

X-Ray FEL Oscillator: The performance and feasibility

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The first success of hard x-ray FEL was achieved by extreme high-gain amplification of initially incoherent seed to intense, quasi-coherent x-rays known as the self-amplified spontaneous emission (SASE). Free-electron lasers for hard x-rays can also be constructed in an oscillator (XFELO) configuration, producing fully coherent x-rays with ultrahigh spectral purity and brightness – the spectral bandwidth of about 1 meV is four orders of magnitude narrower than, the average brightness is five orders of magnitude higher than, and the peak brightness is comparable in magnitude to that of SASE devices. These characteristics of an XFELO would enable revolutionary scientific opportunities as well as drastically improve experimental techniques developed at third-generation x-ray facilities. An XFELO requires a continuous sequence of ultralow emittance electron bunches and employs an optical cavity consisting of high-reflectivity Bragg crystals and grazing incidence, curved mirrors. We discuss the performance of an XFELO and the progress in the feasibility study of the technical components.