

A model for thermal effects in free-electron lasers

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In the present work we extend results of a previous paper [1] and develop a semi-analytical model to account for thermal effects on the nonlinear dynamics of the electron beam in free-electron lasers. We relax the condition of a cold electron beam, as used previously, but still use the concept of compressibility to evaluate the time scale for saturation and the peak laser intensity in high-gain regimes of a SASE scheme.

Although full wave breaking is absent in a warm model, the appearance of a series of discontinuities in the electron density trigger the saturation process. We show that full wave-particle simulations agree well with the predictions of the model.

[1] E. Peter, A. Endler, F.B. Rizzato, and A. Serbeto, *Physics of Plasmas* **20**, 123104 (2013)