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Directed high-power THz radiation from transverse laser wakefield excited in an electron density filament SERGE KALMYKOV, Leidos, Albuquerque, NM 87106, ALEXANDER ENGLESBE, JENNIFER ELLE, MATTHEW DOMONKOS, ANDREAS SCHMITT-SODY, High Power Electromagnetics Division, Air Force Research Laboratory, Kirtland Air Force Base, NM 87117
— A tightly focused femtosecond, weakly relativistic laser pulse partially ionizes the ambient gas, creating a string (a "filament") of electron density, locally reducing the nonlinear index and compensating for the self-focusing effect caused by bound electrons. While maintaining the filament over many Rayleigh lengths, the pulse drives inside it a three-dimensional (3D) wave of charge separation - the plasma wake. If the pulse waist size is much smaller than the Langmuir wavelength, electron current in the wake is mostly transverse. Electrons, driven by the wake across the sharp radial boundary of the filament, lose coherence within 2-3 periods of wakefield oscillations, and the wake decays [J.-R. Marques et al., Phys. Plasmas 5, 1162 (1998)]. The laser pulse is thus accompanied by a short-lived, almost aperiodic electron current coupled to the sharp index gradient. The comprehensive 3D hydrodynamic model shows that this structure emits a broad-band THz radiation, with the highest power emitted in the near-forward direction. The THz radiation pattern contains information on wake currents surrounding the laser pulse, thus serving as an all-optical diagnostic tool. The results are tested in cylindrical and full 3D PIC simulations using codes WAKE and EPOCH.

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