All the modules of the system will consist of thin slab zig-zag units similar to the one used in these initial demonstration tests. They consist of a quartz zig-zag cell containing a pair of 1.5 mm thick × 17 mm high Cr:LiSAF crystal slabs, which are flashlamp pumped by a pair of 6″ Xe flashlamps. The slabs are cooled using a flowing index matching fluid. A detailed description of the optical configuration of these unique zig-zag cells is given in reference 1.

Using one of these modules, we reported near diffraction limited performance from a Cr:LiSAF laser operating at 5 Hz with over 1J per pulse output (reference 2).

This paper reports of recent progress made with this system that demonstrated higher extractable energy in the module (while maintaining medium quality), and furthered the design to accommodate this better performance at the 5 Hz rep-rate. A stable optical cavity with a set of intra-cavity corrector lenses (added to compensate for medium distortions) was set up as shown schematically in Figure 1. Laser performance data are shown in Figure 2. The laser quickly reaches steady state to operate with a measured average energy output of 8.8J/pulse at a record 44 W of average power.

Current zig-zag cells use longitudinal coolant flow along the long slab axis. Longitudinal flow limits the flow rate at practical cell pressures and allows pump non-uniformities to result in medium phase distortions. Work is currently proceeding on the development of a transverse flow cell. Transverse flow will allow operation at higher repetition rates while reducing the need for external phase corrections. Initial results with this new design have shown better medium control as well as reduced angular jitter of the beam measured in far-field. Figure 3 shows the improvement in the far-field spot jitter using transverse flow compared to longitudinal flow. Higher reprate measurements will be carried out when the current laboratory power supplies are up-graded.

These large aperture (1 × 1 cm^2) high pulse energy Cr:LiSAF thin slab lasers can be compared to similarly sized rod lasers. Maximum repetition rate reported for a 19 mm diameter Cr:LiSAF rod was 0.05 Hz (Ref 3). The 5 Hz data reported here represents an increase in average repetition rate of a factor of 100 for over high energy Cr:LiSAF lasers using simple rod geometries. This work was supported by the Air Force Research Laboratory under prime Agreement F29601-99-D-0131.

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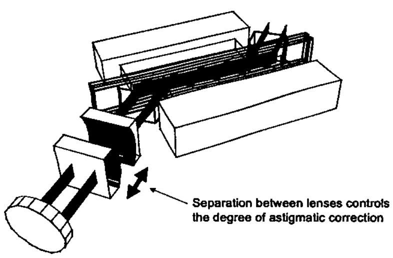
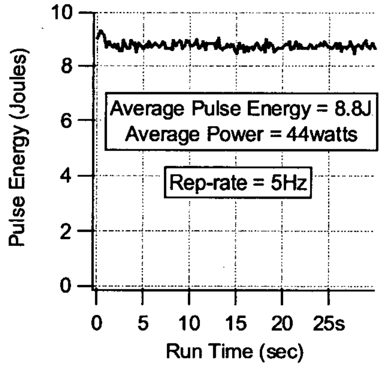
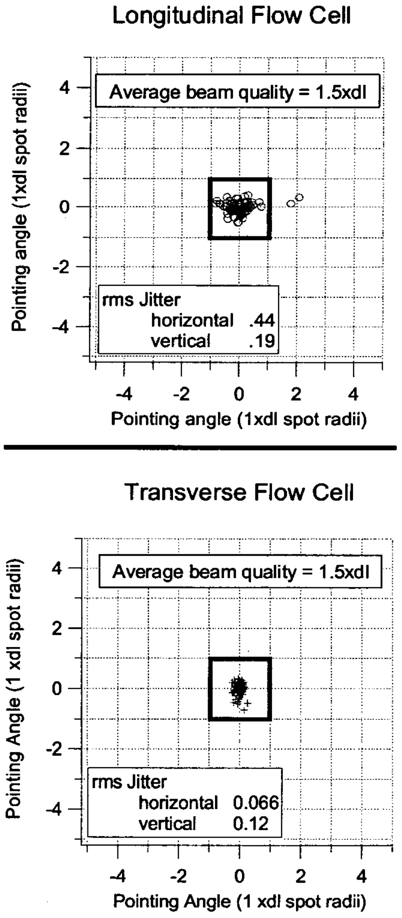


CThI4 **Fig. 1.** Oscillator cavity with adjustable correction for low order medium distortions.



