Section 2
PROGRESS IN LASER FUSION

2.A Initial Experiments on OMEGA

The OMEGA laser facility, a 24-beam neodymium phosphate glass system capable of peak output powers of the order of 12 TW at 75 psec duration pulses, and maximum output energies of the order of 4.8 KJ has recently become operational as a target irradiation facility. Six beams of this system have previously been utilized as the ZETA facility for an extensive series of short pulse (of the order of 75 psec) experiments at high intensities (10^{15}–10^{17} W/cm^2) examining the behavior of thin and thick shell targets in what has become known as the "exploding pusher" regime, with symmetric irradiation.

In April of this year, 24-beam target experiments commenced on the OMEGA facility. This series of shots is also being run in the short pulse exploding pusher regime in order that the laser system performance and primary baseline diagnostics can be characterized under known operating conditions. Apart from this overall objective, the series of shots has three specific objectives:

1. To fully characterize the degree to which all 24-beams of OMEGA can routinely be positioned and targeted with high temporal and spatial accuracy, and to increase the confidence level in our ability to take a large number (up to 8) shots on each day that target experiments are scheduled.
2. To perform a selected series of 24-beam high power experiments with simple thin shell exploding pusher

targets, in a parametric region already well explored, to ensure full operation of primary experimental diagnostics such as plasma calorimetry, x-ray photography, and neutron diagnostics. In addition, these experiments permit the examination of scaling laws for symmetrically driven exploding pusher targets at higher powers than previously used at LLE.

3. To make an initial evaluation of the degree to which the uniformity of irradiation is a factor in the performance of these types of targets.

Although these experiments are still in progress, and thus the analysis of results tentative, several noteworthy achievements have been attained.

Tests specifically designed to determine beam pointing and focusing and target centering accuracy were made through x-ray photography of gold-coated spherical targets irradiated with symmetric six-beam combinations, each beam focused on the surface of the target. Examination of the sizes and relative positions of the individual x-ray images on the surface of the target then permitted estimation of the position of best focus for each beam and the beam pointing and centering accuracy. The axial position of focus could be estimated to an accuracy of the order of 50 μm, while it was found that individual beams could be routinely pointed with an accuracy of the order of 11 μm. This degree of accuracy in fact approaches the limits set by visualization and stability of the target. The maximum excursion of any individual beam recorded during these tests was of the order of 25 μm. In addition, the individual beamlines have been timed relative to one another to within 3 psec with the use of a CW laser interference technique.

A number of shots have been taken to examine scaling laws for exploding pusher targets irradiated by 24 beams with total on-target power levels of up to 8 TW and pulse durations of $\sim$ 100 psec. Simple glass microballoon targets, filled with 20 atm of DT having diameters in the 150-250 μm range have been used and among other features the effects on target performance of variations in the imposed intensity distribution on target have been examined. In general, it was found that the overall laser light absorption is a strong function of beam focus position reaching a peak value of the order of 40% for center-focused beams. Neutron yield is found to scale with specific absorbed energy up to values of $\sim$ 1 J/ngm, and in a series of six shots on May 19, three consecutive shots recorded yields in excess of 10^{10} neutrons at incident power levels of $<$ 7 TW. The peak neutron yield so far obtained is 1.35×10^{10} neutrons. These results represent a considerable improvement in the overall yield efficiency so far attained in any laser fusion experiment (Fig. 13), yield efficiency being here defined as the ratio of the total energy in thermonuclear products to the total absorbed laser energy. In addition to the diagnostics quoted above, x-ray crystal spectrographic, neutron TOF, and x-ray micrographic measurements are

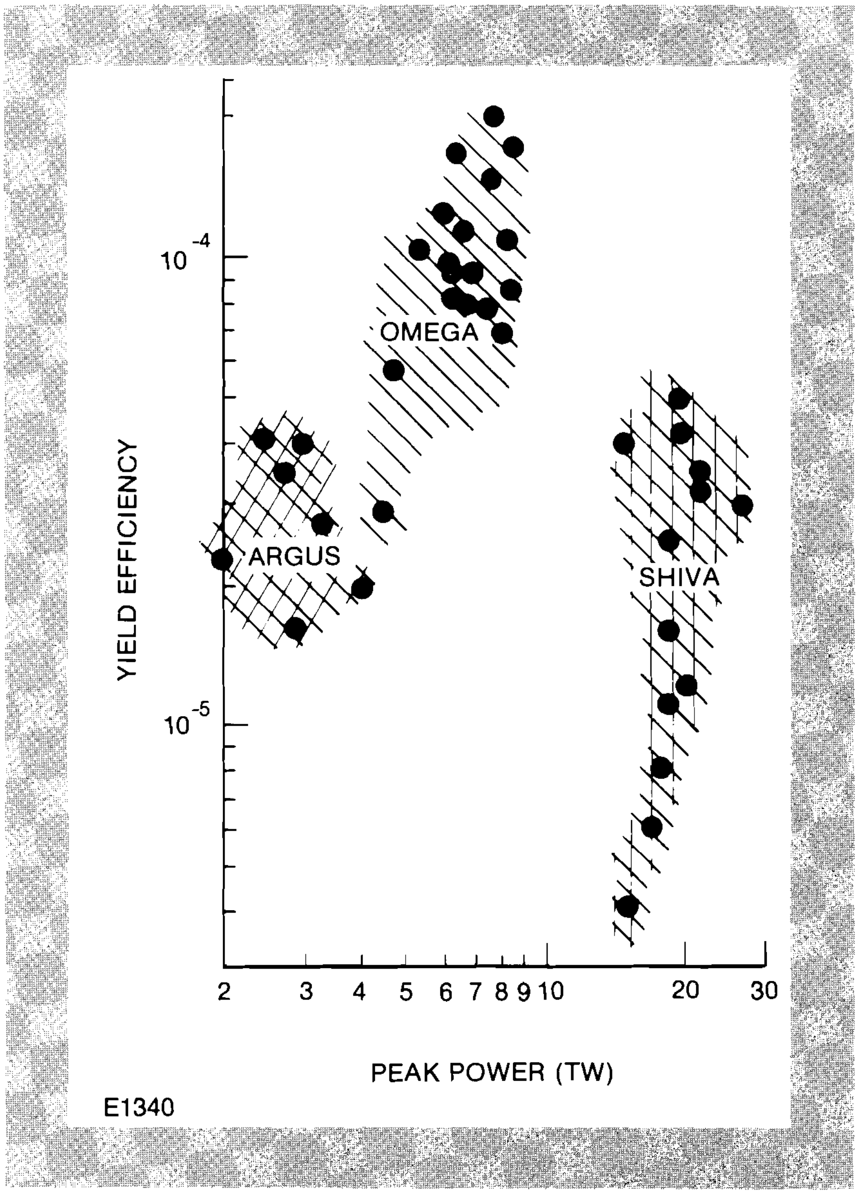

Fig. 13
Yield efficiency of exploding-pusher targets.

being made as well as development of the so-called "knock-on" determination of fuel ρR through analysis of the spectra of elastically scattered deuterons and tritons. These investigations will be described in more detail in a later LLE Review when an overall summary of exploding pusher target experiments on OMEGA will be given.