Advanced Optical Technology Ltd

Technical Note 14

Towards Short Pulses at > 100kHz Rep-Rates

Introduction

A number of users have applications that would benefit from the availability of short Q-switched pulses at very high repetition rates. The applications are diverse. They span some specific fine materials processing applications through to use of the laser as an illumination source for very high speed photography. As a result, AOT has initiated a development programme to explore the practicality of a reliable > 100kHz short pulse product based on our ACE laser technology proven at lower rep-rates.

Oscillator Trials

The starting point for the work has been a Nd:YVO oscillator, similar in a number of respects to those of our SP range. The unit has been modified and adapted to allow > 100kHz operation. We have conducted a preliminary characterisation of the new oscillator in our R&D laboratory. Figure (1) below shows the recorded pulse duration as a function of repetition rate over the range 50-350kHz.

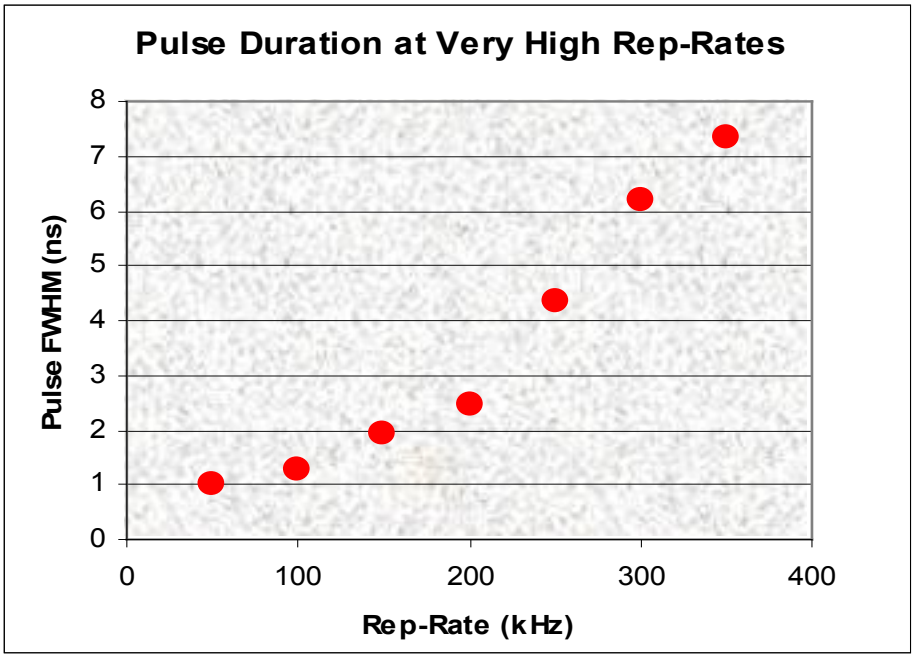
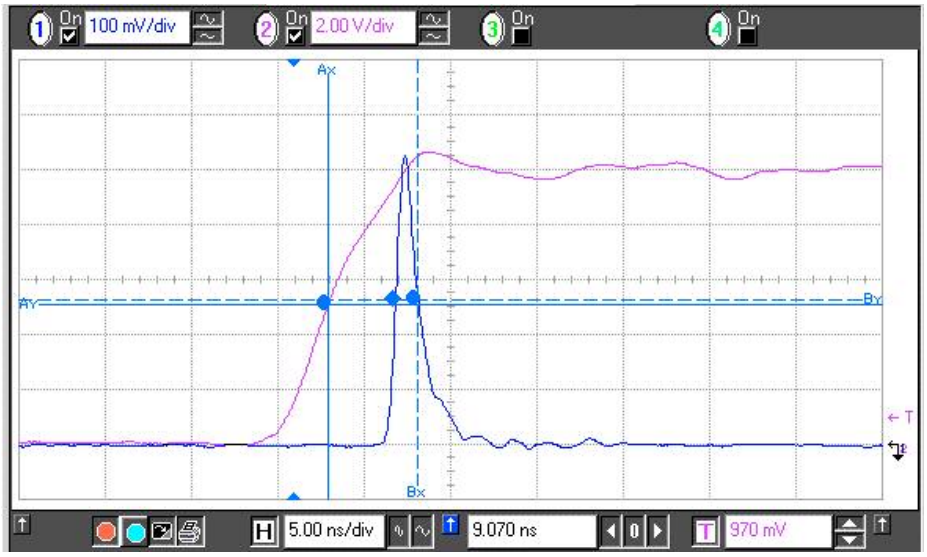
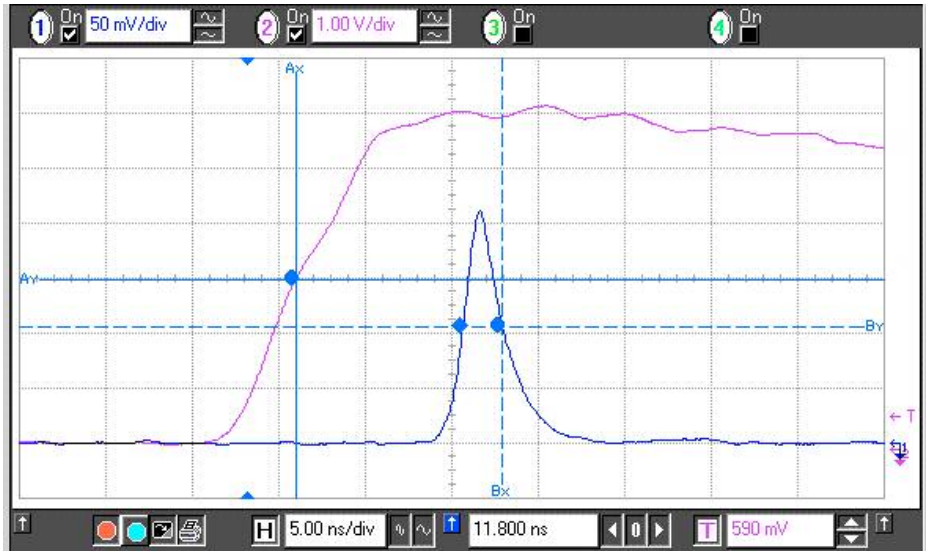


