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Optimization of Echo-Enabled Harmonic Generation toward coherent soft X-ray free-electron laser in current and future synchrotron light sources

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For storage-ring-based free-electron lasers (FELs), prebunching via echo-enabled harmonic generation (EEHG) is an efficient way to reduce the radiator length and improve the longitudinal coherence as well as output stability. We propose a conceptual design, which uses two straight sections of a synchrotron to seed coherent soft X-ray emission. This scheme requires no change of the storage ring lattice and is fully compatible with other beamlines. To take the large energy spread (of the order of 10-3) of a storage ring electron beam into account, we developed a new modelling tool (EEHG optimizer) and successfully applied it to maximize the prebunching from harmonic 50 to 200 for nearly any synchrotron light source, with significant benefits. We developed a generalized EEHG model based on the critical parameters (momentum compaction, beam emittances, and Twiss functions) determining EEHG performances, which is applicable to nearly any synchrotron light source. We show by numerical simulations that for most of the currently operated and future light sources, the EEHG scheme can produce a significant prebunching up to harmonic 200, and thus generate a few MW scale peak power at 1.25 nm wavelength.

Funding Agency

Footnotes

Storage Ring based FEL.

I have read and accept the Privacy Policy Statement

Yes

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