Advanced Optical Technology Ltd

Technical Note (5)

ACE Short Pulse MOPA Products

In November 2002, AOT launched the first of their new short pulse MOPA (oscillator + amplifier) laser products. These operate to > 1W average power, are based on Nd:YVO4 and the specifications can be found on the company's Internet site: www.AOTLasers.com. The product launch followed a detailed investigation by the company of the relative merits of high power oscillators and MOPA systems for user applications at power above that of the ACE oscillator products.

In our initial trials, summarised in Technical Note (3), 'High Average Power ACE Laser Performance', we noted that our unique resonator design allowed higher pump power to be used to raise oscillator output. We reported 1064nm power to 1W at 20kHz, and 80µJ/pulse energy at low rep-rates, with a diode pump of 4-5W power. Our MOPA studies showed similar excellent performance with the same overall pump power, but using two diodes pumping oscillator and amplifier modules, respectively.

In the year following this initial work, AOT carefully studied the merits of the two high power laser formats and firmly came to the view that MOPAs offered the best performance and reliability for customer applications. Key drivers behind this decision were the need of excellent beam quality across the power range for most applications and the proven reliability of current ACE laser oscillators with current performance power diodes.

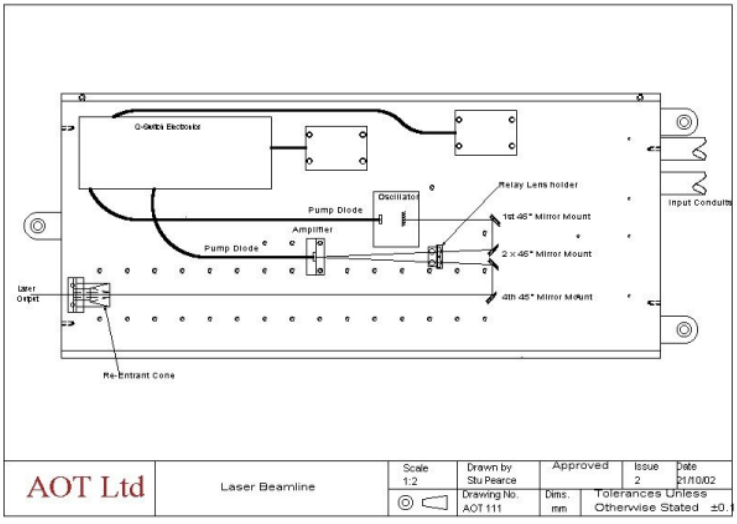


Fig (1)

The new MOPA products have a simple compact format providing easy use together with the customer option of 'drop-in' higher harmonic modules, similar to the ACE oscillator range. A schematic of the MOPA optical layout is shown in Figure (1). Of note is that the double-pass amplifier gain module and pump arrangement are of design similar to that in our life-proven ACE oscillator.

We have carefully designed the beam relaying through the MOPA system to allow high gain and power extraction from the amplifier without excessive power loading on any of the optical components. As a result, the amplifier achieves a small signal gain of around x10 and delivers a very high extraction efficiency (similar to the oscillator) under operating conditions. Figure (2) below shows test data collected from two pre-production AOT-YVO-3Q-HRR/MOPA units. It can be seen that the oscillator average power (and therefore pulse peak power) is doubled by the amplifier across the rep-rate range.