Figure (1) FWHM pulses duration of developmental oscillator at very high rep-rates. Average power from the oscillator was in the range ~ 500-750mW, depending on rep-rate.

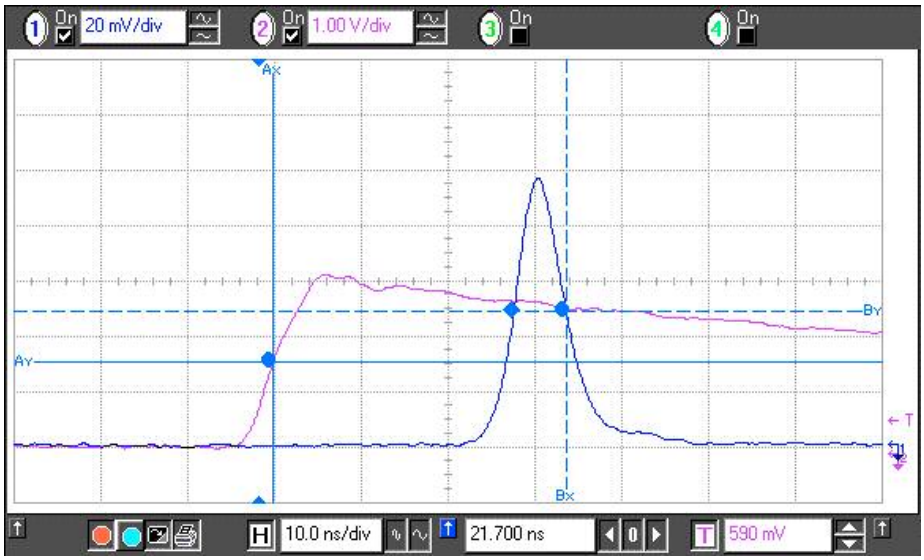
Across the rep-rate range of the trial, the temporal pulses were well formed. Figure (2) shows examples of the shapes at 100kHz, 200kHz and 300kHz. The pulses were recorded with an InGaAs diode + oscilloscope combination of ~ 1.5GHz bandwidth.



