Enhancement of Target Normal Sheath proton acceleration through multi-pulse laser-target interaction

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Target normal sheath acceleration (TNSA) has been the most commonly used accelerating method for protons in laser-matter interaction for the past decades, thanks to a relatively simple experimental implementation. However, even with the continuous increase of the available laser power, the poor scaling of the maximum energy of the accelerated protons with the laser energy still constitutes a major drawback for many interesting applications. Recent experiments proposed to split the energy of the main laser pulse in two pulses, incident on the target within a short time delay, showing that an increase of the proton energy and number was possible [1]. Further investigations with careful control of the time delay between the pulses suggested however that the conditions for such an increase could be quite specific [2].

In this paper, we describe a slightly modified TNSA scheme, consisting of splitting the main laser pulse in two pulses of equal energy incident on the target simultaneously, but with different angles of incidence. Based on 2-dimensional simulations with the EPOCH Particle-In-Cell code, we show that the multi-pulse interaction that arises leads to an increase of the peak value of the electric fields and substantial modification of the hot electron generation process, which leads to a higher hot-electron temperature. This in turn leads to a strong enhancement of the proton energy (from 8.5 to 14 MeV with a 45 degree angle and 0.8 J laser) and proton number, and this conclusion remains valid for a large range of incident angle for the laser pulses.

References

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