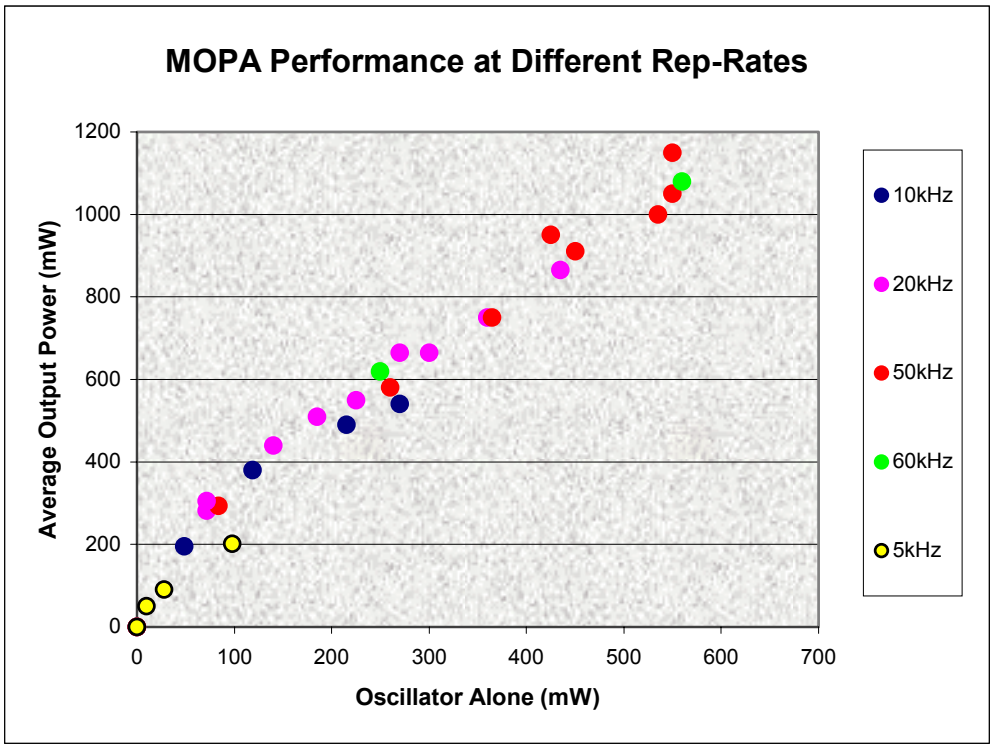
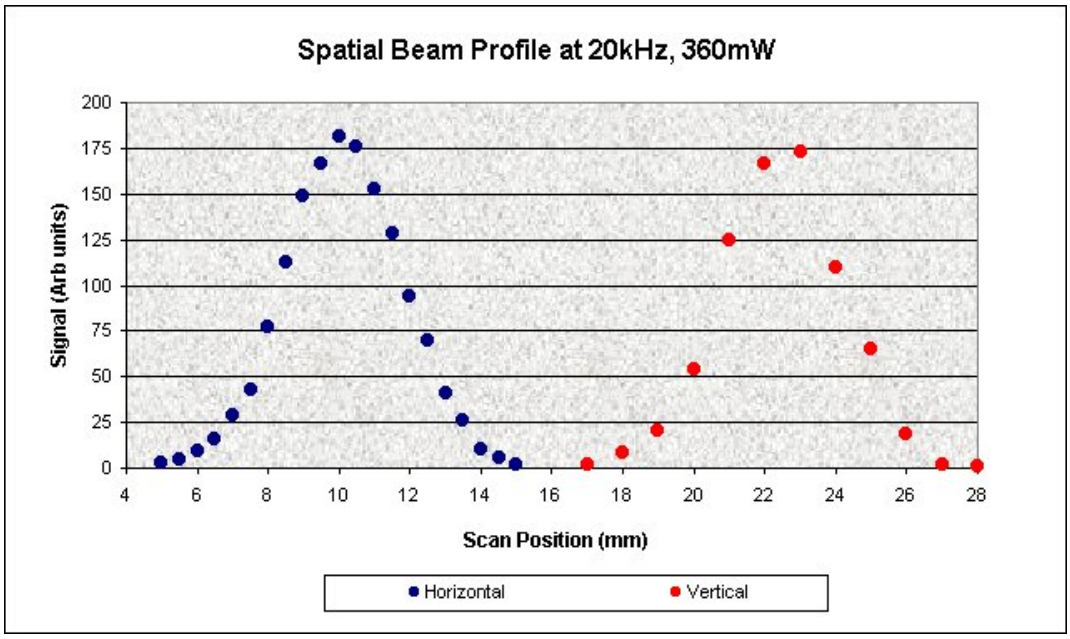


Fig (2)

The amplifier characteristics in the MOPA laser are well matched to the incoming TEMoo beam and preserve the excellent oscillator mode quality after amplification. Many measurement of the spatial profile (obtained using a detector behind a small pinhole scanned across the beam) confirms this over the MOPA laser operating power and rep-rate range. As an example, Figure (3) below shows data for two different power levels at 20kHz from one of the prototype lasers.



