Simulations of bremsstrahlung emission in interactions of ultra-intense laser pulse with foil target

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Contemporary and upcoming multi-petawatt lasers will produce short pulses which, when focused to a spot on the order of a few microns, generate strong electromagnetic fields of intensities $I \sim 1 \times 10^{22}\,\mathrm{W/cm^2}$, opening new possibilities in generating laboratory γ rays by a variety of processes involving fast electrons which are generated during the interaction of an intense laser pulse with a target. Two main sources of energetic photons generated in an interaction with a thin foil target are bremsstrahlung and radiation reaction (including non-linear Compton scattering).

Bremsstrahlung emission from the interaction of a short ultra-intense laser pulse with solid foils is investigated using Particle-in-Cell (PIC) code EPOCH. A module for simulating bremsstrahlung has been implemented in the PIC loop to self-consistently account for the dynamics of the laser-plasma interaction, plasma expansion, and the emission of γ ray photons. The conversion efficiency of the energy of the laser pulse to the energy of the γ rays is studies as a function of the intensity of the driving pulse, the thickness of the target, the pre-plasma profile, and the target material. In thin targets, refluxing of hot electrons plays an important role. Simulations reveal that the angular distribution of the emitted photons exhibits a four-directional structure with the angle of emission decreasing with the increase of width of the target. It is shown that the dependence of the mean angle of emitted photons on target thickness is due to the hot electrons losing energy in the TNSA field during refluxing.