Distribution in the UK & Ireland

Lambda

Characterisation, Measurement & Analysis

Lambda Photometrics Limited
Lambda House Batford Mill
Harpenden Herts AL5 5BZ
United Kingdom
E: info@lambdaphoto.co.uk
W: www.lambdaphoto.co.uk
T: +44 (0)1582 764334
F: +44 (0)1582 712084

DIRECT CPA-FREE PULSE AMPLIFICATION

In the ever-evolving landscape of photonics, the seamless integration of ultra-low noise seeders and high-performance amplifiers has become paramount for unlocking new frontiers in research and industry. This application note explores the capabilities of Menhir Photonics advanced laser technology and neoLASE amplifier systems, designed to deliver unprecedented power and energy scaling providing flexibility, and reliability for applications in nonlinear **frequency conversion**, **supercontinuum generation**, and **material processing**.

We describe here how the MENHIR-1030 seeder can be easily amplified using a neoLASE neoYb pre-amplifier and main-amplifier module. An average power of 11 W in a single-stage and up to 55 W in a double-stage configuration is achieved. We find that the low intensity noise of the pulse train and the high beam quality of the seeder are well conserved. Additionally, we demonstrate frequency conversion via SHG to the visible at 515 nm with high efficiency > 50% and up to 6.5 W of average output power.

Menhir Photonics' product strengths

Excellent passive power and beam stability

Robust and reliable turnkey system

neoLASE's product strengths

Compact amplifiers, high single-pass gain

Low nonlinearity, CPA-free amplification

Free-space or fiber-coupled modules

Application use case

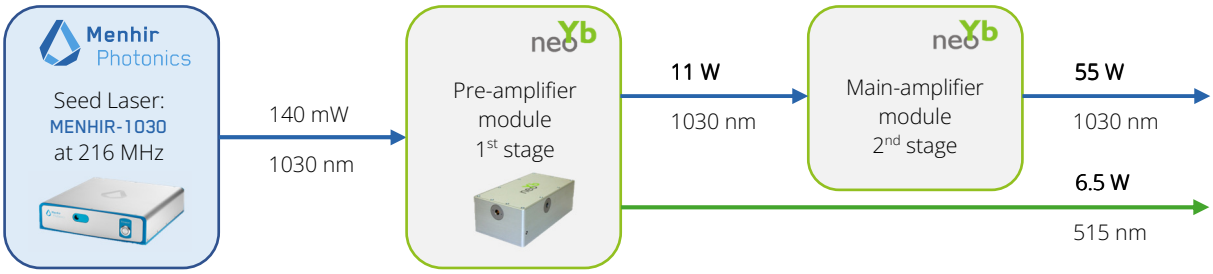

Figure 1 — Amplification scheme. The MENHIR-1030 seed laser is amplified in the 1st pre-amp stage. This output can be converted to green or further amplified in the 2nd main-amp stage.

Single-stage amplification

The MENHIR-1030 seeder used in the following demonstration operates at 216 MHz repetition rate, with more than 100 mW output power, and sufficiently large spectral bandwidth to provide transform-limited 200-fs pulses. Together with the plug-and-play neoLASE neoYb amplifier, this system enables turnkey operation. The amplifier system is optimized for modular use according to customer-specific needs and features CPA-free boosting of pulse energy and average output power.

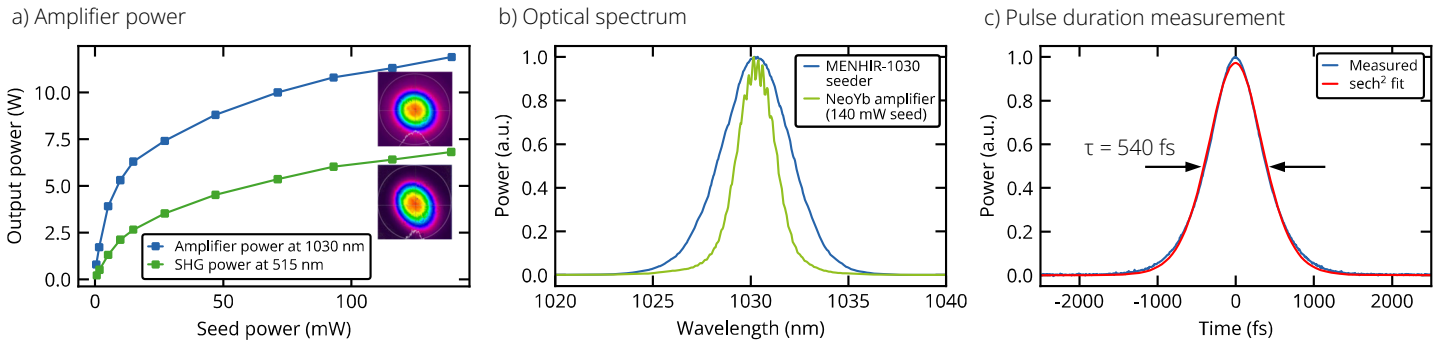

Figure 2 — Amplification results. a) Average power vs. seed power for the IR output at the seed wavelength of 1030 nm and optional frequency-doubled SHG output at 515 nm. b) Optical spectrum of the seeder and the amplifier at different seed powers. c) Pulse duration measurement at the highest power of more than 11 W with highest seed power. The measurement shows a sech² pulse duration of 540 fs.

Figure 2 summarizes the amplified pulse train characteristics after the first amplifier stage. An average output power of more than 11 W can be reached at a maximum seeder power of 140 mW while keeping the pump power in the amplifier constant. We measure an excellent beam quality at maximum power with 96% ellipticity and an $M^2 < 1.1$. Figure 2b illustrates the expected gain-narrowing effect originating from the acceptance bandwidth in the amplifier. At highest seeder input power (blue), the largest bandwidth is obtained which allows for transform-limited pulse durations below 500 fs. We measure a slightly chirped sech² pulse duration of 540 fs in Figure 2c using an autocorrelator. The analysis of the relative intensity noise (RIN) indicates that the amplifier conserves the outstanding low-noise properties for the seeder. We measure < 0.1% RIN when integrated from 10 Hz to the shot-noise level at 1 MHz. A pulse energy of more than 50 nJ is achieved in this single-stage amplification scheme.

Frequency conversion and second-stage amplification

Key advantages of the system's modularity are demonstrated by frequency conversion and further amplification. Up to 6.5 W power at 515 nm wavelength is easily achieved while maintaining excellent beam quality. Using a second main-amplifier stage, as depicted in Figure 1, the average power can be boosted to more than 50 W. Scaling the power to the 100-W level will be possible by an additional amplifier module as well as CPA-free energy scaling up to 50 µJ by reducing the seed repetition rate.

Related products

MENHIR-1030 seeder		neoLASE neoYb	
Repetition rate	80 MHz – 2.5 GHz	Typical input power	1 – 100 mW (pre-amp) 1 – 10 W (main-amp)
Average power	> 100 mW	Typical output power	5 – 15 W (pre-amp) 30 – 60 W (main-amp)
Central wavelength	1030 +/- 5 nm	Beam Quality	TEM_{00}, $M^2 < 1.3$
Spectral bandwidth at -3 dB	> 5 nm	Pulse duration	< 900 fs