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1Hz Pellets Injection and Laser Synchronous System for Continuous Laser Confinement Fusion and Neutron Generation

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We succeeded in injection of spherical deuterated polystyrene bead pellets at 1 Hz and symmetrical engagement and irradiation of them with two ultra-intense laser beams. (i) This is the first demonstration of ultra-intense laser engagement of injected flying pellets. The laser intensity was high enough to produce a DD neutron yield of 9.5×10^4/4pi sr/shot. (ii) We observed channel formation through the free-falling pellets, which might be the evidence to support a scheme for fast ignition.
Deuterated polystyrene (CD) beads whose diameter is 1mm are used as pellets. Each pellet free-falls to the laser focal point 18 cm below at 1 Hz. The signals from the two photodiodes above the focal point are sequentially sent to a laser controller, which forecasts the arrival time at the focal point and sends a shooting-request signal to the diode-pumped, ultra-intense laser HAMA appropriately. As soon as HAMA receives the signal, its two laser beams are emitted onto the injected pellet with an appropriate delay time. In experiments, up to 1,300 continuous injection was successfully demonstrated. Currently, pellets are successfully engaged by two counter laser beams at the probability of about 70%. The laser energy, pulse duration, wavelength, and the intensity were 0.63 J per beam, 104 fs and 811 nm, 4.7×10^18W/cm^2, respectively. In 7% of engaged shot, neutron generation was observed. The maximum yield of produced neutrons is 9.5×10^4/4pi sr/shot, that was four times larger than that of single beam experiment, although the total laser energy is same as 1.2J. Moreover, the laser is found out to bore a straight channel with 10um-diameter through a bead. One possible explanation about channel boring is as follows: Free-electrons generated by the pre-pulse and pedestal components of the laser pulse might work as a guiding wire for the fast-electrons generated by the main high intensity pulse using the guiding wire. The intense laser is expected to transport sufficient energy along the path from the focal point to the core. We conceived this idea of hole boring, as a means for obtaining a clean path from the focal point to the core. The hole boring observed in this experiment can be applied for the fast-ignition.

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