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Charged particle dynamics and nano-target evolution in relativistic tightly focused electromagnetic fields KONSTANTIN POPOV, University of Alberta, Canada, VALERY BYCHENKOV, Lebedev Physics Institute, Russia, WOJCIECH ROZMUS, RICHARD SYDORA, University of Alberta, Canada —
The electromagnetic field structure of a tightly focused laser pulse is calculated using Stratton-Chu integrals over the surface of a focusing mirror. The details of acceleration mechanisms and characteristic scalings of maximum attainable particle energy vs. maximum laser power and focusing optics were studied. The applicability of paraxial Gaussian beams is discussed. The 3D particle-in-cell (PIC) simulations of interaction between a tightly focused laser and nano-targets such as clusters and ultra-thin foils were performed with electromagnetic code SCPIC. In addition to the dynamical properties found in the test particle simulations, a new mechanism of Coulomb field assisted attosecond electron bunch formation has been identified. This basic mechanism includes the interplay between the laser and electrostatic fields of the partially evacuated target. Each bunch contains mono-energetic electrons. The length, density and average energy of the bunch are given in terms of simple analytical expressions. Electron acceleration and bunch formation have been also studied under more realistic conditions of the targets having a pre-plasma.

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