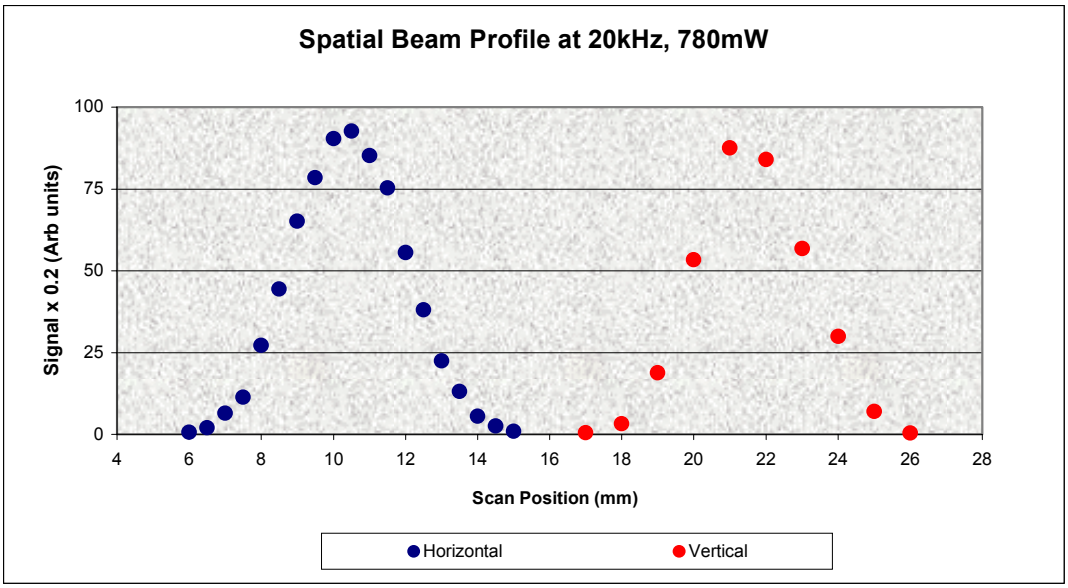


Fig (3)

The MOPA laser spatial scans show that the beam profile is insensitive to the laser power level. In figure (3) the horizontal and vertical scan widths (TEMoo mode I/e^2 intensity points) were the same to 1-2% in each case. The measured full angle beam divergence was 5.0mrad at 360mW and 4.6mrad at 780mW i.e. the MOPA laser beam waist size changed by < 10% for a x2 power change.

The MOPA laser is designed to operate at high efficiency (i.e. with the amplifier saturated), and results show that this has little effect on the laser pulse duration. Figure

(4) below records the effect of oscillator rep-rate on the FWHM pulse width from one of the prototype MOPA lasers. The results are very similar to those of the oscillator operating alone.

