Advanced Optical Technology Ltd

Technical Note 18

Short Laser Pulses at High Rep-Rate: January 2009

In Technical Note 14 we reported our initial investigation of short pulse generation to 100kHz and above. In the interim, we have developed a better understanding of the resonator parameters that control performance and can now offer customers 500ps - 1ns TEMoo pulses to at least 100kHz.

There is some trade-off between pulse duration and average power at high rep-rates, and we are able to adjust the resonator design to suit customer needs (See Refs 1 & 2 for resonator optimisation). For example, Fig (1) below shows the measured pulse duration (FWHM with a 1.5GHz 'scope and ~ 100ps photodiode) as a function of pulse energy for an SP resonator set-up to give the shortest (~ 500ps) pulses at 50-100kHz. The resonator achieved average power up to ~ 1200mW.

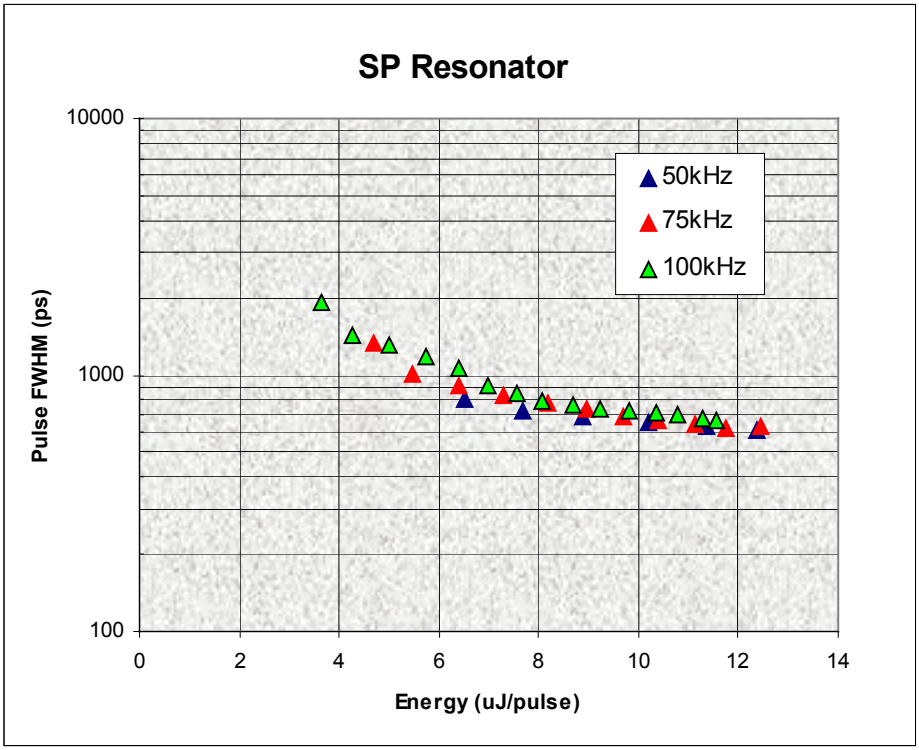

Fig (1) SP oscillator optimised for shortest pulses under high rep-rate operation.

In this case, the pulse durations were also recorded with ~ 20ps resolution using a high speed photodetector and sampling oscilloscope. Fig (2) shows the pulse shapes at 100kHz.

