L.11: Modular pump head design for diode-side-pumped Nd:YAG laser

A modular pump head was designed, fabricated and tested for diode-side-pumped high power CW Nd:YAG laser at SSLD. Previous pump head designs were non-modular and do not support flexibility in orienting pump diodes with respect to the active medium.

Modular pump configuration comprises of three pump diodes loaded on a disc with suitable diffused reflector to reflect the pump light. This forms a fundamental building block, shown in Fig L.11.1, which consists of three pump diodes kept at 120° with respect to each other. Pump light from the diodes were coupled to the laser rod through a window of approximately 1 mm wide formed near the joining of two Spectralon reflectors. Number of such disc's required to make a pump head is decided by the length of the active medium and that of the laser diode. Attractive feature of this design is that the disc can be oriented at any angle with respect to the previous and the subsequent discs, which facilitates in pumping the active medium in different configurations.

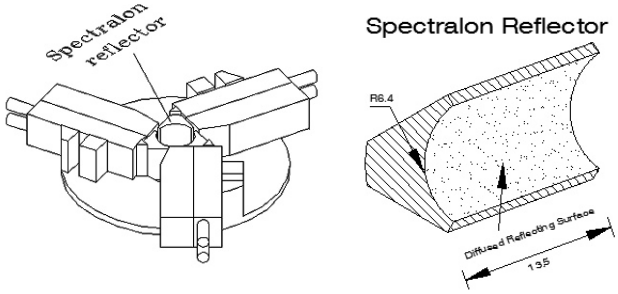
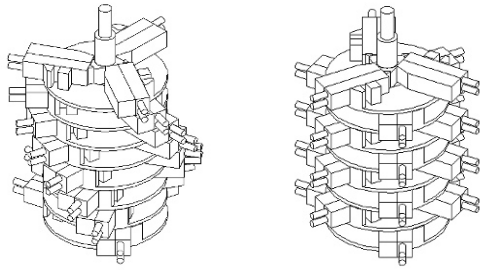


Fig L.11.1: Fundamental building block and diffused Spectralon reflector

Three schemes were tried in which successive discs are rotated by 15°, 60° and 0° forming helical (HC), sixty degree rotated (SDR) and linear configurations (LC) respectively. Nd:YAG rod of ϕ6 x150 mm, 0.6% doping was pumped by 8 discs containing 24 pump diodes with a total pump power of 1.8 kW. Fluorescence and laser profiles, thermal lensing, output power and beam propagation factor (M^2) were monitored to identify the optimum configuration. Figures L.11.2 (a) & (b) shows the HC and SDR configurations.

Fluorescence profile (Fig L.11.3) were flat top like and Gaussian like for SDR and HC configuration respectively irrespective of pump power, whereas, LC showed flat profile at low pump power but became Gaussian like at high pump powers. Thermal lensing recoded was ~ 5D/kW to 5.25D/kW for all configurations.



(a) (b)

Fig L.11.2: (a) Helical and (b) Sixty Degree Rotated configurations

Output power and M^2 parameters were measured for three different resonator lengths (RL) namely 220, 330 and 440 mm. RL of 220 mm did not show much difference in output power and M^2 values for all configurations. At RL of 330 mm, HC showed saturation of output power at 1.4 kW pump power, hence HC scheme was discontinued for higher RL. For 440 mm RL, the output power and M^2 values were better for SDR geometry.

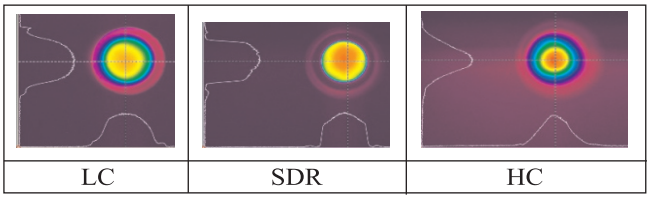
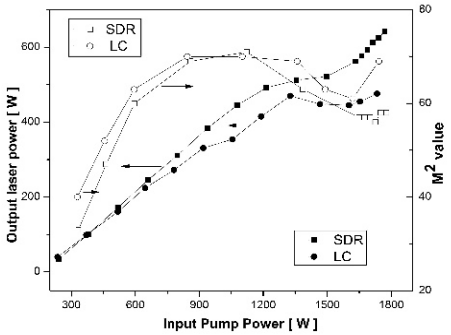


Fig L.11.3: Fluorescence profiles recorded at 1kW for LC, SDR & HC

Figure L.11.4 shows the input Vs output power and input Vs M^2 values for SDR and LC types at RL of 440 mm. Output power of 640 W and M^2 value 58 was recorded with SDR, whereas LC delivered 475 W output power at M^2 value of 69. The higher output power and low M^2 value from SDR pump head can be attributed to flat top like fluorescence profile at high pump powers. SDR type pump head clearly out-performed the other two configurations.



L.11.4: Input Vs output and Input Vs M^2 for the SDR & LC configurations at RL 430 mm.

Reported by:
R. Sundar (sundhu@rrcat.gov.in), K. Ranganathan, K. S. Bindra