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Enhanced Self-Seeding with Ultrashort Electron Beams

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We describe a new method to produce intensity stable, highly coherent, narrow-band x-ray pulses in self-seeded free electron (FEL) lasers. The approach uses an ultrashort electron beam to generate a single spike FEL pulse with a wide coherent bandwidth. The self-seeding monochromator then notches out a narrow spectral region of this pulse to be amplified by a long portion of electron beam to full saturation. In contrast to typical self-seeding where monochromatization of noisy self-amplified spontaneous emission pulses leads to either large intensity fluctuations or multiple frequencies, we show that this method produces a stable, coherent FEL output pulse with statistical properties similar to a fully coherent optical laser. With self-consistent, start-to-end simulations we show that laser heater shaping and cathode shaping techniques both can produce the electron beam current profile needed for the enhanced self-seeding scheme.

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