CThI4 **Fig. 2.** Measured steady state output of 44 W from a Cr:LiSAF power oscillator operating at 5 Hz.



CThI4 **Fig. 3.** Improved far-field pointing jitter with Transverse cell.

CThI5 **11:15 am**

200W continuous-wave TEM$_{00}$ mode1064-nm beam generation by a laser-diode-pumped Nd:YAG laser amplifier

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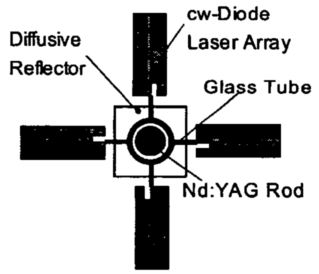
1. Introduction

The advent of high-power laser diode-pumped solid-state lasers has significantly enhanced efficiency, brightness, and reliability of diode-pumped solid-state lasers. High average power, continuous-wave TEM$_{00}$ mode beam sources are of interest in many industrial and scientific fields. Frequency converted ultraviolet or visible Q-pulse TEM$_{00}$ mode beam sources are in particular, attractive in information technology field for drilling or trimming of printed circuit boards. Although, various attractive continuous-wave TEM$_{00}$ mode beam sources have been reported,[1–6], average output power of these systems is limited at the level of 100W. In this work, we have enhanced the output power of continuous-wave TEM$_{00}$ mode up to 200W by use of a Nd:YAG laser amplifier system. This is what we believe the highest number obtained with diode-pumped solid-state laser systems.

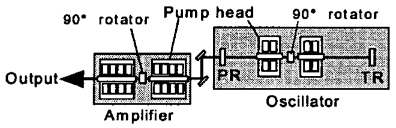
2. Experiment

Figure 1 shows a cross section view of a side pump module used for the experiment. A Nd:YAG rod is surrounded by a flow tube and a diffusive reflector. Linear continuous-wave laser diodes are placed in 4-fold symmetry around the rod axis. Details of the pumping part are reported in.[7]

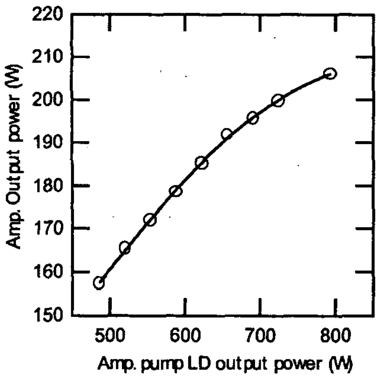
Figure 2 shows an experimental setup of a diode pumped Nd:YAG laser amplifier system. The oscillator produces a maximum output power of 110W at the beam quality of M^2 = 1.1 with 575 W total pump LD output power. Details of the laser performance of the oscillator are going to be reported elsewhere. The amplifier consists of two pump heads and a 90 degrees polarization rotator. The amplifier was designed to achieve



CThI5 **Fig. 1.** Cross section view of the pump module.



CThI5 **Fig. 2.** Schematic drawing of the experimental setup.



CThI5 Fig. 3. Amplifier output power as a function of pump LD output power.

polarization dependent bifocusing compensation.[8]

Figure 3 shows 1064-nm average output power of the amplifier system as a function of amplifier pump LD output power. A maximum output power of 206 W was obtained at the beam quality of $M^2 = 1.34$ with 800 W amplifier pump LD power.

3. Summary

We have enhanced continuous-wave TEM_{00} mode 1064-nm output power by using a Nd:YAG laser amplifier system. The maximum output power of 206 W was achieved at 1375 W pump LD power. Further enhancement of the output power, pulse mode operation, frequency-conversion is now under way.

