§18. Laser Fusion Research

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Since April, 2003, we started the construction of heating laser of 10kJ/10ps/1.06 mm ; named LFEX (Laser for Fusion Experiment), for FIREX-I. The LFEX will be completed before the end of 2007. The expected rise time of the short pulse LFEX is less than 1ps and the focus diameter is smaller than 30 mm. As the front end of the laser, OPCPA is introduced to improve the contrast ratio to less than 10^{-8} . For pulse compression, segmented dielectric gratings will be used. The R&D for the coherent combining of the pulse compressed segmented beam has started [1]. After the completion of LFEX, we will start the foam cryogenic cone shell target experiment in late 2007.

Cone shell target implosion is studied by experiments and simulations for the FIREX-I target design. The detail of implosion hydrodynamics has been explored with a new implosion code PINOCO. The recent implosion simulations for FIREX targets show that a core plasma density is as high as the maximum density of spherical implosion and the area density can be higher than the spherical implosion.

By the peta watt laser heating simulation researches , we found that the cone top is heated up to a few 100 keV by electrostatic and electromagnetic collective interactions between relativistic electrons and back ground electrons. This reduces the laser relativistic electron energy to enhance the stopping power and the delayed energy transport from the heated cone top to the core keep core heating for a long time after the laser pulse. We believe that those processes related to the core heated should be controlled in the FIREX experiments. The scalability of these processes will be verified in the FIREX-I experiment and related theory and simulation research. From those understanding on the heating physics and the cone shell implosion hydrodynamics, we believe that the hot spark $(rR)_h$ and the temperature will reach 0.45 g/cm^2, and 5keV respectively in the FIREX-I.

The target fabrication and irradiation system with characterization of DT cryogenic foam layer are also under development as the collaboration program between Osaka University and NIFS(National Institute for Fusion Science). The DT fuel will be fed to the foam shell layer through a capillary and then, frozen to a solid layer. Then , The integrated FIREX-I experiment will start before the end of 2007. If the gain of the order of 0.1 and the temperature higher than 5keV are achieved in FIREX-I before the end of 2008, we plan to proceed to the FIREX-II in 2009. "Recent results and future prospects on fast ignition research: theory and experiment

Reference

1) N.Miyanaga, et al, Proceedings of IFSA2002, Monterey, Ca., US.
2) H.Nagatomo, Prodeedings of the IFSA2002, Monterey, Ca., US