Modeling of radiation losses in ultra-high power laser matter interaction

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Radiation losses of electrons in ultra-intense laser fields constitute a process of major importance when considering laser-matter interaction at intensities of the order of and above $10^{22} \text{ W/cm}^2$. Radiation losses can strongly modify the electron (and in turns ion) dynamics, and are associated with intense and directional emission of high energy photons. Accounting for such effects is therefore necessary to a correct modeling of, e.g. electron and ion acceleration and creation of secondary photon sources at the forthcoming ultra-high power laser facilities [Ref. 1].

To account for radiation losses in the particle-in-cell code PICLS [Ref. 2], we have introduced the radiation friction force obtained by Sokolov [Ref. 3] using a renormalized Lorentz-Abraham-Dirac model. The associated angular and energy spectra of the radiated high-energy photons are also computed.

In this talk, we will present a study of the effect of radiation friction on the electron and ion dynamics in various regimes of ion acceleration [Ref. 4]. A wide range of laser intensity, target thickness and target density is explored, allowing for the study of directed-Coulomb-explosion (DCE) of nanometric targets, radiation pressure acceleration (RPA) of thin foils, and hole-boring (HB) of semi-infinite targets.

We will discuss the effect of radiation losses on the electron heating and accelerated ion energy spectrum. In particular, we will show that the piston velocity in the HB regime is reduced, and that its correct modeling requires to account for the high-energy photon momentum flux in the pressure balance [Ref. 5].

Finally, the angular and energy spectra of high-energy photons for all three interaction regimes (DCE, RPA and HB) will also be discussed.

3. V. Sokolov et al, Phys. Rev. E 81, 036412