atom cloud was ~ 120 μK for a laser detuning Δ_L = -3.5Γ and an axial field gradient of ~13 G/cm. Fig. L.7.2 shows the images of the atom cloud at intervals of 1 ms during free expansion.

(Contributed by: S. C. Mehendale, scm@cat.ernet.in)

L.8 Highly efficient diode-side-pumped CW Nd:YAG laser

We have developed a highly efficient Diode-pumped CW Nd:YAG laser generating 195W of output power in multimode operation for the diode pump power of 423W. This corresponds to an optical-to-optical efficiency of 46% and the electrical-to-optical efficiency of 23%. This is to the best of our knowledge, the highest electrical-to-optical efficiency reported for a CW diode side-pumped Nd:YAG laser. The system consists of a Nd:YAG rod, a gold-coated flow tube and three diode pump modules. The Nd:YAG rod is 4mm in diameter and 0.9 at.% Nd-doped with finely ground barrel surface. The rod is surrounded by a gold-coated, 10mm outer diameter flow tube for water-cooling. Each diode pump module consists of three 50W water-cooled 1-cm diode laser bars (Model JOLD50-CANC-1L). The diode laser radiation is polarized >95% parallel to the fast axis.

The flow tube has gold coating on the outside surface with three narrow windows of 1.5mm width, over its length. Diode pump modules are located 0.5mm in front of the center of 3-fold symmetric windows to couple the diode beams into the flow tube. The temperature of water for cooling the diode bar is set to 19.5°C, where the center wavelength of the diode modules is about 805.4nm at maximum driving current. Although the center wavelength deviates from the absorption peak of the Nd:YAG laser medium (808.5nm), the output power is maximum due to wing-pumping method. In this method peak diode emission wavelength is set near the edges of the peak absorption line of Nd:YAG to take advantage of better pumping uniformity over the cross-section of the laser rod.

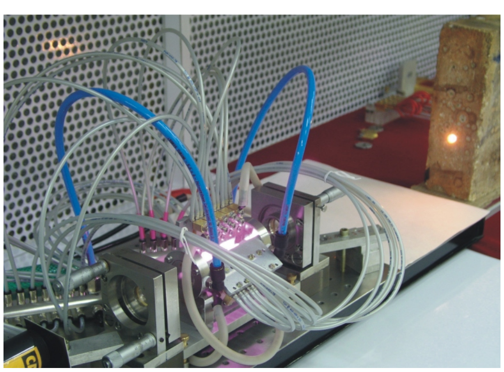

Fig. L.8.1

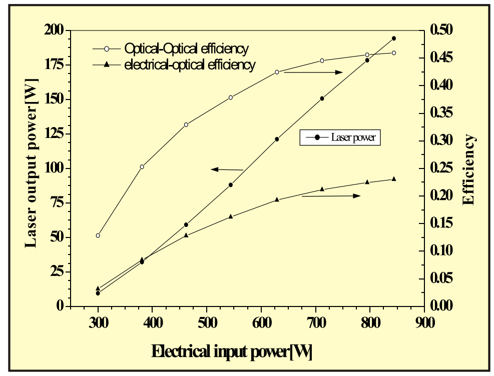

Fig. L.8.2

The output performance of the side-pumped Nd:YAG laser is investigated in multimode operation using plano-concave symmetric resonator with 5m ROC mirror with 12% transmission as output coupler. The cavity mirrors are separated at a distance of 125mm. Figure L.8.1 & L.8.2 show the system photo and characteristics of the output power and efficiencies versus input electrical pump power. The pumping efficiency has been measured by pump power leakage analysis method and it is found to be more than 94%. The pumping efficiency is defined as the ratio of the power absorbed by the rod to the total diode pump power. The high efficiency of the system can be attributed to wing-pumping method resulting in uniform pump light distribution and better pumping efficiency due to p-polarized pump beams.

(Contributed by : T.P.S. Nathan; nathan@cat.ernet.in)

L.9 Compact efficient intracavity frequency doubled Nd:YAG laser producing 30W average green power

High average power green beam at 532 nm are useful for many basic research studies, industrial and medical applications. Such sources can be realized by intracavity frequency doubling in a Q-switched Nd:YAG laser. We have developed a compact linear cavity for intracavity green generation as shown in Fig.L.9.1. The cavity was a plane-plane resonator stabilized by the thermal lensing effect. The rear mirror (M1) is highly reflecting at the fundamental wavelength. The flat end mirror (M2) is highly reflecting at the fundamental wavelength and highly transmitting at the second harmonic wavelength at 532 nm. The mirror M2 was coated directly on the KTP surface. The other surface of the KTP crystal (M3) was coated highly reflecting at the second harmonic wavelength and highly transmitting at the fundamental wavelength in order to retro reflect the green beam that generated in the backward direction. The reason for coating mirrors on the KTP crystal was to minimize the intracavity loses to its absolute minimum value since the efficiency of intracavity second harmonic generation decreases rapidly with the increasing intracavity losses.

