13-W, M^2<1.2 Nd:YLF Laser Pumped by a Pair of 20-W Diode-Laser Bars

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A multipass Nd:YLF gain element is the basis of an efficient, near-diffraction-limited, laser that can be operated at 1047 nm either cw or Q-switched (Fig. 1). The design has particular significance because the combination of efficiency (>33% optical), power (>13 W), and beam quality (M^2<1.2) has been obtained in a side-pumped geometry with a single pump-coupling lens per diode-laser bar. In addition, the output powers observed both in near-diffraction-limited operation and multimode (>16 W) are, to our knowledge, the highest powers reported to date for cw, diode-pumped Nd:YLF lasers.

The 3-cm-long Nd:YLF crystal is transversely pumped by a pair of 1-cm-long, 20-W diode-laser bars. The diode-laser bars are coupled to the gain element through a single fiber lens attached directly to each bar package. These lenses minimize the divergence of the pump light in the plane perpendicular to the linear emitter. The bars are offset on opposite sides of the Nd:YLF crystal to create a sheet of gain in the crystal. The pump faces of the crystal have segmented dielectric coatings to allow double-pass pump absorption. The pump geometry is a central feature of the design in that it yields a laser that is relatively insensitive to the alignments, spectra and temperatures of the diode-laser bars. The laser resonator is aligned for multiple passes through the gain region, either with closely spaced external mirrors or by depositing segmented coatings directly on the end facets of the gain element. The data presented here were obtained in a five-pass configuration with AR/HR-coated facets.

The three-mirror laser resonator, including a cylindrical mirror, a spherical mirror and a flat output coupler, is designed to produce a diffraction-limited beam at a specific operating point (*i.e.*, ~18 W incident on each pump face of the gain element). The combination of mirrors is a simple means of compensating for the elliptical thermal lensing in the Nd:YLF crystal, while the physical layout facilitates inclusion of an acousto-optic modulator for Q-switching.

A number of lasers have been assembled and observed to yield similar performance. In cw operation, the lasers typically produce over 13 W at 1047 nm, linearly polarized (>100:1), with $1.0<M^2<1.2$. Typical Q-switched data are presented in Fig. 2, where the pulse-repetition-rate was varied over the range 5-120 kHz. The combination of peak power and beam quality is well suited to second harmonic generation. As an initial demonstration at 10 kHz, 6.8 W was generated at 523.5 nm via external doubling with 11.2 W incident on a 15-mm-long, noncritically phase-matched LiB_3O_5 crystal.

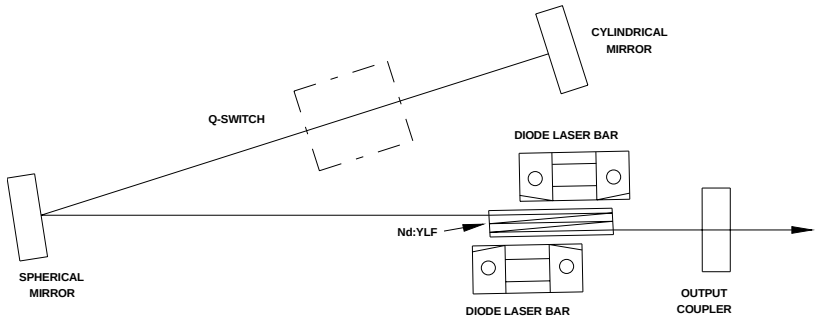

Fig. 1. Schematic of laser (5-pass Nd:YLF).

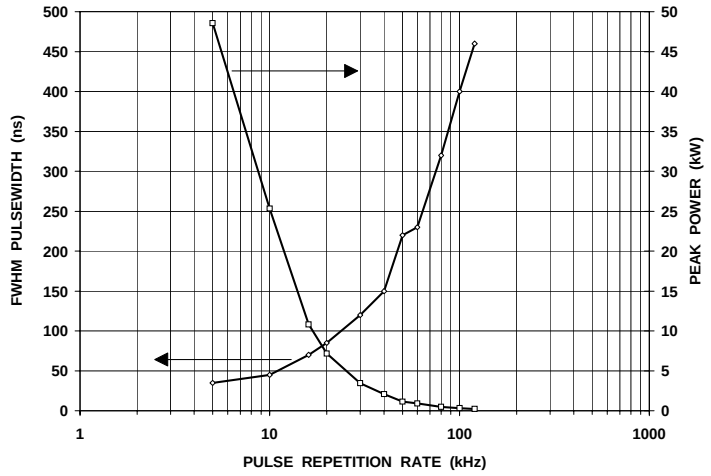

Fig. 2. Peak power, pulse-width vs. PRF.