



Electron Phase Space Shaping in an RF-cavity-based UTEM

Developing new methods for tailoring the phase-space distribution of electron beams is a challenging and essential task in next-generation particle accelerators, compact x-rays sources, and ultrafast electron microscopy. RF-cavities are routinely employed in accelerator science to manipulate the electrons' phase-space. This contribution shows the use of a miniaturized RF-cavity to chop the continuous beam of a conventional transmission electron microscope into ultrashort pulses. We developed an RF-cavity-based ultrafast transmission electron microscope (UTEM) generating few-100-fs pulses with GHz-MHz repetition rate, which preserves the low emittance and energy spread of the TEM Schottky field emission gun.

Beyond time-resolved investigation of specimens, UTEMs entitle novel free-electron quantum optics. We devise techniques to control and shape the electron wavefunction amplitude and phase for coherent detection methods and distinct phase-contrast imaging. A laser oscillator is integrated into the RF-cavity-based UTEM setup, thus allowing the observation of the synchronized interaction between free-electrons and fs-laser pulses.

We propose to exploit this interaction to coherently shape the electron wavefunction in photon-induced near-field electron microscopy and light-based Zernike phase plate imaging. We present experimental results and a theoretical model of the ponderomotive interaction between free-electrons and laser pulses, which opens the path to the phase-manipulation of high-relativistic electron beams.

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