Progress in Laser Fusion Using Frequency-tripled Nd:glass Laser

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High-density compression of a D-T mixture to induce thermonuclear fusion of these nuclei may be achieved by inertial confinement of the D-T fuel using an extremely high-power laser system. At the university of Rochester's Laboratory for Laser Energetics, such compression experiments are performed using the OMEGA Upgrade laser. The laser system consists of 60 beams with energy on target up to 30 KJ. The pulse shape is made of a foot pulse (2~6ns) and a main pulse (≤0.5ns). Targeting accuracy is $\pm 15\mu m$, irradiation and non-uniformity of $\pm 1\% \sim 2\%$ rms, and repetition rate of 1 shot per hour. One of the major issues in the laser fusion is to minimize the Rayleigh-Taylor hydrodynamic instabilities which are caused by the irradiation beam non-uniformity and the geometrical imperfection of fuel capsule. Such perturbations may be described in terms of spherical harmonics and those l-mode components responsible for degradation of the uniform compression have been identified for both direct and indirect schemes. In order to reduce the irradiation non-uniformity to 1~2%, several schemes are being developed including distributed phase plate and smoothing by spectral dispersion. Several techniques are also being studied to fabricate geometrically perfect cryogenic fuel capsules. In the direct drive approach, rms surface finish should be less them 1000Å. In order to achieve such surface finish, β-layering and the plasma heating of the solid D-T fuel layer are developed. The OMEGA Upgrade project is a part of US Department of Energy Inertial Confinement Fusion Program. By 1999, the OMEGA Project is expected to produce ignition scale performance using a cryogenic fuel capsule. Such performance will pave the technological and experimental basis for National Ignition Facility in the US, a 200-beam, 1.8 MJ · solid state laser, being constructed at Lawrence Livermore National Laboratory.