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Title: Fast Ignitor Coupling Physics

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Fast Ignitor Coupling Physics (U)

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The Fast Ignitor is an alternate approach to ICF in which short pulse lasers are used to initiate burn at the surface of the compressed DT fuel. The aim is to avoid the need for careful central focussing of final shocks, and possibly to lower substantially the energy requirements for ignition [1]. Ultimately, both goals may prove crucial to Stockpile Stewardship. For success with the Fast Ignitor,the laser energy must be efficiently deposited into megavolt electrons, which must, in turn, couple to the backgound ions within an alpha particle range. To understand this coupling, we have used ANTHEM plasma simulation code [2] to model the transport of hot electrons generated by an intense ($\geq 3 \times 10^{18}$ W/cm^2) short pulse 1.06 μm laser into plasma targets over a broad range of densities (0.35 to $10^4 \times n_{crit}$). Ponderomotive effects are included as a force on the cold background and hot emission electrons of the form , $F_{h,c} = -(\omega^2{}_{p_{h,c}}/2\omega^2)\ \nabla I$, in which I is the laser intensity and $\omega_p{}^2 = 4\pi e^2 n/m_o\gamma$ with m_o the electron rest mass.

We show that: 1) the intense (30 MG to 1.5 GG) magnetic fields arise in this interaction are due to the ponderomotive push on background electrons, and tardy electron shielding, and that 2) these fields can confine the heated electrons to the surface, possibly aiding fast ignition.

Figure 1 collects typical simulation results. Frame (a) shows axial cuts of the magnetic field for a 3.3 x 10^{18} W/cm^2 glass laser drive producing 700 keV electrons with 40% absorption in an initial 50 times overdense plasma. It shows a peak field of 300 MG at 340 fs directed in consistency with a central stream of hot electrons into the plasma. Frame (b) shows concomitant B-field contours. In (c) we show the total ion charge density Zn_i and the electron division into hot n_h and cold n_c density components. Frame (e) is the hot emission electron flux nv_h, (f) gives the return flow nv_c, and (d) gives the total, $nv = nv_h + nv_c$. Clearly, the hot electrons are strongly focussed along the central axis of the beam through the null point in magnetic field.

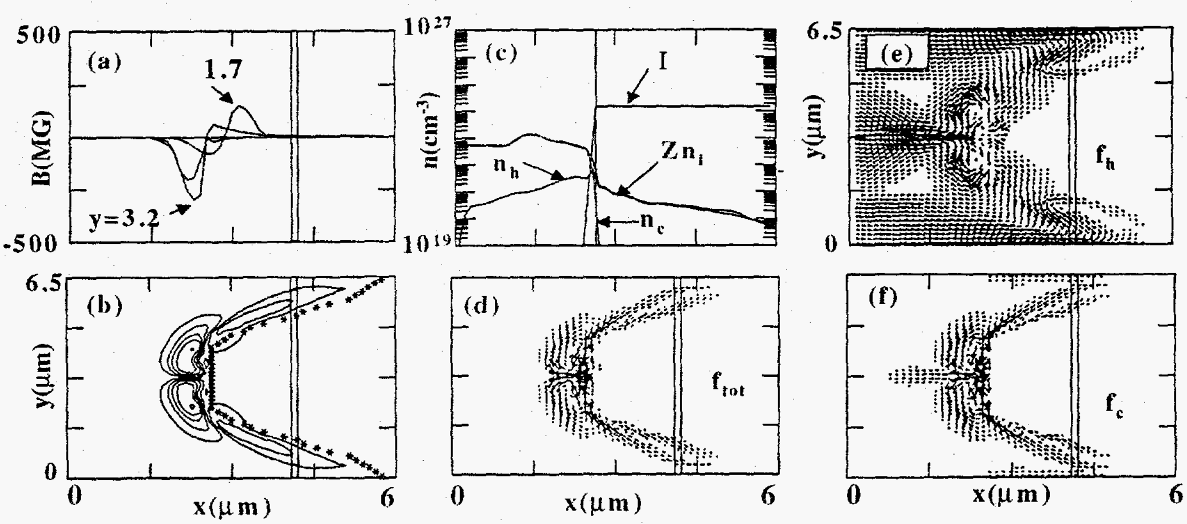

Figure 1. Magnetic fields, densities and electron flux under intense laser illumination.

ANTHEM indicates that the focussing effect grows more intense as both the background density and the laser intensity is increased. A resultant trapping of the hot electrons near the surface can lead to energy loss though fast ion surface emission. Such effects must be given careful consideration in capsule design for the Fast Ignitor. (U)

[1] M. Tabak, J. Hammer, M. E. Glinsky, W. L. Kruer, S. C. Wilks, J. Woodworth, E. M. Campbell, M. D. Perry, and R. J. Mason, Phys. Plasmas **1**, 1626 (1994).

[2] R. J. Mason, J. Comput. Phys. **71**, 429 (1987).