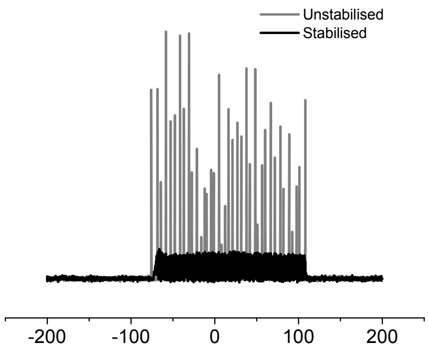
## Quasi-CW Laser Research

Institute of Photonics

The Institute developed the first >20W average output power $Nd:YVO_4$ laser system producing stable, high quality streams of picosecond duration pulses. From this system it was clear that thermal distortions induced by the very high heat loading was the limit to further power increments. Since that time our efforts have been focussed on overcoming these difficulties by a number of advanced laser-engineering techniques. Of these, the introduction of intra-cavity adaptive optic elements has been mentioned previously. The other two techniques attempt to overcome the issue of heat loading in two markedly different ways. The thin-disc crystal geometry (developed initially at Stuttgart) exploits the minimal distortion that is induced via one-dimensional heat flow in the crystal. And the quasi-cw pumping technique attempts to reduce the average heat loading to manageable levels whilst still producing record power/energy levels during the on-time of the laser.

Of these two techniques, the quasi-cw pumping scheme can be considered the most far-reaching, and especially the most challenging with regard to picosecond pulse generation. This technique basically eliminates thermal issues and the need for complex laser geometries by using a pump source that is modulated. In this way the average pump power can be significantly reduced, however, by using a large duty cycle, the laser output can still reach remarkably high levels. At first, the chopped nature of the laser output may seem undesirable, but for many applications this is exactly what is required. So, the philosophy behind the power scaling nature of the quasi-cw pumping approach is to only provide laser pulses when the application demands them, and in this way the power levels and energy of the pulses can be increased dramatically.

One serious drawback of the quasi-cw pumping approach with regard to ultrashort pulse generation using semiconductor saturable absorbers required to be solved before a useful output could be produced. The issue of stability and initiation of self-Q-switching becomes especially relevant when a modulated pump source is used. At the Institute of Photonics these issues have been addressed by the development and incorporation of an elegant opto-electronic feedback stabilisation scheme. Paradoxically electronic signals, derived from the laser output, are applied to an intra-cavity acousto-optic Q-switch to eliminate self-Q-switching and laser turn-on transients, and so stabilise the laser output. In this way, stable picosecond pulse trains with unprecedented power levels of 65-70W have been obtained. Further improvements are underway to extend these lasers to the 100W-1kW regime.




Unstabilised and stabilised picosecond pulse train from 1.3μm Nd:YALO laser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