L.1: Development of 150 W high brightness (M^2 ~19) solid state green laser

Diode Pumped Solid State (DPSS) green laser operating at 532 nm with high output power (> 100W) and high beam quality ($M^2 < 20$) is required for various applications like processing of high reflectivity materials like copper or silicon, pumping of Rh6G based dye lasers /amplifiers and long distance dazzling in defence applications. To address the growing need for such high power and high brightness green laser beam a bench top DPSS green laser system is developed at the Solid State Laser Division of RRCAT producing more than 150 W of average power with M^2 parameter less than 20.

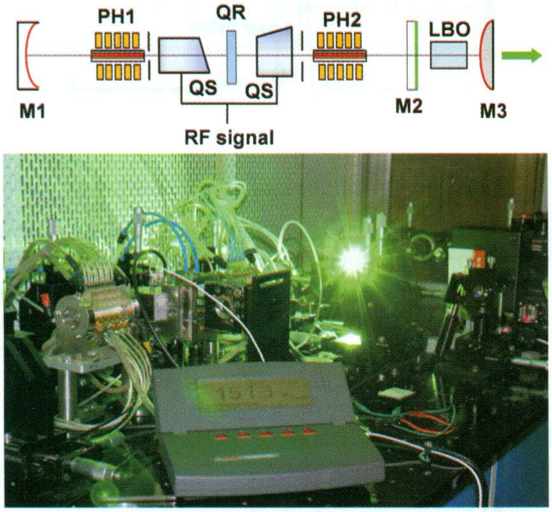

Fig.L.1.1: Schematic (top) and photograph (bottom) of high power high brightness DPSS green laser

The laser arrangement is shown schematically in the top of Fig.L.1.1. The laser consists of a linear resonator with two pump heads (PH1 and PH2), to couple the pump diode beams to the Nd:YAG rod, a nonlinear crystal for intracavity frequency doubling, two acousto-optic modulators (QS1 and QS2) for repetitive Q-switching, a 90° quartz rotator for birefringence compensation. The indigenously designed and developed pump heads have identical geometry with a specified optical pump power per gain module of 750W. Numerical simulations were carried out to calculate the optimum separation between the two pump heads, the rod dimensions and doping concentration as well as the diode-pumping geometry so as to generate a nearly flat-top transverse gain profile with low thermal lensing. A 90° quartz rotator was placed in between the two pump heads for the compensation of the thermally induced birefringence in the laser rod. For second harmonic generation (SHG), a 18 mm long LBO crystal cut for type-II phase matching at room temperature was used. Two orthogonally oriented AO modulators were placed between the pump heads for repetitive Q-switching of the laser at 20 kHz. The laser resonator was a concave-convex linear high finesse cavity at 1064 nm designed to obtain a large mode area at the gain medium and a tight spot size at the LBO crystal for efficient second harmonic generation as well as to obtain good beam quality. The output is taken through the mirror M3 which was antireflection coated at 532 nm.

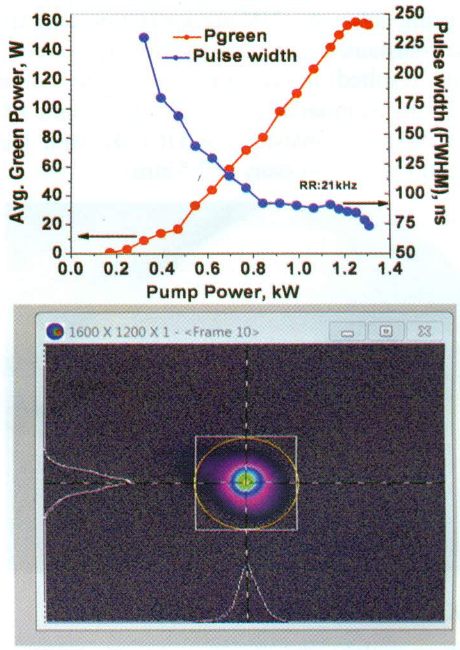

Fig.L.1.2.: Variation of the output average green power and pulse duration as a function of the pump power (top). A recorded spatial profile of the green beam from the laser at 150W of output power.

The performance of the DPSS green laser is shown in Fig.L.1.2(top). The red circles represents the average green power at 20 kHz and the blue circles are the corresponding full width at half maximum (FWHM) of the green pulse as a function of the total pump power. A maximum average power of ~159 W at 532 nm was obtained at 20 kHz of repetition rate with power instability of 1.5% over seven hours of continuous operation and a green pulse duration (FWHM) of ~73 nsec.The laser also showed excellent repeatability in the day to day operation.

The recorded spatial profile of the green beam at the maximum operating pump power is shown at the bottom of Fig..L.1.2. It can be seen that the beam profile is circular in shape with less than 5% difference in spot size for the horizontal and vertical direction of the beam and the M^2 –parameter was ~ 19. With further optimisation the M^2 could be improved to ~14 with some reduction in the output power (~130W).

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