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Gaussian Random Field Generator SERVAL: a Novel Algorithm to Simulate Partially Coherent Undulator Radiation

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We propose a computationally-efficient algorithm to calculate the field of partially coherent synchrotron radiation pulses from undulators. Wavefront propagation simulations play a pivotal role in designing beamline optics at new synchrotron radiation sources. However, they do not account for the stochastic behaviour of the initial radiation field, which is due to shot noise in the electron beam with finite transverse size and divergence. We present an algorithm that allows us to obtain and propagate radiation fields containing multiple transverse stochastic modes within undulator resonance. The proposed algorithm relies on a method for simulating Gaussian random fields. We initially generate the field as Gaussian white noise, and then we restrict its extent in the direct and in the reciprocal domains by using averaged radiation size and divergence. Strictly speaking, this procedure shapes the correct correlation function of the field only under the assumption of quasi-homogeneity. However, we show that the method can be applied with reasonable accuracy also outside of this assumption. We check consistency of the algorithm with the help of well-established approaches in simulating partially coherent undulator fields. Finally, the proposed method is well-suited for educational purposes.

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