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Numerical simulation of a laser plasma driven HGHG FEL

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Laser-wake field accelerators (LWFAs) are potential candidates to produce intense relativistic electron beams to drive compact free electron lasers (FELs) in VUV and X-ray regions. The High-Field Physics and Ultrafast Technology Laboratory at National Central University (NCU) is actively developing a compact LWFA-based high gain harmonic generation (HGHG) FEL aimed at coherent extreme ultraviolet (EUV) radiation. However, the high divergence and excessive energy spread of the LWFA electron beam increase the difficulties in both beam transportation and radiation power growth. Here a start-to-end simulation is presented to study the electron quality threshold of a compact HGHG FEL based on the estimated experimental data of the NCU LWFA group with electron energy of 250MeV. Compare to a Slow-varying envelope approximation-based simulation, a PIC-based calculation is presented to consider the effects of an ultrashort electron bunch. Numerical results indicate that a 4th harmonic radiation at 66.5nm wavelength with megawatt level peak power can be obtained with energy spread up to 0.25%. Showing the feasibility of the proposed scheme and the capability of producing monochromatic coherent radiation.

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