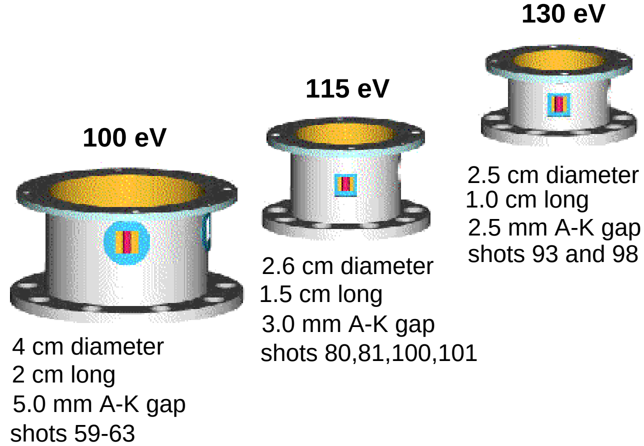
July 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program

A 130-eV radiation temperature has been obtained in a vacuum (non-imploding) hohlraum on Z with 300 tungsten wires as the x-ray source. The 1-cm-long, 2.5-cm-diameter hohlraum is viewed through 4-mm-diameter holes tamped with CH. On a nine-shot series in July, we obtained the hohlraum radiation temperature for a variety of z pinch loads (see figure). Since our first hohlraum shot on April 1, the shot rate has increased from 2.2 per week to the present 4.7 per week during the three weeks Z was operating in July. The Z operation crew are primarily responsible for the improvement in shot rate.



Photographs show relative size of z-pinch hohlraums shot on Z. Temperature was increased by reducing the hohlraum size and the anode-cathode (A-K) gap. Inset on each hohlraum is schematic showing size and location of diagnostic hole in yellow and on-axis z pinch in red. Actual hole for viewing hohlraum wall is at right side on each photo.

A Z shot in July for the Defense Special Weapons Agency used a steel wire array to assess the x-ray yield possible for weapons effects tests. X-ray yields have now been measured for three wire materials on Z: 200 $\pm$ 50 kJ for aluminum at > 1.8 keV, 125 $\pm$ 15 kJ for titanium at > 4.5 keV, and 45 $\pm$ 5 kJ for iron/steel at > 6.5 keV. The Saturn facility at Sandia previously had the highest yields above 3 keV: 10 kJ for titanium, 5 kJ for iron/steel, and 2.5 kJ for copper.

A new Z diagnostic being tested is a laser that will eventually be used to measure, with active shock breakout from a CH ablator, multi-megabar shock pressures in cryogenic D_2. Steady, planar shock waves over millimeter-sized samples with 100-picosecond resolution are necessary to obtain the shock velocity data. Hydrodynamic codes predict that radiation temperatures of < 130 eV will produce < 7-Mbar pressures in the CH. The measured pressures in D_2 will be compared with the equation of state models used in these codes and with Nova data to resolve the discrepancy between the experimental and theoretical pressure vs density relationship for D_2 at pressures between 0.3 to 2 Mbar.

An important diagnostic is an x-ray backlighter to image a fuel capsule inside a hohlraum. As part of developing this diagnostic, a small laser is being installed on Z to backlight an end-on secondary hohlraum. This laser is a modified version of the 150-J, 10-ns infrared laser used in April 1996 on the ion mode version of Z (PBFA X) to generate an active ion source for the ICF program. Imaging a capsule inside a hohlraum will require a much more energetic laser system. A strong possibility for this purpose is one beam of the LLNL Nova laser (3 kJ, 2-ns pulse width) after Nova is shut down for the construction of the NIF. We are addressing two engineering issues related to use of a high-energy laser on Z as a backlighter: construction of a room in the high bay to contain the laser and a beam transport system to protect the laser optics from the transient shocks and debris induced by the z-pinch implosions, and the timing of the laser with respect to the jitter of Z and of the laser system that simultaneously triggers the 36 pulse forming lines.

A low energy version (39 mJ per pulse) of the laser to trigger the high voltage gas switches in the Advanced Pulsed Power Research Module (APPRM) has been shipped to Sandia after extensive testing at Allied Signal in Kansas City. The APPRM was constructed at Sandia by the Test Program and began full voltage operation in June 1996 to validate the design of pulsed power components and systems for a possible plasma radiation source facility with two to three times the current of Z. An energy of 39 mJ is sufficient to trigger and to characterize the performance of the two gas switches in the APPRM. We will be testing the trigger laser at the present level while the laser energy is being upgraded to 90 mJ on a testbed at Allied Signal.

Because of the dramatic progress in our z-pinch research since full voltage operation of Z began in September 1996 and because of our limited funding, we will discontinue research on light ion beams for fusion in FY99. Personnel in the light ion area will begin to contribute their expertise to the z-pinch effort during FY98. The light ion ICF project will complete an integrated test series in FY98 and document the progress to date so that the project can be efficiently restarted should funds become available in the future.

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