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Spherical Convergent Plasma Fusion (SCPF) Neutron Generator by Laser Drive: Theory and Experiment

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We propose a feasible scheme to acquire high ion temperature and high thermal nuclear fusion neutron yield with laser ablated spherical convergent plasmas fusion (SCPF). In our scheme, we use intense lasers (1014-1015W/cm2) pulse of nanosecond duration to irradiate thermonuclear fuel (Carbonized Deuterium, CD)containing layer(˜10microns) lined inside a spherical hohlraum, the fuel layer is ablated and then expands at high speed(˜500km/s) towards the sphere center. The hot fuel plasmas eventually merge at the center and convert most of their kinetic energy to the ion internal energy, raising the ion temperature to a high level of around 10keV. We have done demonstrating experiment on SGIII-prototype facility. In the experiment, we use 6kJ triple-frequency laser to irradiate a CD layer lined inside a 1.7mm diameter spherical hohlraum with one laser entrance hole at each end, wehave acquired a stable DD thermonuclear fusion neutron yield of 3×109. The process is robust and neutron yield isinsensitive to practical experimental environment and parameter fluctuation.The neutron ToF data shows that the ion temperature of the merged plasmas isaround 7keV-8keV.The experiment results agree with our theoretical scaling law and hydrodynamic simulation. The experiment has demonstrated the SCPF to be potentially a high laser fusion neutron generator in future. Improvement and further optimization of this scheme is undergoing.

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