Section 4
LASER SYSTEM REPORT

4.A GDL Facility Report

The first quarter of FY90 saw the continuation of four main experimental programs. The programs are x-ray laser, shine-through, optical probing/interaction, and Thomson-scattering experiments. Significant progress was achieved in all of these projects, and results were reported at the Monterey Conference on Laser Plasma Interactions and the November meeting of the American Physical Society. In preparation for these meetings, additional laser shots were performed by extending the operation schedule to evenings and Saturdays.

A summary of GDL operations this quarter follows:

Beamline Test, Calibration, Tuning, and Laser Alignment Shots	346
Target Shots	
Shine-through	71
X-Ray Laser	49
X-Ray Lithography	3
Probe Beam	86
Thomson Scattering	51
TOTAL	606

ACKNOWLEDGMENT

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4.B OMEGA Facility Report

During this quarter, activities were split between laser enhancements and full-scale target shots. Beam-smoothing and power-balance activities continued with the goal of improving and equalizing the spatial and temporal characteristics of each of the 24 beams. Target drive-uniformity requirements have tightened tolerances on beam profiles and laser-diagnostic calibration and stressed the need for increased diagnostic capability.

After several months of successful operation of SSD on OMEGA at 3 GHz, it was decided that the best way to improve the smoothing of the laser beam was to increase the frequency at which the laser beam was phase modulated. This would have the effect of decreasing the time required for the laser beam to reach its asymptotic level of smoothing. The design goal was a factor-of-3 increase in frequency to 9 GHz.

The major task was then to design and build a lithium niobate microwave phase modulator at 9 GHz that would produce about the same bandwidth, i.e., 3 Å to 5 Å, that the 3-GHz modulator had produced. The basic difficulty was designing a resonant microwave modulator at 9 GHz that would use a crystal of roughly the same dimensions (several millimeters) as those used for the 3-GHz modulator, in order to keep the laser intensity below the damage limit. It had been observed during the design of the 3-GHz modulator that the operation of the resonator was greatly dependent upon the shape of the lithium niobate crystal, not just upon the capacitance of the crystal, which would have been expected. It was believed at that time that the internal crystal resonant modes might have been responsible for these observations. It was decided to make use of this effect in the design of the 9-GHz resonator. The basic idea was to have a resonator, loaded with the capacitance of the crystal, be resonant at a frequency close enough to an internal resonant mode of the lithium niobate to efficiently couple energy into it. At 9 GHz the free-space wavelength is about 3 cm, which means that inside the lithium niobate, with a dielectric constant of 27 or 41 depending on the orientation, the wavelength is of the order of 5 or 6 mm in the two directions. This then places a rough upper bound, i.e., approximately one wavelength, on the dimensions of the crystal. Many designs were tried; the design that finally worked was a rectangular parallelepiped of lithium niobate as a capacitive load at the end of a tunable resonant-transmission-line cavity. With loose-loop coupling to the cavity, a bandwidth of between 3 Å and 4 Å was measured with a pulsed microwave input power of about 40-kW peak at a frequency of 8.45 GHz and 400-ns pulse width.

This preliminary design has now been installed on the OMEGA system and will be used for a short period of time until a new waveguide-coupled cavity is finished, which will have better coupling characteristics and should provide greater bandwidth for the same power input.

Power-balance monitoring has been improved by an automated installation of 24 calorimeters that now provides energy-sensing system-calibration checks on a daily basis. Also, a 24-beam UV streak camera has been installed and is operational on OMEGA. This new diagnostic was brought online to measure the state of power balance on OMEGA and, as of the end of the quarter, it was undergoing final calibration and optimization.

Two incremental improvements to the rod amplifier subsystems during this quarter have had a beneficial impact on the power balance of the system. First, a new alignment fixture ensures accuracies of ±200 μm in rod alignment measurements and allows for all 54 rod amplifiers to be tested for positioning in a single day. Second, new O-ring seals on the rod amplifiers have been installed that can withstand the intense flash-lamp radiation, thereby decreasing the possibility of contamination due to leaking coolant.

In support of the experimental campaigns, a regenerative ring-laser system has been built in the driver line of OMEGA. The resultant 0.5-J IR pulse is converted to 4ω and is to be used as a timing fiducial on x-ray streak cameras, as well as other time-resolved target diagnostics. Target experiments utilizing this fiducial are planned for early next quarter.

A summary of laser shots on OMEGA follows:

Driver Line	85
Laser Test	110
Target	109
Software Test/Other	62
TOTAL	366

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