A satellite laser ranging system based on a micro-chip laser

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Introduction

There has been constant demand on Laser Raging System that it should be not only high accuracy but also be compact, low power consumption and be robust from any environment such as in space. We have developed a micro-chip laser (MCL) that consists of a passive Q-switched Nd:YAG laser pumped by a fiber-coupled laser diode which can be used in the first generation of a compact satellite laser ranging (SLR) system. We focus on the pulse-timing jitter of the MCL. We report on the characteristics of the MCL and its integration with a current SLR system and also provide some preliminary results of experiments with our revised model. We are now developing a dynamic tracking system with a function of reducing the effect of timing jitter in the signal from a Q-sw laser to less than 1 μs.

Micro-chip laser

The preliminary version of our MCL is shown in Figure 1. The laser (Nd:YAG) and Q-sw (Cr:YAG) media are installed in a small package (200x150 mm, Figure 2). The MCL specifications are listed in Table 1. The pumping power is supplied by a fiber-coupled laser diode in another package.

Figure 1 Micro-chip laser

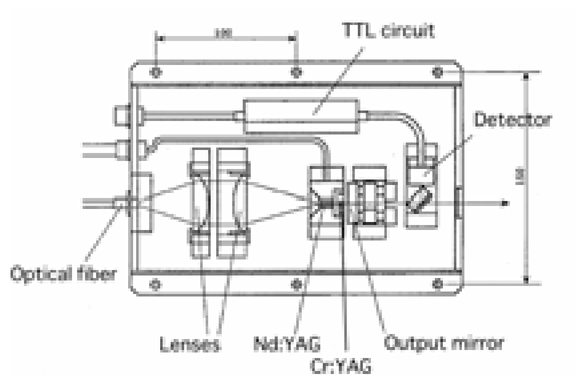


Figure 2 Layout of MCL head

Table 1 Specifications of MCL

Pump LD	wavelength	808 nm
Laser	medium	Nd:YAG (6 X 6 X 10 mm)
Q-sw	Type medium	Passive Cr:YAG (ϕ 4 X 2 mm)
Laser output	Wavelength Energy Pulse-width Mode Repetition rate Power consumption	1064 nm 300 +/- 30 μJ/pulse 2.3 ns TEM_{00} 20 – 100 Hz 60 W

Preliminary results

Figure 3 and Figure 4 show the new SLR system based on the MCL. In this system, the MCL is followed by a power amplifier (PA) and second-harmonic generator (SHG) that converts the laser's wavelength to 532 nm. The maximum output power level of this system is 8 mJ/pulse. We successfully got echoes from the satellite TOPEX using this system successfully (Figure 5).

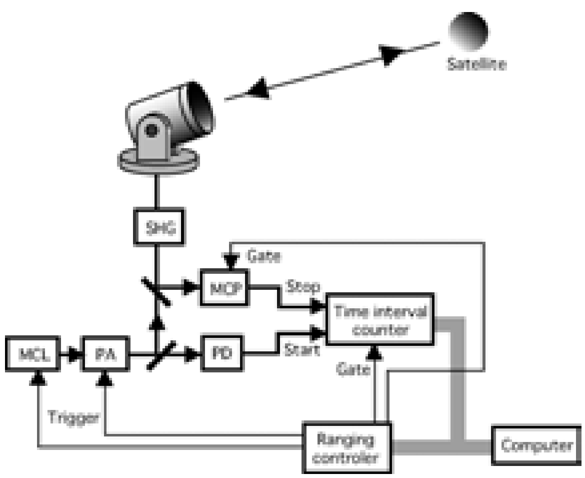


Figure 3 Block diagram of SLR system with MCL

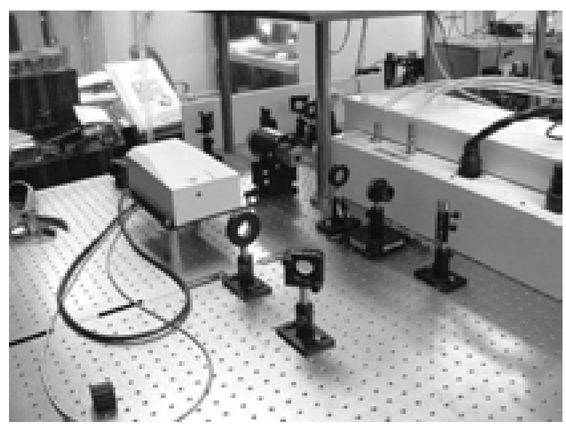
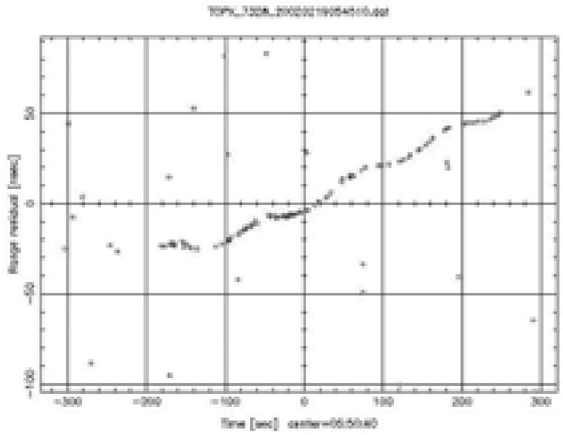


Figure 4 SLR system with MCL



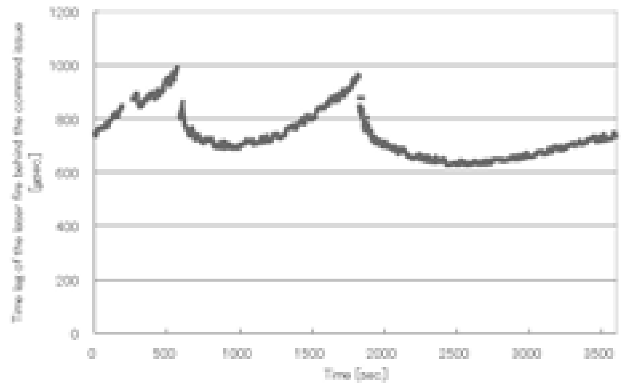


Figure 5 Plot of returns from the satellite TOPEX **Figure 6 Pulse-timing jitter of the MCL**

Future plans

a) Pulse-timing jitter

The pulse-timing jitter of the Q-sw laser was too large (the satellite TOPEX Figure 6), resulting in incoming heavy noise during attempts to obtain returns with a suitable gate window. To ameliorate this problem, we plan to develop a dynamic tracking system that reduces Q-sw laser timing jitter to less than 50 ns.

b) Pulse width

We can get only a few photons in a long-distance ranging. Precision of the ranging is directly depends on a pulse width. A shorter pulse width from the MCL would thus improve precision in ranging.

c) Power

We would also recommend the use of increased output power to achieve maximal effectiveness of an MCL used in compact satellite laser ranging systems.