Pulse-to-Pulse Power Analysis using Descriptive Statistics in a Nd:YAG Passively Q-switched Resonator

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The Nd:YAG Laser, Q-switched and side-pumped by diode semiconductor is widely studied in the scientific area since it is an excellent source of short and high-energy pulses that are attractive to many physical applications like LIBS-LIDAR systems and many others.
Although this laser system is widely used in many applications because of its efficiency, small size and low cost, the set-up has many difficulties regarding pulse-to-pulse stability. Specifically when passively q-switched and wavelength-doubled to 532 nm using a non-linear crystal for second harmonic generation, this instability can hamper greatly the application. The main reason for this amplitude jitter is the non-birefringence of YAG and the plane-plane resonators normally used in conjunction with high-power solid-state lasers.
A scientific analysis of this instability is normally treated in literature by monitoring the output power as a function of time in a y-t diagram that varies either over a series of pulses or, in some cases, a couple of hours [1-3].
Our work shows a fast and efficient methodology to estimate the degree of power stability of a Laser resonator operating in the Q-switched regime observing statistical fluctuations of pulse area. The pulse energy information is then retrieved through the integral of this area in time.
To confirm the validity of our method, we realized the characterization of a plane-parallel Nd:YAG Laser operating in 532 nm. This characterization was realized in two parts: first without quarter-wave plate, and then, with the plate. The application of a quarter-wave plates is a widely explored issue in scientific papers for pulse-to-pulse energy-stabilization. The standard deviation of the pulse area histogram with the quarter-wave plate exhibits an order of magnitude smaller jitter and this fact can be used to develop a new stability criteria in pulsed Laser systems.

References

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