SAND99-1485

April 1999 Highlights of the Pulsed Power Inertial Confinement Fusion Program

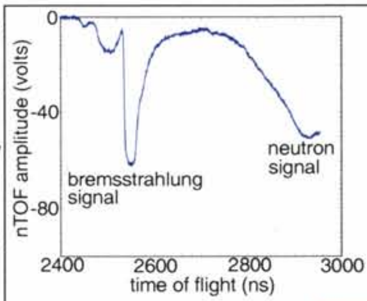

Fig. 1. Neutron-time-of-flight and bremsstrahlung signals on Shot 396.

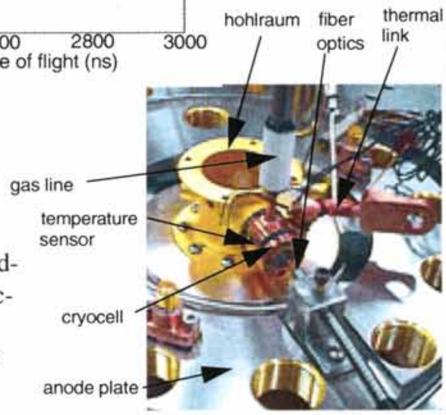

Fig. 2. Z hardware that successfully cooled D_2 to 22 K.

In April we received a DOE Defense Programs award for significant contributions to the Nuclear Weapons Program in developing and applying z-pinch x-ray sources to stockpile stewardship. DOE also recognized pulsed power for outstanding performance at a world-class level as part of the FY98 performance appraisal review. There were 13 Z shots: 3 for LANL weapon physics, 2 to prepare to measure the D_2 equation of state (EOS), 4 to assess energetics of single-sided drive with the z-pinch-driven hohlraum, and 4 to study the variation in x-ray power with the mass of a copper converter foil inside a nested wire array for the dynamic hohlraum.

We hosted an April 27-28 workshop on the potential of z pinches for inertial fusion energy. The topics discussed were reactor chamber design, simplifying the targets using magnetic thermal insulation or double shells rather than cryogenic DT, the use of disposable electrodes, and methods to achieve "standoff" by separating the high-yield implosions from accelerator hardware. On May 6-7 we will host a workshop to review progress in integrated target designs for the three z-pinch high-yield hohlraum configurations.

On three dynamic hohlraum shots in March, beam-generated neutrons were produced with deuterated polystyrene to test the neutron diagnostics. The CD was in the form of 50 μm wires in the inner array of a nested array (Shot 396) or as an annular converter (Shots 397 and 398). We measured $(1.9\text{-}5.5) \times 10^{11}$ beam-generated deuterium neutrons with three detectors (neutron-time-of-flight, indium, and lead probe). The timing of the neutron production was determined from a bremsstrahlung signal coincident with the x-ray diode signals (Fig. 1). The data suggest that high-energy (5-6 MeV) deuterium ions are traveling along the z axis. The neutron-time-of-flight technique, in conjunction with the use of deuterated materials, affords a new, sensitive measure for the production of energetic ions in the vicinity of the pinch.

We are modeling the magnetohydrodynamic (MHD) behavior of conductors at ultra-high current density in conjunction with Z experiments. Unlike previous accelerators that were in the 1 Tesla regime, Z's disc magnetically-insulated transmission lines are in a 100-1200 Tesla regime. Hence, its conductors cannot be modeled as static, infinite-conductivity boundaries. Using the MACH2 code, we are studying the conductor hydrodynamics and characterizing the joule heating, magnetic diffusion, material deformation, and material properties for a range of current densities, rise times, and conductors. Our goals are to predict power flow losses accurately, model the response of particle velocity probe (VISAR) samples in various configurations, and incorporate appropriate EOS and conductivity models in the MHD simulations. Our results will be qualitative until the conductivity model in the code is improved, since it overestimates magnetic field penetration into metals at low temperatures.

Using a cryocell (Fig. 2), cooling of deuterium to a liquid state has been achieved on Z. The purpose of this research is to obtain data on the deuterium EOS. We are fielding 12 VISARs, three spectrographs, and a fiber-optics shock breakout array. Preliminary data indicate that the metallic state of liquid deuterium is observed at a pressure of 500 kbars with the VISAR system on these experiments.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 1602, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov.
Highlights are prepared by Mary Ann Sweeney, Dept. 1602, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.
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