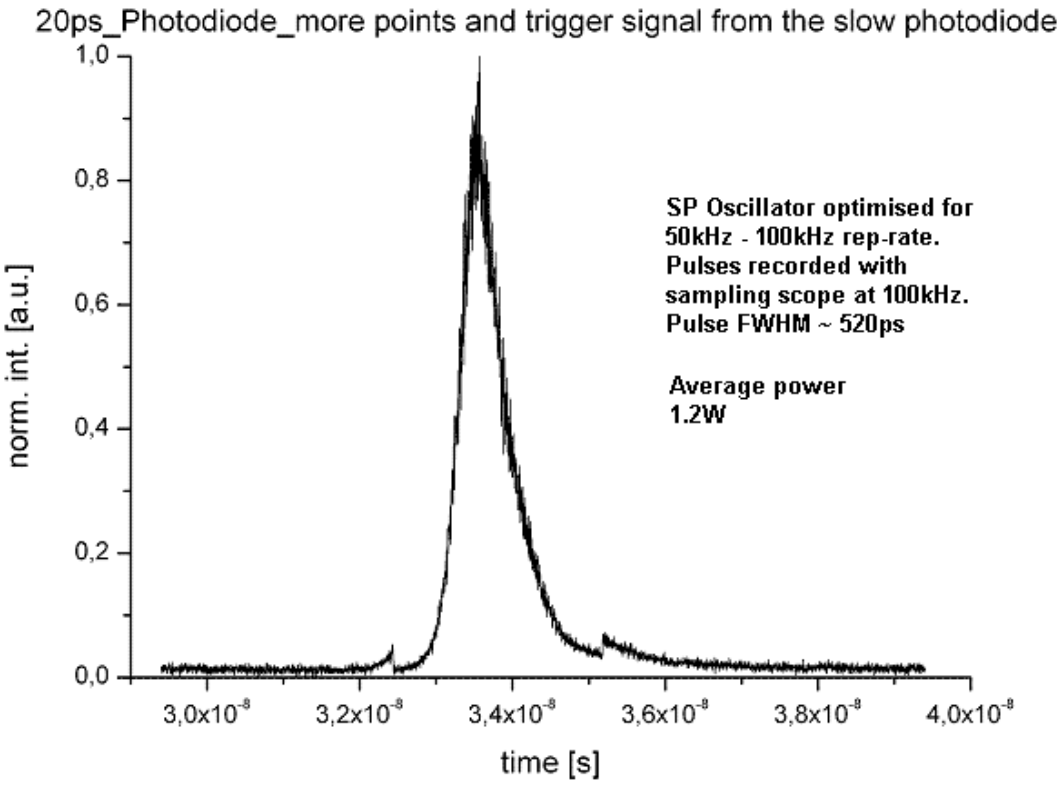

Fig (2)Pulses from SP Resonator at 100kHz and 1200mW

With our standard MOPA format (SP oscillator plus amplifier), these ~ 500ps high rep-rate pulses can be amplified to raise the average power to 3W. Fig (3) below shows MOPA results.

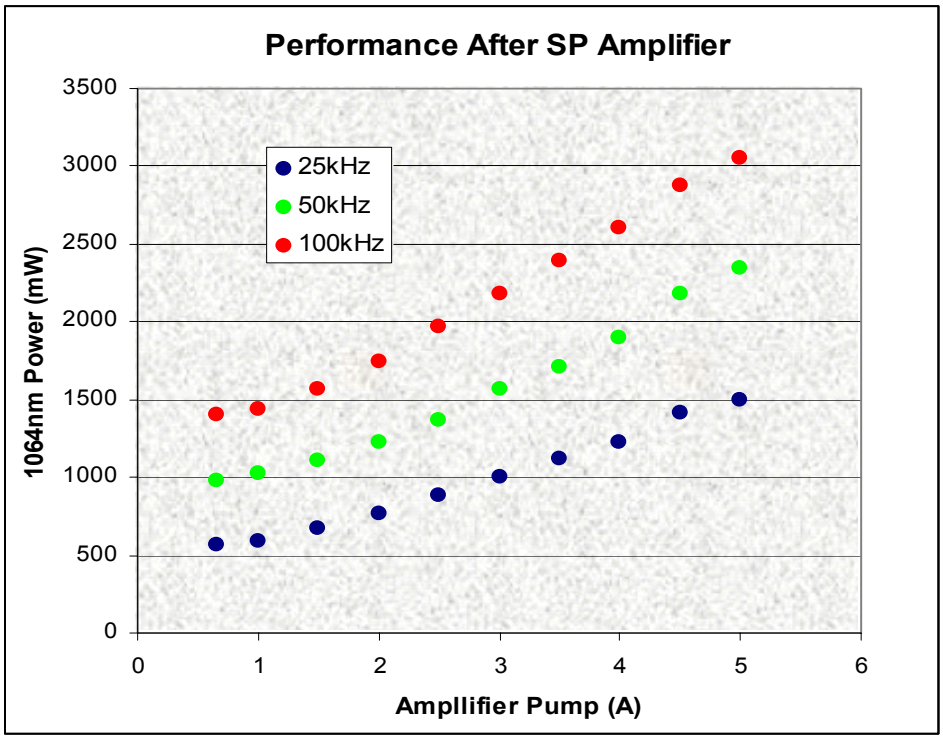

Fig (3) SP/MOPA Optimised for High Rep-Rate Operation

We find that the beam quality at these high rep-rates and powers remains excellent. Conversion to 532nm in length optimised KTP is typically a max of > 50% ie not significantly different to that of our models that operate at lower rep-rates and average powers. At 100kHz, greater than 1500mW @ 532nm is possible and, using LBO doubling and mixing crystals, > 750mW @ 355nm.

