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Tapering enhanced high efficiency THz waveguide oscillator

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The waveguide free electron laser has demonstrated the ability to efficiently convert relativistic electron beam energy into THz radiation in a single passage through a tapered helical undulator. An oscillator configuration can further boost energy extraction efficiency surpassing single-pass state-of-the-art. Embedding the undulator in an oscillator cavity is particularly useful in combination with high repetition rate electron sources, even if at reduced peak brightness, since recirculating a fraction of the radiation as an intense seed can compensate for lower single-pass gain. In this paper, we investigate the efficiency scaling of a tapering-enhanced waveguide oscillator, showcasing its capability for frequency-tuning operation and high-efficiency generation for different wavelengths. Using a thermionic-driven beamline equipped with compression elements, our simulation results indicate a 35% efficiency at 200˜GHz and a 6.67% efficiency at 1.5THz, with out-coupling of a few hundred microjoules and tens of megawatts.

Footnotes

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