# Quasi-cw Nd:LiYF$_4$ blue laser

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***Abstract***

*A high power Nd:YLF blue laser operating in a quasi-CW regime, using second harmonic generation of the 908 nm Neodymium transition, provided about 5.5W peak power at 908 nm and 3.5W at 454 nm.*

***Keywords-component; Nd:YLF; blue lasers; diode pumped lasers***

## I. Introduction

Blue lasers have been considered a fundamental tool for many applications, allowing for real white light laser displays, high-density data storage and other complex scientific applications. Amongst the blue laser obtained by second harmonic generation (SHG) of the three level transition $^4F_{3/2}$-$^4I_{9/2}$ in neodymium doped crystals, a deeper blue emission at 451.5 nm and 454 nm can be achieved with yttrium-lithium-fluoride (Nd:YLiF$_4$), which is a well known birefringent laser media whose emission lines for the σ-polarization and π-polarization are at 908nm and 903nm, respectively [1]. In addition, its very week thermal lensing due to the combination of a negative index lens and positive end face bulging is an additional advantage for laser application.

## II. Laser Setup and Characterization

A 3x3x10 mm$^3$ 0.7at% Nd-doped YLF crystal was pumped by a fiber coupled diode laser emitting at 806nm using two doublets (focal length of 5cm and 20cm, Figure 1) that provided a focus spot size of 450μm inside the crystal. A concave-plane linear cavity of 4cm length with a 100mm curved mirror provided the optimum overlap relation between pump and laser mode radius. The laser was operated using 2ms long pulses and 3% duty cycle.

The optimum transmission at the fundamental 908nm emission was determined by introducing an intracavity Brewster window that was tilted in order to provide different reflectivities.

The second harmonic generation was obtained by introducing a 3x3x15 mm$^3$ BiBO crystal (type I - critical phase match) near the flat mirror where the laser mode was the smallest, Figure 1.

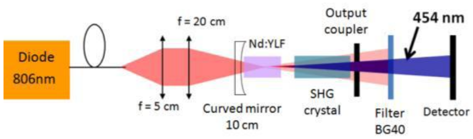


Figure 1. Blue Nd:YLF laser setup

## III. Results and Discussions

A transmission of 2.5% was found to be optimum and a maximum output power of 5.5W corresponding to a slope efficiency of 33.6% was achieved. See Figure 2.

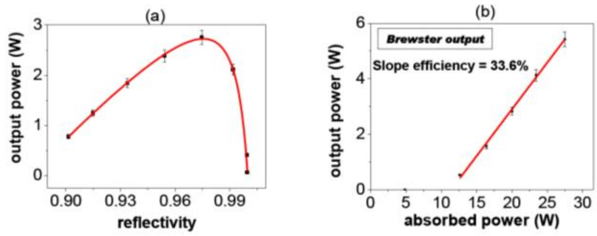


Figure 2. (a) Output power versus reflectivity and (b) output power versus absorbed power.

The blue emission obtained was 3.5W at 454nm, corresponding to a conversion efficiency of 13.7% (Figure 3a). Previous theoretical studies [2] showed that the maximum output power possible in the visible should be as high as the fundamental output power using the optimum transmission. The limitation in the blue emission in this work is attributed to the large laser mode radius inside the doubling crystal that decreases the conversion efficiency and the small effective conversion efficiency of BiBO.

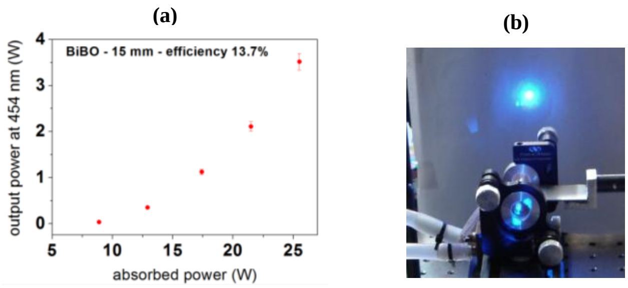


Figure 3. (a) Blue output power curve and (b) the blue laser.

The qcw blue output power of 3.5 W obtained in this research is the highest reported so far.

## References

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[2] R. Smith, "Theory of intracavity optical second-harmonic generation", IEEE Journal of Quantum Electronics QE-6, 215-223(1970).