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1 of 1

Progress Report to DOE
Inertial Confinement Fusion Program
Naval Research Laboratory
Washington, DC 20375

FY 1980

MASTER

IV. PROGRESS

A. Experiments

The initial series of experiments on the acceleration of disc targets has been completed, and we have checked out a number of new diagnostics. The major result of our experiments so far are:

1. We have ablatively accelerated targets to velocities up to 10^7 cm/sec.
2. We have demonstrated efficient laser-plasma absorption (80% at 10^{13} W/cm²).
3. We produced a one component electron temperature at the target of about 300 electron volts, thereby demonstrating good thermal coupling to the target at lower irradiances.
4. We experimentally demonstrated hydrodynamic efficiencies of 20%. This was far in excess of what the community believed possible as recently as a year ago.
5. We examined the effect on nonuniform laser illumination on the acceleration of a disc target.
6. We studied the heat arrival time on the back surface of our disc targets.
7. We measured density profiles of the plasma by means of shadowgraphy and interferometry with multiple time frames.

Our preliminary measurements of absorption and hydrodynamic efficiency, and of ablation pressure, give us some hope that there is an irradiance regime, useful for laser fusion, between the Scylla of backscatter and Charybdis of 2-D effects.

B. Laser Upgrade

We have exceeded our laser energy specification. We have obtained 650 joules in a $3\frac{1}{2}$ nanosecond pulse out of a 10.5cm disc amplifier system. For comparison, note that Shiva requires a 15cm amplifier to produce an equivalent energy. The efficiency of the NRL laser is .25% about three times the efficiency of the Shiva

Pages 1 thru 8 intentionally omitted

system. Nonlinear optical effects are small. Clearly, we have verified that phosphate laser glass in medium-sized disc amplifiers is an attractive choice for laser systems. Preliminary measurements of beam uniformity are very pleasing.

C. Diagnostic Developments

The following is a list of diagnostics that have been used in our target experiments within the last 12 months. A star is placed in front of each diagnostic that was a major revision, or a new type of diagnostic.

1. Light scatter:
 - Mini-calorimeter array
 - Large calorimeters,
 - *Box calorimeter,
 - Streak camera,
 - *Time-resolved continuum emission in the visible spectrum.
2. Probe beam:
 - *300psec probe at 5270 A, timed to the laser pulse,
 - *100psec probe at 5459 A, Raman shifted and timed to the laser pulse
 - *Doppler shift measurements from a scattered probe beam,
 - *Angular distribution of the scattered probe to obtain density surface variations,
 - *Multi-frame interferometry and shadowgraphy.
3. X-ray diagnostics:
 - X-ray pinhole photos,
 - X-ray absolute spectra, 1-100 keV,
 - XUV spectrograph,
 - *Sub-nanosecond time-resolved keV X-rays,
 - *Sub-nanosecond time-resolved sub-keV X-rays,
4. Particle detectors:
 - Mini-calorimeter array,
 - Time-of-flight charge collector array,
 - *Ballistic pendula array.
5. Major purchases:
 - Optical streak camera,
 - *Gigahertz scopes,

D. Stimulated Brillouin Backscatter Theory

1. We developed a two-dimensional optics code to study ray-retrace phenomena and compared predictions with a variety of experiments. Good agreement was found with a variety of backscatter experiments. We have also developed a one-dimensional fluid code to study the laser-target interaction physics. Unlike a large implosion code like Lasnex, this one-dimensional fluid code was designed especially to provide detailed information on the laser plasma interaction region. Good experimental agreement was found for 1-pulse experiments, 2-pulse experiments, and long pulse experiments. Agreement between this fluid code and experiments seems to be superior to that of other 1-D fluid codes now used for laser fusion.

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