March 1998 Progress Report on the Laboratory for Laser Energetics Inertial Confinement Fusion Program Activities

Diode-Pumped Regenerative Amplifier: In an effort to increase reliability and decrease maintenance requirements for key components of the OMEGA system, we are developing a diode-pumped Nd:YLF regenerative amplifier. The active medium is efficiently end-pumped by one or two diode arrays resulting in exceptionally high single-pass gains and excellent TEM_{00} beam quality even without intracavity apertures. The output of the diode arrays was coupled into step-index, 0.6-mm-diam, 0.22-numerical-aperture transport fibers with an efficiency of >50% measured at maximum diode laser output. The output of the transport fiber was re-imaged with 1.6× magnification into the Nd:YLF rod through a dichroic beam splitter. The focused pump beam is circular in the Nd:YLF rod with a cross section of ≤1.3-mm FWHM over the 20-mm length inside the medium. More than 95% of the pump energy was absorbed in the Nd:YLF crystal. The small-signal gain for this pumping scheme was determined using a cw mode-locked Nd:YLF laser operated at 1053 nm that was collimated and apertured so that the probe beam used was ~1 mm in diameter. The measured small-signal, single-pass gain at 1053 nm was 2.2 for one-sided pumping and 4.2 for two-sided pumping (see Fig. 1). For pumping from one side with ~27 mJ of diode energy, the free-running output was 8.8 mJ in a multilongitudinal, fundamental TEM_{00} mode (i.e., 33% of the pump energy delivered to the active medium). At maximum pumping from both sides (50 mJ of diode energy) the free-running output was 20 mJ (multilongitudinal, TEM_{00} mode), which is 40% of the diode laser energy delivered to the Nd:YLF rod (Fig. 2). The measured optical-to-optical differential efficiency was 54%. The highly symmetric output beam has an intensity distribution very close to the intensity distribution calculated for the given laser resonator parameters (see Fig. 3). The measured output energy in the *Q*-switched mode was 13.6 mJ, in a TEM_{00}-mode spatial profile. The *Q*-switched pulse had 140-ns FWHM, which corresponds to less than six round-trips in the laser cavity. We believe that the reported 20-mJ TEM_{00} output energy with 54% differential efficiency for a free-running mode and 13.6-mJ TEM_{00} output energy for a *Q*-switched operation are the highest TEM_{00} output energies reported to date for end-pumped Nd:YLF laser oscillators operated at 1053 nm.

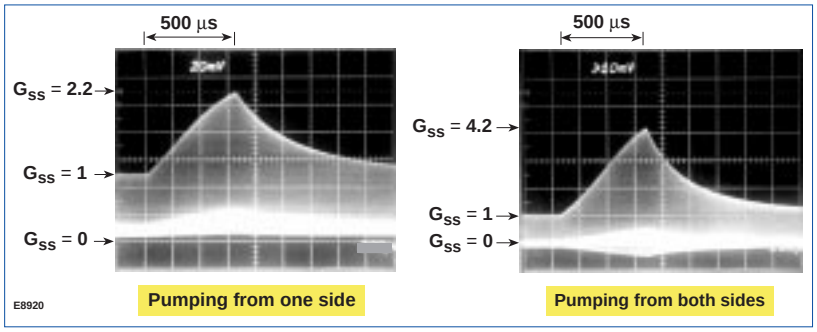

Fig. 1. Measurement of small-signal gain of diode-pumped amplifier for one-sided pumping (left) and two-sided pumping (right).

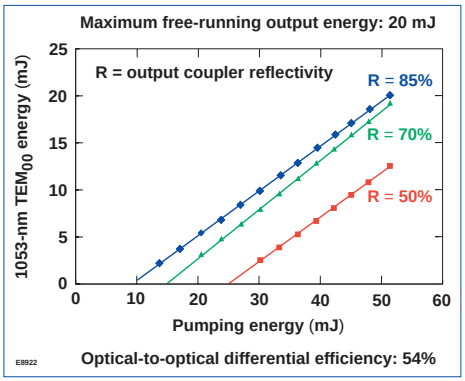

Fig. 2. Free-running output of laser versus pumping energy.

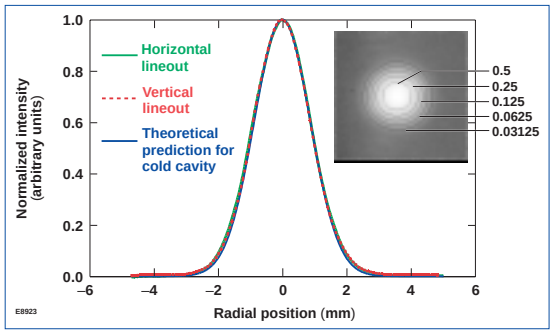

Fig. 3. Output beam profile at 6.4-mJ output energy. Insert is the image of the laser beam on the logarithmic scale with superimposed contour lines.

OMEGA Operations Summary: During March, there was a one-week planned maintenance period for OMEGA—a quarterly hiatus from target shots during which maintenance operations that require system down time are scheduled and accomplished. The concentration of effort was in the target area where routine maintenance was performed and the sixth and final TIM diagnostic shuttle system was installed. During the two weeks following the maintenance week three laser campaigns were carried out to characterize the mid-chain laser far field, investigate SSD performance using UV far-field tests, and re-calibrate the laser diagnostics. A total of 30 target shots were taken during March: 20 shots on target for flat-foil S1/S2 experiments plus 10 diagnostic checkout shots on target (run in parallel with the 20 laser far-field test shots).

Contact: Wolf Seka (716) 275-3815; fax: (716) 275-5960; e-mail: seka@lle.rochester.edu
John M. Soures (716) 275-3866; fax: (716) 256-2586; e-mail: jsou@lle.rochester.edu