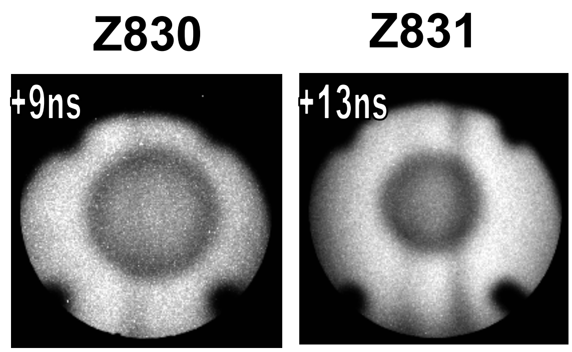
1673 News Notes: March 2002 Edition

Inaugural Edition of 1673 News Notes

Welcome to the first issue of the 1673 News Notes! The goal of this one-page, monthly newsletter is to highlight developments in Org. 1673 at Sandia National Laboratories. The responsibilities of 1673 include inertial confinement fusion experiments using z-pinch driven hohlraums (see article below), developing and operating advanced diagnostics on the Z facility, operating the Z-Beamlet laser facility, and upgrading Z-Beamlet to a Petawatt-class laser. Since progress in each of these areas can affect work in the others, this newsletter will summarize both major accomplishments and future plans in each of these work areas. If you have suggestions for future articles or short updates, please email them to Dan Sinars at dbsinar@sandia.gov.

Fusion Capsule Implosion Experiments



The Z facility can create a very energetic source of x rays known as a "z pinch". The z pinch is produced by passing about 20 million Amperes of current through a 1 cm tall, 2-4 cm diameter, cylindrical array of fine metal wires in about 100 ns (billionths of a second). The wires, which are typically thinner than human hairs, immediately explode and form plasma (a gas-like mixture of electrons and ions). The plasma is accelerated by the strong magnetic fields to the axis of the array, where it is rapidly heated to very high temperatures and begins to emit copious amounts of x rays. If the wire array is placed inside of a gold-coated canister, called a "hohlraum", x rays absorbed by the gold wall surfaces are reemitted into the hohlraum. In this way, the inside of the canister can be raised to a uniform temperature of about 120 eV (1.5 million degrees Celsius).

In Nov./Dec. 2001, Guy Bennett (grbenne@sandia.gov), Mike Cuneo (mecuneo@sandia.gov) and Roger Vesey (ravesey@sandia.gov) headed an experimental series that studied thin-walled, plastic capsules bombarded with x-ray radiation from the Z facility. The principal diagnostic for these experiments was the Z-Beamlet laser, which was used to produce a short burst of high-energy x rays by focusing the laser pulse onto a metal foil. The Beamlet-produced x rays were used to take x-ray pictures, or "radiographs", of the capsule as it was compressed by the radiation from the Z facility.

Two z-pinch sources were used during the experiments, one on each side of a smaller canister called the "secondary hohlraum". A 2 mm diameter, thin-walled plastic sphere was placed in the center of the secondary hohlraum, where it was bathed uniformly in all directions by x rays entering the secondary hohlraum from each of the two z-pinch "primary" hohlraums. The secondary hohlraum reached temperatures of about 75 eV during the tests. The x rays were used to compress the spherical capsule to <1/8 its initial size in about 20 ns. Using x rays produced by the Z-Beamlet laser, radiographs of the capsule implosion were made at several different times during this process, such as the two images shown above. These radiographs were used to evaluate the uniformity of the x-ray radiation bathing the capsule.

These experiments were a significant milestone for the Sandia inertial-confinement fusion (ICF) program, because radiographs of capsule implosions have never before been obtained on the Z facility. Additional capsule implosion experiments planned for May/June 2002 will attempt to optimize the design of the secondary hohlraum, whose size and shape control the uniformity of the x rays bathing the capsules.

Eventually, a plastic capsule filled with deuterium and tritium (hydrogen atoms with one or two extra neutrons, respectively) will be used. If the deuterium and tritium ions can be compressed to high enough densities for a long enough period of time, they will "fuse" together to form a helium ion and an energetic neutron. To obtain energy-producing fusion reactions, the capsules will need to be uniformly compressed to 1/30 or 1/40 of their original size. To obtain such high compression, a more powerful machine will be needed than the Z facility. The present experiments are the first step toward demonstrating that a z-pinch x-ray source can be used for this purpose. If the experiments continue to be successful, it is expected that a larger facility will be approved for construction.

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