Section 3
LASER SYSTEM REPORT

3.A GDL Facility Report

During the first quarter of FY89 the glass development laser (GDL) was used by three in-house experimental groups and one NLUF user. The in-house experiments were conducted in the Beta target irradiation facility and concentrated on x-ray laser studies, x-ray lithography, and the transmission of light through multilayered targets. The x-ray laser experiments were aimed at observing gain in collisionally pumped neon-like nickel and germanium. The x-ray lithography experiment measured the silicon content of corn, which may serve as a new source of ultrapure silicon. These experiments are a collaboration between LLE and researchers at SUNY at Buffalo. The third campaign is a continuation of the study of the temporal behavior of multilayered targets. Ultimately this program will determine the relative importance of transmitted light in the interpretation of various multilayered-target experiments on OMEGA. Users from the University of California at Davis performed experiments that temporally resolved the second-harmonic emission from the target in order to study parametric processes in laser-plasma interactions.

A summary of GDL operations this quarter follows:

Beamline Test, Calibration, Tuning, and Laser Alignment Shots	321
Test Shots	
X-Ray Laser	76
X-Ray Lithography	23
Multilayer Experiments	51
NLUF Users (UCD)	
Timing and Alignment Shots	35
Target Shots	58
TOTAL	564

3.B OMEGA Facility Report

During this reporting period, the OMEGA laser has been reexamined for techniques to improve irradiation uniformity. Two systems were in the process of being integrated into the system to achieve this goal. The first of these, power balance, consists of energy balancing the beams while ensuring that the beam pulse shapes are exact across all 24 beams. The second system involves the smoothing of the fine speckle pattern on target produced by the distributed phase plates. Implementation of several subsystems to accommodate the scheme of smoothing has been accomplished and full integration is expected within the next quarter.

Power-balance evaluation of the frequency-tripled pulse shapes showed strong dependence on the phase-matching angles, polarization angle, and intensity. Using the fiber-coupled, four-beam UV streak camera, tests were done to empirically determine the sensitivity to each of these parameters. Simultaneously, extensive computer modeling was developed to aid in the interpretation of the results and understanding of the conversion process in general. Tests of the birefringence of the last amplification stage of OMEGA, the 90-mm rods, indicated a polarization control element between the amplifier and the conversion crystals was necessary for consistent optimal tripling efficiency.

A high-contrast, high-damage-threshold thin-film polarizer was developed at the University's Thin-Film Coating Facility, and 24 units suitable for installation were delivered in November. The implementation of these devices virtually eliminated the problem of spatially varying polarization states and shot-to-shot changes due to amplifier birefringence. Techniques for error-free phase-match angle tuning were developed, and software was implemented to compensate for any temperature variations from the nominal ambient condition. The combination of these factors has led to stable frequency conversion at 100%$\pm$5% of theoretical performance. By accurately calibrating the output energy diagnostics and balancing the energy in each beam, the last component of power balance is satisfied, yielding the best irradiation balance for direct-drive implosion experiments.

As power balance requires accurate energy balance, a new computerized system was developed to enable faster, more precise adjustment of the distribution of energy from the single driver-line beam to the 24 beamlines. Utilizing tight control of the polarization into the polarizing dielectric beam splitters and an active feedback system, beam-to-beam balance can now be achieved to levels better than 2% rms. A schematic diagram of the system (Fig. 37.37) depicts motorized wave plates to adjust splitter ratios and diodes to monitor the induced change. As the wave plates are manipulated, laser pulses are detected at the output of the system, fed into the computer, and, within 15 min, a complete rebalance of the distribution is accomplished. This capability gets the balance near the stability of the amplifier chains (currently 1.50% rms). Future efforts may improve on these results as the mechanisms of instability are identified and eliminated.

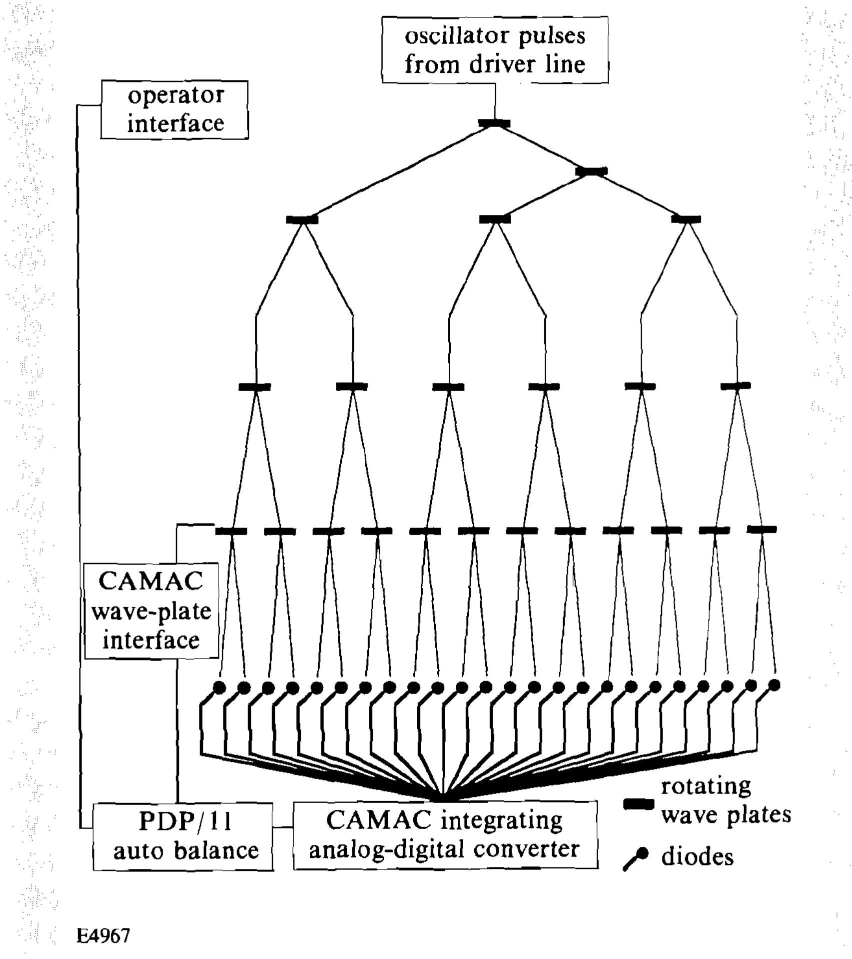

Fig. 37.37
Closed-loop feedback system used for intra-shot beam balancing on the OMEGA laser system.

Spatial smoothing of the power-balanced beams is the other goal of the new-term uniformity program. Since the scheme impacts mainly the front end of the laser system, there have been several changes made in the OMEGA driver line. Increasing the bandwidth of the laser, frequency dispersing the beam, and coupling the frequency-tripled light through distributed phase plates will result in a less-modulated target distribution. Other than the driver line, the only changes that had to be made to the laser were checking the *e*-axis orientation of the conversion crystals and rebuilding the cells to have the same dependence of phase-matching angle to wavelength. All crystals are reoriented at this time, ready for extended-bandwidth frequency-dispersed light. The theory and implementation of these concepts are covered elsewhere in this issue. This approach is one of the most significant laser developments since frequency tripling was pioneered at LLE in the early 1980s.

In summary, the Operations Group has been exclusively involved with the uniformity program. The following shot summary reflects the fact that most shots have been laser test shots for uniformity programs. Demonstration of spectral smoothing on target is this program's primary goal and, given the pace of current activity, results are expected early next quarter.

Driver Line and Test Shots	200
Laser	226
Target	51
TOTAL	477

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