Efficient ps. Laser Ion Acceleration toward High Neutron Yield

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Laser driven neutron sources and their applications have been explored in the projects of the A-STEP program of the JST, since 2016 at ILE, Osaka University and GPI, Hamamatsu. In this paper, new findings for the efficient laser ion acceleration and neutron generation are reported.

The higher ion and neutron yield are realized by producing a pre-plasma before the main pulse in the TNSA. According to the simulations, the short pulse laser absorption and hot electron slope temperature are higher when a pre-plasma is formed on a solid target surface. So, the accelerated ion number and energy are expected to be higher. But, because of the pre-heating, the rear surface of a thin foil expands and then the TNSA field is reduced. The new finding is to steepen the rear surface density profile by controlling the shock breakout time, It is explored by the radiation hydro-simulation. We found that the steepened rear surface density profile is realized by adjusting the pre-pulse intensity and duration and the target thickness. The PIC simulations were carried out to see the pre-pulse effects. According to the results, the total ion energy and the cut-off energy increases by one order with a proper pre-pulse and the target thickness.

As preliminary experiments, the pitcher-catcher schemes were studied with the LFEX laser at ILE and the repetition rate short pulse laser at HPK and GPI. In the LFEX experiments, the 0.5-1 kJ, multi picosecond pulse irradiated a CD foil with proton contamination for accelerating deuteron and proton. The accelerated proton and deuteron number for the energy higher than 10 MeV reaches 10^{14} /shot, which is 10 times higher than that without pre-pulse. The more discussions on the simulations and experiments will be presented.