Making A Multiwavelength Laser Source Portable

by Scott Wohlstein,
SD Laboratories

(Ed. note: Considering the sunny summer weather, we have decided to devote the next few Test Bench columns to the rigors of making optical measurements in nonlaboratory environments. We start with the design of hardware for remote sensing. Next month we'll look at one of the tradeoffs involved when instrumentation goes into orbit.)

Virtually all the excitement involved with diode-pumped solid-state laser systems to date has been focused on milestones of achievement related to laboratory breadboard systems. As these systems become more viable, related applications will be developed. If the most optimistic predictions can be believed, the laser will ultimately become as inexpensive and universal as the light bulb.

The POrtable Multi-Emission Laser Source (POMELS) combines the newest technologies available regarding diode-pumped lasers and fiberoptics. The particular system can provide four different wavelengths; one of them can be modelocked (see figure). The project was originally developed for the Department of Defense Small Business Innovative Research program, through the U.S. Army, as a portable laser scalpel for various types of field surgery. Since "flesh cutting" would require somewhat higher average pulse energies and/or average powers than are currently available, the system was redesigned for remote scientific work in areas as sensing and spectroscopy, for example.

Hardware

POMELS encompasses several innovations. It measures approximately 60 × 30 × 30 cm and has been designed to MIL SPECs for rugged environmental conditions and operation. As a result, the construction is almost entirely comprised of aluminum for lightweight strength. The battery pack (weighing approximately 20 pounds) represents the bulk of the system's weight. The legs are nonslip and terrain-conforming to provide a stable platform in almost all locations. Since most components are nonmoving (except for the path-selection mirrors – M1, M2, M3 and M4), the system can withstand mechanical stress without affecting performance.

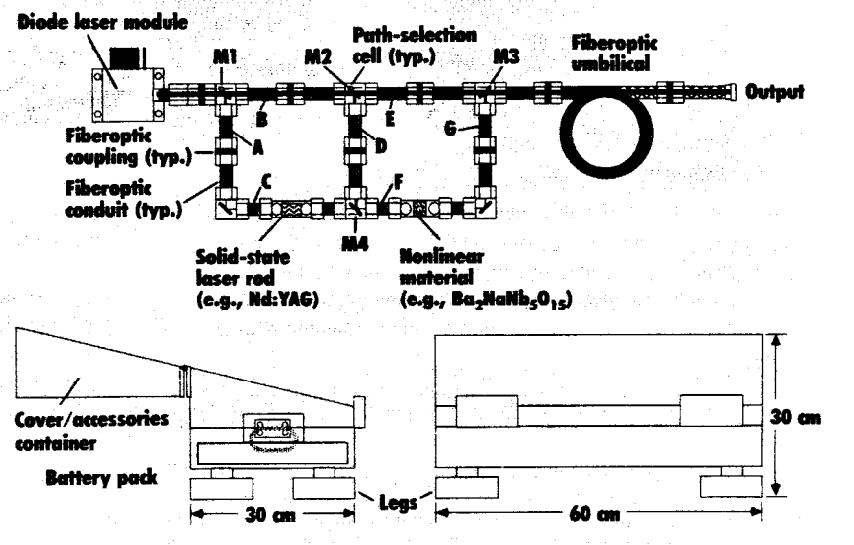
A second key feature is the exclusive use of optical fibers to route the light to various components. By using fiber-coupling spheres, most of the potential misalignment problems with cavities, pumping paths and other optical items can be avoided while coupling the greatest amount of light into the components.

Another factor is the encapsulation of the various components of the system. This greatly reduces the replacement time in the field, eliminates the need for precise alignment, and reduces maintenance difficulties. Some components serve dual purposes, as in the case of the frequency doubler/modelocker, where the material of choice is barium sodium niobate ($Ba_2NaNb_5O_{15}$, sometimes called "banana"). This material can be used in a passive mode for frequency doubling or in an active mode, by applying an rf field, for modelocking. Solid-state laser crystals other than Nd:YAG can obviously be used, although limitations can include such mechanisms as losses through interfaces and fundamental laser pump power.

Performance

The system is powered by a flat-pack battery cell, capable of supplying 5 V at 20 A. Although rated at an hour of continuous operation, realistic runtimes are 45 minutes or less, to accommodate the discharge characteristics of sealed-lead batteries.

Since the control and power management circuitry is CMOS type, the current drain – excluding pump laser essentials – is relatively insignificant. Most of the power drain not related to laser pumping stems from the acousto-optic driver and the control indicators. Miniature, high-energy capacitors are used for such infrequent functions as activating the path-selection mirrors for



Optical diagram and system configuration of POMELS.

Mode	Wave length (nm)	Pulsed or CW	Pulse Width	Pulse Energy (max)	Rep. Rate
1	810	Both*	*	n/a	*
2	405	Both*	*	n/a	*
3	1064	Both*	*	n/a	*
4	532	Both*	*	n/a	*
5	1064	Pulsed	25 ps	18.4μJ	45.1 MHz

*Same dynamics as the pump laser

changing wavelengths.

Different wavelengths are emitted when the appropriate path-selection cells are activated to route the pump light to the required component(s). The table lists the various operational modes; the accompanying figure depicts the system.

When the system is set to operate in Mode 1, all the path-selection cells are open; the pump laser's light (about 4.5 W at 810 nm) passes through segments B and E and emerges through to the fiberoptic umbilical for application.

When the system is set to operate in Mode 2, the pump laser's light transits segments BDFG and emerges through the umbilical at 405 nm.

When the system is set to operate in Mode 3, the pump laser's light is sent through the Nd:YAG (or other) solid-state crystal along path segments ACDE and emerges through the fiber-optic umbilical at 1.064 μm.

When the system is set to operate in Mode 4, the pump laser's light is sent through the Nd:YAG crystal, then through the (passive) $Ba_2NaNb_5O_{15}$ frequency doubler and then through the umbilical for application. The path segments ACFG are transited in this mode.

Mode 5 is, in terms of path routing, identical to Mode 4. However, in this case, an rf driving field converts the $Ba_2NaNb_5O_{15}$ crystal into a mode-locker. Here, the output is a train of 25-ps pulses at 1.064 μm, at a repetition rate of 45.1 MHz and a pulse energy of nearly 20 μJ per pulse.

The POMELS system, in this configuration, is geared for several remote sensing and remote spectroscopy applications. With higher-powered diode lasers becoming more widely available (and ultimately more inexpensive), the preliminary design for general surgical use may be realized within a few years. *L&O*

Scott Wohlstein is president of SD Laboratories, Convent Station, N.J.

EDITORIAL EVALUATION

Circle number on Reader Service Card
I found this department:

Very Useful	Useful	Not Useful
Circle 322	Circle 323	Circle 324