The above discussion has concerned our model SP oscillator set-up to deliver the shortest pulses (ie ~ 500ps) at high rep-rate. In the case where average power and pulse energy are important (ie users are less concerned with achieving the minimum pulse length), other trade-offs can be made. For example, a recent customer application required an oscillator-only solution (to be compact and economic) that gave TEMoo pulses at 100kHz and > 1.5W average power but still maintained a pulse length < 1ns. The optimised oscillator provided ~ 800ps FWHM pulses. Fig (4) below shows the oscillator test data.

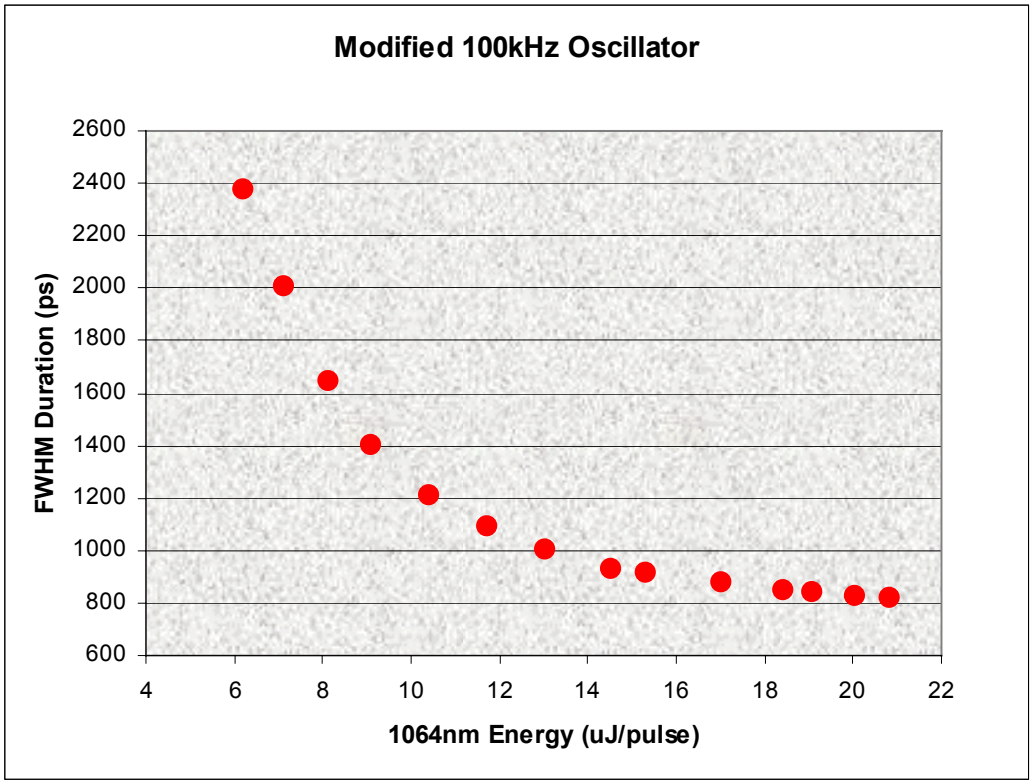

Fig (4) Oscillator optimised for high power at high rep-rate (producing 2W at 100kHz in ~ 800ps pulses)

The object of this short note has been to highlight to our customers and laser users that there is flexibility in the design and set-up of the resonators in our lasers. Some trade-offs can be made between key parameters ie rep-rate, pulse duration, pulse energy and average power without compromising beam quality and the ability to accurately trigger/synchronise the pulses. As a result, if the specifications of our standard models do not fully meet the requirements of your application, we invite you to contact the company and discuss specific needs.

References

1) 'Theory of the Optimally Coupled Q-Switched Laser', Degnan JJ, IEEE J Quantum Electronics, Vol 25, p214-20, (1989)
2) 'Maximum Peak Power Generation from Q-Switched Lasers', Ping Li, Qingpu Wang, and Da Gao, Optics & Laser Technology, Vol 31, p247-250, (1999)