June 1999 Highlights of the Pulsed Power Inertial Confinement Fusion Program

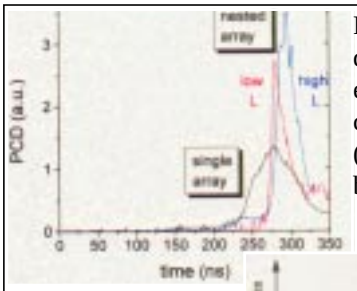

Fig. 1. Photoconducting diode signals for ~200 eV x rays on MAGPIE compare transparent (high L) and magnetic buffer (low L) modes.

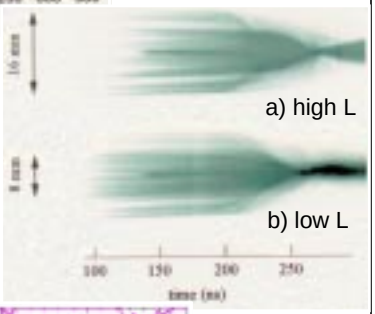

Fig. 2. Radial optical streaks with a) high and b) low inductance path for inner array.

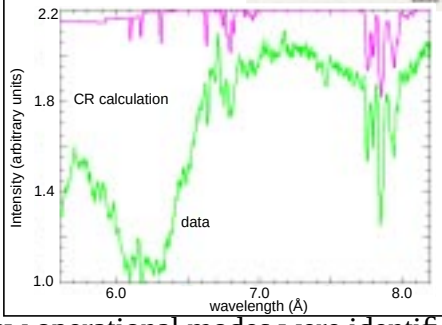

Fig. 3. Al K_α spectrum on Z compared with CR calculation at 75 eV, 2 x 10^{20} ions/cc.

Z pinches were a hot topic at the IEEE International Conference on Plasma Science June 20-24 in Monterey. The conference and the computational methods workshop were organized by Sandia. Our research was represented at both ICOPS and at the IEEE Pulsed Power Conference, held the following week in Monterey.

Success in generating intense x rays on the 20-MA Z with multiple-wire arrays has sparked new interest in studying the early stage of wire plasma formation on low-current generators. Some of the most interesting results presented at ICOPS were obtained at Imperial College and Cornell with Sandia funding. We will describe the Cornell effort in July. On the 1.5-MA MAGPIE at Imperial College, nested array implosions show a sharpening of x-ray power at stagnation similar to that on Z (Fig. 1). By varying the inductive path for current in the inner array, two new operational modes were identified. With high inductance L, the inner wires initially carry negligible current and undergo little expansion; hence, plasma from the outer array streams through the inner one. Current is then transferred to the inner array so it accelerates from rest (Fig. 2a) and implodes rapidly onto the already stagnated outer array. With low inductance (Fig. 2b), the inner wires carry current and expand. Their global magnetic field acts as a buffer between the two arrays, causing the inner one to implode ahead of the outer one. These modes contrast with the hydrodynamic collision of two shells, without current in the inner shell, that has been used in r-z modeling of nested arrays to explain the mitigation of Rayleigh-Taylor instabilities.

We are using time-resolved x-ray crystal spectrography on Z to determine the temperature of an Al foil heated by a z pinch. The foil, tamped on both sides with CH, covers a slot in the return current can. The foil temperature is determined from the K_α absorption spectrum (Fig. 3) and the data are compared with collisional radiative (CR) calculations of foil heating. Confidence in the comparison is a prerequisite to interpreting more complex radiation-heating experiments, such as those involving radiation propagation and shock physics. The method may provide a reliable way to measure hohlraum temperature without a diagnostic hole and to measure radiation propagation in ICF-relevant materials, such as CH foams.

The Z shots were 2 for LANL weapon physics, 3 to evaluate initial conditions and interaction of the pinch with a dynamic hohlraum, 2 to develop NIF-relevant temperature drives, one with in-situ preheating of the wires that shortened the x-ray pulse by 14%, 2 for D_2 equation-of-state data, 2 to diagnose a foam ball radiated by x-rays from a z-pinch-driven hohlraum, and 2 for insulator flashover studies.

The $14M, 35-ft-diameter, 150-ton NIF target chamber was dedicated June 11 by Secretary Richardson. Sometimes referred to as the “wiffle ball” because of its 200 machined holes, the chamber was placed on a permanent pedestal inside NIF on June 17. Sandia was responsible for the design, stress analysis, procurement, and fabrication of the chamber and the design of the vacuum system. The next task, to cover the chamber with 16” of gunite, is scheduled for completion in June 2000.

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