TOWARD EFFICIENT HEATING IN THE FAST IGNITION SCHEME WITH STABLE COMPRESSION, PLASMA MIRROR AND EXTERNAL B-FIELD

S. Fujioka[1*], T. Johzaki[2], Y. Arikawa[1], A. Morace[1], A. Yogo[1], Z. Zhang[1,9], S. Sakata[1], S. Kojima[1], Y. Abe[1], S-H. Lee[1], K. Matsuo[1], K- F. Law[1], T. Yamamoto[1], K. Shigemori[1], Y. Hironaka[1], T. Sano[1], Y. Sakawa[1], M. Hata[1], A. Sunahara[3], T. Ozaki[4], H. Sakagami[4], H. Sawada[5], Y. Sentoku[5], J. J. Santos[6], P. Nicolai[6], J. Breil[6], M. Bailly-Grandvaux[6], X. Vaisseau[1], K. Kondo[7], K. Mima[1,8], Y. Fujimoto[1], K. Yamanoi[1], T. Norimatsu[1], S. Tokita[1], Y. Nakata[1], T. Jitsuno[1], N. Miyanaga[1], H. Nishimura[1], H. Shiraga[1], J. Kawanaka[1], H. Nagatomo[1], H. Azechi[1]

[1]Institute of Laser Engineering, Osaka University, Suita, Osaka, Japan
[2]Graduate School of Engineering, Hiroshima University, Higashi-Hiroshima, Japan
[3]Institute for Laser Technology, Suita, Osaka, Japan
[4]National Institute for Fusion Science, Toki, Gifu, Japan
[5]University of Nevada Reno, Reno, NV, USA
[6]University of Bordeaux, CNRS, CEA, CELIA, UMR 5107, F-33405 Talence, France
[7]Research Laboratory for Nuclear Reactor, Tokyo Institute of Technology, Tokyo, Japan
[8]The Graduate School of the Creation of New Photonics Industries, Hamamatsu, Japan
[9]Institute of Physics, Chinese Academy of Science, Beijing 1000080, P. R. China
*sfujioka@ile.osaka-u.ac.jp

Direct-drive fast-ignition is an attractive approach owing to relaxing the requirements on fuel assembly compared to the central hot spot ignition. The heating efficiency is defined as the ratio between the heating laser energy and the increment of internal energy of the fuel core induced by relativistic electron beam (REB) heating. The efficiency was evaluated to be 0.37% from a previous experiments [1]. The experimental results clarify three scientific challenges for achieving the high efficiency with the current GEKKO-XII and LFEX system: (i) high areal density core formation, (ii) optimization of REB energy distribution, and (iii) guiding and collimation of REB to the fuel core.

Based on radiation-hydrodynamic simulation, a dense core with > 0.2 g/cm^2 of areal density can be produced from a 200 μm-diameter solid sphere compressed by temporally-tailored converging shock wave. This is preferable for the fast-ignition scheme due to its hydrodynamic stability and simplicity even though the hot spark can not be produced only by the converging shock. Time sequence of the core formation was measured with monochromatic ps-flash Ti-$K\alpha$ x-ray backlight imaging. The REB had high-energy tail in the previous experiment due to pre-plasma formation in a laser-matter interaction region. Intensity contrast of the LFEX laser was improved up to 10^9 at 100 ps before the main pulse. Furthermore, a plasma mirror was implemented in LFEX to achieve 10^{11}. After these improvements, 50% of the total REB energy is carried by a low energy component of the REB whose slope temperature is close to the ponderomotive scaling value (~ 1 MeV). In order to control the divergence of the REB, we propose to apply strong external magnetic field to the REB path to the fuel core. Generation of 1 kT magnetic field [2,3] has already been demonstrated. Guiding of REB by the external magnetic field is being tested. Effects of the external magnetic field on implosion hydrodynamics are also investigated experimentally and theoretically for optimization of magnetic field geometry after the fuel compression.

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