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COMMENT

Miniaturized terahertz-driven electron accelerator

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Terahertz-driven (THz-driven) electron acceleration has recently emerged as a promising approach for developing the future compact ultrashort pulsed electron sources. Zhang et al. [1] have developed a segmented terahertz electron accelerator and manipulator (STEAM) and demonstrated the device by employing millimeter-scale drivers in the THz range. The benefits of high field-gradients and compactness can be realized in a practical acceleration device with a high degree of control and stability. The essential accelerator beam manipulations, including acceleration, compression, streaking, focusing, and deflection, are achieved in a single STEAM device. The STEAM is the first THz-driven device shown to handle moderate charge bunches (up to 20 fC per bunch) and provide significant (> 50%) relative changes in energy with a clean shift of the energy spectrum. These capabilities demonstrate STEAM's usability and represent a significant advancement over previous devices, which either involved few-electron beams or modulated the energy spectrum by a few percents. It also shows its capability as a useful electron source with intrinsic synchronization that provides 100 fs bunches with sufficient charge for ultrafast electron diffraction studies. The small-scaled STEAM device should be critical for future accelerator technology of further pulse-compression and synchronization.

The future of these THz-driven devices is fascinating. Due to the short field-exposure-times and high frequencies of single-cycle THz pulses, field-gradients of ~1 GV/m can be expected with sub-mJ THz pulses that are now available, enabling beam manipulations beyond conventional accelerators.

Reference

1. Zhang D, Fallahi A, Hemmer M, Wu X, Fakhari M, Hua Y, Cankaya H, Calendron A L, Zapata L E, Matlis N H, Kärtner F X. Segmented terahertz electron accelerator and manipulator (STEAM). Nature Photonics, 2018, 12(6): 336–342

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