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Observation of sub-femtosecond structures in laser wakefield accelerated electron bunches

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Laser wakefield accelerators (LWFA) feature unique electron bunch characteristics, namely micrometer beam size with duration ranging from a few fs to tens of fs. Precise knowledge of the longitudinal profile of such ultra-short electron bunches is essential for the design of future table-top x-ray light-sources.

Spectral measurements of broadband transition radiation from LWFA electron bunches passing through a metal foil are especially promising for non-destructively analyzing ultrashort longitudinal bunch characteristics with single-shot capability.

We present recent experimental results of different LWFA injection mechanisms, such as self-truncated ionization-injection and self-injection. By analyzing the transition radiation spectra and reconstructing electron bunch profiles including error analysis, we determine electron bunch profiles and peak currents of the respective injection regimes. In addition to bunch durations and peak currents, we discuss sub-fs beam micro-structures and systematic experimental scans of the nitrogen doping concentration for ionization-induced injection.

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