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Author

Jiao, Y (Jiao, Yi); Ratner, DF (Ratner, Daniel F.); Chao, AW (Chao, Alexander W.)

Title

Terahertz coherent radiation from steady-state microbunching in storage rings with X-band radio-frequency system

Source

PHYSICAL REVIEW SPECIAL TOPICS-ACCELERATORS AND BEAMS, vol.14, no.11, NOV 18 2011, 110702.

Abstract

The mechanism of steady-state microbunching (SSMB) has been proposed [D. F. Ratner and A. W. Chao, Phys. Rev. Lett. 105, 154801 (2010)] to produce steady-state microbunched beams by using laser modulations in a storage ring for generating coherent radiation with high repetition rate at wavelengths from the submillimeter to extreme ultraviolet range. In the present paper, we analyze the dynamics of the SSMB system with a Hamiltonian and Jacobi matrix approach and identify the original proposal of SSMB as a mechanism with period-1 fixed point in phase space. We then propose an alternative SSMB mechanism with period-2 fixed point, which is able to produce microbunched beams with shorter bunch length and, hence, higher harmonic. Taking the SPEAR3 storage ring as an example, we illustrate the application of the period-2 SSMB to generate terahertz (THz) steady-state coherent radiation in a storage ring using an X-band radio-frequency (rf) system instead of a more technically demanding laser system. Issues covered include choice of rf parameters, system errors, beam lifetime, collective effects, and radiation power evaluation. Compared to the more traditional low-momentum-compaction operation mode, the proposed SSMB scheme potentially promises higher beam current, larger bunching factor, and hence brightness increase of at least 1 order of magnitude.