Researches on laser-driven implosions and fusion fuel mixture

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In inertial confinement fusion (ICF) research, the objectives of the target physics experiments are to address and understand critical physics issues that determine the conditions required to achieve high gain in an implosion capsule. The directly driven targets can be divided into two types: ablating targets and exploding pusher targets. The implosions of ablating targets utilize the heating of pressure created by laser ablating target material and so the target walls should be fairly thick. However, the implosions of exploding pusher targets are driven principally by electron thermal conduction (i.e., hot electrons heat target shells). Hot electrons lose part of energy in the wall, heat the shell, pass through the DT gas fuel reaching the opposite target wall and the microshell implodes at last. Hence, the wall thickness should be half of the even free path of hot electrons.

It is possible that a small amount of high Z atoms are mixed into the fusion fuel for such causes as interfacial instability in the implosion process. Therefore, it is of great importance to understand and interpret the condition theoretically and experimentally where high Z materials are mixed into the fusion fuel. When laser-induced fusion reaction occurs, fusion energy is released and at the same time energy needs expending to produce and heat plasma as well as maintain plasma radiation.

Neutron yield is a sensitive indicator for the conditions achieved in the implosion. As a result, what is mentioned above can be demonstrated qualitatively by watching the changes in neutron yield. There are many approaches to measure implosion DT neutron yields. An plastic scintillation detector was employed in the experiment performed on the ShenguangII laser facility due to the advantage that neutron signals and X-ray signals from laser-material interaction can be distinguished from different times of flight. The research results show that the heating of hot electrons dominates for driven-directly exploding pusher targets and that implosion neutron yield will decrease considerably if any high Z material is mixed into the fusion fuel.