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Ponderomotive Scattering of Sub-Picosecond Ultracold Electron Bunches

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We are developing an ultrafast and Ultracold Electron Source (UCES), based on near-threshold, two-step, femtosecond photoionization of laser-cooled rubidium gas in a grating Magneto Optical Trap (MOT). This source delivers stable ultrafast electron bunches with a unique combination of high bunch charge and low transverse emittance ˜1.9 nm·rad, demonstrating the cold electron temperature ˜25 K.

Recent development focused on long term stabilizing the electron beam. By pulsing the high voltage accelerator potential, the effects of surface charge buildup in the accelerator structure are mitigated and secondary electron emission as a result of ion impacts on the cathode is prevented.

This made a high resolution ponderomotive scattering measurement possible, in which a 1.1 mJ, 25 fs, 800 nm laser pulse is focused onto the electron bunch to a waist of 5.9 µm in vacuum. The ponderomotive force scatters the electrons which can be detected in the transverse profile. In this way the electron bunch length inside the self-compression point of the UCES has been measured to be 735±7 fs. Some wavelength dependent temporal structure originating from the ionization process could be observed.

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