

240-GHz smoothly tunable single-frequency Nd:YVO₄/LBO laser

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This work presents for the first time development of a CW single-frequency Nd:YVO₄ laser with intra-cavity frequency doubling and a uniquely broad output frequency tuning range of 240 GHz around 532 nm. The presented laser's layout is shown in Fig. 1.

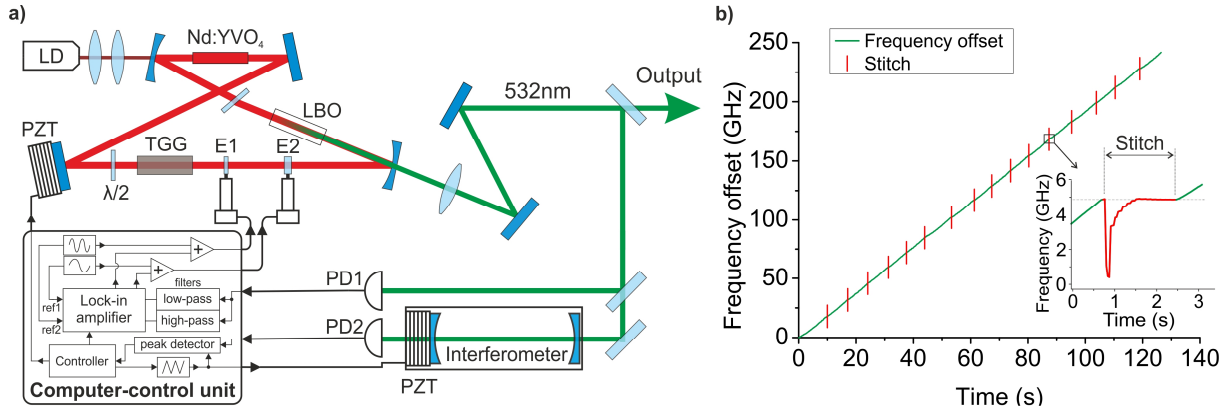


Fig. 1. (a) Schematic layout of the fiber-coupled end-pumped Nd:YVO₄/LBO laser: LD - fiber-bundled laser diode, E1, E2 – galvanometer-controlled solid étalon, PD1, PD2 – photodiode, PZT - piezoelectric multi-layer actuator; (b) Frequency tuning trace of the laser output.

A 808-nm laser diode is used to pump the laser's active element through a fibre with a 400- μ m core. Generation of the second harmonic happens in a non-critically phase-matched LBO crystal, producing a TEM₀₀ output green beam. Output power of the Nd:YVO₄ laser at 532 nm exceeds 1.4 W, the radiation line width falling within 5 MHz.

Selection of a single generation frequency and control over its spectral position is carried out by two actuated solid Fabry-Pérot étalons, and spectral "stitching" of consecutive continuous tuning ranges is done with an external scanning confocal Fabry-Pérot interferometer featuring spectral resolution better than 5 MHz. This report provides a detailed description of the algorithm used in the presented Nd:YVO₄ laser to automatically control its frequency selectors and to ensure automatic scanning of the laser output frequency across an ultra-wide spectral range. One of the remarkable features of this algorithm is that it requires neither a wavelength meter nor any calibration for normal operation. Moreover, the proposed algorithm is applicable in many CW diode-pumped solid-state (DPSS) lasers (Nd:YAG/YLF/YAP, Yb:YAG/LuAG, and others) with analogous ring cavity configuration ensuring single-frequency operation both at the fundamental radiation frequency and at the frequency of the intra-cavity second harmonic radiation.

Proposed and successfully implemented in this work, the new advanced method of «stitching» several continuously scannable ranges of laser output frequency allowed an order-of-magnitude increase in continuous output frequency scanning range without "stitching" compared to analogous Nd:YVO₄/LBO lasers [1] and a corresponding six-fold increase in smooth continuous scanning range with "stitching" [2].

The present work also discusses ways to achieve even broader smooth tuning range of the second harmonic radiation of Nd:YVO₄ lasers reaching ~500 GHz. These new opportunities of broad-range tuneability of both Nd:YVO₄ and analogous DPSS lasers, which until recently were considered as predominantly "single-wavelength" sources, brings these lasers within the realm of broadly and precisely tuneable sources of radiation. Relatively large continuous tuning range of such lasers may be efficiently extended into various spectral domains through parametric transformation, thus opening for them many applications relying on powerful tuneable lasers.

References

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- [2] D. Radnatarov, S. Khripunov, S. Kobtsev, and V. Lunin, "High-power CW single-frequency Nd:YVO₄/LBO laser quasi-continuously tuneable over a wide frequency range," *Proc. SPIE*, 9135, "Laser Sources and Applications II", 91350F (2014).