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Coherent kW THz radiation from an SSMB storage ring via self-sustained laser modulation

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Due to the unique role of terahertz (THz) radiation in the electromagnetic spectrum, it possesses significant scientific value and potential applications in fundamental science, biomedical research, spectroscopy, and etc. This paper proposes a novel mechanism for generating continuous kilowatt-level coherent terahertz radiation in steady-state microbunching storage rings, based on self-sustaining laser modulation processes. The analysis employs the transfer matrix method from accelerator physics, considering the dynamical evolution of electron beams during multiple passes through the laser modulator, as well as radiation damping and quantum excitation effects in the storage ring. Numerical tracking results demonstrate the feasibility of this mechanism. In a demonstrative case, we show that 1 kW continuous coherent radiation can be achieved at 5 THz frequency, corresponding to electric field strengths on the order of MV/m. Since this scheme is based on free electrons, its radiation output characteristics can be tuned over a broad frequency range of 1-10 THz, offering extremely high application value in scientific research.

Footnotes

Funding Agency

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