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THz streaking of ultrashort electron bunches

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Recently, we proposed to use building blocks of THz metamaterials for streaking of ultrashort electron bunches. Such building blocks allow for a precise control of the electric and magnetic near-field distribution in a volume that is defined by the geometry of the structure. THz radiation with wavelengths on the order of a hundred micron is well matched to the transverse and longitudinal size of typical electron bunches in advanced accelerators. Moreover, today's pulsed THz sources provide field strengths up to hundreds of MV/m and thus become competitive with standard microwave sources. When combined with structures featuring high values of either electric or magnetic field enhancement, the maximum field strength can even be ten to a hundred fold higher.

Here, the streaking device is a split ring resonator loaded by a single cycle THz pulse. Electron bunches passing through the resonator's gap experience a transverse momentum kick which sign and magnitude depends on the longitudinal bunch position. Thus, the longitudinal bunch density is mapped onto the transverse axis and can be measured with a spatially resolved electron detector. Detailed simulations and experimental results are presented for the 3 MeV ultrafast electron diffraction facility at KAERI.

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