OCTOBER 2002 HIGHLIGHTS
OF THE
PULSED POWER INERTIAL CONFINEMENT FUSION PROGRAM

Dynamic Materials Properties and Nuclear Survivability Experiments on Z

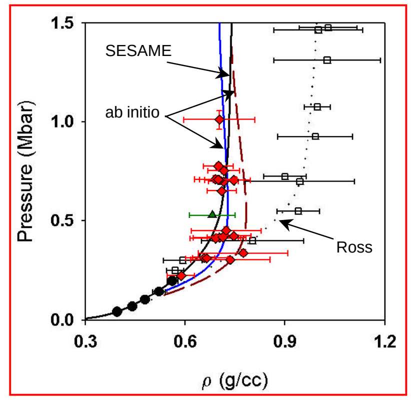

Figure 1. Z (red diamonds), gas gun (solid circles), and Nova (open squares) data for deuterium compared with ab initio calculations and the SESAME and Ross models.

We recently completed two level-2 milestones for NNSA campaigns using Z: a Dynamic Materials Properties (DMP) milestone to obtain data at 1 Mbar for liquid deuterium (D_2) and a Nuclear Survivability (NS) milestone to begin cavity system-generated electromagnetic pulse (SGEMP) experiments to validate models to certify the stockpile.

For the DMP milestone, we launched cold, high velocity (to 28 km/s) flyer plates and got 1-Mbar in D_2 in August 2002. We began to evaluate this technique in 2000 (see May 2000 *Highlights*) and obtained, in 2000 and 2001, data in the 0.3-0.8 Mbar range. As shown in Figure 1, the pressure and density relationship (shock Hugoniot) agrees with the SESAME model (used in most of our hydrodynamics codes) and with ab-initio molecular dynamics calculations, but disagrees with the greater compressibility in Nova data and the Ross model. Our recent data contribute to the controversy about the deuterium data obtained at Sandia, Lawrence Livermore National Laboratory, and Naval Research Laboratory and have implications for inertial confinement fusion (ICF) and for stellar and planetary models. To develop a plan to resolve these discrepancies, the ICF laboratories will hold a workshop to discuss the data and the computational models.

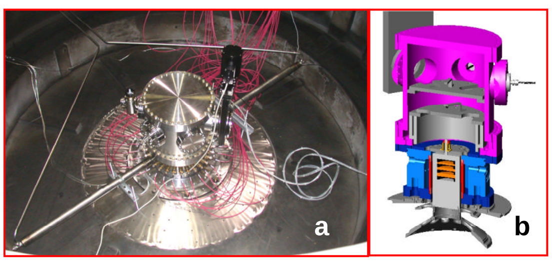

Figure 2. The containment system: (a) post-shot on Z and (b) in cross-section.

The quality of our data motivated us to design a containment system for Z to allow measurement of the properties of radioactive materials such as depleted uranium and irradiated stainless steel. The system must permit rapid turn-around between shots and use of special nuclear materials (SNM). We demonstrated the containment system in Fig. 2 on two consecutive Z shots. An upper chamber contains the debris, and an explosive fast valve closes the electrical power feed ~20 µs after maximum pressure in a material sample. Completely hermetic seals were produced: a radioactive tracer indicated no material escaped. In addition to these technology demonstrations, we received a positive National Environmental Policy Act determination for use of SNM on Z.

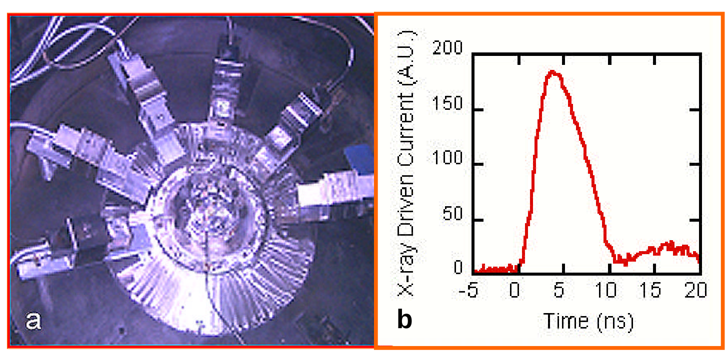

Figure 3 (a) Six test cavities for SGEMP experiments arrayed around z-pinch load. (b) An example of an x-ray-driven current measured within a cavity on a Z experiment.

The NS Campaign began cavity SGEMP experiments using stainless steel wire-array z-pinch x-ray sources jointly developed by Sandia and the Defense Threat Reduction Agency. The sources produce nominally 40 kJ of 6.7 keV x-rays at about 10 TW. The high photon energies, coupled with the 40 kJ in x rays, enable use of reasonably sized Faraday-shielded cavities that should have significant electron current. This is an important regime to test models being developed for the Advanced Simulation and Computing Campaign to support stockpile certification. A good x-ray source is necessary, but not sufficient, so the NS Campaign team had previously characterized the debris environment (electrons, electrical noise, and hard x-rays) and assessed how to mitigate its effects. Consequently, the first joint Sandia-Atomic Weapons Establishment shots on Z with six cavities produced high-quality current measurements (see Figure 3).

For more information on this article contact: Chris Deeney, cdeene@sandia.gov; or SNL ICF Manager: Keith Matzen, mkmatze@sandia.gov.
SNL Highlights and other information can be found at our website: http://www.sandia.gov/pulspowr/hedicf/hedicf.html.

Sandia is a multiprogram laboratory operated by the Sandia Corporation, a Lockheed Martin Co., for the United States Department of Energy under Contract No. DE-AC04-94AL85000.
SAND2002-4227P

Sandia National Laboratories