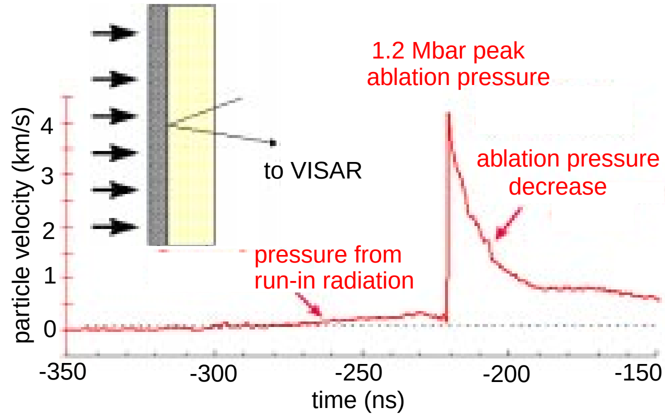
# January 1998 Highlights of the Pulsed Power Inertial Confinement Fusion Program




Particle velocity profile on Shot 180 and schematic of experimental setup to measure ablation loading on Z.

Issues related to the use of z pinches for ICF include capsule ablator physics, diagnostic hole closure, and radiation symmetrization. Aspects of these issues were studied experimentally on some of the 14 Z shots this month. We made significant progress in the ability to use Z for equation-of-state (EOS) measurements and in optimizing radiated power from nested wire arrays.

Diagnostics on two single-wire-array shots measured x rays from the tungsten plasma striking a central copper cylinder and from the cylinder stagnating on axis, as well as x rays from an on-axis secondary hohlraum, to study radiation transport to the secondary. LANL had two shots to assess hole closure and radiation transport for a weapons physics experiment. On the LANL shots, burn-through foils are being tested to absorb early run-in radiation from the wire plasma that perturbs radiation transport via hole closure or creation of a subsonic radiation wave. As a part of ongoing hole closure studies, tamping layers using two different plastic densities were compared; the lower density was more effective in keeping the hole open.

A velocity interferometer, referred to as a VISAR, has measured the complete temporal history of a radiatively-driven pressure wave in z-pinch implosions for shock pressures >1 Mbar. In this experiment on Z (see figure), a sample assembly of 175-μm-thick aluminum and a LiF laser window directly monitored the pressure profile produced during implosion of a nested wire array. The data quality is extremely good, about that obtained in gas guns, and provides detailed, previously-unavailable information on the z-pinch implosions. In particular, the particle velocity record shows the detailed motion produced by plasma radiation over an implosion period of ~80 ns, a 1.2 Mbar shock wave from the pinch formation, and the unloading pressure history resulting from a decrease in temperature at the ablation surface over ~100 ns. This information will allow determination of the ablation temperature history at the sample surface and should be valuable for validating fully-coupled physics models of the ablation process. The new capability will also enable a new regime of material property studies on Z, including EOS and thermophysical property data in pressure and temperature regimes inaccessible by other methods.

Eight of the shots were part of a series to optimize the radiated power from nested arrays. The mass of the inner tungsten array is being increased relative to that of the outer array, since 2D magnetohydrodynamic calculations by both SNL and LANL indicate this change should decrease the effect of Rayleigh-Taylor instabilities on the wire plasma implosion and increase radiated power. On Shot 179 we had the shortest x-ray pulse to date, 4 ns full width at half maximum. Peak radiated power was 290±40 TW, as compared to 200 TW with a single array. After we determine the optimum configuration, both vacuum and dynamic hohlraums will be tested with nested arrays.

Planning for X-1 is in the preconceptual design phase. The experiments on Z are providing the technical foundation to address the scaling of pulsed power, power flow, and radiation output for a z-pinch source to the factor of three increase in electrical current to 60 MA proposed for X-1. The objectives of X-1 are to provide 1) a cold (< 10 keV) and warm (10 to 80 keV) x-ray environment for radiation effects testing of weapons components and subsystems in the absence of underground tests, 2) a high-yield (200 - 1000 MJ fusion output) facility to address the long-term mission need of the National ICF Program, and 3) a flexible, well-characterized source for weapons physics applications. A scoping study for the target chamber design is being conducted by the University of Wisconsin and a seminar was held at Sandia on January 28 to review the planned work and to identify critical issues. One of the unique requirements of the design will be the need to protect hardware and diagnostics from the anisotropic effect of energetic, magnetically-driven shrapnel.

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