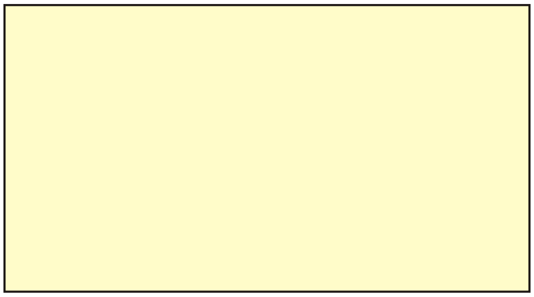

Fig. L.9.1

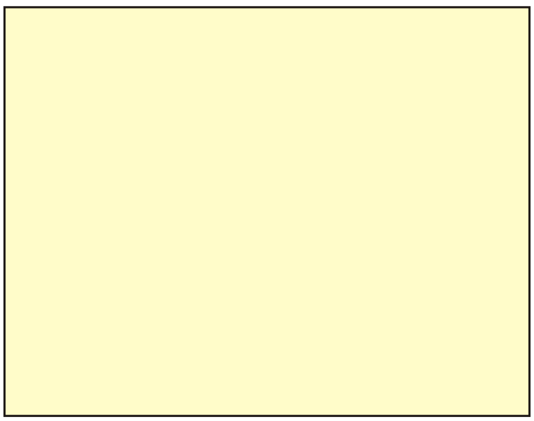

Fig. L.9.2

The KTP crystal was 10 mm long and was cut for type II phase matching. It was kept within a water-cooled jacket to maintain its temperature within ± 0.2 ^{o}C so that the polarization is preserved in order to avoid back conversion and to obtain stable operation. The pump head consists of a 60 mm long Nd:YAG rod (4 mm diameter) with 0.6 at.% Nd^{3+} doping concentration enclosed with in a gold coated flow tube. The rod was pumped transversely by six number of laser diodes with total emitted power of 180 watts. The detail of the pumping geometry is described earlier. The laser was Q-switched with the help of an acousto-optic modulator with 17 kHz of repetition rate. The total cavity length is only 15.8 cm. The output green power increases linearly with the incident diode power and show no sign of roll over (Fig. L.9..2). At the maximum incident pump power of 174 W, 30.1 W of average green power was obtained corresponding to 17.3 % optical to optical conversion efficiency. The pulse width was measured to be 165 ns. Further effort to reduce the pulse width by changing the cavity configuration is going on.

(Contributed by: T.P.S. Nathan; nathan@cat.ernet.in)

L.10 200mW SLM green laser at 532nm using ICSHG technique

We have developed a compact SLM green laser with more than 200mW of output power at 532nm by diode end-pumping a semi-monolithic and a-cut $Nd:YVO_4$ crystal with 2-at-% doping concentration and 1.0mm thickness. The $Nd:YVO_4$ crystal was provided with adequate heat sinking and was end pumped using a fiber coupled laser diode with 100μm core diameter and the focus spot-size at the gain medium was 117μm. The cavity was plane-plane geometry stabilized by the pump induced thermal lens in the gain medium. A type-II phase matched and one side coated KTP crystal with 3x3x7mm length was used to produce 532nm by intracavity SHG of 1064nm. A home-built high stability temperature (Stability < 20mK) controller was used to adjust the temperature of the KTP crystal and hence the wave plating effect of 1064nm, when it makes a round trip inside the KTP crystal. A 2mm thick Brewster plate was kept with its transmission axis at 45^{0} to the fast axis of the KTP crystal, but parallel to the c-axis of the $Nd:YVO_4$ crystal.

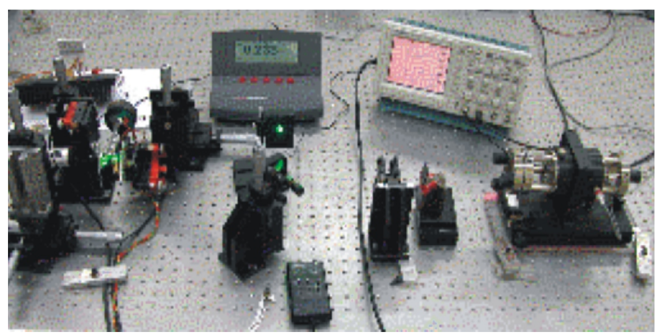

Fig.L.10.1 *Experimental Setup of fiber coupled laser diode end pumped SLM green at 532nm operating at 235mW green power.*

The combination of temperature controlled wave plating of KTP crystal along with loss discrimination offered by the Brewster plate and the short absorption depth of $Nd:YVO_4$ crystal provided SLM operation. The system operated in SLM with 207mW of output power at a pump power (Laser Diode) of 1.1W, when the KTP temperature was adjusted to be 35.50^{0}C. We confirmed SLM by analyzing the leaked 1064nm laser beam with the help of a scanning plane-plane Fabri-Perot Interferometer.

(Contributed by: T.P.S. Nathan; nathan@cat.ernet.in)