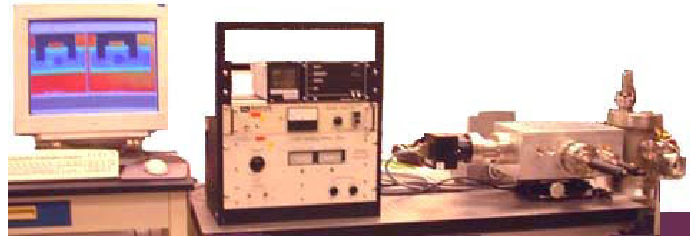
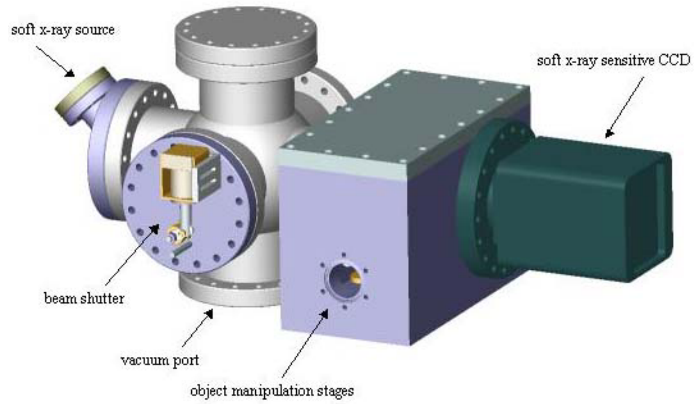
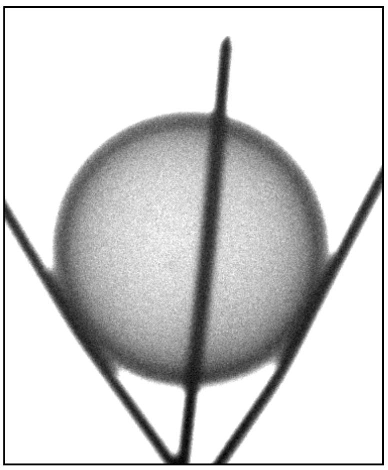
1673 News Notes: November 2002 Edition



Radiography/Tomography Characterization System

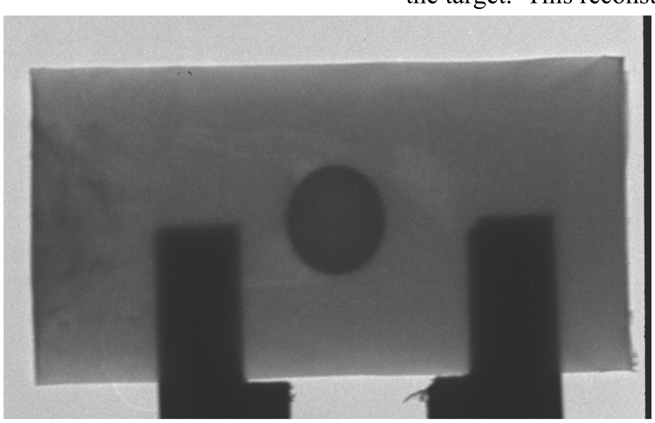


Low-density foam targets are commonly used to study High Energy Density science on facilities such as Sandia's Z-machine. These targets can be fabricated with densities approaching 1 mg/cm^3, the density of air, and machined into a variety of complex shapes. Characterization of these novel targets is a challenge. Systems that use visible light, like a simple microscope, can't see inside the objects. Commercially available x-ray probes use x rays that are too penetrating, resulting in low-contrast images. To overcome these limitations Larry Ruggles and Walt Simpson of Dept. 1673 have designed and built a radiography system for the Target Fabrication group at Sandia complete with custom analysis software and optimized for characterizing low-density targets. This system is based on a device originally developed to support capsule implosion experiments on the Z machine. The new system is located in the Target Fabrication laboratories, making it quick and efficient for Target Fabrication staff to characterize targets under development for an experiment at one of the NNSA High Energy Density Science laboratories.



The diagnostic uses a continuous electron beam to generate an ~100 micron diameter source of x-rays. By changing the electron-beam target material and the x-ray filters, the x-ray photon energy can be varied from 0.1 to 9 keV. This feature allows the user to characterize centimeter-scale hydrocarbon objects with densities from 0.02 mg/cm^3 to 250 mg/cm^3. The samples are kept under vacuum during this process, since the x-ray absorbtion of many centimeters of air (N_2 and O_2 at 1.2 mg/cm^3) can be much greater than that of typical low-density foams composed of carbon and hydrogen.

The x-rays from the source are used to project a radiographic image of a target, magnified ~1.5X, onto an x-ray CCD camera. The present system translates up to four targets into view without opening the vacuum system to reload, and ~12 target images can be taken in a day. Larry and Walt are presently upgrading the system so that it can individually rotate up to 9 different targets without breaking the vacuum. The ability to rotate the targets will allow multiple images of the same target to be made from different viewing angles. Using computer software, the multiple two-dimensional images of the target will be combined to generate a three-dimensional reconstruction of the target. This reconstruction process, called tomography, is commonly used in medical imaging systems to non-invasively look at the body. The spatial resolution of the 2-D images is presently about 40 microns (about 1/2 the thickness of a human hair), and will improve to ~30 microns when the system is upgraded. The 3-D reconstruction will have a resolution >40 microns that varies with the number of 2-D images used.



Two sample images from the characterization system are shown. The top image is a 100 mg/cm^3 foam-shell sphere made for inertial fusion energy experiments at the Naval Research Laboratory. The bottom image shows a 12-mm-long, 14 mg/cm^3 foam cylinder containing an embedded capsule. Such targets are used during "dynamic hohlraum" inertial fusion energy tests on the Sandia Z-machine.

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