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Experimental Platform for Efficient Heating of Fusion Fuel with Fast-Ignition Scheme

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A series of experiments were carried out to evaluate energy coupling efficiency from a heating laser to a fuel core in the fast-ignition scheme of laser-driven inertial confinement fusion. Here we break down the efficiency, which is governed by enormous interactions and instabilities among intense laser, high-energy-density plasma, and relativistic electron beam (REB), into three measurable parameters: (i) energy conversion efficiency from a laser to a REB, (ii) probability of collision between the REB and a fusion fuel core, and (iii) fraction of energy deposited in the fuel core from the REB. These three parameters were measured in the basic experiment under mimic plasma circumstances of the integrated fast-ignition experiment. In the heating experiment, fusion neutron yield was measured to understand the heating mechanism by comparing the yield with a two-dimensional Fokker-Planck computation of the REB transport in the core plasma. The experimental results indicate that 'unstoppable'and 'diverging'problems of the REB must be solved for heating the fuel core efficiently with the REB. Guiding of the REB by > 1 kT magnetic field produced by a laser-driven capacitor-coil target is essential to overcome these difficulties.

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