAEA; formerly JAERI and JNC), proposed each own 5-6 GeV ERL project for the future light source. Thereafter, these institutes with a participation of the members of Institute for Solid State Physics, University of Tokyo (ISSP) agreed to promote an ERL-based next-generation synchrotron light source in Japan based on their stimulated technologies. As a first step towards this course, we are planning to construct together an ERL test facility at KEK site in order to resolve technical and physical challenges. The ERL test facility will comprise a 5-10 MeV injector, a superconducting main linac, and a return loop. The beam energy of the main linac will initially be a few tens of MeV, and will be upgraded up to about 200 MeV. We have organized an R&D team for the ERL test facility and started to develop critical components for the ERL light source such as a photocathode DC gun and a superconducting cavity. We present current status and plans of the ERL project.