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A New Electro-Optic Detection Scheme for Recording Electron Bunch Shapes With High Resolution and Record Recording Length

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Non-destructive, single-shot recording of longitudinal bunch profiles is a prerequisite for accelerator commissioning and operation. A common strategy for the measurement of ultra-short electron bunches is to sample the Coulomb field with femtosecond laser pulses. However, recording electric field evolution in single-shot with THz bandwidth is a largely open problem and has been recognized as a fundamental bottleneck.
We present here a novel electro-optic sampling strategy that is theoretically capable to overcome this limit, and achieve femtosecond resolution for any recording length. This new conceptual approach is based on mathematical concepts from photonic time stretch theory and information diversity in radio-frequency communication. We show numerically and experimentally that this approach enables recording of THz electric field and electron bunch shapes in single-shot with high bandwidth than previous spectral decoding single shot techniques.
This technique opens the way to ultrafast electric field shape characterization with femtosecond resolution in new situations, including longitudinal bunch profile monitoring, studies of microbunching instabilities, and THz pulses generated at free-electron lasers.

Journal of Synchrotron Radiation Special Issue: will you submit your contribution?

no

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