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Generation of short current spikes by laser modulation at FLASH

Monday 2 June 2025 16:00 (2 hours)

Generating few- or sub-femtosecond radiation pulses in a free-electron laser requires precise control of the longitudinal phase space density of the driving electron bunch, as the FEL process depends strongly on the bunch current- and energy spread profile. In an experiment conducted at FLASH, an energy modulation with linearly increasing amplitude is imprinted onto part of the bunch by a shaped laser pulse in a modulator undulator upstream of the first bunch compression chicane. In subsequent longitudinally dispersive sections, a short current spike is created, as the linearly modulated region is compressed more strongly than the rest of the bunch. Measurements with a transverse-deflecting structure verify the creation of a short current spike, whose duration falls below the temporal resolution of the measurement setup of approximately 7fs. It is demonstrated that the position of the spike within the bunch can be controlled by the timing of the modulating laser pulse. Together with a second current spike created by non-linear bunch compression, the laser-induced spike forms a promising basis for a future double-pulse lasing scheme with controllable pulse separation.

Footnotes

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