Record efficiency Nd:YLF passively Q-switched laser

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The development of high-power Q-switched lasers with short pulse duration of less than ten nanoseconds showing a high degree of power scalability whilst maintaining diffraction limited beam quality and high repetition rates is still a major field of research among laser developers. Among the most common resonator designs are the longitudinally diode-pumped laser, which shows some restrictions with respect to power scaling of the TEM_{00} mode due limited access of the pump beam to the resonator mode, and the diode-side-pumped laser that usually suffers from small overlap between the fundamental mode and the pump laser and therefore, generally has poor beam quality and/or low efficiency during fundamental mode operation. There are only a few designs that allow for efficiency and power scalability of the TEM_{00} mode employing a side-pumping configuration, the most successful design being de grazing incidence laser developed by Damzen et al. In this letter we present a new laser design based on a side pumping configurations that employs a 1 mol% doped $Nd : YLiF_4$ slab in a double-pass configuration. The design allows power scalability of the TEM_{00} mode without the insertion of any additional mode-selective devices into the resonator. The resonator achieves single transversal mode by well calculated screening of the inverted population inside the crystal by the two passes of the fundamental mode in such a manner that any higher order mode encounters insufficient gain to oscillate. We achieve record qcw-efficiency in excess of 50 % using a 20 % output coupler. By using a $Cr^{4+} : YAG$ saturable absorber inside the laser cavity and a 40 % output coupler we were able to obtain Q-switched laser pulses of the order of 10 ns with up to 2.5 mJ at 1053 nm.