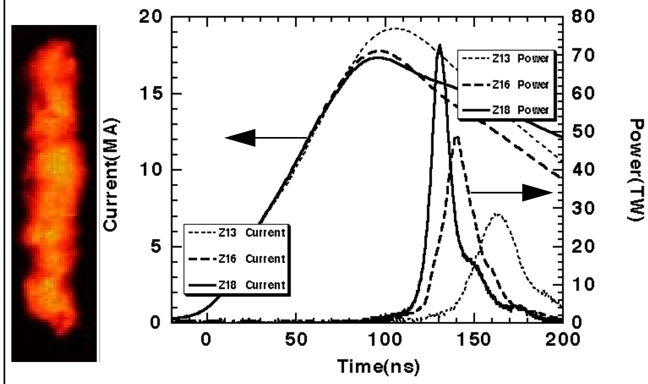
October 1996 Highlights of the Pulsed Power Inertial Confinement Fusion Program



Load current and radiated power vs time for Shots 13 (4th radiation shot, 85-kV charge), 16 (7th radiation shot, 90-kV), and 18 (9th radiation shot, 90-kV). Inset shows pin-hole camera image of imploded wires from Shot 18.

On the ninth x-ray radiation source shot on PBFA II in the z pinch mode (20-MA at the vacuum insulator stack, 50-TW_e PBFA Z), we achieved an x-ray output energy of 1.4 MJ. A tutorial on z pinch physics was given in mid October to the National Research Council panel reviewing the ICF program. The SABRE accelerator is fully operational again in an ion extraction mode.

The first z-pinch-driven x-ray radiation source shot on PBFA Z, using a 4-cm-diameter, 2-cm-long tungsten wire array load and 74-kV electrical charge in each of the 36 accelerator modules, was October 2. We are testing the pulsed power components using successively higher-voltage, shorter-implosion-time wire array loads. A soft x-ray energy of 0.75 MJ in a 28-ns radiation pulse was measured on this first shot, using tungsten wires 18 microns in diameter. After two shots at 74-kV, we increased to 85-kV electrical charge. Between October 8 and October 29, seven shots were done at 85- to 90-kV charge. On the seventh shot (on October 29), PBFA Z generated 1.4 MJ in x rays. The peak x-ray power was ~ 70 TW, and the x-ray pulse width was 13-ns full width at half maximum. X-ray data were taken using x-ray diodes, resistive bolometers, time-integrated and time-resolved spectrometers, and photoconducting detectors. The z-pinch load consisted of 120 tungsten wires, 11.8 microns in diameter, arranged in a cylindrical array at a diameter of 4 cm and a length of 2 cm. The 123-ns implosion time is longer than the 100-ns optimum predicted for PBFA Z. We anticipate further improvement as the implosion time is reduced. For comparison, *at a similar x-ray pulse width*, the lower-current (10-MA at the stack), 20-TW_e Saturn produces 0.45 MJ and 35 TW in x rays; the peak x-ray power achieved on Saturn was 75 $\pm$ 10 TW for a 6-ns radiation pulse.

The electrical coupling to the load is close to our predictions. Detailed measurements show that a current of 17 - 19.5 MA is delivered to the load, depending on the load dynamics of an individual shot, and that the current to the vacuum insulator stack is 19.5 - 20.5 MA. More than 2.5 MJ of electrical energy is delivered to the magnetically insulated transmission lines. The overall wall-plug-to-x-ray-efficiency for Shot 18 (the ninth radiation shot) is 12%. We will continue to optimize the electrical/load coupling, the x-ray production, and the power flow for the next few months during the commissioning phase of PBFA Z. We expect to meet our first milestone (a total x-ray energy of 1.5 MJ) in early November. The design goal for PBFA Z is 1.5 MJ and 150 TW of x-ray energy and power.

The RF generator from PBFA X (the ion extraction mode of PBFA II) is being used on the lower power SABRE accelerator to remove non-lithum contaminants from electrode surfaces and from the substrate. Work is proceeding on the design of the optical path for a new infrared laser, expected to arrive in a month, and on an upgraded version of the existing dye laser for experiments using the active lithium ion source LEVIS.

Visitors in September and October included Ingo Hoffman (GSI, Darmstadt), Ken Whitney and Bryan Oliver (NRL), Koichi Kasuya (Tokyo Institute of Technology), Kazuhito Yasuike (Osaka University), Joe MacFarlane and Ping Wang (U. Wisconsin), and Yogi Gupta (Washington State Univ.). One of our ion beam theorists returned from a three-month stay at FZK in Germany, and Oliver Boine-Frankenheim from GSI joined our program for about 12 months to study ion beam generation and divergence reduction.

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