July 2000 Highlights of the Pulsed Power Inertial Confinement Fusion Program

Fig. 1. Iron K-shell powers on Z.

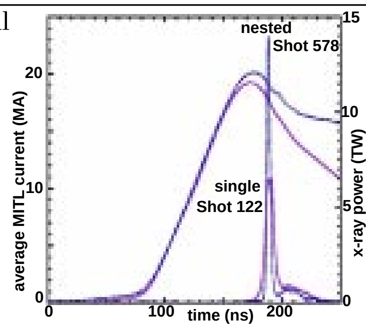
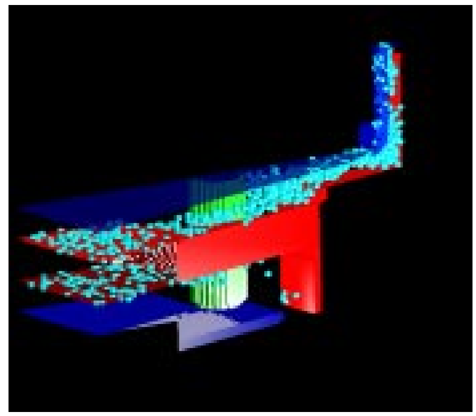


Fig. 2. 3-D simulation exhibits significant flow of convolute electrons into inner magnetically insulated transmission line.



General Gordon, head of the National Nuclear Science Administration, visited Z July 31. The Garwin panel has issued its written review of our pulsed power programs.

We had 11 Z shots: the last 3 of 5 shots to develop Mo x-ray sources for the Defense Threat Reduction Agency (DTRA), 3 shots with a z-pinch-driven hohlraum affixed to the middle of a single wire array (Aug. 99 *Highlights*) instead of two independent arrays (Mar. 99 *Highlights*) and with different wire tensioning, 4 shots to assess spectroscopically the behavior of a gas-filled capsule in a dynamic hohlraum (DH), and the first of 2 shots to characterize effects of instabilities on DH capsule radiation symmetry. On the capsule radiation symmetry shot, half of the wire array was Al so the foam cylinder surface could be viewed with a large format pinhole camera; the other half was W of equal mass.

Developing 5 - 20 keV x-ray sources is critical for weapon and radiation effects testing; Z can supply 5 - 10 keV sources. In April we measured the narrowest total x-ray pulse yet (3.5 ns) from nested stainless-steel arrays. The shots were designed to assess iron K-shell x-ray emission. The K-shell pulse was 3 ns wide and the power was 15 TW. The pulses are substantially narrower than for a single array (Fig. 1) of any wire type tested to date. The results are particularly impressive because of the array diameters (5.5 - 7 cm). Nesting the arrays increases x-ray power by limiting instabilities during the z-pinch implosion. The high powers and fast risetimes could provide the opportunity for challenging ASCI code validation experiments.

Electron flow in three Z geometries is being calculated on the ASCI RED computer with a new version of the three-dimensional QUICKSILVER code that runs on distributed-memory parallel computers and also subcycles the electron advance to reduce the run time significantly. The total electron loss is similar for each geometry, but the loss distribution is quite different. Figure 2 shows the loss for the standard 12-post geometry; the other geometries are with 6 posts and a 12-post geometry with smaller-diameter upper posts.

We will use an Ag/Cu/Au alloy wire on Z to improve wire initiation, uniformity, and wire merger and study the role of opacity. Silver's low resistivity and high vapor pressure provide uniform initiation and rapid expansion, gold increases radiation efficiency, and copper provides mechanical strength. By altering the proportions of Ag, Au, and Cu, we can vary the pinch opacity. The wire, fabricated by California Fine Wire, has been tested at Cornell University. The energy deposited in the alloy wires is 3.5 - 5 times higher than in tungsten wires because creation of a wire plasma sheath is delayed. As a result, the alloy wire plasma expands radially up to 10 times faster, and axial and azimuthal perturbations of the plasma shell are reduced. The Cornell tests suggest that, if we lengthen the Z prepulse from 50 ns to 200 ns, complete merger of the wire cores will occur for a 300-wire, 2-cm-diameter array. We plan to test these expectations on Z by making minor modifications in the water section. This activity is for a Level-2 milestone of the ICF campaign; it is also relevant to the dynamic materials, secondary certification, and hostile environment campaigns for stockpile stewardship.

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