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Digital control of a pulsed Ho:YLF ring laser

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<p>We have previously demonstrated a novel laser pulse energy control system based on two analog controllers to control a Q-switched Nd:YLF laser. We now present the improved technique based on a custom-designed high-speed FPGA (field programmable gate array) digital logic controller, together with experimental results from controlling a high-energy Ho:YLF ring laser.

Laser pulses of constant and predictable energies are required in most applications, especially materials processing, micro-machining and medical laser surgery. Furthermore, for these applications the time between individual laser pulses may be purposely varied, which result in significant pulse-to-pulse variations in energy. These variations can cause damage and/or non-uniform processing of optics and target materials.

Simultaneous electronic control of both an intra-cavity loss modulator (acousto-optic modulator) and the laser pump source (laser diode) provides the means to accurately stabilise and control the output pulse energy. This “dual loop” electronic feedback technique has been successfully demonstrated using two analog PID (proportional, integral and derivative) controllers. We have now implemented the control in a high-speed digital controller, adding several advantages in terms of computer programmability, flexibility and accuracy. The digital electronics consist of a FPGA processing unit (which can calculate programmed control algorithms at high-speed in parallel) sandwiched between high-speed analog-to-digital and digital-to-analog converters.

The digital dual loop pulse control system was connected to a custom developed 2 micron single-frequency Ho:YLF ring laser. Normally, injection-seeding and resonator-length control (based on the Pound-Drever-Hall technique) are used to achieve stable single-frequency pulsed operation. The digital pulse control system provided a less expensive and more compact method for stable operation, and could selectively produce between 15 – 45mJ pulses set via a computer control interface. The control could also maintain constant pulse energies (within 4.3

Level (Hons, MSc,
   PhD, other)?

PhD

Consider for a student
   award (Yes / No)?

No

Would you like to
 submit a short paper
 for the Conference
 Proceedings (Yes / No)?

Yes

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