Spherically convergent plasma fusion neutron generation by laser drive

Guoli Ren[1], Jie Liu[1], Ji Yan[2], Ke Lan [1]

[1]Institute of Applied Physics and Computational Mathematics, Beijing, China

[2]Laser Fusion Research Centre, Mianyang, China

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 (10^{14}-10^{15} W/cm^2) pulse of nanosecond duration to irradiate thermonuclear fuel (such as Carbonized Deuterium, CD) containing layer (~10 microns) lined inside a spherical hohlraum, the fuel layer is ablated and then expands at high speed (~500 km/s) towards the sphere center. The hot fuel plasma 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 10 keV. We have done demonstration experiment on SGIII-prototype and SGII-upgrade facility. In the experiments, we use 6-12 kJ triple-frequency laser to irradiate a CD layer lined inside a 1.7~2.0 mm diameter spherical hohlraum with one laser entrance hole at each end, we have acquired a stable DD thermonuclear fusion neutron yield of $3\text{-}5\times10^9$. The process is robust and neutron yield is insensitive to practical experimental environment and parameter fluctuation. The neutron ToF data shows that the ion temperature of the merged plasmas is around 7 keV-8 keV. The experiment results agree with our theoretical scaling law and hydrodynamic simulation. The experiment has demonstrated that the SCPF scheme can potentially be a high-flux laser fusion neutron generator in future. Improvement and further optimization of this scheme is undergoing.

[1] G. Ren, J. Yan, J. Liu, K. Lan, et al., Phys. Rev. Lett. 118, 165001(2017)