An Intense Terahertz Radiation Source at the Compact ERL

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The Compact ERL is the energy recovery linac (ERL) test facility that will be constructed at KEK Tsukuba campus as a joint project of the KEK, JAEA, and other institutes. The Compact ERL has a great feasibility of producing intense terahertz radiation using coherent synchrotron radiation (CSR) from its electron beams. Although the primary purpose of the facility is the demonstration of the key technologies that are essential to build ultra-brilliant new synchrotron light source based on the ERL, the limited user operation with the terahertz CSR is now examined. In this presentation, we show the parameters of the Compact ERL and discuss expected performances of the terahertz radiation.

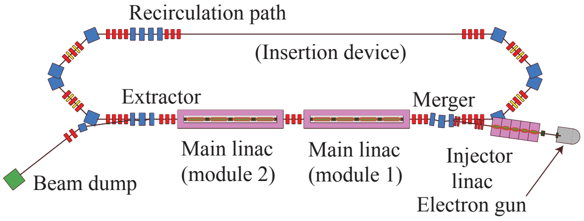

Fig. 1. Lattice of the Compact ERL.

Table 1 Tentative parameters of the test facility

	Parameters (final goal)
Injection energy	5 MeV (10-15 MeV)
Injector beam power	500 kW (1 MW)
Beam energy in the recirculation path	~60 MeV (160-200 MeV)
SC cavities for main linac	9 cells x 4: single module (two modules)
Normalized emittance	1 mm·mrad (0.1 mm·mrad)
Beam current	10 mA (100 mA)
RMS bunch length	Usual mode : σ_τ = 1-2 ps (Short bunch : σ_τ = 0.1 ps)

Figure 1 shows the plan of the Compact ERL and Table 1 lists the tentative parameters. In order to generate the CSR of the wavelength λ_{CSR} , the electron bunch length should be shorter than

$$\sigma_z = \frac{\lambda_{CSR}}{2}.$$

For example, the electron bunch with the bunch length of 0.2 ps (60μm) can generate the CSR of the energy 10 meV (120 μm). In order to achieve such short bunch length, however, the bunch compression is inevitable.

For the bunch compression [1],[2], the off-crest acceleration at the main acceleration module firstly generates the energy gradient in the electron bunch. Then the difference of the orbit length depending on the particle energy at the arc section can compress the bunch length. The linear path length difference of the arc, R_{56}, can be optimized by the quadrupoles and the second order effect, T_{566}, by the sextupoles. Furthermore, in order to suppress the emittance growth by the CSR, Twiss parameter α at the end of the arc section is fixed. Finally, the simulation results show that, if the bunch charge is smaller than about 0.5nC, the bunch length can be compressed to about 0.2ps at the 65MeV beam energy [3]. The estimated photon flux from the bending magnet at the arc of the ERL test facility is shown in Fig. 2.

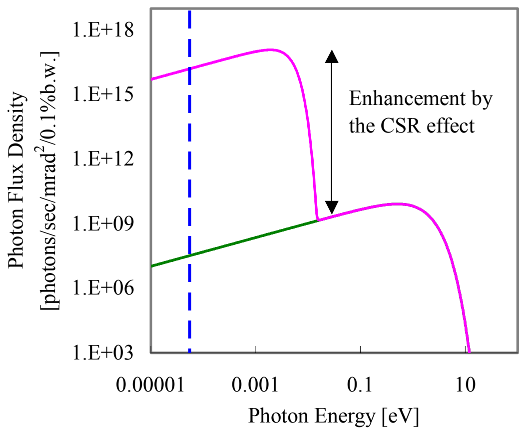

Fig. 2. Radiation spectrum from the bending magnet of the arc section of the Compact ERL. The beam current is 100 mA (= 77 pC x 1.3 GHz), the bunch length 0.2ps, and the beam energy 65MeV.

[1] M. Shimada, K. Yokoya, T. Suwada and A. Enomoto, ”Lattice and beam optics design for suppression of CSR-induced emittance gowth at the KEK-ERL test facility”, NIM A 575, (2007) 315

[2] R. Hajima, ”Emittance commpensation in a return arc of an energy recovery linac”, NIM A 528, (2004) 335

[3] M. Shimada, K. Harada, R. Hajima, ”Bunch compression and the emittance growth dur to CSR”, Proc. of ERL 2007