(a)



(b)



(c)

Figure (2) Pulse temporal shapes at; (a) 100kHz, (b) 200kHz and (c) 300kHz, where pulse FWHM values were 1.3ns, 2.5ns and 6.2ns, respectively. Initial step (from Q-switch monitor) was used as a timing reference for the oscilloscope.

The oscillator TEMoo beam quality at > 100kHz did not deteriorate significantly and compared well to that of the standard resonators at lower pulse rates. The oscillator allowed a best harmonic conversion to 532nm in KTP of ~ 40%, and over 200mW in the 100-200kHz range.

MOPA Trials

Further initial experiments were undertaken with the developmental oscillator coupled to a standard AOT amplifier. The power scaling was modelled and, as expected, the arrangement allowed the average power at 1064nm to be efficiently more than doubled to ~ 1700mW. With the MOPA in this format, conversion to 532nm in KTP remained good, providing a power of > 700mW at 150kHz and > 500mW at 250kHz. Pulses at the second harmonic shortened so that at 250kHz, they were ~ 3.1ns FWHM duration (cfi ~ 4.3ns at 1064nm).

Figure (3) shows the 532nm far-field beam from the MOPA running at 250kHz and giving ~ 475mW. The beam full angle implies a waist diameter at the KTP of ~ 56um and (in the low conversion limit) of the order 80um for the 1064nm pump. The latter value is consistent with the 0.5x demagnification used for the 1064nm pump beam following the amplifier.

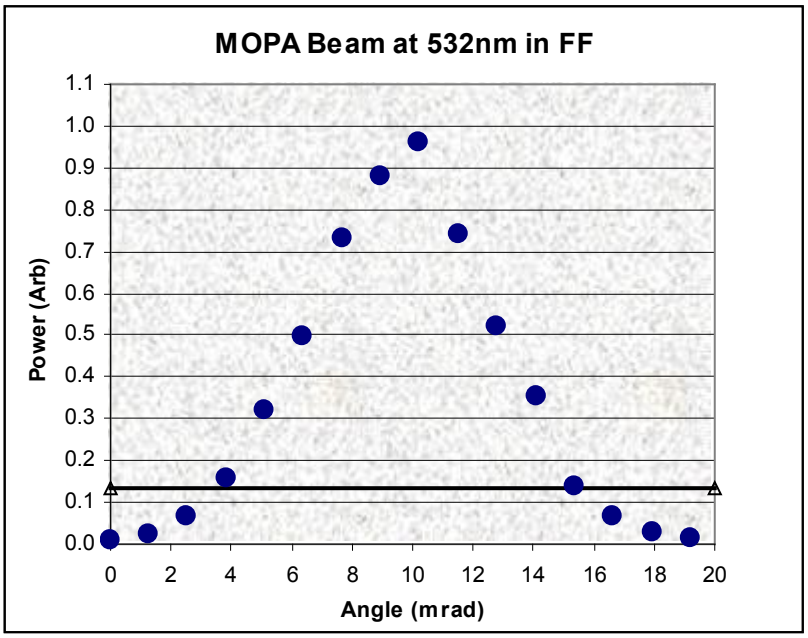


Figure (3) Far-field 532nm beam from the KTP doubling crystal at 250kHz. In this example, the MOPA was operated at ~ 1500mW and produced ~ 475mW at 532nm in ~ 3.1ns pulses.

Summary

Our preliminary study has shown that > 100kHz pulse performance can be achieved from ACE laser technology whilst maintaining a short pulse duration, high pumping efficiency and a good TEMoo beam quality. In the next 2-3 months, AOT will complete the development study preparatory to introducing new very high rep-rate laser products later in 2006.