May 2000 Highlights of the Pulsed Power Inertial Confinement Fusion Program

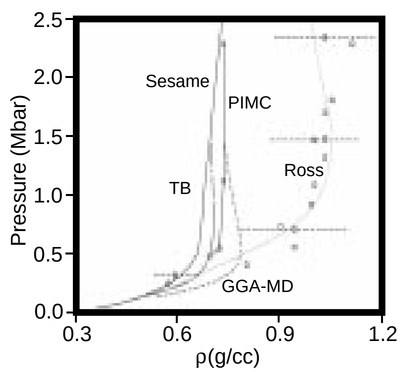

Fig. 1. Pressure vs density curves for D_2 from L. Collins. Nova data (open squares) disagree with most models. Horizontal lines show data error.

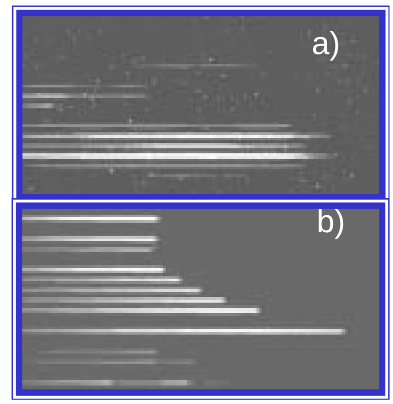

Fig. 2. Shock breakout data for D_2 in a) z-pinch mode and b) with new flyer plate technique.

The external review of our programs was May 17-19. In the oral outbrief summary, the panel noted the increased level of high quality, innovative, and exciting science done in the last 3 years. The 11 Z shots in May were 2 for LLNL on the physics of accretion disks, 2 to study z-pinch power flow, 2 in a long-pulse short-circuit mode, 3 to launch titanium flyer plates into deuterium (D_2), 1 to test a more precise wire-array design, and a flux compression shot.

In ~600 shots on Z, we have produced a flexible, well-characterized radiation environment for weapon physics, radiation effects, ICF studies, and basic science. Weapon scientists who use Z have expressed interest in improvements in the quality and precision of the data and the x-ray energy available. We are examining the options for a modernization of Z, called Z Mod, to recapitalize aging (15-years-old) equipment, increase the precision, and enhance the usage of the oversubscribed facility. The specific technical goals for Z Mod include increasing the energy efficiency to 20% (from 15%), doubling the energy of each of the 36 pulsed power modules, and decreasing the maintenance.

The written report of Dick Garwin's 15-member review panel should be issued by July. Our interactions with LLNL, LANL, AWE, and DTRA on stockpile stewardship, efforts in diagnostic and computational development, and equation-of-state (EOS) experiments were commended during the oral outbrief summary. The panel said preserving Sandia's pulsed-power leadership is an important national objective.

The nature of the EOS of hydrogen and its isotopes can have profound implications for ICF, Jupiter's interior, and white dwarf cooling. Nova data indicate liquid deuterium is ~50% more compressible than most models assume (Fig. 1). Over the past year, we have tried to get accurate D_2 EOS data on Z. With direct z-pinch radiation, the pressure uniformity on our D_2 samples was good, but the pulse attenuated rapidly; with a foam-filled hohlraum, the pressure pulse was nearly constant, but the pressure was low and uniformity poor. We are now using a new method, a spinoff of the isentropic compression technique, that is very promising (Fig. 2). The magnetic pressure generated in a short-circuit mode launches "cold" flyer plates to high velocities into the D_2 cell. With this method, we have reached pressure states ranging from 300-450 kbars in deuterium. The data quality is good, but the shock pressures are not yet large enough to resolve the discrepancy between Nova data and ab-initio molecular dynamics calculations. At pressures of ~1 Mbar, we should be able to evaluate the differences. We will attempt these measurements in the near future.

We measure the absolute power and energy from x-ray sources on Z with time-resolved resistive bolometry. Difficulties arise, particularly for bolometers in axial locations, because of electrical noise and the need to measure current and voltage simultaneously. Uncertainties can be 15-25%, even with shielded coax. We have demonstrated, on Shots 568-573, a new fiber-optic-controlled, battery-powered, essentially-noise-free bolometer system. With characterization and calibration, the accuracy should be better than 5%.

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Archived copies of the *Highlights* beginning July 1993 are available at http://www.sandia.gov/pulspowr/hedicf/highlights.