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High-quality electron beams and free electron lasing based on a laser wakefield accelerator at SIOM

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Laser wakefield accelerators (LWFAs) are capable of generating ultra-high accelerating gradient up to 100 GV/m, and hold a great potential as a candidate for driving compact free electron lasers (FELs). However, the stability and insufficient beam quality, in terms of energy spread, large initial divergence, present a substantial obstacle to the realization of high-gain FELs. With the in-house developed 200-TW laser system with a repetition rate of 1-5 Hz and a well-designed gas target, a stable and high quality LWFA has been experimentally obtained. Here, we present an experimental demonstration of undulator radiation amplification in the exponential-gain regime. The amplified undulator radiation, typically centered at the 27 nanometers, has a maximum radiation energy of approximate 150 nJ. The maximum gain was estimated to be 100-fold in the third of the three undulators with the orbit kick method, indicating an undoubtable exponential gain. Such a proof-of-principle experiment will expedite the development of future compact facilities with broad applications.

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