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Impact of Electron Beam Energy Chirp on Optical-Klystron-Based High Gain Harmonic Generation

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External seeding schemes allow the generation of stable and fully coherent free electron laser (FEL) radiation but can be limited in repetition rates in orders of tens of Hz. This limitation is mainly posed by limited average power of the seed lasers that are required to provide hundreds of MW peak power to modulate the electron bunches. An optical-klystron-based high gain harmonic generation (HGHG) scheme, which can be implemented in several existing and upcoming seeded FEL beamlines with minimal to no additional installations, overcomes this limitation by greatly reducing the required seed laser power. In this work, we carefully study the scheme with detailed simulations that include imperfections of electron beam properties such as a quadratic electron beam energy chirp that characterizes existing FEL facilities. We discuss the optimization steps that in these conditions ensure successful operation, opening the path towards exciting science at FELs with fully coherent and high repetition rate FEL radiation.

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