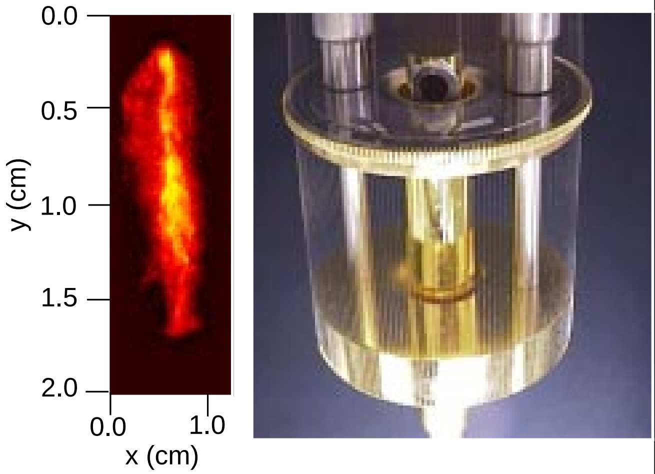
# May 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program




Time-resolved pinhole camera image of Ti K-shell x rays on Shot 67. Photo of thin-walled, 8-mm-dia gold cylinder inside 3-cm-dia wire array for Shots 73 - 75 to compare x-ray spectrum viewed by on-axis and off-axis secondary hohlraums. Posts are removed before a shot. Hardware shown in the orientation as it was installed in PBFA Z.

We had 12 experimental shots on PBFA Z this month: 3 for tungsten wire length scans, 1 with titanium wires, 4 with aluminum, 1 with a smaller gap between the return current can and the outer edge of the wire array (2 mm instead of the usual 5 mm), and 3 to compare the x-ray spectrum in an on-axis and an off-axis secondary hohlraum attached to a primary vacuum hohlraum. On the titanium shot (Shot 67), a world record of 90 kJ was obtained from K-shell x rays above 4.5 keV. Talks on z pinches, diagnostic development, and light ion research were given at the IEEE Intl. Conf. on Plasma Science, the Intl. Conf. on Dense Z Pinches, and the Particle Accelerator Conf.

The titanium 80-wire shot on which a record 90 kJ was obtained from K-shell x rays above 4.5 keV was done to prepare for DSWA weapons effects tests in the summer aimed at eventual revalidation of components in the stockpile. Although the wire diameter used on Shot 67 was 25 microns (i. e., thicker than what is believed to be optimum), the energy in x rays is still a factor of nine higher than the previous world record of 10 kJ on Saturn. With more but smaller diameter wires, a factor of two improvement in the titanium yield may be possible.

As part of the effort to improve the z-pinch radiation source further, we evaluated a shorter tungsten wire array length (1 cm instead of 2 cm) as a means of increasing the radiated power per unit length. The array diameter was 3 cm and the wires were 10 microns in diameter. The 1-cm length produced greater total x-ray power (210 TW on Shot 65 vs 200 TW for a 2-cm length on Shot 51) and greater power per unit length of the wire array. The shorter array length had less inductance, therefore allowing more electrical energy at peak current to be coupled into the load. Moreover, we observed that the difference between the observed x-ray yield (1.9 MJ) and the predicted radial kinetic energy (0.65 MJ) increased for the 1-cm-long pinch, suggesting that PdV work and turbulent heating play a proportionally greater role in shorter pinches. We attribute this increased heating to the fact that, from flux conservation, the total magnetic energy surrounding the pinch at stagnation is unchanged by the decrease in length. The physical processes that convert this available magnetic energy into thermal energy thus proceeded exactly as for the 2-cm-long pinch.

The load inductance is also decreased by using a smaller gap at the base of the wire array between the return current can and the outer edge of the array. Shot 68, with a 2-mm gap that extended the database collected with 5-, 4-, and 3-mm gaps, showed that even this smaller gap does not close under the influence of the extreme radiation fluence. Higher hohlraum temperatures result from the decreased radiation losses with smaller gaps. Since mechanical assembly tolerances can be a limiting factor in time and expense at very small gaps, we intend to use 2-mm or larger gaps for most of our hohlraum experiments.

On May 1 and 2 we had our first planned maintenance of PBFA Z. Three new prototype water-transmission-line biplates with diverter switch gaps set at 7.6 cm were installed; six optics related to laser triggering of the pulse forming lines and seven laser triggered gas switches were replaced; the insulator stack compression by vacuum pumping on the upper anode and cathode was measured; the large-format pinhole camera tank was re-welded.

Preliminary divergence data from a large-format ion pinhole camera on SABRE indicate 30 mradians for lithium and 17 mradians for protons. The data are without increased magnetic insulation and electron limiters that, based on 3-D electromagnetic simulations, should reduce divergence. An axial electron diverter that would create a preferred path for electron flow on axis has been proposed by Cornell and is being modeled; this diverter may be better than a limiter since electrons will not be lost in the magnetically insulated transmission line and $B_\theta$ will exist down to the axis.

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