# Diode-Pumped High-Power cw Nd:YAG Lasers

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## ABSTRACT

Diode laser side-pumped, cw Nd:YAG rod lasers operating at pump powers up to 1.1 kW will be reported on. In multimode operation at 1064 nm, output powers of more than 300 W cw are observed. Higher pump powers up to several 100 W/cm can be achieved by using fiber-coupled diode lasers as pump sources.

## 1. INTRODUCTION

Diode-pumped solid-state lasers operating at high cw power levels are attractive sources for various applications in materials processing and laser based metrology, because of their reliable and highly efficient operation and lifetimes in the range of several 10.000 hours. Low power end-pumped solid-state lasers have demonstrated their superiority compared to lamp-pumped lasers for many years [1,2]. But power scaling possibilities of end-pumped configurations are limited because of the thermally-induced stress fracture of the laser materials [3]. Therefore, the transverse pump geometry has to be used for output powers beyond 100 W cw [4].

This contribution reports on the realization of high power diode laser side-pumped Nd:YAG lasers in rod geometry. As pump sources linear diode laser arrays as well as fiber-coupled diode lasers are used. The laser performance and power scaling of the side-pumped Nd:YAG rod lasers at an emission wavelength of 1064 nm will be discussed.

## 2. ND:YAG ROD LASERS SIDE-PUMPED WITH LINEAR DIODE LASER ARRAYS

Our first approach to high power systems was based on the application of linear diode laser arrays. A detailed description of the experimental setup has been published elsewhere [4]; hence, we

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only mention some essential features here. A sketch of the pumping arrangement is shown in Fig. 1. The laser rod (diameter: 5 mm, length: 220 mm, Nd-doping: 0.9 at.%) is mounted inside a flow tube, which is antireflection coated at 808 nm, for direct water cooling.

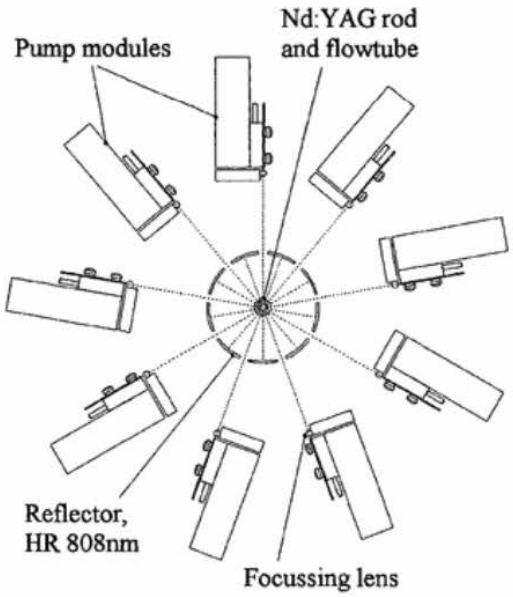


Fig.1. High power Nd:YAG rod laser, side-pumped by 108 diode lasers.

The optical pump source consists of 108 linear diode arrays (Jenoptik Laserdiode JO LD 10L) with a nominal output power of 10 W each at 808 nm. For each pump module, 6 diode lasers with similar emission wavelengths are selected. Each diode laser is attached to a copper heatsink. The radiation of the diode lasers of each module is imaged into the laser rod by an antireflection coated cylindrical lens (diameter: 3 mm, length: 80 mm).

Eighteen pump modules are arranged in a nine-fold symmetry around the laser rod yielding a total pump power of 1100W at the rod. Pump light reflectors are mounted around the rod opposite each pump module in order to reflect back transmitted diode laser radiation into the active medium.

The output characteristics of the side-pumped rod lasers at the laser wavelength of 1064 nm are investigated in a short, linear planar-concave resonator with a highly reflecting mirror at a radius of curvature of 5000 mm. A maximum output power of 300 W is achieved at the maximum pump power corresponding to a pump power at laser threshold of 190 W, and an optical slope efficiency of 32 %. The wallplug efficiency is determined to about 7 %, the beam parameter product to approximately 30 mm·mrad. In an 800 mm long, symmetrical resonator with flat mirrors, a beam parameter product of 5 mm·mrad is obtained at an output power of 200 W cw. This radiation can be efficiently coupled into an optical fiber with a diameter of 100 µm and 0.1 numerical aperture (NA).