January 1999 Highlights of the Pulsed Power Inertial Confinement Fusion Program

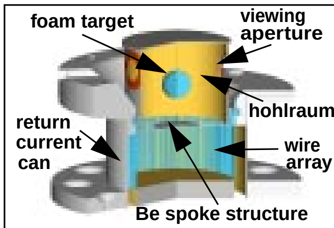

Fig. 1. Experimental configuration used to evaluate the radiation flux to a foam target with the z-pinch-driven hohlraum concept.

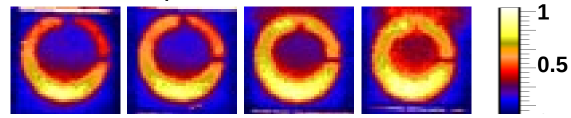

Fig. 2. Time-resolved x-ray images, 2 ns apart, of foam target.

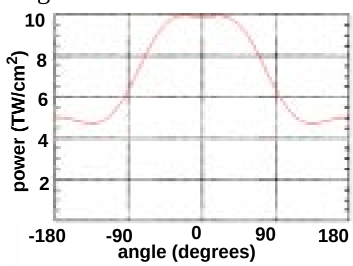

Fig. 3. Incident power on foam target as function of angle at time of peak temperature (t_{peak}), calculated with the Lightscape™ code.

A three-day workshop to discuss design ideas for ZX, a follow-on accelerator to Z, was held. Attendees included French and Russian as well as U.S. researchers. Activity on Z in January began with a week for planned maintenance of the top level of the insulator stack. We had nine Z shots: one short circuit shot to prepare for long-pulse-mode studies, a fourth plasma-armature magnetic flux compression shot in collaboration with the French, four LANL weapon physics shots, and three shots to evaluate the radiation flux to a z-pinch-driven hohlraum.

The dynamic hohlraum concept, in which the imploding z pinch also serves as a hohlraum wall, is the leading candidate for producing high temperature with a z pinch. We have developed a simple model of the dynamic hohlraum to determine the optimal system parameters and radiation temperature as a function of the drive current. This model can be used as a starting point for detailed Lasnex simulations.

In the last year, the dynamic hohlraum concept was extended to record temperature levels in a collaborative effort with Los Alamos. The result is a new z-pinch x-ray source for weapon physics, using a central foam cylinder, that provides a 230-eV x-ray source temperature at the entrance to an attached, end-on hohlraum. This x-ray source was recently used for two LANL weapon physics experiments on Z. The source is hotter and more energetic than previous sources used for the LANL experiments and opens a wider range of parameters and conditions that may be accessed for weapon physics, equation-of-state, and opacity applications and for code validation.

In the z-pinch-driven hohlraum concept, a collaborative effort between Sandia and LLNL, the fusion capsule is separated from a pair of imploding z pinches. The capsule, located in a central hohlraum, does not directly view x rays from stagnation of the two z pinches but, instead, sees an x-ray source that consists of re-emission from the walls of the return current can and the hohlraum. In a series of Z experiments with a single imploding z pinch, we are evaluating the radiation environment produced in an attached, end-on hohlraum (Fig. 1). The beryllium spokes that separate the x-ray source region from the hohlraum provide a current path during the implosion of the wire array and, at later time, become relatively transparent to allow flow of radiation to the hohlraum. In comparing the experimental results to 2-D Lasnex simulations, we discovered that the x-ray transmission through the spokes was ~25% less than predicted. Elemental analysis of the beryllium used for the spokes showed that it actually contains 5-7% nickel and, when the simulation is redone to account for this, the calculated transmission (55%) is in good agreement with the measured transmission of 58±10%. Time-resolved target images (Fig. 2) were obtained using x rays re-emitted off the hohlraum wall to backlight the target. These images have a marked top to bottom asymmetry, in qualitative agreement with radiosity (Fig. 3) and 2-D Lasnex simulations. In future experiments we will use techniques such as x-ray shields to demonstrate our ability to calculate, measure, and control the location of the asymmetry of the one-sided radiation drive. Experiments with a two-sided drive are also being planned to improve symmetry.

Contact: Jeff Quintenz, Inertial Confinement Fusion Program, Dept. 9502, 505-845-7245, fax: 505-845-7464, email: jpquint@sandia.gov.

Highlights are prepared by Mary Ann Sweeney, Dept. 9502, 505-845-7307, fax: 505-845-7890, email: masween@sandia.gov.
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