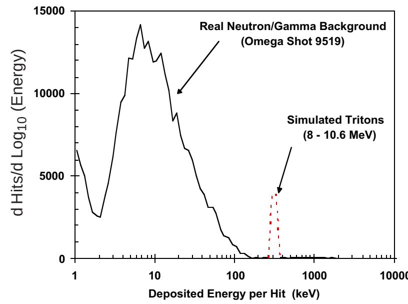
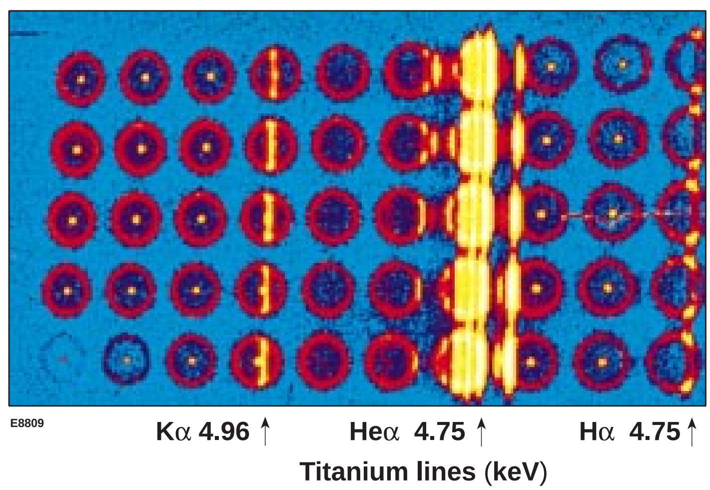
November 1997 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

***Summary*:** A novel pinhole-array x-ray spectrograph was demonstrated on OMEGA, and analysis of past experiments continues. In this report, we discuss the development of core diagnostics, based on a unique charged-particle spectrograph, and the demonstration, for the first time, of high-quality polyimide capsules.

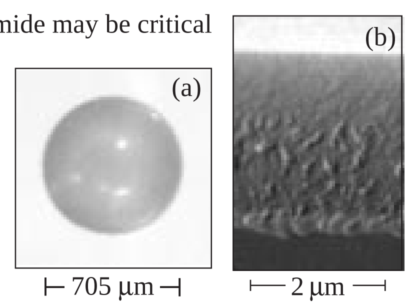
***Core Diagnostics*:** Determination of core conditions and implosion symmetry is required for OMEGA direct-drive implosion experiments. To achieve this goal, a novel charged-particle spectrometer is nearing completion. Recent tests of the CCD detectors for this spectrometer have been performed on OMEGA, and excellent separation was demonstrated between the expected triton signal (which will be used to determine the fuel ρR) and the measured neutron/gamma background (see figure). This instrument will be used in conjunction with a second, compact spectrometer, which has been assembled. Data from the two spectrometers, mounted at different positions, will provide information about asymmetries in flux and ρR. This effort—partially funded by an NLUF grant—is based on a strong collaboration between MIT, LLE, and LLNL.



***Pinhole-Array X-Ray Spectrograph*:** A new type of x-ray spectrometer was tested on OMEGA. An array of 400 pinholes was placed in front of a flat, x-ray–dispersing crystal, yielding narrow-bandwidth, two-dimensional target images at different x-ray wavelengths. The figure shows a section of the image obtained from a thick-titanium–coated capsule implosion. In the vertical direction (perpendicular to dispersion) the array is tilted so that the image-center photon energy changes by approximately 10 eV between adjacent images. Images where the spectrum is continuous span an approximately 100-eV spectral range. Individual lines yield monochromatic images of only a section of the capsule (this can be remedied by replacing the flat crystal with a curved one). However, as the image shows, the lines (bright yellow lines in the image) are wide enough for imaging the core, even with a flat crystal. An alternative application of this device is to serve as a high-spectral-resolution spectrometer. For example, the fine-structure splitting of the Hα line of titanium is clearly seen, indicating a resolution higher than 500, compared to <100 without the pinhole array.



***Polyimide Capsules*:** The greater strength and room-temperature permeability of polyimide may be critical for cryogenic experiments that require high-aspect-ratio capsules. Thin-wall, high-aspect-ratio polyimide capsules have now been successfully fabricated and tested by the LLE Target Fabrication Group. The accompanying micrographs show (a) a 705-μm-diam polyimide shell with a 2.5-μm wall and (b) a dense microstructure (the photo shows the cross-sectioned capsule wall). This target survived pressurization to 750 psi at a rate of 75 psi/s and depressurization to atmospheric pressure at 250 psi/s, without fracturing. By contrast, current plasma polymer capsules, with equivalent dimensions, cannot survive pressurization rates greater than ~1 psi/s or an overpressure of ~120 psi max.



***OMEGA Operations Summary*:** OMEGA shot operations in November included target shots and shots for laser optimization. Ten shots were dedicated to the S3 campaign (spherical burnthrough and mix studies), including some exploratory x-ray spectroscopy experiments. In preparation for the installation of ion-etched DPP's, a focus scan of seven shots was conducted. The short week of November 18th was dedicated completely to scheduled maintenance. During this month two days were allocated to full operations training (practical demonstrations as well as lectures), organization, and "housekeeping." OMEGA clean-room performance continues to remain well within specifications (Class 1000 cleanliness).

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