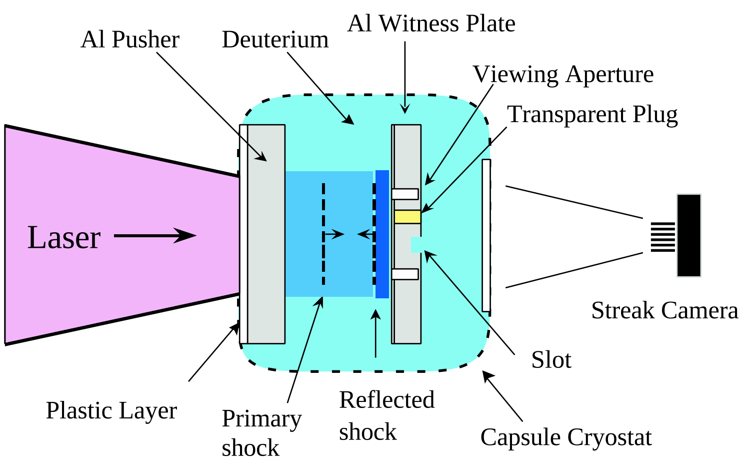
NRL LASER FUSION PROGRAM

November-December 1999

Bimonthly Highlights

EOS Reflected Shock Experiments with Liquid Deuterium at 1-6 Mbar

New laser driven shock experiments at NRL have been used to study the Equation-of-State (EOS) properties of liquid deuterium. Reflected shocks are utilized to increase the shock pressure and to enhance the sensitivity to differences in compressibility. This approach does not require any assumptions about the optical or X-ray refractive properties of the shock front and does not suffer from parallax errors of side-view diagnostics.



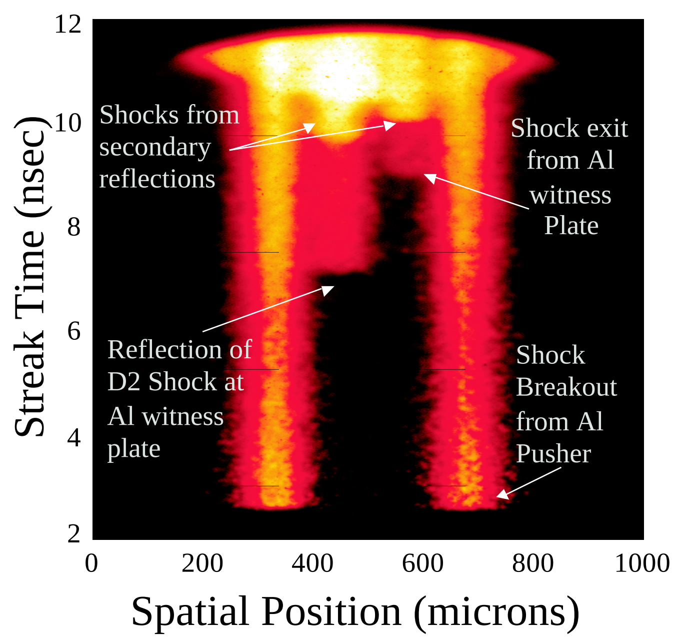
For 0.5-2.0 Mbar pressures in the primary shock and 1-6 Mbar in the reflected shock, we found that the data does not agree with standard SESAME EOS tables but are best described by equations of state which have large increases in compressibility in the 0.5 to 2.0 Mbar region. By use of independent techniques, this experiment gives the first confirmation of earlier observations of enhanced compressibility in liquid deuterium at LLNL.

The Nike KrF laser is used to drive special EOS target capsules at an intensity of 10^{13}-10^{14} W/cm^3. The target consists of an aluminum pusher, a deuterium payload region, and an aluminum witness plate anvil mounted in a miniature copper cryostat filled with liquid deuterium at a temperature of 20 deg K.

The laser driven pusher launches a shock in the liquid deuterium. It propagates across the 40 to 80 mm gap and impacts a second aluminum plate. After impact, the deuterium shock reflects from the higher impedance aluminum witness plate and transmits a shock into the witness plate.

The experiment measures the pressure of the reflected shock as a function of the initial shock velocity in the deuterium. A single streak camera records the time history of all shock events. Two open holes give a clear view of the rear side of the aluminum pusher while the third hole is filled with a clear polymer having a thin indicator layer at the surface of the witness plate. The shock speed is determined from the known dimensions of the gap and the measured transit time across the gap.

The pressure of the reflected and transmitted shocks is determined from the speed of the transmitted shock in the witness plate and the known EOS properties of aluminum. As a result of the additional compression under reflection and our determination of the pressure in the aluminum witness plate, this technique gives us the advantage of enhanced sensitivity to equation-of-state physics issues.



Initial measurements show that the compressibility of deuterium at a million atmospheres is strongly enhanced and is consistent with substantial molecular dissociation.

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