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Challenges of Seeded Free-Electron Lasers

STEPHEN MILTON, Colorado State University

A principle advantage of the free-electron laser (FEL) over the more conventional atomic-transition based laser is its ability to be tuned to an arbitrary wavelength. In fact this advantage is even more pronounced as wavelengths extend into the x-ray regime. Early FELs operated in an oscillator configuration, i.e. similar to conventional laser, and so relied heavily on mirrors. This configuration gave the FEL output both good transverse and longitudinal coherence properties. But mirrors have limitations, and if one wants to construct an FEL that can operate in the x-ray regime then one is forced to rethink the FEL configuration. Over the past decade electron beam sources and beam control have achieved beam qualities sufficient for the FEL to operate in the x-ray regime; however, present devices are not configured as oscillators and indeed the process in these single pass configurations start from synchrotron radiation shot noise. As such, even though the FEL process saturates and the transverse beam quality is almost completely coherent, longitudinally the coherence is poor. If one could seed the FEL and operate the system in an amplifier mode then the longitudinal coherence could be greatly improved. In this talk we will review the status of the FEL and then dive into the issue one faces when attempting to seed the FEL at very short wavelengths. We will also touch upon some other interesting opportunities that seeding provides as well as highlight some interesting seeding concepts presently being explored.