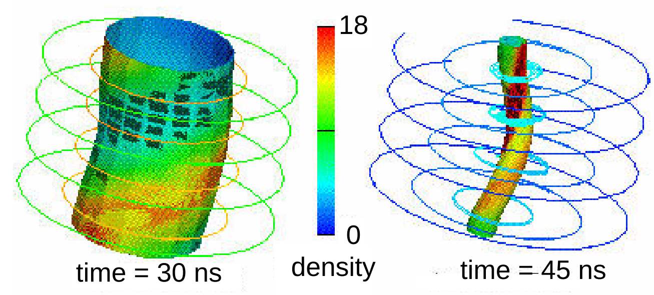
October 1997 Highlights of the Pulsed Power Inertial Confinement Fusion Program



Growth of helical MHD instability mode in a z pinch as simulated with ALEGRA. Time is relative to start of voltage pulse. Density of the plasma is plotted in mg/cc. Magnetic field lines are also shown on a relative scale.

We had 18 z-pinch shots: two to assess the role of plasma fill within a foam annulus, four to evaluate equation-of-state diagnostics, a power-flow shot to test performance of a smaller radial MITL gap, four with nested wire arrays, two on-axis hohlraum shots, three to optimize the temperature in a vacuum hohlraum, and two LANL weapons physics shots.

An experimental program is underway to develop advanced time-resolved diagnostics for equation of state (EOS), weapon physics, and ICF applications. The first phase of this development was accomplished in four Z shots that used dual aluminum velocity interferometry probes to obtain velocity profiles, as well as a variety of standard temperature and shock breakout diagnostics to characterize the shock loading conditions in secondary hohlraums adjacent to a large primary hohlraum. The velocity interferometry probe, called a VISAR, is bonded to a LiF laser window and mounted at the end of an off-axis secondary. With an Al probe, measurements of 2-3 Mbar pressures will be possible; with a tungsten probe, 6-Mbar measurements will be possible. Time-dependent radiation effects were seen in these experiments that are not presently understood, but which must be resolved to make precision shock EOS measurements on Z.

Development of a 2D and 3D, massively parallel z-pinch simulation capability is continuing. ALEGRA is a strong-shock-wave physics code written in C++/C/Fortran that features an unstructured, multi-material, arbitrary-Lagrangian-Eulerian grid and runs on the Sandia/INTEL teraflops computer, serial workstations, and workstation networks. The C++ class structure combines hydrodynamics, magnetics, and radiation packages to simulate MHD radiation transport problems that have finite resistivity. The code, a collaboration of several Sandia departments, has been used by others to simulate neutron generator power supplies, fire sets, and weapons effects. We have demonstrated the ability of ALEGRA to simulate liner implosions and low-mode MHD instabilities (see figure) and are beginning to benchmark the code against detailed z-pinch experiments.

Three separate diagnostics are available on Z to measure, at the ends of long (~ 24-m) line-of-sight pipes, the x-ray fluence (in J/cm^2) from a z pinch: x ray diodes, bolometers, and time-integrated calorimeters. A comparison among the data provided by these instruments, which in some cases view the hohlraum wall from different lines of sight, is underway to understand the sensitivities of the various diagnostics and to identify any inconsistencies.

The design of a “Nova-class” laser to be used as an x-ray backlighter on Z was reviewed. This laser system uses multi-pass laser amplification as for the National Ignition Facility, rather than the single-pass amplification scheme used in Nova, and will reuse, where appropriate, components from Nova and Beamlet. The system will be designed to allow for both area and point projection sources. Point projection, which is the harder of the two to achieve, is being designed to obtain a spatial resolution of 25 µm and an x-ray energy of 9 keV, with the potential for 15 keV. Frequency conversion from 1-µm to 0.53-µm light will be done in a temperature- and vibration-controlled optical clean room adjacent to the high bay. The design will not preclude amplification of chirped pulses and focusing of short pulses in the target chamber. Based on Beamlet and Nova experience, the laser is expected to require three technicians for routine operation.

A 2D resonant atomic density diagnostic is operational in the ion source support laboratory to characterize the LEVIS (Laser EVaporation Ion Source). A 2D snapshot shadowgraph of a specific atomic state can be produced because of the large increase in the index of refraction near an atomic resonance transition. This capability allows us to probe for the presence of numerous species in the plasma density regime between $10^{12}/cm^2$ and $10^{15}/cm^2$. Laser thermal desorption is used as a probe to characterize, in situ and quantitatively, the effectiveness of plasma discharge cleaning. With discharge cleaning we have reduced hydrogen desorbed from the source film to several monolayers; this reduction is important in increasing the lithium purity as we prepare for an integrated test series for the light ion ICF project before suspending this research. The technique is applicable to development of models of plasma turn on and plasma inventory in pulsed power.

Fabrication of the NIF target chamber has begun. Sandia personnel are involved in monitoring the manufacturing of the chamber until completion in FY99.

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