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Free-electron laser spectrum evaluation and automatic optimization

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Abstract

The radiation generated by a seeded free-electron laser (FEL) is characterized by a high temporal coherence, which is close to the Fourier limit in the ideal case. The setup and optimization of a FEL is a non-trivial and challenging operation. This is due to the plethora of highly sensitive machine parameters and to the complex correlations between them. The fine tuning of the FEL process is normally supervised by physicists and is carried out by scanning various parameters with the aim of optimizing the spectrum of the emitted pulses in terms of intensity and line-width. In this article we introduce a novel quantitative method for the evaluation of the FEL spectrum via a quality index. Moreover, we investigate the possibility of optimization of the FEL parameters using this index as the objective function of an automatic procedure. We also present the results of the preliminary tests performed in the FERMI FEL focused on the effectiveness and ability of the automatic procedure to assist in the task of machine tuning and optimization.

Keywords: free-electron laser, optimization, ascent-gradient, stochastic-extremum-seeking, control-system

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