§60. Formation of High Areal Density Core Plasma Using Slow Velocity Implosion

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In fast ignition scheme, the high energy electron or ions is applied to achieve the ignition condition of the temperature, where a central hot spot (CHS) is not required [1]. That is, the implosion core required for fast ignition system is different from that of the CHS scheme. Only the main fuel of the low temperature and high density is required in fast ignition. Therefore, it is necessary to design targets, which is different from that of the CHS[2].

One of the realistic solution is "slow velocity implosion" scheme, where a hot spot is not formed. Another advantage of the scheme is the suppression of the Rayleigh-Taylor instability. In order to avoid the mass density reduction due to hydrodynamic instability, the acceleration of the imploding shell should be kept low. In addition, reducing the velocity of the inner shell is important to prevent stagnation, and the keeping the shell in low isentrope is ideal. After these theoretical study, it is necessary to verify the scheme experimentally in near future. A preliminary experiment for the scheme is planned to realize the concept of the slow velocity implosion. In this year we focus on the pulse shaping which is most important technical method.

Experiment results

The laser pulse shaping is a major key technique for design of the slow velocity implosion[3]. In general, tailored pulse with long rise-time is applied for low isentrope compression[4]. In order to evaluate the differences of the preheating between pulse with and without long foot pulse was irradiated to a target using HIPER laser system in GXII. Two types of laser pulse shapes are shown in Fig. 1. The irradiation timing of each beam are controlled, and quasi-tailored pulse shape is obtained. The dotted line indicates the pulse with foot of which intensity is function of t^3 at rising stage.

Optical diagnostics are conventional methods[5]. Polystyrene target (25μmt) with 0.03 μm Aluminum coating is irradiated by the laser. The self-emission of rear surface is collected by streak camera (SOP: Streaked Optical Pyrometer). Result can be achieved by converting streak camera signal to energy, then energy to temperature according to Planck's law (Fig.2). Firstly interference fringes are generated due to Etalon interferometer. As target increases its velocity, Doppler effect causes the shift of fringe position get velocity deduced (VISOR).

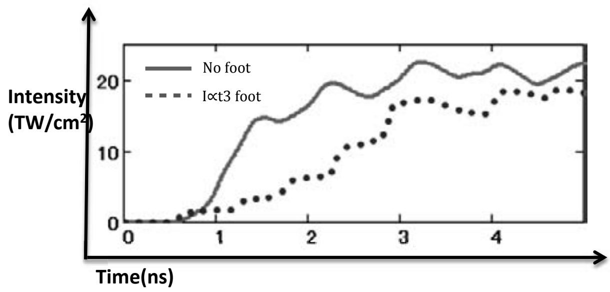

Figure 1 Two different laser pulses

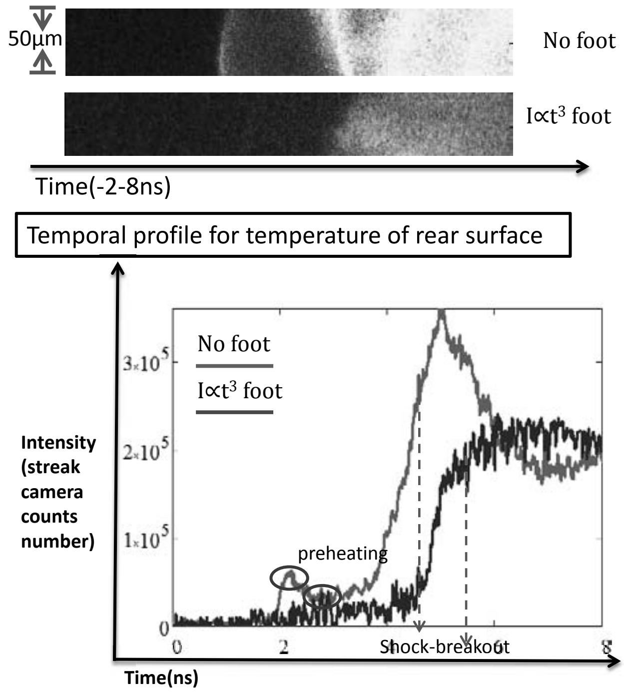

Figure 2. Temperature reduction at shock-breakout time by I∝t^3 foot is measured by SOP

Summary

For pulse-shaping method, we can see that temperature and velocity at rear surface has evidently decreased at shock-breakout time. For target-coating method, we can see that copper layer has reduced temperature of rear surface to a low level and prevent the ionization of aluminum. Adiabat got controlled from both methods.

More "smoothly increasing" pulse in order to generate a better sequence of shocks and suppress the entropy inside the target will be tried next year. This time copper also reduced the overall temperature and implosion speed, which may influence the imploding efficiency. Further parameterization is necessary to find a more suitable way of coating.

1) R. Betti and C. Zhou, Phys. Plasmas **12**,110702.

2) M.H.Key, Phys. Plasmas **14**, 055502.

3) W. Theobald, *et al*, Phys. Plasmas **18**, 056305.

4) H. Nagatomo *et al.*, EPJ Web of Conf. **59** 03007, 2013.

5) K. Otani, K. Shigemori, et al, Phys.Plasmas **17**, 032702.