Development of THz Sources Based on Femtosecond Electron Pulse Train

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t-ACTS (test Accelerator as Coherent THz Source) project has been progressed at Tohoku University, Sendai. We have employed an RF gun equipped with LaB_6 (or CeB_6) thermionic cathode as a beam source, which was designed to produce very short electron bunches. The gun consists of two independent cavities so as to manipulate longitudinal phase space. Though velocity bunching scheme was initially introduced to compress the bunch extracted from photocathode RF gun, we have been aware that relatively low energy and “thin line” distribution in the longitudinal phase space of the beam obtained in the thermionic RF gun is much more suitable for velocity bunching in accelerating structures. Bunch charge in a micropulse is not so much significant because we have expected another aspect of application with bunch train in a macropulse. According to careful simulations, we expect bunch length around 50 femtosecond with a charge of ~ 20 pC.

In t-ACTS project an isochronous accumulator ring is under construction as a source of broadband THz radiation. Because the bunch length is preserved in almost complete isochronous system, high average power of coherent synchrotron radiation (CSR) may be provided to user. Of course the beam quality such as energy spread shall degrade and higher order effect is getting serious after certain turns, so the beam should be kicked out and then next bunch train is injected.

Since the bunch length is already much shorter than the wavelength of THz radiation, conventional FEL scheme is no longer in focus. However, by using oscillator configuration, coherent pile-up of the CSR was expected, so that the short bunch and the radiation field have been studied based on 1-D FEL equations. Since the bunching factor of 50 femtosecond bunch is already more than 0.7, so that we call oscillator “bunched FEL”.