4. References

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CThI6 11:30 am

Compact 300-W diode-pumped oscillator with 500 kW pulse peak power and external frequency doubling

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1. Introduction

For numerous industrial and scientific applications continuously pumped, repetitively Q-switched solid-state oscillators are attractive due to their compactness, stability, and high efficiency. High average power frequency conversion of these systems is commonly performed intracavity.[1,2] Owing to pulse peak powers up to 500 kW the developed system is suitable for external high average power frequency doubling.

2. Resonator Design

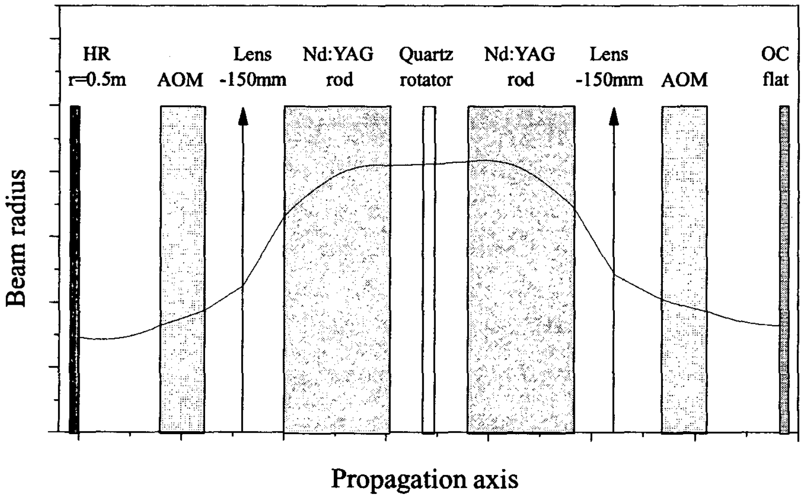
Figure 1 shows a scheme of the developed oscillator. The resonator contains two identical diode pumping chambers that supply each an optical pumping power of 800 W with a homogeneous pumplight distribution in both Nd:YAG rods. Thermally induced phase distortions were investigated using a Shack-Hartmann wavefront measurement system. To compensate for thermally induced stress birefringence a 90° quartz rotator is used. Two additional lenses with a focal length of –150 mm move the resonator stability zones towards higher refractive powers of the active media and decrease the times-diffraction limit factor M^2. The highly reflective mirror has a concave curvature of 0.5 m, the flat output coupling mirror has a reflectivity of 50%. Two acoustooptic modulators with an RF power of 50 W each facilitate Q-switching for the high gain oscillator. The oscillator operates dynamically stable for thermally induced refractive powers of 6.4 and 9.0 diopters per rod. The corresponding stability zones exhibit a width of 16% (zone I) and 13% (zone II).

3. Continuous Wave Operation

Operation in the first stability zone yields a continuous output power of 185 W, in the second stability zone 305 W output power are obtained. During an operation time of 60 min the fluctuations in output power were less than 0.4% without stringent requirements on cooling water temperature (see Fig. 2). The experimentally determined times-diffraction limit factors are M^2 = 4.3 and M^2 = 9.1, respectively. All beam quality measurements were carried out according to the international standard "Test methods for laser beam parameters", ISO/CD 11 146.[3] Hereby the beam radius is determined by the second moment of the intensity distribution. The strongly attenuated output beam was focused with a +350 mm lens yielding an external beam waist. A CCD camera based beam profile system was used to determine the beam diameter along the beam's caustic.

4. Q-switch Operation

Two intracavity acoustooptic modulators facilitate Q-switching in both stability zones with pulse repetition rates from 40 kHz down to 10 kHz. The average output power shows just a slight dependence on the repetition rate and covers 170–180 W in the first and 260–270 W in the second stability zone. A pulse duration (FWHM)



CThI6 Fig. 1. Schematic of the birefringence compensated two-rod resonator with a cavity length of 70 cm. The calculated curve shows the multimode beam propagation inside the resonator; AOM: acoustooptic modulator, OC: output coupler.