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Optimizing direct laser acceleration of leptons

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Advanced plasma-based acceleration schemes hold a promise to provide multi-GeV electron bunches over a mm- or cm-scale. The next generation of laser facilities will allow to both create and accelerate leptons with the same laser system. Electron-positron pairs can be generated using either Breit-Wheeler or Bethe-Heitler pair production. In some cases, the very same laser can provide direct laser acceleration (DLA) of leptons in the radiation-reaction-dominated regime.

The DLA scheme has already demonstrated electron beams of ∼nC charge in experiments. Increasing the laser power is bound to augment the DLA electron charge content even further. Electron beam loading allows for accelerating positrons without transverse beam breakup, because it alters the background field structure. Here we present an analytical and numerical study of the lepton acceleration and beam loading. With extreme laser intensities, the interaction in the radiation-dominated regime provides a high flux of emitted photons, in hard x-ray and gamma-ray ranges. These photons can then be used as a seed for electron-positron pair creation, as well as a radiation source for applications.

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