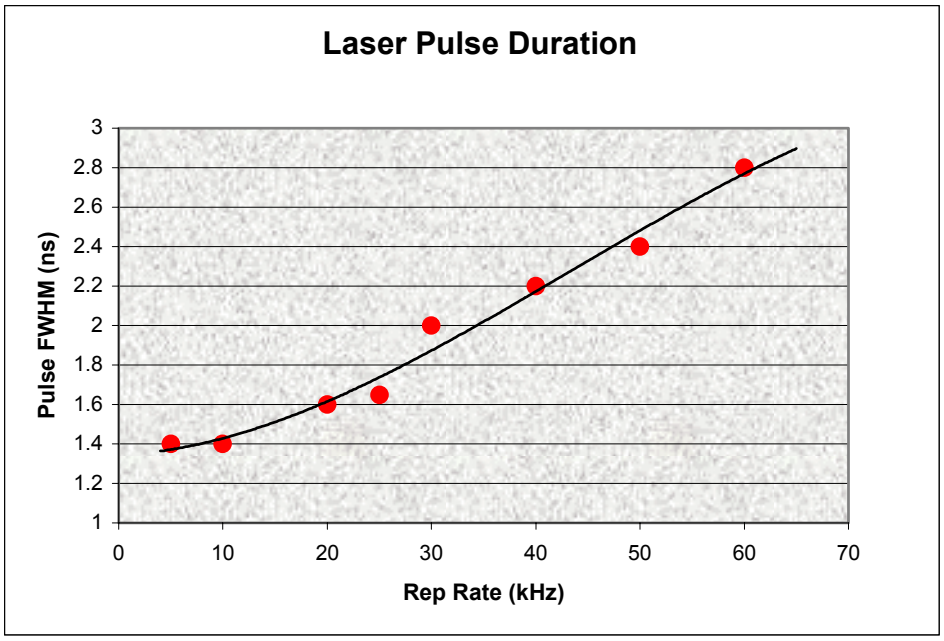


Fig (4)

High beam quality and peak powers are required for good harmonic efficiency. The MOPA format, which doubles pulse peak power and maintains good TEMoo mode quality, is ideal for achieving high conversion efficiencies. We have investigated 532nm operation with a range of different cut KTP doubling crystals with a view to selecting a single arrangement for the MOPA products that gives good power performance over the full rep-rate range. Figure (5) below shows that, with the optimised harmonic arrangement, 532nm energy to 25µJ/pulse at low rep-rates and 400mW average power for a significant part of the operating range, are achieved.

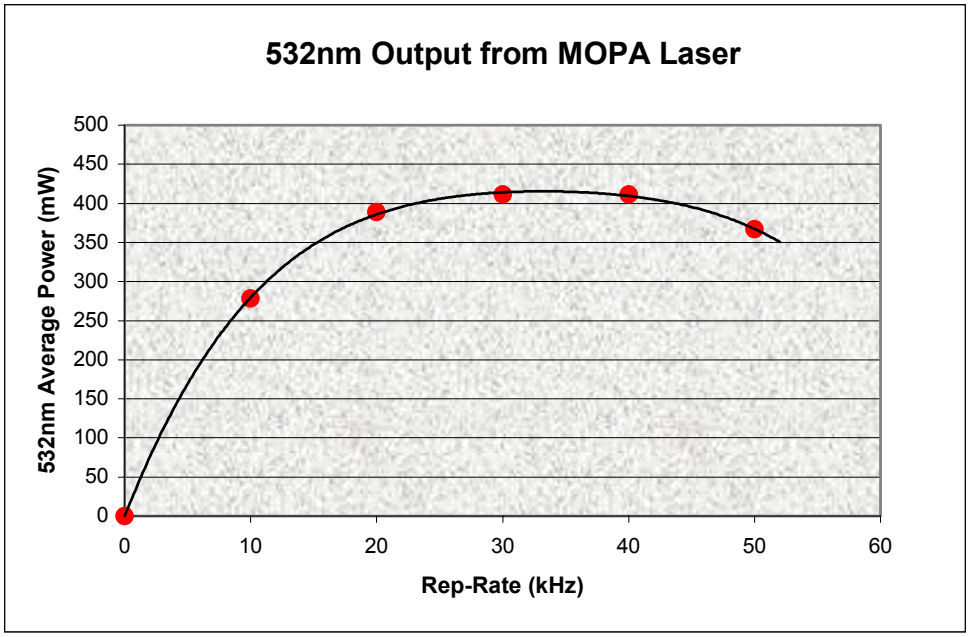


Fig (5)

Work is on-going at AOT to characterise performance at higher harmonics (i.e. 355nm and 266nm) to similarly provide optimised performance at these wavelengths across the MOPA laser operating range. The work, when complete, will result in further product harmonic options.

In some key applications, overall equipment efficiency is important e.g. because of limited available source power or a requirement to minimise dissipated heat. This requirement has been a guiding consideration in the design of all AOT short pulse products, including the MOPA lasers. We have taken care to adopt energy efficient design in all aspects of the product and this has resulted in even the higher power MOPA models (AOT-YVO-2QSP-HRR/MOPA and AOT-YVO-3Q-HRR/MOPA) having a low (~ 80W) maximum wall-plug power requirement.

14 November 2002
AOT Ltd