A new model for TNSA in the multi-ps laser-foil interactions

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In laser-matter interactions in the intensity level of $10^{18}$ W/cm$^2$, a few tens MeV ions can be generated. Ion acceleration in the interaction of thin foils with sub ps-1 ps laser pulses has been described conventionally by the self-similar plasma expansion theory assuming an isothermal condition [1]. Recently, an ion acceleration experiment using multi-ps laser pulses from kilojoule class laser LFEX was conducted [2] where the large spot size of 70 μm with the peak intensity $2.3 \times 10^{18}$ W/cm$^2$ results electron heating and ion acceleration exceeding the conventional 1D isothermal model. To understand such an interaction in the multi-ps regime where the electron heating during the laser irradiation is a key ingredient, we here present a new model for plasma expansions that takes the time variation of electron temperature, i.e. sound velocity, into account. Based on the temperature evolution obtained by a PIC simulation corresponding to the LFEX experiment, the theory was validated by comparing the maximum ion energy between theory and simulations. [1] A. Yogo, K. Mima, N. Iwata et al., submitted to Nat. Comm. [2] P. Mora, Phys. Rev. Lett. 90, 185002 (2003).