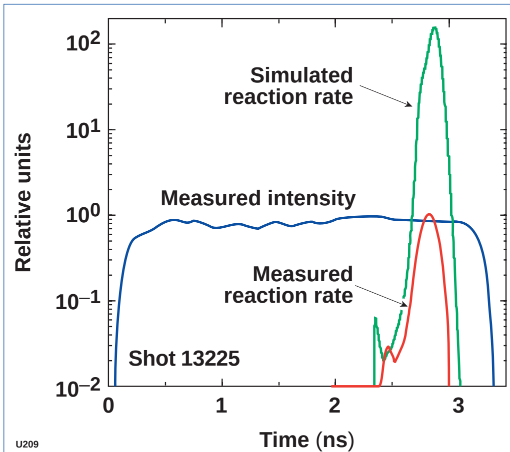
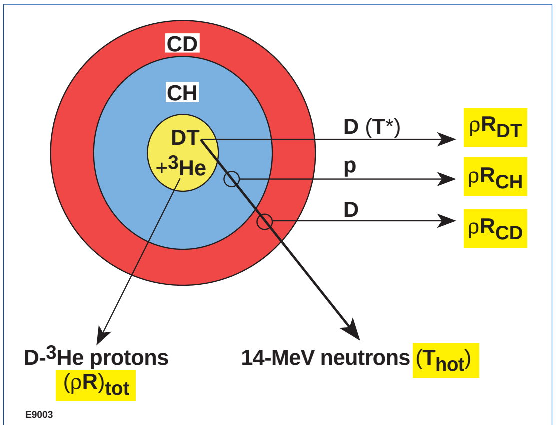
September 1998 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Integrated Spherical Implosion Experiments: We have investigated direct-drive spherical implosions with varying hydrodynamic convergence, ablator adiabat, and varying laser uniformity with the intent of clearly separating the shock yield from the compression yield. This approach allows a clean investigation of the temporal evolution of both the shock and compression yields. The neutron temporal diagnostic (NTD) is the main diagnostic for these experiments. This diagnostic is calibrated absolutely in time to within ±20 ps relative to the laser pulse incident on the target. Typical results obtained from NTD for a DT-filled plastic target with 18 kJ_{UV} in a 3-ns pulse (shot 13225) are shown in the figure along with predictions from a corresponding one-dimensional hydrodynamics *LILAC* simulation. The shock and compression yield phases are clearly separated in this figure, and a significant and unexpected difference between predicted and simulated shock yield profiles and magnitudes is apparent. We are currently concentrating our efforts on understanding these discrepancies. The transfer of kinetic energy into thermal energy may not proceed as efficiently as predicted by our one-dimensional simulations. Two-dimensional simulations are now investigating the extent to which the velocity fields must be perturbed in order to explain the observations.



Comparison of an experimental thermonuclear reaction rate history (red curve), obtained using the neutron temporal diagnostic (NTD), with results of a one-dimensional hydrodynamic *LILAC* simulation (green curve).

High-Density Diagnostics: A novel technique for measuring ρR simultaneously in three different regions of the compressed target has been examined theoretically. This scheme uses targets composed of DT gas contained in a shell of CH overcoated by CD. All three regions can be diagnosed by knock-on particles as detected by the charged-particle spectrometer. Knock-on deuterons are produced in the DT and CD layers by elastically scattered 14-MeV DT neutrons; knock-on protons are produced in the plastic. The number of knock-ons produced in each layer is proportional to the ρR of that layer (see figure). Knock-on deuterons produced in DT undergo energy loss due to ρR of the plastic and CD and therefore can be distinguished from knock-on deuterons produced in the CD region. In fact, the deuteron knock-on spectrum by itself contains ρR information about all three regions, and the knock-on proton spectrum will allow a self-consistency check for ρR of the CH layer. Additional information about ρR can be obtained by adding ^{3}He to the fuel and measuring the energy loss of the D-^{3}He proton. The fuel temperature can be obtained by a neutron time-of-flight measurement of the 14-MeV neutrons.



Cryogenic Target System: In mid-September UR/LLE personnel traveled to SatCon Inc., Cambridge, MA, to complete the final integration of systems needed to operate the upper pylon shroud-retraction linear motor. The motor and shroud simulator, comprising a total mass of 185 lbs, were accelerated against gravity in excess of 2.6 g's and achieved velocities of 4.8 m/s. This trajectory performance demonstrates the ability of retracting the cold shroud clear of incident laser beams while exposing the cryogenic target to less than 50 msec of ambient heating.

OMEGA Operations Summary: The OMEGA facility operated at a high availability for the month of September. There were 13 target shot days and 145 target shots performed, including 31 for the LANL indirect-drive campaign, 32 for diagnostic development (CPS checkout), 22 for neutronics diagnostics calibration, 15 for Rayleigh–Taylor instability (RTI) studies of beam imprinting, 25 for RTI burnthrough experiments, and 20 for the integrated spherical capsule campaign. This concludes FY98 with a total of 882 target shots for the year and an increased shot rate capable of sustained operations at 30 shots per week.

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