NRL LASER FUSION PROGRAM

January-February 2001

Bimonthly Highlights

Simulations of the NIF Direct Drive Target

We have analyzed direct drive targets for NIF with fully integrated FAST simulations that include thermonuclear burn and alpha particle transport. The baseline for these studies is the all-DT pellet driven by 1.6MJ of NIF laser light (fig.1).

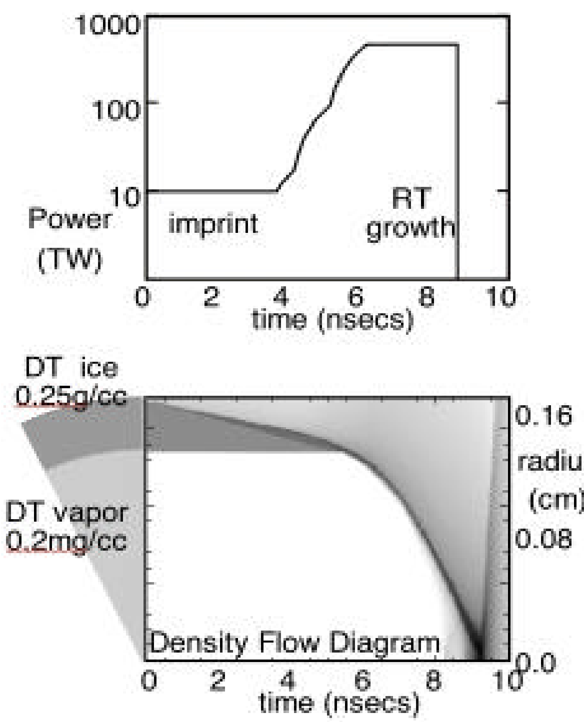

Fig.1

This pellet absorbs 70% of the frequency tripled glass laser light incident and produces 58 MJ of yield in 1D. 1D simulations combined with imprint studies and standard RT dispersion relations predict a maximum of about 5 e-folds of RT growth (occurring near l=128). For the NIF surface finish standards and 1 THz SSD optical smoothing, this would lead to a shell distortion of order 25 microns at the deceleration point.

Simulations have been done in two dimensions (r,theta) in order to directly calculate the hydrodynamic instability growth and to predict the degradation of the gain that results.

The 2D simulations include all of the phenomena that affect the symmetry and stability of the pellet: the outer & inner surfaces of the pellet are perturbed to NIF specifications (2.0 μm inner, 0.123 μ m outer rms surface finishes); the laser drive includes both spatial and temporal (1Thz) incoherence; and the power imbalance and beam misalignment are set to NIF specifications that give ~ 2% (time integrated) low-mode nonuniformity on the pellet. An example of such a calculation, which resolves modes from l=2 through 128, is shown in fig. 2 just as significant thermonuclear burn begins.

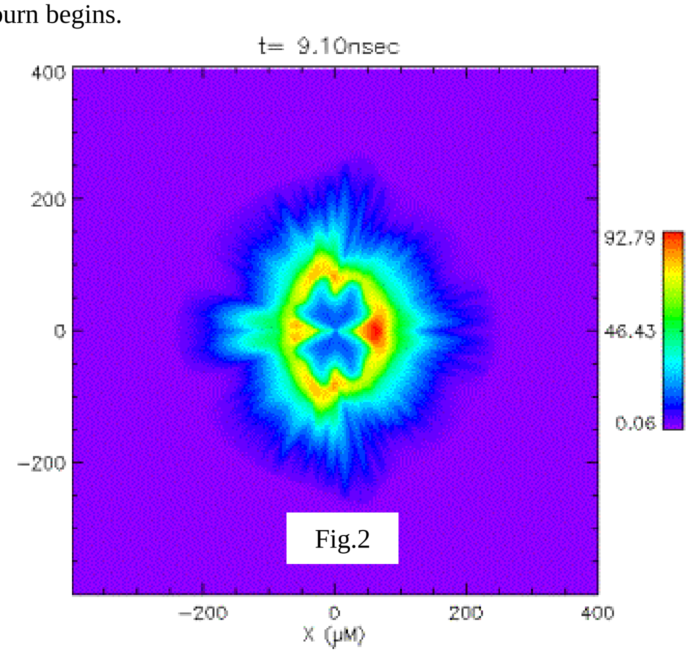

Fig.2

(Modes are considered resolved in our simulations if there exists at least 16 grid points per mode). The gain resulting from these nonuniformities is 18, or about 1/2 of the full 1D yield. Other simulations that independently vary surface perturbations, power imbalance, and laser bandwidth show that the power imbalance/beam misalignment contribution is the dominant contribution to gain degradation, with a lesser yet significant contribution due to the inner surface nonuniformity. There still remains the problems of the effect of the the higher mode contributions (l >128) on the gain of the pellet; studies in progress are expected to address this issue.

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