State of the art of the studies of alternative direct drive ignition schemes

Tikhonchuk V.T.

CELIA, Université de Bordeaux – CNRS – CEA, Talence, France  
ELI-Beamlines, Institute of Physics, Czech Academy of Sciences, Dolní Břežany,  
 Czech Republic

Alternative ignition schemes use separate laser pulses for the pellet implosion and hot spot ignition. Such approaches are promising for future fusion energy production as they allow to reduce the ignition energy, make the target more robust and promise to obtain a higher efficiency [1]. In spite of general attractiveness of these schemes and their solid physical background, the experience of last 15 years of international research shows us the considerable challenges on the way to their practical realization. The common denominator of these problems are the energetic electrons, the physics of their generation and transport and the control of their energy deposition. In this review I present the recent advanced in the physics of energetic electron transport in application to the fast and shock ignition schemes.

The major challenge for the fast ignition is the divergence of the relativistic electron beam. Developed recently technique of a strong magnetic field generation with laser driven coils [2] allows an efficient electron transport over the distance of a hundred microns and allowed to achieve a record ion temperature of 3 keV in the compressed core in the integrated experiment on the GEKKO-LFEX laser system [3].

Hot electrons created in laser plasma interaction with solid targets at laser intensities above   
1015 W/cm2 can deposit their energy in depth of the target thus augmenting the strength of the shock and/or preheating the target upstream the shock. These issues are of a vital importance for the shock ignition scheme. Our recent studies demonstrate the vulnerability of the standard target design to the fast electron preheat [4] and a necessity of a better control of the hot electron generation and transport. Several results related to the control of hot electron generation and transport in the converging geometry on the OMEGA laser system [5] will be presented as well as the design for the strong shock experiment on the LMJ facility scheduled for the spring 2019.

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