Time-Domain Terahertz Science Improves Relativistic Electron-Beam Diagnostics

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Linear accelerators are used as drivers for new femtosecond x-ray free-electron lasers (FELs), or employed in new tera-electron-volt (TeV) linear electron-positron colliders for high energy physics. For these applications, spatiotemporal analysis of the emitted radiation is crucial for performance characterization. A powerful new technique for spatiotemporal analysis of the relativistic electron beam is under development at the FEUx facility at the University of Amsterdam. The method is based on the measurement of the temporal and spatial structure of the electron beam. The electron beam, which is generated by a free-electron laser, is focused into a Faraday cup and detected by a position-sensitive detector. The temporal and spatial structure of the electron beam is then determined by analyzing the signal from the detector.

The electron-optic detection of the local nonradiative electric field that travels with the electron bunch has recently emerged as a powerful new technique for spatiotemporal analysis of the relativistic electron beam. In our experiment, we measured the length of an individual electron bunch by using a high-speed diode. The electron bunch length is measured by using a Faraday cup placed inside the vacuum pipe at the entrance of the undulator.

References

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