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PD/P8-04: Deuteron Beam Driven Fast Ignition of a Pre-Compressed Inertial Confinement Fusion Fuel Capsule

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Fast Ignition is recognized as the most promising approach to achieving the high energy gain target performance needed for commercial inertial confinement fusion (ICF). However, there are a number of physics issues related to the traditional approach of using a petawatt laser to generate a relativistic electron beam that should penetrate and focus on the hot "spark" region of the compressed target. One promising alternate approach that has been proposed by LLNL, LANL and others is the laser generation of a proton beam in an "interaction foil" to ignite the target. However, the total proton flux simply from hydrogen water adsorption on the foil is too low to generate the desired flux. In more recent studies it has been found that ions heavier than protons would provide better focusing on the hot spot if ways to efficiently generate them can be found. Thus, we proposed to utilize a new "Deuterium Cluster" type structure for the laser interaction foil to generate an energetic deuteron beam as the fast ignitor. The deuteron deposition in the target fuel will not only provide heating but also fuse with fuel as they slow down in the target. The preliminary results from recent laser-deuteron acceleration experiment at LANL were encouraging. Also, in most recentcalculations, we found that a 12.73% extra energy gain from deuteron beam-target fusion could be achieved when a quasi-Maxwellian deuteron beam was assumed, and when a ρrb= 4.5 g/cm2 was considered, where ρ is the fuel density, and rb is the ion beam focusing radius on the target. These results provide some insight into the contribution of the extra heat produced by deuteron beam-target fusion to the hot spot ignition process. A further analysis of how a converter foil using ultra-high-density cluster materials can help to achieve the yield requirements for ignition is presented. This also will improve the fast ignition scheme based on the generation of ultrafast acceleration of plasma blocks by picoseconds laser pulses driven by the nonlinear (ponderomotive) force.

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