Numerical Studies of the Spectral Evolution of a Narrow-Bandwidth FEL Oscillator

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ABSTRACT

The design study of an FEL oscillator with a bandwidth of $\Delta \omega / \omega_0 < 10^{-5}$ has been carried out. In this conceptual design, a grating rhomb is used to suppress the sideband instability. The spectral evolution of the FEL has been simulated using a one-dimensional, time-dependent FEL code. The system parameters for the simulations are: electron beam energy 120MeV, current $I = 50A$, electron micropulse length $\delta t_p = 330$ps, optical wavelength $\lambda_o = 0.5\mu m$, and wiggler period $\lambda_w = 2cm$. The detailed dependence of the spectral bandwidth on the frequency chirp introduced by the grating rhomb was investigated. A signal with FWHM bandwidth $\Delta \omega / \omega_0 = 4 \times 10^{-6}$ was obtained in a simulation using a large chirp parameter $\tau_s / \delta t_p = 80$, where $\tau_s$ is the time lag of the sideband (with $\Delta \omega / \omega_0 = -0.01$) behind the central frequency.

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