Master-Oscillator-Power-Amplifier (MOPA) Laser Sources Used as Drive Lasers for Photoinjectors for High-Gain, Free Electron Lasers (FELs)

By

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Abstract

The realization of extremely high gain, and high power in Free Electron Lasers (FELs) employing various photoelectron-cathode schemes is achieved by using different types of drive laser arrangements to extract electron bunches from photocathodes. The performance of FELs depends critically on the power and phase stability of the cathode drive laser, and conversely the type of FEL output dictate the laser-amplifier schemes to be employed for the drive laser. The drive laser arrangement is master-laser-oscillator-power-amplifier (MOPA). The oscillator is typically passively mode-locked to an injection-seeded power amplifier system because this scheme provides a lower noise configuration. Time-synchronized, picosecond drive laser-amplifier configurations are frequency-tuned to optimize the FEL output. Depending on the application, drive lasers have been designed to operate over a wide frequency range (0.1 KHz - 2 GHz) using a master oscillator, rf-coupled to the mode locked (ML) laser. Specifically, the pulse train from the ML laser is pulse sliced and drives a cascaded optical amplifier system which initiates FEL electron bunches at a prescribed RF master oscillator frequency or a subharmonic. The resulting beam of these unbound electron bunches are further accelerated to relativistic velocities. This beam then propagates through a magnetic structure to ultimately transition, via a kinetic energy conversion, to high power coherent FEL photons.

This paper describes two of the more promising high power laser-optical amplifier setups currently being considered for driving photo injectors in the next generation of high brightness FELs. The simultaneous use of both high repetition rate and fast pulse (<10ps) high optical peak power amplifiers is not yet feasible. Consequently, the ability to emit a high current photo electron off a low work-function cathode material, via the augmented photoemission process from a photocathode to "high" current (~1 ampere) FEL accelerator, remains to be demonstrated. The stability effects and suppression of drive laser amplifier dynamic-noise characteristics are also discussed.