WC4 (Invited)
3:00 pm – 3:30 pm

LOW NOISE HIGH POWER ULTRA-STABLE SS LASER FOR 1550NM WAVELENGTH BAND

L.S.Watkins, C.Ghosh, R.Gandham, S.Leffler, R.VanLeeuwen, Q.Wang and B.Xu.

Princeton Optronics, Mercerville, NJ

Introduction

Low noise lasers are needed for a number of analog and digital communications systems as well as for other analog signal processing applications. We have developed a tunable laser technology based on optical pumping of Yb and Er doped high phosphate glass [1]. Er doped glass is widely used for fiber amplifiers in the 1550nm wavelengths. High phosphate glass permits very high doping of Yb and Er so that small cavity length solid-state lasers can be built. Methods for tuning these lasers include rotating glass etalon and tunable Bragg fiber. We have developed a tunable laser using piezoelectric moveable mirror for mode selection and cavity tuning. The properties of these lasers are high SMSR and low RIN.

The relaxation oscillation peak for these lasers occurs in the 100kHz to 1MHz range and can typically be −70dB/Hz. We have developed a novel noise reduction technology that reduced this peak by >50dB using a non-linear material in the cavity to dampen out the noise and reducing the RIN at the relaxation oscillation peak to −120 dB/Hz or lower. In addition we have designed and built high stability lockers for stabilizing the frequency of the laser.

The highest power we obtained with this laser design was ~40mW into a PMF fiber. More recently we have been investigating laser configurations to increase the laser power to 500mW or greater at the same time improving the noise performance even further. Finally we are refining our ultra-stable locker technology to improve the frequency stability of the laser.

Low Noise Laser

Figure 1 shows the current laser cavity layout. The singlemode edge emitter is collimated and directed into the glass. The slight angle is to prevent back-reflections de-stabilizing the pump laser chip. Both the tunable etalon, for mode selection, and the output coupler, for frequency tuning, use piezo elements.

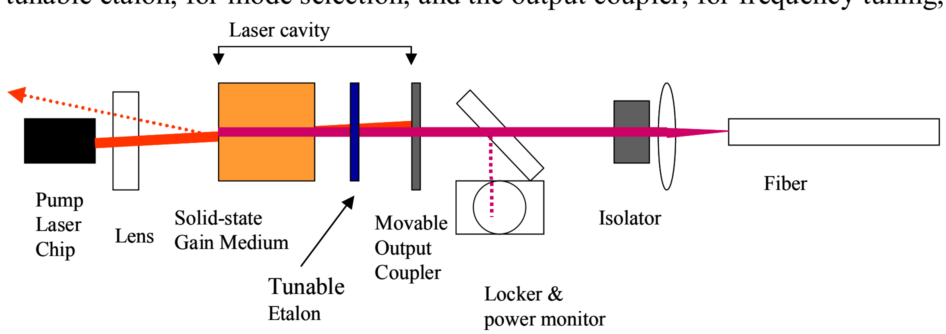

Figure 1. Optical layout of tunable laser in its current form. The noise reduction material replaces the output coupler optical material.

Table 1. Properties of lockers used to stabilize laser frequency.

Locker Version	Standard	Mark I	Mark II
FSR	214GHz	50GHz	25GHz
Finesse	2.3	4.4	200
Bandwidth	93GHz	11GHz	125MHz
Lock slope	1.5e-11/Hz	1.1e-10/Hz	1.1e-8/Hz
Shot Noise Limit	420kHz	10kHz	100Hz

The locker shown in Figure 1 has low finesse ULE glass air spaced etalons and is used for standard laser operation. For ultra-stable frequency locking new fiber coupled lockers were designed. Table 1 shows the parameters for the lockers. The standard locker used two low finesse etalons and could be used to lock any wavelength. The Ultra-stable lockers used one high finesse etalon and have a separate temperature control from the laser. All ultra-stable lockers have a laser power monitor for normalization.

Results

The tunable laser was connected up to the Mark II locker using low noise control electronics to stabilize the frequency. The short-term stability of the average laser frequency was ~5kHz for time periods of 10 minutes. Figure 2 shows the RIN spectra and the >50dB reduction at the relaxation oscillation frequency obtained using the non-linear material in the laser cavity. The linewidth was measured to be ~35kHz.

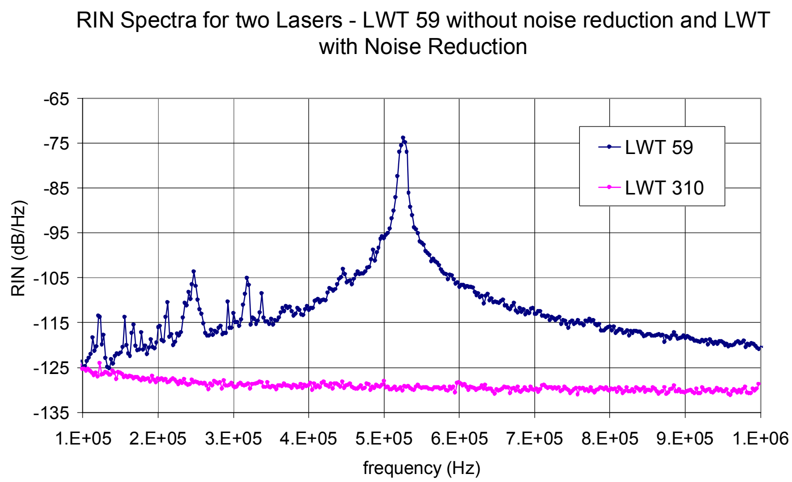

Figure 2. RIN spectra of LWT 59 (glass OC) and LWT 310 (Non-linear OC). Lasing wavelength 1535 nm and bandwidth resolution 1 kHz.

A new three mirror cavity layout is being developed to achieve significantly higher power and improved inherent stability. The L/I curve for this laser is shown in Figure 3 and the optical slope efficiency is 20%. The linewidth for this laser was ~7kHz and the SMSR >70dB. The presentation will discuss the latest results for this laser giving power, noise and wavelength stability results.

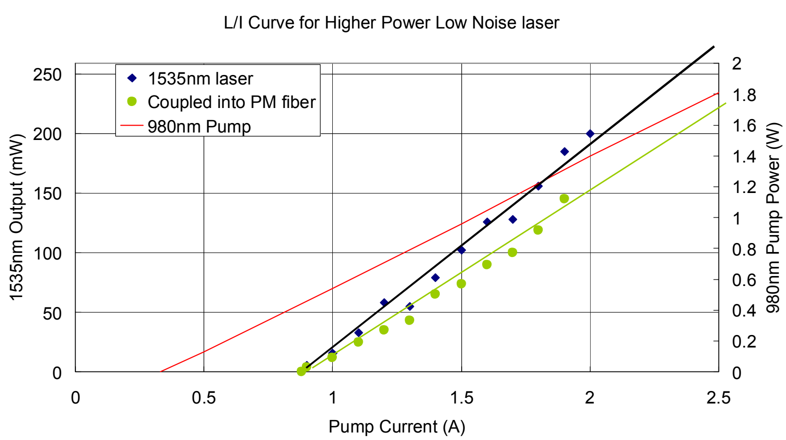

Figure 3. L-I curve for higher power laser. Shows peak power of 200mW prior to fiber coupling.

References

[1] P. Laporta, et al, "Amplitude and frequency stabilized solid-state lasers in the near infrared", Journ Physics D: Appl Phys, 34, 2396, (2001)

This work was supported in part by DARPA and SPAWAR