Abstract

Recently, Impact Fast ignition (IFI) was proposed as a new ignition scheme of the Inertial Confinement Fusion (ICF). In the IFI method, we accelerated a small portion of the fuel (called "impactor") to a super-high velocity to collide with a pre-compressed main fuel. The kinetic energy of the impactor is converted to the thermal energy of both ions and electrons, and it becomes an igniter. In the concept of the IFI scheme, the Rayleigh-Taylor (RT) instability on the impactor is the most important issue to be investigated. Suppression of the RT instability is necessary to achieve a high gain in the IFI method. The implosion performance of the main fuel is also another important issue. The main fuel must be compressed to the required density with the appropriate areal-density. A new diagnostic method is necessary to be developed to measure the high density achieved by the implosion experiment.

In order to suppress the ablative RT instability on the accelerated impactor, we used low-density foam target. We observed the growth of the RT instability on the low-density foam target and the solid-density CH target with the same laser intensity, the same areal-density and the same initial perturbation wavelength. Observed growth rates were 0.84±0.15 (1/ns) and 1.33±0.1 (1/ns), respectively. The growth rate for the low-density foam target is suppressed in comparison with the solid-density CH target.

We developed the method of density measurement using the Fermi degeneracy effect. We produced the model of charged particle stopping power in degenerate plasma. And, the measurement of DT/DD neutron yield ratio and ion temperature of plasma was developed. The density of highly compressed plasma was measured in implosion experiments. The maximum value of the measured density of plasma was 350±50 g/cm^3.

In order to prove the effectiveness of IFI method, we had started a fundamental experiment and an integrated experiment. The acceleration of the impactor up to the super-high velocity was examined in the planar and also spherical geometry and was successfully achieved with the velocity higher than 6×10^7 cm/s in the fundamental experiment. As for the spherical convergence of the impactor and the impact heating were demonstrated by an integrated experiment by using the spherical plastic shell with the conical guide for the impactor.