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## Unaveraged Simulation of Superradiance in FEL Oscillators

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Generation of few-cycle FEL pulses with a high extraction efficiency was achieved at JAERI-FEL [1] and KU-FEL [2]. The observed lasing can be understood as superradiance, radiation from bunched electrons in the slippage region. In the superradiance FEL oscillators, the high-extraction efficiency is accompanied by significant energy variation of the electrons during the undulator. Therefore, numerical studies of such FELs should be conducted by unaveraged simulation codes, in which macro-particles are not bound to bunch slices. In this paper, superradiant FEL pulse evolution in the FEL oscillators is studied by using one-dimensional [3] and three-dimensional [4] simulation codes.

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