

HIGH REPETITION RATE DUV-NIR TUNABLE FEMTOSECOND LASER SYSTEM

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The growing demand for high-power, high-repetition-rate femtosecond laser systems arises from their potential to enhance signal-to-noise ratios and acquisition speeds in scientific and biomedical imaging [1-3]. However, the fixed central wavelength of most solid-state femtosecond oscillators limits their versatility. To address this, we present a pre-chirp managed rod-type Yb-doped fiber amplifier system [4] capable of generating tunable wavelength femtosecond pulses through optical parametric amplification (OPA) and nonlinear harmonic generation.

The developed OPA, based on two LBO stages pumped with 30 W of second-harmonic signal and seeded with a broadband supercontinuum from a KGW crystal, delivers tunable wavelength output from 675 nm to 2.2 μm with sub-70 fs signal and sub-100 fs idler pulses. The total output power exceeds 11 W - the highest reported for femtosecond OPAs at a 76 MHz repetition rate - with excellent stability ($\sim 1\%$ RMS) and low relative intensity noise (RIN) across the 1 kHz – 40 MHz bandwidth.

Further wavelength extension of femtosecond laser system is achieved through down-conversion of initial 1030 nm wavelength radiation to second (SH), third (TH), and fourth (FH) harmonic signals in BBO crystals, producing up to 41 W, 17.7 W, and 2.3 W of average power with conversion efficiencies of 60 %, 26 %, and 3 %, respectively. Generated harmonic signals exhibit nearly Gaussian shaped spatial intensity distribution with M^2 value lower than 1.3 and $< 1\%$ RMS long term stability over 10 hours of continuous operation.

This versatile, high-power, tunable femtosecond laser source offers new opportunities for applications such as stimulated Raman scattering microscopy, ultrafast spectroscopy, and deep-UV imaging with enhanced spatial resolution.

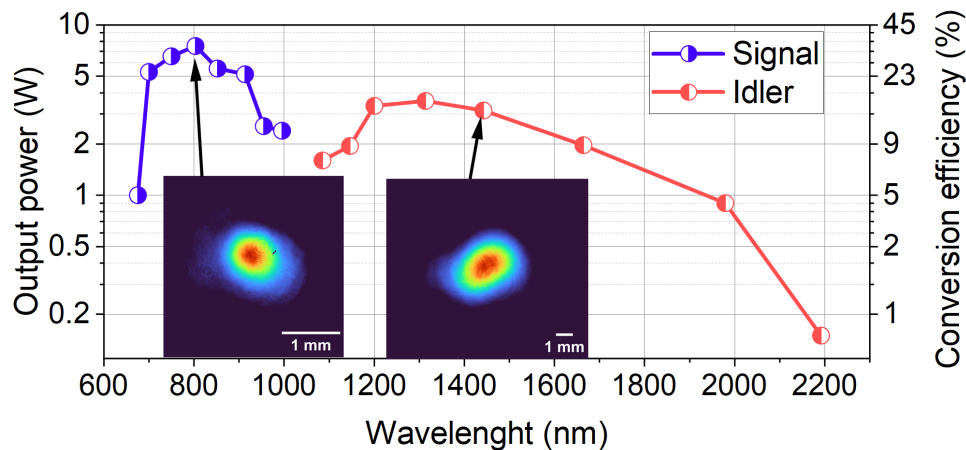


Fig. 1. Average output powers of 76 MHz LBO OPA signal (blue) and idler (red) waves as function of wavelength. The right y-axis displays conversion efficiency in OPA2 stage. The inset shows the near-field profiles of signal wave at 800 nm and idler wave at 1450 nm.

Keywords: Optical parametric amplifier, third harmonic generation, fourth harmonic generation, femtosecond pulses, fiber amplification.

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